DISSERTATION

OCCUPATIONAL INJURIES AMONG CRAFT BREWERY WORKERS IN COLORADO

Submitted by

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ABSTRACT

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Workers at craft breweries in the U.S. are an understudied occupational cohort in a rapidly growing industry. Between 2015 and 2019, the number of craft breweries in Colorado grew 120% (Brewers Association, 2020). At the start of 2020, Colorado had more than 420 craft breweries with more than 9,100 workers. California is the only state with more craft breweries than Colorado. In the U.S., 8,000 craft breweries employed 161,000 workers (Brewers Association, 2020). As craft brewery workers produce beer through manufacturing processes, they are exposed to numerous occupational hazards that have been associated with injuries. These hazards include awkward body postures, lifting/carrying heavy loads, highly repetitive activities, sharp edges on materials and equipment, hot surfaces, and high levels of noise. According to national injury surveillance data, occupational injury rates are higher among brewery workers compared to all industries including private, state, and local government. Unfortunately, the national injury surveillance data do not differentiate between large and craft breweries. Craft breweries are substantially smaller than large industrialized breweries. An analysis of national injury data that includes all sizes of breweries may lead to erroneous perceptions of injuries affecting craft brewery workers. To date, no published studies have specifically outlined occupational hazards and injuries associated with craft brewing tasks. To effectively improve safety among craft brewery workers, it is critical that researchers and industry stakeholders have a better understanding of the occupational exposures related to injuries specific to craft brewery workers. The purpose of the present study was to characterize injuries specific to craft brewery workers and to identify their contributing factors in order to inform practitioners tasked with directing intervention resources.

Researchers used data from workers' compensation to analyze injuries among Colorado craft brewery workers from 2013 to 2018. Researchers then analyzed accident narratives using the revised agent-host-environment epidemiologic model to better understand the relationship between the reported injury claim

and the contributing factors to the agent, host, environment, and vehicle. Informal interviews with subject matter experts supplemented the workers' compensation analysis. Due to restrictions caused by the COVID-19 Pandemic, qualitative data were collected through virtual informal interviews with subject matter experts. Researchers developed a series of injury process models to highlight the relationship between injury characteristics and contributing factors that resulted in an injury nature. These models included information on how an injury nature was the result of an injury event when energy was transferred from the environment or vehicle to the injured workers' anatomical region.

Researchers analyzed 570 claims. Results of the present study indicated that new workers experience occupational injuries, as more than 60% of claimants had less than two years of tenure at the time of injury. Among claims that incurred costs, the median total claim cost was $680 and the mean total claim cost was $2,100. Claims associated with sprains/strains incurred the highest costs per claim and the highest cumulative cost. Sprains/strains and contusions were the most frequent injury natures. The low back, hands, and fingers were the most frequently injured body parts. By analyzing accident narratives, researchers determined that injuries in craft breweries were typically associated with claimants either carrying items or performing cleaning tasks. The majority of injuries occurred in the packaging hall area of the craft brewery. Subject matter experts described how the packaging hall typically had the highest number of workers and the greatest proportion of new workers compared to other regions of the craft brewery. Contusions, lacerations, and burns affected the hands/fingers whereas sprains/strains predominately affected the low back. Sprains/strains and contusions both typically occurred in the packaging area of the craft brewery while the claimant carried an item. Lacerations typically occurred in the packaging area or kitchen. Burns typically occurred in the brewery or kitchen. Both burns and lacerations occurred while the worker performed maintenance work, cleaning activities, or food preparation tasks. Findings from this study (including the injury process models) can help guide practitioners tasked with developing interventions to reduce injuries and improve the quality of work life among craft brewery workers.

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CHAPTER 1: INTRODUCTION

The purpose of this dissertation was to investigate the burden of occupational injuries among Colorado craft brewery workers. Craft brewing work environments contain physical hazards associated with increased risks of occupational injury, and yet no formal studies have investigated occupational injuries among craft brewery workers. Researchers performed a precursory investigation of available injury information using national injury surveillance data and information from professional trade organizations. Workers' compensation (WC) data have been used to understand injuries among many other occupational cohorts. Accident narratives typically accompany WC data and provide additional insight into circumstances surrounding the claim. Researchers in the present study partnered with Colorado's largest workers' compensation insurance carrier to analyze injury claims specific to craft breweries in Colorado.

Researchers developed specific aims to understand injury characteristics, determine costs associated with injuries, and identify contributing factors to injuries. Each specific aim includes research hypotheses and objectives that lead to new knowledge in this topic area:

Specific Aim 1: To characterize WC claims in the Colorado craft brewing industry between July, 2013 and June, 2018. Specific Aim 1 was accomplished by analyzing claims based on injured anatomical region, injury nature, injury event, claimant age, and claimant tenure.

Research hypotheses:

1.1. Of the three injured anatomical regions (upper limb, lower limb, and trunk region), the most frequently injured anatomical region is the upper limb.

1.2. Of the five injury nature categories (burn, contusion, laceration, sprain/strain, and "other"), the most frequent injury nature category is contusion.

1.3. Of the five injury event categories (contact with objects and equipment, exposure to harmful substances and environment, slips/trips/falls (STF), overexertion and bodily reaction, and "other"), the most frequent injury event category is exposure to harmful substances and environments.

1.4. Of the five age categories (≤ 24, 25-34, 35-44, 45-54, and ≥ 55 years old), claims are most frequently reported among workers aged between 25-34 years old.

1.5. Of the six tenure categories (< 1, ≥ 1 to < 2, ≥ 2 to < 3, ≥ 3 to < 4, ≥ 4 to < 5, and ≥ 5 years), claims are most frequently reported among workers with < 1 year of tenure.

Specific Aim 2: To determine how total claim costs (medical costs plus indemnity costs) are related to injury characteristics. Specific Aim 2 was accomplished by assessing the relationship between cost and injured anatomical region, injury event, injury nature, claimant age, and claimant tenure.

Research hypotheses:

2.1. Injuries to the upper limb incur the greatest median claim costs relative to the lower limb and the trunk region.

2.2. Of the five injury nature categories (burn, contusion, laceration, sprain/strain, and "other"), laceration incurs the greatest median claim costs.

2.3. Of the five injury event categories (contact with objects and equipment, exposure to harmful substances and environment, slip/trip/fall, overexertion and bodily reaction, and "other"), the injury event of overexertion and bodily reaction incurs the greatest median claim costs.

2.4. Of the five age categories (≤ 24 years old, 25-34 years old, 35-44 years old, 45-54 years old, and ≥ 55 years old), median claims costs are greater among older claimants than younger claimants. Specifically, median claim costs are greater among those between claimants aged 45-54 years old.

2.5. Claimants with longer tenure (≥ 1 year) incur greater median claim costs relative to claimants with shorter tenure (< 1 year).

Specific Aim 3: To investigate workers' compensation claims specific to manual materials handling (MMH) tasks. Specific Aim 3 was accomplished by assessing the distributions of these specific claims by injured anatomical region, injury event, injury nature, claim type, total claim costs, claimant age, and claimant tenure.

Research hypotheses:

3.1. Claimants performing MMH tasks at the time of injury have a significantly greater proportion of injuries to their trunk region compared to claimants performing other (non-MMH) tasks.

3.2. Claimants performing MMH tasks at the time of injury have a significantly greater proportion of sprains/strains compared to claimants performing other (non-MMH) tasks.

3.3. Claimants performing MMH tasks at the time of injury have a significantly greater proportion of overexertion and bodily reaction injury events compared to claimants performing other (non-MMH) tasks.

3.4. Claimants performing MMH tasks at the time of injury have a significantly greater proportion of claims classified as indemnity compared to claimants performing other (non-MMH) tasks.

3.5. Claimants performing MMH tasks at the time of injury incur greater mean total claim costs compared to claimants performing other (non-MMH) tasks.

3.6. Claimants performing MMH tasks at the time of injury are younger compared to claimants performing other (non-MMH) tasks.

3.7. Claimants performing MMH tasks at the time of injury have shorter tenure compared to claimants performing other (non-MMH) tasks.

Specific Aim 4: To develop an injury model specific to the craft brewing industry. Specific Aim 4 was accomplished by an analysis of the accident narratives as described in the First Report of Injury form (FROI) and the results generated from Specific Aims 1, 2, and 3. This model was used to better understand relationships between injury characteristics and contributing factors to the claim.

Research Objectives:

4.1. Use data from the FROI accident narrative to identify contributing factors to the claim based on the revised agent-host-environment epidemiologic model.

4.2. Develop an injury model for the craft brewing industry based on the results of workers' compensation analysis and the contributing factors identified in the revised agent-host-environment epidemiologic model.

CHAPTER 2: LITERATURE REVIEW

2.1. Scope of literature review

The literature review begins with a discussion of the U.S. craft brewing industry (with an emphasis on craft breweries in Colorado) and associated physical hazards in brewing environments. A significant challenge to researchers was a lack of peer-reviewed publications specific to occupational injuries in craft breweries. To understand the state of injuries among craft breweries, researchers must extract general information from national surveillance databases and professional trade organizations. Workers' compensation data presented an opportunity to investigate injuries from a targeted occupational cohort (e.g. craft brewery workers). The WC system and its potential for contribution to occupational injury research is presented. In addition to information directly available from the WC data, accident narratives contain details of the occupational exposures that contributed to the injury. Analyzing these occupational exposures was useful in the development of an injury model to assist in the development of injury prevention guidelines within the craft brewing industry.

2.2. Craft brewing industry

2.2.1. Definition of a craft brewery

Breweries produce beer through fermentation using hops, grain, yeast, and water. Craft breweries are small and independent brewing facilities (Alworth, 2015). The Brewers Association defines breweries as "craft breweries" if they produce no more than 6,000,000 barrels annually (Brewers Association, 2020). Most craft breweries actually brew much less than 6,000,000 barrels annually. In 2019, 97% of craft breweries in the U.S. produced less than 15,000 barrels. The median production of craft breweries was 375 barrels annually (Brewers Association, 2020). For comparison, Anheuser-Busch InBev, one of the largest brewing corporations in the world, produced more than 520,000,000 barrels in 2017 (Institute and National Beer Wholesalers Association, 2019). To be considered an independent brewery, 75% or more

of the brewing facility must be owned by the craft brewers themselves. A U.S. Alcohol and Tobacco Tax and Trade Bureau (TTB) Brewer's Notice is required for a facility to be considered a craft brewery (Brewers Association, 2019). Other notable features of craft breweries include innovation, community, and philanthropy (Alworth, 2015; Duarte Alonso et al., 2018; Patterson et al., 2016; Thurnell-Read, 2014).

2.2.2. Craft brewery growth

The concept of craft beer began with home-brewing. People applied unique variations to traditional brewing recipes and created flavorful, small batch brews in their homes. These unique flavors were not available from large breweries at the time. The craft beer movement officially began in 1978 when President Jimmy Carter signed a bill (House of Representatives, H.R. 1337) legalizing the sale and distribution of home-brews (Alworth, 2015). The popularity of craft beer grew, which increased the production within existing craft breweries and the construction of new craft brewing facilities. In 1980, there were eight official craft breweries and 40 large breweries in the U.S. (Elzinga et al., 2015). Between the years 2000 and 2010, the number of craft breweries in the U.S. grew from 1,496 to 1,756, but after 2010 the number of craft breweries rapidly increased (Elzinga et al., 2015). By 2019, there were 8,386 breweries in the U.S. More than 98% of all operational breweries in the U.S. at that time were considered craft breweries (Brewers Association, 2019). The U.S. craft brewing industry accounted for 13% of beer production and for 25% of all sales in the $111.4 billion U.S. beer market (Brewers Association, 2019). To date, Colorado has the second highest number of craft breweries in the U.S. with more than 420 craft breweries (Brewers Association, 2020). Figure 2.1. illustrates craft brewery growth in Colorado for the last 30 years.

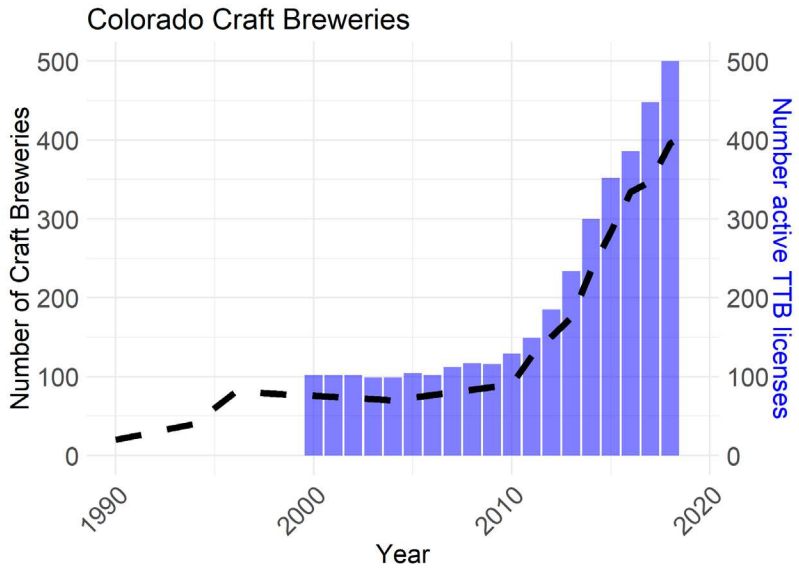

Figure 2.1. Growth of the craft brewing industry within Colorado by number of craft breweries (dotted line) and active U.S. TTB brewer's licenses (solid bars) by year (Brewers Association, 2020).

2.2.3. Craft brewery size

The Brewers Association estimated that 161,000 workers (including servers) were employed at craft breweries throughout the U.S. in 2019 and more than 9,000 workers within craft breweries in Colorado (correspondence with Brewers Association Chief Economist, 2020). Even when overall brewing production decreased in 2018, jobs within craft breweries grew eight percent (Institute and National Beer Wholesalers Association, 2019).

The number of workers per brewery (craft or large) varies considerably. In 2017, the U.S. Bureau of Labor Statistics (BLS) investigated employment per brewery by state. Colorado had 24.7 workers per brewery, based on reports of 5,528 workers in 224 breweries (BLS, 2017). However, that same year, Colorado had 348 craft breweries (in addition to large breweries) (Brewers Association, 2020). Therefore, this specific BLS report does not accurately represent all operational Colorado breweries (large and craft). Colorado is also home to multiple large breweries (notably Anheuser Busch in Larimer County and Coors Brewery in Jefferson County). These large breweries employ more than 1,000 people each, while 80% of craft breweries employ fewer than 60 employees (*Colorado Brewers Guild Economic Impact Study 2016*,

2016). A professional trade organization estimated that in 2019 there were 21.6 workers per craft brewery in Colorado, which was higher than the national estimate of 19.2 workers per craft brewery (correspondence with Brewers Association Chief Economist, 2020). Brewpubs (craft breweries with an attached restaurant) were included in this national trade organization survey. Due to the restaurant component, brewpubs are coded differently than other craft breweries under national industry classification schemes. The BLS employment estimate is based on national industry classification schemes. Therefore, the BLS employment estimate of workers per brewery does not accurately represent workforce sizes in craft breweries in Colorado.

2.3. Occupational health and safety in breweries

2.3.1. Occupational hazards in craft breweries

Brewing, regardless of production scale, is considered part of the manufacturing industry. Workers produce beer through various processes that involve handling bags of ingredients, maneuvering hoses, transferring hot liquid between tanks, and packaging beer in cans, kegs, or bottles. Throughout the brewing process workers are exposed to occupational hazards including awkward body postures, lifting and carrying heavy loads, highly repetitive activities, sharp edges on materials and equipment, hot surfaces, and high levels of noise. Awkward body postures include any deviation from standing or at-rest postures (e.g. leaning, stooping, squatting, bending). Craft breweries are small operations that often lack resources to invest in expensive automated equipment, thus many tasks are completed manually. During MMH tasks, workers may be exposed to awkward postures for extended periods of time, excessive weight of loads moved, and high frequency of lifts. Previous occupational research in other industries has associated these exposures with an increased risk of a worker experiencing an occupational injury (Marras et al., 1993; Potvin, 2008; Punnett et al., 1991; Putz-Anderson et al., 1997; Waters et al., 1993).

Few specific elements of brewing work have been investigated regarding workers' risks of injury. The National Institute for Occupational Safety and Health (NIOSH) conducted a Health Hazard

Evaluation within a large brewery in Colorado, citing keg handling as a primary challenge (Mcglothlin et al., 2000). Keg handling was identified as a contributing factor to the risk of developing musculoskeletal disorders from a study done at a Canadian neighborhood pub (Jones et al., 2005). The combination of awkward body postures and heavy loads was also identified in previous research on keg handling during packaging operations in a Colorado craft brewery (Brents et al., 2019). Thermal burns are another hazard among craft brewing tasks. In May 2020, inspectors from the Occupational Safety and Health Administration (OSHA) issued general duty clause citations to two separate Colorado craft brewing facilities for the same issue – employees were exposed to burns from accidental contact with hot steam pipes.[1]

Craft breweries often include a space called a taproom to serve beer to customers. Taprooms present additional occupational hazards related to beverage and food handling. Depending on the size and layout of the building, craft brewing facilities often share space with the taproom or food service area. According to a 2018 professional trade organization survey, 17% of craft breweries had production/packaging and restaurant/taproom in the same space and 75% separated the two spaces with walls or floors. Approximately 8% of craft breweries had separate buildings for production/packaging and taproom/restaurant on the same campus (Brewers Association, 2020). When brewing spaces and taprooms share spaces, this overlap may create additional physical hazards (e.g. cramped quarters, slippery floors, broken glass, and cooking-related hazards). Additional numerous physical hazards exist for workers to become injured during craft brewing activities when the craft brewery includes a taproom.

[1] A template of the pending citation is presented in Appendix 8.1.

In a presentation by OSHA consultants from Colorado State University, 265 hazards were identified from 33 inspections of craft breweries during a six-month period (January to June 2019) (Colorado State University Health and Safety, 2019, slide 3). The most commonly identified hazards were related to a lack of hazard communication, improper electrical setup, lack of personal protective equipment and respiratory protection, lack of control of hazardous energy (due to lack of lock-out-tag-out or machine guarding), and fire safety issues.[2]

2.3.2. Occupational safety and health in breweries overview

No formal research on occupational injuries among craft brewery workers currently exists. In response to the rapid industry expansion, numerous published studies have investigated the economic diversity and cultural impact of the craft breweries (Duarte Alonso et al., 2018, 2017; Gatrell et al., 2018), but none have addressed occupational health and safety challenges. However, research of occupational injuries has been conducted in many other industries, including: wood product manufacturers in Ohio (Beery et al., 2014); agricultural workers in Colorado (Douphrate et al., 2009a, 2009b); construction workers in Colorado (Glazner et al., 2005; Schwatka et al., 2013); ambulance drivers in Ohio (Meyers, 2018); Midwestern grain handlers (Ramaswamy and Mosher, 2017); drywall carpenters in Washington (Schoenfisch, 2012), truck drivers in Kentucky (Chandler et al., 2017); seafood industry workers in Alaska, Oregon, and Finland (Kaustell et al., 2020; Syron et al., 2019; Syron et al., 2017); loggers in Montana and Idaho (Lagerstrom et al., 2017); and private industry workers in Ohio (Tarawneh et al., 2019; Wurzelbacher et al., 2016). Research methods used in previous WC studies among different industries may be applied to investigate occupational injuries among craft brewery workers. To

[2] A full list of the cited compliance hazards is presented in Appendix 8.2.

investigate occupational injuries within craft breweries, researchers may start with available information presented by national surveillance data and resources from professional trade organizations.

2.3.3. National injury surveillance

In the U.S., industries are categorized using the North American Industry Classification System (NAICS). This hierarchical system includes 20 two-digit classifications for broad industry and 96 subcategories with 317 industry groups (census.gov, 2020). The NAICS replaced the Standard Industrial Classification system in the early 1990s, as part of the North American Free Trade Agreement. This new four-digit classification system was the result of the collaboration between the Economic Classification Policy Committee (with representatives from Census Bureau, BLS, and the U.S. Office of Management and Budget), Statistics Canada, and the Instituto Nacional de Estadistica, Geografia, e Informatic (census.gov, 2020).

The subsector classification of beverage and tobacco product manufacturing (and 28 industries within this subsector) was introduced in 1995 as a part of Agreement Number 6 (census.gov, 2020). Breweries are under the subcategory of beverage manufacturing within the beverage and tobacco product manufacturing category (as outlined in Figure 2.2.). Beverage manufacturing includes the production of nonalcoholic beverages, alcoholic beverages through fermentation process, and alcoholic beverages through distillation. NAICS were first used by the U.S. Census Bureau in 1997 (census.gov, 2020).

- 31-33 Manufacturing
-- 312000 Beverage and tobacco product manufacturing
--- 312100 Beverage manufacturing
---- 312110 Soft drink and ice manufacturing
---- 312111 Soft drink manufacturing
---- 312112 Bottled water manufacturing
---- 312113 Ice manufacturing
---- 312120 Breweries*
---- 312130 Wineries
*includes (ale brewing, beer brewing, beverages, beer, ale, and malt liquors, manufacturing, breweries, lager brewing, malt liquor brewing, near beer brewing, nonalcoholic beer brewing, porter brewing, stout brewing).

Figure 2.2. Hierarchical coding system used by NAICS to classify breweries (census.gov, 2020)

The BLS stratifies injuries by industry using the NAICS hierarchical classification scheme to generate an annual injury report, known as the Survey of Occupational Injuries and Illnesses (SOII). Injury data are collected from companies in accordance with the Occupational Safety and Health Act of 1970 (Bureau of Labor Statistics, 2016). An injury is considered recordable if the injured worker experiences days away from work, requires restricted work or transfer to another job, requires medical treatment beyond first aid, experiences foreign bodies embedded in the eye, loss of consciousness, or death (Occupational Safety and Health Act of 1970, 29 CFR 1904.7 General recording criteria). Published BLS SOII data include annual counts and incidence rates per 100 full-time employees for occupational injuries and illnesses by industry. Statistics on injury nature, injured anatomical region, days away from work due to injury, time of day injury occurred, injury frequencies, and injury rates by industry are included in the BLS SOII data. Previous studies have investigated industry-specific injuries by selecting cases using national industry classification code systems. Beery et al. selected injury data specific to wood product manufacturing employees in Ohio using NAICS (Beery et al., 2014). NAICS is specific to US, Mexico, and Canada. In Finland, researchers selected injury data specific to fish farmers using Standard Industrial Classification Codes (Kaustell et al., 2020).

According to the 2018 BLS SOII data, reported injuries among beverage manufactures accounted for 0.3% of all reported injuries and illnesses (BLS, 2019). The majority of total recordable injuries within beverage manufacturing sub-industry classifications were soft drink manufacturing (48.0%) followed by breweries (21.1%), wineries (16.5%), bottled water manufacturing (7.2%), and ice manufacturing (3.3%) (Bureau of Labor Statistics, 2019). That same year, the BLS Census of Fatal Occupational Injuries reported three fatal occupational injuries (all transportation incidents) within soft drink manufacturing (Bureau of Labor Statistics, 2019).

In 2018, the incidence rate (IR) of total recordable nonfatal occupational injury and illness cases among breweries was 3.6 per 100 full-time employees, which was lower than the beverage manufacturing industry (IR 4.8), but higher than “all industries including private, state, and local government” (IR 2.8)

(Bureau of Labor Statistics, 2019). Each year between 2013 and 2018, the annual IR of occupational injuries in beverage manufacturing consistently exceeded that among "all industry" in the U.S.

While the IR reflects overall injury burden among brewery workers (and beverage manufacturing workers), details of the distribution of total recordable cases provides additional insight into injury characteristics. More than a third of injuries (34.4%) at breweries were due to slips, trips, or falls (STF), which was higher than both beverage manufacturing (23.4%) and all industry (26.7%) (Bureau of Labor Statistics, 2019). The percentage of injuries among breweries due to exposure to harmful substances and environments was three times higher (12.5%) than injury percentages within beverage manufacturing (4.3%) and all industry (4.5%) (Bureau of Labor Statistics, 2019). Examples of exposure to harmful substances or environments include extreme temperatures, water pressure, electricity, noise, and other harmful substances (cdc.gov, 2020). Thermal burns (from exposure to temperature extremes) accounted for 6.3% of reported injuries among breweries, more than five times higher than the percentage of burns affecting beverage manufacturers and all industry (both 1.6%) (Bureau of Labor Statistics, 2019). Burns and corrosions (from exposure to harmful substances such as acids and caustics) were also elevated among brewery workers (3.1%) compared to beverage workers (1.3%) and all industry workers (0.4%) (Bureau of Labor Statistics, 2019).

NAICS offers a simple hierarchical system to organize industries, but this classification system may overgeneralize industries. Currently, available injury data from the BLS SOII represent all breweries (both large and craft breweries) within the beverage manufacturing industry category. Work environments, including physical hazards, differ between large and craft breweries. Craft breweries are smaller in terms of volume of produced beer and number of employees. A craft brewery in the U.S., by definition, must produce less than six million barrels annually (7.04 million hectoliters) (Alworth, 2015). To contrast, Anheuser-Busch InBev, one of the largest brewing corporations in the world, annually produces more than 500 million barrels (600 million hectoliters) (Institute and National Beer Wholesalers Association, 2019). Large breweries have much higher production demands and have more resources to

invest in highly automated equipment. While some craft breweries also have automated systems, the majority of facilities rely on manual methods. Given the different work environments between craft and large breweries, developing injury prevention guidelines exclusively based on injury data that do not differentiate between them may lead to ineffective workplace improvement strategies for craft breweries.

In addition to different production demands and sizes, craft breweries are not well represented in the BLS SOII data. According to U.S. Census Bureau, in 2017, there were 3,211 brewery beverage manufacturing firms identified by NAICS 312120 in the entire U.S. (census.gov, 2019). However, according to a professional trade organization, there were 8,836 operational breweries in the U.S. and 98% identified as craft breweries (Brewers Association, 2019). Therefore, more than 5,000 craft breweries were not included in the NAICS database. The reason for the lack of craft brewery representation among the NAICS database is twofold; first, brewpubs (craft breweries with a restaurant component) are classified under NAICS as restaurants instead of breweries; secondly, the SOII is based on injury records per a federal recording and reporting requirement that applies to businesses with more than ten employees (Occupational Safety and Health Act of 1970, 29 CFR 1904.1 Partial exemption for employers with 10 or fewer employees). While a professional trade organization estimated that there were 19.2 workers per craft brewery in 2019 (161,007 workers employed among the 8,386 craft breweries), this value includes waitstaff and brewpubs (correspondence with Brewers Association Chief Economist, 2020). As previously described, brewpubs are classified under different NAICS than other craft breweries. If craft breweries are exempt from federal reporting requirements due to workforce size or are not classified as breweries (as is the case with brewpubs), they are unlikely to be represented in the BLS SOII national injury surveillance databases.

2.3.4. Professional trade organizations

Professional trade organizations provide essential services, including surveillance data, to the craft brewing industry. These data are primarily focused on production and distribution metrics. While these professional trade organizations lack (formal) injury surveillance systems, they offer numerous safety

resources. In Colorado, professional trade organizations specific to the craft brewing industry include the Master Brewers Association of the Americas, the Brewers Association, and the Colorado Brewers' Guild. Each organization is discussed below:

The Master Brewers Association of the Americas, established in 1887, is an international professional trade organization that provides brewing education, technical information, and continuous improvement strategies to its members. As of 2020, the Master Brewers Association of the Americas has more than 4,000 members in more than 50 countries. The Master Brewers Association of the Americas began publishing technical quarterly journals in 1964. Their membership consists of individuals involved in the beer business and does not differentiate between craft, non-craft, big, small, domestic, or global brewers (Master Brewers Association of the Americas, 2020). The Master Brewers Association of the Americas has an extensive online library of technical safety documentation for best practices.

The Brewers Association, founded in 1978, is a national professional trade organization whose primary purpose is to promote and to protect the development and growth of the craft brewing industry. As of 2020, the Brewers Association had more than 5,600 members (Brewers Association, 2020). The Brewers Association is responsible for the formal definition of craft breweries: small, independent, beer brewers. The Brewers Association monitors craft beer production, distribution, openings/closings, and employment data (focusing on salary and wages). Throughout the year, the Brewers Association publishes supportive resources, hosts virtual seminars, and facilitates an annual conference. Within the last five years, the Brewers Association has allocated resources to emphasize safe brewing practices among their members. In 2015, the Brewers Association introduced a safety ambassador position and collaborated with Grand Valley State University to develop free online safety training videos. These 14 video modules address how to avoid acute and traumatic injuries, such as extreme temperatures and

chemical exposures associated with common craft brewing tasks (Brewers Association, 2019).[3] In 2018, the Brewers Association collaborated with the University of Colorado Business School to administer an online safety survey to measure workers' perceptions of safety culture across craft breweries in the US. Results of this study (presented at the mid-year 2020 virtual Craft Brewers Conference) identified a disconnect between employees and employers on perceptions of safety (Brewers Association, 2020). The Brewers Association addressed opportunities for improvement in communication, training, and development (or enhancement) of written programs (Brewers Association, 2020).

The Colorado Brewers' Guild, established in 1995, is state-level professional trade organization that promotes and protects Colorado craft breweries. As of 2020, the Colorado Brewers' Guild has more than 250 members. The Colorado Brewers' Guild primarily tracks production and employment within the industry and hosts an annual technical conference. In 2019, the Colorado Brewers' Guild launched its own independent insurance agency, the Brewers Insurance Cooperative of Colorado LLC (Brewers CoOp), to provide industry specific support and to help reduce insurance cost. As the Brewers CoOp grows, there is a plan to create a pooled WC insurance program (coloradobeer.org, 2019).

2.3.5. Occupational Safety and Health Administration Craft Brewing Alliance

In November 2018, OSHA implemented a Local Emphasis Program to prioritize safety inspections of establishments classified as beverage manufacturing facilities within Colorado. OSHA expanded this program to be a Regional Emphasis Program in October 2019, including all states in Region VIII (Colorado, North Dakota, South Dakota, Wyoming, Montana, Utah). The goal of all OSHA Emphasis Programs (Local and Regional) is to increase safety compliance, to decrease rates of injuries, and to

[3] A full list of the modules available on the Brewers Association online safety training program is in Appendix 8.3.

improve worker safety and health in that targeted industry (in this case, beverage manufacturing environments). Pending any revisions or extensions, the beverage manufacturing Regional Emphasis Program within OSHA Region VIII will expire on September 30, 2024 (OSHA, 2020).

As the beverage manufacturing Regional Emphasis Program was launched, an alliance was established between OSHA and craft brewing trade organizations (the Brewers Association, the Master Brewers Association of the Americas, and the Colorado Brewers' Guild). The purpose of this alliance was to create a working partnership between OSHA and the craft brewing community. The goal of this collaboration is to reduce injuries affecting craft brewery workers. Alliance members meet quarterly to discuss enforcement challenges and current events related to occupational health and safety in craft breweries.

The lack of formal injury surveillance data within the craft brewing industry is a substantial hindrance to researchers and stakeholders who wish to understand the true burden of injuries in this occupational cohort. No single uniform database exists. While national injury surveillance databases provide general injury statistics and professional trade organizations provide educational resources, WC data provide information on injuries affecting a specific industry (in this case, craft breweries).

2.4. Workers' compensation

2.4.1. Overview of workers' compensation

Employers across the U.S. are required to provide WC insurance to cover costs associated with occupational injuries (Utterback et al., 2014). Associated costs from an occupational injury may include medical expenses (e.g. costs associated with emergency responders, hospital stay, surgeries, medical procedures, and diagnostic tests), rehabilitation (e.g. physical therapy), occupational therapy (training for new skills if the injured worker is unable to return to their original job), long-term disability, lost wages due to injury (2/3 weekly wages), employer liability (e.g. legal and administrative costs associated with

liability claims and lawsuits fighting fraudulent WC claims), and beneficiary costs (e.g. burial, settlements in the case of a worker's death) (Colorado.gov, 2020).

In the U.S., each state chooses to be monopolistic or non-monopolistic regarding WC insurance coverage. Monopolistic states require businesses to purchase WC insurance from a single state-run insurance fund. As of 2020, North Dakota, Ohio, Washington and Wyoming are the only monopolistic states in the U.S. Non-monopolistic states allow businesses to purchase WC insurance from private insurance companies (National Association of Insurance Commissioners, 2020).

Regardless of where a business purchases WC insurance, the process is as follows: An employer (policy holder) purchases a WC insurance package from the insurance provider. The policy holder pays an annual premium. The premium is calculated from the policy holder's industry multiplier (established annually by a third party monitoring organization), the policy holder's company's size (estimated by annual payroll), and the policy holder's experience modifier (presented in Formula 2.1). The experience modifier is calculated based on the last three years of the policy holder's reported injuries that incurred costs. A policy holder is not assigned an experience modifier until they have existed for at least three years. Premiums typically fluctuate annually. To decrease premium costs, a policy holder may incorporate a deductible plan, where the policy holder assumes some risk and by setting aside a predetermined amount of money to cover occupational injury related costs. A higher deductible decreases the annual premium costs because the policy holder themselves will cover more occupational injury related costs before the insurance provider begins payments. In non-monopolistic states, businesses may negotiate cheaper premiums with different private WC insurance providers.

$$Annual\ Premium\ (\$) = (industry\ multiplier)\ \times (experience\ modifier)\ \times (payroll(\$))$$

Formula 2.1. Annual WC premium estimation

2.4.2. Workers' compensation in Colorado

Per the 1915 Colorado Workers' Compensation Act, businesses with more than one employee are legally required to provide WC insurance to cover the costs of occupational injuries. Full and part-time employees must be covered. An employee is defined as someone hired to perform services for pay (Colorado Department of Labor and Employment, 2020). Independent contractors must provide a certificate of insurance to prove they have their own WC insurance. Per the Colorado Workers' Compensation Act, workers whose occupational injuries cause them to miss three or more shifts are eligible for lost wages (indemnity). Colorado is a "no-fault state" regarding WC insurance. Therefore, occupational injuries due to carelessness by the employee or employer negligence are still covered, unless activities leading to claims are willful or illegal. In 2017, Colorado Governor Hickenlooper signed the Uninsured Employer Act (House Bill 17-1119, Article 67) to protect employees of uninsured or underinsured employers. The Uninsured Employer Act provides funds (the Colorado Uninsured Employer Fund) to pay employees for insufficiency in employer coverage and empowers the Colorado Division of Workers' Compensation in the Department of Labor and Employment to collect funds from delinquent employers (Colorado Department of Labor and Employment, 2020). The Colorado Uninsured Employer Fund became accessible to provide financial assistance to eligible injured workers on January 1, 2020 (Colorado Department of Labor and Employment, 2020).

Since 1987, Colorado has been a non-monopolistic state regarding WC. Businesses purchase WC insurance from a variety of providers. Employers may obtain WC insurance by purchasing a plan from a commercial insurance provider or by providing evidence of self-funding (either individually or through groups and/or pools). The following sections describe the different types of WC insurance coverage:

- **Commercial insurance provider:** There are more than 500 private commercial WC insurance carriers in the U.S. Pinnacol Assurance insures most companies in Colorado. Originally known as the State Compensation Insurance Fund, Pinnacol Assurance began operating in 1915 when the Colorado Workers' Compensation Act was enacted. When Colorado transitioned to a

non-monopolistic state in 1987, Pinnacol Assurance became a quasi-public authority, meaning that Pinnacol Assurance will work with any company and any industry (Pinnacol.com, 2020). Pinnacol Assurance offers competitive rates and covers businesses that were declined by other carriers. Pinnacol Assurance offers discounts and incentive programs for businesses that implement safety programs and maintain positive safety records (Pinnacol.com, 2020).

- **Self-funding (individual):** To qualify for individual self-funding WC insurance, the company must meet the following requirements: exist for at least five years (or be a subsidiary of a company that is at least five years old), employ at least 300 full-time employees in Colorado, and/or have a parent company with assets of at least $100 million USD (colorado.gov, 2020). The Executive Director of the Colorado Department of Labor and Employment issues a special permit for self-insurers that must be renewed annually.
- **Self-funding (group and/or pool):** To qualify for a group/pool self-funding WC insurance, a company may pool its liability with other businesses in a similar industry. The Division of Insurance in the Department of Regulatory agencies assists companies in joining and/or forming pools.

Once a company purchases a WC insurance policy, the reporting procedure is typically as follows: When a worker experiences an occupational injury, that individual must inform their employer of the injury within four days. The injured worker is then referred to as the claimant. The claimant's supervisor completes a First Report of Injury form (FROI) within ten days. This form includes the claimant's demographic and employment information, as well as details about the injury incident (date, time, injury

nature, injury event, and injured anatomical region).[4] There is also a free response section on the FROI form that provides additional space to detail the accident. This section is known as the accident narrative. The policy holder must contact the WC insurance provider within that same ten day window. If the WC claim is admitted and accepted, the WC insurance provider coordinates with the claimant to cover relevant costs. If the plan includes a deductible, the policy holder will cover costs until the deductible is met, at which point the WC insurance provider assumes coverage. The WC insurance provider is also responsible for notifying the Colorado Division of Workers' Compensation with a letter of claim admission or denial within 20 days.

The Colorado Division of Workers' Compensation is a state agency (part of the Colorado Department of Labor and Employment) that administers and enforces WC law in Colorado. The Colorado Division of Workers' Compensation oversees and provides resources for WC insurance providers, employers, claimants, and health care providers. The Colorado Department of Labor and Employment (and Colorado Division of Workers' Compensation) may fine employers who fail to provide adequate insurance up to $250 per day per employee. Additionally, the Colorado Department of Labor and Employment has the authority to issue cease and desist orders and shut down businesses for not holding WC insurance.

For injury tracking and premium calculations, industries are often classified by codes under the National Council on Compensation Insurance (NCCI). The Colorado Division of Workers' Compensation reports injury metrics to the NCCI which are used to establish insurance rates. The NCCI was founded in 1923 to track and analyze WC information. The NCCI consists of four-digit codes used to classify companies by industry and associated work tasks. The NCCI is a third-party organization that analyzes

[4] An example of Pinnacol Assurance's FROI is available in Appendix 8.4.

injury trends in order to provide objective insurance rates (NCCI.com, 2020). The NCCI annually reviews WC claims by industry and calculates premiums. States may designate NCCI as their licensed statistical organization and mandate that insurance companies use NCCI classification schemes. Monopolistic states have their own reporting system and estimate their own premiums. Non-monopolistic states that choose to not use the NCCI classification schemes estimate their own premiums and are referred to as independent bureau states. As of 2020, independent bureau states include California, Delaware, Indiana, Massachusetts, Michigan, Minnesota, New Jersey, New York, North Carolina, Pennsylvania, and Wisconsin (NCCI.com, 2020). Colorado is a non-monopolistic state and collaborates with the NCCI to calculate WC premiums.

NCCI codes are applied to reflect the most appropriate type of work performed by the employees at a company. Therefore, the policy holder may be assigned multiple NCCI codes. For example, NCCI codes assigned to craft breweries may include (but are not limited to) breweries & drivers (NCCI#2121), restaurants not otherwise classified (NCCI#9082), salespersons or collectors-outside (NCCI#8742), bar, discotheque, lounge, nightclub or tavern (NCCI#9084), and clerical office employees not otherwise classified (NCCI#8810). Similar to NAICS codes, the NCCI classification scheme does not differentiate companies by size (employment or production). Therefore, it is impossible to determine if a business is a craft brewery solely by NCCI code assignment.

2.4.3. Brief description of workers' compensation limitations

Researchers may use workers' compensation data to understand injuries and illnesses affecting a specific industry (in this case, craft breweries in Colorado). However, this approach has limitations. The data only represent workers who filed a claim. Underreporting of injuries by employees is a significant limitation with WC data. Work-related injuries may not be reported for multiple reasons, including stigmatization with reporting, lack of knowledge of the WC system, lack of resources to cover lost work time, and disincentives from supervisors to report (Azaroff et al., 2002; Douphrate, 2008; Meyers, 2018; Schwatka et al., 2013). Workers' compensation premiums are often based on experience modifiers, which

are calculated from claim frequency and costs associated with claims. Therefore, in an attempt to lower the experience modifier (and lower premium costs), companies might be incentivized to not report an injury or to underreport the true costs associated with a claim (Azaroff et al., 2002; Douphrate, 2008).

Workers' compensation data only represent injured workers and therefore might not be representative of the overall industry demographics. Researchers can search for overall industry demographic data from other resources, including national workforce and professional trade organizations' surveillance data. An example of a professional trade organization providing demographics data is a nation-wide survey conducted by the Brewers Association in 2018 (Brewers Association, 2020). Researchers could also compare WC data to other injured workforce data. The Colorado Division of Workers' Compensation publishes an annual report detailing injuries by industry and demographics. However, the annual report by the Colorado Division of Workers' Compensation only includes severe claims (those that resulted in indemnity or medical costs). Data directly available from WC insurance providers often include claims that both did and did not result in indemnity or medical costs.

Researchers could also compare WC data to national injury surveillance databases. Industry classification systems and reporting criteria can present challenges to researchers. Since Colorado is a non-monopolistic state, brewery owners may purchase WC insurance from a variety of insurance providers. Thus, even if researchers partnered with the largest WC provider in Colorado (Pinnacol Assurance), not all craft breweries are guaranteed to be included in the dataset. Despite these limitations, WC data provide unique information regarding injury costs, injury event, injury nature, and injured anatomical regions among targeted occupational groups. This information can be used to improve researchers' and stakeholders' understanding of the relationship between occupational injuries and craft brewing tasks and to develop injury prevention guidelines for the industry.

2.5. Injury classification

2.5.1. Injury classification overview

Data from WC claims include claimant demographic and injury information. Injury classification systems structure and organize injury characteristics based on data from injury reports (including WC claims data). Analyzing claimant and injury information provides insight into injury characteristics among a population of interest (in this case, craft breweries). The accident narrative from WC data provides additional information not captured within injury classification systems.

2.5.2. Occupational Injury and Illness Classification System

Within WC injury classification, insurance companies apply a revised version of the Occupational Injury and Illness Classification System (OIICS) to organize data. In 1992, the BLS developed OIICS as a hierarchical classification scheme to uniformly characterize injuries and incidents. The OIICS was redesigned and revised in 2010 and 2012. The most recent version of OIICS is referred to as v2.01 (cdc.gov, 2020). NIOSH collaborated with the BLS to develop a searchable digital interface for OIICS. The purpose of this digital interface is to assist researchers, policy makers, employers, and other relevant parties who are interested in understanding occupational injury data from national injury surveillance reports. The OIICS hierarchical coding structure includes the nature of injury, affected part of body, injury event, and source.[5] Injury nature represents the principal physical characteristic of the injury. Part of body represents the anatomical region directly affected by the injury nature. The injury event is the manner in which the injury or illness was produced by the source. The source represents objects or factors

[5] The hierarchical coding structure is available in Appendix 8.5.

responsible for the injury. However, limiting source to two factors prevents injuries with multiple contributing factors from being represented appropriately.

2.5.3. Accident narratives

Instead of depending exclusively on OIICS information within WC data and claimant demographics, researchers may obtain valuable information from the accident narratives obtained from the FROI form filed after the injury. The FROI contains a free-response section referred to as the accident narrative. The claimant and their supervisor may provide a detailed account of the injury incident in the accident narrative. Researchers may use accident narratives to select specific cases, identify work task at time of injury, and/or identify contributing factors using injury investigation methods.

Keyword searches within the accident narrative enable researchers to select claims associated with specific injury details not otherwise found on the FROI or identified by OIICS. Syron et al. identified specific work tasks among commercial fishers in Oregon and Alaska from accident narratives (Syron et al., 2017; Syron et al., 2019). Lagerstrom et al. used accident narratives from incident reports to determine loss of control events among fatal all-terrain vehicle events (Lagerstrom et al., 2016). Douphrate et al. used accident narrative details to identify tractor-rollovers and livestock-handling related injuries among agriculture workers (Douphrate et al., 2009b, 2009a). Schoenfisch et al. used accident narratives from WC and private health insurance claims to isolate a specific type of worker (drywall-carpenters) from a large WC dataset of construction workers (Schoenfisch, 2012). Beery et al. searched within accident narratives to identify saw-related claims among wood manufacturing injuries (Beery et al., 2014).

In addition to using accident narratives to select specific injury characteristics, contributing factors to injury may be identified from the same bodies of text in order to gain insight into injury etiology. Occupational injury literature (regardless of industry) frequently emphasizes the numerical distributions and rates of coded WC data (Kaustell et al., 2020; Ramaswamy and Mosher, 2017). This approach provides valuable information on where hazards are within an industry, but lacks insight into injury

etiology (Park, 2002). Park recommends a systematic analysis of injury cases (through accident narratives) to understand the exposures that contributed to the injury incident (Park, 2002). While more time-consuming, the results provide more comprehensive insight that may lead to the development of better prevention strategies.

2.5.4. Analysis of accident narratives

The epidemiological triangle is a simple approach to identify contributing factors from accident narratives (see Figure 2.3.). This one-dimensional model consists of three exposure categories: the external agent, the susceptible host, and the environment that brings the two together (cdc.gov, 2020). In terms of occupational injury analysis, the agent represents the energy, the host represents the injured worker, and the environment represents the physical and social environments where the injury incident occurred. The vehicle, an additional component of the epidemiological triangle, is the entity responsible for the agent interacting with the host (Runyan, 1998). Lagerstrom et al. applied the epidemiological triangle model to classify incident reports among fatal all-terrain vehicle accidents in order to investigate the interaction between helmet-use (host), type of crash (agent), and location of death (environment) from the data provided by the U.S. Consumer Product Safety Commission (Lagerstrom et al., 2016). Douphrate et al. used the epidemiological triangle model to characterize accident narratives in WC data to investigate the relationships between agriculture workers (host), livestock or tractor-rollover events (agent), and dairy parlor or livestock pen (environment)(Douphrate et al., 2009b, 2009a).

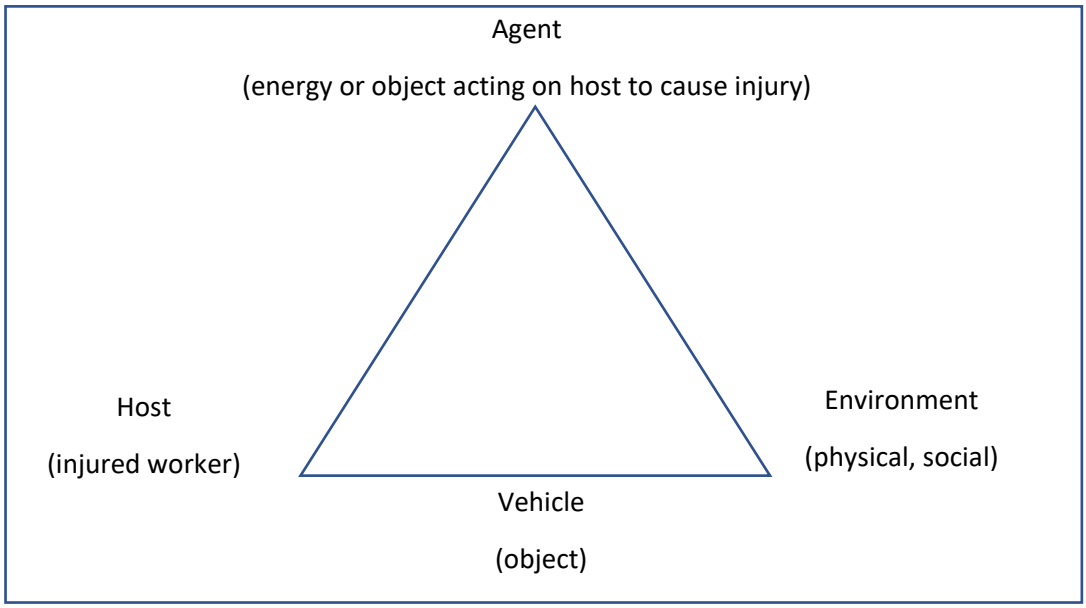

Figure 2.3. Epidemiological triangle model (including vehicle)

Haddon expanded on the epidemiologic triangle by adding three temporal aspects to the injury producing event (before, during, after) to each exposure category (agent, host, environment) (Haddon, 1968; Runyan, 2003). Haddon's primary research focused on investigating motor vehicle accidents and categorizing contributing factors for injury in order to identify potential prevention strategies within a highway safety context. The environmental exposure category represented both the physical surroundings that contributed to the injury-producing event (e.g. roadway, weather, and other physical characteristics) and the social environment (e.g. drunk driving, texting while driving, and seatbelt usage). In 1994, researchers established that Haddon's matrix could be successfully applied to other industries (Runyan, 2003). Haddon's matrix framework was applied to identify factors contributing to construction injuries at the Denver International Airport (Glazner et al., 2005). Runyan recognized Haddon's matrix as a useful tool for guiding epidemiologic research, conceptualizing etiological factors, and developing prevention strategies (Runyan, 2003).

