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Estimating the population prevalence of traditional and novel occupational exposures in Federal Region X

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Abstract

Objective: Federal Region X is an administrative region in the northwestern United States comprised of the states of Alaska (AK), Idaho (ID), Oregon (OR), and Washington (WA). Quantifying the number of workers in this region exposed to harmful circumstances in the workplace, and projected changes over time will help to inform priorities for occupational health training, risk reduction, and research.

Methods: State data for WA, ID, OR, and AK were used to estimate number of workers by occupation, in 2014 and 2024. These data were merged with a Canadian job-exposure matrix

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AUTHORS' CONTRIBUTION

AD performed data analysis, cleaning, and manipulation. She assisted with interpretation of the data and drafted the first copy of the manuscript. Additionally, she helped with revisions. MB came up with the idea for this project, and took the lead on data interpretation. She helped critically revise the manuscript for important intellectual content and supervised the work of AD. JL provided the CANJEM data, and assisted with the analysis and interpretation of the CANJEM data. He critically revised the manuscript for important intellectual content. JS originally developed and collected the data for CANJEM. He helped with the data analysis and interpretation of the CANJEM data, as well as providing important revisions to the manuscript. NS oversaw the data management, analysis, and interpretation at the University of Washington. He critically revised the manuscript, and refined the original conception of the project. All authors gave final approval of the version to be published and have given agreement to be accountable for all aspects of the work, and ensure that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

DISCLOSURE (AUTHORS)

The authors declare no conflicts of interest.

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INSTITUTION AND ETHICS APPROVAL AND INFORMED CONSENT

Work was performed at the University of Washington, Seattle, WA, USA. No ethics review or IRB approval was carried out as this project is using existing data that is publicly available, de-identified, and aggregated on a population level. Therefore, it is considered exempt research.

DISCLAIMER

None.

SUPPORTING INFORMATION

Additional Supporting Information may be found online in the supporting information tab for this article.

(CANJEM) which characterizes chemical exposures, and O*NET, which ranks occupations with particular physical, ergonomic, and psychosocial exposures.

Results: Of the exposures considered, psychosocial and ergonomic exposures were the most prevalent among the regional workforce, though traditional chemical exposures are still common and increasing.

Conclusions: Exposure surveillance will inform prioritization of risk reduction strategies, ultimately leading to a decrease in occupational injury and illness. Findings from this analysis will help to prioritize occupational health training and research in the region.

Keywords

exposure surveillance; needs assessment; psychosocial exposures

1 | BACKGROUND

Understanding the burden of work-related morbidity and mortality is a key component of public health prevention. However, both the number of people exposed to occupational hazards and the amount of resultant disease and injury are difficult to accurately quantify, both globally and regionally.[1] Here, we aim to quantify the number of workers in the United States Federal Region X, consisting of the states of Alaska (AK), Idaho (ID), Oregon (OR), and Washington (WA), exposed to adverse circumstances in the workplace, and projected changes in exposures in this region. This will inform regional priorities for occupational health research and training. Several estimates of the prevalence of exposures in the workplace have been developed, but they have been largely focused on carcinogens and other regulated chemical exposures, and generally do not take into account psychosocial, ergonomic, and physical exposures.[2–8] More commonly, estimates of the burden of occupational injury and illness are made using health endpoint data, and these have been made on regional,[9] national,[10–13] and global scales,[9,14–17] with many estimates being updated as new data become available. By estimating the number of people exposed in the workplace, we can also capture the risk for diseases that are not typically identified as occupational illnesses, we can inform prevention strategies, and we can enact risk reduction strategies prior to illness or injury occurring. These burden estimates are an important part of ongoing occupational health surveillance, which has been highlighted as an important scientific area for increased development in the United States.[1]

A few studies have estimated the prevalence of occupational carcinogens in Australia and the United Kingdom.[2–8,18] Rushton et al[18] have estimated occupational carcinogen exposure in Great Britain using both exposure and endpoint data. The Australian Work Exposure Study characterized exposure to a number of chemical exposures through telephone surveys of the workforce.[2–5,7,8] While these are both extensive and well-developed methods, their definition of exposure is limited to carcinogens and other regulated chemical exposures, and do not include physical, ergonomic, or psychosocial exposures.

Estimates of the burden of occupational injury, illness, or fatality on a global scale have been conducted by a number of groups, including the World Health Organization’s

(WHO) Comparative Risk Assessment methodology,[14] the Institute for Health Metrics and Evaluation's (IHME) Global Burden of Disease (GBD) estimates,[19] and the International Labour Organization's (ILO) global estimates.[20] The largest source of occupational exposure data in the United States comes from compliance-based sampling. The United States Occupational Safety and Health Administration (Federal OSHA) has compliance sampling data available from 1972.[21] In Federal Region X, Washington State recently summarized 9 years of exposure assessment information collected during industrial hygiene compliance inspections during 2008–2016.[22] However, compliance sampling is generally initiated either by an accident, complaint, or referral, an employer's workplace injury and illness history, or due to the exposure or workplace being part of a national or statewide emphasis area.[22] Therefore, compliance-based exposure sampling does not provide representative exposure information for all workplaces, and does not provide estimates of the prevalence of exposure among the workforce. Other collection of occupational exposure data in the United States have been led by the National Institute for Occupational Safety and Health (NIOSH). However, almost all of these efforts, such as the Occupational Health Indicators (OHIs), established in conjunction with the Council of State and Territorial Epidemiologists (CSTE), provide surveillance information, but do not quantify exposure.[23]

The underlying principle of occupational health is that workplace exposures can cause adverse health outcomes, and therefore, controlling exposures at work can reduce the burden of occupational injury and illness, resulting in improved health and well-being of a population. It is for this reason that we choose to focus on assessing the burden of exposure, as this will allow us to support training and education to address and control these exposures, influencing worker health and well-being. In this paper, we aim to quantify the number of workers in United States Federal Region X (AK, ID, OR, and WA) exposed to traditional (ie, chemical, biological, physical, safety) and non-traditional (ie, psychosocial) exposures in the workplace, both currently and projected to 2024 (for AK, ID, and OR) and 2025 (for WA).[24,25] This descriptive analysis will aid in informing research and training priorities in Region X. We focused on Region X because it is the charge of our NIOSH Education and Research Center (ERC) to assess the burden of occupational exposures and needs of the region our Center serves, though the methods presented here could be replicated for other geographic regions.

