Accepted: 9 February 2017

DOI 10.1002/ajim.22706

WILEY AMERICAN JOURNAL OF INDUSTRIAL MEDICINE

BRIEF REPORT

Analysis of workers' compensation disabling claims in Oregon's seafood preparation and packaging industry, 2007-2013

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BACKGROUND: Few occupational health and safety studies have focused on the US seafood preparation and packaging industry, and none on Oregon's seafood industry.

METHODS: Oregon workers' compensation (WC) disabling claims data were analyzed. Oregon Employment Department and US Census Bureau data were used as denominators for rates.

RESULTS: During 2007-2013, there were 188 accepted disabling claims, with an average annual rate of 24 claims per 1000 workers. Men experienced a significantly higher rate (27.6 per 1000) than women. The most frequent incident characteristics and circumstances were: by nature—traumatic injuries to muscles, tendons, ligaments, joints (42%); by body part—upper extremities (44%); and by event—overexertion and bodily reaction (48%), and contact with objects and equipment (31%).

CONCLUSION: Analyzing WC disabling claims data provides important preliminary information for understanding workplace hazards to develop control strategies. Reducing traumatic and cumulative injury risk among seafood workers is paramount.

KEYWORDS
occupational safety and health, Oregon, seafood preparation and packaging industry, workers' compensation

1 | INTRODUCTION

The limited research on occupational health and safety in the seafood preparation and packaging industry has demonstrated that it is high-risk for adverse health and safety outcomes. This industry comprises onshore establishments and floating factory ships that engage in one or more of the following: (1) canning seafood; (2) smoking, salting, and drying seafood; (3) eviscerating fresh fish by removing heads, fins, scales, bones, and entrails; (4) shucking and packing fresh shellfish; (5) processing marine fats and oils; and (6) freezing seafood.[1] Seafood contributes to human health and well-being in a variety of ways, including through its consumption, related employment, and economic value. With a growing global population, seafood is an important component of food security, offering animal protein, omega-3 fatty acids essential for brain development, micronutrients, and vitamins.[2,3] Seafood continues to be the most-traded food commodity internationally.[4] In the United States (US) in 2014, the estimated consumption of seafood was 14.6 pounds per capita and the value of all processed fishery products was over $10 billion.[5] It is vital to protect the health and safety of the workers who prepare and package seafood.

Occupational hazards in the seafood preparation and packaging (ie, processing) industry include: (1) bioaerosols containing allergens, microorganisms, and toxins; (2) bacterial and parasitic infections; (3) poor ergonomic practices; (4) machinery and equipment; (5) excessive noise levels; (6) low temperatures; and (7) poor workplace organization.[6] Globally, risk factors for musculoskeletal disorders among seafood processors include highly repetitive and forceful upper extremity movements, localized mechanical stress, awkward and/or static postures at workstations, prolonged standing, and temperature extremes.[7–13] Few occupational health and safety studies on the

Institution at which the work was performed: Oregon State University.

seafood processing industry have been conducted in the US. However, these studies indicate that further research on the US industry is merited, as they identified high rates of musculoskeletal disorders, respiratory problems, elevated noise exposure, and traumatic injuries.[14–21]

To our knowledge, there have been no occupational health and safety studies conducted on Oregon's seafood processing industry. Although employment in Oregon's seafood processing industry dipped in 2009, between 2010 and 2013 it grew steadily, with 1240 workers employed in 2013.[22] The number of workers fluctuates seasonally, with lower employment in February through April, and higher employment in July through September. For seasonal, entry-level jobs on processing lines, skill requirements are minimal. During the busy season, seafood processors often work 12-h shifts, 7 days a week. The base pay for processors is typically minimum wage. Quality inspection and truck driving positions require more skill and are higher paid. In 2013, there were 24 businesses involved in seafood processing and business consolidation has been a trend. This mirrors the geographic consolidation in Oregon's fishing fleets, with ports in Astoria, Newport, and Charleston constituting 95% of all commercial fish landings by volume in 2013. That year, commercial fishermen landed roughly 349 million pounds of fish and shellfish in Oregon, with a dockside value of $178 million. Seafood processing adds value to the product.[22]

This study aims to characterize occupational health and safety in Oregon's seafood processing industry by analyzing workers' compensation disabling claims data during 2007-2013. The study's long-term goal is to inform injury and illness prevention efforts, in order to lower the burden among workers, as well as to lower the associated costs to employers.