2.6. Literature review conclusion

The craft brewing industry has experienced rapid growth within the U.S. and Colorado. Craft brewing work environments contain physical hazards associated with increased risks of occupational injury, and yet no formal studies have investigated the burden of occupational injuries among craft brewery workers. National injury surveillance data provide general information, but the inability to differentiate between large and craft breweries could lead to less effective prevention strategies for craft breweries. Professional trade organizations track information specific to craft breweries but provide educational materials rather than injury surveillance data. Workers' compensation data have been used to understand injuries among many other occupational cohorts, but has not been previously used to analyze injuries among craft brewery workers. Analysis of WC data provides information on injured workers' demographics, employment history, injury costs, injured anatomical region, injury nature, and injury event within a selected industry. Thus, WC data can be a useful resource for understanding the burden of injuries within Colorado craft breweries. Analyzing qualitative data from the accident narratives enables researchers to identify contributing factors related to occupational injuries. The identification of contributing factors to occupational injuries among craft brewery workers may lead to the development of targeted injury prevention strategies. Additionally, a combination of WC analysis and accident narrative analysis may help researchers understand the state of occupational health and safety within craft breweries and lead to the development of industry guidelines and prevention measures to reduce the risk of occupational injuries.

CHAPTER 3: METHODS

3.1. Methods overview

The following section describes how Specific Aims 1, 2, 3, and 4 of this dissertation were achieved. All results were based on workers' compensation (WC) claims data specific to craft breweries in Colorado. The process in which WC claims data were collected is described followed by a description of the variables and statistics used to achieve each specific aim. Research hypotheses and research objectives statements are also outlined.

3.2. Description of Dataset

3.2.1. Claims selection criteria

Researchers collaborated with Colorado's largest WC insurance carrier, Pinnacol Assurance, to obtain a database of WC claims filed and policies held by craft breweries between July, 2013 and June, 2018. One common data collection method among previous WC studies was to sort claims by NCCI or NAICS codes (Beery et al., 2014; Douphrate et al., 2006; Lagerstrom et al., 2017; Schwatka et al., 2013; Syron et al., 2017). However, the NAICS classification for breweries does not differentiate between large and craft breweries. Furthermore, craft breweries may be assigned multiple NCCI codes. Therefore, selecting cases solely using NAICS or NCCI codes was inappropriate. Instead, personnel from Pinnacol Assurance selected claims through a combination of searches by NAICS codes, NCCI codes, and company descriptions. Personnel from Pinnacol Assurance removed personal identifiers (e.g. company names and addresses) prior to providing the dataset to the researchers. Only closed WC claims were selected for the present study, meaning that selected claims were no longer incurring additional medical or indemnity costs. Data extracted from the First Report of Injury form (FROI) included claimant demographics (age, sex, tenure), injury details (nature, event, anatomical region), claim type, costs, and accident narrative.

The present study was submitted to and approved by the Colorado State University Institute Review Board (granted an exemption due to the anonymized nature of the dataset).

3.2.2. Injured anatomical region defined

The injured anatomical region, reported in the FROI form, identified the body part directly affected by the injury incident. For the present study, head, neck, and torso were all collapsed into the trunk region. Previous research on injuries within a specific cohorts (grain handling, biofuels production, rock climbing, dairy, cattle, and livestock workers) have referred to the head, neck, and torso collectively as a single body region (Douphrate et al., 2009b; Ramaswamy and Mosher, 2018, 2017; Schöffl et al., 2013). The hand/fingers, forearm, arm, and shoulder were collapsed into the upper limb region. The foot, leg, knee, thigh, and hip were collapsed into the lower limb region. Claims not included within the trunk region, upper limb, or lower limb injured anatomical region categories were collapsed into a category called "other." For analysis, injured anatomical regions were collapsed into four main categories: upper limb, lower limb, trunk region, and "other." Each body part per injured anatomical region, including the "other" category, is listed in Table 3.1.

Table 3.1. Injury categories by injured anatomical region

Upper Limb	Trunk region	Lower Limb	"Other"
Elbow	Abdomen/Groin	Ankle	Multiple Body Parts
Finger(S)	Buttocks	Foot	No Physical Injury
Hand	Chest	Knee	Unclassified
Lower Arm	Ear(S)	Lower Leg	
Shoulder(S)	Eye(S)	Upper Leg	
Thumb	Facial Bones		
Upper Arm	Head/Skull		
Wrist	Hip		
	Low Back		
	Lung		
	Mouth		
	Neck Vertebrae		
	Nose		
	Upper Back Area		

3.2.3. Injury nature defined

The purpose of injury nature was to describe the principal physical characteristic of the injury and was classified according to OIICS. Injury nature was extracted from the FROI form in the present study. More than 80% of claims were associated within one of the four injury nature categories (burn, contusion, laceration, and sprain/strain). Injury nature was collapsed into five categories with "other" being the fifth category. The five injury nature categories used in the present study were:

- **Burns** were considered tissue damage resulting from exposure to a variety of sources, including heat, flame, hot substance, chemical exposure, or radiation. Common types of burns included thermal, scalding, and chemical burns (cdc.gov, 2020).
- **Contusions** (also referred to as bruises) were considered injuries to the body's surface without causing an open wound. Swelling may or may not occur during a contusion.
- **Lacerations**, also known as cuts, were the result of soft tissue tears. Lacerations may also include open wounds.
- **Sprains/strains** were injuries affecting muscles, joints, tendons, and ligaments. Specifically, sprains involved the stretching or tearing of ligaments and strains involved the stretching or tearing of muscles and tendons (cdc.gov, 2020).
- **"Other"** included "all other," "all other cumulative injuries," foreign body, puncture, dermatitis, fracture, poisoning-chemical, concussion, electric shock, hernia, dislocation, crushing, hearing loss, inflammation, and respiratory disorders.

3.2.4. Injury event defined

Injury event described the source of energy that produced the injury and was extracted from the FROI form. More than 50 different injury event details corresponded to seven injury event categories of the OIICS scheme within the dataset (contact with objects and equipment, exposure to harmful substances or environments, STFs, fire and explosion, overexertion and bodily reaction, transportation incident, and

violence and other injuries by persons or animals). In the present study, more than 90% of claims were associated with four injury event categories (contact with objects and equipment, exposure to harmful substances or environments, STFs, and overexertion and bodily reaction). Therefore, injury event was collapsed into five categories with "other" as the fifth category.[6] The injury event category "other" included violence and other injuries by persons or animals and fires and explosions. The five injury event categories used in the present study were:

- **Contact with objects and equipment** included struck by falling objects, stationary objects, tools, moving parts, and other objects; caught handled objects or machinery; and foreign body in eye.
- **Exposure to harmful substances or environments** included cuts, burns, electric shock, and explosion.
- **Slips, trips, or falls (STFs)** included instances of falls (or slips or trips) on the same level, different levels, stairs, ice, snow, liquid or grease spills, or from a ladder or scaffolding.
- **Overexertion and bodily reaction** included repetitive motion, strains from lifting, twisting, pulling, pushing, holding, carrying, and reaching as well as cumulative related events.
- **"Other"** included violence and other injuries by persons or animals and fires and explosions.

3.2.5. Claimant demographics defined

Claimant age and claimant tenure were the primary demographic variables of interest in the present study. Claimant age represented how old the claimant was at the time of injury (in years). Age was presented continuously in the FROI form and was analyzed both continuously and categorically. Claimant age was grouped into five categories: ≤24 years old, 25-34 years old, 35-44 years old, 45-54 years old,

[6] A complete list of injury event details and corresponding category is available under Appendix 8.6.

and ≥ 55 years old. Ten-year gaps were chosen based on how age was categorically presented in national datasets (including the BLS SOII and Census Bureau information) as well as in previous WC studies (Lagerstrom et al., 2017; Schwatka et al., 2013; Syron et al., 2017). By grouping claimant age in a similar manner to existing databases and studies, researchers were able to compare the burden of injuries among craft brewery workers to other industries. Claimant sex was classified as male or female. Claimant tenure represented the duration of a claimant's employment at the time of injury (reported in days but converted to years for analysis). Tenure was grouped into six categories: < 1 year (0 to 364 days), ≥ 1 to < 2 years (365 to 729 days), ≥ 2 to < 3 years (730 to 1,094 days), ≥ 3 to < 4 years (1,095 to 1,459 days), ≥ 4 to < 5 years (1,460 to 1,824 days), and ≥ 5 years (1,825 days or more).

3.2.6. Claim type defined

Each WC claim was assigned a specific claim type by Pinnacol Assurance. Claim type was classified as medical-only or medical-plus-indemnity. Medical-only claims represented claims where injuries only required medical treatment. Medical-plus-indemnity claims represented the claims associated with injuries that incurred lost wages in addition to medical treatment. Claim type can be applied as a representation for claim severity, where claims classified as medical-plus-indemnity represent more severe injury cases.

3.3. **Specific aims and statistical methods**

Details of unique methods, descriptive statistics, and statistical tests used for each specific aim are described in the sections below. Significance for all tests were based on $\alpha = 0.05$. Analyses were performed in RStudio Version 1.2.1335.

Specific Aim 1: *To characterize workers' compensation claims in the Colorado craft brewing industry between July, 2013 and June, 2018.*

The purpose of Specific Aim 1 was to analyze claims based on injured anatomical region, injury nature, injury event, claimant age, and claimant tenure. All claims were used in the statistical analyses.

Research Hypotheses and Statistical Methods:

1.1. Of the three injured anatomical regions (upper limb, lower limb, and trunk region), the most frequently injured anatomical region is the upper limb.

Descriptive statistics: The number of claims and distribution of claims by injured anatomical region were calculated.

Statistical test: Analysis using a Chi-square Goodness of Fit test was performed to determine if there are significant differences in the distribution of claims by injured anatomical region.

H_0: The distribution of claims by injured anatomical region is the same across the three anatomical regions.

H_a: The distribution of claims by injured anatomical region is not the same across the three anatomical regions.

1.2. Of the five injury nature categories (burn, contusion, laceration, sprain/strain, and "other"), the most frequent injury nature category is contusion.

Descriptive statistic: The number of claims and distribution of claims by injury nature category were calculated.

Statistical test: Analysis using a Chi-square Goodness of Fit test was performed to determine if there are significant differences in the distribution of claims by injury nature.

H_0: The distribution of claims by injury nature is the same across the five injury nature categories.

H_a: The distribution of claims by injury nature is not the same across the five injury nature categories.

1.3. Of the five injury event categories (contact with objects and equipment, exposure to harmful substances and environment, STFs, overexertion and bodily reaction, and "other"), the most frequent injury event category is exposure to harmful substances and environments.

Descriptive statistic: The number of claims and the distribution of claims by injury event category were calculated.

Statistical test: Analysis using a Chi-square Goodness of Fit test was performed to determine if there are significant differences in the distribution of claims by injury event.

$H_{0:}$ The distribution of claims by injury event is the same across the five injury event categories.

H_a*:* The distribution of claims by injury event is not the same across the five injury event categories.

1.4. Of the five age categories (≤ 24 years old, 25-34 years old, 35-44 years old, 45-54 years old, and ≥ 55 years old), claims are most frequently reported among claimants aged between 25 and 34 years old.

Descriptive statistic: The number and distribution of claims by age categories were calculated. The median (interquartile range) and mean (standard deviation) age were calculated as well.

Statistical test: Analysis using a Chi-square Goodness of Fit test was performed to determine if there are significant differences in the distribution of claims by age category.

$H_{0:}$ The distribution of claims by age category is the same across the five categories.

H_a*:* The distribution of claims by age category is not the same across the five categories.

1.5. Of the six tenure categories (< 1, ≥ 1 to < 2, ≥ 2 to < 3, ≥ 3 to < 4, ≥ 4 to < 5, and ≥ 5 years), claims are most frequently reported among claimants with less than one year of tenure.

Descriptive statistic: The number and distribution of claims by tenure category were calculated. The median (interquartile range) and mean (standard deviation) tenure duration were calculated as well.

Statistical test: Analysis using a Chi-square Goodness of Fit test was performed to determine if there are significant differences in the distribution of claims by tenure.

$H_{0:}$ The distribution of claims by tenure is the same across the six tenure categories.

$H_{a:}$ The distribution of claims by tenure is not the same across the six tenure categories.

Specific Aim 2: *To determine how total claim costs (medical costs plus indemnity costs) are related to injury characteristics.*

The purpose of Specific Aim 2 was to assess the relationship between the variables analyzed in Specific Aim 1 (injured anatomical region, injury nature, injury event, claimant age, and claimant tenure) in the context of cost.

Claim costs represented the financial cost associated with a claim. In the FROI, claim costs were presented as medical and indemnity. Medical costs were specific to costs associated with treating the occupational injury (medical treatments). Indemnity costs represented lost wages and were indicative of more severe injuries (those that incurred lost time and required wage compensation). For the present study, medical and indemnity costs per claim were added together to create a new cost variable, total costs. Total costs represented the sum of medical and indemnity costs associated with a specific claim. All cost variables were adjusted using the BLS Consumer Price Index inflation calculator to the most recent year of claims in the dataset (2018).

Since the WC claims data were skewed and zero-inflated, non-parametric statistical tests were performed to investigate relationships between categorical variables and total claim costs. Analysis using statistical tests were performed on total costs because this variable represents the sum and overall direct financial burden of injuries. Analysis using a Kruskal-Wallis test was performed to determine if the distribution of a continuous variable (cost) is different among categorical variables. If $p < 0.05$, the null hypothesis (that the distribution of cost is similar among the categories) was rejected and there was evidence of a relationship between the distribution of cost and categories. Analysis using a Mann-

Whitney U test was performed if the null hypotheses from the Kruskal-Wallis tests was rejected. Analysis using the Mann-Whitney U test was performed to compare the distribution of cost between pairs of categories to assign rank. If $p < 0.05$, the null hypothesis (that the distribution of costs is similar between pairs of categories) was rejected. All claims (those that incurred costs and no costs) were represented.

Research Hypotheses and Statistical Methods:

2.1. Injuries to the upper limb anatomical region incur the greatest median claim costs relative to lower limb and the trunk region.

Descriptive Statistics: The median (and interquartile range) medical, indemnity, and total claim cost were calculated by injured anatomical region (as well as mean and standard deviation).

First Statistical Test: Analysis using a Kruskal-Wallis test was performed to determine if the distribution of total claim costs is similar among injured anatomical regions.

H_0: The distribution of total claim costs is the same across all injured anatomical regions.

H_a: The distribution of total claim costs is not the same across all injured anatomical regions.

Second Statistical Test: If $p < 0.05$ from the results of the Kruskal-Wallis test, analysis using a Mann-Whitney U test was performed to compare the distribution of total claim cost between pairs of injured anatomical regions to assign rank.

H_0: The distribution of total claim costs is the same between pairs of injured anatomical regions.

H_a: The distribution of total claim costs is not the same between pairs of injured anatomical regions.

2.2. Of the five injury nature categories (burn, contusion, laceration, sprain/strain, and "other"), lacerations incur the greatest median claim costs.

Descriptive Statistic: The median (and interquartile range) medical, indemnity, and total claim costs by injury nature category were calculated (as well as mean and standard deviation).

First Statistical Test: Analysis using a Kruskal-Wallis test was performed to determine if the distribution of total claim cost is similar among injury nature categories.

$H_{0:}$ The distribution of total costs is the same across the injury nature categories.

H_a*:* The distribution of total claim costs is not the same across the injury nature categories.

Second Statistical Test: If $p < 0.05$ from the results of the Kruskal-Wallis test, analysis using a Mann-Whitney U test was performed to compare the distribution of total claim costs between pairs of injury nature categories to assign rank.

$H_{0:}$ The distribution of total claim costs is the same between pairs of injury nature categories.

H_a*:* The distribution of total claim costs is not the same between pairs of injury nature categories.

2.3. Of the five injury event categories (contact with objects and equipment, exposure to harmful substances and environment, STFs, and overexertion and bodily reaction, and "other"), the injury event of overexertion and bodily reaction incurs the greatest median claim costs.

Descriptive Statistic: The median (and interquartile range) medical, indemnity, and total claim costs by injury event category were calculated (as well as mean and standard deviation).

First Statistical Test: Analysis using a Kruskal-Wallis test was performed to determine if the distribution of total claim cost is similar among injury event categories.

$H_{0:}$ The distribution of total claim costs is the same across the injury event categories.

H_a*:* The distribution of total claim costs is not the same across the injury event categories.

Second Statistical Test: If $p < 0.05$ from the results of the Kruskal-Wallis test, analysis using a Mann-Whitney U test was performed to compare the distribution of total claim cost between pairs of injury event categories to assign rank.

$H_{0:}$ The distribution of total claim costs is the same between pairs of injury event categories.

H_a*:* The distribution of total claim costs is not the same between pairs of injury event categories.

2.4. Of the five claimant age categories (≤24 years old, 25-34 years old, 35-44 years old, 45-54 years old, and ≥ 55 years old), median claims costs are greater among older claimants than younger claimants. Specifically, claim costs are greatest among those between claimants aged 45-54 years old.

Descriptive Statistic: Median (and interquartile range) medical, indemnity, and total claim costs by claimant age category were calculated (as well as mean and standard deviation).

First Statistical Test: Analysis using a Kruskal-Wallis test was performed to determine if the distribution of total claim cost is similar among claimant age categories.

$H_{0:}$ The distribution of total claim costs is the same across the claimant age categories.

$H_{a:}$ The distribution of total claim costs is not the same across the claimant age categories.

Second Statistical Test: If $p < 0.05$ from the results of the Kruskal-Wallis test, analysis using a Mann-Whitney U test was performed to compare the distribution of total claim cost between pairs of age categories to assign rank.

$H_{0:}$ The distribution of total claim costs is the same between pairs of age categories.

$H_{a:}$ The distribution of total claim costs is not the same between pairs of age categories.

2.5. Claimants with longer tenure (≥ 1 year) have greater median claim costs relative to claimants with shorter tenure (< 1 year).

Descriptive Statistic: Median (and interquartile range) medical, indemnity, and total claim costs by tenure category were calculated (as well as mean and standard deviation).

First Statistical Test: Analysis using a Kruskal-Wallis test was performed to determine if the distribution of total claim cost is similar among tenure categories.

$H_{0:}$ The distribution of total claim costs is the same across tenure categories.

$H_{a:}$ The distribution of total claim costs is not the same across tenure categories.

Second Statistical Test: If $p < 0.05$ from the results of the Kruskal-Wallis test, analysis using a Mann-Whitney U test was performed to compare the distribution of total claim cost between pairs of tenure categories to assign rank.

H_0: The distribution of total claim costs is the same between pairs of tenure categories.

H_a: The distribution of total claim costs is not the same between pairs of tenure categories.

Specific Aim 3: To investigate workers' compensation claims specific to MMH tasks.

The purpose of Specific Aim 3 was to assess the distributions of WC claim characteristics and costs specific to claims associated with MMH tasks at the time of injury. Claim costs were determined using the same methodology as described in Specific Aim 2. All claims (those that incurred costs and no costs) were represented with the exception of Specific Aim 3.5, where only claims that incurred costs were represented. The accident narratives were used to identify the presence of MMH tasks at time of injury. Specifically, a keyword search was performed to extract relevant claims which would then be manually assessed. Keywords include any variation of the verbs "to lift," "to carry," "to move," "to push," "to pull," "to hold," "to load," "to deliver," and any variation of the nouns "keg," "pallet," "bag," "box," "barrel," "case," "can," "bottle," "container," "grain," and "ingredient." After claims were selected based on the keyword search, they were manually reviewed to confirm that MMH tasks were present at the time of injury. Claims were coded as yes or no to indicate if MMH tasks were performed at the time of injury.

Research Hypotheses and Statistical Methods:

3.1. Claimants performing MMH tasks at the time of injury have a significantly greater proportion of injuries to their trunk region compared to claimants performing other (non-MMH) tasks.

Descriptive Statistic: The number and the proportion of claims with MMH at the time of injury and an injured trunk region were calculated.

Statistical Test: Analysis using a two-sample proportion test was performed to determine if the proportion of claims related to injured trunk region among claims associated with MMH tasks differs from the proportion of trunk region-related injuries among claims associated with other (non-MMH) tasks.

$H_{0:}$ The proportion of claims affecting the trunk region is not significantly greater among those who performed MMH tasks compared to other (non-MMH) tasks.

H_a*:* The proportion of claims affecting the trunk region is significantly greater among those who performed MMH tasks compared to other (non-MMH) tasks.

3.2. Claimants performing MMH tasks at the time of injury have a significantly greater proportion of sprains/strains as the injury nature compared to claimants performing other (non-MMH) tasks.

Descriptive Statistic: The number and the proportion of claims with MMH at the time of injury and sprains/strains as the injury nature were calculated.

Statistical Test: Analysis using a two-sample proportion test was performed to determine if the proportion of sprains/strains among claims associated with MMH tasks differ from the proportion of sprains/strains among claims associated with other (non-MMH) tasks.

$H_{0:}$ The proportion of claims with sprains/strains as injury nature is not significantly greater among those who performed MMH tasks compared to other (non-MMH) tasks.

H_a The proportion of claims with sprains/strains as injury nature is significantly greater among those who performed MMH tasks compared to other (non-MMH) tasks.

3.3. Claimants performing MMH tasks at the time of injury have a significantly greater proportion of overexertion and bodily reaction injury events compared to claimants performing other (non-MMH) tasks.

Descriptive Statistic: The number and the proportion of claims with MMH at the time of injury and injury events of overexertion and bodily reaction were calculated.

Statistical Test: Analysis using a two-sample proportion test was performed to determine if the proportion of overexertion and bodily reaction injuries among claims associated with MMH tasks differs from the proportion of overexertion and bodily reaction among claims associated with other (non-MMH) tasks.

$H_{0:}$ The proportion of claims with the injury event of overexertion and bodily reaction is not significantly greater among those who performed MMH tasks compared to other (non-MMH) tasks.

$H_{a:}$ The proportion of claims with the injury event of overexertion and bodily reaction is significantly greater among those who performed MMH tasks compared to other (non-MMH) tasks.

3.4. Claimants performing MMH tasks at the time of injury have a significantly greater proportion of claims classified as indemnity compared to claimants performing other (non-MMH) tasks.

Descriptive Test: The number and the proportion of claims with MMH at the time of injury and claim type were calculated.

Statistical Test: Analysis using a two-sample proportion test was performed to determine if the proportion of indemnity claims among claims associated with MMH tasks differ from the proportion of indemnity claims among other (non-MMH) tasks.

$H_{0:}$ The proportion of claims classified as indemnity is not significantly greater among those who performed MMH tasks compared to other (non-MMH) tasks.

H_a The proportion of claims classified as indemnity is significantly greater among those who performed MMH tasks compared to other (non-MMH) tasks.

3.5. Claimants performing MMH tasks at the time of injury incur greater mean total claim costs compared to claimants performing other (non-MMH) tasks

Descriptive Statistic: The mean (standard deviation) and median (interquartile range) total claim cost among claimants who performed MMH tasks and those who performed other (non-MMH) tasks were calculated.

Statistical Test: Analysis using a gamma generalized linear model (GLM) was performed to investigate the relationship between total claim cost and MMH tasks when adjusting for other claim characteristics (injury event, injury nature, injured anatomical area, claimant age, claimant tenure, and claim type). The distribution of total claim cost data in the present study was skewed. The dataset consisted of a high proportion of low-cost (and zero-cost) claims and a low proportion of high-cost claims. Previous studies have investigated optimal analysis methods to study skewed data in other types of data, such as healthcare costs (Griswold et al., 2004; Jones, 2012). Gamma GLM provided a flexible way to model non-normal data (e.g. healthcare) and produced more efficient estimators compared to more restrictive alternatives (Manning et al., 2005). For the present study, the primary focus was the relationship between MMH tasks and total cost per claim.

$H_{0:}$ There is no difference in the distribution of total claim cost among workers performing MMH tasks and other (non-MMH) tasks when adjusting for injured anatomical region, injury event, injury nature, claimant age, claimant tenure, and claim type.

$H_{a:}$ There is a difference in the distribution of total claim cost among workers performing MMH tasks and other (non-MMH) tasks when adjusting for injured anatomical region, injury event, injury nature, claimant age, claimant tenure, and claim type.

3.6. Claimants performing MMH tasks at the time of injury are younger compared to claimants performing other (non-MMH) tasks.

Descriptive Statistic: The mean (standard deviation) and median (interquartile range) claimant age among claimants who performed MMH task and those who performed other (non-MMH)

tasks were calculated, when adjusting for injury event, injury nature, injured anatomical area, total claim cost, claimant tenure, and claim type.

Statistical Test: Analysis using a linear regression model was performed to investigate the relationship between claimant age and MMH association when adjusting for other claim characteristics (injury event, injury nature, injured anatomical area, total claim cost, claimant tenure, and claim type). The distribution of claimant age data in the present study was moderately skewed. The dataset consists of a higher proportion of younger claimants than older claimants. For the present study, the primary focus was the relationship between MMH activity and claimant age at the time of injury.

$H_{0:}$ There is no difference in the distribution of claimant age among workers performing MMH tasks and other (non-MMH) tasks when adjusting for injured anatomical region, injury event, injury nature, total claim cost, claimant tenure, and claim type.

$H_{a:}$ There is a difference in the distribution of claimant age among workers performing MMH tasks and other (non-MMH) tasks when adjusting for injured anatomical region, injury event, injury nature, total claim cost, claimant tenure, and claim type.

3.7. Claimants performing MMH tasks at the time of injury have shorter tenure compared to claimants performing other (non-MMH) tasks.

Descriptive Statistic: The mean (standard deviation) and median (interquartile range) tenure among workers who performed MMH task and those who performed other (non-MMH) tasks were calculated, when adjusting for injury event, injury nature, injured anatomical area, total cost, claimant age, and claim type.

Statistical Test: Analysis using a linear regression model was performed to investigate the relationship between claimant tenure and MMH association when adjusting for other claim characteristics (injury event, injury nature, injured anatomical area, total claim cost, claimant age, and claim type). The distribution of claimant tenure data in the present study was moderately

skewed. The dataset consisted of a higher proportion of claimants with shorter tenure than claimants with longer tenure. For the present study, the primary focus was the effect of MMH activity and claimant tenure at the time of injury.

$H_{0:}$ There is no difference in the distribution of tenure among workers performing MMH tasks and other (non-MMH) tasks when adjusting for injured anatomical region, injury event, injury nature, total claim cost, claimant age, and claim type.

$H_{a:}$ There is a difference in the distribution of tenure among workers performing MMH tasks and other (non-MMH) tasks when adjusting for injured anatomical region, injury event, injury nature, total claim cost, claimant age, and claim type.

Specific Aim 4: To develop an injury model specific to the craft brewing industry.

The purpose of Specific Aim 4 was to consolidate the most significant occupational factors related to injuries among craft brewery claimants into a model that communicates the relationship between injury characteristics and contributing factors that result in different injury natures. Specific Aim 4 was accomplished by an analysis of the accident narratives described in the FROI data and the results generated from Specific Aims 1, 2, and 3.

Research Objectives and Statistical Methods:

4.1. Use data from the FROI accident narrative to identify contributing factors to the claim based on the revised agent-host-environment epidemiologic model.

A revised agent-host-environment epidemiologic model was used to identify contributing factors for each exposure category per claim. Elements of Haddon's matrix were used in the present study: host (injured worker or claimant), agent (energy), environment (physical and social), and vehicle (object that transferred agent to host) (Haddon, 1968). Unfortunately, the provided accident narrative text lacked sufficient detail to successfully incorporate Haddon's temporal dimension (before, during, and after injury incident). Contributing factors to the host exposure included activities the claimant was engaged in at the

time of claim (e.g. carrying items, cleaning, or walking). Contributing factors related to the agent exposure category included the type of energy transfer that resulted in the claim (e.g. chemical, electrical, mechanical, and thermal). Contributing factors related to the vehicle exposure category included details about the object responsible for the energy transfer that resulted in the claim (e.g. keg, hose, glassware, cleaning chemicals). The accident narratives provide information about contributing factors to the physical environment (e.g. brewery, bottling line, festival environment, draft trailer, cooler, as well as the presence of snow/ice or wet conditions) and social environment (e.g. rushed, crowded). A template for claims analysis using the revised agent-host-environment epidemiologic model is presented in Table 3.2. Similar to methods used by Glazer 2005, a single researcher coded the WC accident narratives to identify contributing factors for agent, host, environment, and vehicle exposures. For quality assurance, a second researcher reviewed and coded the accident narratives. Coding results were compared and researchers discussed any coding discrepancies to reach a consensus (Glazner et al., 2005; Syron et al., 2019). If a consensus could not be reached, a third researcher was consulted as the tiebreaker.

The mean (and standard deviation) of the number of contributing factors per agent, host, vehicle, and environment exposure per claim were determined. Frequency counts were conducted to identify common contributing factor words and phrases by exposures per claim. Qualitative analyses of contributing factors were performed using the software programs R Studio Version 1.2.1335.

Table 3.2. Template of revised agent-host-environment epidemiologic model applied to WC accident narratives

Claimant ID				
Accident Narrative				
Exposure	Agent	Host	Environment	Vehicle
Contributing factor(s)				

4.2. Develop injury model for the craft brewing industry based on results of workers' compensation analyses and the contributing factors identified based on the revised agent-host-environment epidemiolocal model.

The present study investigated the distribution and costs of claims by injury nature category. Injury characteristics (results of Specific Aims 1, 2, and 3) and contributing factors identified from the revised agent-host-environment epidemiologic model (results of Research Objective 4.1.) interact to cause the injury nature. In other words, the injury nature resulted from an injury event where the agent was transferred between the host's injured anatomical region and the vehicle while the host performed an activity in the environment. This relationship is illustrated through the diagram in Figure 3.1.

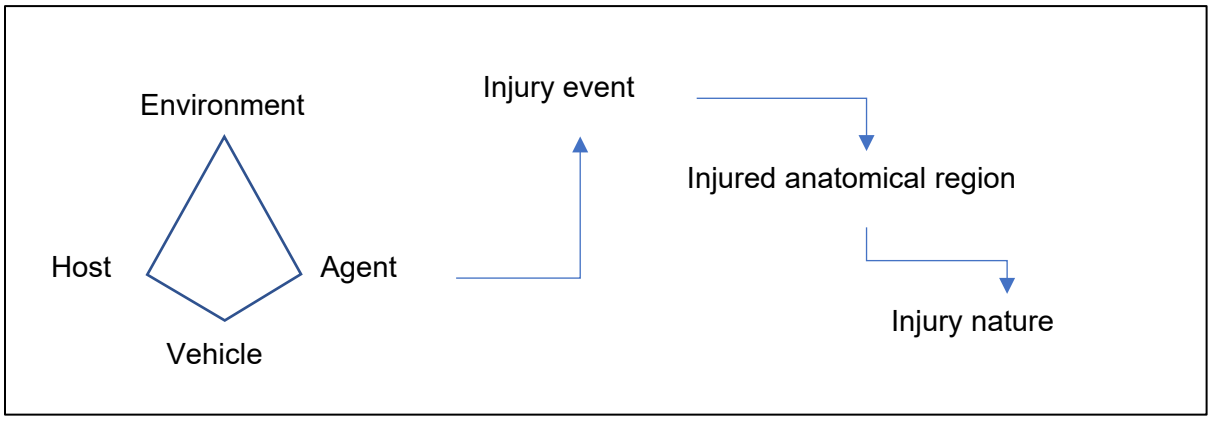

Figure 3.1. Injury model template for injuries among craft brewery workers

CHAPTER 4: RESULTS

4.0. General descriptive results

Data for the present study were provided by Pinnacol Assurance, Colorado's largest WC insurance company. The dataset represented craft breweries that held policies between 2013 and 2018. One hundred and thirty craft breweries held policies during the claim period. Approximately 40% (49) of those craft breweries filed claims. There were 570 claims within the dataset. Thus, 570 claims were analyzed in the present study. In the dataset, claims were assigned a policy identification code and a claimant identification code. The policy identification code was associated with the policy holder, or craft brewery. The policy identification code allowed researchers to quantify how many claims were filed per craft brewery. The claimant identification code was associated with the injured worker. The number of unique claimant identification codes allowed researchers to quantify how many unique claimants were represented in the dataset. Five hundred and seventy unique claimant identification codes were present, thus 570 individual workers were injured during the claim period. For the remainder of this section, the phrase "craft breweries" refers to those who both held polices and filed claims.

The number of claims filed per craft brewery varied (see Table 4.0.). Of the 49 craft breweries who filed claims, 45% filed a single claim during the claim period. Thus, 45% (22) of craft breweries were associated with 4% (22) of claims. To contrast, 18% (9) of craft breweries filed more than ten claims each and were associated with 84% (480) of the claims. Among craft breweries who each filed more than ten claims, each filed an average of 50 claims. One craft brewery filed 125 claims between 2013 and 2018.

Table 4.0. Summarized results of claims filed per craft brewery and total claims filed[7]

Number of breweries	Number of claims per brewery	Sum of claims
22	1	22
16	2-5	53
2	6-10	15
9	>10	480

4.0.1. Distributions of claims by claim type, cost, and lost time

Types of claims were classified as medical-only or medical-plus-indemnity. Medical-only claims only incurred costs associated with medical treatment. Claims classified as medical-plus-indemnity incurred costs associated with medical treatment as well as wage compensation for lost time. The majority (94%) of claims were classified as medical-only. Thirty-six claims (6%) were classified as medical-plus-indemnity.

Total claim cost (the sum of medical and indemnity costs) for individual claims ranged from $0 to $62,925. The cumulative cost of all claims in the present study was $771,888. The distribution of total claim cost was skewed as the majority of claims incurred low or no costs, as illustrated by a histogram in Figure 4.1. Thirty six percent of claims incurred $0 in total claim costs. All claims that incurred indemnity costs also incurred medical costs. The highest total claim cost was $62,924. The highest medical claim cost was $52,733. The highest indemnity cost was $27,966. Among all claims, the median medical and total claim cost was approximately $370. Among all claims, the median indemnity claim cost was $0. A summary of total claim cost, medical cost, and indemnity cost results for all claims is outlined in Table 4.1.

[7] A complete table of claims filed per craft brewery is available in Appendix 8.7.

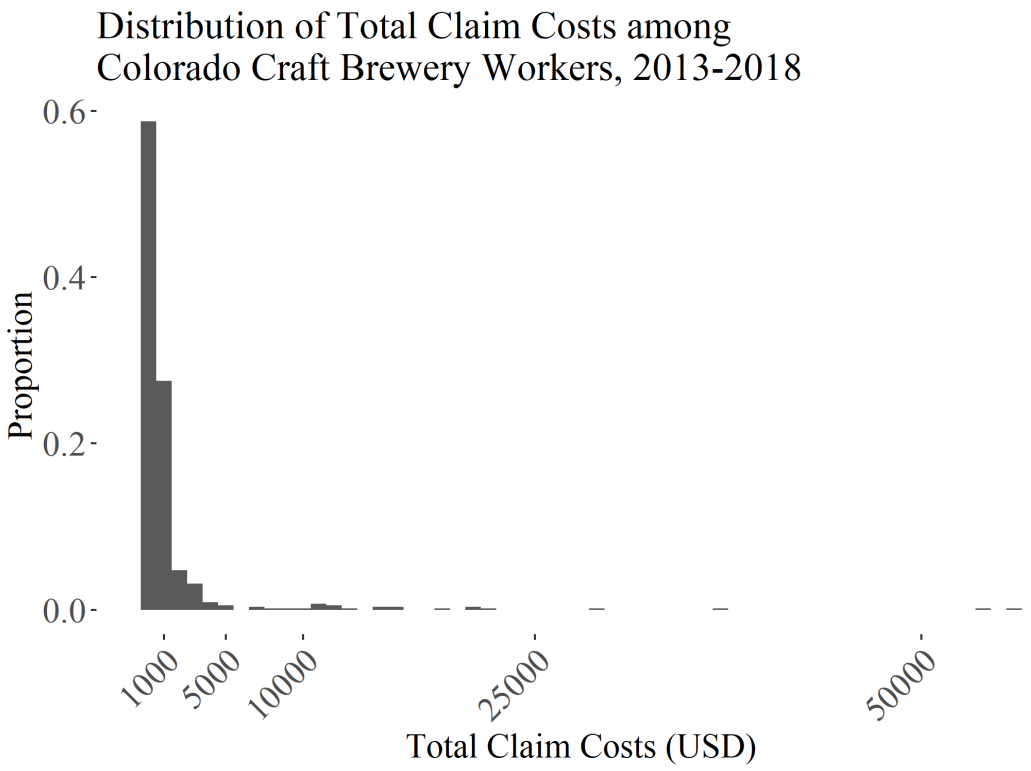

Figure 4.1. Histogram of total claim costs among Colorado craft brewery claimants (2013-2018).

Table 4.1. Descriptive statistics of cost for all claims

Cost variable (all claims, n=570)	Median (IQR) ($)	Mean (SD) ($)	Minimum, maximum ($)	Cumulative ($)
Indemnity	$0 ($0 ,$0)	$261.55 ($1,783.34)	$0, $27,965.50	$149,084
Medical	$365.7 ($0, $829.85)	$1,092.64 ($3,411.98)	$0, $52,732.70	$622,803.70
Total	$368.3 ($0, $839.22)	$1,354.19 ($4,574.22)	$0, $62,924.29	$795,082.20

The distributions of claims with reported total costs, medical costs, and indemnity costs were investigated. Total costs and medical costs were reported in 64% (367) of claims. The lowest total claim cost and medical claim cost was $39. Six claims incurred total claim and medical claim costs that were each less than $100. Indemnity claim costs were reported in 6% (36) of claims. The lowest indemnity claim cost was $96. When assessing claims that incurred costs, the median indemnity claim cost was more than three times greater than median medical and median total claim costs. Likewise, the mean indemnity claim cost was more than twice that of the mean medical and mean total claim costs. Thus,

indemnity costs were less frequent but overall higher than medical or total claim costs. A summary of cost among claims that incurred costs is outlined in Table 4.2.

Table 4.2. Descriptive statistics of cost for claims that incurred costs

Cost variable>0.00	Count (%)*	Median (IQR) ($)	Mean (SD) ($)
Indemnity	36 (6.32%)	$2,191.45 ($564.12, $4,221.17)	$4,141.22 ($5,931.03)
Medical	367 (64.39)	$677.60 ($389.70, $1,302.5)	$1,697.01 ($4,131.6)
Total	367 (64.39)	$678.80 ($390.35, $1,325.95)	$2,103.24 ($5,563.18)

*% is out of 570 claims

If an injury caused an employee to miss work, lost time (in days) was included in the FROI. Lost time was a metric recorded by Pinnacol Assurance. Cumulatively, 1,297 days of lost time were reported during the claim period. Twenty-six claims (5%) reported lost time. Reported lost time ranged from one day to 579 days. A summary of lost time is outlined in Table 4.3. The distribution of lost time was skewed, and the majority of claims did not incur any lost time, as displayed by a density plot in Figure 4.2. When considering the distribution of lost time among all claims, the median was zero days with a mean of 2.5 days. When considering the distribution of lost time among claims associated with three or more lost days, the median was 19 days with a mean of 53 days. Thirty-six claims (6%) incurred indemnity claim costs, but not all claims that incurred indemnity costs were associated with lost time. All claims with three or more reported lost days incurred indemnity claim costs.

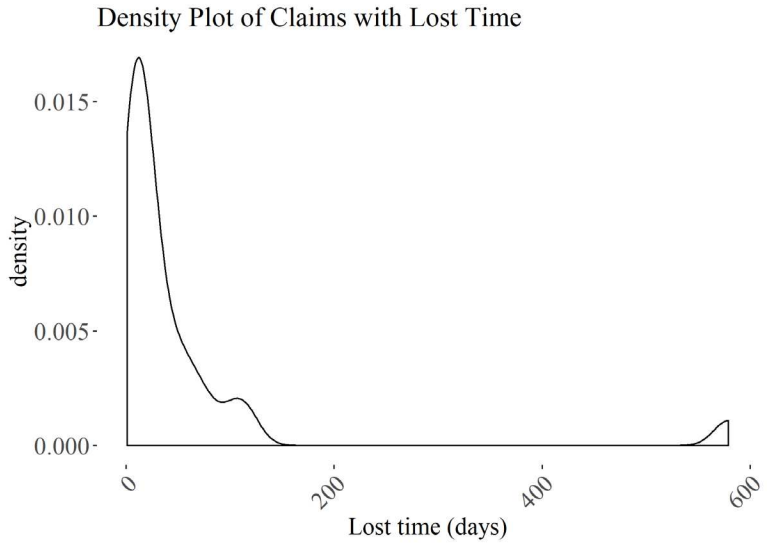

Figure 4.2. Density plot of lost time reported among Colorado craft brewery workers (2013-2018).

Table 4.3. Descriptive statistics of number of days lost associated with claims that resulted in lost time (days) and indemnity costs

	Count (%)	Median (IQR) (days)	Mean (SD) (days)	Minimum (days)	Maximum (days)
All claims	570 (100)	0 (0,0)	2.28 (25.74)	0	579
Claims with days away	26 (4.56)	18.5 (5.5,45.75)	49.88 (112.31)	1	579
Claims with ≥3 days away	24 (4.21)	19 (10, 49.5)	53.92 (116.15	3	579
Claims with indemnity cost ≥ $0.01	36 (6.32)	9 (0, 25)	36.03 (97.59)	0	579
Claims with indemnity cost ≥ $0.01 and ≥ 3 days away	24 (4.21)	19 (10, 49.5)	53.92 (116.15	3	579

4.0.2. Claimant characteristics

The FROI included the age, sex, and tenure of the claimant at the time of injury. Claimant age was reported as a continuous variable. Age was not reported in 3% of claims. Age ranged from 18 to 65 years, with a mean of 32 years. Researchers collapsed age into five categories for further analysis (≤24 years old, 25-34 years old, 35-44 years old, 45-54 years old, and ≥ 55 years old). The distribution of age as a continuous variable is displayed as a histogram in Figure 4.3. Claimant sex was reported as a categorical variable. The majority of claimants identified as male (79.6%). Claimant tenure was reported as a continuous variable in the FROI. Tenure was not reported in 11% of claims. Tenure ranged from one day to 34 years, with a mean of 2.2 years. The tenure category ≥5 years represented five to 34 years**.** The distribution of tenure was skewed towards claimants having shorter tenures. Researchers collapsed claimant tenure into pre-defined groups for analysis (< 1 year , ≥ 1 to < 2 years, ≥ 2 to < 3 years , ≥ 3 to < 4 years, ≥ 4 to < 5 years , and ≥ 5 years). The distribution of tenure (as a continuous variable) is displayed by a histogram in Figure 4.4. The distributions of claimant age and tenure are outlined in Table 4.4.

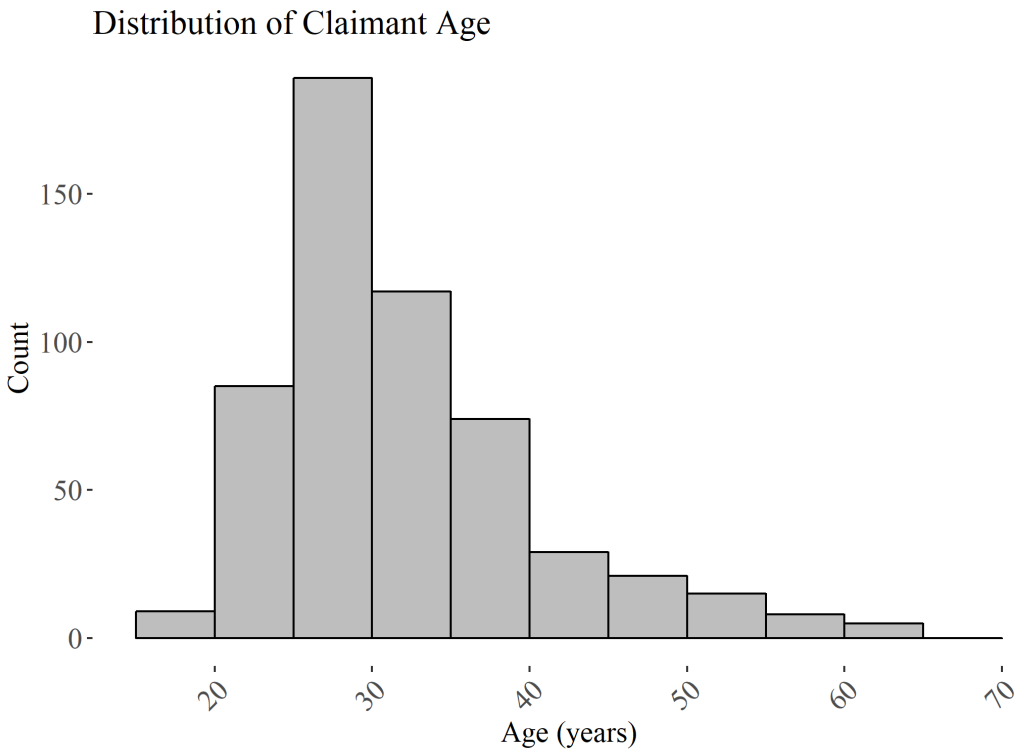

Figure 4.3. Histogram of claimant age among Colorado craft brewery claimants (2013-2018). Bin-width represents five years.

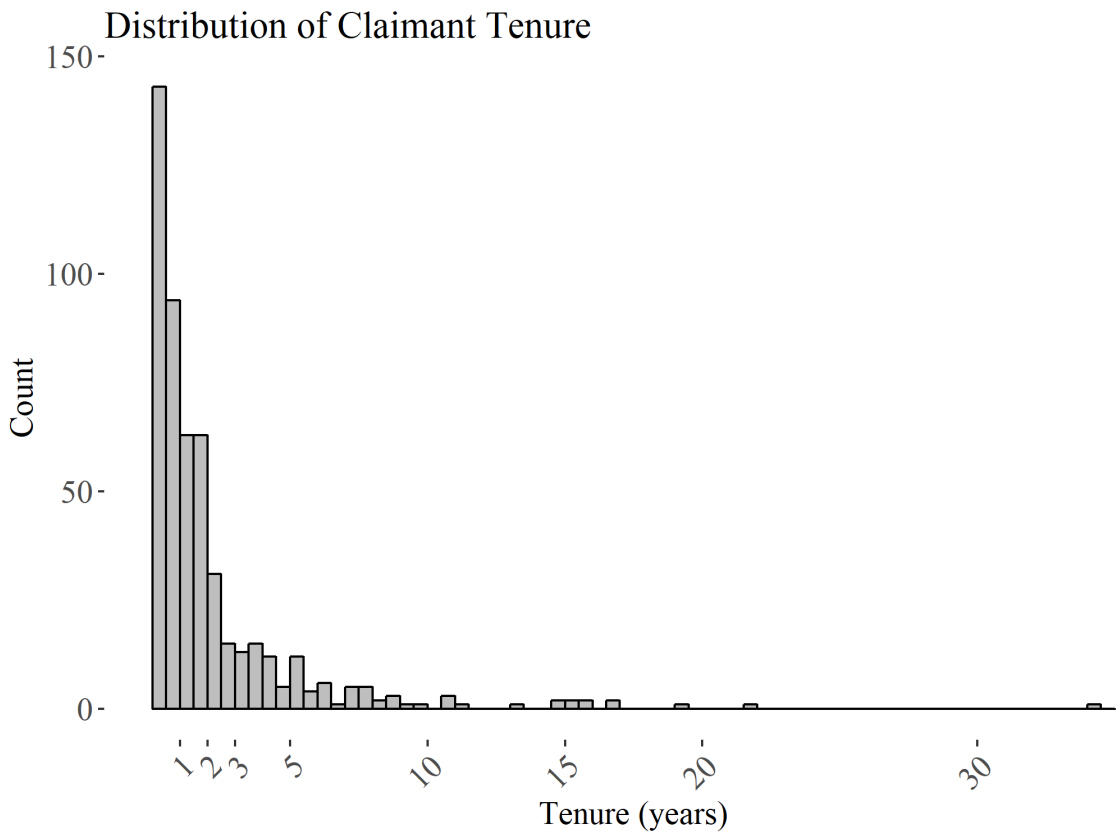

Figure 4.4. Histogram of tenure among injured Colorado craft brewery claimants (2013-2018). Bin-width represents six months

Table 4.4. Distributions of claimant characteristics

Claimant Characteristic	Median (IQR)	Mean (SD)	Minimum	Maximum
Age (years)	30 (27,36)	32.4 (8.38)	18.00	65.00
Tenure (days)	407 (150,860.5)	782.95 (1189.43)	1.00	12,574.00
Tenure (years)	1.12 (0.42, 2.36)	2.15 (3.26)	0.0027	34.45

4.1. Results of Specific Aim 1:

The purpose of Specific Aim 1 was to characterize the distributions of WC claims in the Colorado craft brewing industry between July, 2013 and June, 2018. Specific Aim 1 was accomplished by analyzing claims based on injured anatomical region, injury nature, injury event, claimant age, and claimant tenure. All 570 claims were used in the statistical analyses. Research hypotheses described in Chapter 3 Methods addressed primary research questions about the variable distributions in the Colorado

craft breweries WC dataset. If researchers found evidence of differences in the distributions of claims by variable, further statistical tests were performed. Specifically, additional statistical tests assessed the differences among the distributions of variables. A pairwise proportion test with a Bonferroni adjustment was performed to protect from Type 1 Error. Results of each research hypothesis within Specific Aim 1 are described below:

4.1.1. Distribution of claims by injured anatomical region

The most frequently injured anatomical region was the upper limb (43%) followed by the trunk region (33%) and lower limb (22%). Approximately 2% (11) of claims were classified as "other" anatomical region and were excluded from statistical analyses. The distribution of claims injured anatomical region and body part is outlined in Table 4.5. Researchers rejected the null hypothesis and had evidence that there were differences in the distribution of claims by injured anatomical region (χ^2=218.34, df=3, $p < 0.0001$). Since evidence of a relationship between claims and injured anatomical region was identified, analysis using a pairwise proportion with Bonferroni adjustment was performed (χ^2=291.12, df=3, $p < 0.0001$). Pairwise test results of the proportions of injured anatomical region distribution are presented in Table 4.6. The proportion of injuries affecting upper limb was greater than the trunk region ($p=0.0039$), which was greater than the proportion of injuries affecting the lower limb ($p < 0.0001$), which was greater than the proportion of injuries affecting the "other" category ($p < 0.0001$). The results supported Research Hypothesis 1.1. that the upper limb was the most frequently injured anatomical region.