2 | METHODS

2.1 | Employment estimates

2.1.1 | Sources of employment data—Current and projected employment data by 2010 Standard Occupational Classification code (2010 SOC) were collected for the four states in Federal Region X (AK, ID, OR, and WA) from state Departments of Labor. Employment data from 2014 and projected employment data for 2024 was used for AK,[26] ID,[27] and OR,[28] while employment data from 2015 and projected employment data for 2025 was used for WA.[29] Methodologies used to calculate employment projections differ by state. Washington State develops industry projections which are divided among occupations based on a combination of historical employment data from BLS, occupational staffing patterns from a statewide survey, and predictive indicators to project the future direction of the economy.[30] Other states apply the BLS methodology to the state level. Briefly, this method considers changes in the population and labor participation rates, and economic factors that may cause an increase or decrease in demand for a given industry, and distributes this change in employment among the occupations within an industry, based on industry-specific data.[31] For both the BLS method and Washington State method, the reported projections calculated for each occupation are specific to that occupation, though informed by larger industry group changes.[30,31]

2.1.2 | Employment estimates by occupation—

Different levels of the 2010 Standard Occupational Classification System (2010 SOC) were aggregated for current and projected employment estimates, by state. The SOC groups workers into categories defined by occupation for data collection and dissemination purposes.[32] SOC codes are hierarchical, with the six-digit codes (Detailed Occupation Code) being the most detailed category, and the two-digit codes (Major Group Code) being the broadest; though any number of digits (from two to six) can be used to describe occupations with increasing detail.[33] All states reported employment numbers by the SOC 2010 Detailed Occupation (6-digit) code. Data were tabulated as the number of workers reported in each SOC code, and the percentage of the total workforce reported in each SOC code.

The change in employment between 2014 and 2024 was calculated for each SOC code, as shown below in Equation 1.

$$\begin{aligned}&\%\ \text{change in employment by SOC}\\&= \frac{\text{projected employed by SOC, 2024} - \text{employed by SOC, 2014}}{\text{employed by SOC, 2014}} * 100\end{aligned} \quad (1)$$

This was done in order to account for projected changes in population size during the 10 year period.

2.2 | Chemical exposure estimates

2.2.1 | CANJEM overview—

Characterization of current and projected exposure to selected chemical hazards was conducted using data from a Canadian job-exposure matrix (CANJEM)[34] which contains estimated exposure information for nearly 300 chemical agents. CANJEM is explained in detail elsewhere.[35,36] Briefly, CANJEM was built from the accumulated databases of several case-control studies that were carried out in Canada and that involved a common intensive protocol to ascertain occupational exposures of each study subject. Over the years, over 9000 subjects were interviewed to obtain detailed lifetime job histories and for each job, the subject was asked to provide a detailed description of the nature of the enterprise, the nature of the worksite, the types of tasks done, any controls implemented in the worksite, and several other related questions. Over 30 000 jobs were described and each one was meticulously evaluated by a team of expert chemists and industrial hygienists who first coded the job according to occupational and industry classifications and then assessed the job for potential exposure to nearly 300 chemical agents.[35] For each agent thought to be exposed, the coders rated their degree of confidence in the exposure occurring (possible, probable, definite; a measure of reliability), the frequency of exposure in a workweek (hours/week), and the estimated intensity of exposure (low, medium, high). The earliest jobs were in the late 1920s and the most recent in 2005, but the vast majority were in the window 1950–1990.

This large database of jobs coded to occupation and for exposure was reconfigured to produce CANJEM. For each SOC occupation code (as well as other classifications), CANJEM shows the proportion of workers who were exposed to each of nearly 300 agents. In addition to this proportion, which is interpreted as the probability of a worker in that occupation being exposed, CANJEM provides the distributions of three exposure characteristics among the workers who were exposed to that agent: reliability of the assessment, intensity, and exposure frequency. Further, a continuous frequency-weighted intensity of exposure (FWI, FWI = exposure intensity * frequency of exposure in hours worked per week/40 h) was also calculated for each job, with exposure intensity being weighted as low = 1, medium = 5, and high = 25.[35] Low, medium, and high exposure levels were based on occupations where the substance occurs at levels above an expected background for the general population relative to circumstances leading to the highest reported exposures, and do not reflect regulatory exposure limits.

2.2.2 | CANJEM exposure estimates—For this analysis, we included 21 chemical agents, selected based on their frequency of exposure in the Canadian population that informed the JEM (eg, PAHs from any source, engine emissions, organic solvents), their historical importance to the burden of occupational disease (eg, asbestos, silica, lead), their reflection of the characteristics of the workforce in the Pacific Northwest region of the United States (eg, pesticides), and their emerging interest in environmental and occupational health (eg, phthalates, isocyanates). For each agent, we estimated the number of workers exposed in each SOC code based on a version of CANJEM with the following restrictions: jobs held between 1985 and 2005, and SOC codes with ≥ 10 jobs from ≥ 10 subjects. These criteria were imposed to focus on jobs held closest to our time period of interest and to exclude SOC codes with very low numbers of jobs or subjects, which would decrease precision of the estimates. These restrictions led to exclusion of about 300 SOCs, likely leading to small underestimates of the prevalence of exposure. To estimate the number of people exposed to the chemical agents for each SOC, we multiplied the probability of exposure from the JEM by the number of people employed in that SOC. We summed the estimated number of workers exposed across all SOC codes for each chemical agent, for both the 2014 and 2024 employment profiles, and a percent of the workforce exposed was thereby calculated.

The estimated number of workers highly exposed was calculated in a similar manner. We multiplied the proportion of people highly exposed in each SOC code (defined as the proportion of jobs in a SOC code with FWI ≥ 5) by the total number of people calculated to be exposed in the SOC code, and then summed all SOC codes for each agent, for both time points. An FWI ≥ 5 corresponds to medium levels of exposure for 40 h per week or high levels of exposure for eight or more hours per week. Supplementary Table S1 defines the 21 CANJEM agents we chose for this analysis, as well as the number and percentage of SOCs that had any proportion of workers exposed, were unexposed, and excluded from analyses due to not meeting the inclusion criteria (≥10 jobs from ≥10 subjects for jobs held 1985–2005).

2.3 | Exposure estimates derived from O*NET

2.3.1 | O*NET overview—Characterization of current and projected exposure to selected chemical, biological, physical, ergonomic, safety, and psychosocial exposures was conducted using data collected by O*NET, a job characterization tool funded by the Employment and Training Administration under the United States Department of Labor. The primary aim of O*NET is to identify skills needed, tasks performed, and job characteristics for different occupations, which would inform job seekers or researchers.[37] However, some of the metrics relate to ergonomic, physical, safety, and psychosocial hazards that may be present in the occupation. Questionnaires are collected from workers, employers, and occupation experts[38] across all SOCs and ask participants to rate various work conditions on an ordinal scale. On average, about 600 occupations are updated yearly, so the entire O*NET database, is completely updated every several years.[39] Between 2001 and 2011, O*NET had about 160 000 employees participate from nearly 125 000 establishments.[40] As no SOC codes have missing data in the O*NET database, none were excluded from our O*NET analyses.

2.3.2 | O*NET exposure estimates—The 0–100 scoring reported by O*NET represents weighted-average frequency or intensity of the metric for each SOC code. The 29 metrics selected for inclusion in this project were those that reflect workplace exposures known to be related to adverse health outcomes. Because O*NET does not provide prevalence of exposure by occupation, but rather a 0–100 ranking of how frequently or intensely an exposure is experienced, we set a “high exposure” threshold for each O*NET exposure included in this analysis (See Supplementary Table S2 for the thresholds chosen for each exposure). For each of the 29 exposures, we only kept those SOC codes that were considered “high exposure” based on the defined thresholds. Merging the “high exposure” SOC codes for each exposure with the employment data for each state, we calculated the number and percentage of workers exposed at a high exposure level for 2014 and 2024.