2 | METHODS

2.1 | Data sources

De-identified workers' compensation (WC) disabling claims data were obtained from the Oregon Health Authority's Environmental Public Health Section. The Environmental Public Health Section has a data sharing agreement with the Department of Consumer and Business Services (DCBS). DCBS is Oregon's largest regulatory and consumer protection agency and includes the Workers' Compensation Division. Oregon employers are required by law to have WC benefits for their employees.[23] Employers can choose self-insurance, insurance through a commercial company, or insurance through the State fund. The process by which DCBS receives information on WC claims starts with any employee (hourly, part-time, or full-time) experiencing an on-the-job injury or illness. Within 90 days of the incident, the employee has the right, but not the obligation, to either notify the employer and complete a Report of Job Injury or Illness claiming a work-related injury or disease, or the employee can go to a physician and complete the worker section of the Worker's and Physician's Report for Workers' Compensation Claims. Within 5 days of knowledge or notice of the claim, the employer is required to report the claim to an insurer. Within 72 h of treating a worker, the physician is required to report the claim to an insurer. The insurer determines if the claim is accepted or denied. If the claim is accepted, then the insurer assigns disability classification. A claim is considered to be disabling if it results in an employee missing 3 or more days of regularly scheduled work, overnight hospitalization, likely permanent disability, or death. The insurer is required to report disabling claims to DCBS.[24]

The Oregon WC disabling claims dataset included the following information that was utilized in this study: claim acceptance status; industry; occupation; workers' gender and age; incident characteristics and circumstances; fatality status; temporary disability days paid; indemnity costs; and medical costs. The DCBS Workers' Compensation Division reviews claims information and then manually codes each claim using the following classification systems: industry by the North American Industry Classification System (NAICS); worker position by the Standard Occupational Classification System (SOC); and incident characteristics and circumstances by the Occupational Injury and Illness Classification System (OIICS). The OIICS measures include: the body part affected; the nature of the injury/illness; the event that caused the injury/illness; and the source of the injury/illness. To validate that coding is accurate, DCBS runs programming and reviews random samples of the dataset. When employees are coding, certain codes cannot be entered together, in order to prevent data entry errors. An additional quality control measure involves DCBS reviewing the hard copies of claims documents that are stored in-house in order to confirm that reviewers collected all of the relevant information that was available to code.

In order to construct disabling claims rates for the seafood processing industry, employment data were used for the denominator, representing the total number of workers at risk. These denominator data were determined from these two sources: (1) State of Oregon Employment Department and (2) US Census Bureau's Local Employment Dynamics partnership. The Oregon Employment Department provides data on the total number of workers employed in the seafood processing industry each month, including both full- and part-time workers. Each firm in the industry reports this employment data to the Oregon Employment Department. However, the Oregon Employment Department does not collect data on workers' age or gender. Therefore, demographics data from the US Census Bureau were used to supplement the State of Oregon employment data in order to estimate workers' age and gender. The US Census Bureau has a data-sharing collaboration with the State of Oregon, called the Local Employment Dynamics partnership. The Local Employment Dynamics partnership provides Quarterly Workforce Indicators, which include worker demographics by state, industry, year, and quarter. These age and gender data are constructed from a variety of sources, including the 2000 Census, Social Security Administrative records, and individual tax returns. In order to protect the confidentiality of employers and workers, the US Census Bureau distorts the Quarterly Workforce Indicators age and gender data using a system of multiplicative noise infusion, whereby all released data are "fuzzed."[25] Therefore, the total number of employees reported by the Local Employment Dynamics partnership does not exactly match the total number of employees reported by the Oregon Employment

Department. The Local Employment Dynamics data were used to estimate the age and gender distribution of workers in the industry. We applied the age and gender proportions from the Local Employment Dynamics data to the Oregon Employment Department data in order to estimate worker demographics. While these sources provided the necessary information for the seafood processing industry as a whole, they do not contain the information by occupations within the industry.

Institutional Review Board ethics review was not required because the study did not involve human subjects, given that (1) the workers' compensation claims dataset did not contain individually identifiable information and (2) the data were not collected for this study.