Table 4.5. Distributions of claims by injured anatomical region and body part

Anatomical Region	Body Part	Region Count (%)	Part Count (%)
Upper Limb		244 (42.80)	
	Finger(s)		75 (13.16)
	Hand		50 (8.77)
	Forearm		38 (6.67)
	Shoulder(s)		28 (4.91)
	Wrist		21 (3.68)
	Thumb		18 (3.16)
	Elbow		8 (1.4)
	Upper Arm		6 (1.05)
Trunk Region		190 (33.33)	
	Low Back		73 (12.81)
	Head/Skull		29 (5.09)
	Eye(S)		26 (4.56)
	Facial Bones		16 (2.81)
	Upper Back Area		15 (2.63)
	Abdomen/Groin		10 (1.75)
	Chest		7 (1.23)
	Neck Vertebrae		5 (0.88)
	Mouth		3 (0.53)
	Nose		3 (0.53)
	Buttocks		1 (0.18)
	Ear(S)		1 (0.18)
	Lung		1 (0.18)
Lower Limb		126 (22.11)	
	Knee		44 (7.72)
	Foot		37 (6.49)
	Ankle		27 (4.74)
	Lower Leg		14 (2.46)
	Upper Leg		1 (0.81)
	Hip		3 (0.53)
“Other”		10 (1.75)	
	No Physical Injury		4 (0.7)
	Multiple Body Parts		3 (0.53)
	Unclassified		3 (0.53)

Table 4.6. Results of pairwise proportion test with Bonferroni adjustment for injured anatomical region[8]

	Lower Limb	"Other"	Trunk region	Upper Limb
Lower Limb	-	-	-	-
"Other"	< 0.0001	-	-	-
Trunk region	< 0.0001	< 0.0001	-	-
Upper Limb	< 0.0001	< 0.0001	0.0039	-

In addition to anatomical region, detailed information about body parts per body region was available in the FROI. More than 50% (125) of claims within the upper limb affected the hand and fingers followed by the forearm and the shoulder. Of injuries affecting the trunk region, the majority of injuries were related to the low back (38%). Knees were the most commonly injured body part within the lower limb (35%) followed by the foot (30%) and the ankle (21%).

4.1.2. Distribution of claims by injury nature

The two most frequent injury nature categories were sprains/strains and contusions. More than 50% of claims were identified as sprains/strains and contusions followed by lacerations. The distribution of claims by injury nature is outlined in Table 4.7. Researchers rejected the null hypothesis and had evidence that the distribution of claims by injury nature was not homogenous (χ^2= 70.1, df=4, $p < 0.0001$). Given that the distribution was not homogenous, further statistical analyses were conducted using a pairwise proportion test with Bonferroni adjustment (χ^2= 87.6, df=4, $p < 0.0001$). The proportions of sprains/strains and contusions were significantly greater than the proportions of lacerations, burns, and injuries classified as "other" injury nature ($p < 0.05$). However, the proportion of sprains/strains was not significantly greater than the proportion of contusions (p=1). The proportion of lacerations was not

[8] Exact proportions used in the Bonferroni adjustments pairwise proportions tests are presented in Appendix 8.8.

significantly greater than the proportion of injuries classified as “other” injury nature. Results of pairwise tests of the proportions of injury nature are presented in Table 4.8. The results did not support Research Hypothesis 1.2. that sprains/strains were the most frequent injury nature. Rather, sprains/strains and contusions were the most frequent injury natures in the present study. The category “other” injury nature collectively accounted for 16% of all injuries. Within the “other” injury nature category, “all other injuries” accounted for 5% followed by foreign bodies (2%) and puncture (2%).

Table 4.7. Detailed descriptive statistics for injury nature

Injury Nature Category	Injury Nature Detail	Category count (%)	Detail count (%)
Sprain/strain		163 (28.55)	
Contusion		154 (26.97)	
Laceration		108 (18.91)	
Burn		56 (9.81)	
“Other”		90 (15.80)	
	All Other		15 (2.63)
	All Other Cumulative Injuries		14 (2.45)
	Foreign Body		14 (2.45)
	Puncture		10 (1.75)
	Dermatitis		8 (1.4)
	Fracture		8 (1.4)
	Poisoning-Chemical		5 (0.88)
	Concussion		4 (0.7)
	Electric Shock		3 (0.53)
	Hernia		3 (0.53)
	Dislocation		2 (0.35)
	Crushing		1 (0.18)
	Hearing Loss		1 (0.18)
	Inflammation		1 (0.18)
	Respiratory Disorders		1 (0.18)

Table 4.8. Results of pairwise proportion test with Bonferroni adjustment for injury nature[9]

	Burn	Contusion	Laceration	"Other"	Sprain/Strain
Burn	-	-	-	-	-
Contusion	< 0.0001	-	-	-	-
Laceration	< 0.0001	0.012	-	-	-
"Other"	0.035	< 0.0001	1.00	-	-
Sprain/strain	< 0.0001	1.00	0.0013	< 0.0001	-

4.1.3. Distribution of claims by injury event.

More than two thirds (78%) of claims were associated with the injury events of overexertion and bodily reaction, exposure to harmful substances or environments, and contact with objects and equipment. The distribution of claims by injury event is outlined in Table 4.9. Researchers rejected the null hypothesis and had evidence that the distribution of claims by injury event was not homogenous (χ^2=97.3, df=4, $p < 0.0001$). Given that the distribution was not homogenous, further statistical analyses were conducted using a pairwise proportion test with Bonferroni adjustment (χ^2=121.7, df=4, $p < 0.0001$). The proportions of the injury events of contact with objects and equipment, exposure to harmful substances or environments, overexertion and bodily reaction were not statistically significantly different ($p > 0.05$) with all proportions between 0.23 and 0.28. The distributions of claims within these three injury event categories were all significantly greater ($p < 0.05$) than the slips, trips, or falls (STFs) and "other" injury events. The proportion of STFs was significantly greater ($p < 0.05$) than "other." Results of pairwise tests of the proportions of injury event are presented in Table 4.10. The results did not support Research Hypothesis 1.3. that the most frequent injury event category was exposure to harmful substances and

[9] Exact proportions used in the Bonferroni adjustments pairwise proportions tests are presented in Appendix 8.7

environments. Twenty eight percent of claims were associated with overexertion and bodily reaction and 27% of claims were associated with exposure to harmful substances and environments.

The category "other" injury event collectively accounted for 6% (35) of all claims. Motor vehicle related injury events (miscellaneous motor vehicle and motor vehicle collision) accounted for approximately 2% (9) of claims. In the present dataset, these "other" injury events occurred at a lower frequency compared to overexertion and bodily reaction, exposure to harmful substances or environments, contact with objects and equipment, and STFs. The distribution of "other" injury events is outlined in Table 4.9.

Table 4.9. Descriptive statistics of claims by injury event[10]

Injury Event Category	Injury Event Detail	Category count (%)	Detail count (%)
Overexertion and bodily reaction		161 (28.25)	
Exposure to harmful substances or environments		155 (27.19)	
Contact with objects and equipment		131 (22.98)	
Slips, trips, or falls		88 (15.44)	
"Other"		35 (6.14)	
	Animal or Insect		5 (0.88)
	Misc, Other Than Physical Cause of Injury		12 (2.11)
	Miscellaneous Motor Vehicle		2 (0.35)
	Motor Veh-Coll/Vehicle		9 (1.58)
	Other		5 (0.88)
	Struck or Injured By Fellow Worker, Patient		2 (0.35)

[10] Complete descriptive statistics of claims by injury event detail are available in Appendix 8.9.

Table 4.10. Results of pairwise proportion test with Bonferroni adjustment for injury event[11]

	Contact with objects and equipment	Exposure to harmful substances or environments	Slips, trips, or falls	"Other"	Overexertion and bodily reaction
Contact with objects and equipment	-	-	-	-	-
Exposure to harmful substances or environments	1.00	-	-	-	-
Slips, trips, or falls	0.016	< 0.0001	-	-	-
"Other"	< 0.0001	< 0.0001	< 0.0001	-	-
Overexertion and bodily reaction	0.49	1.00	< 0.0001	< 0.0001	-

4.1.4. Distribution of claims by age categories.

Claimants aged between 25-34 years old filed the most claims followed by those between 35-44 years old. Age was not reported in 3% of claims. The distribution of claims by age category is outlined in Table 4.11. Researchers rejected the null hypothesis and had evidence that the distribution of claims among age categories was not homogenous ($\chi 2 = 537.66$, df=4, $p < 0.0001$). Given that the distribution was not homogenous, further statistical analysis was conducted using a pairwise proportion test with Bonferroni adjustment ($\chi 2 = 839.7$, df=5, $p < 0.0001$). The proportion of claimants ≤ 24 years old was significantly less ($p < 0.05$) than 25-34 years old, 35-44 years old, and ≥ 55 years old. The proportion of claimants 25-34 years old was significantly greater ($p < 0.05$) than all other age groups (including NA). The proportion of claimants aged 35-44 years old was significantly greater ($p < 0.05$) than ≤ 24 years old, 45-54 years old, ≥ 55 years old, and NA. However, the proportion of claimants aged 35-44 years old was significantly less ($p < 0.05$) than 25-34 years old. The proportion of claimants aged 45-54 years old, ≥ 55 years old,

[11]Exact proportions used in the Bonferroni adjustments pairwise proportions tests are presented in Appendix 8.8.

and NA were not significantly different ($p > 0.05$). Results of pairwise tests of the proportions of claims by age category are presented in Table 4.12. The results supported Research Hypothesis 1.4. that claims were most frequently reported among claimants aged between 25-34 years old.

Table 4.11. Descriptive statistics by age category

Age category	Count (%)
≤ 24 years old	65 (11.4)
25-34 years old	319 (55.96)
35-44 years old	112 (19.65)
45-54 years old	38 (6.67)
≥ 55 years old	18 (3.16)
NA	18 (3.16)

Table 4.12. Results of pairwise proportion test with Bonferroni adjustment for age group[12]

	≤ 24 years old	25-34 years old	35-44 years old	45-54 years old	≥ 55 years old	NA
≤ 24 years old	-	-	-	-	-	-
25-34 years old	< 0.0001	-	-	-	-	-
35-44 years old	0.0025	< 0.0001	-	-	-	-
45-54 ages old	0.11	< 0.0001	< 0.0001	-	-	-
≥ 55 years old	< 0.0001	< 0.0001	< 0.0001	0.138	-	-
NA	< 0.0001	< 0.0001	< 0.0001	0.138	1.00	-

4.1.5. Distribution of claims by tenure categories

Claims were most frequently reported among claimants with < 1 year of tenure followed by those with ≥ 1 to < 2 years of tenure. The distribution of claims by tenure category is outlined in Table 4.13. All tenure categories except ≥ 5 years represented one year, while the tenure category of ≥ 5 years

[12] Exact proportions used in the Bonferroni adjustments pairwise proportions tests are presented in Appendix 8.8.

represented a range of five to 30 years. Tenure was not reported in 11% of claims. Researchers rejected the null hypothesis and had evidence that the distribution of claims by tenure category was not homogenous ($\chi^2 = 412$, df=5, $p < 0.0001$). Given that the distribution was not homogenous, further statistical analyses were conducted using a pairwise proportion test with a Bonferroni adjustment. The proportion of claimants with < 1 year of tenure was significantly greater ($p < 0.05$) than all other tenure categories (including NA). The proportion of claimants with ≥ 2 to < 3 years was not significantly greater than claimants with ≥ 5 years and claimants with unreported tenure (NA). Results of pairwise tests of the proportions of claims by tenure category are presented in Table 4.14. The results supported Research Hypothesis 1.5. that claims were most frequently reported among claimants with < 1year of tenure.

The specific tenure among claimants classified in the tenure category ≥ 5 years was explored. Claimants within this category had between five to 34 years of tenure.[13] Forty percent of these claimants had five or six years of tenure. Thirty percent had between seven and nine years of tenure. Twenty seven percent had between ten and 19 years of tenure. One claimant had 22 years of tenure and one claimant had 34 years of tenure.

Table 4.13. Descriptive statistics for distribution of tenure

Tenure	Count (%)
< 1 year	237 (41.58)
≥ 1 to < 2 years	126 (22.11)
≥ 2 to < 3 years	46 (8.07)
≥ 3 to < 4 years	28 (4.91)
≥ 4 to < 5 years	17 (2.98)
≥ 5 years	56 (9.82)
NA	60 (10.53)

[13] The full distribution of tenure among claimants with ≥5 years are available in Appendix 8.10.

Table 4.14. Results of pairwise proportion test with Bonferroni adjustment for tenure[14]

	NA	< 1 year	1-2 years	2-3 years	3-4 years	4-5 years	≥ 5 years
NA	-	-	-	-	-	-	-
< 1 year	< 0.0001	-	-	-	-	-	-
1-2 years	< 0.0001	< 0.0001	-	-	-	-	-
2-3 years	1.00	< 0.0001	< 0.0001	-	-	-	-
3-4 years	0.012	< 0.0001	< 0.0001	0.86	-	-	-
4-5 years	< 0.0001	< 0.0001	< 0.0001	0.0060	1.00	-	-
≥ 5 years	1.00	< 0.0001	< 0.0001	1.00	0.046	< 0.0001	-

4.2. Results of Specific Aim 2:

The purpose of Specific Aim 2 was to determine how total claim costs (medical costs plus indemnity costs) were related to injury characteristics. Specific Aim 2 was accomplished by assessing the relationship between cost and injured anatomical region, injury event, injury nature, claimant age, and claimant tenure. All 570 claims were used in statistical analysis with categorical variables. Research hypotheses (as described in Chapter 3 Methods) addressed the primary research questions about how costs were distributed within the WC dataset in the present study. If researchers found evidence of difference in the distribution of claim costs by variable, then further statistical analyses were performed. Specifically, analysis using a Mann-Whitney U test was performed to compare the distribution of cost between pairs of categories to assign rank. Results of research hypotheses within Specific Aim 2 are described below:

[14]Exact proportions used in the Bonferroni adjustments pairwise proportions tests are presented in Appendix 8.8.

4.2.1. Claim cost by injured anatomical region

Claims associated with injuries that affected the lower limb incurred the highest median total claim costs followed by the upper limb and trunk region. Claims associated with injuries to the lower limb incurred the highest mean total claim costs followed by trunk region and upper limb. The median claim costs for the lower limb, trunk region, and upper limb ranged from $286 to $397. Claims associated with trunk region injuries incurred the highest cumulative total claim costs, exceeding $300,000. Claims associated with upper limb injuries incurred the second highest cumulative claim costs, exceeding $280,000. Approximately 2% of claims were classified as "other" injured anatomical region and were excluded from statistical analyses. The distribution of claim cost by injured anatomical region (median, mean, and cumulative cost) is outlined in Table 4.15. Researchers failed to reject the null hypothesis that claim costs are the same across all injured anatomical regions (Kruskal-Wallis χ^2= 0.8545, df=3, p=0.8364). The results did not support Research Hypothesis 2.1. that the claims associated with injuries to the upper limb would incur the greatest median claim costs. Instead, researchers observed that median claim costs among lower limb and upper limb were greater than claim costs associated with trunk region injuries.

Table 4.15. Descriptive statistics for total claim cost by injured anatomical region

Anatomical Region	Median total claim cost (IQR) ($)	Mean total claim cost (SD) ($)	Range of total claim cost ($)	Cumulative total cost ($)
Lower Limb	$396.70 ($0, $837.65)	$1,590.84 ($5,566.37)	$0, $54,403.88	$198,043.52
Trunk Region	$286.11 ($0, $993.02)	$1,523.05 ($5,161.73)	$0, $62,924.29	$307,576.87
Upper Limb	$380.83 ($0, $777.90)	$1,136.42 ($3,522.97)	$0, $36,924.85	$283,300.07
"Other"	$0 ($0, $1,158.47)	$614.02 ($886.57)	$0, $2,303.38	$6,161.79

Total, medical, and indemnity costs were investigated by injured anatomical region. Claims associated with injuries to the lower limb incurred the highest mean and median medical claim costs. Claims associated with injuries to the trunk region incurred the highest mean indemnity claim costs. The distributions of indemnity and medical claim costs by injured anatomical region are outlined in Table 4.16

Table 4.16. Descriptive statistics for medical and indemnity costs for injured anatomical region

Anatomical Region	Medical claims costs ($)		Indemnity claims costs ($)	
	Median (IQR)	Mean (SD)	Median (IQR)	Mean (SD)
Lower Limb	$396.70 ($0, $837.65)	$1,364.44 ($5,014.48)	$0 ($0, $0)	$226.40 ($1,214.28)
Trunk region	$286.10 ($0, $943.30)	$1,068.31 ($2,753.21)	$0 ($0, $0)	$454.74 ($2,786.81)
Upper Limb	$380.80 ($0, $777.90)	$995.38 ($2,923.7)	$0 ($0, $0)	$141.74 ($781.81)
"Other"	$0 ($0, $1,158.47)	$614.02 ($886.57)	$0 ($0, $0)	$0 ($0, $0)

4.2.2. Claim cost by injury nature.

Each claim was assigned an injury nature. Claims associated with lacerations and "other" injury nature incurred the highest median total claim costs (more than $400). However, claims associated with sprains/strains incurred the greatest cumulative total costs, exceeding $300,000 followed by "other" injury nature and contusions (each exceeding $140,000). Cumulative total costs related to lacerations and burns each were less than $85,000. The distribution of claim costs by injury nature is outlined in Table 4.17. Researchers rejected the null hypothesis and had evidence that total claim costs by injury nature were not homogenous (KW χ^2=27.47, df = 4, $p < 0.0001$). Analysis using a Mann-Whitney Wilcoxon pairwise test was conducted to further investigate associations and ranks of total claim costs between pairs of injury nature categories. Based on results of the Mann-Whitney U pairwise test, total claim costs associated with "other" injury nature were higher than contusions ($p < 0.001$) and burns ($p=0.006$). Claims associated with sprains/strains also incurred greater total claim costs than contusions ($p=0.005$). Claims associated with contusions incurred the lowest median total claim cost ($177). Claims categorized as "other" injury nature included "all other," "all other cumulative injuries," foreign body, puncture, dermatitis, fracture, poisoning-chemical, concussion, electric shock, hernia, dislocation, crushing, hearing loss, inflammation, and respiratory disorders. Results of the Mann-Whitney U test for total claim cost and injury nature are outlined in Table 4.18. The results did not support Research Hypothesis 2.2. that lacerations would incur

the highest median claim costs. Instead, lacerations incurred the second highest median claim costs, and claims classified as the injury nature "other" incurred the highest median claim costs.

Table 4.17. Descriptive statistics for total claim cost by injury nature

Injury Nature	Median total claim cost (IQR) ($)	Mean total claim cost (SD) ($)	Range of total claim cost ($)	Cumulative total cost ($)
Burn	$234.95 ($0, $449.50)	$1,495.22 ($7,351.04)	$0, $54,403.88	$83,852.99
Contusion	$176.70 ($0, $593.70)	$895.26 ($3,131.93)	$0, $22,674.25	$140,374.32
Laceration	$478.10 ($0, $730.10)	$623.94 ($1,269.54)	$0, $12,012.60	$66,963.63
Sprain/strain	$414.00 ($0, $1,342.70)	$2,019.70 ($6,126.91)	$0, $62,924.29	$348,773.11
"Other"	$558.10 ($142.03, $1,496.22)	$1,714.58 ($3,362.01)	$0, $19,023.15	$155,118.20

Table 4.18. Results of Mann-Whitney U pairwise tests for total claim cost and injury nature

	Burn	Contusion	Laceration	"Other"	Sprain/strain
Contusion	0.958	-	-	-	-
Laceration	0.214	0.100	-	-	-
"Other"	0.006	<0.0001	0.078	-	-
Sprain/strain	0.100	0.005	0.449	0.449	-

Medical and indemnity costs were also investigated by injury nature. Among indemnity costs, claims associated with sprains/strains incurred the greatest mean indemnity costs. The distribution of medical and indemnity claim costs by injury nature is outlined in Table 4.19. Claims associated with lacerations incurred the lowest mean indemnity costs. Claims associated with sprains/strains incurred the highest mean medical and indemnity claim costs followed by "other" injury nature. Contusions incurred the second lowest mean medical claim costs and the third highest mean indemnity claim costs. Burns incurred similarly mean medical claim costs to "other" injury nature and the second lowest mean indemnity claim costs.

Table 4.19. Descriptive statistics for medical and indemnity claim cost by injury nature

Injury Nature	Medical claims costs ($)		Indemnity claims costs ($)	
	Median (IQR)	Mean (SD)	Median (IQR)	Mean (SD)
Burn	$234.95 ($0, $449.50)	$1,387.96 ($7,065.65)	$0 ($0, $0)	$107.26 ($509.41)
Contusion	$176.70 ($0, $571.95)	$705.59 ($2,223.27)	$0 ($0, $0)	$189.67 ($1,199.98)
Laceration	$478.10 ($0,$730.10)	$577.92 ($895.66)	$0 ($0, $0)	$46.03 ($459.13)
Sprain/strain	$411.70 ($0, $1,325.40)	$1,531.20 ($3,885.71)	$0 ($0, $0)	$488.50 ($2,798.72)
"Other"	$558.10 ($142.03, $1,414.70)	$1,388.81 ($2,359.34)	$0 ($0, $0)	$325.77 ($1,734.90)

4.2.3. Claim cost by injury event

Claims due to overexertion and bodily reaction incurred the greatest median total claim costs, compared to STFs which incurred the lowest median total claim costs. Claims associated with the "other" injury event incurred the highest cumulative total costs, exceeding $360,000. The distribution of total claim cost by injury event is outlined in Table 4.20. Researchers rejected the null hypothesis and had evidence that total claim costs were not homogenous across the injury event categories (KW χ^2=20.4, df = 4, p=0.005). Analysis using a Mann-Whitney U test was conducted to further investigate associations between total claim costs among pairs of injury event categories. Claims associated with overexertion and bodily reaction incurred higher median total costs compared to contact with objects and equipment (p=0.004) and compared to exposure to harmful substances of environments (p=0.016). Results of the Mann-Whitney U test for total claim cost and injury event are outlined in Table 4.21. The results supported Research Hypothesis 2.3. that claims associated with the injury event of overexertion and bodily reaction would incur the greatest claim costs.

Table 4.20. Descriptive statistics for total claim cost and injury event (Specific Aim 2.3.)

Injury Event	Median total claim cost (IQR) ($)	Mean total claim cost (SD) ($)	Range of total claim cost ($)	Cumulative total cost ($)
Contact with objects and equipment	$283.60 ($0, $686.00)	$494.45 ($1,051.01)	$0, $10,958.40	$64,835.03
Exposure to harmful substances or environments	$362.40 ($0, $675.00)	$941.79 ($4,533.88)	$0, $54,403.88	$146,299.66
Slips, trips, or falls	$259.40 ($0, $1,195.47)	$1,681.94 ($4,255.09)	$0, $22,674.25	$154,808.28
Overexertion and bodily reaction	$510.10 ($0, $1,499.90)	$2,181.37 ($6,006.70)	$0, $62,924.29	$67,470.04
“Other”	$266.00 ($0, $1,076.30)	$1,769.35 ($5,421.48)	$0, $28,963.87	$361,669.24

Table 4.21. Results of Mann-Whitney U test for total claim cost and injury event

	Contact with objects and equipment	**Exposure to harmful substances or environments**	**Slips, trips, or falls**	**“Other”**	**Overexertion and bodily reaction**
Exposure to harmful substances or environments	1.000	-	-	-	-
Slips, trips, or falls	1.000	1.000	-	-	-
“Other”	1.000	1.000	1.000	-	-
Overexertion and bodily reaction	0.004	0.016	0.320	1.000	-

Medical and indemnity claim costs were also investigated by injury event. Claims due to overexertion and bodily reaction incurred the highest median and mean medical claim costs. Claims due to “other” injury events incurred the highest mean indemnity claim costs followed by overexertion and bodily reaction. The distribution of medical and indemnity claim costs by injury event is outlined in Table 4.22.

Table 4.22. Descriptive statistics for medical and indemnity claim cost by injury event

Injury Event	Total claim costs ($)		Medical claims costs ($)		Indemnity claims costs ($)	
	Median (IQR)	Mean (SD)	Median (IQR)	Mean (SD)	Median (IQR)	Mean (SD)
Contact with objects and equipment	$283.60 ($0, $686.00)	$494.45 ($1,051.01)	$283.60 ($0, $686.00)	$450.48 ($747.49)	$0 ($0, $0)	$43.97 ($357.50)
Exposure to harmful substances or environments	$362.40 ($0, $675.00)	$941.79 ($4,533.88)	$362.40 ($0, $675.00)	$871.27 ($4,302.01)	$0 ($0, $0)	$70.52 ($488.28)
Slips, trips, or falls	$259.40 ($0, $1,195.47)	$1,681.94 ($4,255.09)	$259.40 ($0, $1,195.47)	$1,343.99 ($3,108.44)	$0 ($0, $0)	$337.95 ($1,585.92)
Overexertion and bodily reaction	$510.10 ($0, $1,499.90)	$2,181.37 ($6,006.70)	$510.10 ($0, $1,448.10)	$1,726.41 ($4,028.11)	$0 ($0, $0)	$454.96 ($2,606.95)
“Other”	$266.00 ($0, $1,076.30)	$1,769.35 ($5,421.48)	$266.00 ($0, $864.10)	$929.19 (41,968.73)	$0 ($0, $0)	$840.15 ($3,514.45)

4.2.4. Claim cost by age categories

Claim costs were greatest among claimants aged 45-54 years old with a median cost of $600 per claim. To contrast, claimants younger than 45 years incurred median total claim costs between $350 to $380. Claimants ≥ 55 years old incurred the lowest median total claim costs at $77. Claimants between 25-34 years old incurred the greatest cumulative total cost, exceeding $350,000. Claimants aged between 35-44 years old incurred the second greatest cumulative total costs, exceeding $250,000. The distribution of total claim cost by age category is outlined in Table 4.23. Researchers failed to reject the null hypothesis that the distribution of claims costs was the same across age categories (KW χ^2=6.3027, df = 4, p=0.177). The results did not support Research Hypothesis 2.4. that median claims costs would be greater among older claimants than younger claimants. Instead, researchers observed that median claim costs were similar among older and younger claimants.

Table 4.23. Descriptive statistics for total claim cost by age category

Age Category	Median total claim cost (IQR) ($)	Mean total claim cost (SD) ($)	Range of total claim cost ($)	Cumulative total cost ($)
≤ 24 years old	$355.00.10 ($0, $597.20)	$377.52 ($366.96)	$0, $1,478.38	$24,694.72
25-34 years old	$380.00 ($0, $902.85)	$1,085.56 ($2,654.60)	$0, $22,295.33	$353,396.18
35-44 years old	$353.40 ($0, $876.93)	$2,118.41 ($7,157.61)	$0, $62,924.29	$251,221.68
45-54 years old	$600.00 ($96.80, $1,962.72)	$3,716.22 ($9,799.88)	$0, $54,403.88	$143,096.19
≥ 55 years old	$76.95 ($0, $1,112.18)	$748.49 ($1,119.55)	$0, $4,144.64	$13,546.93
NA	$178.35 ($0, $620.72)	$505.91 ($859.53)	$0, $3,407.66	$9,126.55

Medical and indemnity claim costs were also investigated by age category. Claims from claimants aged between 45-54 years old incurred the highest mean and median medical and indemnity claim costs. The distribution of medical and indemnity claim costs by age category is outlined in Table 4.24.

Table 4.24. Descriptive statistics for medical and indemnity claim costs by age category

Age Category	Medical claims costs ($)		Indemnity claims costs ($)	
	Median (IQR)	Mean (SD)	Median (IQR)	Mean (SD)
< 25 years old	$355.10 ($0, $591.00)	$374.79 ($365.43)	$0 ($0, $0)	$2.73 ($21.98)
25-34 years old	$375.30 ($0, $880.85)	$946.52 ($2,104.71)	$0 ($0, $0)	$139.03 ($823.07)
35-44 years old	$353.40 ($0, $804.12)	$1,484.53 ($4,404.84)	$0 ($0, $0)	$633.87 ($3,355.57)
45-54 years old	$600.00 ($96.8, $1,962.72)	$2,929.21 ($8,753.22)	$0 ($0, $0)	$787.01 ($2,850.00)
> 54 years old	$76.95 ($0, $1,040.82)	$545.44 ($703.95)	$0 ($0, $0)	$203.05 ($655.58)
NA	$178.35 ($0, $620.72)	$505.91 ($859.53)	$0 ($0, $0)	$0 ($0)

4.2.5. Claim cost by claimant tenure

Claimants with longer tenure (≥ 1 year) incurred greater median claim costs relative to claimants with shorter tenure (< 1 year). Claimants with ≥ 1 year but < 3 years of tenure incurred median total claim costs around $300. Claimants with ≥ 3 but < 5 years of tenure incurred the highest median total claim

costs exceeding $500. Claimants with < 1 year of tenure incurred the lowest median total claim cost at approximately $300. However, claimants with < 1 year of tenure incurred the highest cumulative total costs, exceeding $295,000. Claimants with ≥ 1 to < 2 years of tenure incurred the second highest cumulative total costs, exceeding $171,000. Claimants with ≥ 5 years of tenure incurred the third highest cumulative total cost, exceeding $110,000. The distribution of total claim cost by tenure category is outlined in Table 4.25. Researchers failed to reject the null hypothesis that claim costs were homogenous across tenure categories (KW $\chi 2$=9.0092, df=5, p=0.1087). The results did not support Research Hypothesis 2.5. that claimants with longer tenure (≥ 1 year) would incur greater median claim costs relative to claimants with shorter tenure (< 1 year). Instead, researchers observed that median claim costs were similar among claimants regardless of length of tenure.

Table 4.25. Descriptive statistics for total claim cost by claimant tenure

Tenure	Median total claim cost (IQR) ($)	Mean total claim cost (SD) ($)	Range of total claim cost ($)	Cumulative cost ($)
< 1 year	$281.60 ($0, $735.50)	$1,191.20 ($4,432.23)	$0, $62,924.29	$295,888.90
≥ 1 to < 2 years	$364.90 ($0, $784.47)	$1,309.36 ($3,914.10)	$0, $28,963.87	$171,620.18
≥ 2 to < 3 years	$338.50 ($143.88, $1150.92)	$2,008.49 ($7,993.92)	$0, $54,403.88	$92,603.77
≥ 3 to < 4 years	$541.90 ($186.88, $1,114.08)	$1,385.17 ($2,455.72)	$0, $11,265.91	$38,924.08
≥ 4 to < 5 years	$511.90 ($0, $1,191.50)	$1,363.38 ($2,743.00)	$0, $11,396.28	$23,382.57
≥ 5 years	$372.65 ($0, $1,130.83)	$1,991.84 ($5,847.05)	$0, $36,924.85	$113,624.13
NA	$417.35 ($0, $781.08)	$978.3 ($2,089.62)	$0, $12,332.89	$59,038.62

Medical and indemnity claim costs were investigated by tenure category. Claimants with ≥ 5 years of tenure incurred the highest mean indemnity claim costs followed by claimants with < 1 year of tenure and claimants with ≥ 1 to < 2 years of tenure. The distribution of medical and indemnity claim costs by tenure category is outlined in Table 4.26.

Table 4.26. Descriptive statistics for medical and indemnity claim costs by tenure

	Medical claims costs ($)		Indemnity claims costs ($)	
Tenure	Median claim cost (IQR)	Mean claim cost (SD)	Median claim cost (IQR)	Mean claim cost (SD)
< 1 year	$281.60 ($0, $711.50)	$864.54 ($2,453.13)	$0 ($0, $0)	$326.66 ($2,198.88)
≥ 1 to < 2 years	$364.90 ($0, $779.65)	$1,017.38 ($2,601.06)	$0 ($0, $0)	$291.98 ($1,909.30)
≥ 2 to < 3 years	$338.50 ($143.88, $1,150.92)	$1,950.21 ($7,737.76)	$0 ($0, $0)	$58.28 ($285.04)
≥ 3 to < 4 years	$541.90 ($186.88, $1,114.08)	$1,195.14 ($1,826.52)	$0 ($0, $0)	$190.03 ($698.69)
≥ 4 to < 5 years	$511.90 ($0, $1,191.50)	$1,288.82 ($2,460.81)	$0 ($0, $0)	$74.55 ($307.39)
≥ 5 years	$372.65 ($0, $1,130.83)	$1,564.39 ($4,633.60)	$0 ($0, $0)	$427.45 ($1,832.54)
NA	$417.35 ($0, $781.08)	$950.48 ($1,993.86)	$0 ($0, $0)	$27.82 ($143.05)

4.3. Results of Specific Aim 3:

The purpose of Specific Aim 3 was to investigate how task type was related to injury characteristics. Specific Aim 3 was accomplished by assessing the relationship between task type and injured anatomical region, injury event, injury nature, claim type, total claim costs, claimant age, and claimant tenure. Overall, MMH tasks were identified among 29% (164) of claims and other (non-MMH) tasks among 71% (406) of claims. Cumulatively, claims associated with MMH tasks incurred 808 days of lost time over the claim period, compared to 489 days of lost time associated with injuries that occurred during other (non-MMH) tasks. Research hypotheses (described in Chapter 3 Methods) addressed primary research questions about specific injury characteristics and task. If researchers found evidence of a relationship between task and other injury characteristics, further analyses were performed. Results of research hypotheses within Specific Aim 3 are described below:

4.3.1. Distribution of claims by task and injured anatomical region

Claimants performing MMH tasks at the time of injury had a greater proportion of injuries to the trunk region compared to claimants performing other (non-MMH) tasks. The proportion of claims

affecting the trunk region among MMH tasks was 0.52 (86 claims), and the proportion of claims affecting the trunk region among claimants performing other (non-MMH) tasks was 0.26 (104 claims). The counts of claims affecting the trunk region by task are outlined in Table 4.27. Researchers rejected the null hypothesis and had evidence that the proportion of claims affecting the trunk region was significantly greater among those who performed MMH tasks than those who performed other (non-MMH) tasks (χ^2=36.623, 95%CI (0.191, 1.00), $p < 0.0001$). The results supported Research Hypothesis 3.1. that claimants performing MMH tasks at the time of injury would have a significantly greater proportion of injury to the trunk region compared to claimants performing other (non-MMH) tasks. More than 50% of injuries among MMH tasks were related to the trunk region, twice that of the trunk region injuries among claimants performing other (non-MMH) tasks.

Table 4.27. Distribution of claims by workers performing MMH and injured trunk region

Anatomical region	MMH task (count)	Other (non-MMH) task (count)	*sum*
Trunk region	86	104	*190*
Not trunk region	78	302	*380*
sum	*164*	*406*	*570*

After addressing the initial Research Hypothesis 3.1. that focused on the upper limb, the distribution of claims among all injured anatomical regions was investigated. Of claims associated with MMH tasks, the trunk region was the most commonly injured anatomical region (52%) followed by the upper limb (30%) and lower limb (18%). Among claims associated with other (non-MMH) tasks, the upper limb was the most commonly injured anatomical region (49%) followed by the trunk region (26%) and the lower limb (23%). Approximately 3% of claims that occurred during other (non-MMH) tasks affected "other" injured anatomical regions. The "other" injured anatomical region category included multiple body parts (three claims), no physical injury (four claims) and unclassified (three claims). The counts of claims by injured anatomical region and task are outlined in Table 4.28.

Table 4.28. Detailed distribution of claims by workers performing MMH and injured anatomical region

Anatomical region	MMH task (count)	Other (non-MMH) task (count)	*sum*
Lower Limb	29	94	*123*
Trunk region	86	104	*190*
Upper Limb	49	198	*247*
Other		10	*10*
sum	*164*	*406*	*570*

4.3.2. Distribution of claims by task and injury nature

Claimants performing MMH tasks at the time of injury experienced a greater proportion of sprains/strains compared to claimants performing other (non-MMH) tasks. The proportion of sprains/strains among claimants performing MMH tasks was 0.52 (85 claims) and the proportion among those performing other (non-MMH) tasks was 0.19 (78 claims). The counts of claims by sprains/strains and task are outlined in Table 4.29. Researchers rejected the null hypothesis and had evidence that the proportion of sprain/strains among those performing MMH tasks was greater than those performing other (non-MMH) tasks (χ^2=60, 95% CI (0.25, 1), $p < 0.0001$). The results supported Research Hypothesis 3.2. that claimants performing MMH tasks at the time of injury would have a significantly greater proportion of sprain/strains compared to claimants performing other (non-MMH) tasks.

Table 4.29. Distribution of claims by injury nature and MMH task

Injury nature	MMH task (count)	Other (non-MMH) task (count)	*sum*
Sprains/strains	85	78	*163*
Not sprains/strains	79	328	*407*
sum	*164*	*406*	*570*

After addressing the initial Research Hypothesis 3.2. that focused on sprains/strains, the distribution of claims among all types of injury natures was investigated. Among MMH tasks, sprains/strains was the most common injury nature (52%) followed by contusions (30%). Among injuries that occurred during other (non-MMH) tasks, the most common injury natures were contusions (26%) and lacerations (25%) followed by sprains/strains (19%) and other (17%). Contusions accounted for similar proportions of claims among MMH (30%) and other (non-MMH) tasks. Burns accounted for 13% of all claims

associated with other (non-MMH) tasks and 3% of all claims associated with MMH tasks. Of the 57 burns, 90% occurred during other (non-MMH) tasks and 10% during MMH tasks. Lacerations accounted for 25% of claims with other (non-MMH) tasks and approximately 4% of claims associated with MMH tasks. Claim counts by injury nature and task are outlined in Table 4.30.

Table 4.30. Detailed distribution of claims by injury nature and MMH task

Injury nature	MMH task (count)	Other (non-MMH) task (count)	*sum*
Sprains/strains	85	78	*163*
Lacerations	6	101	*107*
Burns	5	51	*57*
Contusions	49	105	*154*
Other	19	71	*90*
sum	*164*	*406*	*570*

"Other" injury nature accounted for 12% of claims associated with MMH injuries and 18% of claims associated with other (non-MMH) tasks. There was an overlap between MMH and other (non-MMH) tasks for injury events classified as "other," specifically "all other," "all other cumulative," dermatitis, and inflammation. The counts of claims classified as "other" injury nature and task are outlined in Table 4.31. The most common types of "other" injury natures among MMH tasks were "all other cumulative injuries," hearing loss, and inflammation. The most common types of "other" injury nature among other (non-MMH) tasks were foreign body, "all other," puncture, and dermatitis.

Table 4.31. Distribution of "other" injury nature details

"Other" injury nature	Other (non-MMH) tasks, count (%)	MMH tasks, count (%)
All Other	13 (3.20)	2(0.49)
All Other Cumulative Injuries	6 (1.48)	8 (1.97)
Concussion	3 (0.74)	
Crushing		1
Dermatitis	8 (1.97)	1(0.25)
Dislocation	2 (0.49)	
Electric Shock	3 (0.74)	
Foreign Body	14 (3.45)	
Fracture	5 (1.23)	
Hearing Loss		3 (0.74)
Hernia		1(0.25
Inflammation	1 (0.25)	3 (0.74)
Poisoning-Chemical	5 (1.23)	
Puncture	10 (2.46)	
Respiratory Disorders	1 (0.25)	

4.3.3. Distribution of claims by task and injury event

Claimants performing MMH tasks at the time of injury had a greater number of claims related to the injury event of overexertion and bodily reaction compared to claimants performing other (non-MMH) tasks. The proportion of overexertion and bodily reaction claims among claimants performing MMH tasks was 0.60. The proportion of overexertion and bodily reaction claims among claimants performing other (non-MMH) tasks was 0.15. The distribution of claims by task and overexertion and bodily reactions is outlined in Table 4.32. Researchers rejected the null hypothesis and had evidence that the proportion of claims with the injury event overexertion and bodily reaction was significantly greater among those who performed MMH tasks compared to those who performed other (non-MMH) tasks (χ^2=114.99, 95%CI (0.377, 1), $p < 0.0001$). The results supported Research Hypothesis 3.3. that claimants performing MMH tasks at the time of injury would incur a greater proportion of claims due to overexertion and bodily reaction compared to claimants performing other (non-MMH) tasks.

Table 4.32. Distribution of claims by injury event and MMH task

Injury event	MMH task (count)	Other (non-MMH) task (count)	*sum*
Overexertion	99	62	*161*
Not overexertion	65	344	*409*
sum	*164*	*406*	*570*

After addressing the initial Research Hypothesis 3.3. that focused on overexertion and bodily reaction, researchers investigated the distribution of claims among all types of injury events. Among MMH tasks, overexertion and bodily reaction was the most common injury event (60%) followed by contact with objects and equipment (24%). Among other (non-MMH) tasks, exposure to harmful substances or environment was the most common injury event (35%) followed by contact with objects and equipment (22%), STFs (18%), and overexertion and bodily reaction (15%). All 35 claims due to "other" injury event occurred during other (non-MMH) tasks. The most frequent injury events classified as "other" included "miscellaneous other than physical cause of injury" (12 claims), motor vehicle collision (9 claims), and animal or insect (five claims). The counts of claims by task and injury event are outlined in Table 4.33.

Table 4.33. Detailed distribution of claims by injury event and MMH task

Injury event	MMH task (count)	Other (non-MMH) task (count)	*sum*
Contact with objects and equipment	40	91	*131*
Exposure to harmful substances or environments	11	144	*155*
Slips, trips, or falls	14	74	*88*
Overexertion and bodily reaction	99	62	*161*
"Other"		35	*35*
sum	*164*	*406*	*570*

4.3.4. Distribution of claims by task and claim type

Claimants performing MMH tasks at the time of injury did not have a greater proportion of claims classified as indemnity compared to claimants performing other (non-MMH) tasks. The proportion of indemnity claims among workers performing MMH tasks was 0.067 (11 claims) and the proportion

among those performing other (non-MMH) tasks was 0.062 (25 claims). The distribution of claims by task and claim type (indemnity and not indemnity) is outlined in Table 4.34. Researchers failed to reject the null hypothesis that the proportion of indemnity claims among claimants performing MMH tasks was not greater than those performing other (non-MMH) tasks (χ^2 =0.0029217, 95%CI (-0.0364, 1), p=0.4784). The results did not support Research Hypothesis 3.4. that claimants performing MMH tasks would have a greater proportion of claims classified as indemnity compared to claimants performing other (non-MMH) tasks. Instead, similar proportions of indemnity claims were reported among claims that occurred during MMH and other (non-MMH) tasks.

Table 4.34. Distribution of claims by claim-type and MMH task

Claim type	MMH task (count)	Other (non-MMH) task (count)	*sum*
Indemnity	11	25	*36*
Not indemnity	153	381	*534*
sum	*164*	*406*	*570*

4.3.5. Distribution of claims by task and total claim costs

Claimants performing MMH tasks at the time of injury incurred slightly higher total costs per claim compared to costs associated with other (non-MMH) tasks. During the claim period, the cumulative cost of claims associated with MMH tasks ($269,081) was approximately half of the cumulative cost associated with claims that occurred during other (non-MMH) tasks ($526,002). The distribution of total claim costs by task are outlined in Table 4.35. Based on descriptive statistics (without adjusting for other injury characteristics), claims associated with MMH and other (non-MMH) tasks incurred similar median claim costs. However, mean claim costs associated with MMH tasks were greater than mean costs associated with other (non-MMH) tasks.

Table 4.35. Descriptive statistics for total claim costs among MMH tasks and other (non-MMH) tasks

Task		Count (%)	Median total claim cost (IQR) ($)	Mean total claim cost (SD) ($)	Range of total claim cost ($)	Cumulative cost ($)
MMH	Claims that incurred costs	108 (29.43)	$677.85 ($394.57, $1,455.67)	$2,373.38 ($6,691.34)	$39.42, $62,924.29	$269,080.70
	All claims	164 (28.77)	$385.75 ($0, $918.47)	$1,562.95 ($5,537.69)	$0, $62;924.29	$269,080.70
Other (non-MMH)	Claims that incurred costs	259 (70.57)	$678.80 ($390.35, $1,233.40)	$1,990.59 ($5,029.11)	$49.12, $54,403.88	$526,001.50
	All claims	406 (71.23)	$360.95 ($0, $818.45)	$1,269.86 ($4,126.67)	$0, $54,403.88	$526,001.50

Since the distribution of total claim cost data was not normally distributed, nonparametric statistical methods were applied. Analysis using a gamma GLM was performed to analyze the relationship between total claim cost and task while adjusting for other injury characteristics. Mean total claim cost was the dependent variable. The injury model included: task, injured anatomical region, injury nature, injury event, claimant age (continuous), claimant tenure (continuous), and claim type. The multiplicative difference in average total claim cost comparing those who performed MMH tasks at the time of injury to those who performed other (non-MMH) tasks, when adjusting for injury event, injury nature, injured body region, claimant age, claimant tenure, and claim type, was 1.141 (95% confidence interval (CI) (0.886, 1.476), p=0.31).[15] The mean total claims cost was 14.1% higher for injuries involving MMH tasks compared to those who performed other (non-MMH) tasks when adjusting for variables. Researchers failed to reject the null hypothesis that there was no difference in the distribution of total claim cost among claimants performing MMH tasks and other (non-MMH) tasks when adjusting for injured anatomical region, injury event, injury nature, claimant age, claimant tenure, and claim type. The results

[15] The formula and model output is available in Appendix 8.11.

did not support Research Hypothesis 3.5. that claims associated with claimants performing MMH tasks incurred higher costs.

4.3.6. Distribution of claims by task and claimant age.

There was not a significant difference in age of claimants performing MMH tasks at the time of injury compared to those performing other (non-MMH) tasks. Based on descriptive statistics (without adjusting for other injury characteristics), claims associated with MMH and other (non-MMH) tasks affected claimants of similar ages. The age range of claimants injured while performing other (non-MMH) tasks was slightly larger than claimants performing MMH tasks at the time of injury.

To investigate the relationship between age and task, descriptive statistics were first performed. The distribution of claimant ages by task, specifically median and mean, are outlined in Table 4.36. The distribution of age by task are displayed in scatter plots overlaying violin plots in Figure 4.5. Since claimant age was normally distributed, parametric tests were used to investigate the relationship between age and task while adjusting for other injury characteristics. Analysis using a linear regression model was performed to investigate the relationship between claimant age and task when adjusting for other injury characteristics. The linear regression model included claimant age (continuous), task, injured anatomical area, injury nature, claimant tenure (continuous), and claim type. Tenure was included in the model because it was moderately correlated with claimant age.[16] There was a -1.54 additive difference in age (95% CI (-2.77, 0.66), p=0.08).[17] The mean age of claimants was 1.1 years younger among those who performed MMH tasks at the time of injury compared to those who performed other (non-MMH) tasks at

[16] Correlation results and a scatter plot of claimant age and claimant tenure is in Appendix 8.12.

[17] The formula and model output are available in Appendix 8.13.

the time of injury, when adjusting for age (continuous), task, injured anatomical area, injury nature, tenure (continuous), and claim type. Researchers failed to reject the null hypothesis that there was no difference in the distribution of claimant age among workers performing MMH tasks and other (non-MMH) tasks when adjusting for injured anatomical region, injury event, injury nature, total claim cost, claimant tenure, and claim type. The results did not support Research Hypothesis 3.6. that claimants performing MMH tasks at the time of injury were younger than claimants who performed other (non-MMH) tasks.