All data analysis was conducted using the statistical software package R version 3.1.0.[41]

3 | RESULTS

In 2014, the workforce in Region X was approximately 6.6 million, and projected to increase to about 7.7 million by 2024. More than half (56.5%) of the Region X workforce resides in Washington, followed by Oregon (28.1%), Idaho (10.3%), and Alaska (5.1%). The percentage of the workforce in each occupation group is similar across the four states in several categories, mostly in the professional and service occupations. However, due to the distribution of workers across the region, many of the trends seen here are driven by the workforce in Washington.

Table 1 shows total employment, by state and Region X, in 2014 (2015 for WA) aggregated at the SOC Major Group level (2-digit occupation category). This table also displays the projected percent change in employment by SOC Major Group from 2014 to 2024. In the region, the occupation categories that employ the most people in 2014, by Major Group, are Office and Administrative Support occupations (13.2%), Sales and Related occupations (9.3%), Food Preparation and Serving Related occupations (8.0%), and Computer and Mathematical Occupations (6.8%). Computer and Mathematical Occupations are projected to increase more than any other occupation category by 2024 (15.9%), largely driven by an increase in Washington (18.6%). The next largest projected increase in regional employment is Construction and Extraction Occupations (6.6%). Some occupation categories are projected to decrease regionally in employment, including Architecture and Engineering (−7.6%), which is largely driven by a decrease in Washington (−12.7%).

Table 2 shows the total number and percent of workers exposed to selected chemical agents, using CANJEM data, by state and Region X in 2014, as well as the percent projected change in workers exposed from 2014 to 2024. The most common chemical exposures in the region are cleaning agents (11.3% of all workers exposed), organic solvents (9.0%), and engine emissions (8.4%). Wood dust exposure is projected to increase more than any other of the selected chemical exposures between 2014 and 2024 in the region (4.7%). Exposure to lubricating oils and greases is projected to decrease in the region (−3.1%).

Figure 1 displays the percent exposed to each CANJEM agent by state in addition to the percent highly exposed (in dark gray). The top four agents with highly exposed populations in the region are Alkanes (C18 +), Engine emissions, PAHs from any source, and Welding fume.

Table 3 displays the number and percent exposed to selected chemical, biological, ergonomic, physical, psychosocial, and safety hazards, based on the O*NET database, by state and Region X in 2014. Four psychosocial and work environment hazards have the highest prevalence, with working a short or long work week (less than or more than 40 h a week) having the highest exposure in the region, at 42.3% of the workforce. The percent of workers experiencing time pressure in their working environments is high in all states, at 39.9% in the region overall. Two ergonomic hazards are also experienced frequently, with standing and sitting more than half the time experienced by 36.8 and 29.0% of workers in the region, respectively. Table 3 also shows the projected percent change in O*NET exposures from 2014 to 2024 by state and overall for Region X. The largest projected increase in selected O*NET exposures for the region is the number of workers working at heights once a week or more (3.9%), driven by Washington (6.9% increase). The largest projected decrease in O*NET exposure for the region is dealing with physically aggressive people once a week or more (−6.7%).

4 | DISCUSSION

Of the exposures considered here, both from CANJEM and O*NET, the psychosocial and ergonomic hazards were experienced by the largest percentage of the regional workforce. Despite the traditional emphasis on chemical and biological hazards, the frequency with which the workforce experiences these stressful conditions emphasizes the importance of work arrangements as predictors of stress-related outcomes in the workforce. Of note, data presented here is an estimate of the number of workers exposed to a subset of occupational hazards, not an estimate of the number of workers at risk for occupational injury or illness. While risk estimates cannot directly be made using these data, the results presented here can inform prevention strategies to reduce risk of occupational injury and illness for all exposed workers.

Working under time pressure is an element of job demand,[42,43] which is associated with increased levels of stress, decreased mental health,[44] higher injury rates, and higher rates of chronic disease.[45] Working long weeks is associated with poorer general health, increased injury and illness rates, and increased mortality,[46] and working short weeks or working an irregular or seasonal work schedule, when not by choice, can be considered elements of job insecurity, which is related to stress, increases in injury, and illness,[47] and a decrease in overall well-being.[48] Workers in lower socioeconomic positions, racial and ethnic minorities, and immigrants typically experience greater job insecurity, making it an important aspect of occupational health disparities.[49] The other exposures in the top five experienced regionally were standing for more than half the day (36.8%) or sitting for more than half the day (29.0%). Sitting for long periods of time has been linked to an increase in several chronic diseases including obesity, type 2 diabetes, and cardiovascular disease[50] and standing for long periods of time can result in muscle fatigue, lower back and leg pain, and cardiovascular problems, among other adverse outcomes.[51]

Chemical exposures of high prevalence identified through CANJEM estimates include cleaning agents (11.3%), organic solvents (9.0%), and engine emissions (8.4%). These exposures are driven by relatively high exposures in a handful of occupation categories. For example, half or more of the workers in Building and Grounds Cleaning and Maintenance Occupations, Healthcare Support and Healthcare Practitioners and Technical Occupations, Food Preparation and Serving Related Occupations, and Personal Care and Service Occupations are exposed to cleaning agents. Nearly half the workers are exposed to some degree to organic solvents in Building and Grounds Cleaning and Maintenance Occupations and Construction and Extraction Occupations. Finally, at least 60% of workers in Transportation and Material Moving Occupations are exposed to some degree to engine emissions. In the occupational categories identified above, continued focus on selected chemical agents is needed to help reduce and prevent future exposure.We have attempted to project changes in the prevalence of exposure over the next decade. These projections are based solely on changes in employment patterns, not on expected changes in use of the chemicals or production and control technologies. Exposure to wood dust is projected to increase 4.7% in the region, and the number of workers exposed to phthalates is projected to increase 8%, although the number of workers exposed is small. Workers across several occupations are exposed to wood dust, including Farming, Fishing, and Forestry Occupations and Construction and Extraction Occupations. The projected increase in Construction and Extraction Occupations account for the increase in the number of people projected to be exposed to wood dust by 2024. The number of workers exposed to crystalline silica is projected to increase by 3.3% by 2024. However, due to the new crystalline silica standard issued by OSHA in 2017, the typical level of exposure may be lower.[52] Of note, 2.6% of the workforce is employed in jobs where lead exposure occurs, and 2.9% of the workforce is employed in jobs where asbestos exposure occurs, indicating that even occupational exposures with well-established links to illness continue to persist in the region.

CANJEM is subject to the same limitations as all JEMs, of which exposure misclassification is probably the most significant.[53] However, having been based on a detailed and painstaking exposure assessment protocol in a case-control framework, CANJEM represents a credible instrument for assessing occupational exposures across the occupational spectrum.[54] The subset of CANJEM that was used for this analysis represents jobs held, and exposures encountered, from 1985 to 2005, which is not necessarily an accurate assessment of job exposures for 2014–2015, projected out to 2024–2025, due to changes in materials, occupational standards, and work practices. Further, we excluded about 300 SOCs in CANJEM because these SOCs had no recorded data for the time period of interest (1985–2005), any of which could have been exposed. Therefore, we are likely underestimating the numbers of exposed persons to a small degree. Despite these inherent limitations, CANJEM is the most relevant JEM available for North America, and represents the most recent iteration available.