2.2 | Analysis

For our analysis of WC disabling claims among Oregon's seafood processing industry workers during 2007–2013, we included only those claims which had been accepted by January 2015, when we obtained the data. The following NAICS codes specific to the seafood processing industry included: *311711: Seafood Canning*, *311712: Fresh and Frozen Seafood Processing*, and *311710: Seafood Product Preparation and Packaging*.

The Oregon Workers' Compensation Division staff reviews claims information and codes employees' occupation (SOC) as well as injury/illness characteristics and circumstances (OIICS) with the most highly-detailed and specific codes possible. In order to conduct the analysis for this study, we reviewed the detailed SOC and OIICS codes for each claim and then assigned the broader code based on the classification system's hierarchical categories. For example, if the Division staff reviewed a claim and coded the nature of the injury with the OIICS code *1211: Herniated disc*, we assigned the more general code *12: Traumatic injuries to muscles, tendons, ligaments, joints*.

In order to characterize occupational health and safety outcomes in Oregon's seafood processing industry, the frequency and rates of disabling claims were calculated by the year that the incident occurred, the study period, as well as workers' gender and age. Risk ratios (RR) and 95% confidence intervals (CI) were calculated. Cross-tabulations were calculated for incident characteristics and circumstances by occupation. The range and median for medical costs, indemnity costs, and number of temporary disability days paid were calculated by nature of injury. Pearson's chi-square tests were performed to examine the statistical association between body part and nature, as well as between event and source. The same test was performed to examine the statistical association between occupation and nature, as well as occupation and event. All analyses were completed in R statistical software.[26]

3 | RESULTS

During 2007-2013, there were 188 accepted WC disabling claims in Oregon's seafood processing industry. No occupational fatalities in Oregon's seafood processing industry were reported in the WC disabling claims dataset during the study period.

3.1 | Rates and risk ratios

Among all Oregon industries during 2007-2013, there was an annual average of 16 805 accepted WC disabling claims in the dataset, as well as an annual average of 1 655 816 Oregon workers.[27] This resulted in an all-industry annual average rate of 10.15 disabling claims per 1000 workers for the state. During the study period, there was a decreasing trend in the all-industry disabling claim frequency and rate. In 2007, the all-industry disabling claim rate was 11.9 claims per 1000 workers and by 2013 the claim rate was 8.0 per 1000 workers.

For Oregon's seafood processing industry during 2007-2013, Table 1 presents the frequency, rate, and RR of claims by year, study period, gender, and age. Annual average employment in the seafood processing industry grew from 1074 workers in the year 2007 to 1210 workers in the year 2013.[28] During 2007-2013, the annual average claim rate was 24 claims per 1000 workers. Overall, there was an increasing trend in both the claim frequency and claim rate during the study period, with slight drops in 2009 and 2013. The claim rates in years 2011 and 2012 were statistically higher than in 2007 ($P < 0.05$). The majority of claims, almost three-quarters, were among men (136, 72%). Likewise, the claim rate for men was significantly higher than for women (27.6 per 1000 workers vs. 17.9 per 1000 workers, RR = 1.54, $P = 0.007$). Workers aged 25-34 had the highest frequency (51, 27%), as well as highest rate of claims (35.8 per 1000 workers). Compared to the workers aged 14-24, the risk of a claim was higher among workers aged 25-34 (RR = 1.79, $P = 0.015$) and lower among workers 65 years of age and older (RR = 0.21, $P = 0.003$).

3.2 | Injury and illness characteristics and circumstances

Table 2 presents the cross-tabulation of incident characteristics, which were reported for all claims. Pearson's Chi-square test showed the association between the nature of injury and the body part affected was significant (Pearson's = 116.1, $P < 0.001$). Roughly half of the claims involved traumatic injuries of some type. The most common nature of incidents included traumatic injuries to muscles, tendons, ligaments, and joints (80, 42%). For body part, the most frequently affected areas were upper extremities (83, 44%). Most of the traumatic injuries to muscles, tendons, ligaments, and joints were to the trunk of the body. Almost all of the open wounds were to the upper extremities. Traumatic injuries to bones, nerves, and the spinal cord occurred most frequently to the upper extremities. All of the musculoskeletal disorders were to the upper extremities.