Table 4.36. Descriptive statistics for claimant age (years) by task (not adjusted for other variables)

Task	Median (IQR) (years)	Mean (SD) (years)	Range of age (years)
MMH	30 (27,36)	32.43 (7.86)	19, 61
Other (non-MMH)	30 (26,36)	32.39 (8.61)	18, 65

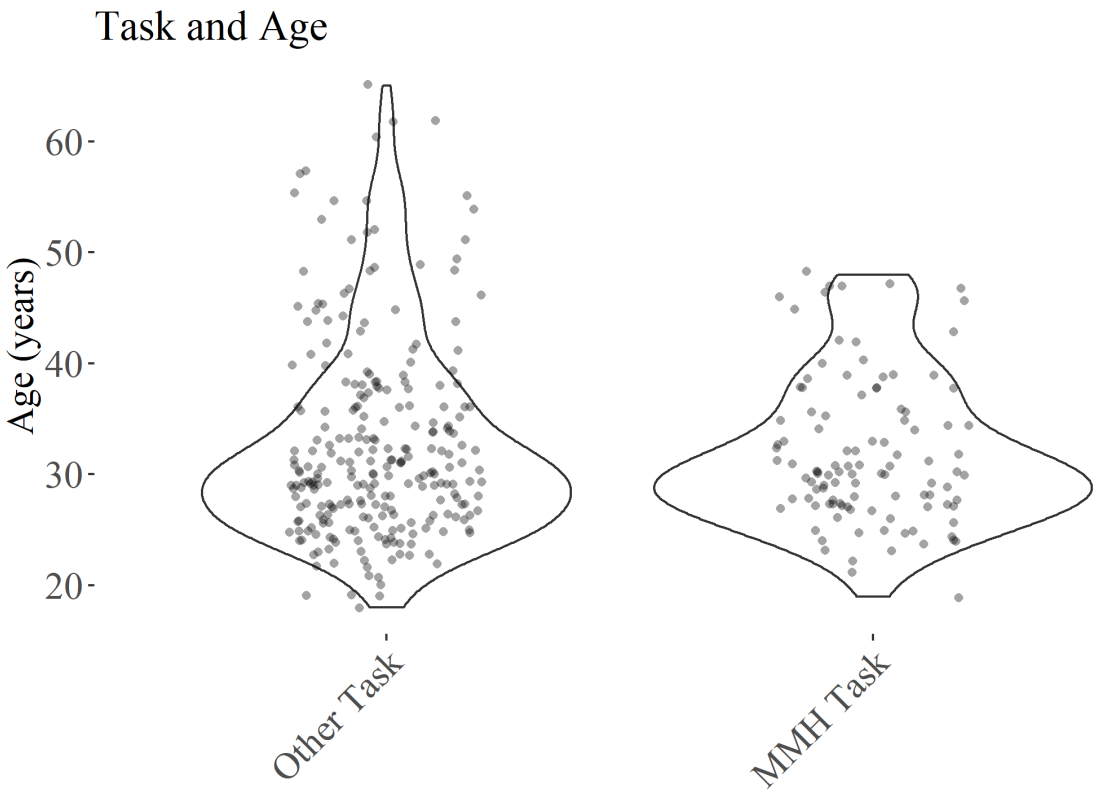

Figure 4.5. Violin plots stacked with scatter plots of claimant age by task among Colorado craft brewery workers (2013-2018)

4.3.7. Distribution of claims by task and claimant tenure

Claimants performing MMH tasks at the time of injury had slightly longer tenure compared to claimants performing other (non-MMH) tasks. According to descriptive statistics, median and mean tenure were longer among claimants performing MMH at the time of injury. The distribution of claimant tenure by task is outlined in Table 4.37. The distribution of tenure by task using violin plots overlaying scatter plots is displayed in Figure 4.6. Analysis using a linear regression model was performed to investigate the relationship between claimant tenure and task when adjusting for other injury characteristics. The linear regression model included tenure (continuous), task, injured anatomical area, injury nature, age (continuous), and claim type. Age was included in the model because it was moderately correlated with tenure.[18] There was a -0.31 additive difference in average tenure (95% CI (-0.977, 0.362), p=0.37).[19] The mean tenure was 0.31 years shorter among claimants who performed MMH tasks at the time of injury compared to those who performed other (non-MMH) tasks, when adjusting for injured anatomical area, injury nature, injury event, age, and claim type. Researchers failed to reject the null hypothesis that there was no difference in the distribution of claimant tenure among claimants performing MMH tasks and other (non-MMH) tasks when adjusting for injured anatomical area, injury nature, injury event, age, and claim type. The results did not support Research Hypothesis 3.7. that tenure would be shorter among claimants who performed MMH tasks at the time of injury compared to those who performed other (non-MMH) tasks.

[18] Correlation results between claimant age and claimant tenure is in Appendix 8.12.

[19] The formula and model output are available in Appendix 8.14.

Table 4.37. Descriptive statistics for claimant tenure and task

Task	Median (IQR) (years)	Mean (SD) (years)	Range of tenure (years)	Range of tenure (months)
MMH	1.28 (0.55,3.11)	2.21 (2.5)	0.025, 14.89	0.30, 178.68
Other (non-MMH)	1.06 (0.37,2.15)	2.13 (3.54)	0.003, 34.45	0.033, 413.39

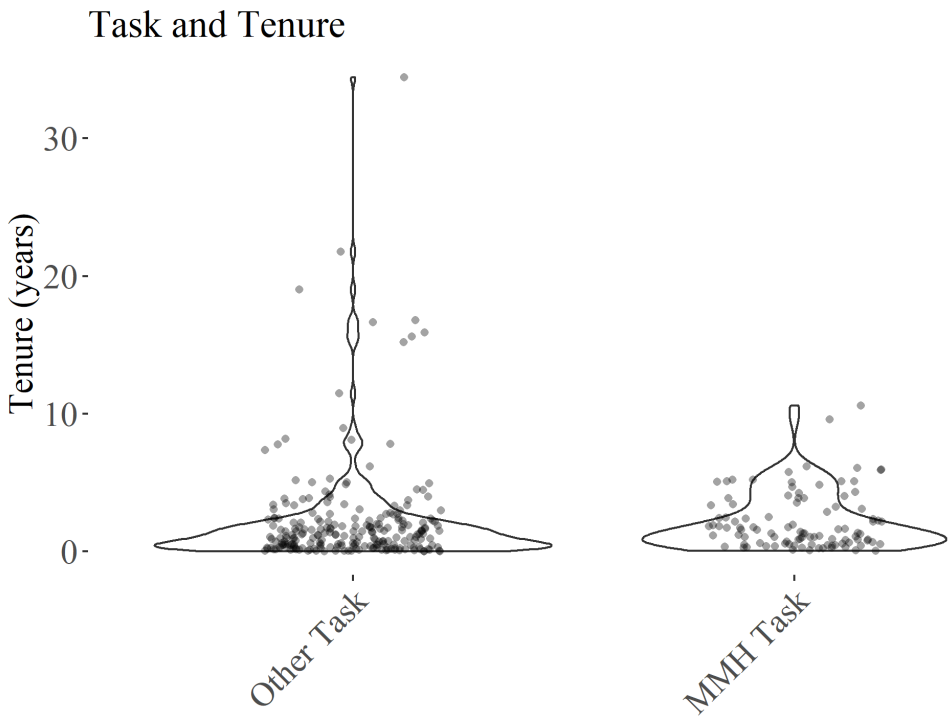

Figure 4.6. Violin plots stacked with scatter plots of claimant tenure by task among Colorado craft brewery claimants (2013-2018)

4.4. Results of Specific Aim 4.

4.4.1. Research Objective 4.1.

Each claim (n=570) included an accident narrative. The accident narratives from the FROI were analyzed to obtain a qualitative perspective of the injuries affecting craft brewery claimants.[20] Researchers used the revised agent-host-environment epidemiologic model to identify contributing factors to the injury from the accident narratives. Examples of contributing factors identified from the WC accident narratives using the revised agent-host-environment epidemiologic model are presented in Tables 4.38. and 4.39.

Table 4.38. Example of completed template using the revised agent-host-environment epidemiologic model on WC accident narratives

Claimant ID	1716842			
Accident Narrative	Full keg fell off pallet and smashed finger filling kegs			
Exposure	Agent	Host	Environment	Vehicle
Contributing factor(s)	Mechanical (energy)	Operating kegging line Filling kegs	Brewery kegging line (packaging hall)	Keg (full)

Table 4.39. Example of completed template using revised agent-host-environment epidemiologic model on WC claims data

Claimant ID	1733298			
Accident Narrative	He was moving a hot water hose from a kettle to a fermenter and he had a valve open and got some boiling water into his boot moving hot water			
Exposure	Agent	Host	Environment	Vehicle
Contributing factor(s)	Thermal (energy)	Moving a hose	Brewery Cellar	Liquid (boiling water) Hose (open value)

[20] All accident narratives are available in Appendix 8.15.

The level of detail provided within the accident narrative varied among claims. The average word count per accident narrative was approximately 20 words but ranged from one to 52 words. The distribution of word count among claims is outlined in Table 4.40. For example, some claims provided detail such as:

- stepped on a broken pallet with a rusty nail in it opening the bay door
- he was tightening the round plate that come in contact with the bottle tops, the light curtain broke and didn't release air pressure so his hands were caught under the round plate. tightening the round plate on bottling line
- he was emptying beer out of wooden barrels and his back began to hurt him after a long day of this work. moving wooden barrels

The level of detail provided in the accident narrative was a limiting factor in identifying contributing factors related to the agent, host, environment, or vehicle. Some accident narratives were vague and only provided short phrases, such as:

- car accident driving
- cutting the cheese
- keg machine maintenance
- sanitizing tank
- keg machine
- while lifting kegs
- walking

Table 4.40. Distribution of words per accident narrative free response

Mean word count (SD)	Median word count (IQR)	Minimum word count	Maximum word count
18.50 (10.72)	17 (10, 25)	1	52

Accident narratives were coded based on the revised agent-host-environment epidemiologic model (per Research Objective 4.1.). After identifying contributing factors for each injury claim, researchers analyzed the data to identify patterns. The contributing factors data were compared against quantitative WC data. Specifically, contributing factors identified from the accident narratives based on the revised agent-host-environment epidemiologic model were compared to the results of Specific Aims 1, 2, and 3.

Two researchers each separately coded every accident narrative (n=570) to identify contributing factors to injury (agent, host, environment, and vehicle). Researchers then compared their coding for quality assurance purposes. Initially, the primary researcher identified disagreement in 21.0% of claims, with the majority of discrepancies under the environment contributing factor category. The secondary researcher identified disagreement in 9.0% of the coded claims, with most discrepancies within the environment contributing factor category. Together, both researchers reviewed all claims with any identified discrepancy, discussed, and reached a consensus on 98.8% of claims. The remaining 1.2% of questionable claims (including seven environmental contributing factors and one vehicle contributing factor) were discussed with a third researcher to resolve the remaining discrepancies. After consensus was reached on the coding for all accident narratives, the identified contributing factors were analyzed.

Most claims had at least one contributing factor per claim per exposure category. Each accident narrative had an average of 4.7 contributing factors, with a range of one to ten. The distribution of contributing factors identified per contributing factor category are outlined in Table 4.41. The number of contributing factors represented the amount of relevant information that could be extracted from the accident narrative. A single contributing factor to agent was identified for nearly all claims.

Table 4.41. Distribution of number of contributing factors identified per accident narrative

Number of contributing factors per claim	Host, count (%)	Environment, count (%)	Agent, count (%)	Vehicle, count (%)
1	270 (47.87)	245 (59.76)	565 (100)	424 (81.70)
2	254 (45.04)	123 (30.0)		92 (17.73)
3	33 (5.85)	33 (8.05)		3 (0.58)
4	5 (0.89)			
5	2 (0.35)			

4.4.1.1. Agent contributing factors

The agent represented the energy responsible for causing the injury in the revised agent-host-environment epidemiologic model. Agent was identified in 565 claims (99%). A single agent contributing factor was assigned to those claims. Four unique agents were identified from the accident narratives:

chemical, electrical, mechanical, and thermal. Mechanical energy was the most common agent associated with a claim (84%). Thermal and chemical energies together accounted for 14% of claims. The distribution of types of agent identified from accident narratives is outlined in Table 4.42.

Table 4.42. Agent contributing factors classified from accident narratives

Agent contributing factor	Count (%)
Mechanical	481 (84.39)
Thermal	44 (7.72)
Chemical	36 (6.32)
Electrical	4 (0.71)

Claims associated with a transfer of mechanical energy included lacerations, sprains/strains, and anatomical regions struck or caught between objects. Examples of accident narratives where mechanical energy was the agent included:

- cutting lettuce at hyperspeed
- cut hand while scrubbing dishes in a sink washing dishes
- he was emptying beer out of wooden barrels and his back began to hurt him after a long day of this work
- caught finger under empty keg while transporting moving empty kegs

Claims associated with a transfer of thermal energy included contact between the host and hot liquids or steam. Examples of accident narratives where thermal energy was the agent included:

- he kicked the fryer filter machine to move it a bit, spilling oil onto his foot
- employee was reaching into a kettle to remove bag of ginger and burned his forearm

Claims associated with a transfer of chemical energy included contact between the host and cleaning/sanitizing materials. Examples of accident narratives where chemical energy was the agent included:

- caustic splashed into eye while wearing safety glasses cip[clean in place] fermenter
- phos acid [phosphoric acid] shot out of line hitting worker in face/eye cleaning

4.4.1.2. Host activities

The host represented the injured worker in the revised agent-host-environment epidemiologic model. In the present study, the host represented the claimant. Ten activities that the host was performing at the time of injury were identified: carrying items, brewing activities, maintenance, cleaning, food preparation/service, walking/climbing/standing, stocking, pushing/pulling, driving, and miscellaneous. At least one host activity was identified in 99% of the claims' accident narratives. Between one and five host activities were identified per claim. One or two host activities were identified in more than 90% of claims. Overall, 907 host activities identified were identified from accident narratives. Within this data, there were 465 unique host activities that were grouped into ten contributing factor host categories. The distribution of the ten primary host activities is outlined in Table 4.43. Among the ten host activities, carrying items and brewing were the most commonly identified activities followed by maintenance and cleaning. Additionally, ten percent of identified host activities were related to food preparation/service host activities. Multiple host activities allowed for overlap, or a comprehensive look at host activity. For example, within the accident narrative "lifting 50-pound bags of malt grain milling," two host activities were identified: carrying items (lifting) and brewing activity (milling).

Table 4.43. Host activities classified from accident narratives

Activity	Detailed activity	Activity count (%)	Detail count (%)
Carrying items		215 (23.7)	
	Carrying		24 (2.65)
	Delivering		10 (1.1)
	Lifting		54 (5.95)
	Load/unload		19 (2.09)
	Moving/handling		71 (7.83)
	Stacking		12 (1.32)
Brewing activities		166 (18.3)	
	Bottling		15 (1.65)
	Canning		6 (0.66)
	Kegging		24 (2.65)
	Producing		15 (1.65)
Maintenance		134 (14.77)	
	Adjusting		6 (0.66)
	Brewing maintenance		37 (4.08)
	Fixing		17 (1.87)
Cleaning		123 (13.56)	
Food preparation/service		92 (10.14)	
	Cooking		50 (5.51)
	Serving		15 (1.65)
	Slice/dice		23 (2.54)
Walking/climbing/standing		78 (8.6)	
	Climbing		5 (0.55)
	Entering/exiting		5 (0.55)
	Standing		8 (0.88)
	Stepping		7 (0.77)
	Walking		43 (4.74)
Miscellaneous		50 (5.51)	
Stocking		23 (2.54)	
Pushing/pulling		13 (1.43)	
Driving		13 (1.43)	

Carrying items represented any host activities related to weight-bearing tasks. Host activities grouped into carrying items included: carrying bags, carrying kegs, delivering beer, down stacking kegs, dumping barrels, flipping boxes, lifting (bags, heavy objects, beer, hops, bins, cases, containers), loading boxes, moving hoses, moving pumps, putting beer away, stacking (boxes, cases), transporting items, unloading items, and rolling material.

When accident narratives described the claimant as performing brewing-related tasks at the time of injury, those contributing factors were classified as brewing. Brewing activities represented contributing

factors specific to the brewing process (including packaging and quality control, regardless of weight-bearing). Host activities grouped into brewing included: bottling beer, performing brewing operations, kegging, measuring carbonation, milling, stirring, wrapping pallets, and sampling.

Maintenance represented tasks occasionally or sporadically performed, which included adjusting, fixing, and repairing material/equipment throughout the facility. Host activities classified as maintenance included: adjusting pipes, adjusting pallet topper, clearing jam, disconnecting hoses, fixing jam, fixing draught leak, inspecting pump, preparing filter, relocating cooler, reassembling guest brink, replacing labels, and setting up keg machine. Examples of brewing maintenance included setting up the kegging machine, preparing filters, and maintaining canning line.

Cleaning represented tasks commonly or frequently performed, which included sanitizing, rinsing, and non-maintenance activities. Host activities classified as cleaning included: adding cleaner, cleaning bottles (scrubbing), cleaning out brew tank, washing glassware, sweeping, setting up and taking down materials.

Food preparation/service represented activities where employees might cook food and/or deliver food or beer to the customer. Host activities classified as food preparation/service included bartending, cooking, cutting (food), frying, preparing food, and serving beer/food.

When accident narratives described the claimant as moving or standing in the facility at the time of injury, the host activity was classified as walking/climbing/standing. Host activities grouped into walking/climbing/standing included: climbing ladder, ducking under conveyor, entering building, exiting forklift, running, standing, stepping, walking, and leaving desk.

When accident narratives described the claimant as arranging product or performing inventory, but did not require weight-bearing activities, and did not specify brewing or food service, the host activities were classified as stocking. Host activities classified as stocking included: getting product, organizing materials, reaching, and stocking.

When accident narratives described the claimant as exerting a force by pushing or pulling (but not explicitly performing a weight-bearing activity), the contributing factor host activity was classified as pushing/pulling. Host activities classified as pushing/pulling included: pushing barrel onto rack, pushing pallet, pulling a broken bottle out of bottling line, pulling stuck material, and pulling grain cart.

When accident narratives described the claimant as driving or operating a motor vehicle at the time of injury, the host activity was classified as driving. Host activities classified as driving included: driving and backing up forklift.

When accident narratives described the claimant doing something at the time of injury that was not considered carrying, maintenance, cleaning, food preparation/service, walking/climbing/standing, stocking, pushing/pulling, or driving, the host activity was classified as miscellaneous. Host activities that were classified as miscellaneous included: playing games, drinking, typing, and training.

4.4.1.3. Environmental contributing factors

The environment represented the area where the injury occurred in the revised agent-host-environment epidemiologic model. Environmental contributing factors could represent the physical or social environment. Physical environmental contributing factors were classified into six categories: brewery, food preparation, service area, walking/working surfaces, general physical environmental characteristics, and unspecified. Only 72% of accident narratives provided sufficient level of detail to identify any environmental contributing factors. The number of environmental contributing factors identified per claim varied from one to three. A single environmental contributing factor was identified in approximately 60% of all claims. Overall, accident narratives provided the least amount of detail to identify environmental contributing factors. However, some accident narratives provided sufficient information to assign multiple environmental contributing factors, which allowed for a comprehensive look at the environment where the injury occurred. For example, in the narrative “slipped and fell on new epoxy floor in the bottling line,” two physical environmental contributing factors were identified; bottling

line (brewery) and slippery floor (general physical environment). The distribution of environmental contributing factors identified in the accident narratives is outlined in Table 4.44.

Most claims occurred within the brewery. Some accident narratives provided sufficient detail that allowed researchers to code for areas within the brewery, including packaging (bottling, canning, and kegging line) and production (boil kettle, tanks, cellar, conveyors, fermenters, sensory lab, and production floor). Multiple accident narratives provided sufficient detail that researchers were able to specify the type of packaging. The bottling line was identified in 23 claims (3.8%), the kegging line was identified in 21 claims (3.5%), and the canning line was identified in eight claims (1.3%).

Food preparation represented the areas were food was cooked, prepared, or cleaned. Examples of food preparation areas included the kitchen and dish pit.

The service area environment represented areas where beer and food were served. Examples of service area included the taproom, tasting room, and restaurant.

Many accident narratives described the claimant as walking around the facility or climbing stairs without explicitly stating where in the facility the injury occurred (brewery, food preparation, or service area). In these cases, the physical environment was categorized as walking/working surfaces.

When the accident narrative described the claimant interacting with snow/ice or other slippery surfaces, the environmental contributing factor was classified as general physical environment. Examples of environmental contributing factors classified as the general physical environment included snow, ice, slippery surfaces, uneven surfaces, or debris.

When the accident narrative described the claimant as driving or otherwise interacting with a motor vehicle, the physical environment contributing factor was classified as vehicle related. Examples of vehicle-related environmental contributing factors included cars, trucks, truck beds, and forklifts.

Environmental contributing factors that could not be explicitly categorized within the brewery, food preparation, service area, or general physical environment were classified as unspecified facility or unspecified outside. For example, a cooler could be part of the brewery or restaurant/taproom. Unless the exact location could be determined from the accident narratives, cooler was classified as unspecified facility. Cooler was identified in 13 of the claims' accident narratives (2.3%).

Social environment referred to how claimants interacted with people around them. Accident narratives that included phrases such as rushing and lack of attention were indicative of social environmental contributing factors. Approximately 1% of accident narratives provided sufficient information to identify social environmental contributing factors. Typically, accident narratives that provided information that could be classified as social environmental contributing factors also included information about physical environmental contributing factors. For example, in the accident narrative "cutting lettuce at hyperspeed,"[21] both physical and social environmental contributing factors were identified; kitchen and rushing. Furthermore, in the accident narrative "rushing downstairs and hit hip on handrail going downstairs from second floor to first floor,"[22] both physical and social environmental contributing factors were identified; walking/working surfaces and rushing.

[21] Example from Claimant Identifier 2122315 see Appendix 8.15.

[22] Example from Claimant Identifier 2195051 see Appendix 8.15.

Table 4.44. Physical environmental contributing factors classified from accident narratives

Physical Environment	Detailed environment	Environment count (%)	Detail count (%)
Brewery		367 (61.27)	
	Packaging		111 (18.53)
	Production		49 (8.18)
Food-preparation		61 (10.18)	
	Kitchen		59 (9.85)
Service (bar, taproom)		31 (5.18)	
Walking/working surfaces		24 (4.01)	
	Stairs		15 (2.50)
General physical environment		38 (6.34)	
	Slippery surface		14 (2.34)
	Ice or snow		13 (2.17)
Unspecified facility		26 (4.34)	
Vehicle-related		23 (3.84)	
Unspecified outside		15 (2.50)	

4.4.1.4. Vehicle contributing factors

The vehicle was the object responsible for the transfer of energy (agent) to the claimant (host) that resulted in a claim within the environment in the revised agent-host-environment epidemiologic model. Vehicle contributing factors were classified into 12 categories: equipment, containers, cooking equipment, liquid, structure, cleaner, glass, hose/lines, motor vehicle, sharp edge, animal/insect, and miscellaneous. Vehicle contributing factors were identified in 91% of claims. The number of vehicle contributing factors identified per claim varied from one to three. A single vehicle contributing factor was identified in more than 80% of claims. The distribution of vehicle contributing factors identified in the accident narratives is outlined in Table 4.45.

Vehicle contributing factors were classified as equipment when, at the time of injury, the claimant interacted with tools or machinery within the facility that could be easily removed or rearranged. Equipment included: tools (broom, brush, computer, gloves, drill, ladder, step stool, mat, scraper, wrench, tables, or pallets) and machinery (conveyor, de-palletizer, drill, or lift assist devices). Occasionally, accident narratives described the claimant's contact with faulty or broken equipment at the time of injury. Examples of faulty equipment included: dull knife, broken pallet, cracked plastic, metal splinter, bottle dryer jam, hole in pipe, or bottling line malfunctions.

Vehicle contributing factors were classified as structure when, at the time of injury, the claimant interacted with elements of the facility that cannot be easily removed or rearranged. Structure included: doors, curbs, drains, catwalks, floor, pipes, railing, or shelves.

Vehicle contributing factors were classified as containers when, at the time of injury, the claimant interacted with equipment used to transport other materials. Containers included: kegs, barrels, cases, boxes, bags, buckets, or tubs. Barrels are typically used in production for aging beers. Kegs are pressurized metal containers used to transport beer. Both empty and full kegs were identified in accident narratives. Cases included boxes of beer (cans, bottles). Ingredients were typically packaged in bags or boxes. Cleaning chemicals and supplies were typically transported in buckets or tubs. Dishes and glassware were also carried in tubs.

Vehicle contributing factors were classified as cooking equipment when, at the time of injury, the claimant interacted with equipment used to cook/prepare food or process ingredients. Cooking equipment included: knife, tray, plate, grill, fryer, or ingredients.

Vehicle contributing factors were classified as liquid when, at the time of injury, the claimant interacted with oil, water, or other liquids or gels at the time of injury. Claimants interacted with liquids in the brewery as well as in the food preparation/service areas. Liquids included: boiling water, boiling wort, pressurized water, oil, hot liquor, hot water, wet floor, splashed solder, ice, snow, grease, or fruit puree.

Vehicle contributing factors were classified as cleaner when, at the time of injury, the claimant interacted with cleaning materials. Cleaning materials were used to clean brewing equipment and environments as well as in the service/food preparation equipment and environments. Cleaner included: caustic, chlorinated cleaner, dish soap chemical, cleaning solution, lye, nitric acid, oven cleaner, pressurized phosphoric acid, sanitizer, or sodium.

Vehicle contributing factors were classified as glass when, at the time of injury, the claimant interacted with glass in the brewing or in the food preparation/service area. Glass included: bottles,

glassware, or broken glassware. Glassware was explicitly mentioned in 27 of the claims' accident narratives (4.4%). Bottles were explicitly mentioned in 15 of the claims' accident narratives (2.4%). Broken glass was explicitly identified in eight of the claim's accident narratives (1.3%).

Vehicle contributing factors were classified as hoses/lines when, at the time of injury, the claimant interacted with hoses or lines. Claimants typically used hoses to transfer liquids within the brewery. Lines were used to transport beer from cooler to the taproom. Hoses/lines included: hose, valve cap, lines, or valves.

Vehicle contributing factors were classified as motor vehicle when, at the time of injury, the claimant was operating a motor vehicle or driving. Motor vehicle included: car, truck, or forklift.

Vehicle contributing factors were classified as sharp edge when, at the time of injury, the claimant interacted with something sharp (other than a knife). Knives were typically classified as cooking equipment (unless it was explicitly stated that the knife was used outside of food preparation/service activities). Sharp edges included: sharp and rough edges and surfaces on machinery or tools.

Vehicle contributing factors were classified as animal/insect when, at the time of injury, the claimant interacted with an animal or insect. Animal/insect included: dogs, spiders, or wasps.

Vehicle contributing factors were classified as miscellaneous if the claimant interacted with something that did not align with any of the previously mentioned vehicle contributing factor categories.

Table 4.45. Vehicle contributing factors classified from accident narratives

Vehicle	Detailed vehicle	Vehicle count (%)	Detailed vehicle count (%)
Equipment		143 (23.45)	
	Machinery		32 (5.19)
	Pallets		25 (4.05)
	Tools		68 (11.02)
Container		133 (21.55)	
	Bag		7 (1.13)
	Barrel		7 (1.13)
	Box		14 (2.27)
	Bucket		10 (1.62)
	Case		9 (1.46)
	Keg		65 (10.53)
Cooking equipment		60 (9.72)	
	Dish/plate/tray		5 (0.81)
	Food		6 (0.97)
	Knife		29 (4.7)
Liquid		57 (9.24)	
	Ice/snow		11 (1.78)
	Oil		10 (1.62)
	Water		23 (3.73)
Structure		58 (7.45)	
	Door		15 (2.43)
Cleaner		36 (5.83)	
Glass		34 (5.51)	
Hose/lines		27 (4.38)	
	Hose		23 (3.73)
	Valve		4 (0.65)
Miscellaneous		21 (3.4)	
Motor vehicle		17 (2.76)	
	Car		12 (1.94)
	Forklift		4 (0.65)
Sharp edge		11 (1.78)	
Animal/insect		5 (0.81)	

4.4.2. Research Objective 4.2.

The purpose of Research Objective 4.2. was to further explore relationships between injury characteristics and results of the revised agent-host-environment epidemiologic model. In order to gain additional qualitative perspective on the WC analysis, researchers shared results of the present study (Specific Aims 1, 2, 3, and Research Objective 4.1.) with subject matter experts during informal interviews. Common themes from those discussions are described below. After the primary results of

Specific Aims 1 through 3 and Research Objective 4.1. were addressed, additional relationships between injury nature and other injury characteristics were assessed. The purpose of this additional analysis was to gain further understanding of occupational injuries among craft brewery workers.

4.4.2.1. Distribution of claims by injury nature and injured anatomical region

While results of Specific Aims 1.1 and 1.2 investigated the distribution of injured anatomical region and injury nature individually, the relationship between the two injury variables was investigated in Research Objective 4.2. All four injury natures (burn, contusion, laceration, and sprain/strain) were observed among all three injured anatomical regions (lower limb, upper limb, and trunk region). More than 50% of all sprains/strains affected the trunk region followed by the lower limb (26%) and upper limb (24%). Specifically, 32% of all sprains/strains were observed in the low back (classified within the trunk region). Among burns, contusions, and lacerations, the upper limb was the most commonly injured anatomical region followed by lower limb and the trunk region. More than 75% of lacerations affected the claimant's upper limb. Specifically, 36% of all lacerations affected fingers (classified within the upper limb). More than 50% of burns affected the upper limb followed by trunk region (23%) and lower limb (21%). More than 40% of contusions affected the upper limb followed by lower limb (31%) and trunk region (28%). The most frequently injured anatomical areas among claims classified as "other" injury nature were the trunk region (42%) and upper limb (38%). Contusions were the most frequent injury nature among claims that affected the lower limb. Sprains/strains were the most frequent injury nature among claims that affected the trunk region. Lacerations were the most common injury nature among claims that affected the upper limb. Among injuries to the lower limb, the most frequent injury natures were contusions (38%) and sprains/strains (34%). Among injuries to the trunk region, the most frequent injury natures were sprains/strains (43%) followed by contusions (23%). Among injuries to the upper

limb, the most frequent injury natures were lacerations (33%) followed by contusions (26%). The distribution of claims by injury nature by injured anatomical region is outlined in Table 4.46.[23]

Table 4.46. Distribution of claims by injury nature and injured anatomical region

	Burn	Contusion	Laceration	Sprain/strain	"Other"	*sum*
Lower Limb	12	47	12	42	10	*123*
Trunk Region	13	43	14	82	38	*190*
Upper Limb	30	63	81	39	34	*247*
"Other"	1	1			8	*10*
sum	*56*	*154*	*107*	*163*	*90*	*570*

4.4.2.2. Distribution of claims by injury nature and injury event

While results of Specific Aims 1.2 and 1.3 investigated the distribution of claims by injury nature and injury event individually, the relationship between the two injury variables was investigated in Research Objective 4.2. Not all injury nature categories were observed among all injury event categories. Burns were exclusively associated with exposure to harmful substances or environments and contact with objects and equipment. The majority of burns were due to exposure to harmful substances or environments (98%). Over 50% of contusions were due to contact with objects and equipment followed by STFs (36%). Approximately 12% of contusions were due to overexertion and bodily reaction or "other" injury events. The majority of lacerations were due to exposure to harmful substances or environments (84%). The majority of sprains/strains were due to overexertion and bodily reaction injury events (79%) followed by STFs (12%). Approximately ten percent of sprains/strains were due to contact with objects and equipment or "other" injury events. Claims classified as "other" injury nature were associated with every type of injury event. The majority of claims classified as "other" injury nature were

[23] A full distribution of claims by injury nature and body part (within injured anatomical region) is available in Appendix 8.21.

due to contact with objects and equipment (33%) followed by overexertion and bodily reaction (26%), "other" injury events (20%), exposure to harmful substances or environments (11%), and STFs (10%).

Injury event may be described as the action resulting in an injury nature. In the present study, the injury event of contact with objects and equipment resulted in injuries classified as contusions (61%) and "other" injury natures (23%), lacerations (11%), and burns (1%). The injury event of exposure to harmful substances and environments resulted in lacerations (58%), burns (36%), and "other" injury natures (6%). Slips, trips, or falls resulted in contusions (64%) followed by sprains/strains (23%). Overexertion and bodily reaction predominately resulted in sprains/strains (80%). "Other" injury events resulted in "other" injury natures (51%), sprains/strains (26%), and contusions (23%). The distribution of claims by injury nature and injury event is outlined in Table 4.47.

Table 4.47. Distribution of claims by injury nature and injury event

	Burn	Contusion	Laceration	Sprain/strain	"Other"	*sum*
Contact with objects and equipment	1	80	14	6	30	*131*
Exposure to harmful substances or environments	55	NA	90	NA	10	*155*
Slips, trips, or falls		56	3	20	9	*88*
Overexertion and bodily reaction		10		128	23	*161*
"Other"		8		9	18	*35*
sum	*56*	*154*	*107*	*163*	*90*	*570*

4.4.2.3. Distribution of claims by injury nature and claimant age

While results of Specific Aims 1.2 and 1.4 investigated the distribution of claims by injury nature and claimant age individually, the relationship between the two injury variables was investigated in Research Objective 4.2. Each type of injury nature was observed in each age category. Among burns, the majority of claimants were 25-34 years old (55%) followed by claimants < 24 years old (20%). The majority of contusions occurred among claimants between 25-34 years old (57%). Lacerations were frequently reported among workers aged 25-34 years old (57%). Among sprains/strains, 54% were reported among claimants between 25-34 years old. "Other" injury natures were reported among claimants aged 25-34 years old (58%).

The distribution of claims injury natures was explored by age category. The most frequent injury natures among workers < 24 years old were contusions (29%) and lacerations (28%) followed by burns (17%). Among workers between 25-34 years old, the most frequent injury natures were sprains/strains (28%) and contusions (27%) followed by lacerations (19%) and "other" injury nature (16%). The most frequent injury natures among workers between 35-44 years old were sprains/strains (37%) followed by contusions (23%) and lacerations (21%). Among workers between 45-54 years old, the most frequent injury natures were sprains/strains (39%) followed by contusions (26%). Only 18 claims were reported for workers ≥ 55 years old. However, among workers ≥ 55 years old the most frequent injury natures were contusions (56%) followed by sprains/strains (22%). Age at the time of injury was not reported in 18 claims. Among workers who did not report their age at the time of injury, the most frequent injury natures were sprains/strains (39%) and "other" injury nature (28%). The distribution of injury nature by claimant age is outlined in Table 4.48.

Table 4.48. Distribution of claims by injury nature and age

	Burn	Contusion	Laceration	Sprain/strain	"Other"	*sum*
≤ 24 years old	11	19	18	8	9	*65*
25-34 years old	31	87	61	88	52	*319*
35-44 years old	7	26	23	41	15	*112*
45-54 years old	5	10	1	15	7	*38*
≥ 55 years old	1	10	1	4	2	*18*
NA	1	2	3	7	5	*18*
sum	*56*	*154*	*107*	*163*	*90*	*570*

4.4.2.4. Distribution of claims by injury nature and tenure

Following results of Specific Aims 1.2 and 1.5, which investigated the distribution of claims by injury nature and claimant tenure individually, the relationship between the two injury variables was explored.

Each type of injury nature was observed in each tenure category. Among burns, the majority of claimants had < 1 year of tenure (52%). Among contusions, 40% occurred among claimants with <1 year of tenure followed by those with ≥ 1 to < 2 years (29%). Forty five percent of the lacerations occurred among claimants with < 1 year of tenure followed by claimants with ≥ 1 to < 2 years (24%).

Sprains/strains were most frequently reported among claimants with < 1 year (36%) followed by claimants with ≥ 1 to < 2 years (20%). The distribution of "other" injury nature was highest among claimants with < 1 year or tenure (43%).

The distribution of claims by injury natures was explored by tenure category. The most frequent injury nature categories among claimants with < 1 year of tenure were contusions (26%) and sprains/strains (25%) followed by lacerations (20%). Among claimants with ≥ 1 to < 2 years of tenure, the most frequent injury nature category was contusions (35%) followed by sprains/strains (25%), and lacerations (21%). For claimants with ≥ 2 to < 3 years of tenure, the most frequent injury nature categories were sprains/strains (24%) and contusions (24%) followed by "other" injury nature (22%), lacerations (17%), and burns (13%). The most frequent injury nature category among claimants with ≥ 3 to < 4 years of tenure was sprains/strains (43%) followed by "other" injury nature (18%), lacerations and contusions (14% each), and burns (11%). Claimants with ≥ 4 to < 5 years of tenure constituted the smallest tenure category in the present study, with seventeen claims. Among claimants with ≥ 4 to < 5 years of tenure, the majority of claims were associated with sprains/strains (65%) followed by contusions (24%). Among claimants with ≥ 5 years of tenure, the most frequent injury nature was sprains/strains (48%) followed by contusions (25%). Among claims where tenure was unreported, the most frequent injury natures were lacerations (27%) and contusions (25%). The distribution of injury nature by claimant tenure is outlined in Table 4.49.

Table 4.49. Distribution of claims by injury nature and tenure

Tenure	Burn	Contusion	Laceration	Sprain/strain	"Other"	*sum*
< 1 year	29	62	48	59	39	*237*
≥ 1 to < 2 years	7	44	26	32	17	*126*
≥ 2 to < 3 years	6	11	8	11	10	*46*
≥ 3 to < 4 years	3	4	4	12	5	*28*
≥ 4 to < 5 years	1	4		11	1	*17*
≥ 5 years	4	14	5	27	6	*56*
NA	6	15	16	11	12	*60*
sum	*56*	*154*	*107*	*163*	*90*	*570*

4.4.2.5. Distribution of claims by injury nature and contributing factors based on the revised agent-host-environment epidemiologic model

While results of Specific Aims 1.2 and Research Objective 4.1 investigated the distribution of claims by injury nature and contributing factors based on the revised agent-host-environment epidemiologic model separately, the relationship between them was explored in Research Objective 4.2. Researchers assessed the distribution of claims by injury nature and contributing factors from the revised agent-host-environment epidemiologic model. These results provided a qualitative perspective on the distribution of claims by injury nature among occupational injuries of Colorado craft brewery claimants. The sections below detail the distribution of claims by injury nature among agent, host, environment, and vehicle contributing factors.

4.4.2.5.1. *Distribution of claims by injury nature and agent contributing factors*

Within the revised epidemiologic agent-host-environment model, agent referred to the form of energy responsible for the injury. By investigating claims by injury nature and agent, researchers were able to learn more about types of injuries affecting craft brewery workers. The distribution of claims by agent contributing factor and injury nature is outlined in Table 4.50. Mechanical energy was identified as the agent of injury in claims related to contusions, lacerations, sprains/strains and "other." All contusions, lacerations, and sprains/strains were associated with mechanical energy. The most common type of agent identified among burns was thermal energy (75%) followed by chemical energy (23%). Mechanical, thermal, chemical, and electrical energies were identified in claims with the injury nature classified as "other."

Table 4.50. Distribution of claims by injury nature and agent

	Agent				
Injury Nature	Mechanical	Thermal	Chemical	Electrical	*sum*
Burn		42	13	1	*56*
Contusion	154				*154*
Laceration	107				*107*
Sprain/strain	163				*163*
"Other"	57	2	23	3	*85*
sum	*481*	*44*	*36*	*4*	*570*

4.4.2.5.2. *Distribution of claims by injury nature and host activities*

Per the revised agent-host-environment epidemiologic model, the injury occurred when the vehicle transferred the agent to the host. In the present study, the claimant was the host. By investigating claims by injury nature and host activities, researchers were able to better understand what the claimant was doing at the time of injury.

The most frequently identified host activities were carrying items, operating equipment/machinery, cleaning, and maintenance. Over 75% of claims associated with carrying items were sprains/strains (55%) or contusions (24%). The majority of injury natures associated with operating equipment/machinery were contusions (34%) and "other" injury nature (34%). Examples of injury natures withing the category "other" that occurred while claimants operated machinery/equipment included dermatitis (11%), foreign body in the eye (11%), and punctures (8%). The majority of injury natures associated with cleaning were "other" injury nature (27%) and lacerations (27%). Examples of injury natures within the category "other" that occurred while claimants cleaned included foreign body in the eye (26%), punctures (14%), and chemical poisonings (14%). The distribution of injury natures among claims associated with maintenance activities were lacerations (33%) followed by contusions (23%) and sprains/strains (20%). Among claims associated with service/food preparation, the claimant experienced lacerations (40%) or burns (17%). While driving accounted for a small percentage of host activities in the present dataset, the most frequent injury nature among those claims were contusions (57%) followed by sprains/strains

(24%). In accident narratives where the claimant was walking/climbing/standing at the time of injury, the claim typically resulted in a contusion (43%) or sprains/strains (35%).

The distribution of host activity by injury nature was also investigated. The majority of sprains/strains occurred while the claimant was carrying items (40%). Among burns, claimants were either cleaning (20%), performing maintenance (19%), or serving/preparing food (18%). More than 40% of contusions occurred while workers were operating equipment (21%) or carrying items (21%). Contusions were also associated with walking/climbing/standing host activities (17%). Burns were associated with cleaning (20%), maintenance (19%), and service/food preparation activities (18%). More than 60% of lacerations occurred while claimants were performing maintenance (25%), cleaning (22%) or doing service/food preparation activities (22%). Claims associated with "other" injury nature occurred during operating activities (31%) and while performing cleaning tasks (22%). The distribution of claims by host activities and injury nature is outlined in Table 4.51.

Table 4.51. Distribution of claims by host activities and injury nature

Host category	Sprain/strain	Burn	Contusion	Laceration	"Other"	*sum*
Brewing	28	12	4	5	1	*50*
Carrying items	107	8	47	9	25	*196*
Cleaning	20	18	23	36	35	*132*
Driving	5		12		4	*21*
Maintenance	25	17	28	41	13	*124*
Operating	15	6	48	24	48	*141*
Push/pull		2	5	4		*11*
Serving/food preparation	13	16	13	37	14	*93*
Stocking	3	2	9	1	3	*18*
Walking/climbing/standing	31	1	38	7	12	*89*
Miscellaneous	17	8		3	1	*29*
sum	*264*	*90*	*227*	*167*	*156*	*904*

4.4.2.5.3. *Distribution of claims by injury nature and environmental contributing factors*

Within the revised epidemiologic agent-host-environment model, environment referred to physical or social setting related to where the host was at the time of injury. In the present study, the majority of environmental contributing factors were specific to the physical environment. By investigating injury

nature and environment, researchers were able to learn more about where injuries occur in craft breweries.

The brewery was the most common physical environment among all injury natures. Approximately a third of claims that occurred in the brewery were associated with sprains/strains (32%). The majority of claims that occurred in the packaging environment (80%) were associated with sprains/strains, contusions, and lacerations. Lacerations (36%) and burns (29%) were the most frequent injury natures associated with claims that occurred in the kitchen. While the overall percentage of claims that occurred within the service/food environment was low, most of those claims were associated with lacerations (38%), sprains/strains (27%), or contusions (24%). Production was the third most commonly identified environment among burns (16%). The largest percentage of claims that occurred in production were associated with burns (29%). General physical environment, such as slippery or wet surfaces, was the third most frequent environment among contusions (23%) and the second most frequent environment among "other" injury nature (18%). Contusions were the most frequent injury nature (42%) that occurred in the general physical environment (such as slippery or wet surfaces). The majority of claims that occurred in general facilities (such as stairs or coolers) were associated with sprains/strains (80%). More than 50% of claims that occurred in motor vehicles were associated with sprains/strains. The distribution of claims by injury natures and environmental contribution factors is outlined in Table 4.52.

Table 4.52. Distribution of claims by environmental contributing factors and injury nature

Environmental category	Sprain/strain	Laceration	Contusion	Burn	"Other"	*sum*
Brewery	88	34	60	51	40	*213*
Packaging	32	28	29	8	14	*111*
Production		2		15		*17*
General facility	16	4				*20*
Motor vehicle	11	1	8		1	*21*
Physical environment	13	2	22		15	*52*
Service/food	10	14	9		4	*37*
Kitchen/food preparation area		20	10	16	10	*56*
social		1		2		*3*
Part of the facility		1	10			*11*
Miscellaneous	6	2	9	3		*20*
sum	*176*	*109*	*97*	*95*	*84*	*561*

4.4.2.5.4. *Distribution of claims by injury nature and vehicle contributing factors*

The injury resulted when the agent was transferred between the vehicle and the host according to the revised agent-host-environment epidemiologic model. In the present study, the vehicle represented the object involved in the energy transfer with the claimant during the injury event. By investigating claims by injury nature and vehicle, researchers were able to learn more about the object involved in the claim.

Contusions**,** the most frequently observed injury nature in the present study, were associated with equipment (35%), containers (27%), and part of the structure (12%). Approximately ten percent of contusions were associated with a liquid. Thirty percent of claims that involved liquids resulted in contusions. Sprains/strains, the second most frequently observed injury nature in the present study, was associated with containers (39%) and equipment (28%). Container was the overarching category for kegs, barrels, buckets, and other items used to transfer material. Kegs accounted for 42% of containers associated with sprains/strains. Lacerations, the third most common injury nature in the present study, was associated with sharp edges (31%), bottles/glass (25%), or equipment (20%). Sharp edges included plastic, metal, or glass. Burns were frequently observed in claims where the vehicle was liquid (43%), cleaner (18%), or cooking equipment (16%). Fifty-five percent of claims that involved liquids resulted in

burns. Liquid was the overarching category for water, oil, or liquid chemicals. “Other” injury nature was associated with a claimant’s contact with cleaner (26%) or equipment (25%). The distribution of claims by injury nature and vehicle contribution factor is outlined in Table 4.53.

Table 4.53. Distribution of claims by vehicle and injury nature

Vehicle category	Sprain/strain	Burn	Contusion	Laceration	“Other”	*sum*
Liquid	8	30	16		1	*55*
Container	59	3	46	6	14	*128*
Cooking equipment	8	11	6	4	5	*34*
Equipment	43	6	62	25	23	*159*
Hose-related	12	7	13	4	4	*40*
Part of structure	10	1	21	14	3	*49*
Sharp edge	2			40	2	*44*
Motor vehicle	4		3		3	*10*
Cleaner		13			24	*37*
Bottles/glass			2	33	3	*38*
Miscellaneous	6		2	3	12	*23*
sum	*152*	*71*	*171*	*129*	*94*	*617*

4.4.2.6. Distribution of claims associated with hoses and lines

Hoses and lines were identified as vehicles in claims associated with sprains/strains, contusions, and burns. Researchers decided to further investigate the role of hoses and lines in claims. The accident narratives were used to identify the presence of hoses and lines involved in claims. Specifically, a keyword search was performed to extract relevant claims that were then manually assessed. Keywords included any variation of the words “draught,” “draft,” “line,” or “hose.” Seventy-one claims’ accident narratives explicitly mentioned words related to hoses or lines.

The distributions of injury characteristics and the distributions of contributing factors based on the revised agent-host-environment epidemiologic model were investigated among claims associated with hoses or lines. The most frequently injured anatomical regions among these claims were the upper limb (39%) and trunk region (38%). The most frequently identified injury events associated with hoses or lines were exposure to harmful substances or environments (34%) or overexertion and bodily reaction (30%). Sprains/strains occurred in 30% of claims associated with hoses or lines. The least common injury nature,

"other," accounted for 17% of these claims. Within "other" injury nature, two foreign body (3%) and two poisoning-chemical injury natures were identified. The distributions of injury characteristics specific to hose and line-related claims are outlined in Table 4.54.

Table 4.54. Distributions of injury characteristics among claims associated with hoses and lines

Injury characteristic category	Injury characteristic	Injury characteristic detail	Characteristic count (%)	Count detail (%)
Injured anatomical region				
	Upper limb		28 (39.4)	
	Trunk Region		27 (38.1)	
	Lower limb		14 (19.7)	
	"Other"		2 (2.8)	
Injury event				
	Overexertion and bodily reaction		21 (29.6)	
	Contact with objects and equipment		12 (16.9)	
	Exposure to harmful substances or environments		24 (33.8)	
	Slips, trips, or falls		10 (14.1)	
	"Other"		4 (5.6)	
Injury nature				
	Sprain/strain		21 (29.6)	
	Laceration		14 (19.7)	
	Contusion		13 (18.3)	
	Burn		11 (15.5)	
	"Other"		12 (16.9)	
		All other		3 (4.2)
		All other cumulative		1 (1.4)
		Dermatitis		1 (1.4)
		Dislocation		1 (1.4)
		Foreign body		2 (2.8)
		Fracture		1 (1.4)
		Inflammation		1 (1.4)
		Poisoning - chemical		2 (2.8)

When the revised agent-host-environment epidemiologic model was applied to classify contributing factors to the agent of injury using accident narratives, the most frequently classified agent was

mechanical energy (75%) followed by chemical energy (15%). When hoses or lines were associated with a claim, the claimant was typically packaging (22%), performing maintenance (20%), carrying items (18%), or cleaning (17%). Within the host activity carrying items, moving hoses was explicitly described in 13% of these claims. Walking was associated with nine percent of these claims. “Stepping on hoses” was explicitly described in three claims’ accident narratives. The claim typically occurred in the brewery (85%) and sometimes within the packaging hall (32%) or bottling line (12%). The vehicle identified in claims associated with hoses or lines included a hose (28%), liquid (20%), or equipment/machinery (17%). Liquid could be water or chemical substances. Cleaner was explicitly described in seven percent of these claims. The distributions of contributing factors based on the revised agent-host-environment epidemiologic model among claims related to hoses and lines are outlined in Table 4.55.