There are also several limitations regarding the use of O*NET data which are generated from self-reported subjective questionnaires and therefore subject to bias and misclassification. Data from O*NET questionnaires was not collected in order to inform occupational exposure surveillance, or assess the exposures in the workforce, as has been done here. BLS collected these data in order to understand what types of skills workers need in different occupations, and what the different work contexts and values occupations have in order to inform job seekers. Overall, while we made efforts to capture a variety of exposures using CANJEM and O*NET data, this exposure surveillance project does not represent all exposures that we would be interested in exploring, and all relevant exposures experienced by the workforce. Moreover, the data generated from CANJEM and O*NET cannot be directly compared, due to differences in objectives, collection methodologies, and resultant metrics. While CANJEM has data on frequency and intensity of exposure by SOC, O*NET only has probability of exposure by SOC. This resulted in the use of different exposure definitions for the two data sets.

Finally, BLS data does not capture all workers comprehensively: contingent, self-employed, temporary, and undocumented workers are either not captured, or only partially represented in the BLS data. In 2017, BLS estimated that 3.8% of workers held jobs considered contingent, 6.9% of workers were independent contractors, 1.7% were on-call workers, and 0.9% were temporary workers. BLS notes these categories are not mutually exclusive.[55] Because the burden of occupational exposures is disproportionately borne by workers of low socioeconomic status, or of minority or immigrant status,[49] it is increasingly important to continue to develop surveillance methods that quantify the hazards faced by these undercounted populations.[56]

5 | CONCLUSION

This project combines existing data sources in a novel way in order to assess the burden of occupational exposure in Federal Region X. While we chose to focus on Region X, the methods described here could be replicated with different geographic areas and time periods. The findings from this analysis call for increased training and research on psychosocial and ergonomic exposures in the workplace, in addition to continued attention on traditional and well-known chemical exposures (ie, engine emissions, wood dust, cleaning agents). Understanding which exposures are experienced by the largest number of persons in the region may also help prioritize areas for increased regulatory or control interventions in the region. This knowledge could inform campaigns focusing on prevalent, but poorly characterized or unregulated, exposures, which would improve data availability for ongoing surveillance of exposures that are not currently covered under compliance-based sampling (ie, psychosocial exposures). Improved occupational exposure surveillance, for all types of occupational exposures, is needed in order to develop appropriate prevention measures in the workplace, and to inform research, training, and policy needs.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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REFERENCES

1. National Academies of Sciences Engineering and Medicine. 2018. A Smarter National Surveillance System for Occupational Safety and Health in the 21st Century. Washington, DC: The National Academies Press.
2. Driscoll TR, Carey RN, Peters S, et al. The Australian work exposures study: occupational exposure to polycyclic aromatic hydrocarbons. Ann Occup Hyg. 2016;60:124–131. [PubMed: 26324826]
3. Driscoll TR, Carey RN, Peters S, et al. The Australian work exposures study: prevalence of occupational exposure to formaldehyde. Ann Occup Hyg. 2016;60:132–138. [PubMed: 26342091]
4. Driscoll TR, Carey RN, Peters S, et al. The Australian work exposures study: occupational exposure to lead and lead compounds. Ann Occup Hyg. 2016;60:113–123. [PubMed: 26324825]
5. Si S, Carey RN, Reid A, et al. The Australian work exposures study: prevalence of occupational exposure to respirable crystalline silica. Ann Occup Hyg. 2016;60:631–637. [PubMed: 26888888]
6. Rushton L, Hutchins S, Bagga S, et al. Estimation of the burden of occupational cancer in great britain. J Epidemiol Commun H. 2011;65:A28–A28.
7. Peters S, Carey RN, Driscoll TR, et al. The Australian work exposures study: prevalence of occupational exposure to diesel engine exhaust. Ann Occup Hyg. 2015;59:600–608. [PubMed: 25711950]
8. Carey RN, Driscoll TR, Peters S, et al. Estimated prevalence of exposure to occupational carcinogens in Australia (2011–2012). Occup Environ Med. 2014;71:55–62. [PubMed: 24158310]
9. Ezzati M, Lopez AD, Rodgers A, Vander Hoorn S, Murray CJ. Selected major risk factors and global and regional burden of disease. Lancet. 2002;360:1347–1360. [PubMed: 12423980]
10. Leigh JP, Markowitz SB, Fahs M, Shin C, Landrigan PJ. Occupational injury and illness in the United States − Estimates of costs, morbidity, and mortality. Arch Intern Med. 1997;157:1557–1568. [PubMed: 9236557]
11. Feyer AM, Langley J, Howard M, et al. The work-related fatal injury study: numbers, rates and trends of work-related fatal injuries in New Zealand 1985–1994. New Zeal Med J. 2001;114:6–10. [PubMed: 11243677]

12. Jarvholm B, Reuterwall C, Bystedt J. Mortality attributable to occupational exposure in Sweden. Scand J Work Env Hea. 2013;39:106–111.

13. Driscoll T, Mitchell R, Mandryk J, Healey S, Hendrie L, Hull B. Work-related fatalities in Australia, 1989 to 1992: an overview. J Occup Health Safety. 2001;17:45–66.

14. Nelson DI, Concha-Barrientos M, Driscoll T, et al. The global burden of selected occupational diseases and injury risks: methodology and summary. Am J Ind Med. 2005;48:400–418. [PubMed: 16299700]

15. Takala J, Hamalainen P, Saarela KL, et al. Global estimates of the burden of injury and illness at work in 2012. J Occup Environ Hyg. 2014;11:326–337. [PubMed: 24219404]

16. Concha-Barrientos M, Nelson DI, Fingerhut M, Driscoll T, Leigh J. The global burden due to occupational injury. Am J Ind Med. 2005;48:470–481. [PubMed: 16299709]

17. Forouzanfar MH, Afshin A, Alexander LT, et al. Global, regional, and national comparative risk assessment of 79 behavioural, environmental and occupational, and metabolic risks or clusters of risks, 1990–2015: a systematic analysis for the Global Burden of Disease Study 2015. Lancet. 2016;388:1659–1724. [PubMed: 27733284]

18. Rushton L, Hutchings SJ, Fortunato L, et al. Occupational cancer burden in Great Britain. Brit J Cancer. 2012;107:S3–S7. [PubMed: 22710676]

19. Gakidou E, Afshin A, Abajobir AA, et al. Global, regional, and national comparative risk assessment of 84 behavioural, environmental and occupational, and metabolic risks or clusters of risks, 1990–2016: a systematic analysis for the Global Burden of Disease Study 2016. Lancet. 2017;390:1345–1422. [PubMed: 28919119]

20. Hämäläinen P, Takala J, Kiat TB. Global Estimates of Occupational Accidents and Work-Related Illnesses 2017. 2017; Available online at: http://www.icohweb.org/site/images/news/pdf/Report%20Global%20Estimates%20of%20Occupational%20Accidents%20and%20Work-related%20Illnesses%202017%20rev1.pdf.

21. United States Department of Labor. Integrated Management Information System (IMIS): Establishment Search. 2018; Available online at: https://www.osha.gov/pls/imis/establishment.html.