Table 3 presents the cross-tabulation of circumstances surrounding incidents. Pearson's Chi-square test indicated that the event was significantly associated with the source (Pearson's = 441.9, $P < 0.001$). By event, almost half of the claims involved workers' overexertion and bodily reaction and approximately one-third of the claims were due to contact with objects and equipment. The most frequent sources were workers' bodily motion or position (43, 24%) and containers (43, 24%).

TABLE 1 Frequency and rate of disabling claims in Oregon's seafood processing industry by year, gender, and age, 2007-2013

	No. disabling claims (%)	No. workers	Rate per 1000 workers (95%CI)	RR (95%CI)	*P*-value
Year					
2007	17 (9)	1074	15.8 (9.2-25.2)	1.00	/
2008	18 (10)	1063	16.9 (10.1-26.6)	1.07 (0.55-1.98)	0.87
2009	16 (8)	1007	15.9 (9.1-25.7)	1.00 (0.51-1.98)	1.00
2010	28 (15)	1111	25.2 (16.8-36.2)	1.59 (0.88-2.89)	0.13
2011	34 (18)	1125	30.2 (21.0-42.0)	1.91 (1.07-3.39)	0.03
2012	41 (22)	1210	33.9 (24.4-45.7)	2.14 (1.22-3.74)	0.01
2013	34 (18)	1239	27.4 (19.1-38.1)	1.73 (0.97-3.09)	0.07
Study period					
2007-2013	188 (100)	7829	24.0 (20.7-27.7)		
Gender					
Female	52 (28)	2907[+]	17.9 (13.4-23.4)	1.00	/
Male	136 (72)	4922[+]	27.6 (23.2-32.6)	1.54 (1.13-2.12)	0.007
Age					
14-24	26 (14)	1302[+]	20.0 (13.4-29.6)	1.00	/
25-34	51 (27)	1424[+]	35.8 (26.8-46.8)	1.79 (1.13-2.86)	0.015
35-44	39 (21)	1528[+]	25.5 (18.2-34.7)	1.28 (0.78-2.09)	0.379
45-54	49 (26)	1647[+]	29.8 (22.1-39.1)	1.49 (0.93-2.38)	0.100
55-64	19 (10)	1216[+]	15.6 (9.4-24.3)	0.78 (0.44-1.41)	0.454
65-99	3 (2)	712[+]	4.2 (0.9-12.3)	0.21 (0.06-0.69)	0.003

CI, confidence interval; RR, risk ratio; [+], estimated no. workers during 2007-2013.

Table 4 presents the cross-tabulation of the nature and event. Pearson's Chi-square test indicated that the event was significantly associated with the nature of incident (Pearson's = 144.04, $P < 0.001$). The vast majority of traumatic injuries to muscles, tendons, ligaments, and joints resulted from overexertion and bodily reaction (57, 71%). Three-quarters of open wounds resulted from contact with objects and equipment. Likewise, most contusions and abrasions resulted from contact with objects and equipment. Traumatic injuries to bones, nerves, and spinal cord most frequently resulted from contact with objects and equipment, as well as falls, slips, and trips. As would be expected, almost all of the musculoskeletal disorders were coded as resulting from overexertion and bodily reaction.

3.3 | Occupation

Various occupations comprise the seafood processing industry. Table 5 presents the frequency and percentage of claims by workers' occupation, stratified by the nature of incident as well as the event resulting in the incident. There was no evidence that nature differed by occupation (Pearson's = 43.2, $P = 0.404$), nor that event differed by occupation (Pearson's = 32.8, $P = 0.715$).

TABLE 2 Nature and body part for WC disabling claims in Oregon's seafood processing industry, 2007-2013

	Body part (*n* = 188)						
Nature (*n* = 188)	Upper extremities	Trunk	Lower extremities	Multiple parts	Head	Neck	Total (row %)
Traumatic Injuries to muscles, tendons, ligaments, joints	18	38	12	10	0	2	80 (42)
Open wounds	23	0	1	1	0	0	25 (13)
Contusions, abrasions	8	3	8	2	3	0	24 (13)
Multiple types	10	4	4	5	1	0	24 (13)
Traumatic injuries to bones, nerves, spinal cord	10	2	5	0	0	0	17 (9)
Musculoskeletal disorders	13	0	0	0	0	0	13 (7)
Other	1	0	1	1	2	0	5 (3)
Total (column %)	83 (44)	47 (25)	31 (17)	19 (10)	6 (3)	2 (1)	188