Table 4.55. Distributions of contributing factors classified by the revised agent-host-environment epidemiologic model specific to hose-related claims

Elements of the revised agent-host-environment epidemiologic model	Detail	Count (%)
Agent		
	Chemical	11 (15.4)
	Mechanical	53 (74.6)
	Thermal	7 (9.9)
Host		
	Brewing	8 (6.3)
	Carrying	23 (18.1)
	Cleaning	22 (17.3)
	Maintenance	23 (19.7)
	Packaging	28 (22.1)
	Walking	11 (8.7)
Environment		
	Brewery	100 (84.8)
	Service	8 (6.8)
	Packaging	38 (32.2)
	Kegging	7 (5.9)
	Bottling	14 (11.9)
	Production	11 (9.3)
	Physical	6 (5.1)
Vehicle		
	Liquid	17 (19.5)
	Equipment/machinery	15 (17.2)
	Hose	24 (27.6)
	Cleaner	6 (6.9)
	Glass/sharp edge	9 (10.3)
	Keg	8 (9.2)
	Faulty equipment	7 (8.1)

4.4.2.7. Distribution of claims associated with cleaning

Cleaning was a frequently identified host activity based on the revised agent-host-environment epidemiologic model (14%). Researchers decided to further investigate the types of injuries associated with cleaning activities. The accident narratives were used to identify the presence of cleaning or cleaning-related activities at the time of injury. Specifically, a keyword search was performed to extract relevant claims that were then manually assessed. Keywords included any variation of the words clean, rinse, sanitizing, scraping, washing, buffing, mopping, and sweeping. Following the keyword search, 121 claims were identified.

The distributions of injury characteristics and elements of the revised agent-host-environment epidemiologic model were investigated among claims associated with cleaning. The most frequently injured anatomical regions were the upper limb (46%) and trunk region (36%). The majority of claims were the result of an exposure to hazardous substance or environment (42%). Lacerations and "other" injury nature were the most frequent injury nature associated with claims that occurred during cleaning tasks (25% each). Contusions were the third most frequent injury nature associated with cleaning tasks (20%) followed by burns (17%). Among claims classified as "other" injury nature, the most frequent injury nature was foreign body (9 claims), poisoning-chemical (5 claims), and puncture (5 claims). The distributions of injury characteristics among claims associated with cleaning are outlined in Table 4.56.

Table 4.56. Distributions of injury characteristics specific to cleaning related claims

Injury characteristic	Detail	Count (%)
Injury nature		
	Burn	21 (17.4)
	Contusion	24 (19.8)
	Laceration	30 (24.8)
	"Other"	30 (24.8)
	Sprain/strain	16 (13.2)
Injured anatomical region		
	Lower limb	21 (17.4)
	Trunk region	43 (35.5)
	Upper limb	56 (46.3)
	"Other"	1 (0.8)
Injury event		
	Contact with objects and equipment	31 (25.6)
	Exposure to harmful substances or environments	51 (42.1)
	Slips, trips, or falls	20 (16.5)
	Overexertion and bodily reaction	13 (10.7)
	"Other"	6 (5.0)

When the revised agent-host-environment epidemiologic model was used to classify the agent from accident narratives, the majority of cleaning-related claims were associated with mechanical energy (65%). Chemical energy was identified in 15% of cleaning-related claims followed by thermal energy in 10% of those claims. Claimants cleaning at the time of injury were typically in the brewery (70%). Food preparation/service environments (such as the taproom or kitchen) were identified in 19% of claims

followed by production areas (16%). Tanks were explicitly mentioned in 12% of cleaning-related claims' accident narratives. Wet and slippery surfaces were specifically described in 4% of those claims' accident narratives. Liquid was the most frequently identified vehicle in claims associated with cleaning (29%). Approximately 25% of vehicles were identified as chemicals and 8% were identified as water. Equipment/machinery was identified as the vehicle in 20% of cleaning-related claims. Examples of equipment/machinery included brooms, buckets, hoses, lids, sprayers, and valve caps. Glass and bottles were specifically described as vehicles to injury in 15% of cleaning-related claims' accident narratives. The distributions of contributing factors based on the revised agent-host-environment epidemiologic model among claims related to cleaning are outlined in Table 4.57.

Table 4.57. Distributions of contributing factors based on the revised agent-host-environment epidemiologic model specific to cleaning-related claims

Elements of the revised agent-host-environment epidemiologic model	Detail	Count (%)
Agent		
	Chemical	27 (22.3)
	Electrical	2 (1.7)
	Mechanical	81 (66.9)
	Thermal	11 (9.1)
Environment		
	Brewery	81 (70.4)
	Food preparation/Service	22 (19.1)
	Packaging	9 (7.8)
	Production	18 (15.7)
	Tanks	14 (12.2)
	Wet/slippery surface	5 (4.3)
Vehicle		
	Chemical	33 (24.6)
	Equipment/machinery	27 (20.1)
	Hose	11 (8.2)
	Knife/scraper	4 (3.0)
	Glass/bottles	19 (14.9)
	Water	11 (8.2)
	Liquid	39 (29.1)

4.4.2.8. Distribution of claims associated with kegs

Kegs were one of the most frequently identified vehicles in all accident narratives (11%). Researchers decided to further investigate the role of kegs in claims. The accident narratives were used to identify the presence of kegs involved in claims. Specifically, a keyword search was performed to extract relevant claims that were then manually assessed. Keywords included any variation of the word keg or barrel. Eighty-nine claims' accident narratives explicitly mentioned kegs or barrels.

The distributions of injury characteristics were investigated among claims associated with kegs. The most frequently injured anatomical regions among these claims was the trunk region (44%). The most frequent injury events associated with keg-related claims were overexertion and bodily reaction (43%) and contact with objects and environment (40%). Contusions (39%) and sprains/strains (35%) were the most frequent injury natures associated with these claims. The distribution of claims specific to keg-related claims are outlined in Table 4.58.

Table 4.58. Distributions of injury characteristics among keg related claims by injury nature, injured anatomical region, and injury event

Injury characteristic	Injury characteristic detail	Count (%)
Injury nature		
	Burn	6 (6.7)
	Contusion	35 (39.3)
	Laceration	5 (5.6)
	Sprain/strain	31 (34.8)
	"Other"	12 (13.5)
Injured anatomical region		
	Lower limb	24 (27.0)
	Trunk region	39 (43.8)
	Upper limb	26 (29.2)
Injury event		
	Contact with objects and equipment	35 (39.3)
	Exposure to harmful substances or environments	12 (13.5)
	Slips, trips, or falls	4 (4.5)
	Overexertion and bodily reaction	38 (42.7)

Table 4.59. Distributions of injury characteristics based on the revised agent-host-environment epidemiologic model specific to keg-related claims

Elements of the revised agent-host-environment epidemiologic model	Detail	Count (%)
Agent		
	Chemical	4 (4.5)
	Mechanical	80 (90.0)
	Thermal	5 (5.6)
Host		
	Brewing	10 (6.8)
	Carrying/stacking kegs	73 (49.7)
	Cleaning kegs	7 (4.8)
	Delivering kegs	9 (6.1)
	Lifting	19 (12.9)
	Moving	35 (23.8)
	Operating (including kegging line)	25 (17.0)
	Packaging kegs	6 (4.1)
Environment		
	Brewery	78 (75.7)
	Motor vehicle	8 (7.8)
	Packaging	34 (33.0)
	Kegging	21 (20.4)
	Production	4 (3.9)
	Physical	7 (6.8)

4.4.2.9. Subject matter expert interview themes

Researchers conducted informal interviews among representatives from the Brewers Association, the Colorado State University Fermentation Science and Technology Program, and various craft breweries in Colorado. Collectively, this group represented more than 100 years of experience in the craft brewing industry. All subject matter experts had worked in the craft brewing industry and many were leaders in the field. Subject matter experts held positions that included craft brewery founders, directors of craft brewing educational programs, safety and loss consultants for craft breweries, members of the Brewers Association Safety Subcommittee, and special projects managers at the Brewers Association and craft breweries in Colorado.

Results of Specific Aims 1, 2, 3, and Research Objective 4.1 were shared with seven subject matter experts on virtual platforms (Zoom 5.0). The purpose of these 60 to 90 minute discussions was to solicit subject matter experts' perspectives on how results of the present study may contribute to improving health and safety in the craft brewing industry. Subject matter experts shared their observations and personal experiences regarding occupational injuries in craft breweries. Overall, subject matter experts were pleased that the quantitative and qualitative data in the present study aligned with their views of the current safety challenges facing the craft brewing industry. They agreed with researchers' findings that the upper limb and trunk regions were the most vulnerable to injury due to manual handling demands and direct contact with hot materials. Several subject matter experts agreed how younger workers were typically less experienced and lacked knowledge about hazardous tasks. Subject matter experts were very interested in the reported costs associated with injuries, as that information may be useful when justifying intervention strategies to upper management and stakeholders. They were also interested in the results of the contributing factors analysis, as it supported observations from their personal experiences in craft breweries. Some subject matter experts were especially interested in data from the present study regarding cleaning because the Brewers Association recently received a grant to develop a draught line cleaning safety training program. Additional themes that emerged during the informal interviews included a reliance on institutionalized knowledge and lack of documented or formalized training, typical career paths of workers within craft breweries, and the burden of occupational injuries. Subject matter experts agreed that results of the present study would be beneficial for targeting interventions to reduce injuries within craft breweries.

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CHAPTER 5: DISCUSSION

5.1. Scope of discussion

The purpose of the discussion was to evaluate the results of the present study and to compare them to previous research and external resources. While no published studies on injuries in craft breweries (or large breweries) exist, researchers may compare results of the present study to national injury surveillance databases, industry trade organization surveys, and perspectives from subject matter experts. Researchers may also compare results of the present study to previous WC studies on occupational injuries among industries with similar demographics and manually intensive tasks, such as logging, fishing, manufacturing, and ambulance workers. These comparisons provide context to the burden of craft brewing injuries in relation to more frequently studied industries.

5.2. Number of claims

Given the number of claims and the number of craft breweries in the present study, each craft brewery filed an average of seven claims. However, this average did not accurately represent the number of claims filed per brewery. Instead, the majority of claims were reported from a relatively small number of craft breweries. Approximately 20% of craft breweries in the present study accounted for more than 80% of the claims. Subject matter experts noticed that a few craft breweries were associated with many claims and commented:

> You'll see that you had 570 cases, but you didn't have 570 breweries. You're going to find there were breweries that had no cases - obviously they weren't on your list. And then you have businesses that were on there many times because their culture is ill.

The dataset in the present study represented 570 claims that occurred at Colorado craft breweries from 2013 through 2018. During the claim period of the present study, 2,590 injuries from brewery workers in the U.S. were reported in the BLS SOII data (bls.gov, 2020).

Not all states or U.S. territories are required to report SOII data to the BLS. Specifically, Colorado, Florida, Idaho, Mississippi, New Hampshire, North Dakota, Oklahoma, Rhode Island, and South Dakota are not required to contribute to the BLS SOII, as displayed in Figure 5.0. If a state or territory is not required to report SOII data, companies may choose to individually report their injury/illness data and this information is reflected in the national SOII summary data. Unfortunately, it was impossible for researchers to determine how many injuries occurred at Colorado breweries based on the information in the BLS SOII national summary data.

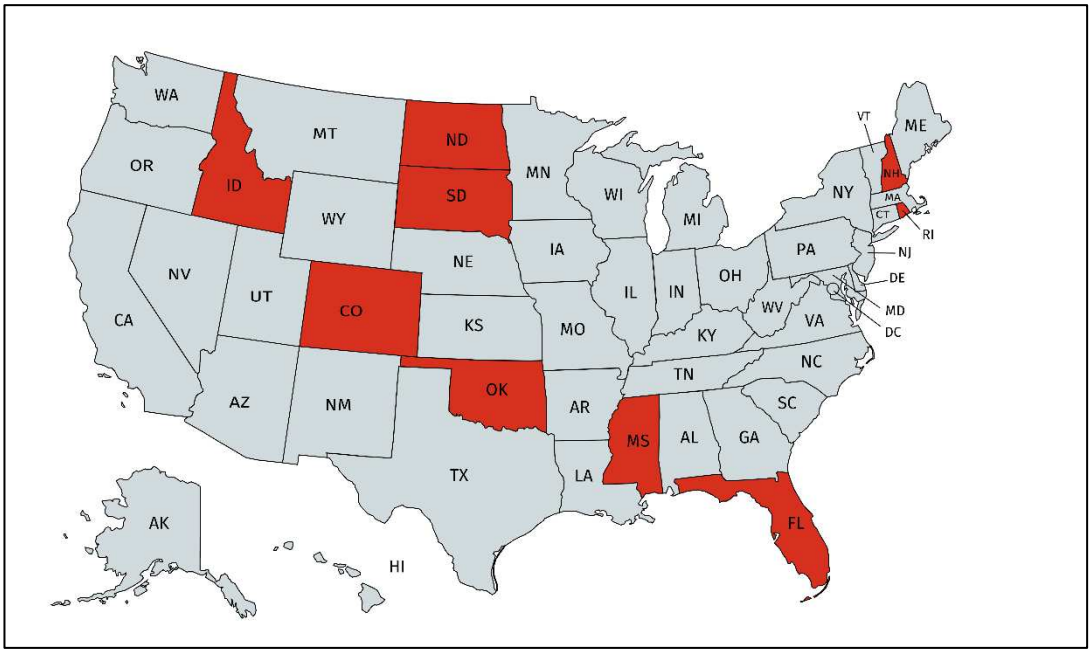

Figure 5.0. States that are colored dark red are not required to participate in the BLS SOII.

The BLS SOII data were categorized by industry classification codes. Thus, researchers were unable to differentiate between large and craft breweries within the overall classification of breweries (NAICS 312120). Additionally, injury information included in the BLS SOII data is based on OSHA 300 logs. Companies with ten or more employees or companies classified as high risk by OSHA are required to submit OSHA 300 injury logs.

The Brewers Association conducted a health and safety survey where managers were asked about their current workforce size. Workforces varied from one to more than 1,000 with a median of five full-

time employees. Respondents also reported that the number of part-time workers ranged from zero to more than 150, with a median of five. Regarding workforce size, one subject matter expert commented that businesses may underestimate their workforce size in an effort to reduce WC rates or reporting requirements. To reduce full-time employee counts, breweries may exclude part-time workers or use volunteers. One subject matter expert described how "[craft breweries] would have seven employees, but then on bottling days they would bring in volunteers. … so technically you don't have ten employees, but on certain days 15 to 20 people are on-site doing work." Injuries to volunteers are not reflected in WC injury counts.

Since data in the BLS SOII are based on OSHA 300 logs, only severe injuries are represented. All injuries reported in the BLS SOII data are also likely to be reported in WC. However, not all claims reported to WC will meet the criteria to be reported in the BLS SOII data (or considered an OSHA recordable injury). Therefore, researchers cannot directly compare injury proportions reported in the BLS SOII data to the WC data. Despite these limitations in the ability to directly compare data, information from the BLS SOII data may still provide insight to injuries affecting brewery workers in the U.S.

5.3. Distributions of claims by cost, lost time, and claim-type

The cumulative cost of all claims in the present study exceeded $770,000. This cost reflects payment by the WC carrier. Policy holders (craft breweries) would see these costs represented by increases in rates and premiums. Among claims that incurred costs, the median total claim cost was $680, and the mean total claim cost was $2,100. Observed costs in the present study were similar to costs among injuries in other industries. For example, the median total claim costs from previous studies on occupational injuries varied from $335 among agricultural workers (Douphrate et al., 2009a) to $1,920 among loggers (Lagerstrom et al., 2017).

In the present study, the highest total claim cost for a single claim was $63,000. The highest single claim cost in the present study was lower than the highest claim costs reported in previous occupational

injury studies in other industries. For example, the maximum claim cost was $300,000 among seafood packagers (Syron et al., 2017), $430,000 among agricultural workers handling livestock (Douphrate et al., 2009b), and $1,155,171 among loggers (Lagerstrom et al., 2017).

While the majority of claims in the present study incurred costs, 33% of claims did not. These zero-cost claims lowered overall descriptive statistics. It was important to include all claims (regardless of costs) in frequency and distribution-based statistical analyses. Asfaw et al. investigated zero-cost WC claims and stated that claims with no reported WC costs were not truly zero-cost (Asfaw et al., 2013). Associated costs may have been covered using non-WC insurance, such as the injured worker's personal insurance or other healthcare systems. While a claim may have no reported WC costs, it is possible that the costs of that injury were absorbed through another system. Asfaw et al. estimated that zero-cost WC claims contribute $212 million to other healthcare cost systems (Asfaw et al., 2013).

Lost time refers to a period of time where the claimant was unable to work due to the occupational injury. Depending on the severity of the injury, the claimant might not be able to work for a certain period of time. In the present study, the majority of claimants did not report lost time. Only 26 claims were associated with lost time, which ranged from one day to 570 days per claim. This range of lost time was similar to previous WC studies. For example, reported WC lost time ranged from one to 1,340 days per claim among agriculture workers (Douphrate et al., 2009b) and from one to 481 days among seafood processing workers (Syron et al., 2017). Furthermore, more than 25% of reported injuries among fish farmers resulted in seven to 14 days of lost time (Kaustell et al., 2020). If a claimant misses work, they may be eligible for indemnity (wage compensation for lost time). In the present study, 36 claims were associated with indemnity costs and were classified as medical-plus-indemnity claims. Not all claims that incurred indemnity were associated with reported lost time. Following the injury, the claimant could have undergone task reassignment or work modification instead of missing work. Azaroff et al. described how injured workers could avoid lost time (and lost wages) by performing "light duty" or modified work (Azaroff et al., 2002). A study on occupational injuries among Alaskan seafood processing workers used

a WC dataset that included a variable for "physical restrictions indicator or presence." This variable specified if the injured worker had modified or restricted tasks upon returning to work, although that information was missing in 60% of claims (Syron et al., 2019). Whether or not an injury caused a worker to have modified or restricted work was reported in the BLS SOII data. Unfortunately, the WC data in the present study did not include a variable indicating modified or restricted work. However, one subject matter expert described his modified work experience following a severe knee injury that occurred when he was working on the bottling line. He did not miss any workdays because:

> I became a carpet walker and was doing a lot of office work and working on the brewing schedule for about three and a half months because I couldn't bend my leg. But I did have physical therapy that was twice a week for three months and so all of that cost added up. But I still continued to work since I was reassigned to an office job.

The Brewers Association conducted a health and safety survey that asked respondents about their personal experiences with occupational injuries. Among those who indicated that they had experienced an injury at their current workplace, the majority (76%) indicated that their injury did not cause them to miss work (Embry, Stinchfield, 2020). Lost time could be underestimated because workers feel social pressure to keep working and prematurely return to work. One subject matter expert described how:

> If you were injured and can't lift 50 pounds and can't do your job, then they do task modification or reassignment and put you on paperwork for a couple days. From my experience, they have you do what you can. For example, you can still mash and do all the cleaning stuff. You can watch the wort all the way until it enters the fermenter, but you can't lift the bags to put them into the mill. They would probably have somebody help you but then it gets tricky because when you're like 'hey I need you to help me,' they're like giving you attitude: 'aren't you better yet?' And then it's putting that burden on someone else, which can pressure someone to return to work before they're fully recovered and then it just continues to aggravate that injury.

In the present study, the cost per claim was investigated by task. Based on results of descriptive statistics for cost by task, claims associated with MMH and other (non-MMH) tasks incurred similar mean costs per claim ($680). Claims that occurred during MMH tasks incurred median claim costs that were approximately $300 greater than median claim costs associated with other (non-MMH) tasks. However, these descriptive statistics did not account for confounding with the different injury

characteristics. Since claim costs in the present study were skewed towards zero-cost and low-cost claims, analysis using a gamma GLM model was performed to investigate the relationship between mean claim cost and task type, when adjusting for injury characteristics (injury event, injury nature, injured body region, claimant age, claimant tenure, and claim type). Based on the results of the model, the mean claim cost among those who performed MMH at the time of injury was 14% greater than those who performed other (non-MMH) tasks at the time of injury, when adjusting for different injury characteristics. While the mean tenure estimate generated was not statistically significant, subject matter experts agreed that injuries that occurred during MMH could be more burdensome (incurred costs and/or lost time) to the employee and employer. This concept was supported by subject matter experts, who described the burden of injuries he observed in the barrel aging area: "it seems like recovery is long when you strain muscles or throw your back out … it takes weeks sometimes to recover so I can see that being the highest cost exactly." Even though indemnity claims were equally distributed among MMH and other (non-MMH) tasks (6% each), claims that occurred during MMH tasks incurred more days of lost time (808 days cumulative) than claims that occurred during other (non-MMH) tasks (429 days cumulative). However, the cumulative cost of claims that occurred during other (non-MMH) tasks ($526,002) was approximately twice as high as the cumulative cost of claims that occurred during MMH tasks ($269,081). This difference in cumulative cost between claims associated with MMH and other (non-MMH) tasks was likely due to more reported claims being associated with other (non-MMH) tasks. Previous studies have observed how injuries that occur during MMH tasks, such as back pain and repetitive motion injuries, may develop gradually (Gatchel and Schultz, 2014; Utterback et al., 2014; Waters et al., 1993). Acute injuries, in contrast to gradual injuries, develop quickly. Examples of acute injuries include burns, lacerations, and contusions. Results of previous research revealed that WC data better represent acute injuries as opposed to chronic injuries (Utterback et al., 2014). Thus, injuries associated with MMH were likely underreported and therefore underrepresented in the present study. Chronic injuries were not exclusive to MMH and could still occur as claimants perform other (non-MMH) tasks.

5.4. Distribution and cost of claims by injured anatomical region

The present study investigated the distribution and costs of claims by injured anatomical region. Researchers compared the distribution of injuries by injured anatomical area within the present study to the distribution of injuries reported in the BLS SOII data. Data on injured anatomical regions as reported by different industries, including breweries, were included in the BLS SOII data during the claim period.[24]

In the present study, the upper limb region was most frequently associated with claims. The fingers and hand were the most commonly injured body part within the upper limb. Previous studies on occupational injuries in different cohorts (logging, fish farming and processing, and grain handling) have also observed that the majority of injuries affected workers' hands and fingers (Kaustell et al., 2020; Lagerstrom et al., 2017; Ramaswamy and Mosher, 2017; Syron et al., 2019; Syron et al., 2017). For example, over 25% of all injuries affected hands among injured Finnish fish farmers (Kaustell et al., 2020).

Claim costs were not statistically significantly different among claims associated with different anatomical regions. However, even though fewer claims were associated with the trunk region, the cumulative cost of claims associated with the trunk region ($300,000) was greater than the cumulative cost of claims associated with the upper limb ($280,000). Claims associated with trunk region injuries incurred the lowest median claim costs, but the second highest mean claim costs. This cost distribution

[24] The distribution of injuries by anatomical region as reported by the BLS SOII is outlined in Appendix 8.16.

was because there were many low or zero-cost claims, but some trunk region-related claims incurred very high costs. The low frequency but high cost of trunk region-related claims was also observed in two previous studies that used WC claims data to investigate injuries among agriculture workers (Douphrate et al., 2009a, 2006).

When the claims in the present study were analyzed by task (MMH or other), the distribution of claims by injured anatomical area shifted. Among claims that occurred during MMH tasks, the trunk region was the most frequently affected anatomical region. More than 50% of injuries among MMH tasks were related to the trunk region, twice that of injured trunk regions among claimants performing other (non-MMH) tasks. After sharing these results with subject matter experts, they confirmed that most MMH tasks in breweries were likely to include lifting and carrying product. Lifting and carrying heavy loads are risk factors associated with back pain (Marras et al., 2010; Waters et al., 1993). A subject matter expert described the burden of trunk region injuries that he observed in a barrel-aging area: “that's where most of our overexertion injuries came from because it's a weird twisting of the body and the torso to move those barrels and they weigh 600 pounds when they're full.”

Among claims that occurred during other (non-MMH) tasks, the upper limb was the most frequently injured anatomical region. Subject matter experts agreed that other (non-MMH) tasks would affect the upper limb – such as reaching into tanks, cleaning materials, getting splashed while brewing, or operating the packaging line. One subject matter expert described how operating the packaging line may be repetitive and monotonous and lead to repetitive motion injuries: “I have a repetitive stress injury in my elbow from working on the bottling line.” Injuries to the upper limb, such as irritation and dermatitis, were associated with contact with water and chemicals. When mixing chemicals and transferring liquids, subject matter experts descried how “chemicals and hot water could get over and into their gloves.” Water and chemicals were also associated with dermatitis among injured fish processing workers (Syron et al., 2019). In the present study, in response to reading a claim on dermatitis from liquid exposure, one subject matter expert commented that:

> The dermatitis one is interesting, but I could see it. I mean, my hands will take a long time, if ever, for them to go back to some kind of normalcy from having contact with chemicals for so many years. Even though you wear gloves, you still get water or liquid in them.

The distribution of injuries in the present study was compared to injuries reported by the BLS SOII data. The distribution of injuries by injured anatomical region were similar between the present study and the BLS SOII data. A larger percentage of injuries affected the upper limb and the trunk among craft brewery claimants in the present study than brewery workers reported in the BLS SOII data.

5.5. Distribution and cost of claims by injury event

The present study investigated the distribution and costs of claims by injury event category. Researchers compared the distribution of injuries by injury event within the present study to the distribution of injuries reported in the BLS SOII data.[25]

In the present study, the majority of all claims were due to overexertion and bodily reaction (28%) and exposure to hazardous substances and environments (27%). Overexertion and bodily reaction was also identified as the leading injury nature in previous WC studies among fish processing (Syron et al., 2019; Syron et al., 2017), ambulance workers (Meyers, 2018), agriculture workers (Douphrate et al., 2009b), and grain handlers (Ramaswamy and Mosher, 2017). Exposure to hazardous substances and environments was one of the most frequently observed injury event category among craft brewery workers in the present study as well as among fish farmers (Kaustell et al., 2020) and wood product manufacturers (Beery et al., 2014). Modules in the Brewers Association online safety training address exposure to hazardous substances or environments in multiple modules. Content in these training modules

[25] The distribution of injuries by injury event as reported by BLS SOII is outlined Appendix 8.16.

address hazards such as atmospheric hazards, CO2 hazards, chemical and sanitizer handling and storage, and broken glass. For example, content in the training module on fermentation and cellaring addresses atmospheric and CO2 hazards, lock-out-tag-out, personal protective equipment, and sanitizing best practices. Contact dermatitis due to wet surfaces or chemical sanitizer exposure is addressed in the "keg filling" module. While these hazards are addressed in training modules, health and safety professionals have identified unmitigated hazards within operational craft breweries. In a presentation by OSHA consultants from Colorado State University, 33 inspections of craft breweries (in a six-month period) identified many hazards associated with exposure to hazardous substances and environments (Colorado State University Health and Safety, 2019, slide 3). Examples of commonly observed hazards were related to exposure to hazardous substances and environments included improper electrical setup, lack of personal protective equipment, lack of adequate respiratory protection, and lack of control of hazardous energy (e.g. lack of lock-out-tag-out and machine guarding).

In the present study, the injury event of STFs accounted for 16% of claims. Multiple modules in the Brewers Association online safety training address STFs: bottling, grain handling, canning, keg filling, fermentation and cellaring, transfer and boiling, mashing, and working on elevated surfaces. Content in these modules advises the viewer to keep pathways clear when carrying/moving product and equipment as well as how to mitigate wet floors. In the present study, hoses were identified in accident narratives that described claimants carrying, moving, or stepping on hoses. Some hose-related claims incurred no costs and other claims incurred thousands of dollars in costs. A 35-44 year old claimant with 4-5 years of tenure experienced a zero-cost sprain/strain to their ankle from an overexertion and bodily reaction event

when they "stepped off stool onto hose re-assembling guest brink."[26] While this claim did not have reported cost, the claimant could have used their personal insurance to cover possible costs. A 25-34 year old claimant with 1-2 years of tenure incurred a $420 sprain/strain to their ankle due to overexertion and bodily reaction when they rolled their ankle stepping on a hose while fixing conveyors.[27] Another claimant, a 25-34 year old with 1-2 years of tenure, incurred a $1,600 lower arm fracture from an STF when he was making beer and tripped over a hose and fractured his forearm.[28] The Master Brewers Association of the Americas published a best practice document on hose management in an effort to improve awareness and decrease accidents associated with tripping over hoses (Rosenberg, 2020). Recommendations by the Master Brewers Association of the Americas ranged from costly investments (such as replacing hoses with steel hard piping) to low cost workstation modifications (such as installing wall hooks to remove unused hoses from walkways).

When claims were analyzed by task, the distribution of claims by injury event shifted. The majority of claims due to exposure to hazardous substances and environments, contact with objects and equipment, or STFs occurred during other (non-MMH) tasks. The majority of claims due to overexertion and bodily reaction occurred during MMH tasks. The distribution of claims due to contact with objects and equipment was predominately associated with other (non-MMH) tasks but was observed frequently among both tasks. Given the nature of work in a craft brewery, workers are exposed to objects and equipment regardless of task type. One accident narrative described how a claimant's hand was caught

[26] Example from Claimant Identifier 1749190, available in Appendix 8.15.

[27] Example from Claimant Identifier 1756367, available in Appendix 8.15.

[28] Example from Claimant Identifier 2144354, available in Appendix 8.15.

between dishes when carrying plates to the kitchen.[29] The injury event of contact with objects and equipment occurred in the brewhouse as well, as recorded in the following accident narratives: "smashed pinky between kegs building pallet order"[30] and "impact injury between two full 55-gal steel drums when manually handling drums."[31]

Claim costs were statistically significantly different among claims due to different injury events. Specifically, claim costs due to overexertion and bodily reaction were statistically significantly more expensive than claims due to contact with objects and equipment or exposure to hazardous substances and environments. While the majority of claims in the present study were due to overexertion and bodily reaction or contact with objects and equipment, these claims incurred low costs. The cumulative cost of claims due to overexertion and bodily reaction was half that of claims due to exposure to harmful substances or environments. While there were many low or zero-cost claims due to overexertion and bodily reaction in the present study, some claims were very costly. For example, one claim due to overexertion and bodily reaction resulted in a sprain/strain to a claimant's trunk region that incurred more than $15,000 and more than 100 days of lost time.[32] Subject matter experts elaborated on the burden of injuries due to overexertion and bodily reaction. One subject matter expert used to manage a barrel aging program at a craft brewery where workers were required to rotate barrels as the beer aged. Two workers rotate a single barrel in Figure 5.1. That same subject matter expert expanded on injuries he observed in the barrel aging program:

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[29] Example from Claimant Identifier 2101401, available in Appendix 8.15.

[30] Example from Claimant Identifier 1759041, available in Appendix 8.15.

[31] Example from Claimant Identifier 2307678, available in Appendix 8.15.

[32] Example from Claimant Identifier 2325312, available in Appendix 8.15.

> That [barrel aging] area is where most of our overexertion injuries came from because it's a weird twisting of the body and the torso to move those barrels and they weigh 600 pounds when they're full. It seems like recovery is long when you strain muscles or throw your back out, it's not like you're up and running within a couple of days you can't just throw a brace on it or put a bandage on it and go. It takes weeks sometimes to recover, so I can see that being the highest cost exactly.

Figure 5.1. Two workers move a barrel (50-236 kg., 110 -520 lbs.)

Contact with objects and environments accounted for 27% of all claims but incurred low cumulative costs as well as the lowest mean and median costs per claim. Low cost claims due to contact with objects and equipment were also observed in a study on injuries among agricultural workers (Douphrate et al., 2006) and grain elevator workers (Ramaswamy and Mosher, 2017).

The distribution of injuries by injury event was compared between the present study and injuries reported in the BLS SOII data. Overexertion and bodily reaction was the most common injury nature reported among craft breweries in the present study and in the breweries reported in the BLS SOII data. In the present study, exposure to harmful substances or environments was three times more common among craft brewery claimants than injured brewery workers represented in the BLS SOII data. Craft brewery workers are more likely to be in direct contact with hot surfaces and materials (such as hot liquids, cleaning chemicals) and sharp edges (like packaging machinery). Exposure to harmful substances and

environments in the craft breweries could be due to workers performing more manual tasks in lieu of automated procedures. Subject matter experts emphasized how craft breweries, as smaller operations, are limited in cost and physical space to implement automated machinery. Subject matter experts also discussed how working on bottling lines (especially manual bottling lines) exposes workers to risks of lacerations. Subject matter experts also described how working the kegging lines (cleaning in particular) exposes workers to strong cleaning chemicals and heat (steam cleaning). Contact with objects and equipment accounted for fewer injuries among craft brewery claimants in the present study than those reported in the BLS SOII data. Slips, trips, or falls were half as common among craft breweries than injuries reported in the BLS SOII data. The distribution of injuries where the injury event was classified as "other" was much greater among injuries from craft breweries than those reported in the BLS SOII data. Motor vehicle and transportation-related incidents were reported in a few injuries among craft brewery claimants (2%), but none were reported among injuries reported in the BLS SOII data. This could be due to industry classification guidelines within the BLS SOII. Breweries are assigned a different NAICS code than fleet and delivery systems. Craft breweries are smaller operations and may not be large enough to implement multiple NAICS codes within a company.

5.6. Distribution and cost of claims by claimant characteristics

The present study investigated the distribution and costs of claims by claimant characteristics (age and tenure). Researchers compared the distribution of injuries by claimant characteristics within the present study to the distribution of injuries reported in the BLS SOII data. While sex was not included in the specific aims of the present study, it was reported in the WC data. Data on claimant sex may be used as an additional factor to help determine how thoroughly the present study represents the craft brewing workforce.

While claimant age and tenure were moderately correlated in the present study, subject matter experts agreed that younger workers typically had less tenure than older workers. The presence of new workers as claimants with short tenure indicated a lack of institutionalized training and safety practices within the

craft brewing industry. Many subject matter experts described the current state of work in the craft brewing industry as very much "learn by experience" and that the industry relies on institutionalized knowledge rather than documented training and job safety analysis or job hazard analyses.

5.6.1. Distribution and cost of claims by claimant age

Claimant age was investigated in the present study, along with the distribution and costs of claims by age. Researchers compared the claimants' ages within the present study to the ages among injured brewery workers represented in the BLS SOII data.[33] Researchers also discussed these findings with subject matter experts.

One subject matter expert has led multiple training programs in diverse industries over the course of his career. He frequently asks his program participants at what age did they experience their first big accident (in life and at work): "for men it's around 16 to 21 and for women it's around 18 to 24 and then it diminishes greatly with experience." This insight was supported by the results in the present study, where the majority of injuries affected claimants 25-34 years old. This age group also accounted for the largest proportion of injuries among agriculture workers (Douphrate et al., 2009b) and ambulance drivers (Meyers, 2018). In the present study, one subject matter expert described why so few claims were reported among workers ≤ 24 years old as compared to workers between 25-34 years old:

> I don't want to lose my job, I'm just happy to be working here. Workers between 25-34 years old, on the other hand, are more likely to report injuries because they have already been in the industry for some time, are aware of WC, and do not have good enough medical insurance to pay out of pocket, so they have the incentive to report the injury.

[33] The distribution of injured worker age as reported by the BLS SOII is outlined in Appendix 8.16.

In the present study, claimants between 24-34 and 35-44 years old incurred the greatest cumulative costs and accounted for 85% of all claims. Claimants between 45-54 years old accounted for seven percent of all claims but incurred the highest mean claim cost ($3,700) and median claim cost ($600). Higher costs per claim among older claimants in the present study was similar to results of other studies in different industries. For example, in a study on WC claims among construction workers, older workers experienced fewer injuries, but those injuries incurred greater costs (Schwatka et al., 2013). Additionally, a study on grain elevator handlers observed lower frequencies of claims among older workers, but higher cost claims among older workers (Ramaswamy and Mosher, 2017). In the present study, claimants aged ≥ 55 years old incurred the lowest costs (median, mean, and cumulatively) and accounted for four percent of all claims. One subject matter expert commented how older workers are likely to be in less physically demanding jobs:

> When you're 55 and still working at a brewery, you're just like, 'I'm going to be the safety guy doing other stuff' and 'I'm not doing that job that you want me to do because that's going to get me hurt. You have one of those 34-year-olds do it.'

Claimant age was investigated by task in the present study. Based on descriptive statistics, claimants performing MMH tasks at the time of injury were of similar ages compared to those performing other (non-MMH) tasks. However, this claimant age estimate does not consider the effect of the different injury characteristics (injured anatomical region, injury event, injury nature, claimant tenure**,** and claim type). In order to adjust for confounding, analysis using a linear model was performed to investigate the relationship between age and task when adjusting for different injury characteristics. Based on results of this analysis, claimants who performed MMH tasks at the time of injury were slightly younger than those who performed other (non-MMH) tasks. While the mean age estimate was not statistically significant, subject matter experts agreed that younger workers were more likely to be performing manual tasks than other (non-MHH) tasks at the time of injury. They described how career paths in the craft brewing industry typically begin with MMH and low-skill tasks. As workers gain knowledge about brewing practices and experience, they perform tasks that require more skill versus physical labor. Subject matter

experts emphasized that, in addition to being assigned less complex and more manual tasks, these younger workers simply are unaware of occupational hazards:

> When people are younger and recently enter a workforce, they take more risks, they have less experience, they're not used to dealing with the level of energy of these commercial systems… especially if they come from a smaller operation or from outside manufacturing altogether.

Claimants in the present study were younger than injured workers reported in the BLS SOII data. Specifically, the proportion of claimants ≤34 years old was greater in the present study than what was reported in the BLS SOII data. Subject matter experts agreed that the craft brewing industry demographic overall was skewed towards a younger workforce. One subject matter expert shared that "I'm 40 and I was definitely considered an 'old man' there [craft brewery] because a lot of the guys that work there are in their early 20s to their mid-30s."

5.6.2. Distribution and cost of claims by claimant tenure

Claimant tenure was investigated in the present study. Specifically, the distribution and costs of claims by claimant tenure was investigated. Researchers compared the claimants' tenure within the present study to the tenure among injured brewery workers represented in the BLS SOII data.[34] The Brewers Association conducted a health and safety survey that asked respondents (both managers and employees) about the duration of their craft brewing career.[35] Given the scope of the Brewers Association health and safety survey, researchers were able to compare tenure among claimants from the present study to injured workers who participated in the Brewers Association health and safety survey. Subject matter

[34] The distribution of injured worker tenure as reported by the BLS SOII is in Appendix 8.17.

[35] Selected results of the Brewers Association health and safety survey is available in Appendix 8.18.

experts shared their observations and perceptions on the role of tenure and injury outcomes or safety behaviors.

The majority of claims occurred among workers with < 5 years of tenure. Higher proportions of claims among inexperienced workers have also been observed in numerous previous studies on occupational injuries: more than 70% of agriculture workers who experienced tractor-related injuries had < 2 years of experience (Douphrate et al., 2009b); 25% of injured loggers had < 6 months of experience (Lagerstrom et al., 2017); 32% of distribution center workers with low back disorders had < 1 year of tenure (Marras et al., 2010); and 50% of injured grain elevator workers had ≤ 2 years of tenure (Ramaswamy and Mosher, 2017). In the present study, when discussing tenure with subject matter experts, one commented that after working in small craft breweries for a number of years, workers are more likely to be hired by established craft breweries. These established (oftentimes larger) facilities are more likely to have resources to invest in upgraded equipment and staff resources. She said:

> From my experience, in your one to five-year range you're working at smaller places that can't accommodate or engineer-out hazards. [After] ten years, then you can get a job at Odell or New Belgium where they have resources for automated systems.

Claim cost was not statistically significantly different by tenure. Lagerstrom et al. also did not observe statistically significant differences in median claim cost by tenure among loggers (Lagerstrom et al., 2017). In the present study, claimants with < 1 year of tenure had the lowest median costs per claim but incurred the highest cumulative costs ($296,000) because they accounted for more than 40% of claims. The observed differences in magnitude between mean and median claim costs among claimants with < 1 year, ≥ 1 to < 2 years, and ≥ 2 to < 3 years indicated that each tenure category was associated with many low cost claims and some high cost claims. Subject matter experts commented that claimants with ≥ 2 to < 3 years of tenure are “still new, still want to impress bosses, grateful to be in industry, and take on tasks delegated from ‘more seasoned’ workers.” Claimants with ≥ 5 years of tenure (ranging from

five to 34 years) accounted for approximately ten percent of all claims in the present study and incurred the lowest mean claim costs, indicating that most claims were low-cost.

Claimant tenure was investigated by task in the present study. Based on descriptive statistics, claimants who performed MMH tasks at the time of injury had similar tenure to those who performed other (non-MMH) tasks. However, these values do not consider the effect of the different injury characteristics (injured anatomical region, injury event, injury nature, claimant age, and claim type). In order to adjust for confounding, analysis using a linear model was performed to investigate the relationship between tenure and task when adjusting for injured anatomical region, injury event, injury nature, claimant age, and claim type. Based on results of this model, claimants who performed MMH tasks at the time of injury had less tenure than those who performed other (non-MMH) tasks, when adjusting for injured anatomical region, injury event, injury nature, claimant age, and claim type. While this mean tenure estimate was not statistically significant, subject matter experts agreed that workers with less tenure were more likely to be performing MMH tasks than other (non-MHH) tasks at the time of injury. Subject matter experts described how typical career paths in craft breweries begin with MMH-intensive, low skill tasks. As workers gain knowledge about brewing practices and experience, they perform tasks that require more skill than physical labor. Examples of beginner MMH tasks include loading trucks, transferring ingredients around the brewery, and carrying boxes of materials. Examples of more advanced MMH tasks include dosing the brew tanks and taking quality samples. However, this trend of graduating beyond physical labor is not consistent for all craft breweries. Subject matter experts described how "some workers stay on the packaging line and other manual tasks for their entire craft brewery career." Additionally, small operations may require an "all-hands-on-deck approach" where everyone, regardless of their tenure, is required to assist with manual tasks.

Injured worker tenure was reported differently between the present study and the BLS SOII data. In the present study, tenure was represented by six categories: < 1 year, ≥ 1 to < 2 years, ≥ 2 to < 3 years, ≥ 3 to < 4 years, ≥ 4 to < 5 years, and ≥ 5 years. Tenure was reported in the BLS SOII data by three

categories: < 1 year, ≥ 1 to < 5 years, and ≥ 5 years. In order to compare the distribution of claimant tenure in the present study to results reported in the BLS SOII data, researchers had to collapse tenure categories to match the categories in the BLS SOII data.[36] The percentage of claimants with < 1 year of tenure was approximately double in the present study compared to that reported in the BLS SOII data. This difference in observed tenure could be due to the younger overall demographic of the craft brewing industry and/or a higher occurrence of injuries among new workers in craft breweries. Regarding injuries among new workers, a subject matter expert comment:

> It wasn't that they [claimants] were irresponsible or bad people, they just didn't have experience in production. It was the lack of institutionalized (unwritten) knowledge. You didn't even have that institutional knowledge of like 'hey don't touch this because it is hot.'

One subject matter expert recalled minimal training when she started working at a craft brewery. It was very much a "learn on the job" type of atmosphere, she described. The purpose of the Brewers Association online training is to provide preliminary education for workers. Respondents to the Brewers Association health and safety survey were asked about new hire training. The majority of respondents indicated that they had received some kind of new employee training (formal or informal). More than 50% of the respondents received an employee handbook. Results of the survey highlighted a difference in perspective of resources between management and employees. Among those who participated in the survey, more than 60% of managers thought there was a formal new hire training program while approximately 40% of employees were aware of any training programs (Embry, Stinchfield, 2020). When asked about additional trainings, more than 60% of the respondents indicated that they received new

[36] A side by side comparison of the distributions of injuries by tenure category in both the present study and the BLS SOII is available in Appendix 8.17.

training when their duties changed and more than 50% had some level of refresher training (twice a year, annual, or not regularly scheduled). In the present study, the percentage of claimants with ≥ 1 to < 5 years of tenure was similar to that reported in the BLS SOII data. This coincides with subject matter experts' conclusions that after one year, workers have started to understand how to perform tasks safely or to delegate tasks to other workers. In the present study, the proportion of claimants with ≥ 5 years of tenure was less than those reported in the BLS SOII data. Many craft breweries are new establishments, which could contribute to the observed small distribution of claimants with ≥ 5 year tenure in the present study. Managers who responded to the Brewers Association survey where asked how long their current facility had been open. The duration ranged from a few months to 34 years with a median of 2.4 years and a mean of 5.7 years. If a craft brewery has been operational for five years, the maximum tenure for any employee is five years. Most craft breweries begin as one or two-person operations, so even if a facility has been operational for five years, only a few employees may have a five-year tenure.

Respondents to the Brewers Association health and safety survey were asked about the duration of their craft brewing career, including their tenure and overall experience.[37] Respondents who identified as employees were also asked how many other breweries had they worked at and had they been injured on the job. Thirty percent of respondents who identified as employees reported that they had experienced an injury at their current job. Respondents' reported tenure (regardless of injury experience) ranged from less than one year to more than thirty years, with a mean of four years. The majority of respondents had only worked at one craft brewery. Approximately 30% of respondents had worked at two craft breweries and approximately five percent reported working at three craft breweries. Employees were asked in the health

[37] Selected findings from the Brewers Association health and safety survey is available in Appendix 8.18.

and safety survey if they had experienced a work-related injury at their current place of employment. Of those who reported experiencing an injury, their tenure ranged from less than one year to more than ten years, with a mean of three years. Employees' experience exceeded tenure, which indicated that most employees had previously worked in the craft brewing industry**.** Of those who reported an injury, their experience ranged from less than one year to 25 years in the craft brewing industry, with a mean of five years. Of the employees who had experienced an injury, the majority had worked at only one craft brewery and more than 25% of respondents had worked at two craft breweries. Employees who been injured at work had fewer years of experience, less tenure, and worked at fewer craft breweries than craft brewery workers overall.

In the present study, tenure was not reported in 11% of claims. Tenure was reported in 100% (2,590) of injuries in the BLS SOII data. One reason for the difference in reported tenure could be that WC systems do not require this information, but the BLS SOII does. Injury data and claimant information are submitted by the company to their WC insurance provider. The insurance provider will process the claim even if some sections of the FROI are incomplete. If an injury meets OSHA injury recording requirements, the company must also record the incident on an OSHA 300 log. Data in the BLS SOII are extracted directly from OSHA 300 and OSHA 301 logs. OSHA's Form 301: Injury and Illness Incident Report has a section the injured employee's date of hire.[38]

5.6.3. Distribution and cost of claims by claimant sex

While not a specific aim in the present study, sex was included in the WC data. Investigating the distribution of claims by sex provides another variable that researchers may use to determine how well the

[38] Examples of the OSHA Form 300 and OSHA Form 301 are available in Appendix 8.19.

present study represents the overall craft brewing industry and how it compares to other WC data cohorts and BLS SOII data. The majority of claimants (80%) in the present study identified as male. Given the structure of WC data, researchers only had access to demographics about the claimant (demographic information on the overall workforce was not available). Male dominated injured cohorts have also been observed in previous studies on occupational injuries: 88% of Colorado agriculture workers who experienced livestock-handling related injuries (Douphrate et al., 2009b); 87% of injured Finnish fish farmers (Kaustell et al., 2020); 82% of Alaskan seafood processors (Syron et al., 2019); 97% of injured construction workers (Schwatka et al., 2013); 72% of Oregonian seafood packagers (Syron et al., 2017); 54% of injured ambulance workers in Ohio (Meyers, 2018); 99% of injured drywall carpenters in Washington (Schoenfisch, 2012); and 93% of injured truckers in Kentucky (Chandler et al., 2017). Researchers may also compare results of the present study to the distributions of injuries by sex among breweries as reported in the BLS SOII data.[39] The distribution of male claimants was higher in the present study than that reported in the BLS SOII data. The Brewers Association conducted a demographics survey, which allowed researchers in the present study to compare the distribution of injured male craft brewery workers to the overall distribution of male craft brewery workers. Results of this survey reported that 72% of all U.S. craft brewery workers were male (Brewers Association, 2020). Additionally, demographic information collected during the Brewers Association health and safety survey indicated that the majority of respondents (83%) were male (Embry, Stinchfield, 2020). In that same survey, respondents were asked if they personally experienced an occupational injury while working in the craft brewing industry. Approximately 30% of eligible respondents indicated that they had personally experienced an injury while at work. Among respondents who had experienced an occupational injury at a

[39] The distributions of injuries by sex as reported by the BLS SOII are available in Appendix 8.16.

craft brewery, 75% identified as male. Based on results of surveys by the Brewers Association, not only is the craft brewing industry male dominated, males are also experiencing the majority of injuries.