22. Vroman T, Whitaker C, Schoonover T. Industrial Hygiene Exposure Assessment Measurements in Washington State: Summary Results from the Division of Occupational Safety and Health (DOSH) Compliance Inspections, 2008–2016. 2018; Available online at: https://www.lni.wa.gov/Safety/Research/FACE/Files/WorkerExposureAssessmentInWashingtonState.pdf. Accessed August 21, 2018.

23. Council of State and Territorial Epidemiologists (CSTE). Occupational Health: Indicators. Available online at: https://www.cste.org/group/OHIndicators. Accessed September 3, 2018.

24. Schulte PA, Guerin RJ, Schill AL, et al. Considerations for incorporating “Well-Being” in public policy for workers and workplaces. Am J Public Health. 2015;105:E31–E44.

25. Peckham TK, Baker MG, Camp JE, Kaufman JD, Seixas NS. Creating a future for occupational health. Ann Work Expos Heal. 2017;61:3–15.

26. State of Alaska. Alaska Occupational Forecast 2014 to 2024. 2014; Available online at: http://live.laborstats.alaska.gov/occfcst/. Accessed April 1, 2018.

27. Idaho Department of Labor. Occupational and Industry Projections: Projections 2014–2024. 2014; Available online at: https://lmi.idaho.gov/projections. Accessed April 1, 2018.

28. State of Oregon Employment Department. 2014–2024 Employment Projections. 2015; Available online at: https://www.qualityinfo.org/projections#1. Accessed April 1, 2018.

29. Washington State Department of Labor. Washington Employment Estimates2016;Available online at: https://esd.wa.gov/labormarketinfo/employment-estimates. Accessed April 1, 2018.

30. Washington State Employment Security Department. 2017 Employment Projections. 2017; Available online at: https://fortress.wa.gov/esd/employmentdata/docs/industry-reports/2017-projections-report.pdf. Accessed September 3, 2018.

31. United States Department of Labor. Employment Projections: Projection Methodology. 2018; Available online at: https://www.bls.gov/emp/documentation/projections-methods.htm#occupational_employment. Accessed September 3, 2018.

32. U.S. Bureau of Labor Statistics. Standard Occupational Classification System. 2018; Available online at: https://www.bls.gov/soc/. Accessed August 21, 2018.
33. U.S. Bureau of Labor Statistics. 2010 SOC User Guide. 2010; Available online at: https://www.bls.gov/soc/soc_2010_user_guide.pdf.Accessed August 21, 2018.
34. Lavoue J CANJEM. 2018; Available online at: http://canjem.ca/.Accessed March 15, 2018.
35. Sauvé JF, Siemiatycki J, Labréche F, et al. Development of and selected performance characteristics of CANJEM, a general population job exposure matrix based on past expert assessments of exposure. Ann Work Exp Health. 2018;62:783–795.
36. Siemiatycki J, Lavoué J. Availability of a new job-exposure matrix (CANJEM) for epidemiologic and occupational medicine purposes. J Occup Environ Med. 2018;60:e324–e328. [PubMed: 29642096]
37. U.S. Bureau of Labor Statistics. O*NET OnLine. 2018; Available online at: https://www.onetonline.org. Accessed April 1, 2018.
38. U.S. Bureau of Labor Statistics. O*NET Questionnaires. 2018; Available online at: https://www.onetcenter.org/questionnaires.html. Accessed August 7, 2018.
39. O*NET Resource Center. O*NET Occupation Update Summary. 2018; Available online at: https://www.onetcenter.org/dataUpdates.html. Accessed September 3, 2018.
40. U.S. Department of Labor. O*NET Data Collection Program. 2012; Available online at: https://www.onetcenter.org/dl_files/omb2011/Supporting_StatementA.pdf. Accessed September 3, 2018.
41. R: a language and environment for statistical computing [computer program].
42. Karasek RA Jr. Job demands, job decision latitude, and mental strain: implications for job redesign. Adm Sci Q. 1979;24:285–308.
43. Karasek R, Brisson C, Kawakami N, Houtman I, Bongers P, Amick B. The Job Content Questionnaire (JCQ): an instrument for internationally comparative assessments of psychosocial job characteristics. J Occup Health Psychol. 1998;3:322. [PubMed: 9805280]
44. Sanne B, Mykletun A, Dahl AA, Moen BE, Tell GS. Testing the job demand–control–support model with anxiety and depression as outcomes: the Hordaland Health Study. Occup Med. 2005;55:463–473.
45. Johnson JV, Hall EM. Job strain, work place social support, and cardiovascular disease: a cross-sectional study of a random sample of the Swedish working population. Am J Public Health. 1988;78:1336–1342. [PubMed: 3421392]
46. Caruso CC, Hitchcock EM, Dick RB, Russo JM, Schmit JM. Overtime and extended work shifts: recent findings on illnesses, injuries, and health behaviors. DHHS (NIOSH) Publication. 2004(2004–143).
47. Quinlan M, Mayhew C, Bohle P. The global expansion of precarious employment, work disorganization, and consequences for occupational health: a review of recent research. Int J Health Serv. 2001;31:335–414. [PubMed: 11407174]
48. De Witte H, Vander Elst T, De Cuyper N. 2015. Job insecurity, health and well-being. Sustainable Working Lives. Springer. pp. 109–128.
49. Landsbergis PA, Grzywacz JG, LaMontagne AD. Work organization, job insecurity, and occupational health disparities. Am J Ind Med. 2014;57:495–515. [PubMed: 23074099]
50. Katzmarzyk PT, Church TS, Craig CL, Bouchard C. Sitting time and mortality from all causes, cardiovascular disease, and cancer. Med Sci Sports Exerc. 2009;41:998–1005. [PubMed: 19346988]
51. Waters TR, Dick RB. Evidence of health risks associated with prolonged standing at work and intervention effectiveness. Rehabil Nurs. 2015;40:148–165. [PubMed: 25041875]
52. U.S. Department of Labor. Silica: Overview. 2017; Available online at: https://www.osha.gov/dsg/topics/silicacrystalline/. Accessed August 1, 2018.
53. Olsen J Limitations in the use of job exposure matrices. Scand J Soc Med. 1988;16:205–208. [PubMed: 3232049]
54. Siemiatycki J Exposure assessment in community-based studies of occupational cancer. Occup Hyg. 1996;3:41–58.

55. U.S. Bureau of Labor Statistics. Economic News Release: Contingent and Alternative Employment Arrangements Summary. 2018; Available online at: https://www.bls.gov/news.release/conemp.nr0.htm. Accessed August 1, 2018.