TABLE 3 Source and event for WC disabling claims in Oregon's seafood processing industry, 2007-2013

	Event (n = 182)							
Source (n = 179)	Overexertion & bodily reaction	Contact with objects & equipment	Falls, slips, trips	Transport incidents	Exposure harmful subst.	Animal-related	Un-known	Total (row %)
Bodily motion/ position	40	0	3	0	0	0	0	43 (24)
Containers	26	16	1	0	0	0	0	43 (24)
Floors & walkways	0	0	24	0	0	0	0	24 (14)
Fish & shellfish	7	8	0	0	1	1	0	17 (10)
Machinery	2	11	0	0	0	0	0	13 (7)
Vehicles	3	3	0	5	0	0	0	11 (6)
Other	2	6	0	0	1	0	0	9 (5)
Materials	2	5	0	0	0	0	0	7 (4)
Furniture & fixtures	3	2	1	0	0	0	0	6 (3)
Tools & equipment	2	4	0	0	0	0	0	6 (3)
Unknown	1	1	0	0	1	0	6	9
Total (column %)	88 (48)	56 (31)	29 (16)	5 (3)	3 (2)	1 (1)	6	188

By occupation, over half of the claims occurred among workers in Production occupations (104, 57%). These occupations involve hands-on seafood packaging and processing tasks. For example, within the Production occupational category (SOC code 510000), more detailed subcategories included: Packaging and Filling Machine Operators and Tenders (code 519111); Fish Cutters and Trimmers (code 513022); and Food Batchmakers (code 513092). Among Production workers, the most frequent nature of the incident was traumatic injuries to muscles, tendons, ligaments, and joints (n = 45). The most frequent event was overexertion and bodily reaction (n = 50), followed by contact with objects and equipment (n = 27).

By occupation, almost a quarter of the claims were among Transportation and Material Moving workers (39, 22%). Among these workers, the most frequent nature of the incident was traumatic injuries to muscles, tendons, ligaments, and joints (n = 12), followed by contusions and abrasions (n = 8). The most frequent events were overexertion and bodily reaction (n = 16) and contact with objects and equipment (n = 16).

3.4 | Costs

Table 6 presents the range and median of medical costs, indemnity costs, and temporary disability days paid by the nature of the incident. Medical costs, indemnity costs, and temporary disability days paid were reported for 183 (97%) claims. Each of the 183 claims reported having both medical and indemnity costs, while the remaining five claims were missing cost information. Medical costs paid by the resolved date ranged from \$25 to \$277 900, with a median cost of \$2556. Indemnity costs ranged from \$7 to \$122 300, with a median cost of \$873. Cost information is useful for making relative comparisons, as the actual costs are higher than those reported. Temporary disability days paid ranged from 1 to 481 days, with a median of 22 days. The majority of claims (169, 90%) in the dataset were closed. By nature, traumatic injury to bones, nerves, and spinal cords resulted in the highest median medical costs and indemnity costs, as well as the second highest median temporary disability days paid. Claims involving multiple injuries/illnesses resulted in the second highest median medical and indemnity costs, and the highest median temporary disability days paid.

4 | DISCUSSION

This epidemiologic study is the first to measure risk and characterize occupational health and safety outcomes in Oregon's seafood processing industry by analyzing accepted WC disabling claims data for 2007-2013. The detailed results presented here could be used as a starting point for informing future research as well as occupational injury and illness prevention strategies.

4.1 | Disabling claim rates

It is encouraging that there were no occupational fatalities reported in Oregon's seafood processing industry during 2007-2013. However, there was a high rate of WC disabling claims in this industry, which is concerning. In comparison to Oregon's all-industry, annual average WC disabling claim rate of 10.15 claims per 1000 workers, the rate in Oregon's seafood processing industry was 24 claims per 1000 workers. Oregon's seafood processing industry disabling claim rate was nearly two and a half times higher than the all-industry rate. Additionally, while the disabling claim rate for all industries in Oregon decreased over the study period, the rate in the seafood processing industry increased. Potentially, a contributing factor for the increasing trend in the seafood processing industry claim rate over the study

TABLE 4 Nature and event for WC disabling claims in Oregon's seafood processing industry, 2007-2013