5.7. Distribution of claims by contributing factors based on revised agent-host-environment epidemiologic model

In order to better understand the context of claims among craft brewery workers, researchers classified contributing factors based on the revised agent-host-environment epidemiologic model. Basic information on the FROI included the injury nature, injury event, and injured anatomical region. By referencing the revised agent-host-environment epidemiologic model, researchers were able to better understand where and how claims occurred. The relationship between injury characteristics and contributing factors (which were identified based on the revised agent-host-environment epidemiologic model) provided valuable insight into understanding injuries among craft brewery workers. The injury nature was the result of an injury event when an agent transferred between the vehicle and injured anatomical region, while the claimant was doing an activity in an environment.

In the present study, an average of 4.7 contributing factors were identified per accident narrative. More contributing factors were identified per accident narrative in the present study than previous occupational injury studies. For example, Glazner et al. identified 2.7 contributing factors per accident narrative in a study among construction workers at Denver International Airport (Glazner et al., 2005). Douphrate et al. identified 3.9 contributing factors per accident narrative among tractor-related claims (Douphrate et al., 2009a) and 3.4 contributing factors per accident narrative among livestock-handling related claims (Douphrate et al., 2009b). Four exposure categories (agent, host, environment, and vehicle) were used in the present study, whereas previous studies on occupational injuries used three exposure categories (agent, host, and environment). The traditional epidemiologic triangle highlighted the agent, host, and environment. Haddon and Runyan emphasized how agent was intended to represent the energy associated with injury and the vehicle represented the object responsible for transferring the energy to the host to result in injury (Haddon, 1968; Runyan, 1998). While previous studies combined agent and

vehicle, researchers in the present study chose to separate agent and vehicle following a video-chat discussion about the epidemiologic triangle and the revised agent-host-environment epidemiologic model with Dr. Runyan (correspondence with Dr. Runyan, 2020).

5.7.1. Agent and claim characteristics

Based on information provided in the accident narrative and FROI, agent was identified in almost all claims (99%). Four unique agent contributing factors were identified in the present study: mechanical, chemical, thermal, and electrical energies. The majority of claims were caused by a transfer of mechanical energy (85%). Most injury natures were associated with a transfer of mechanical energy between the host and vehicle (sprain/strain, contusion, and laceration). Many injury event categories were associated with mechanical transfers of energy: overexertion and bodily reaction, contact with objects and equipment, and STFs. Depending on the vehicle and the environment, exposure to harmful substances and environments could be associated with mechanical, thermal, electrical, or chemical energy. For example, a transfer of electrical energy would result in shock (which was included in "other" injury nature category). A transfer of thermal or chemical energy between the vehicle and host would result in a burn.

5.7.2. Brewery and packaging hall claim characteristics

The brewery was the most commonly identified environment in all claims. The brewery was the overarching area that encompassed multiple environments, including the packaging hall and brewhouse. The packaging hall represented kegging, canning, or bottling. The brewhouse represented the cellar, tanks, and other brewing equipment. Within the brewery, the packaging hall was the most frequently identified environment among the claims' accident narratives. In the present study, subject matter experts described how the packaging hall typically had the highest number of workers and the greatest proportion of new workers compared to other regions of the brewing facility. One subject matter expert described how:

> The way a lot of people enter the brewing career is they start in a packaging line where they're moving a lot of material or schlepping sacks of grain or cases of bottles or things like that because those are low technology and low experience requirement jobs.

Many tasks within the packaging hall require workers to directly interact with machinery and products. Packaging machinery requires empty containers to be loaded onto lines where they are cleaned and filled with beer. Depending on the level of automation within a craft brewery, workers may directly handle and load the containers. In less automated systems, repetitive motion injuries may occur from repeated exertions required to load cases of bottles, cans, or kegs on and off the packaging machinery. Regardless of automation levels, workers have to sweep up broken glass bottles or damaged containers. Multiple modules in the Brewers Association online safety training are dedicated to canning, bottling, kegging, and powered industrial trucks. One subject matter expert described how, in an effort to save money and maximize resources, craft breweries may purchase secondhand equipment. When describing craft breweries' relationship with secondhand equipment, she described how "it [the secondhand equipment] was designed poorly initially, so it's even more challenging to retrofit the equipment for a better design." Lagerstrom et al. described similar challenges facing loggers, who lack the resources or finances to install or retrofit engineering controls on equipment to improve work tasks (Lagerstrom et al., 2017). The lack of modern (or any) automated equipment leaves manual handling responsibilities to the workers. Additionally, instead of investing in equipment (secondhand or new), many craft breweries rely on manual handling. One subject matter expert recalls sitting in meetings where decisionmakers and upper management's attitudes were: "oh we don't need that equipment, we have physical bodies that can do that right now" and "we have physical labor that can handle that for now, so we'll look at that equipment later." Craft breweries continue to rely on workers to perform manual tasks. In the present study, carrying items was the most frequently identified host activity among all accident narratives. Claimants were observed carrying, lifting, loading, moving, and stacking objects/equipment at the time of injury in nearly a quarter of all accident narratives. In other industries, manual handling, lifting, and carrying were also frequently identified activities in accident narratives: loggers handling equipment

(Lagerstrom et al., 2017); seafood processing workers handling product (Syron et al., 2019); ambulance workers maneuvering patients and equipment (Meyers, 2018); and truck drivers working with trailers (Chandler et al., 2017).

In the present study, researchers referenced the revised agent-host-environment epidemiologic model to identify the vehicle responsible for the energy transfer. Among claims that occurred in the brewery and packaging hall, vehicle represented the item claimants were manually handling at the time of injury. More than 20% of all vehicle contributing factors identified in the present study were classified as containers. More than half of all identified containers were kegs. Craft brewery workers frequently handle stainless steel kegs, which are used to store and transport beer. These durable, portable, reusable, pressurized containers have a single spear valve, which is the only opening used to clean, to fill, and to drain liquid. Kegs are cleaned and sterilized before they are filled with beer. Craft brewery workers typically handle full, empty, and partially full kegs throughout their shift. One of the most popular sizes of kegs used in craft breweries is the half-barrel keg. A half-barrel keg is 59.0 cm high, has a diameter of 41.0 cm, holds 58.7 liters (15.5 U.S. gallons), and weighs between 13.5 kg (29.7 lbs.) when empty and 72.8 kg (161.5 lbs.) when full of beer (Alworth, 2015; Jones et al., 2005). A worker maneuvers a half-barrel keg on a wooden pallet in Figure 5.2. In the present study, researchers observed sprains/strains, contusions, and "other" injury natures that were associated with keg handling. For example, a fractured foot claim incurred $2,200 following contact with objects and equipment when the claimant "was moving a full half barrel keg and dropped the full keg 14 inches and it fell on his foot."[40] Another claimant experienced an abdominal hernia claim that incurred over $12,300 from an overexertion and bodily reaction event after

[40] Example from Claimant Identifier 1978336, available in Appendix 8.15.

lifting kegs.[41] The burden of manually handling kegs has been addressed in a few previous studies. For example, a study on keg handling in a neighborhood pub used the 3D SSPP (Static Systems Posture Predictor) to conduct a biomechanical analysis of bartenders lifting and pulling kegs. Workers' estimated joint compression forces exceeded recommended limits when handling kegs, which indicated that workers were at an increased risk of developing a musculoskeletal disorder (Jones et al., 2005). While a neighborhood pub is not a craft brewery, they may share similar work demands. A previous study on craft brewery workers operating a kegging line identified factors of the job that put workers at an increased risk of developing low back musculoskeletal disorders (Brents et al., 2019, 2017). Kegs are heavy items that are sanitized with hot water and strong chemicals before they are filled with beer. This process of cleaning and filling kegs is referred to as kegging. Subject matter experts identified kegging as another hazardous packaging task due to the chemical and heat exposures, in addition to physical handling. One subject matter expert described how, when she started her craft brewing career, keg cleaning relied heavily on chemical methods. However, keg cleaning styles have shifted over time to reduce the use of strong chemicals and instead use steam and hot water methods. In this case, one hazard replaces another (chemical burns versus thermal burns). The production scale of keg cleaning dictates the size of machinery and the level of automation. The most basic keg cleaning requires the worker to manually inject cleaning material through the keg spear. Advanced keg cleaning systems automatically clean the kegs internally and externally in enclosed machinery. Some of these advanced systems still require workers to manually lift kegs onto the line to be cleaned (Brents and Rosecrance, 2019).

[41] Example from Claimant Identifier 2263642, available in Appendix 8.15.

Figure 5.2. A worker rolls a half-barrel keg (14 kg - 73 kg., 30 - 161 lbs.)

5.7.3. Cleaning

Workers clean the brewery, taproom, and kitchens. Researchers referenced the revised agent-host-environment epidemiologic model to classify contributing factors in order to better understand the circumstances that resulted in a cleaning-related claim. Claimants performed cleaning tasks in more than 20% of all claims in the present study. Sections on the FROI indicated the injury nature, injury event, and injured anatomical area related to the claim. Analysis of the accident narratives using the revised agent-host-environment epidemiologic model enabled researchers to better understand where the claimant was located and which cleaning methods were used at the time of injury. Additional information from the accident narrative analysis may assist in deciding where to allocate intervention resources.

Claimants use both cleaning chemicals and hot water to clean equipment and materials in craft breweries. Workers use cleaner in the brewery to clean tanks, in the taproom to clean beer lines, and in the kitchen to clean cooking equipment. In the present study, tanks were identified as the environment in

12% of cleaning-related claims. The majority of cleaning-related claims occurred in the brewing production and packaging areas (27%) followed by food preparation/service environments (19%). In Figure 5.3., a craft brewery worker uses pressurized water to clean the floor next to a kegging machine where kegs are cleaned with steam and caustics. The agent associated with the cleaning-related claims was typically mechanical or chemical. Lacerations (from sharp edges) and burns (from harsh chemicals or extreme heat) accounted for 42% of injury natures among cleaning-related claims. Liquid was identified as the vehicle in 29% of cleaning-related claims and chemical was identified in 25% of the cleaning-related claims. In the present study, claimants were exposed to chemical cleaners and hot water through hoses and buckets. One accident narrative described how "while attempting to switch a valve, the employee bumped his knee against a hose line that was not properly connected, causing a partial disconnection and spraying caustic chemical cleaner on him."[42] Another claimant experienced a foreign body in their eye "when pouring caustic cleaner into a container, it splashed up and into their left eye." [43] Chemical-usage was also associated with foreign bodies in the eye in previous studies on injuries among seafood processing workers in Alaska (Syron et al., 2019) and Finnish fish farmers (Kaustell et al., 2020). Subject matter experts detailed how the craft brewing industry has shifted from mostly chemical-based cleaning solutions to chemical and steam-based cleaning solutions. One subject matter expert recalled that:

> The earlier days of when I was brewing, I was using a lot more chemical cleaning. You'd still be using hot water, but you relied more on chemicals to do all of your sanitizing and cleaning tasks. Around 2012, people started using the steam sanitizing method.

[42]Example from Claimant Identifier 1956770, available in Appendix 8.15.

[43] Example from Claimant Identifier 2228696, available in Appendix 8.15.

Figure 5.3. A worker cleans a floor with pressurized water next to a machine that cleans kegs

Subject matter experts associated with the Colorado State University Fermentation Science and Technology Program announced how all chemical handling had been engineered out of their primary teaching brewery. Steam techniques may replace some chemicals in brewing and sanitization processes. However, cleaning draught beer lines still requires the use of strong chemicals. Long thin hoses are required to transfer beer from kegs (in coolers) to taps in the restaurant or taproom. In the present study, a claimant's hand was exposed to caustic cleaning chemicals when:

> The pump fell off the back bar causing the cleaning lines to be pulled out of the caustic bucket. This caused caustic [chemicals] to pour onto the floor and his pants. His hands and feet were exposed to caustic.[44]

[44] Example from Claimant Identifier 1932313, available in Appendix 8.15.

While accidental chemical exposure from draught beer lines was not common in the present study, it has the potential to cause serious injury. Subject matter experts recounted a near-miss when a salesperson almost ingested sanitizer when draught beer lines had not been completely rinsed. Additionally, subject matter experts described the challenge that "a lot of the people responsible for the draught line have minimal science knowledge or chemical safety awareness." In October 2020, the Brewers Association received the Susan Harwood Training Program Grant from OSHA to develop draught line safety training (Brewers Association, 2020). Injury data on chemical exposure from the present study may assist the Brewers Association as they develop virtual training modules on safe chemical handling methods for cleaning draught lines.

5.7.4. Food/service preparation

Analyses of the environment and host contributing factors based on the revised agent-host-environment epidemiologic model were especially helpful in identifying claims related to service/food preparation or those that occurred in the kitchen/taproom. The service/food preparation environment was where the worker would serve beer in a taproom, deliver food to customers in a restaurant setting, prepare food in a kitchen, or clean glassware and plates. A case study on physical demands of bartenders, waitresses, and cooks at a neighborhood pub identified multiple tasks that increased the worker's risk of developing a musculoskeletal disorder (keg handling, carrying food ingredients, reaching for items, and carrying trays) (Jones et al., 2005).

In the present study, according to the FROI, a claimant experienced a laceration on their finger. Further analysis of contributing factors using the revised agent-host-environment epidemiologic model

afforded more specific information: the claimant was slicing bread in the kitchen at the time of injury.[45] While food preparation/service activities were only identified in 10% of claims' accident narratives, all of these claims would be excluded from current national injury surveillance strategies. Even though these claims occurred at a craft brewery, establishments with a restaurant component would be classified under different NAICS codes. To date, national injury surveillance strategies rely on NAICS to organize injuries.

Per Colorado Liquor License Laws, establishments (including craft breweries) that wish to sell alcohol for on-premise consumption are required to provide food for sale. Craft breweries (in Colorado) that have on-premise consumption of alcohol must to provide food to customers, therefore food preparation/service activities are required by a portion of the workforce. Per 12-47-409 of the Colorado Liquor Code, in order to obtain a beer and wine license:

> A beer and wine license shall be issued to persons selling malt and vinous liquors and fermented malt beverages for consumption on the premises. Beer and wine licensees shall have sandwiches and light snacks available for consumption on the premises during business hours but need not have meals available for consumption.[46]

Craft breweries may sell snacks, partner with food trucks, or incorporate a restaurant into their facility to comply with Colorado Liquor License requirements. Subject matter experts commented that many craft breweries choose to use food trucks in order to reduce or eliminate hazards and tasks associated with food preparation. Some craft breweries choose to have a restaurant not only to comply legally, but to set themselves apart from other craft breweries. However, craft breweries with a restaurant

[45] Example from Claimant Identifier 2011144, available in Appendix 8.15.

[46] Available from https://www.colorado.gov/pacific/sites/default/files/Liquor%20Code%202018.pdf

are classified under different NAICS than production-only craft breweries. By analyzing WC data, researchers were able to analyze injuries from craft breweries with and without restaurants, regardless of NAICS constraints.

For breweries that choose to sell snacks or have a restaurant, a kitchen is typically the space where food is prepared and dishes are cleaned. In the present study, the kitchen and service spaces were the third most frequently identified environments where the claims occurred. Lacerations were the most frequent injury nature among claims that occurred in the kitchen and food/service preparation areas. Burns were the second most frequent injury nature among claims that occurred in the kitchen.

5.7.5. Coolers

When coolers were identified in the accident narratives, researchers were unable to determine if the cooler was associated with the brewhouse or with the taproom/restaurant areas. Coolers are cold rooms and may be used to store beer and ingredients. Both the brewhouse and taproom/restaurant require ingredients to be kept cool. Depending on the facility, craft breweries might have separate or shared cooler spaces for brewing and food service. In a presentation at the Craft Brewers Conference 2020, industry representatives described the typical layout of craft breweries (based on an online survey). The majority of craft breweries had production/packaging and taprooms/restaurants in the same building, either separated by walls/floors (75%) or shared in the same open space (17%). Approximately eight percent of craft breweries reported that their production/packaging and taproom/restaurant were housed in separate buildings on the same campus (Embry, Stinchfield, 2020). Given that craft breweries share spaces between the brewhouse and taproom/restaurant, craft brewery workers may interact with hazards associated both brewing and food service. The coolers may be cramped and slippery. If kegs are stored in the cooler with lines to the taproom, workers will regularly have to enter the cooler to adjust lines and kegs as they serve beer. Kegs and boxes may be precariously stacked. An example of a worker navigating a dolly loaded with kegs in a crowded cooler is displayed in Figure 5.4. Jones et al. performed biomechanical analyses of bartending tasks and recognized hazardous conditions with crowded coolers

(Jones et al., 2005). In the present study, claims that occurred in coolers were associated with both brewing and service/food preparation tasks. For example, a sprain/strain to the trunk region incurred an $8,600 claim following an STF while the claimant "was lifting a tray of food in the walk-in cooler and slipped and felt a pull in his back."[47] In another example, a sprain/strain to the trunk region incurred a $200 claim following contact with objects and equipment when, "as another team member was in the process of moving a keg into our cooler in the taproom, the keg came loose, hit the door to the cooler … and the door fell from its hinges onto the claimant."[48] Coolers are challenging work environments for craft brewery workers due to the cramped space and potential for slippery surfaces. Ambulance workers may face similarly challenging environments, as one study on Ohio ambulance workers described workers maneuvering patients and heavy equipment through tight or cluttered spaces (Meyers, 2018).

[47] Example from Claimant Identifier 2074234, available in Appendix 8.15.

[48] Example from Claimant Identifier 2084484, available in Appendix 8.15.

Figure 5.4. A worker maneuvers kegs using dolly in a crowded cooler

5.8. Distribution and cost of claims by injury nature and injury model

The present study investigated the distribution and costs of claims by injury nature category. Injury characteristics and contributing factors based on the revised agent-host-environment epidemiologic model create circumstances that cause the injury nature. In other words, the injury nature resulted from an injury event where the agent was transferred between the injured anatomical region and the vehicle, while the host performed an activity in the environment. Based on results of the present study, specific elements of each step in the injury model were identified for sprains/strains, contusions, lacerations, burns, and "other" injury nature. Injury prevention efforts can target elements of the injury model individually or together. For example, engineering the brewing process so that workers never directly contact chemicals addresses the environment and vehicle while preventing the injury event, therefore preventing a burn injury. Likewise, implementing PPE (gloves and eye protection) would prevent the hands or eyes from coming in contact with hazardous chemicals, therefore preventing a burn injury. Researchers compared the distribution of claims by injury nature within the present study to the distribution of injuries reported

in the BLS SOII data. Injury nature among injuries in different industries, including breweries, was reported in the BLS SOII data during the claim period.[49]

5.8.1. Sprains/strains

The results of the present study indicated that sprains/strains were the most frequent type of injury nature (29%). Sprains/strains were also the most frequent type of injury in studies of occupational injuries including fish farmers and packagers (Kaustell et al., 2020; Syron et al., 2019), loggers (Lagerstrom et al., 2017), ambulance workers (Meyers, 2018), construction workers (Schwatka et al., 2013), and agriculture workers (Douphrate et al., 2009b, 2009a, 2006). In the present study, claims associated with sprains/strains incurred the highest costs per claim and highest cumulative cost. Sprains/strains were associated with the highest mean claim cost, which was almost five times greater than the median claim cost. The differences between the low median and high mean costs indicated that while there were many low or zero-cost claims associated with sprains/strains, there were also some high cost claims associated with sprains/strains. The combination of the number of claims that incurred any cost with those that incurred high costs, caused sprains/strains to incur the highest cumulative cost compared to different injury nature categories. In the present study, a sprain/strain to the shoulder/upper limb incurred $37,000 following an overexertion and bodily reaction event when the claimant was moving bags of grain (raw material).[50] While this particular claim in the present study did not incur reported lost time, other sprains/strains did incur lost time. For example, a sprain/strain to the low back (trunk region) incurred $56,000 and 579 days of lost time following an overexertion and bodily reaction event after the claimant

[49] The distribution of claims by injury nature as reported by the BLS SOII is outlined in Appendix 8.16.

[50] Example from Claimant Identifier 1910007, available in Appendix 8.15

"felt pain in his back after working and wrapping pallets with stretch wrap."[51] Another industry that reported sprains/strains with lost time was fish farming. Kaustell et al. observed that 66% of all sprains/strains among fish farmers incurred between one and four weeks of lost time (Kaustell et al., 2020).

Sprains/strains were a result of a transfer of mechanical energy from the vehicle to the injured worker. The injury event of overexertion and bodily reaction facilitated the transfer of mechanical energy that resulted in a sprain/strain. The injury model for sprains/strains among Colorado craft brewery workers is outlined in Figure 5.5. The trunk region, specifically the low back, was most frequently affected by sprains/strains in the present study as well as previous WC studies. For example, in a study on ambulance service workers in Ohio, over 30% of all WC claims were associated with sprains/strains to the back (Meyers, 2018). Additionally, Kaustell et al. observed that the trunk accounted for 38% of all sprains/strains injuries among fish farmers during the study period (Kaustell et al., 2020). In the present study, most sprains/strains occurred in the brewery and packaging area while claimants carried containers. Marras et al. observed low back disorders among workers who frequently lifted objects and performed MMH tasks in Midwestern manufacturing and distribution centers (Marras et al., 1993, 2010).

[51] Example from Claimant Identifier 2304438, available in Appendix 8.15.

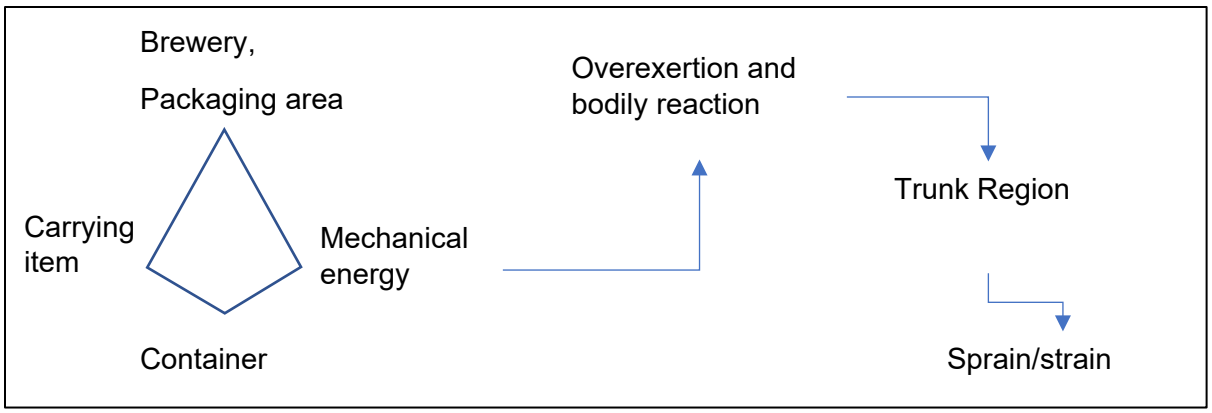

Figure 5.5. Injury model for sprain/strains among craft brewery workers

Sprains/strains among claimants between 25-34 years old accounted for 15% of all claims in the present study. Additionally, sprains/strains among claimants with < 1 year of tenure accounted for 10% of all claims. Sprains/strains were the most frequent injury nature among claimants between 25-54 years old and claimants with ≥ 2 years of tenure. Claimant age and tenure were moderately correlated, with younger claimants having shorter tenures at their time of injury. Typically, younger claimants (workers aged between 25-34 years of age) are likely to be newer to the craft brewing industry than older workers. As a result, these younger workers are more likely to perform work tasks that require less technical skill and more manual handling. Subject matter experts described how a workers' craft brewing career typically starts with tasks that require low technical skill, such as working on the packaging line. One subject matter expert stated, "most people start on the low skill tasks, like working the bottling line before they start measuring chemicals and dosing brews." The proportion of claims due to sprains/strains among MMH tasks was more than double the proportion of claims due to sprains/strains among other (non-MMH) tasks. The distribution of sprains/strains by task corresponds with findings from existing research on the relationship between MMH and sprains/strains (Gatchel and Schultz, 2014; Putz-Anderson et al., 1997; Waters et al., 1993). In their Online Safety Training, the Brewers Association offers material on preventing sprains/strains through a combination of short written information supplemented with 60 – 90 second videos. These instructional materials include injury-avoidance techniques, such as instructing the

viewer to keep the weight of a lifted load close to their center of mass, to lift with their knees, to avoid twisting while lifting, to ask for assistance, and to use tools when necessary.

Manually intensive tasks require workers to frequently handle products and interact with machinery. Based on results of the revised agent-host-environment epidemiologic model, the majority of sprains/strains claims occurred in the brewery and packaging environments. The packaging environment has many moving parts and hazardous exposures. Bottles were also identified in claims associated with sprains/strains or repetitive motion from the bottling line. A craft brewery worker manually loads boxes of glass bottles onto a bottling line in Figure 5.6. One subject matter expert personally has residual elbow pain from working the bottling line, “I have a repetitive stress injury in my elbow.” When NIOSH conducted a Health Hazard Evaluation Report at a large brewery in Colorado, the packaging line was identified as an area for high risk for upper extremity musculoskeletal disorders from awkward postures, repetitive motion, and forceful exertions (Ramsey et al., 2011). The upper extremity and trunk region were also identified as body regions at increased risk for musculoskeletal disorders among beverage workers at an African Coca Cola bottling plant, per the results of a Nordic Musculoskeletal Questionnaire and Rapid Entire Body Assessment (Abaraogu et al., 2015, 2016). These studies (Ramsey et al., 2011, and Abaraogu et al., 2015, 2016) were performed at large beverage manufacturing facilities with highly automated equipment and packaging (bottling and canning) lines. In craft breweries, packaging is performed on a much smaller scale.

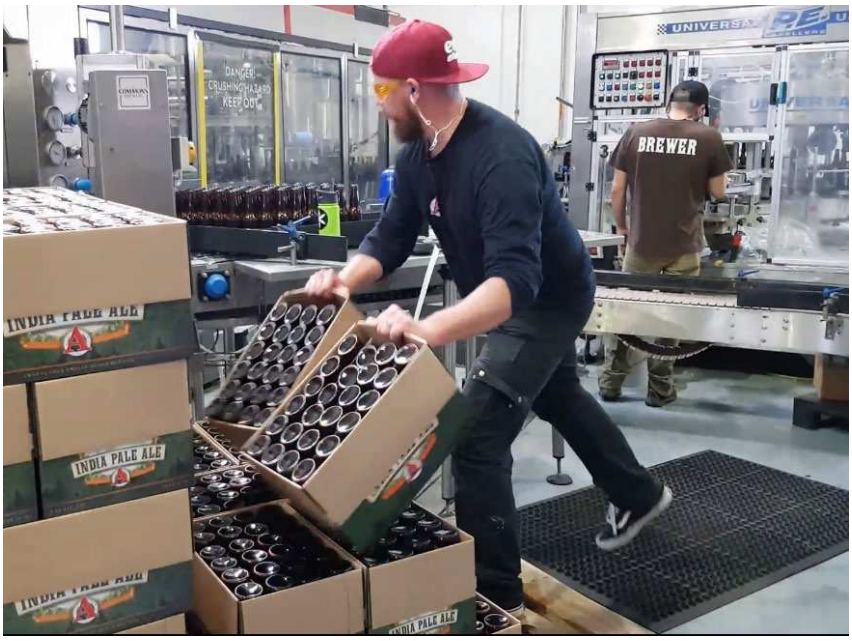

Figure 5.6. A worker grasps two cases of bottles to load them onto the bottling line (one case is 6 kg or 13 lbs.).

The distribution of injuries classified as sprains/strains was similar in the present study to the distribution of sprains/strains reported among breweries reported in the BLS SOII data**.** Given this similarity, workers may experience similar injury natures in both craft brewing facilities and larger breweries. Despite differences in production scale, the basic process of brewing and packaging beer presents similar risks for sprains/strains to the workers.

5.8.2. Contusions

The second most frequent type of injury nature in the present study was contusions (27%). Claims associated with contusions incurred some of the lowest costs (both median and mean costs). The mean claim cost associated with contusions was five times greater than the median claim cost of contusions. While there were many low or no-cost claims associated with contusions, there were some expensive claims. Cumulatively, contusions were the third most expensive injury nature. Therefore, contusions were frequent, but not very expensive (when compared to different injury nature categories). A study on

occupational injuries among loggers also identified contusions as a frequent injury nature that incurred low median costs per claim (Lagerstrom et al., 2017). In the present study, for example, a contusion to the lower limb incurred a $730 claim following an STF after the 25-34 year old claimant "walked into a walk-in cooler and slipped on a lid while stocking the appetizer side."[52] In another claim, a zero-cost contusion to the lower limb was reported following contact with objects and equipment when the claimant (with < 1 year of tenure) was changing a keg in the walk-in cooler. "When another keg began to fall, he attempted to catch the keg with his left leg and was hit pretty hard by the keg."[53]

Contusions were observed predominately among claimants between 25-34 years old and claimants with < 2 years of tenure. Younger workers are more likely to be new to the craft brewing industry and lack the institutionalized knowledge of older, more tenured workers. Newer workers are more likely to be performing low skill, highly repetitive or highly manual tasks. The combination of the lack of safety knowledge and high-risk tasks may lead to more contusion-related claims among young, new craft brewery workers.

Contusions were the result of mechanical energy being transferred between a host's anatomical region and the vehicle while in the environment. The injury model for contusions is outlined in Figure 5.7. Contusions typically occurred following the injury event of contact with objects or equipment or an STF. Contusions following contact with objects and equipment was also frequently observed in a study on injured seafood packaging operators in Oregon (Syron et al., 2017). In the present study, the upper limb was the most frequently injured anatomical region because claimants typically experienced contusions

[52] Example from Claimant Identifier 1980709, available in Appendix 8.15.

[53] Example from Claimant Identifier 2213384 , available in Appendix 8.15.

after inserting their hands into machinery (to clear a jam) or their hand was caught between products. Previous WC studies on occupational injuries among agriculture workers and fish processors also observed contusions frequently affecting the upper limb (Douphrate et al., 2009b; Syron et al., 2019). In the present study, for example, a claimant with 1-2 years of tenure was operating machinery in the packaging area and "was pushing boxes into the drop packer [machinery] on the bottling line and accidentally placed his finger between the brake pads that move back and forth to the stop boxes."[54] A 25-34 year old claimant with 1-2 years of tenure experienced a contusion to their hand following an STF when they "tripped on a pallet jack and landed on right hand/wrist wrapping a pallet."[55] Common host activities associated with contusions included carrying items, operating, or walking/climbing/standing. For example, one accident narrative described how a claimant tried to catch a falling yeast brink: "rolling yeast brink through annex door and it tipped, he tried to save it, it smashed finger between the door frame and brink."[56] Another claim's accident narrative described how "[I] caught [my] finger under empty keg while transporting and moving empty kegs."[57] In the present study, most contusions occurred in the brewery environment and packaging areas.

[54] Example from Claimant Identifier 2153723, available in Appendix 8.15.

[55] Example from Claimant Identifier 2067190, available in Appendix 8.15.

[56] Example from Claimant Identifier 2168989, available in Appendix 8.15.

[57] Example from Claimant Identifier 2089324, available in Appendix 8.15.

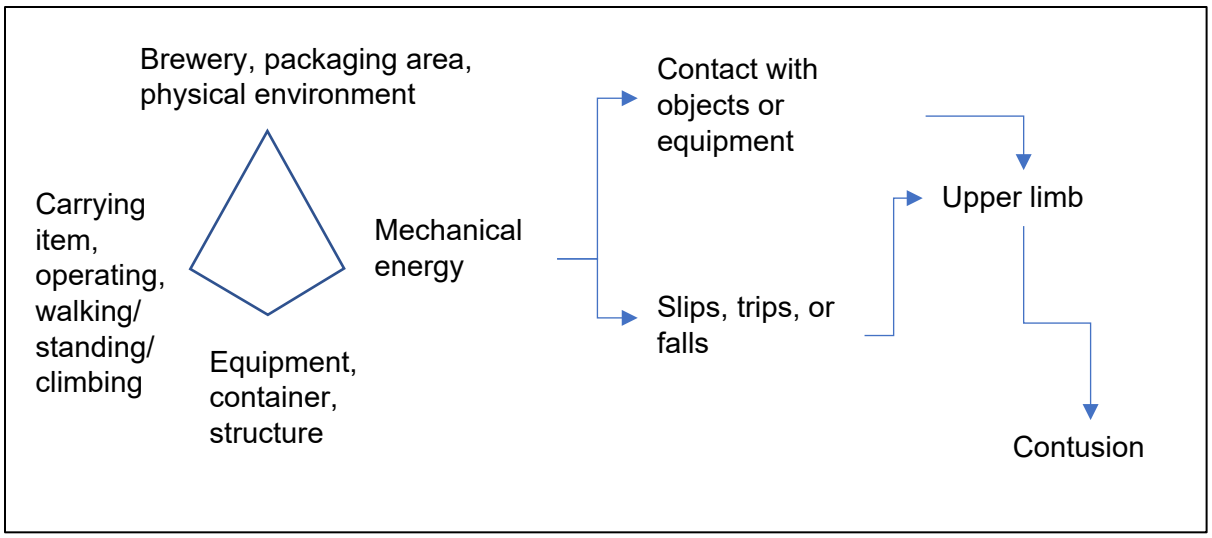

Figure 5.7. Injury model for contusions among craft brewery workers

The frequency of injuries classified as contusions among injuries in the present study was seven times greater than injuries represented in the BLS SOII data. In order for an injury to be reported in the BLS SOII data, it must be recordable per OSHA standards. Injuries are considered OSHA recordable if the injured worker required treatment beyond first aid, was admitted to the hospital, experienced an object in their eye, or died (Michaels, 2015). In the present study, while some contusions incurred higher costs (and were likely more severe), many contusions incurred very low or no costs (and were likely less severe or did not require treatment beyond first aid). Therefore, not all contusions in the present dataset would be considered recordable and thus not be reported in the BLS SOII data.

5.8.3. Lacerations

The third most common injury nature in the present study was lacerations. Claims associated with lacerations incurred the lowest cumulative cost. From a cost per claim perspective, lacerations were associated with the lowest mean costs but the second highest median claim costs. The median claim cost was second highest because more claims associated with lacerations incurred actual claim costs. For example, a laceration to the thumb incurred $500 when a 25-34 year old claimant was emptying low fill

cans and a can ruptured in their hand.[58] Lacerations were frequently observed among younger claimants and claimants with < 1 year of tenure.

Lacerations were the result of a mechanical transfer of energy following exposure to a harmful substance or environment. The injury model for lacerations is outlined in Figure 5.8. The upper limb was the most frequently injured anatomical region in lacerations. Lacerations were the result of exposure to hazardous substances or equipment, typically sharp edges. Sharp edges may occur on machinery, equipment, and glass. Lacerations due to sharp edges were also the most common injury nature in a study on saw-related injuries among Ohio wood product manufactures (Beery et al., 2014). Among lacerations in the present study, the bottling line was the most frequently identified environment. The upper limb was the most frequently affected body region because claimants typically experienced lacerations after inserting their hands into machinery (to fix a jam) or clean objects. For example, a laceration to the finger incurred $600 following exposure to harmful substances or environment when the < 24 year old claimant with < 1 year of tenure tried pulling a broken bottle out of the bottling line.[59] Machinery such as packaging equipment can have sharp, unguarded edges. The bottling line requires cases of glass bottles to be loaded onto the line where they are filled then removed and packaged. Depending on the level of automation within a craft brewery, workers may directly interact with the bottles. In less automated systems, repetitive motion injuries may occur from repeated exertions required to load cases of glasses on and off the machinery. The majority of lacerations occurred during other (non-MMH) tasks. The kitchen was a frequently identified environment where claimants cut or sliced food at the time of injury. Lacerations that resulted from contact with glassware and broken bottles typically occurred in the brewery

[58] Example from Claimant Identifier 2151128, available in Appendix 8.15.

[59] Example from Claimant Identifier 1686350, available in Appendix 8.15.

(bottling line) and kitchen/taproom. Some lacerations were observed in the service area because beer is typically served in glasses. For example, a laceration to the finger incurred $770 when a 25-34 year old claimant with 1-2 years of tenure was washing glassware and a glass broke.[60]

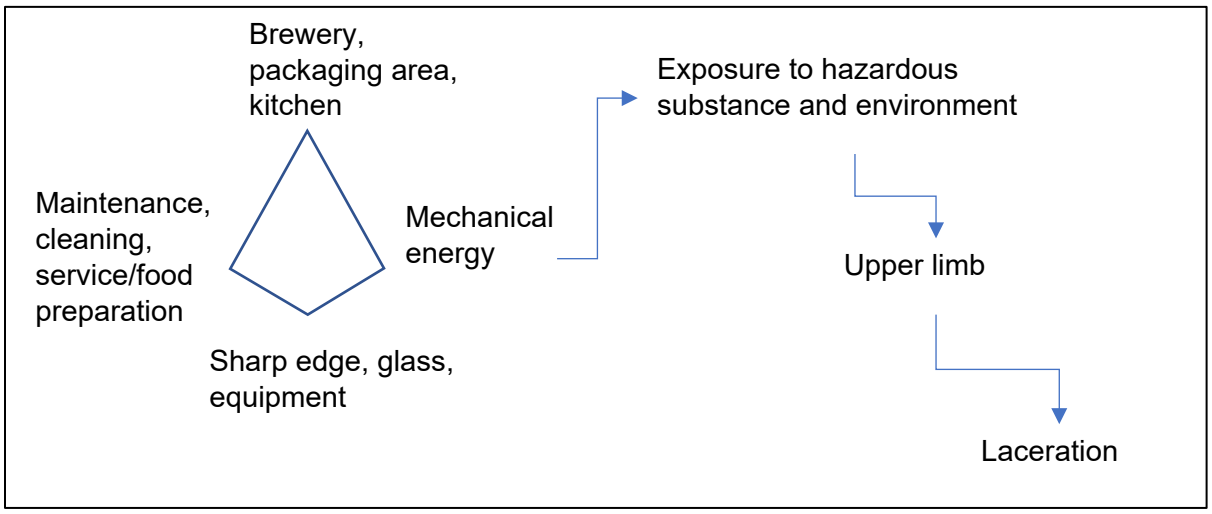

Figure 5.8. Injury model for lacerations among craft brewery workers

Proportions of lacerations reported in the present study and the BLS SOII data were similar. If lacerations require treatment beyond first aid, they are considered recordable to OSHA 300 logs (Michaels, 2015). While work environments differ between large and craft breweries, workers may have similar exposures to sharp surfaces from equipment, machinery, and bottles.

5.8.4. Burns

Burns were the least common injury nature category in the present study. Claims associated with burns incurred the lowest median cost per claim and the third highest mean claim cost. The cumulative

[60] Example from Claimant Identifier 2268047, available in Appendix 8.15.

cost of burns was the second lowest in the present study. Burns were not frequently reported, but the severity of the injury ranged from minimal to severe. Among burns, the mean claim cost was six times greater than the median. Therefore, claims associated with burns typically incurred low costs, but a few claims were very costly. For example, a burn to the lower limb incurred $11,000 following exposure to harmful substances or environments when a 25-44 year old claimant with <1 year of tenure "got sodium in his boot burning left foot while cleaning" and lost 48 days of work. [61] While burns were uncommon in the present study and accounted for approximately 10% of the dataset (56 claims), burns are taken seriously by regulatory agencies. In May 2020, inspectors from the OSHA issued general duty clause citations to two separate Colorado craft brewing facilities for the same issue: employees were exposed to risks of burns from accidental contact with hot steam pipes.[62] These citations were issued because workers were exposed to burn hazards, whether they were performing MMH tasks or other (non-MMH) tasks. Subject matter experts explained how the severity of burn injuries can vary: "in a burn you could have a burn that just got dressed and the individual was out of work for a couple days to a life-threatening burn over 30 percent of your body." Burns have the potential to be fatal. While repairing a crack in a fermentation tank at a Tennessee craft brewery, a contractor suffered fatal burns when a fire erupted due to excess oxygen in the tank.[63] Few fatalities have occurred within the craft brewing industry, but burns have the potential to be very serious. These rare but serious events are considered newsworthy and thus important to consider in regards to industry image and perceptions.

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[61] Example from Claimant Identifier 1813450, available in Appendix 8.15.

[62] A template of the pending citation is presented in Appendix 8.1.

[63] Pell, M.B. (2013, July 12). Insight: Fast-growing U.S. craft brewers struggle with worker safety. Reuters. Available from https://www.reuters.com/article/us-brewing-safety/insight-fast-growing-u-s-craft-brewers-struggle-with-worker-safety-idUSBRE96B0MW20130712

Burns were the result of exposure to harmful substances or environments and contact with objects and equipment. The injury model for burns is outlined in Figure 5.9. In the present study, the upper limb was the most frequently injured anatomical region associated with burns. In comparison, more burns affected the trunk region than upper limb among injured fish packers (Syron et al., 2019). In the present study, the most common type of agent identified among burns was thermal energy followed by chemical. Among burns, claimants were either cleaning, performing maintenance, serving/preparing food, or brewing. The majority of burns involved a transfer of thermal energy from a liquid (hot water or oil) or cooking equipment (hot pots, pans). Containers were associated with burns when the claimant spilled a bucket of chemicals (cleaner) or when chemicals splashed on the worker. The majority of burns occurred during other (non-MMH) tasks. Thirteen percent of all claims that occurred during other (non-MMH) tasks were burns. Burns may occur when workers contact hot machinery or liquids. Burns were frequently observed in claims where the vehicle was liquid (43%), cleaner (18%), or cooking equipment (16%). Among burns, the majority of claimants were 25-34 years old with < 1 year of tenure. One accident narrative described how a claimant was getting glue and "sat on a bucket with chemicals on it."[64] When discussing burns, one subject matter expert shared her personal experience of getting second-degree chemical burns. She shared that:

> I was doing an acid clean on one of the tanks (nitric phosphoric blend- it was a stronger acid) and I was wearing the Carhartt's [pants] that were scotch guarded …where they would keep the inside of your leg dry even when you're in wet conditions. I had emptied the acid into the tank. I was getting CIP [clean-in-place] cycle going and there must have been some leftover acid in the container and when I was putting my hand down to walk to put the container back, some must have splashed on my super industrial Carhartts. I was working a 12-hour shift and I went probably eight hours of the shift with this acid just slowly soaking through my Carhartt pants. I didn't realize it until an hour before my shift was done.

[64] Example from Claimant Identifier1789812, available in Appendix 8.15.

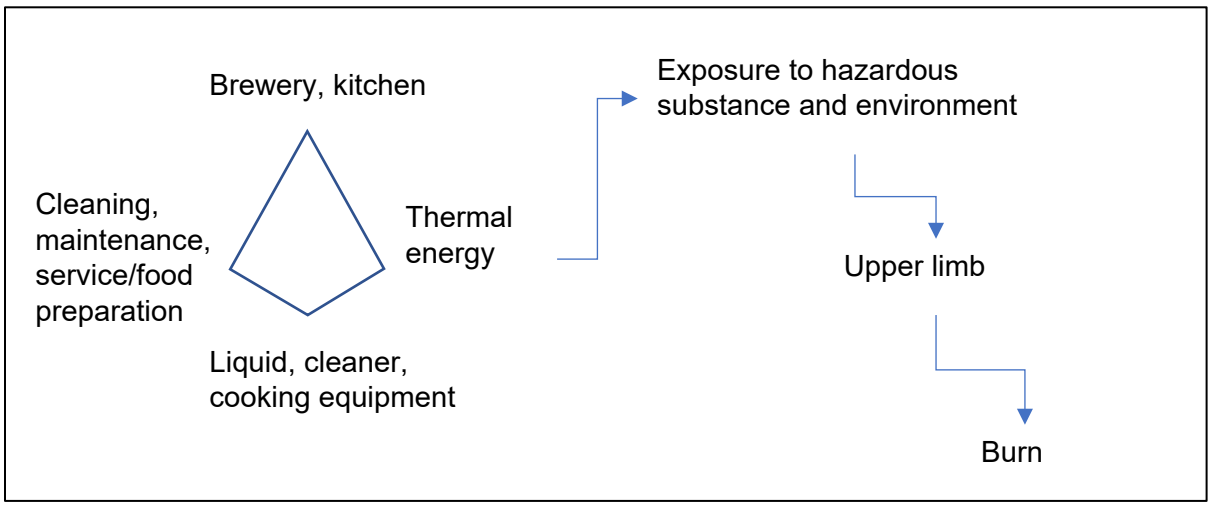

Figure 5.9. Injury model for burns among craft brewery workers

The percentage of burns reported within the present study and in the BLS SOII data were similar. Burns are acute injuries, which are better represented by WC data than chronic injuries (Utterback et al., 2014). Burns were classified in two categories (heat and chemical) in the BLS SOII data, but not in the FROI. Burn type can be determined by investigating injury nature by agent using the revised agent-host-environment epidemiologic model. Among burns, thermal energy was identified in more than 75% of claims followed by chemical burns (23%). The proportion of thermal burns was higher among craft breweries than among the breweries reported in the BLS SOII data.[65] Likewise, the proportion of chemical burns was smaller among craft breweries than breweries reported in the BLS SOII data. The higher presence of thermal burn claims among craft brewery workers may be due to manual handing and working directly with hot equipment and liquids. For example, workers manually adding ingredients to

[65] The comparison of burn type in the present study and BLS SOII is available in Appendix 8.16A.

tanks risk splashes and burns. Additionally, food preparation activities and washing glassware may be more common among craft brewery workers than large, automated NAICS classified breweries.

5.8.5. "Other" injury nature

Claims due to the injury nature category "other" were not frequently reported in the present study. However, these claims were associated with the highest median claim costs, second highest mean claim costs, and incurred the second highest cumulative claim cost. The mean claim cost was three times greater than the median claim cost. Claims associated with "other" injury natures typically incurred costs and some claims were very expensive. Thus, claims classified as "other" injury nature were less frequent, but more costly. For example, a claimant experienced a poisoning-chemical injury nature that incurred $900 when "phosphoric acid shot out of the line, hitting the worker in their face/eye while cleaning."[66]

"Other" injury nature was frequently the result of mechanical or thermal energy transferred from equipment or cleaner to the upper limb. The injury model for "other" injury nature is outlined in Figure 5.10. Host activities associated with "other" injury nature included operating and cleaning. Injury events associated with "other" injury nature were contact with objects and equipment or STFs. These "other" injury nature claims typically occurred in the brewery, packaging area, or due to general physical environmental factors (such as slippery surfaces). Examples of injury natures classified as "other" injury nature in the present study included foreign body, puncture, and dermatitis. Injury nature "other" was frequently reported among claimants aged 25-34 years old with < 1 year or tenure.

[66] Example from Claimant Identifier 1737098, available in Appendix 8.15.

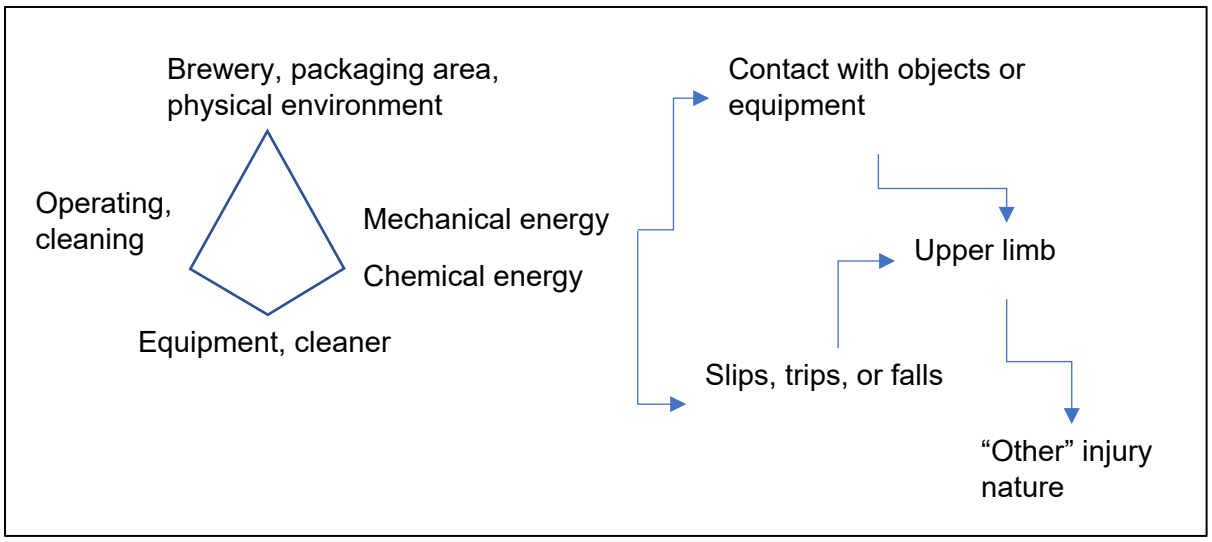

Figure 5.10. Injury model for “other” injury nature among craft brewery workers

The distribution of injuries classified by injury nature as “other” was investigated by task. A smaller percentage of injuries classified as “other” injury nature occurred during MMH tasks compared to other (non-MMH) tasks. Types of injury nature that were classified as “other” and occurred during both MMH tasks and other (non-MMH) tasks included cumulative injuries, dermatitis, and inflammation. Cumulative injuries and inflammation can be associated with physical demands of MMH or other (non-MMH) tasks workers performed throughout the brewery, such as walking or operating machinery. Activities that require repetitive motion, such as using tools or moving objects have been associated with inflammation (Putz-Anderson et al., 1997). Cumulative injuries refer to multiple injuries affecting the claimant and could occur during either MMH or other (non-MMH) tasks.