56. Souza K, Steege AL, Baron SL. Surveillance of occupational health disparities: challenges and opportunities. Am J Ind Med.2010;53:84–94. [PubMed: 20094988]

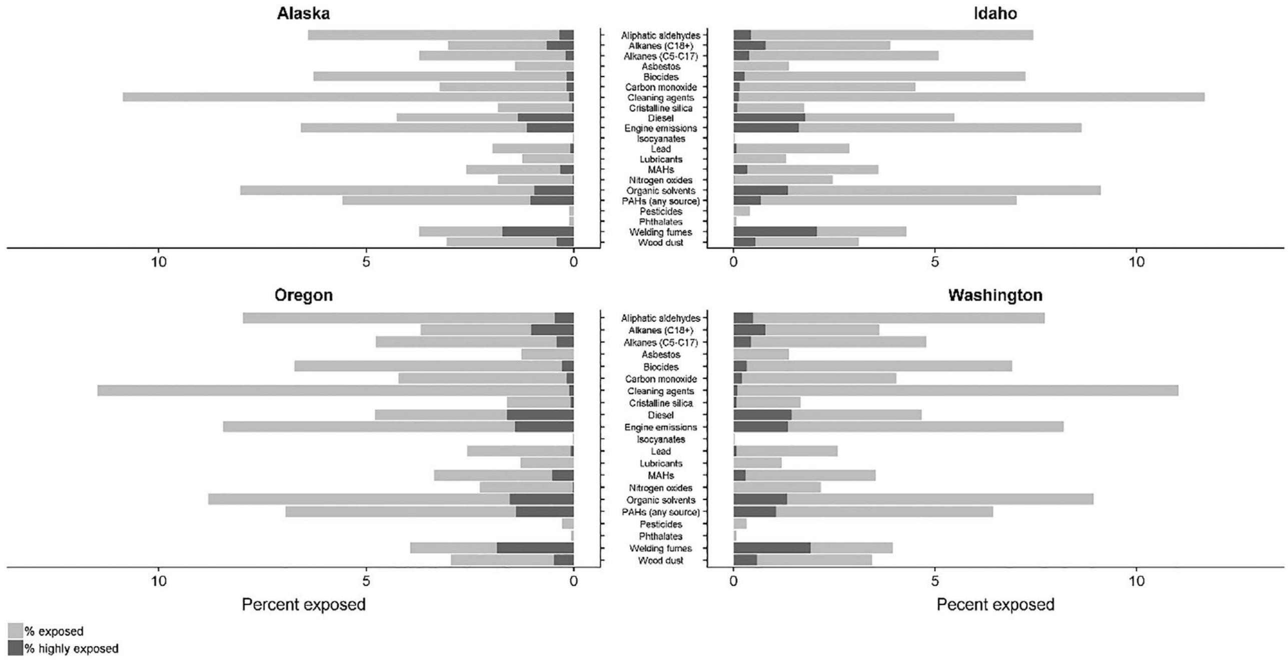

FIGURE 1.

Percent of the workforce exposed to each CANJEM agent by state, percent highly exposed in dark gray. Highly exposed is defined as a Frequency Weighted Intensity (FWI) ≥ 5, corresponding to medium levels of exposure for 40 h per week or high levels of exposure for at least 8 h per week

TABLE 1

Number, in thousands, and percent of total workforce employed by occupation, by state; and percent projected change in employment by occupation, 2014–2024

	Region X		Alaska		Idaho		Oregon		Washington	
	Employed (%)	% change	Employed (%)	% change	Employed (%)	% change	Employed (%)	% change	Employed (%)	% change[a]
Total workforce	**6645.5**	**16.3%**	**338.9 (5.1)**	**5.8%**	**687.8 (10.3)**	**19.9%**	**1864.9 (28.1)**	**14.1%**	**3753.9 (56.5)**	**17.6%**
Management occupations	384.6[b] (5.8)	2.1%	21.2 (6.3)	−0.9%	52.3 (7.6)	3.3%	109.7 (5.9)	0.7%	201.4 (5.4)	2.6%
Business and financial operations occupations	336.9 (5.1)	2.5%	11.4 (3.4)	−2.2%	25.8 (3.8)	4.7%	83.3 (4.5)	1.5%	216.4 (5.8)	2.5%
Computer and mathematical occupations	453.0 (6.8)	15.9%	8.4 (2.5)	−1.8%	16.8 (2.4)	9.6%	94.6 (5.1)	6.9%	333.2 (8.9)	18.6%
Architecture and engineering occupations	139.3 (2.1)	−7.6%	7.8 (2.3)	−4.9%	14.9 (2.2)	−0.5%	31.9 (1.7)	1.5%	84.8 (2.3)	−12.7%
Life, physical, and social science occupations	76.4 (1.1)	−0.5%	7.0 (2.1)	−3.5%	9.1 (1.3)	5.5%	21.8 (1.2)	−2.8%	38.5 (1.0)	0.3%
Community and social service occupations	114.5 (1.7)	−0.9%	6.7 (2.0)	4.3%	12.5 (1.8)	3.3%	35.5 (1.9)	−0.5%	59.8 (1.6)	−2.4%
Legal occupations	47.5 (0.7)	−2.2%	2.1 (0.6)	−11.3%	4.5 (0.7)	3.8%	12.7 (0.7)	−0.5%	28.2 (0.8)	−3.5%
Education, training, and library occupations	377.5 (5.7)	0.7%	20.0 (5.9)	−1.7%	39.1 (5.7)	−1.5%	102.1 (5.5)	−4.2%	216.2 (5.8)	3.5%
Arts, design, entertainment, sports, and media occupations	113.4 (1.7)	1.8%	4.2 (1.2)	−3.0%	9.1 (1.3)	3.0%	32.4 (1.7)	−2.5%	67.7 (1.8)	3.8%
Healthcare practitioners and technical occupations	316.5 (4.8)	4.2%	15.7 (4.6)	6.5%	34.2 (5.0)	−0.1%	98.8 (5.3)	3.3%	167.8 (4.5)	5.5%
Healthcare support occupations	161.6 (2.4)	4.9%	8.7 (2.6)	8.9%	18.1 (2.6)	2.9%	45.8 (2.5)	5.7%	89.1 (2.4)	4.5%
Protective service occupations	111.9 (1.7)	−3.0%	8.7 (2.6)	−2.0%	10.2 (1.5)	−3.7%	30.3 (1.6)	−6.9%	62.8 (1.7)	−0.8%
Food preparation and serving related occupations	529.4 (8.0)	1.0%	27.1 (8.0)	4.0%	55.7 (8.1)	3.2%	161.3 (8.7)	6.2%	285.4 (7.6)	−2.5%
Building and grounds cleaning and maintenance occupations	214.8 (3.2)	0.9%	11.5 (3.4)	0.9%	25.8 (3.7)	−3.6%	60.8 (3.3)	0.3%	116.7 (3.1)	2.3%
Personal care and service occupations	240.9 (3.6)	5.0%	14.2 (4.2)	5.4%	23.4 (3.4)	13.0%	54.1 (2.9)	5.7%	149.3 (4.0)	3.3%
Sales and related occupations	632.5 (9.5)	−2.9%	29.2 (8.6)	0.6%	67.6 (9.8)	−1.9%	192.4 (10.3)	−1.3%	343.3 (9.1)	−4.2%
Office and administrative support occupations	874.6 (13.2)	−3.5%	49.8 (14.7)	<0.1%	103.1 (15.0)	−5.4%	271.9 (14.6)	−5.0%	449.8 (12.0)	−2.4%