	Nature (n = 188)							
Event (n = 182)	Traumatic injuries to muscles, tendons, ligaments, joints	Open wounds	Contusions, abrasions	Multiple types	Traumatic injuries to bones, nerves, spinal cord	Musculoskeletal disorders	Other	Total (row %)
Overexertion & bodily reaction	57	3	3	11	2	11	1	88 (48)
Contact with objects & equipment	7	19	13	7	7	1	2	56 (31)
Falls, slips, trips	11	1	6	4	6	1	0	29 (16)
Transportation incidents	1	1	2	0	1	0	0	5 (3)
Exposure harmful subst.	0	0	0	1	0	0	2	3 (2)
Animal-related	0	1	0	0	0	0	0	1 (1)
Unknown	4	0	0	1	1	0	0	6
Total (column %)	80 (42)	25 (13)	24 (13)	24 (13)	17 (9)	13 (7)	5 (3)	188

period could have been the increased demand for seafood preparation and packaging. During 2007-2013, Oregon seafood landings (ie, the amount of seafood that is harvested and brought to shore for processing) experienced a 22% increase, from 271 062 716 pounds in 2007 to 349 434 448 pounds in 2013.[29] Additional research is necessary to identify causes for the increase in disabling claims in the seafood processing industry.

These results, which demonstrate a high rate of injuries in the Oregon seafood processing industry, are consistent with prior research, which has demonstrated that seafood processors in the Pacific Northwest experienced high rates of musculoskeletal disorders compared to other industries. In Washington State, a study on occupational carpal tunnel syndrome in multiple industries during 1984–1988 found high rates among seafood processing workers as compared to the other industries. Oyster, crab, and clam packing workers experienced carpal tunnel syndrome at a rate of 25.7 per 1000 full-time equivalents (FTEs) and fish canneries processing workers at a rate of 18.2 per 1000 FTEs.[14] A second study in Washington State utilizing workers' compensation claims data investigated work-related disorders of the upper extremities during 1987-1995. Among all industries, the highest rates for carpal tunnel syndrome occurred in shake mills and seafood canneries. The rate among seafood cannery workers was 18.8 per 1000 FTEs.[15] A recent study examined which industries in Washington State were at high risk for common, high-cost injuries by analyzing Washington State Fund compensable workers' compensation claims from 2002–2010. During this time period in Washington, the seafood processing industry (NAICS code 3117) experienced a rate of 31.1 claims per 1000 FTEs.[20]

4.2 | Prevention efforts

Injury and illness prevention efforts should be tailored to control worksites' unique hazards, as well as meet the needs of worker populations who are at highest risk for adverse health and safety outcomes. The majority of disabling claims in Oregon's seafood processing industry occurred among men and those aged 25-54 years. Within an industry, hazards and injury risks vary by occupation. The vast majority of disabling claims occurred in two occupational categories within Oregon's seafood processing industry: production, which involves hands-on seafood packaging and processing tasks, and transportation and material moving.

Prevention efforts in Oregon's seafood processing industry should focus on the following events that resulted most frequently in disabling claims: overexertion and bodily reactions; contact with objects and equipment; as well as falls, slips, and trips. Of special concern are injuries to workers' upper extremities and trunk. Claims involving upper extremities most frequently involved open wounds; traumatic injuries to muscles, tendons ligaments, and joints; and musculoskeletal disorders. The vast majority of claims involving the trunk were traumatic injuries to muscles, tendons ligaments and joints. Traumatic injuries of any type and incidents involving multiple injuries/illnesses had the highest median medical costs, as well as high median indemnity costs and temporary disability days paid.

These results, which show that roughly half of all Oregon seafood processing industry disabling claims involved traumatic injuries to muscles, tendons, ligaments, joints, or bones, are consistent with prior research that identified traumatic injuries among workers who carry out the seafood processing tasks onboard vessels at sea. Recently, a

TABLE 5 Nature and event by occupation for WC disabling claims in Oregon's seafood processing industry, 2007-2013