Types of injury nature that were classified as "other" and only occurred during MMH tasks included crushing, hearing loss, and hernia. Crushing and hernia injury natures could be associated with lifting or moving items, which are common activities during MMH tasks (Putz-Anderson et al., 1997).

Noise-induced hearing loss can develop over time, so it is less likely to be represented by WC (Utterback et al., 2014). For example, approximately 0.5% of WC claims among Alaskan seafood processors were due to hearing loss (Syron et al., 2019). While a single WC claim in the present study

(0.2%) was associated with hearing loss, it represents a larger issue. One subject matter expert recounted how it was standard practice to turn up the volume on a boom box to hear music over the sound of clanking bottles on the bottling line:

> We always wore earplugs when running the bottling line in both the old facility and in the new one. But we had no idea how outrageously high the decibel level was from that glass clanking together and then of course we'd have a radio blaring and turn it up as loud as it could go to blast over all that noise…. I had no idea it was that loud and just like lack of awareness is the primary thing on a lot of these hazards.

Another subject matter expert described how she was involved in the craft brewing industry before hearing protection was emphasized. Many of her brewing friends attribute their current bad hearing to years spent in loud packaging halls and noisy breweries. While her brewing friends associate their poor hearing with past brewing environmental exposures, they did not report or file for WC. Lack of awareness and action surrounding noise-induced hearing loss is a common challenge among manufacturing workers beyond beverage manufacturing. In an effort to improve hearing conservation and decrease hearing loss, the National Occupational Research Agenda incorporated the reduction of occupational hearing loss into their objectives for manufacturing (Manufacturing Sector, 2018). Craft breweries are included in the jurisdiction of the National Occupational Research Agenda. While hearing loss may be rare in WC, it is an issue facing the craft brewing industry.

The injury nature "foreign body in the eye" was identified in 14 claims (2.5%). Foreign bodies embedded in the eye are always considered recordable injuries to OSHA 300 logs (Michaels, 2015). Safety glasses (PPE) may help prevent foreign bodies in the eye and eyewash stations are used to flush foreign bodies out of eyes. In a presentation by OSHA consultants from Colorado State University, eyewash stations and lack of PPE (including safety glasses) were some of the most commonly identified hazards during a six-month period of 33 inspections of craft breweries (Colorado State University Health and Safety, 2019, slide 3). While foreign bodies embedded in the eye was not a common occurrence in the present study, it is considered a high profile injury by OSHA.

The injury nature of electric shock within the "other" injury nature category was identified in three claims in the present study (0.5%). A study of injured construction workers also recorded few cases of electric shock (0.3%)(Glazner et al., 2005). Electric shocks are part of the OSHA "Fatal Four," or the most common causes of construction fatalities (osha.gov, 2020). In a presentation by OSHA consultants from Colorado State University, electrical hazards (wiring methods and general electrical hazards) were commonly identified hazards during 33 inspections of craft breweries over six months (Colorado State University, 2019, slide 3). OSHA consultants described how electric shock could occur when a worker comes in contact with a partially severed/exposed extension cord or steps in a puddle with an exposed live wire. Additionally, items stacked or stored in front of a breaker box that prevent quick access are considered electrical hazards. While electric shock was not a common occurrence in the present study, it is recognized as a high-priority injury by OSHA. In the present study, a claimant experienced electric shock that incurred $1,700 when cleaning a fridge and they "received an electric shock from an open light bulb socket."[67]

Subject matter experts noted that these "other" injury nature cases, especially the costly ones, were considered newsworthy and thus important to consider in regards to industry image and perceptions. The injury nature "crush" was identified in a single claim (0.2%) in the present study. In 2012, a New Hampshire craft brewery worker was fatally crushed when a keg exploded as he filled it for a customer.[68]

[67] Example from Claimant Identifier 1892072, available in Appendix 8.15.

[68] Loder AM (2012, May 4). A closer look at brewery accidents after the deadly Redhook explosion. NPR State Impact. Available from https://stateimpact.npr.org/new-hampshire/2012/05/04/a-closer-look-at-brewery-accidents-after-the-deadly-redhook-explosion/

Fortunately, few fatalities have occurred within the craft brewing industry, but injuries classified as "other" have the potential to be very serious and even fatal.

The distribution of claims classified by injury nature as "other" within the present study was less than that reported in the BLS SOII data. In both the present study and the BLS SOII data, injury nature categories included sprain/strain, contusion, laceration, burn, or "other." In order for an injury nature to be classified as "other," the nature of the injury would not be characterized in the previously mentioned categories. In the present study, more contusions and sprains/strains were reported than claims due the "other" injury nature. The severity of the claims due to contusions and sprains/strains varied, as demonstrated through the range of incurred costs and lost time. Many injuries reported as contusions or sprains/strains would not be considered recordable in the OSHA 300 logs and thus not reported in the BLS SOII data.

5.9. Limitations

5.9.1. Representation of study sample to industry

The craft breweries represented in the present study may not be representative of the overall craft brewing industry in Colorado. The representation of the dataset in the present study can be compared to the Colorado craft brewing industry in two ways; craft breweries that held policies with Pinnacol Assurance or those that held policies and filed claims with Pinnacol Assurance. Between 2013 and 2018, the number of operational craft breweries in Colorado grew from 175 to 396 (brewersassociation.org, 2020). Pinnacol Assurance provided researchers with a WC dataset that represented 130 craft breweries in Colorado between 2013 and 2018. Pinnacol Assurance's craft brewery client base represented between 32.8% and 74.3% of the Colorado craft brewing industry. Approximately 40% (49) of the craft breweries who held policies also filed claims. When the client base was filtered to only include those who reported occupational injuries, the representation of the WC dataset decreased to between 12.4% and 28% of the Colorado craft brewing industry. One reason that not all craft breweries were represented in the dataset is

because Colorado is a non-monopolistic state. Thus, not all craft breweries in Colorado purchased WC insurance from Pinnacol Assurance. However, since Pinnacol Assurance is the largest WC provider in Colorado, they represent more craft breweries than other WC companies. Craft brewing trade organizations (specifically the Colorado Brewers Guild) are currently developing a pooled WC insurance policy for members (coloradobeer.org, 2020). Future WC-based analysis could reference industry trade organization insurance data. The present study represents the most comprehensive injury profile specific to craft brewery workers in Colorado. Future studies could consider analyzing craft brewery WC data from California, which has the most craft breweries in the U.S. However, California is a non-monopolistic state, so that would be a limitation in accessing data. Washington has the third most craft breweries in the U.S. and is a monopolistic state. Therefore, researchers may have better access to comprehensive WC data on their craft breweries.

5.9.2. Tenure

Tenure only represents the claimant's experience at that specific facility. Tenure does not represent any experience from previous employment. For example, information on a FROI could indicate that a claimant had < 1 year of tenure, but they have three years of prior craft brewing experience. If stakeholders relied solely on claimant tenure data, they risk misinterpreting the knowledge base of injured workers and misdirecting interventions. Included in the Brewers Association health and safety survey were questions about tenure, experience, and the number of breweries at which respondents had worked.

5.9.3. Underreporting in worker's compensation

Workers' compensation represents injuries that are reported and filed. Previous studies on WC in other industries estimated that more than 50% of eligible injuries were not reported to WC (Asfaw et al., 2013; Azaroff et al., 2002; Fan et al., 2006). Workers may not report an eligible injury for multiple reasons ranging from not perceiving the injury as work-related to concerns about retaliation or stigma from reporting (Azaroff et al., 2002; Fan et al., 2006). Both Azaroff et al. and Asfaw et. al described how

inconveniences in the WC system (e.g. waiting periods for reimbursements) can drive injured workers to seek medical care through other systems, such as their personal health insurance (Asfaw et al., 2013; Azaroff et al., 2002).

Craft brewery workers who completed the Brewers Association health and safety survey provided information on their experiences with work-related injuries at craft breweries. Of those that experienced an occupational injury, more than 80% reported it to their supervisor. Survey respondents reported that the brewery documented the accident/injury approximately 60% of the time (although 22% of respondents indicated that they were unsure of how the brewery documented their injury). An overall lack of knowledge on how to properly document injuries can lead to underreporting of injuries (Azaroff et al., 2002). Subject matter experts corroborated this claim, stating "there was a lack of awareness of hazards at work and what exactly to do if you got hurt." While discussing noise-induced hearing loss, one subject matter expert recalled, "I had no idea it was that loud and just a lack of awareness is the primary thing on a lot of these hazards."

In addition to a lack of reporting systems, there is a lack of knowledge in the craft brewing industry on which injuries should be reported. One subject matter expert described the injury culture as "well put a band-aid on it, rub some dirt on it, you're a craft brewer not some fancy office worker." However, subject matter experts emphasized that the injury culture is shifting. For example, online training materials help clarify which injuries are reportable and are freely available to interested workers.

5.9.4. Challenges in describing injuries in workers' compensation

The FROI was a one to two-page form that the claimant and their supervisor filled out to characterize the claim for WC. Injured anatomical region was simplified to one body part and region. While there was an option for "multiple body parts," it was rarely selected in the present study. Injury event was collapsed into key phrases: contact with objects and equipment, exposure to hazardous substances or environments, overexertion and bodily reaction, STF, and "other." But what if multiple injury events occurred and

resulted in an injury? Injury nature was simplified into sprain/strain, contusion, laceration, burn, etc. Conceivably, a worker could burn and sprain their ankle simultaneously. This particular incident could be coded as "other, multiple injuries" but no additional detail was provided as to what is included within the multiple injuries. Unless researchers investigated the accident narratives, the simultaneous burn and sprain data would be lost. The level of usefulness of the accident narrative depends on the detail provided by the supervisor and claimant. Throughout informal interviews in the present study, subject matter experts emphasized how busy and overworked craft brewers can be. Thus, additional paperwork is discouraged.

Instead of a cumulative or multiple injury, a worker might only sprain their ankle as they move quickly to avoid a burn. Designated sections on the FROI would describe the claim as a sprain/strain to the ankle. An intervention that allocates resources to reduce sprains/strains would likely not address the burn hazards. Would an intervention be more effective if it targeted factors that created the burn risk or the sprain/strain? Injuries are complicated events, and surface-level FROI investigations may provide limited data. Fortunately, additional analysis methods exist to better understand injury characteristics and how or why injuries occurred.

The FROI simply identifies the injury outcome, but does not thoroughly address how or why the injury occurred. Accidents (and injuries) occur when safeguards and barriers sequentially fail to prevent hazardous energy from being transferred through a system to the worker. Each barrier or safeguard has limitations and when these limitations occur simultaneously, injuries can occur. The Swiss Cheese Model visualizes this concept, where each barrier or safeguard is a slice of cheese and each limitation is a hole in the slice. When the holes align across the slices, a trajectory can move through the holes between slices which represents an injury occurring (Reason, 2000). An illustration of the Swiss Cheese Model is displayed in Figure 5.11. For example, many claims in the present study were associated with chemicals splashing onto a claimant's skin. From an accident investigation perspective, the limitations in each barrier or safeguard that resulted in the chemical contacting the claimant's skin needs to be assessed. The

"Five Whys" is a strategy used in Root Cause Analysis to identify the underlying causal factors that resulted in the incident of interest (Liker and Meier, 2006). For example:1. Why was there a chemical burn? (caustic splashed on worker's hand); 2. Why was the claimant using chemicals? (to clean tanks); 3. Why did the chemical splash? (the hose was not securely attached, so it fell off and sprayed caustic chemical); 4. Why was the claimant's skin exposed? (the worker was not wearing gloves); 5. Why wasn't the claimant's skin protected? (they have gloves but were not wearing them because they fit poorly). The Swiss Cheese Model and a Root Cause Analysis would assess the relationships between barriers and safeguards and their respective limitations that resulted in injury. For example, the injury of chemical splashing a claimant may have been avoided if they were using a less toxic chemical (so dermal contact was not hazardous), had secured the hose correctly (so no splashing occurred), or had worn gloves (so chemical splashed on the glove instead of the claimant's skin). The injury incident occurred because each barrier had limitations that aligned and allowed hazardous chemicals to directly contact the claimant's skin. Safeguards and barriers and their limitations can be better understood by analyzing accident narratives and identifying contributing factors to the injury. Specifically, researchers can apply the revised agent-host-environment epidemiological model to classify contributing factors to injury and understand the relationship between these factors and injury. In the example above, researchers could analyze the accident narratives and determine that the claim occurred in the craft brewery region with tanks (environment). Caustic chemical splashed out of a hose (vehicles) on to the claimant when they incorrectly attached the hose while cleaning tanks (host). The transfer of chemical energy (agent) from the caustic to the claimant's hand resulted in a chemical burn. This approach provides a more comprehensive view of the injury than the simple "chemical burn to hand" on the FROI.

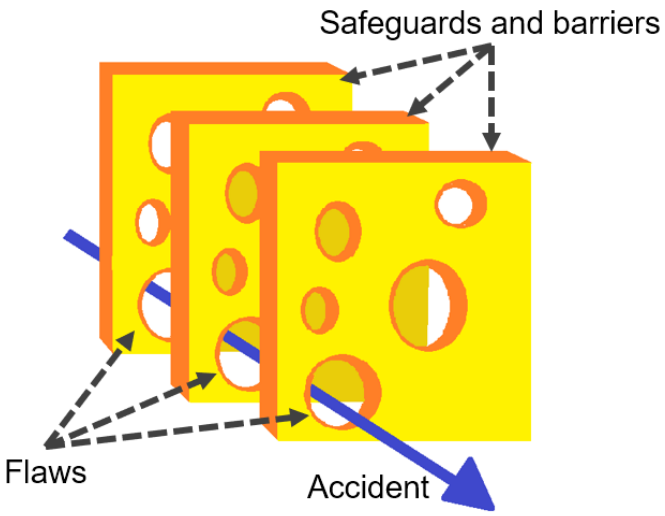

Figure 5.11. Swiss Cheese Model represents how limitations in barriers and safeguards (holes in the cheese slices) can align and allow a trajectory to pass through (blue arrow) and result in an accident (created by Brents 2020, based on Reasons 2000)

While the FROI form provided basic information, the accident narrative section provided additional detail that were useful to further understand the claim incident. The provided accident narratives had varying levels of detail. In a study of injuries among Alaskan seafood processing workers, 75% of accident narratives provided sufficient detail to code for work activity (Syron et al., 2019). Despite variations in detail, researchers can apply accident investigation models to extract additional information from the accident narratives. In the present study, researchers applied the revised agent-host-environment epidemiologic model. Specifically, researchers performed analysis using the revised agent-host-environment epidemiologic model to identify and classify contributing factors to the injury as agent, host, environment, or vehicle. For quality assurance purposes, two researchers coded claims and compared results. The primary researcher identified more discrepancies between the two coded datasets than the secondary researcher. The majority of discrepancies were associated with identifying the environment of where the claim occurred. The primary researcher had five years of experience with the craft brewing industry and thus was more familiar with the brewing process. The secondary researcher was a first-year master's student with no craft brewing industry experience. These differences in craft brewing industry

experience were helpful as each researcher brought a unique perspective to their interpretation of information from the accident narratives. A third researcher (a professor with experience in the craft brewing industry) was consulted as the "tie breaker" to resolve the remaining discrepancies. Following discussion**,** consensus was reached for classifying all contributing factors from the accident narratives according to the revised agent-host-environment epidemiologic model. The researchers were able to extract agent contributing factors from the majority of accident narratives. However, the accident narratives lacked sufficient information for researchers to consistently identify host, vehicle, and environmental contributing factors from all claims.

Haddon developed a temporal aspect to the epidemiologic triangle in order to better understand factors leading to injury (Haddon, 1968). Specifically, he recommended investigating contributing factors to the agent, host, environment, and vehicle before, during, and after the injury. This approach is best used in detailed accident descriptions or focus groups. In the present study, the accident narratives did not provide enough information to clearly identify contributing factors within one timeframe. Researchers in future studies who conduct focus groups with craft brewery workers could incorporate Haddon's temporal aspect of the epidemiologic triangle to better understand how occupational injuries occur in the craft brewing industry.

Informal interviews with subject matter experts supplemented the lack of information from the accident narratives with their observations and experience. Due to the COVID-19 Pandemic, researchers conducted the informal interviews virtually. Once in-person interactions are possible, future researchers could facilitate personal interviews or focus groups. Future studies could conduct focus groups or interviews with craft brewery workers to better understand details and contributing factors associated with occupational injuries in the craft brewing industry.

5.10. Practical recommendations

5.10.1. Introduction to practical recommendations

Results from the present study can be translated into targeted recommendations. These recommendations present approaches to address injury trends identified. This section outlines targeted recommendations for reducing occupational injuries among craft brewery workers in the following areas: new hires, upper limb, sprains/strains, contusions, burns (thermal and/or chemical), lacerations, MMH and other (non-MMH) tasks, kitchen, and packaging. Each targeted recommendation presents suggestions for engineering-level, administrative-level, and individual-level control strategies. Engineering-level controls are modifications to the machinery and work processes to eliminate identified hazards. Administrative-level controls are organizational programs and policies to protect workers from identified hazards. Individual-level controls are equipment and tools workers use to directly protect themselves from identified hazards. For example, identified hazards associated with manual kegging lines include lifting and chemical exposures. An engineering-level control would be to replace the manual kegging line with an automatic keg cleaning and filling line to eliminate workers having to lift kegs and to prevent workers from directly contact chemicals. An administrative-level control would be to provide worker training on how to appropriately handle kegs and cleaning chemicals to mediate exposures. An individual-level control would be to provide appropriate personal protective equipment (PPE) to prevent the worker from directly contacting chemicals (e.g. gloves and safety glasses) and to provide lift-assist devices to help the worker handle kegs.

The feasibility of engineering-level, administrative-level, and/or individual-level control strategies depend on the resources (financial and/or physical restraints) of each individual craft brewery. Stakeholders, upper management, and health and safety practitioners should consider their facility's unique demands and resources when considering these targeted recommendations. Researchers also advise health and safety practitioners to apply the injury process model to their specific workplace (see Figure 5.12.). The injury process model is a tool that health and safety practitioners can use to identify

how and where injuries occur in craft breweries. They can use information from this model to direct cost-effective and site-specific interventions.

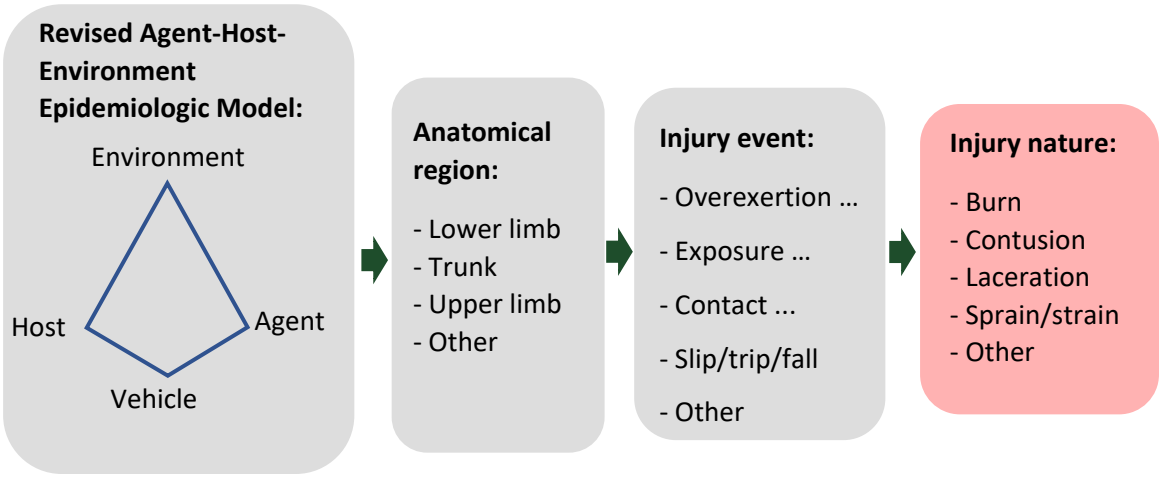

Figure 5.12. Injury Process Model for craft brewery workers. For more information on injury events, refer to section 3.2.4.

5.10.2. New hires

Per Specific Aim 1, researchers identified that injuries frequently affected new hires, with 60% of claims associated with workers with less than two years of tenure. From Specific Aim 4 and the injury process model, researchers were able to identify that many new hires were performing low technical skill, highly manual, and repetitive packaging tasks at the time of injury. Researchers recommend interventions to improve safety among new hires.

Engineering-level control: Update the equipment and machinery which is typically used by new hires to eliminate identified hazards. For example, replace manual bottling lines with automated equipment to eliminate lifting, repetitive motion, and direct contact with broken glass. Alternatively, machine guards could be added to existing equipment to prevent new hires from directly contacting hazardous energy and hazardous surfaces. Many bottling lines have plexiglass doors around them that, when opened, cut power to the machinery, and allow users to safely access bottles or machinery parts.

Administrative-level control: Review and revise new-hire training to educate workers on how to safely operate machinery and perform tasks. Implement refresher courses. Ensure training follows any equipment/machinery updates or modifications. Be sure to include work tasks typically performed by new hires in this training material.

Individual-level control: Provide new hires with appropriate PPE. Ensure that workers are aware of how to use and how to care for their PPE. Examples of PPE for new hires include gloves, safety glasses, and steel-toe shoes.

5.10.3. Upper limb

Researchers identified that the majority of claims affected the upper limb in the present study. Researchers identified lacerations, burns, contusions, and sprains/strains affecting the upper limb. Researchers recommend interventions that focus on upper limb protection.

Engineering-level control: Replace or update equipment to remove the upper limb hazard (e.g. install an automatic bottling line that does not require workers to manually remove broken bottles). Add machine guards to prevent hands/fingers from coming into direct contact with hazardous surfaces or equipment (e.g. install bumpers on sharp surfaces, insulation on hot pipes, light curtains that stop machine operations when breached).

Administrative-level control: Review and revise training to educate workers on upper limb safety (e.g. provide information on operating equipment, laceration hazards, burn hazards, manual handling activities). Implement refresher courses. Ensure training follows any equipment/machinery updates or modifications.

Individual-level control: Management should provide workers with appropriate PPE, as well as training on how to properly use and maintain PPE (e.g. gloves).

5.10.4. Sprains/strains

Per Specific Aims 1 and 2, researchers identified that injuries due to sprains/strains were frequent and costly (per claim as well as cumulatively). From the injury process model in Specific Aim 4, researchers determined that sprains/strains were associated with carrying or lifting items and doing repetitive tasks. Researchers recommend that practitioners target work areas with repetitive motion and/or areas with high lifting demands.

Engineering-level control: Update equipment and machinery to eliminate or reduce repetitive motion and lifting tasks. For example, implement an automated packaging line to eliminate the need to manually lift, carry, and load boxes of bottles and cans onto the packaging line.

Administrative-level control: Review and revise training to educate workers on safe handling procedures. Examples of safe handling procedures include taking appropriate breaks and identifying and executing team-lifts.

Individual-level control: Provide workers with lift-assist devices and proper gloves to provide a safer grip when handling product and equipment.

5.10.5. Contusions

Researchers observed that contusions frequently occurred among workers performing MMH and other (non-MMH) tasks. Interventions that reduce contusions would benefit all craft brewery workers. Contusions typically occurred when workers were struck by falling objects or when a worker's body part was caught between products or machinery.

Engineering-level control: Revise the work area to remove or reduce the risk of workers being struck by falling objects or being caught between product or machinery. For example, construct a physical barricade around the packaging line that cuts power to the machinery when the barricade is breached. This

engineering control stops moving parts and permits workers to safely access inner elements of the machinery.

Administrative-level control: Review and revise training to educate workers to avoid situations where they could be struck by items or caught between product or machinery. For example, advise workers to NOT catch falling products if it puts them at risk of injury. Educate workers to NOT reach into actively operating equipment to clear a jam.

Individual-level control: Provide workers with appropriate PPE and appropriate equipment to reduce the risk of contusions. For example, provide gloves to protect hands/fingers from lacerations when workers clear jams from machinery. Ensure that workers have ample flexibility and mobility while wearing gloves. Provide handling equipment (e.g. a keg-dolly) that securely holds kegs and prevents kegs from falling as the worker maneuvers the kegs in a walk-in cooler, warehouse, or truck.

5.10.6. Burns

Researchers did not frequently observe burns in the present study, but burns have the potential to be very costly. Researchers identified that craft brewery workers experience different kinds of burns – both chemical and thermal. Researchers recommend that practitioners assess both chemical cleaners as well as thermal hazards (such as uninsulated pipes) to reduce burn hazards. Assessing craft breweries to reduce burn hazards is an opportunity for interventions that could prevent potentially high cost injuries.

Engineering-level control: Replace hoses with pipes to prevent workers from directly interacting with hazardous chemicals or hot liquids. Add insulation to equipment to prevent workers from directly contacting hot metal surfaces.

Administrative-level control: Review and revise trainings to ensure that workers are aware of burn hazards and safe chemical handling procedures throughout the facility. Ensure that workers are aware of safety protocols if they do experience a burn (chemical or thermal).

Individual-level control: Provide appropriate PPE to protect workers from directly contacting thermal or chemical burn hazards. Examples of PPE to protect against burns include gloves and safety glasses. Ensure that workers are aware of how to properly use and maintain their PPE.

5.10.7. Lacerations

Researcher observed that lacerations occurred when the injured worker's upper limb contacted sharp glass or metal. Researchers identified lacerations when workers interacted with metal and glass in the brewing area, packaging hall, and food preparation/service areas. Researchers recommend interventions that address the installation of machine guards, training, or PPE in the packaging and kitchen areas.

Engineering-level control: Add machine guards to prevent workers from directly contacting sharp surfaces. Automate machinery to remove broken bottles from the packaging line, rather than requiring workers to manually remove broken bottles.

Administrative-level control: Review and revise trainings to ensure that workers are aware of laceration risks and sharp surfaces throughout the craft brewery.

Individual-level control: Provide appropriate gloves (PPE) to protect workers' hands and fingers from laceration risks. Ensure that gloves provide ample mobility to perform tasks but are thick enough to protect against lacerations. Ensure that workers are aware of when to use gloves and how to maintain their gloves.

5.10.8. Manual materials handling tasks

While injuries that occurred during MMH tasks were not the most common, researchers observed that they accounted for the most lost time. From an employee health and craft brewery productivity perspective, it is important to investigate opportunities to reduce or revise manual material handling demands.

Engineering-level control: Replace manual equipment with automated equipment to remove the need to manually handle objects. Instead of transporting equipment on pallet jacks, implement a forklift driving system. If forklifts are used, ensure that the workspace has appropriate markings and workers are forklift certified.

Administrative-level control: Review and revise training to educate workers to handle items safely. Encourage workers to use lift assist devices and to perform team-lifts. Schedule shifts so that workers can take breaks between manually lifting and carrying tasks. Whenever equipment or procedures are modified, be sure to conduct follow-up training for relevant workers.

Individual-level control: Provide workers with appropriate PPE, lift-assist devices, and handling equipment. Gloves can improve a worker's grip as they handle product. Ensure that the gloves allow for ample movement. Provide lift-assist devices such as keg-dollies and motorized pallet jacks.

5.10.9. Other (non-MMH) tasks

` Researchers identified that more injuries occurred while workers performed other (non-MMH) tasks (71% of all claims) than MMH tasks (29% of all claims) in the present study. Researchers advise practitioners to address hazards associated with other (non-MMH) tasks when developing interventions. Examples of other (non-MMH) tasks include cleaning, packaging, cooking, and operating machinery.

Engineering-level control: Eliminate hazards associated with other (non-MMH) tasks by replacing equipment to automate procedures and/or adding appropriate guards. For example, eliminate direct contact with hazardous chemicals by using pipes instead of hoses. Reduce the repetitive motion required to clean glassware by installing a dishwasher.

Administrative-level control: Review and revise training to educate workers on hazardous environments. For example, workers should be trained on proper chemical handling, how to operate and shut down machinery, how to use cooking tools to reduce the risk of burns and lacerations, and emphasize the need to take work breaks.

Individual-level control: Provide workers with appropriate PPE to provide a barrier between workers and any identified hazards (e.g. chemical or thermal burns, lacerations, sprains/strains). Ensure that workers know how to use and maintain their PPE. Examples of PPE include gloves and safety glasses.

5.10.10. Kitchen

Based on results of the present study, craft brewery workers experienced injuries in the food preparation and service areas (including the kitchen). If a craft brewery has a restaurant and kitchen (or plans to add one), researchers recommend that they address controls to reduce the risk of burns, lacerations, contusions, and sprains/strains.

Engineering-level control: Upgrade or install equipment to reduce manual handling and repetitive motion (e.g. dishwasher and trolley carts to transport plates, glassware, and/or ingredients).

Administrative-level control: Ensure workers know how to perform kitchen tasks while minimizing risks of burns or lacerations. Organize staff schedules to minimize overcrowding in the kitchen area. Review and revise training to educate workers on how to avoid the risk of lacerations and burns, as well as appropriate first aid actions following an incident.

Individual-level control: Provide appropriate PPE to protect workers from burns and lacerations. Instruct workers to use carts and handling equipment. Ensure that workers are aware of how to properly use and maintain their PPE.

5.10.11. Packaging

Researchers observed that packaging, both as a host activity and as a physical environment, was associated with many injuries. Researchers recommend practitioners implement interventions that assess packaging tasks for repetitive motions, lifting, and sharp edges. Researchers also recommend practitioners assess packaging tasks for design modifications to reduce injuries.

Engineering-level control: Modify or replace packaging equipment and machinery to reduce manual handling and repetitive motion. Add machine guards to protect workers from lacerations or contusions.

Administrative-level control: Review and revise training to ensure workers are aware of identified hazards associated with operating packaging lines. Whenever equipment is modified or replaced, facilitate new trainings to educate workers on revised processes. Implement task rotation to ensure workers do not perform repetitive tasks or manual handling for prolonged durations.

Individual-level control: Provide workers with appropriate PPE to provide a barrier between the workers and any identified hazards. Ensure that workers know how to use and maintain their PPE. Examples of PPE include gloves, safety glasses, and steel-toe shoes.

CHAPTER 6. CONCLUSION

Craft breweries are a growing industry. To date, there is a lack of available studies and knowledge on the burden of injuries specific to craft brewery workers. The present study was the first to specifically investigate the distribution, costs, and contributing factors to occupational injuries in the craft brewing industry. Researchers used data from WC to analyze injuries among Colorado craft brewery workers. Specific Aim 1 provided critical information on what injuries occurred among craft brewery workers, and the distributions of injury characteristics overall. Specific Aim 2 considered the costs incurred by injuries and quantified the financial burden of injuries among craft breweries. Specific Aim 3 described the frequency and burden (financial and lost time) of injuries by task – MMH and other (non-MMH) among craft brewery workers. Specific Aim 4 combined elements of the previous aims with the revised agent-host-environment epidemiologic model and developed the injury process model to investigate where and how injuries occurred. The impact of Specific Aim 4 was that it provided information for targeting interventions by workplace, task demands, machinery/equipment, and worker activity. The injury process model is a tool that health and safety practitioners can use to identify how and where injuries occur in craft breweries, and with this knowledge, they can be cost effective by directing site-specific interventions. Informal interviews with subject matter experts supplemented the WC analysis. Due to restrictions caused by the COVID-19 Pandemic, qualitative data were collected through virtual informal interviews with subject matter experts. The purpose of these informal interviews was to establish the relevancy of the results to workers in the craft brewing industry.

Results of the present study informed researchers about injuries among craft brewery workers; specifically, who was injured and what kinds of injuries they experienced. For instance, new craft brewery workers experienced the majority of occupational injuries. Sprains/strains were both the most expensive and the most frequent injury nature. The low back, hands, and fingers were the most frequently injured body parts. Researchers then analyzed the accident narratives by using the revised agent-host-

environment epidemiologic model to better understand the relationship between the reported injury claim and the contributing factors to the agent, host, environment, and vehicle. By analyzing accident narratives, researchers determined that most injuries occurred in the packaging area of the craft brewery. Subject matter experts supported this result when they described how the packaging hall typically had the highest number of workers and the greatest proportion of new workers compared to other areas in the craft brewery. Researchers developed a series of injury process models to highlight the relationship between injury characteristics and contributing factors that resulted in an injury nature. These models included information on how an injury nature was the result of an injury event when energy transferred from the environment or vehicle to the injured workers' anatomical region. Based on these accident models, researchers identified that both sprains/strains and contusions typically occurred in the packaging area of the craft brewery while the claimant carried an item. Lacerations occurred in the packaging area or kitchen and burns occurred in the brewery or kitchen. Both burns and lacerations occurred while the worker performed maintenance work, cleaning activities, or food preparation tasks. Stakeholders can use this information to target intervention areas in craft breweries. For example, practitioners could prioritize safety trainings among new craft brewery hires or among workers in the packaging area of the craft brewery. Findings from the present study (including the injury process models) can help guide practitioners tasked with allocating resources to reduce injuries and improve safety in craft breweries.

One subject matter expert described the burden of occupational injuries: "workers are not just pieces of equipment; injuries literally impact their livelihoods and their lifestyles." Findings from this study can be used to guide and develop interventions to reduce injuries and improve the quality of work life among craft brewery workers.

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Colorado Workers' Compensation Act, Colorado Revised Statutes § 8-40-102 (2017). https://www.colorado.gov/pacific/cdle/workers-compensation-act

H.R.1337 - An Act to amend the Internal Revenue Code of 1954 with respect to excise tax on certain trucks, buses, tractors, et cetera, home production of beer and wine, refunds of the taxes on gasoline and special fuels to aerial applicators, and partial rollovers of lump sum distributions. 95th Congress (1977-1978). https://www.congress.gov/bill/95th-congress/house-bill/1337

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APPENDIX

8.1. OSHA Citation

Template for pending citation from OSHA Englewood Area Office, May 2020:

Section 5(a)(1) of the Occupational Safety and Health Act of 1970: The employer did not furnish employment and a place of employment which were free from recognized hazards that were causing or likely to cause serious physical harm to employees, in that employees were exposed to burns from accidental contact with hot steam pipes:

a) On or about [Date], and at times prior, the employer, did not ensure brewing employees were protected from severe burn hazards due to potential contact with non-insulated and, or unguarded boiling water pipes. These pipes, at approximately 199 degrees Fahrenheit (based on establishment elevation), ran from a gas-fired heating system underneath the brewing kettle and made horizontal entry into the bottom of the mash tun tank. This specific section of piping resembled handrails protruding into the walkway and was adjacent to steps leading up to the brewing kettle and mash tun tank.

Among other methods, feasible and acceptable abatement methods to correct the hazard would be to (1) implement guidance as listed in:

1. Standard Guide for Heated System Surface Conditions that Produce Contact Burn Injuries (C 1055-92)." American Society for Testing and Materials, Philadelphia, PA

2. Implement guidance as listed in: "Preventing Burns from Insulated Pipes," Chemical Engineering, Vol. 88, No. 15 (July 27, 1981), pp. 58-64.

8.2. Compliance hazards in Colorado craft breweries identified by OSHA Consultation (Colorado State University Health & Safety, 2019, slide 3)

Code of Federal Regulations (CFR) number (number of identified hazards)

CFR 1910.1200 Hazard communication (19),

CFR 1910.303 Electrical (wiring methods) (17),

CFR 1910.305 Electrical (general) (17),

CFR 1910.132 Personal protective equipment (12),

CFR 1910.147 Lock out tag out (10),

CFR 1910.212 Machine guarding (10),

CFR 1910.134 Respiratory protection (8),

CFR 1910.157 Portable fire extinguisher/fire safety (8),

CFR 1910.38 Emergency action planning (8),

CFR 1910.151 Eyewash stations (6)

8.3.Modules in Brewers Association Free Online Safety Training

1. Bottling line
2. Canning line
3. Fermentation and cellaring
4. Fermentation cleaning and sanitizing
5. Filtering and carbonation
6. Filtering and pumping
7. Grain handling
8. Grain handling and silos
9. Keg cleaning
10. Keg filling
11. Mashing
12. Powered industrial trucks
13. Transfer and boiling
14. Whirlpooling and cooling

Accessed November 2020. Available from https://www.brewersassociation.org/educational-publications/free-online-brewery-safety-training/.

8.4. Example of Pinnacol Assurance's FROI form

PINNACOL ASSURANCE

FIRST REPORT OF INJURY
To report a claim call your service team:
303-361-4000 or 1-800-873-7242
Or Fax to 303-361-5000 or 1-888-329-2251
or www.pinnacol.com

Early reporting can save you money. Report all injuries immediately!
The information below allows Pinnacol Assurance's customer service representatives to quickly and accurately process your claim. Use the completed form as a guide when reporting by phone or online to save you time. Don't wait to report if you don't have all the answers.

A. Critical Data - *REQUIRED INFORMATION TO BEGIN PROCESSING YOUR CLAIM BY PHONE OR ONLINE.*

Policy Number: _____ Company Name: _____

Address or Location (if different than mailing address): _____

Injured Worker's Social Security Number: ___ - ___ - ____ Date of Injury: _____

First Name: _____ M.I. ____ Last Name: _____

B. Injured Worker Information

Home Address: _____ Phone: _____
City State Zip

Date of Birth: _____ ○ Male ○ Female Marital Status: _____

Language: ☐ English ☐ Spanish ☐ Other: _____ Occupation: _____

Date Hired: _____

Employee Status: ○ Full-time ○ Part-time ○ Seasonal ○ Volunteer ○ Independent Contractor

Days worked per week: _____ and average weekly wage $ _____

OR

Hours worked per day: _____ and hourly pay rate $ _____ and hours worked per week: _____

C. Accident / Injury Information

Fatal Injury? ○ **Yes** ○ **No** **If fatal injury: Date of Death:** _____

Is this a lost-time claim? ○ Yes ○ No (Claim is lost time if there is a loss of more than three scheduled workdays due to the injury.)

Time of Injury: _____ ○ a.m. ○ p.m Time Work Began: _____ ○ a.m. ○ p.m. Last Work Date: _____

Full Pay on Date of Injury: ○ Yes ○ No

Accident Occurred on Employers Premises: ○ Yes ○ No Severe Injury: ○ Yes ○ No

Accident Location: _____ If Applicable: Location Code: _____ Dept. Code: _____

Name of Employer Representative Notified: _____ Date Notified: _____

How did Injury Occur: _____
Attach additional pages if necessary

Specific Activity the Employee Was Engaged In: _____ What Equipment Was Being Used? _____

Body Part(s) Injured: _____

Witnesses: _____
Name(s) & Phone Number(s)

☐ Safety Equipment Provided ☐ Safety Equipment Used ☐ Possible Drug/Alcohol Involved ☐ Employer Questions Liability

D. Medical Provider Information; Where was your employee treated?

☐ No Medical Treatment ☐ Treated by Employer ☐ 911 Called ☐ Walk-In Clinic

☐ Emergency Room ☐ Hospitalized > 24 hrs / Overnight ☐ Possible Surgery

_____
Medical Provider Name Street Address City State Zip Phone

E. Return to Work Information

Has injured worker returned to work? ○ Yes ○ No

Date Returned to Work: _____ Estimated Date of Return to Work: _____

Prepared By: _____ Title: _____
Please Print

Email: _____ Fax: _____

Phone: _____ Date: _____

ZAUCCISBSFR ***Help Your Employee Get Back to Work. Report ALL Injuries Immediately!*** See Reverse 4805

8.5. The hierarchical coding structure of the v2.01 2012 OIICS

Nature	Part of Body	Event/Exposure	Source and secondary source
[1] Traumatic injuries and disorders [2] Diseases and disorders of body systems [3] Infections and parasitic diseases [4] Neoplasms, tumors, and cancers [5] Symptoms, signs, and ill-defined conditions [6] Other diseases, conductions, and disorders [7] Exposures to disease – no illness incurred [8] Multiple diseases, conditions, and disorders [9999] Nonclassifiable	[1] Head [2] Neck, including throat [3] Trunk [4] Upper extremities [5] Lower extremities [6] Body systems [8] Multiple body parts [9] Other body parts [9999] Nonclassifiable	[1] Violence and other injuries by persons or animals [2] Transportation incidents [3] Fires and explosions [4] Falls, slips, trips [5] Exposure to harmful substances and environments [6] Contact with objects and equipment [7] Overexertion and bodily reaction [9999] Nonclassifiable	[1] Chemicals and chemical products [2] Containers, furniture and fixtures [3] Machinery [4] Parts and materials [5] Persons, plants, animals, and minerals [6] Structures and surfaces [7] Tools, instruments, and equipment [8] Vehicles [9] Other sources [9999] Nonclassifiable

(Table 1 was adapted from https://wwwn.cdc.gov/Wisards/oiics/Trees/MultiTree.aspx?Year=2012)

8.6. Injury event detail per injury event category in the present study (from FROI and OIICS)

Injury event	**Injury event details**
Overexertion & bodily reaction	- Strain-Lifting - Strain or Injury - Miscellaneous - Repetitive Motion - Strain or Injury By Twisting - Object Being Lifted or Handled - Strain-Pushing, Pulling - Struck By-Lifted Object - Strain-Using Tool/Machine - Cumulative (ALL OTHER) - Strain-Holding, Carrying - Strain-Reaching
Exposure to harmful substances or environments	- Cut-Tool, Not Powered - Cut-Broken Glass - Burn-Steam, Hot Fluids - Cut - Miscellaneous - Burn-Acid Chemicals - Burn-Contact Hot Object - Cut-Tool Powered

	- Electric Shock-Contact W/ Electric Current - Burn - Miscellaneous - Burn-Fire, Flame - Explosion or Flare Back
Falls, trips, slips	- Fall - Same Level - Fall, On Stairs - Fall On Ice or Snow - Fall or Slip From Liquid or Grease Spills - Fall or Slip From Ladder or Scaffolding - Fall-Slip, No Fall - Fall - Miscellaneous - Fall or Slip From Different Level
Contact with objects and equipment	- Struck By-Falling Object - Strike-Stationary Object - Caught-Object Handled - Foreign Body in Eye - Miscellaneous Strike or Injury - Struck By-Tool, Machine - Caught-Machinery - Miscellaneous Caught in or Between - Struck By-Moving Parts - Strike-Step, Sharp Object - Miscellaneous Striking Against or Stepping On - Struck By-Object By Other - Strike-Step, Sharp Object - Miscellaneous Striking Against or Stepping On - Struck By-Object By Other - Strike-Moving Parts
Other	- Misc, Other Than Physical Cause of Injury - Other - Motor Veh-Coll/Vehicle (transportation incident) - Miscellaneous Motor Vehicle (Transportation Incident) - Animal or Insect (Violence and other injuries by persons or animals) - Struck or Injured By Fellow Worker, Patient (Violence and other injuries by persons or animals)

8.7. Complete results of claims filed per brewery and sum of claims during claim period (2013-2018)

Number of breweries (count)	Claims per brewery (count)	Sum of claims
22	1	22
5	3	15
5	4	20
4	2	8
2	5	10

1	7	7
1	8	8
1	17	17
1	22	22
1	30	30
1	40	40
1	53	53
1	59	59
1	61	61
1	74	74
1	125	125

8.8. Proportions used in Bonferroni adjustments pairwise proportions for additional statistical tests in Specific Aim 1

Injury characteristic	Detail	Count	Other[1]	Yes[2]	No[3]
Injured anatomical region					
	Upper Limb	244	325	0.43	0.57
	Trunk region	190	380	0.33	0.67
	Lower Limb	126	444	0.22	0.78
	Other	10	560	0.02	0.98
Injury nature					
	Burn	56	514	0.10	0.90
	Contusion	154	416	0.27	0.73
	Laceration	107	463	0.19	0.81
	Other	90	480	0.16	0.84
	Sprain/strain	163	407	0.29	0.71
Injury event					
	Contact with objects and equipment	131	439	0.23	0.77
	Exposure to harmful substances or environments	155	415	0.27	0.73
	Falls, trips, slips	88	482	0.15	0.85
	Other	35	535	0.06	0.94
	Overexertion & bodily reaction	161	409	0.28	0.72
Claimant age					
	< 24 years old	65	505	0.11	0.89
	25-34 years old	319	251	0.56	0.44
	35-44 years old	112	458	0.20	0.80
	45-54 years old	38	532	0.07	0.93
	> 55 years old	18	552	0.03	0.97
	NA	18	552	0.03	0.97
Claimant tenure					
	< 1 year	237	333	0.42	0.58
	1-2 years	126	444	0.22	0.78

	2-3 years	46	524	0.08	0.92
	3-4 years	28	542	0.05	0.95
	4-5 years	17	553	0.03	0.97
	over 5 years	56	514	0.10	0.90
	NA	60	510	0.11	0.89

[1] "Other" corresponds to the sum of claims that do not correspond to the specific "detail." For example, 244 claims (Count) affected the upper limb (Detail), so Other is 325, or 570-244.

[2] "Yes" represents the count of claims that corresponded to the value in the "detail" cell. For example, the proportion of claims specific to the upper limb is 244/570, or 0.43.

[3] "No" represents the count of claims that do not correspond to the specific value in the "detail" cell. For example, the proportion of claims not related to the upper limb is (570-244)/570, or 325/570, or 0.57.