	Region X		Alaska		Idaho		Oregon		Washington	
	Employed (%)	% change	Employed (%)	% change	Employed (%)	% change	Employed (%)	% change	Employed (%)	% change[a]
Total workforce	**6645.5**	**16.3%**	**338.9 (5.1)**	**5.8%**	**687.8 (10.3)**	**19.9%**	**1864.9 (28.1)**	**14.1%**	**3753.9 (56.5)**	**17.6%**
Farming, fishing, and forestry occupations	156.7 (2.4)	−4.0%	1.5 (0.4)	0.3%	17.5 (2.5)	−3.0%	44.0 (2.4)	−2.2%	93.8 (2.5)	−5.7%
Construction and extraction occupations	341.3 (5.1)	6.6%	25.1 (7.4)	−5.0%	35.7 (5.2)	4.8%	81.0 (4.3)	5.8%	199.4 (5.3)	8.7%
Installation, maintenance, and repair occupations	240.7 (3.6)	−3.3%	16.6 (4.9)	−1.2%	28.5 (4.1)	0.2%	64.8 (3.5)	−0.4%	130.7 (3.5)	−5.5%
Production occupations	362.4 (5.5)	−7.6%	16.1 (4.7)	−6.1%	40.7 (5.9)	−6.7%	113.1 (6.1)	−2.0%	192.5 (5.1)	−11.3%
Transportation and material moving occupations	419.3 (6.3)	−2.9%	25.9 (7.6)	1.2%	43.4 (6.3)	−2.1%	122.7 (6.6)	−1.0%	227.3 (6.1)	−4.4%

[a] For Washington, percent change is 2015–2025.

[b] Number employed reported in thousands.

TABLE 2

Number, in thousands, and percent exposed by CANJEM agent by state; and percent projected change in exposure, 2014–2024

	Region X		Alaska		Idaho		Oregon		Washington	
	Exposed (%)	% change	Exposed (%)	% change	Exposed (%)	% change	Exposed (%)	% change	Exposed (%)	% change[a]
Total workforce	**6645.5**	**16.3%**	**338.9 (5.1)**	**5.8%**	**687.8 (10.3)**	**19.9%**	**1864.9 (28.1)**	**14.1%**	**3753.9 (56.5)**	**17.6%**
Aliphatic aldehydes	519.1[b] (7.8)	1.0	22.1 (6.5)	2.5	52.5 (7.6)	4.2	151.8 (8.1)	4.7	292.7 (7.8)	−1.7
Alkanes (C18+)	244.3 (3.7)	−1.2	10.4 (3.1)	−2.3	27.1 (3.9)	−0.6	69.4 (3.7)	−0.3	137.4 (3.7)	−1.9
Alkanes (C5-C17)	318.5 (4.8)	0.6	12.8 (3.8)	−1.7	35.3 (5.1)	0.4	89.4 (4.8)	0.7	181.1 (4.8)	0.5
Asbestos	193.6 (2.9)	0.2	10.6 (3.1)	−2.7	20.5 (3.0)	1.0	51.1 (2.7)	0.7	111.5 (3.0)	<0.1
Biocides	457.9 (6.9)	1.3	21.4 (6.3)	2.8	50.2 (7.3)	1.1	126.5 (6.8)	2.0	259.9 (6.9)	0.8
Carbon monoxide	272.4 (4.1)	−0.6	11.0 (3.2)	−1.9	31.0 (4.5)	−0.8	78.6 (4.2)	0.1	151.8 (4.0)	−1.1
Cleaning agents	751.2 (11.3)	0.6	37.1 (11.0)	2.5	81.4 (11.8)	1.7	216.4 (11.6)	2.6	416.3 (11.1)	−0.8
Crystalline silica	116.8 (1.8)	3.3	6.5 (1.9)	−1.6	12.7 (1.8)	1.3	31.5 (1.7)	2.8	66.0 (1.8)	4.4
Diesel engine emissions	322.9 (4.9)	−1.1	14.8 (4.4)	−1.0	38.3 (5.6)	−0.9	90.7 (4.9)	−0.4	179.1 (4.8)	−1.7
Engine emissions	557.3 (8.4)	−1.1	22.9 (6.8)	−0.7	60.4 (8.8)	−1.0	160.7 (8.6)	−0.7	313.2 (8.3)	−1.5
Isocyanates	1.6 (<0.1)	−4.0	0.1 (<0.1)	<0.1	0.2 (<0.1)	−2.5	0.4 (<0.1)	−2.7	1.0 (<0.1)	−5.7
Lead	172.2 (2.6)	−0.1	6.6 (2.0)	−2.1	19.7 (2.9)	−1.2	48.1 (2.6)	−0.2	97.6 (2.6)	<0.1
Lubricating oils and greases	81.9 (1.2)	−3.1	4.2 (1.2)	−1.9	8.9 (1.3)	0.5	24.0 (1.3)	−1.6	44.8 (1.2)	−4.7
Mononuclear aromatic hydrocarbons (MAHs)	230.0 (3.5)	1.5	8.9 (2.6)	−1.8	25.0 (3.6)	0.7	63.0 (3.4)	1.4	133.2 (3.5)	1.7
Nitrogen oxides	146.7 (2.2)	0.2	6.2 (1.8)	−2.1	16.9 (2.5)	−0.6	42.2 (2.3)	1.0	81.3 (2.2)	−0.1
Organic solvents	596.4 (9.0)	0.2	27.6 (8.2)	−0.3	63.4 (9.2)	0.2	166.3 (8.9)	0.6	339.1 (9.0)	−0.1
PAHs from any source	443.2 (6.7)	−0.9	19.1 (5.6)	−1.3	48.9 (7.1)	0.1	131.0 (7.0)	0.9	244.3 (6.5)	−2.1
Pesticides	20.7 (0.3)	1.8	0.4 (0.1)	−0.2	2.8 (0.4)	−4.9	5.2 (0.3)	−1.4	12.3 (0.3)	3.9
Phthalates	5.1 (0.1)	8.0	0.4 (0.1)	−2.9	0.5 (0.1)	6.7	1.2 (0.1)	6.2	3.0 (0.1)	10.3
Welding fumes	264.1 (4.0)	−1.8	12.6 (3.7)	−2.8	29.5 (4.3)	−0.3	73.6 (3.9)	−0.3	148.3 (4.0)	−2.9
Wood dust	224.8 (3.4)	4.7	10.9 (3.2)	−2.4	22.5 (3.3)	3.8	57.4 (3.1)	4.1	134.1 (3.6)	5.5

[a]For Washington, percent change is 2015–2025.

[b]Number employed reported in thousands.