	Occupation (*n* = 181)								
	Production	Transport-ation & material moving	Other	Installation, maint. & repair	Building & grounds cleaning & maintenance	Food prep. & serving	Office & admin	Un-known	Total (row)
Nature									
Traumatic injuries to muscles, tendons	45	12	7	3	5	3	2	3	80
Open wounds	13	6	1	1	1	1	0	2	25
Contusions, abrasions	14	8	0	1	0	0	0	1	24
Multiple	14	7	0	1	1	0	1	0	24
Traumatic injuries to bones	6	5	1	2	0	0	2	1	17
Musculoskeletal disorders	9	1	1	0	0	2	0	0	13
Other	3	0	0	1	1	0	0	0	5
Occupation total	104 (57)	39 (22)	10 (6)	9 (5)	8 (4)	6 (3)	5 (3)	7	188
Event									
Overexertion & bodily reaction	50	16	7	2	3	3	3	4	88
Contact with objects & equipment	27	16	1	5	2	2	0	3	56
Falls, slips, trips	18	5	2	1	1	1	1	0	29
Transportation incidents	2	1	0	0	1	0	1	0	5
Harmful substance	2	0	0	1	0	0	0	0	3
Animal-related	1	0	0	0	0	0	0	0	1
Unknown	4	1	0	0	1	0	0	0	6
Occupation total	104 (57)	39 (22)	10 (6)	9 (5)	8 (4)	6 (3)	5 (3)	7	188

study of occupational safety onboard Alaskan freezer-trawler and freezer-longliner vessels during 2001-2012 found that traumatic injuries occurred during seafood processing tasks and that the two most frequent causes of injuries were being caught in running equipment and slipping knives.[21] Traumatic injuries are a concern across all industries in Oregon. During 2007-2013, 85% of all-industry WC disabling claims were due to traumatic injuries. Among those claims due to traumatic injuries, trauma to muscles, tendons, ligaments, and joints accounted for 59%, and trauma to bones, nerves, and spinal cord accounted for 17%.[30]

Our results on disabling claims in Oregon's seafood processing industry assist with identifying areas in which there is the greatest need for increased support for prevention. Lessons could be learned from injury and illness prevention efforts in other animal product manufacturing industries, for which guidance documents and online resources have already been developed. For example, the Occupational Safety and Health Administration provides an eTool that assists with identifying and controlling major hazards in the poultry processing industry.[31] In the absence of specific information regarding the work tasks associated with disabling claims in the Oregon seafood processing industry, basic safety principles are recommended and could prevent many of the common injuries reported. Appropriate ergonomic tools and equipment, proper machine guarding and maintenance, and safe work practices could be recommended. Good housekeeping, proper flooring, and appropriate footwear could also be recommended.

4.3 | Health outcomes

Much of the seafood processing industry literature focuses on adverse respiratory and dermal outcomes due to seafood allergen exposures. However, the Oregon WC disabling claims data did not capture these types of outcomes. Research conducted around the globe has found that seafood processors are at high risk for developing

TABLE 6 Nature by medical costs, indemnity costs, and temporary disability days paid for WC disabling claims in Oregon's seafood processing industry, 2007-2013

		Medical		Indemnity		Days paid	
Nature	No. claims	Range	Median	Range	Median	Range	Median
Traumatic injuries to bones, etc.	17	$1614-$92 500	$19 080	$888-$46 240	$12 350	22-481	86
Multiple	24	$426-$277 900	$12 120	$134-$122 300	$7458	4-469	91
Traumatic injuries to muscles, tendons, etc.	80	$25-$18 400	$11 615	$7-$27 960	$628	1-194	18
Other	5	$11-$35 300	$2215	$91-$23 800	$1701	2-449	37
Musculoskeletal disorders	13	$118-$5791	$1900	$45-$13 360	$2077	1-190	45
Open wounds	25	$58-$26 980	$1398	$22-$7655	$251	1-60	8
Contusions, abrasions	24	$172-$46 970	$983	$20-$36 970	$403	1-394	9

allergic reactions of the lungs, including occupational asthma, when engaged in activities that cause bioaerosol production, including: butchering, grinding, cracking, and boiling shellfish; degutting, heading, and cooking/boiling fish; mincing seafood; and cleaning the processing lines or storage tanks with high-pressured water hoses.[32] Studies in the United Kingdom, Sweden, and Norway have identified adverse respiratory effects of bioaerosol exposures among salmon processing workers.[33–36] Studies of Canadian and Greenlandic snow crab processors identified a high prevalence of occupational asthma.[37–39] Asthma-like and bronchitic respiratory symptoms were identified among crab processing workers in Dutch Harbor, Alaska, both in onshore facilities and onboard vessels.[17,18] Further research would be needed to determine if these adverse health outcomes are of concern in Oregon's seafood processing industry.