TABLE 3

Number, in thousands, and percent of workforce exposed to O*NET exposures by state and Region X; and percent projected change, 2014 to 2024, in thousands

Exposure	Region X		Alaska		Idaho		Oregon		Washington	
	Exposed (%)	% change, 2014–2024	Exposed (%)	% change, 2014–2024	Exposed (%)	% change, 2014–2024	Exposed (%)	% change, 2014–2024	Exposed (%)	% change, 2015–2025
Total workforce	**6645.5**	**16.3%**	**338.9 (5.1)**	**5.8%**	**687.8 (10.3)**	**19.9%**	**1864.9 (28.1)**	**14.1%**	**3753.9 (56.5)**	**17.6%**
Chemical/biological exposures										
Exposed to disease or infections once a week or more	528.7 (8.0)	2.5	25.4 (7.5)	5.1	62.3 (9.1)	−0.3	155.0 (8.3)	2.0	286.0 (7.6)	3.0
In an enclosed vehicle or equipment once a week or more	699.7 (10.5)	−2.7	41.4 (12.2)	−2.3	88.9 (12.9)	0.2	199.3 (10.7)	−1.6	370.0 (9.9)	−4.1
In an open vehicle or equipment once a week or more	252.7 (3.8)	−2.4	8.0 (2.4)	−4.4	37.3 (5.4)	0.1	61.7 (3.3)	−0.7	145.7 (3.9)	−4.5
Ergonomic exposures										
Cramped work space, awkward positions once a week or more	68.9 (1.0)	−0.3	7.5 (2.2)	−5.8	7.5 (1.1)	1.8	17.5 (0.9)	1.1	36.5 (1.0)	0.4
Exposed to whole body vibration once a week or more	31.5 (0.5)	−3.9	4.3 (1.3)	−8.2	4.9 (0.7)	−2.8	8.2 (0.4)	−2.8	14.1 (0.4)	−2.5
Bending or twisting the body more than half the time	170.2 (2.6)	1.6	11.4 (3.3)	−1.4	17.9 (2.6)	−0.1	45.6 (2.4)	2.4	95.3 (2.5)	2.0
Kneeling, crouching, stooping, crawling more than half the time	56.8 (0.9)	0.7	3.6 (1.0)	2.1	6.9 (1.0)	−1.5	16.3 (0.9)	3.1	30.1 (0.8)	−0.2
Make repetitive motions more than half the time	929.4 (14.0)	−1.5	43.9 (12.9)	−0.2	98.4 (14.3)	−1.8	265.1 (14.2)	−0.5	521.9 (13.9)	−2.2
Sit more than half the time	1,924.9 (29.0)	0.5	87.2 (25.7)	−1.0	186.3 (27.1)	−1.1	520.6 (27.9)	−1.4	1,130.8 (30.1)	1.7
Stand more than half the time	2,448.1 (36.8)	−0.6	123.9 (36.6)	0.8	279.5 (40.6)	0.8	698.1 (37.4)	1.6	1,346.5 (35.9)	−2.2
Physical exposures										
Exposed to radiation once a week or more	65.5 (1.0)	2.8	3.1 (0.9)	10.8	5.1 (0.7)	−4.5	21.2 (1.1)	1.7	36.1 (1.0)	3.9
Outdoors, exposed to weather once a week or more	844.2 (12.7)	−0.6	46.2 (13.6)	−3.0	110.8 (16.1)	0.3	232.9 (12.5)	−0.1	454.3 (12.1)	−0.9
Sounds/noise levels are distracting or uncomfortable once a week or more	922.8 (13.9)	−1.6	50.2 (14.8)	−1.9	101.0 (14.7)	−1.6	259.0 (13.9)	<0.1	512.5 (13.7)	−2.5
Very hot or cold temperatures once a week or more	716.0 (10.8)	−1.8	42.1 (12.4)	−4.1	102.6 (14.9)	0.2	198.6 (10.6)	0.1	372.8 (9.9)	−3.2

Exposure	Region X		Alaska		Idaho		Oregon		Washington	
	Exposed (%)	% change, 2014–2024	Exposed (%)	% change, 2014–2024	Exposed (%)	% change, 2014–2024	Exposed (%)	% change, 2014–2024	Exposed (%)	% change, 2015–2025
Total workforce	**6645.5**	**16.3%**	**338.9 (5.1)**	**5.8%**	**687.8 (10.3)**	**19.9%**	**1864.9 (28.1)**	**14.1%**	**3753.9 (56.5)**	**17.6%**
Psychosocial exposures										
Irregular or seasonal work schedule	1,299.2 (19.5)	1.1	63.2 (18.6)	−2.3	144.4 (21.0)	2.2	342.6 (18.4)	1.0	749.0 (20.0)	0.9
Deal with physically aggressive people once a week or more	34.5 (0.5)	−6.7	3.3 (1.0)	−4.4	2.3 (0.3)	−4.2	11.7 (0.6)	−8.2	17.3 (0.5)	−6.0
Work more or less than 40 hours/week	2,810.2 (42.3)	−1.0	142.6 (42.1)	−0.7	292.4 (42.5)	0.7	781.3 (41.9)	0.4	1,593.8 (42.5)	−2.0
Work < 40 hours/week	857.6 (12.9)	−1.4	48.2 (14.2)	2.8	90.2 (13.1)	−0.1	245.9 (13.2)	1.1	473.3 (12.6)	−3.1
Work > 40 hours/week	1,952.6 (29.4)	−0.9	94.4 (27.9)	−2.4	202.3 (29.4)	1.0	535.4 (28.7)	0.1	1,120.5 (29.8)	−1.5
Some freedom to make decisions	195.2 (2.9)	−3.5	14.9 (4.4)	−5.2	25.0 (3.6)	−4.3	50.0 (2.7)	−2.2	105.3 (2.8)	−3.6
Conflict situations once a week or more	491.6 (7.4)	−0.3	29.1 (8.6)	−0.6	50.7 (7.4)	0.4	136.8 (7.3)	−1.7	275.0 (7.3)	0.4
Make decisions once a week or more	583.9 (8.8)	0.5	15.7 (4.6)	−1.1	54.8 (8.0)	−2.7	147.4 (7.9)	−1.5	366.0 (9.8)	1.2
Highly structured work	272.7 (4.1)	−2.4	17.7 (5.2)	−1.9	28.0 (4.1)	1.1	66.8 (3.6)	1.8	160.1 (4.3)	−4.9
Highly competitive workplace	373.3 (5.6)	−0.6	15.2 (4.5)	−3.5	28.4 (4.1)	1.3	109.6 (5.9)	0.4	220.0 (5.9)	−1.2
Under time pressure	2,651.7 (39.9)	−0.8	129.2 (38.1)	−1.2	287.9 (41.9)	−1.4	751.6 (40.3)	−0.9	1,483.1 (39.5)	−0.7
Safety exposures										
Exposed to hazardous conditions once a week or more	179.1 (2.7)	−6.0	15.2 (4.5)	−5.0	18.9 (2.8)	−1.6	44.8 (2.4)	−2.2	100.2 (2.7)	−9.1
Exposed to hazardous equipment once a week or more	630.2 (9.5)	−0.2	39.4 (11.6)	−3.8	72.0 (10.5)	0.1	174.5 (9.4)	1.1	344.4 (9.2)	−0.4
Working at heights once a week or more	63.0 (0.9)	3.9	5.6 (1.6)	−3.7	6.7 (1.0)	3.1	17.2 (0.9)	0.8	33.7 (0.9)	6.9
Exposed to minor burns, cuts, bites, stings once a week or more	213.4 (3.2)	<0.1	14.0 (4.1)	−2.1	23.2 (3.4)	4.2	67.8 (3.6)	2.9	108.4 (2.9)	−2.0
Pace determined by speed of equipment	240.1 (3.6)	−5.8	12.6 (3.7)	−8.3	26.9 (3.9)	−5.9	69.8 (3.7)	−2.1	130.9 (3.5)	−8.3
Spend time climbing ladders, scaffolds, or poles more than half the time	21.4 (0.3)	2.0	1.6 (0.5)	−4.9	1.8 (0.3)	3.3	5.6 (0.3)	−0.7	12.4 (0.3)	4.1