4.4 | Limitations

This study likely underrepresents the true burden of adverse occupational health and safety outcomes in Oregon's seafood processing industry. Firstly, disabling claims data represent only the most severe incidents, which result in an employee missing 3 or more days of regularly scheduled work, overnight hospitalization, or likely permanent disability. Medical-only claims (those that did not require missing regularly scheduled work or overnight hospitalization) were not included in the dataset. Secondly, underreporting of work-related injuries and underutilization of WC benefits may occur due to various factors and barriers.[40,41] Thirdly, due to lack of available employment data by demographics and occupation, disabling claim rates by age and gender had to be estimated and rates could not be calculated by occupation. Finally, the WC disabling claims data provide limited information on worker demographics, other than age and gender. No narrative descriptions of the circumstances surrounding the incidents were provided in the WC dataset. Therefore, we could not identify specific job tasks associated with the disabling incidents. At this time, the Department of Consumer and Business Services does not foresee narrative descriptions being available in the WC dataset for future analyses. This is unfortunate, given that identifying information about specific job tasks associated with claims in narrative descriptions could be useful for injury prevention efforts. Despite these limitations, the results provide an unprecedented level of data to guide targeted injury and illness prevention strategies in this high-risk and understudied worker population.

5 | CONCLUSION

This is the first study to characterize occupational health and safety outcomes in Oregon's seafood processing industry. Although limited, WC disabling claims data provide an important starting point for understanding workplace hazards in this industry. Our results demonstrate that there are high rates of disabling claims, which represent the most severe, reported incidents. Reducing musculoskeletal injury risk among workers in production and transportation/material moving occupations is paramount. Additional occupational health and safety research on this industry is merited. Future research could address the following: characterize the burden of non-disabling injuries and illnesses; determine if respiratory and dermal problems are a concern; identify hazardous job tasks and facility conditions; and determine worker demographics such as race/ethnicity, language, and educational level. Public health professionals and researchers should engage stakeholders in Oregon's seafood processing industry in order to identify challenges and successes in preventing occupational injuries and illnesses. Together, they should develop practical, effective prevention strategies to lower the burden of adverse outcomes among workers, while lowering workers' compensation costs to employers.

AUTHORS' CONTRIBUTIONS

Laura Syron, MPH: Conception and design of the work; analysis and interpretation of data; drafting the work; final approval to be published and agreement to be accountable for all aspects of the work. Laurel Kincl, PhD: Substantial contributions to the conception and design of the work; interpretation of data; revising the work critically for important intellectual content; final approval to be published; and agreement to be accountable for all aspects of the work. Liu Yang, MS: Substantial contributions to analysis and interpretation of data; revising the work critically for important intellectual content; final approval to be published; and agreement to be accountable for all aspects of the work. Daniel Cain, MA: Substantial contributions to the

acquisition and interpretation of data; revising the work critically for important intellectual content; final approval to be published; and agreement to be accountable for all aspects of the work. Ellen Smit, PhD, RD: Substantial contributions to the conception and design of the work; interpretation of data; revising the work critically for important intellectual content; final approval to be published; and agreement to be accountable for all aspects of the work.

FUNDING

The authors report that there was no funding source for the work that resulted in the article or the preparation of the article.

ETHICS APPROVAL AND INFORMED CONSENT

The work was performed at Oregon State University. Institutional Review Board ethics review was not required because the study did not involve human subjects, given that (1) the workers' compensation claims dataset did not contain individually identifiable information and (2) the data were not collected for the current project.

DISCLOSURE (AUTHORS)

The authors report no conflicts of interest.

DISCLOSURE BY AJIM EDITOR OF RECORD

Rodney Ehrlich declares that he has no competing or conflicts of interest in the review and publication decision regarding this article.

DISCLAIMER

None.

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How to cite this article: Syron LN, Kincl L, Yang L, Cain DT, Smit E. Analysis of workers' compensation disabling claims in Oregon's seafood preparation and packaging industry, 2007-2013. *Am J Ind Med*. 2017;60:484–493. https://doi.org/10.1002/ajim.22706