8.9. Descriptive statistics of claims injury event and injury event detail

Injury Event Category	Injury event detail	Category count (%)	Detail Count(%)
Overexertion & bodily reaction	Strain-Lifting	52 (9.11)	
	Strain or Injury - Miscellaneous	34 (5.95)	
	Repetitive Motion	21 (3.68)	
	Strain or Injury By Twisting	18 (3.15)	
	Object Being Lifted or Handled	9 (1.58)	
	Strain-Pushing, Pulling	7 (1.23)	
	Struck By-Lifted Object	7 (1.23)	
	Strain-Using Tool/Machine	5 (0.88)	
	Cumulative (ALL OTHER)	3 (0.53)	
	Strain-Holding, Carrying	3 (0.53)	
	Strain-Reaching	2 (0.35)	
			161 (28.2)
Exposure to harmful substances or environments	Cut-Tool, Not Powered	31 (5.43)	
	Cut-Broken Glass	29 (5.08)	
	Burn-Steam, Hot Fluids	27 (4.73)	
	Cut - Miscellaneous	26 (4.55)	
	Burn-Acid Chemicals	16 (2.8)	
	Burn-Contact Hot Object	12 (2.1)	
	Cut-Tool Powered	5 (0.88)	
	Electric Shock-Contact W/ Electric Current	4 (0.7)	
	Burn - Miscellaneous	3 (0.53)	
	Burn-Fire, Flame	1 (0.18)	
	Explosion or Flare Back	1 (0.18)	
			155 (27.15)
Contact with objects and equipment	Struck By-Falling Object	37 (6.48)	
	Strike-Stationary Object	19 (3.33)	

	Caught-Object Handled	16 (2.8)	
	Foreign Body in Eye	16 (2.8)	
	Miscellaneous Strike or Injury	11 (1.93)	
	Struck By-Tool, Machine	9 (1.58)	
	Caught-Machinery	6 (1.05)	
	Miscellaneous Caught in or Between	5 (0.88)	
	Struck By-Moving Parts	5 (0.88)	
	Strike-Step,Sharp Object	3 (0.53)	
	Miscellaneous Striking Against or Stepping On	2 (0.35)	
	Struck By-Object By Othr	2 (0.35)	
	Strike-Moving Parts	1 (0.18)	
			132 (23.12)
Falls, trips, slips	Fall - Same Level	32 (5.6)	
	Fall, On Stairs	13 (2.28)	
	Fall On Ice or Snow	10 (1.75)	
	Fall or Slip From Liquid or Grease Spills	9 (1.58)	
	Fall or Slip From Ladder or Scaffolding	8 (1.4)	
	Fall-Slip, No Fall	7 (1.23)	
	Fall - Miscellaneous	5 (0.88)	
	Fall or Slip From Different Level	4 (0.7)	
			88 (15.41)
Other	Misc, Other Than Physical Cause of Injury	12 (2.1)	
	Other	5 (0.88)	
			17 (2.98)
Transportation incident	Motor Veh-Coll/Vehicle	9 (1.58)	
	Miscellaneous Motor Vehicle	2 (0.35)	
			11 (1.93)
Violence and other injuries by persons or animals	Animal or Insect	5 (0.88)	
	Struck or Injured By Fellow Worker, Patient	2 (0.35)	
			7 (1.23)

8.10. Distribution of tenure among claimants with ≥5 years of tenure at the time of injury

Claimant tenure (years)	Count (% within category)
5	12 (21.43)
6	10 (17.86)
7	6 (10.71)
8	7 (12.5)
9	4 (7.14)
10	1 (1.79)

11	4 (7.14)
13	1 (1.79)
15	4 (7.14)
16	2 (3.57)
17	2 (3.57)
19	1 (1.79)
22	1 (1.79)
34	1 (1.79)

8.11. Formula and model output for total claim cost and injury characteristics in present study

$$\begin{aligned}\log(mean\ \widehat{total}\ claim\ cost) &= 5.491 + 0.132(mmh) + 0.096(Anatomical\ Region{:}\ Lower\ Limb)\\ &+ 0.552\ (Anatomical\ Region{:}\ Other) + 0.167(Anatomical\ Region{:}\ Upper\ Limb)\\ &+ 0.253(Injury\ Nature{:}\ Burn) + 0.511(Injury\ Nature{:}\ Laceration)\\ &+ 0.387(Injury\ Nature{:}\ Other) + 0.392(Injury\ Nature{:}\ Sprain, strain)\\ &+ 0.008(Injury\ Event{:}\ Exposure\ \dots) + 0.692(Injury\ Event{:}\ STF)\\ &+ 0.136(Injury\ Event{:}\ Other) + 0.512(Injury\ Event{:}\ Overexertion\ \dots)\\ &+ 0.007(Age) + 0.020(Tenure) + 2.563(Claim\ Type)\end{aligned}$$

Formula 4.1. Gamma GLM model for mean total claim cost and WC injury characteristics

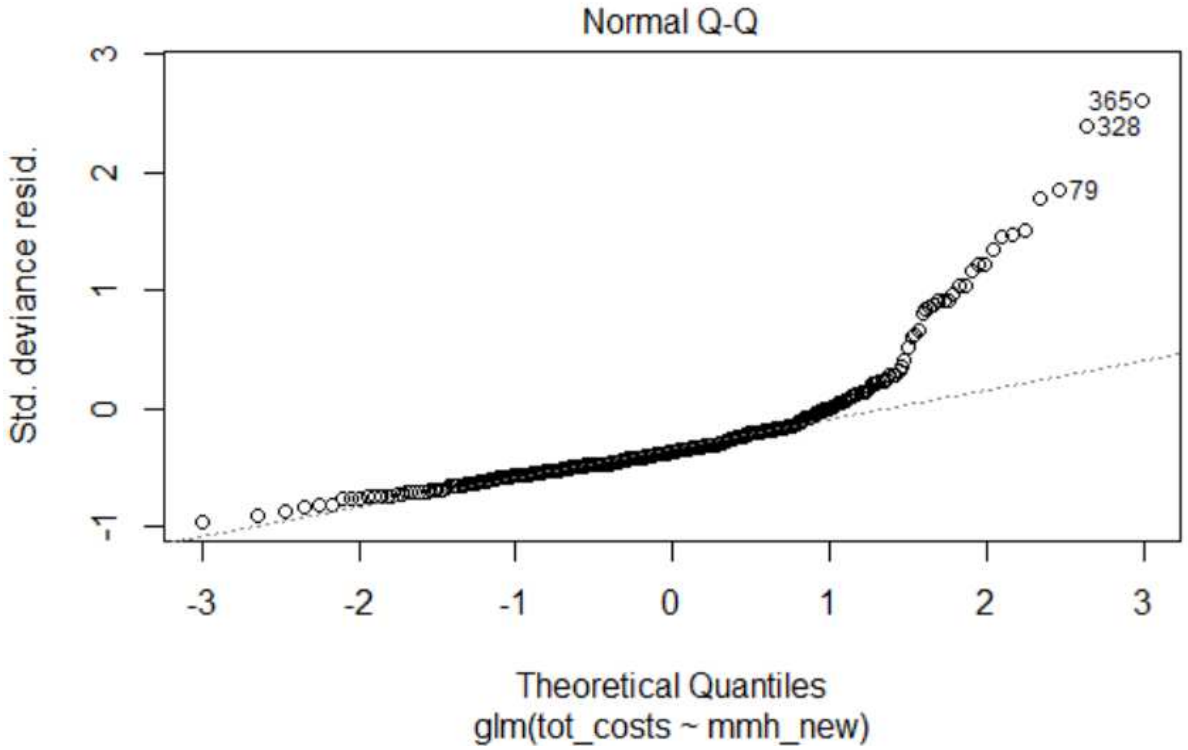
		Estimated Ratio	95% CI[a]	Multiplicative effect[b]
Task				
	Other[c]	Reference		
	MMH	1.141	0.888, 1.471	14.1
Anatomical Region				
	Trunk region	Reference		
	Lower Limb	1.101	0.830, 1.467	10.1
	Other[d]	1.736	0.693, 5.944	73.6
	Upper Limb	1.181	0.918, 1.519	18.1
Injury Nature				
	Contusion	Reference		
	Burn	1.288	0.707, 2.380	28.8
	Laceration	1.667	1.018, 2.798	66.7
	Other[e]	1.460	1.032, 2.072	46.0
	Sprain/strain	1.480	0.988, 2.216	48.0
Injury Event				
	Contact with objects and equipment	Reference		
	Exposure to harmful substances or environments	1.008	0.624, 1.608	0.80
	Falls, trips, slips	1.997	1.400, 2.882	99.7

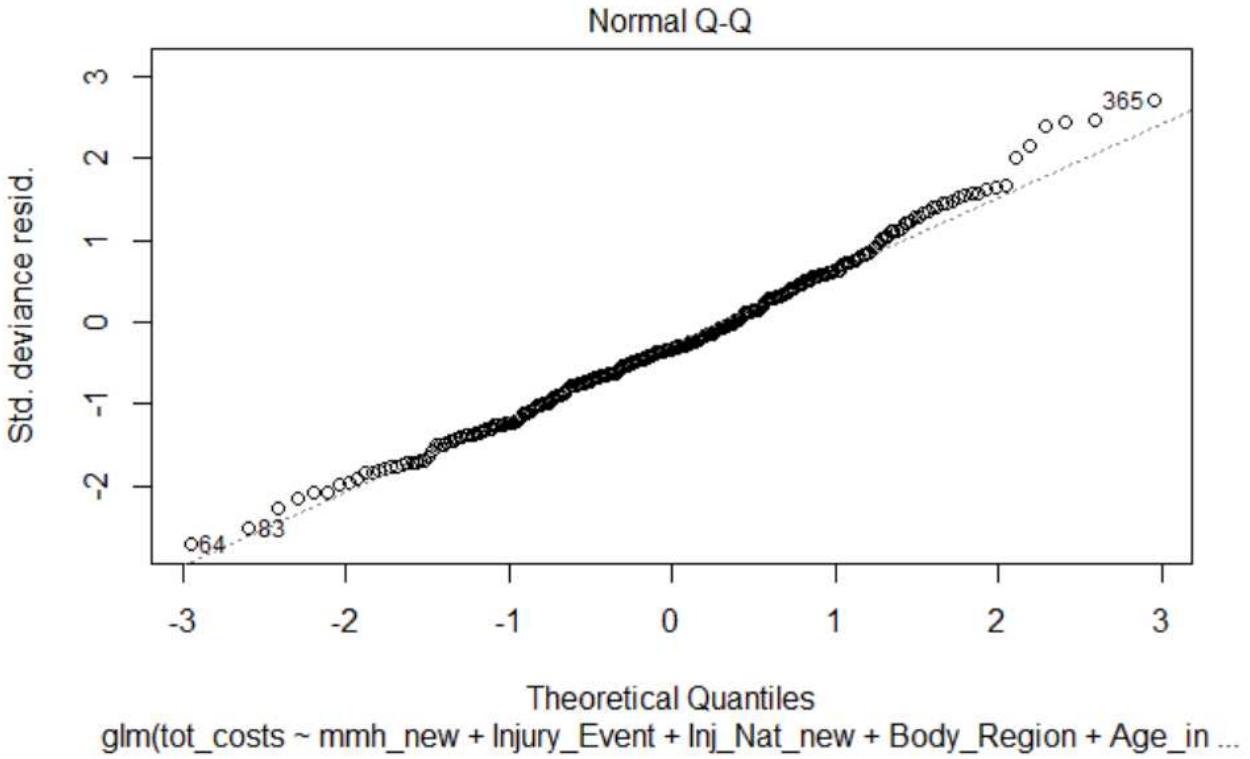
	Other[f]	1.145	0.714, 1.892	14.5
	Overexertion and bodily reaction	1.668	1.118, 2.485	66.8
Age (continuous)		1.019	1.005, 1.034	1.9
Tenure (continuous)		0.989	0.958, 1.025	-1.1
Claim Type	Medical-only	Reference		
	Medical-plus-Indemnity	12.969	9.376, 18.378	1196

[a] Estimated ratios and corresponding 95% CI have been back transformed (i.e. exp(beta))
[b] Multiplicative effect in relation to reference value
[c] Other tasks (non-MMH)
[d] "Other" anatomical region
[e] "Other" injury nature
[f] "Other" injury event

Supplemental statistical analysis for investigating the relationship between cost and task.

A Welch Two Sample t-test was performed to investigate the difference in the distribution between total costs and task (t=0, df=1138, p=1, 95% CI -531.62, 531.62). An additional Welch Two Sample t-test was performed to investigate the difference in the distribution of total claim cost and task among claims that incurred costs, which reduced the sample size (t=0, df=732, p=1, 95% CI (-806.25, 803.25)). Following the Welch Two Sample t-tests, further statistical tests were performed to investigate the relationship between mean total claim cost and task, when adjusting for other injury characteristics.





Raw GLM model output for costs~mmh_new+Injury_Event+Inj_Nat_new+Body_Region+Age_in_Years_at_DOI+tenure+Claim_Type Estimate has not been transformed (exponentiated)

	Estimate	Std. Error	t value	Pr (>|t|)
(Intercept)	5.4910365	0.2655736	20.6761395	0.0000000
mmh_new	0.1319476	0.1293114	1.0203860	0.3083648
Body_RegionLower_Limb	0.0964877	0.1421825	0.6786183	0.4979012
Body_RegionOther	0.5516439	0.5293495	1.0421165	0.2981940
Body_RegionUpper_Limb	0.1666052	0.1251198	1.3315652	0.1840106
Inj_Nat_newBurn	0.2528157	0.3015262	0.8384536	0.4024414
Inj_Nat_newLaceration	0.5111005	0.2529044	2.0209233	0.0441728
Inj_Nat_newOther	0.3781958	0.1668424	2.2667848	0.0241128
Inj_Nat_newSprain_strain	0.3923697	0.1933280	2.0295548	0.0432813
Injury_EventExposure to harmful substances or environments	0.0083944	0.2377155	0.0353128	0.9718537
Injury_EventFalls, trips, slips	0.6916833	0.1841455	3.7561783	0.0002071
Injury_EventOther	0.1358256	0.2336236	0.5813863	0.5614152
Injury_EventOverexertion & bodily reaction	0.5117677	0.1951612	2.6222824	0.0091786
Age_in_Years_at_DOI	0.0189032	0.0067464	2.8019663	0.0054085
tenure_years	-0.0108014	0.0162142	-0.6661677	0.5058141

Claim_TypeIndemnity	2.5625350	0.1663297	15.4063609	0.0000000

8.12. Correlation of age and tenure

Continuous variables tenure and age were investigated in Specific Aim 3.6. and 3.7. *Age and were not highly correlated (Pearson correlation coefficient = 0.382, t=9.21, df=499, p<0.001)*. Following the continuous relationship exploration, the distribution of claims within the categorical variables/ at the categorical variable was explored. The distribution of claims among age and tenure groups is outlined in Table #.

Distribution of age and tenure in present study (2013-2018)

	Tenure							
Age group	< 1 year	≥1 to <2 years	≥2 to <3 years	≥3 to <4 years	≥4 to <5 years	≥5 years	NA	*sum*
< 24 years old	39	11	1	1	NA	1	12	*65*
25-34 years old	143	84	32	16	10	17	17	*319*
35-44 years old	42	18	7	8	6	17	14	*112*
45-54 years old	9	6	3	2	NA	12	6	*38*
> 55 years old	1	5	3	1	NA	6	2	*18*
NA	3	2	NA	NA	1	3	9	*18*
sum	*237*	*126*	*46*	*28*	*17*	*56*	*60*	*570*

Age ~ tenure (Pearson correlation coefficient = 0.382, t=9.21, df=499, p<0.001).

Scatter plot of continuous claimant age and tenure

8.13. Formula and model output for claimant age and injury characteristics in present study

$$
\begin{aligned}
&(mean\ \widehat{age}\ at\ injury) \\
&\quad = 30.93 - 1.054(mmh) - 1.505(Anatomical\ Region{:}\ Lower\ Limb) \\
&\quad - 0.756\ (Anatomical\ Region{:}\ Other) - 0.808(Anatomical\ Region{:}\ Upper\ Limb) \\
&\quad - 0.720(Injury\ Nature{:}\ Burn) - 1.675(Injury\ Nature{:}\ Laceration) \\
&\quad - 0.583(Injury\ Nature{:}\ Other) + 0.878(Injury\ Nature{:}\ Sprain, strain) \\
&\quad + 0.374(Injury\ Event{:}\ Exposure\ \dots) + 2.647(Injury\ Event{:}\ STFs) \\
&\quad + 0.257(Injury\ Event{:}\ Other) + 0.009(Injury\ Event{:}\ Overexertion\ \dots) \\
&\quad + 0.918(Tenure) + 2.393(Claim\ Type)
\end{aligned}
$$

Formula 4.2. Linear regression model for mean age at date of injury and WC injury characteristics

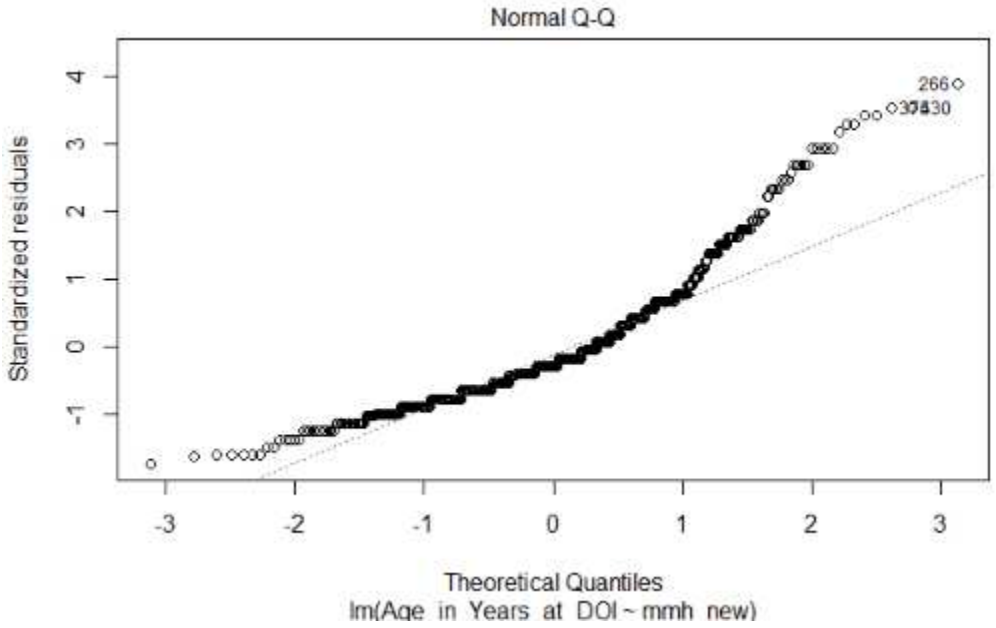
Model output for claimant age and injury characteristics in present study

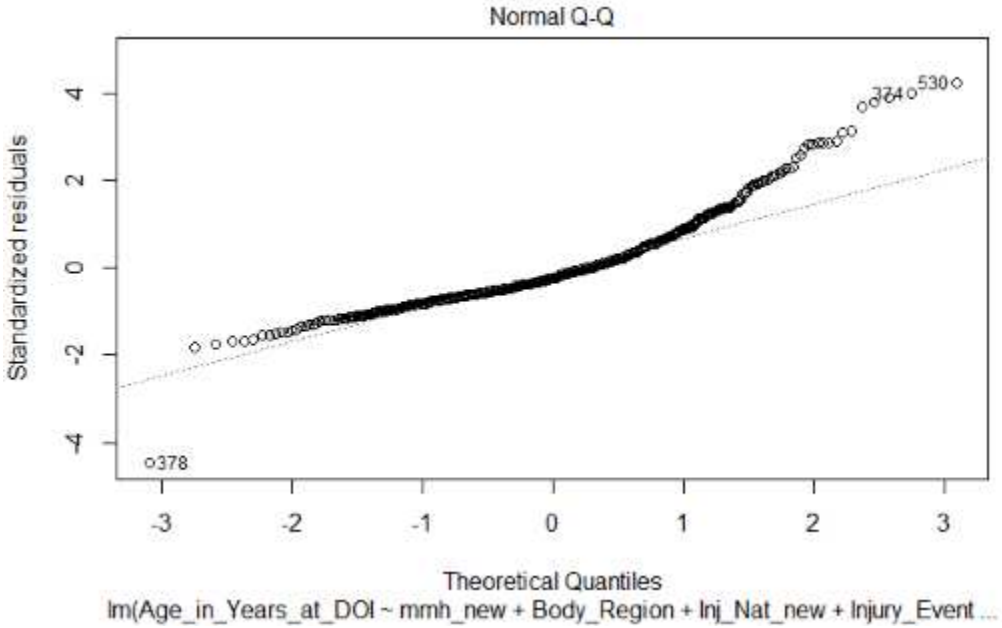
		Coefficient	95% CI
Task			
	Other	Reference	
	MMH	-1.054	-2.768, 0.660

Anatomical Region			
	Trunk region	Reference	
	Lower Limb	-1.505	-3.389, 0.378
	Other	-0.756	-6.469, 4.956
	Upper Limb	-0.808	-2.505, 0.890
Injury Nature			
	Contusion	Reference	
	Burn	-0.720	-4.845, 3.405
	Laceration	-1.675	-5.169, 1.820
	Other	-0.583	-2.934, 1.768
	Sprain/strain	0.878	-1.657, 3.412
Injury Event			
	Contact with objects and equipment	Reference	
	Exposure to harmful substances or environments	0.374	-3.013, 3.761
	Falls, trips, slips	2.647	0.368, 4.926
	Other	0.257	-3.004, 3.517
	Overexertion and bodily reaction	0.009	-2.674, 2.693
Tenure (continuous)		0.918	0.705, 1.131
Claim Type	Medical-only	Reference	
	Medical-plus-Indemnity	2.393	-0.324, 5.110

Additional statistical test results for age ~ mmh et al.

A Welch two-sample T-test was performed to further investigate the distribution of ages by task (t-statistic=0, df=1102, p=1, 95% CI (-0.991,0.991)). An additional Welch separate two-sample T-test was performed to compare the distribution of claimant age by task among claims that incurred costs, which reduced the overall sample size (t-statistic=0, df=712, p=1, 95% CI (-0.035, 0.035)).





Raw LM model output for age ~ task et al.

	Estimate	Std. Error	t value	Pr(>|t|)
(Intercept)	30.9308119	1.0704260	28.8957958	0.0000000
mmh_new	-1.0539371	0.8722209	-1.2083374	0.2275051
Body_RegionLower_Limb	-1.5053316	0.9587059	-1.5701704	0.1170263
Body_RegionOther	-0.7563475	2.9073342	-0.2601516	0.7948570
Body_RegionUpper_Limb	-0.8077885	0.8639732	-0.9349694	0.3502684
Inj_Nat_newBurn	-0.7201794	2.0995090	-0.3430228	0.7317296
Inj_Nat_newLaceration	-1.6745377	1.7785491	-0.9415190	0.3469067
Inj_Nat_newOther	-0.5826733	1.1964454	-0.4870037	0.6264753
Inj_Nat_newSprain_strain	0.8778049	1.2899656	0.6804871	0.4965202
Injury_EventExposure to harmful substances or environments	0.3740617	1.7236771	0.2170138	0.8282887
Injury_EventFalls, trips, slips	2.6470505	1.1600010	2.2819380	0.0229244
Injury_EventOther	0.2566280	1.6594515	0.1546463	0.8771644
Injury_EventOverexertion & bodily reaction	0.0093674	1.3657459	0.0068588	0.9945303
tenure_years	0.9177788	0.1084873	8.4597812	0.0000000
Claim_TypeIndemnity	2.3930406	1.3828772	1.7304795	0.0841794

8.14. Formula and model output for claimant tenure and injury characteristics in present study

$$
\begin{aligned}
&(\widehat{mean\ tenure}\ ) \\
&\quad = -1.577 + 1.19(mmh) + 1.02(Anatomical\ Region{:}\ Lower\ Limb) \\
&\quad + 0.45\ (Anatomical\ Region{:}\ Other) + 0.95(Anatomical\ Region{:}\ Upper\ Limb) \\
&\quad + 1.35(Injury\ Nature{:}\ Burn) + 1.28(Injury\ Nature{:}\ Laceration) \\
&\quad + 0.77(Injury\ Nature{:}\ Other) + 0.82(Injury\ Nature{:}\ Sprain, strain) \\
&\quad + 0.72(Injury\ Event{:}\ Exposure\ \dots) + 0.95(Injury\ Event{:}\ STFs) \\
&\quad + 1.26(Injury\ Event{:}\ Other) + 1.60(Injury\ Event{:}\ Overexertion\ \dots) \\
&\quad + 1.05(Tenure) + 1.08(Claim\ Type)
\end{aligned}
$$

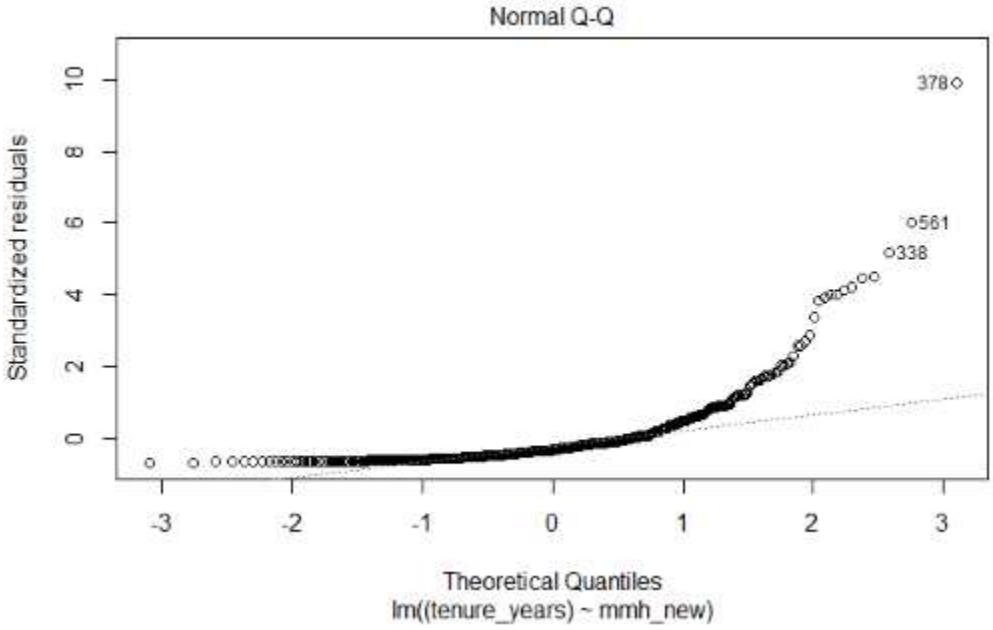
Formula 4.3. Linear model for arithmetic mean tenure at date of injury

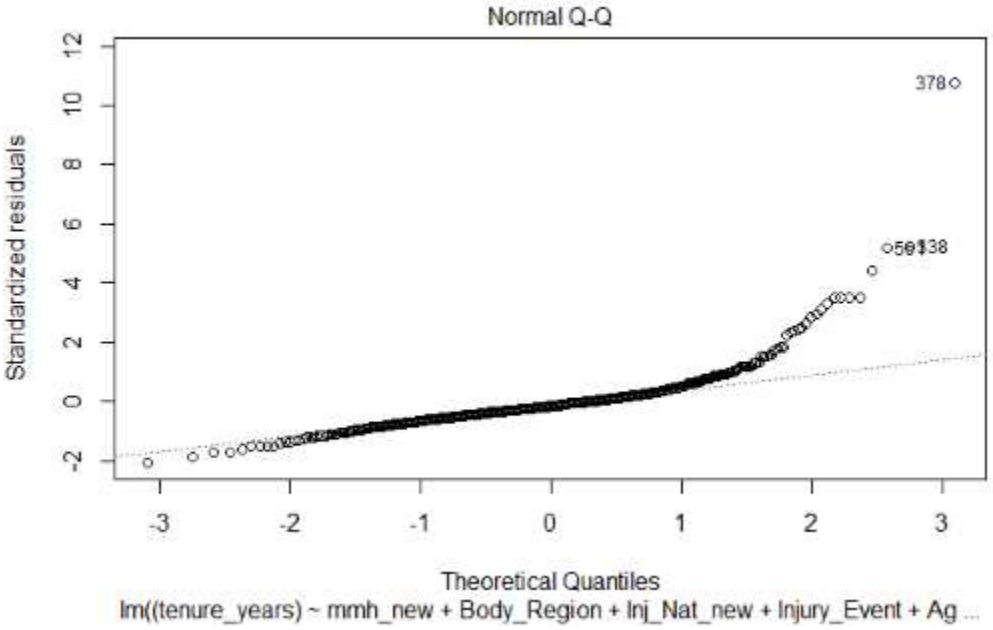
Model output for claimant tenure and injury characteristics in present study

		Estimated ratio	**2.5 %**	**97.5 %**	**Multiplicative risk**
Task					
	Other	Reference			
	MMH	1.189	0.877	1.612	18.9
Anatomical Region					
	Trunk region	Reference			
	Lower Limb	1.022	0.731	1.429	2.2
	Other	0.454	0.165	1.251	-54.6
	Upper Limb	0.951	0.703	1.286	-4.9
Injury Nature					
	Contusion	Reference			
	Burn	1.352	0.650	2.811	35.2
	Laceration	1.283	0.690	2.388	28.3
	Other	0.765	0.504	1.161	-23.5
	Sprain/strain	0.824	0.525	1.292	-17.6
Injury Event					
	Contact with objects and equipment	Reference			
	Exposure to harmful substances or environments	0.718	0.394	1.309	-28.2
	Falls, trips, slips	0.946	0.630	1.421	-5.4
	Other	1.259	0.706	2.246	25.9
	Overexertion and bodily reaction	1.595	0.993	2.561	59.5
Tenure (continuous)		1.046	1.031	1.062	4.6
Claim Type	Medical-Only	Reference			
	Medical-plus-Indemnity	1.079	0.665	1.750	7.9

Supplemental statistics for claimant tenure

A Welch two-sample T-test was performed to further investigate the distribution of tenure by task (t-statistic=0, df=1018, p=1, 95% CI (-0.401,0.401)). An additional Welch separate two-sample T-test was performed to compare the distribution of tenure by task among claims that incurred costs, which reduced the overall sample size (t-statistic=0, df=644, p=1, 95% CI (-0.534 0.534)).





Raw LM model output

	Estimate	Std. Error	t value	Pr(>|t|)

(Intercept)	-2.5179365	0.6793667	-3.7062994	0.0002345
mmh_new	-0.3075109	0.3407112	-0.9025559	0.3672087
Body_RegionLower_Limb	0.2014434	0.3750832	0.5370634	0.5914696
Body_RegionOther	-0.4356432	1.1348320	-0.3838834	0.7012327
Body_RegionUpper_Limb	-0.1813537	0.3374689	-0.5373940	0.5912414
Inj_Nat_newBurn	0.4070468	0.8194686	0.4967204	0.6196108
Inj_Nat_newLaceration	0.3225258	0.6947643	0.4642233	0.6426956
Inj_Nat_newOther	-0.2001942	0.4670775	-0.4286102	0.6683968
Inj_Nat_newSprain_strain	-0.3646723	0.5035272	-0.7242357	0.4692696
Injury_EventExposure to harmful substances or environments	-0.5438525	0.6724455	-0.8087682	0.4190443
Injury_EventFalls, trips, slips	0.4460001	0.4547949	0.9806621	0.3272473
Injury_EventOther	0.1388482	0.6477791	0.2143450	0.8303679
Injury_EventOverexertion & bodily reaction	1.2650974	0.5300436	2.3867797	0.0173782
Age_in_Years_at_DOI	0.1398564	0.0165319	8.4597812	0.0000000
Claim_TypeIndemnity	-0.2025214	0.5414112	-0.3740622	0.7085212

8.15. Accident narratives from FROI in WC craft brewery dataset (2013-2018)

Below is a list of all 570 accident narratives from the FROI in the present study. XXXX have been inserted to remove personal or company identifiers. All formatting (capitalization, spelling) reflects the original content

Claimant identifier	**Accident Narrative**
1686350	bottle broke in a machine & tried pulling it out bottling
1696316	she slipped on the floor while carrying a bus tub full of dishes. she landed on her left elbow with the weight of the bus tub on that arm. bussing dishes
1697734	machine stamped down on his hand and smashed two right fingers cleaning
1697845	new epoxy floor, still slippery. walking across wet floor.
1699227	over extended shoulder while lifting. lifted shop vac
1705571	xxxxx was working on the kegging line when the vaculex (assisted lift) failed causing a 1/2bbl keg to drop and bounce back up. the keg hit his safety glasses and cut his face. kegging beer
1710150	employee was carrying 5 gallon bucket, crusty edge pf bucket grazed leg carrying bucket
1715290	slipped and fell on new epoxy floor. bottling line
1716842	full keg fell off pallet and smashed finger filling kegs
1719935	washing glasses - glass broke and cut finger washing glassware
1720431	moving keg on pallet. smashed between two kegs. moving keg on test pallet.
1721053	slipped walking to get a drink walking

1723199	felt pain in his ankle that worsened throughout the day working
1733298	he was moving a hot water hose from a kettle to a firmentor and he had a valve open and got some boiling water into his boot moving hot water
1734128	cutting produce
1735799	loading cooler. unaware of parked forklift & backed into it w/ pallet jack.
1736510	cleaning a picture frame
1736553	he used one hand to run a piece of stainless through a metal grinder buffing stainless steel
1736914	repetitive motion and use of wrists. scrubbing bottles
1737098	phos acid shot out of line hitting worker in face/eye cleaning
1738474	xxxxx dropped a 1/6 bbl keg on her toe. carrying keg customer ordered a keg of beer.
1738844	strained back lifting heavy items. cleaning out a storage shed.
1739379	broken pint glass, inside right wrist placing down a glass
1741391	while bringing in a keg of beer on a hand truck, slipped on some grease and tweaked back. walking
1749190	stepped off stool onto hose re-assembling guest brink
1750474	removed hot liquor hose clamp from brink, hot water emptied into his boot rinsing yeast brink
1753733	fell by stepping into drain where grate was not put back in place getting a h20 hose
1754027	stepped into gap in scaffolding and caught knee unclogging grist case
1754798	lifting wooded pallet above shoulders, pallet broke and hit elbow, not sure where or how. stacking pallets
1756367	rolled ankle stepping on hose. fixing conveyors
1759041	smashed pinky between kegs building pallet order
1766029	while moving a pallet jack, the front of it smashed my right big toe moving a xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxet jackxxxxxxxxxx
1767764	stocking green chili, poured onto arm
1768633	slipped when getting out of the car stepping out of car
1770227	spider was in pants, bit when he put them on. getting dressed
1773274	putting away 44 lbs boxes of hops putting away hops
1775251	sanitizing tank
1776862	hyper extended knee mashing in
1778736	door hit left hand walking through hall
1779064	broken broom handle caught tip of finger sweeping
1780165	washing hands, ran hand on stainless steel and received a metal splinter to left thumb.
1781503	employee was reaching into a kettle to remove bag of ginger and burned his forearm brewing
1781505	pulling 12 pack ot of shoot got stuck, next pack came out & plate smashed fingers xxxxxxxxxxxxxxxxxxxxxxxxxxxxx
1783586	lifting kegs from above shoulder height
1786894	foot caught in pallet wrap, fell forward on the stairs. caught self with right hand, hurt right hand getting beer boxes
1787197	was working on a tap and heard and snap and pop in left bicep pulling a tap down
1787641	bottle fell off pallet cutting shrink wrap
1787741	slammed finger in door closing door

1788016	after closing they had just mopped the floor and she slipped on the wet floor walking across floor
1788651	lifting a yeast brink, xxxxxxx strained her back.
1789812	sat on a bucket with chemicals on it. getting glue
1792150	while cutting the top off of a plastic xxxxxxxxx alcohol bottle, the knife slipped and cut his hand. setting up to sanitize some parts for a new process
1797687	power wash sprayed leg. power washing
1798145	attempting to open a stuck valve with wrench. slipped bashing finger off valve. employee complained of excessive pain. taking beer sample
1799117	employee was washing a glass, the glass broke cutting his right index finger washing a glass
1800785	too much exposure to dish soap chemical xxxxxxxxxxxxxxxxxxxxxxxxxxxxx
1801007	xxxxx was folding boxes (can cartons) repeatedly when he noticed pain in his right hand. folding can tray cartons
1801772	doing a change over, lanes dropped and hit finger
1801833	lifting plates out of large kettle
1803323	rolling a keg on its edge to load it on the truck. the keg slipped on the concrete and fell directly on top of xxxxx's right foot. loading a keg
1803756	ladder from cleaning crew was set aside to be put away, another employee hit the ladder with a load of dishes and knocked the ladder into knee. appetizer cook online
1804857	on a ladder above grill cook line putting hoods back in place after being cleaned slipped and cut right middle finger on metal pieces putting hoods back in place after being cleaned
1806794	not sure, lifting repetitively. moving kegs
1808558	bottle exploded on the line bottling
1808614	mistepped while wrapping pallets wrapping a pallet with stretch wrap
1812154	reached in brink tank and hot water reached above glove and slight burn on forearm. setting up keg machine
1813450	he got sodium in his boot burning left foot cleaning
1814296	fell and hit head. company event
1815121	repetitive motion - tightening clamps, taping boxes taping box
1816279	cut by imbedded glass during maintenance function fixing bottling line filler
1817168	sweeping the stairs, foot came off the stairs and fell down closing
1817470	repetitive motion injury to left wrist from packaging activities flipping boxes, taping and stacking cases of beer flipping boxes
1818509	missed step on stairs walking up stairs
1818522	working on bottling line label machine and cut finger on metal pallets. preventive maintenance/packaging run
1820478	no injury - seizure walking
1821532	was standing on a pipe to see inside the mayno pump. standing on pipe.
1821668	disconnecting hoses
1823419	dumping out a barrel, fell on finger xxxxxxxxxxxxxxxxxxxxxxxxxxxxx
1823440	was fine all of a sudden he had a sharp pain in lower right back- laid down for a few then threw up xxxxxxxxxxxxxxxxxxxxxxxxxxxxx
1826334	moving chemical drums.

1827821	falling off ladder bringing apples down from top shelf of the cooler bringing apples down from top shelf of the cooler
1828173	employee was moving kegs one hit his knee putting beer away
1829573	burn on oil in pot not provided on froi
1829965	bsr tank
1831528	while setting up festival the wound piched up the metal chaffing pan, it landed between my two xxxxxxxxxxxxxxxxxx, lacerated bruised needed stitches not provided on faxed froi
1832134	pulling the cord to start a xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxlippedxxxxxxx and he struck his forearm against the bar causing a laceration start a powerwasher cleaning
1838339	locking the fence.
1838606	xxxxxx was slicing roast beef on the slicer and sliced her right thumb and index finger, taking off good amount of skin slicing roast beef
1840542	xxxxxxxx on right forearm throwing trash out
1844343	stepping off ladder onto matting and flooring (twisted l knee) organizing products
1844417	twisted around foot caught in floor mat knee twisted serving beer
1844581	while moving kegs of beer moving keg from pallet
1846861	employee was using bathroom after floor was cleaned. exposure to cleaning chemical using bathroom
1847884	sanitizing tank, xxxxxxxxxxxxxxxxxxxxxx in face sanitizing tank
1848222	slipped walking in dish pit. fell on left knee. walking
1848869	a boot filled up with hot water brewing
1849752	keg machine
1850673	employee was turning a valve that was still under pressure and was sprayed on lower arms and xxxxxxxx. cleaning lines
1852122	waitress noticed that lights had fallen down and tried to organize the lights & the lights shocked her. organizing a string of lights
1853178	fire blowback from pizza oven opening pizza oven
1855808	lifting a keg with a customer keg lifting
1858994	hand truck with 2 full kegs fell on leg because of a slick ramp delviering beer
1859512	boiling wort spilled onto right arm and leg while drawing wort into bucket to dissolve yeast in nutrient. drawing wort from boil kettle.
1860540	keg machine maintenance
1860872	hit in the knee with a high chair. clearing tables
1868524	employee dropped a full keg on right big toe adjusting keg location in cooler
1868607	keg hoist hit face kegging beer
1869784	lifting bus tub that was too heavy lifting
1869955	walking through brewery and tripped over hoses. cleaning tanks
1870085	unjamming depalatizer off of feed clearing a fallen bottle
1874285	tripped on rug serving
1875421	smashed his right hand between two kegs delivering kegs
1880316	sitting in a chair, a photo was knocked off the wall and fell on his head, causing a small laceration sitting in a chair

1880475	walked into a cabinet while behind the bar.
1880491	sustained glue burn while trying to scrape glue off box stocking cases
1885580	lifting a keg on top of another one and bumped the keg in front causing xxxx to tweak his back. lifting keg
1886939	floor by door was wet from melted snow, slipped on floor walking by door in kitchen
1887005	xxxxx stood up and hit his head on a tank. he was dazed a bit and then hit his nose on a valve. cleaning a tank
1887084	kegging and down stacking kegs from a triple stack.
1890348	down stacking grain onto separate pallet. tripped on the pallet and put all weight on his right foot as it landed on the pallet and the floor.
1890543	pulling kegs with the pallet jack. pallet jack moved and he did not.
1890594	xxxx got foreign bodies in his eyes (may just be significant amounts of dust) that is severely irritating his eyes. xxxxxxxxxxxxxxxxxxxxxxxxxxneralxxxxxxxxx warehouse work
1890602	putting mats away, slipped and fell putting floor mats away
1891338	moving kegs from truck bed to make to tailgate delivering kegs
1892072	cleaning a reach in fridge which was repaired xxxxxxxxx. received an electric shock from an open light bulb socket cleaning
1900170	put hand into case sealer to pull case out, got hit with hot glue bottling beer
1901387	hose in tank spraying out caustic. got up under his eyes and burned him. cleaning out brew tank
1901755	xx was cooking by the flat top, reached over grabbed a dome lid what was on top of fryers, burnt left index finger and thumb cooking
1902350	grease popped fryer
1902463	while checking the filter, a bottle popped on the reject conveyer. a piece of glass popped and hit him in the face, giving him a small cut. checking the filter on the bottling line
1903025	set a keg up on another keg and it was icy, so the bottom keg slipped and made the top keg fall. he tried to catch it, but it slipped and fell on his right foot. delivering a keg
1903689	walked in to walk in freezer, slipped on ice on floor getting food for line
1904907	employee slipped on a metal roller. fixing a row rebuild in palletizer fixing a row
1907780	taking out garbage & stepped on a nail
1909075	there was a leak in a draught line while they were cleaning the lines with chemicals, a stack of towels was soaked in the leak. added those towels to the washer with bare hands-chemical burned hands loading towels into washing machine
1910007	moving bags of grain(raw materials) organizing raw materials
1911394	3+ years of doing the same repetitive motions on same bottling line work
1913979	picking up tube sand bags, lifting them to his shoulder and carrying them. his back started to get sore around 1-xxxx, and continued to get sore throughout the night. carrying tube sand bags
1914218	changing a xxxxxxxx container, pulled something in his shoulder. moving a n2 container
1916335	hot water burn out of hose cleaning glue machine
1918027	lifting kegs moving kegs
1918521	holding 2 small glasses in one hand and one broke washing dishes
1918587	working by a shelf, a growler fell off the shelf and hit xxxx in the head & shoulder. the growler fell approximately 2 feet. working on computer

1919788	while milling in for brewing, employee felt a tingling in lower back. xxxxxxxxxxxxxxxx when bending down to grab a back the pain was so immense that he could not stand up for 10 minutes. lifting
1920332	alleged slap to the face by head chef preparing soup
1921462	mixing wax and a piece stuck to the bottom of the slow cooker and when it became free, it splashed up and hit my hand
1921826	moving a cask into the cradle and his foot slipped on the ledge. this pulled his lower back.
1923659	xxxxxxxxxxxxxxxxx in depalletizer came lose disengaging machine bottling beer
1923817	xxxxx got a burn on his arm from a splash with the xxxxx working the xxxxx
1924704	while undoing some nuts and bolts on the canning machinery, he caught a sharp edge and cut his knuckle. tearing down canning line
1925568	broke glass in hand on counter and cut finger. washing glasses
1929662	employee was getting on his bike after getting sugar at a king soopers, as he got on his bike, xxxxxxxxxxxxxxxxxxxxx knee getting sugar for a recipe at the king soopers
1932313	the pump fell off the back bar causing the cleaning lines to be pulled out of the caustic bucket. this caused caustic to pour onto the floor and his pants. his hands and feet were exposed to caustic cleaning beer lines
1934604	chase was taking a asceptic sample on a tank. to perform a asceptic sample, you heat the sample valve until it gets red hot. while performing the sample, his thumb slipped and hit the surface. aseptic sample
1934630	employee landed awkwardly while pushing a pallet. pushing a pallet
1936557	xxxx was unloading from a festival and caught his finger in the gate of a company vehicle closing tail gate
1940298	doing prep work using a knife; caught knife under fingernail chopping herbs
1940339	xxxx was clearing a bottle jam by the bottle dryer where the tracks taper from a 3 wide track to a single track. while clearing the jam, a bottle exploded and cut xxxx at the forearm. bottling
1942094	while cleaning beer kegs, the employee accidentally brushed his forearm against a very hot keg and burnt himself. the burn in located on the back of his right forearm. kegging
1942773	xxxxx grabbed a hot pan that was falling from the top of the stove on instinct burning his hand. cooking
1944744	he was moving a barrel. he is experiencing an abdominal strain. moving a barrel
1946104	slipped preforming brewery tour
1947207	serving beer and stepping off the stage and a toddler ran in front of him into his leg and twisted his left leg.
1947234	turning pan with hot oil. oil splashed out and hit his arm. cooking
1947492	after moving kegs around inside the draft trailer, employee is complaining of lower back pain lifting kegs
1948850	cutting onions, knife slipped off top of onion and sliced open finder nail cutting onion
1950961	xxxx was at a festival and was going to get cold beer cases out of the semi truck when the wind came up and the door swung knocking him off the platform getting cases of beer out of truck
1951896	cutting the cheese

1953895	the employee was using a ladder to reach material on a shelf. when the employee was coming down the ladder, with a box, he caught the edge of the box on the ladder and fell. retriveing material with a ladder
1955157	trying to repair a fence escorting guests out
1955630	while putting away beer glasses, the employee was holding two hot glasses in the same hand, the pressure of them against each other caused a glass to shatter. the shattered glass cut her fingers. putting away glasses behind the bar
1955922	coming down off of the catwalk, slipped and hit shin on walkway cutting shin brewing
1956770	while attempting to switch a valve, the employee bumped his knee against a hose line that was not properly connected, causing a partial disconnection and spraying caustic chemical cleaner on him. opening cellar valves
1957375	was lifting a large box and hit himself in the eye - scratched his eye lifting a box
1959680	taking out the trash and the door slammed on his right middle finger taking out trash
1962462	the employee was bringing down a box of labels from a shelf, when he suddenly felt pain in his left shoulder/neck. bringing down a box a labels for packaging
1965194	caught finger as i dropped keg onto side running keg line
1965915	stepped in a drain and fell on my back cookin going line
1970216	backed into sharp edge on a cooler panel moving cooler panels
1971474	steel bottom hatch swung open onto knee cleaning filter
1971749	xxxxx grabbed the last ticket in the kitchen after a lunch rush and emphatically stuck it on the ticket stabber. he pushed it too far and the ticket stabber punctured his hand. celebrating
1972763	while lifting kegs
1973047	glass particle engaged in left knee packaging with case dropper
1973507	opening up a small container "oil killz" and squirted in eye. cleaning concrete
1976292	sprayed with water xxxxxxx canning
1978336	he was moving a full 1/2 barrel keg and he dropped the full keg on his left foot. 1/2 barrel kegs are approx 150 lbs and it was dropped approx 14" onto his foot. cleaning and moving kegs
1979084	slipped on wet floor while carrying dishes stocking dishware
1980709	walked into the walk-in cooler and slipped on a lid that fell off on of the lexans. fell to the ground and injured his left knee stocking the app side line/cooking
1981243	repetitive motion over time flipping boxes, lift boxes, stacking boxes, moving kegs flipping boxes, lift boxes, stacking boxes,
1984419	he was closing up the bar and cut himself on some glass closing up the bar
1986267	tweaked back a little lifting kegs. felt xx this morning and tweaked it a little more again lifting kegs.
1987282	employee was cleaning the underside of a conveyor belt with chlorinated cleaner and some of it splashed back into his eye. cleaning
1988959	the xxxxxxxx was working in the box shop when he noticed that a small spot on his right arm had a burning sensation and could see a red spot. the employee was not around or working with any chemicals. box shop loading
1989280	repetitive motion over time stacking can cases
1991827	removing a drain plug on a heat exchanger with a channel lock wrench and sprained left ring finger removing a drain plug

1993375	while carrying a handful of dirty dishes, xxxx slipped while turning the corner and moving off of a kitchen mat onto tiled flooring. carrying dishes
1993843	employee was removing kegs from the draft trailer and suddenly had a sharp pain in his back. he immediately continued work with some discomfort. moving kegs
1998197	shaking carbonation reader to measure carbonation. left side of upper back and neck seized up brewing
1998780	the xxxxxxxx was building a metal shelving unit when one of the unsupported pieces fell and struck him in the head. the employee did not lose consciousness but did have a minor laceration. assembling shelving unit
1999351	employee was working on a drop packer machine when his finger got caught between the break. packaging
2000217	the employee was submerging a hose inside of a brink tank that holds near boiling water and accidentally put his arms too far in and had water enter his gloves. cip keg machine
2000623	server was walking by the dish pit when a rack of dishes fell on her left foot. walking
2001244	twisted ankle in shoe while walking down stairs with food in hand serving food
2004638	employee was lifting a 1/2bbl keg out of our delivery vehicle ('98 chevy pickup) and dropped the keg on his foot lifting keg beer delivery
2006743	repetitive motion over time stacking pallets
2009756	employee was carrying a mop bucket up two flights of stairs and felt a pinch in his lower back cleaning
2011144	xxxx was slicing bread and sliced his left index finger preparing food in restaurant kitchen
2011773	repetitive motion over time - lifting wine barrels moving wine barrels
2012689	unlocking patio furniture, and hit her hand on the outside wall, because there was a knot in the chain she was unlocking. unlocking patio furniture
2012709	repetitive motion over time xxxxxxx and bottling
2013342	standing on stepstool to clean. stool slipped, fell hit hot grill with head and both hands cleaning
2014727	the employee has been experiencing lower back pain for a few weeks and feels that it is becoming more severe. the employee has been working in the packaging hall moving kegs. kegging
2015162	while carrying hot fryer oil out to the dump container, xxxxxx slipped on some ice and dropped to the ground, slightly injuring his right knee. carrying oil to the dumpster
2016791	an empty keg fell off a pallet and struck the employee on the top of her head. kegging
2017359	employee was climbing down from a ladder and caught his ring on part of the equipment. the ring was rapidly pulled off from the force and caused the injury to occur. climbing down from ladder while brewing
2021839	driving back from dropping off battery cores for left hand. another vehicle made a left turn and crossed him, causing xxxx to crash into the vehicle. driving
2025433	while cleaning kegs, xxxx stood up into the safety cage causing a concussion. cleaning kegs
2025778	while cleaning the exterior of a tank cleaning
2026270	removing plywood planks from a stack while building a xxxxxxxxx of the planks dropped on his foot removing plywood planks from a stack while building a ramp.
2027947	employee was removing cases of beer from his car and strained a muscle in his lower back. moving beer cases from car

2027996	employee was going through a green light at an intersection when another car ran the red light causing the employee to hit the side of the other vehicle. driving
2028162	carrying box of labels is missing
2029086	xxxx was walking into the walking fridge after it had been mopped and slipped walking
2029724	hand slipped while cutting lettuce on cutting board.
2029774	working on packing line, on out feed conveyor, was crouched down and couldnt get back up working on the line
2029880	board broke, box cutter blade punctured forearm cutting board
2029994	piece of glass went through his shoe walking
2030792	the employee was transporting used chemical storage containers to a different area and got some of the unused chemical on his face. moving chemical barrels
2032602	ee moved quickly to address a problem with outfeed on bottling line. twisted/dislocated knee. stacking off cases on bottling line
2037160	pulled keg off filler, set on ground; pulled 2nd keg off and crushed hand between both of them filling kegs
2039755	xxx was thrown off of the back of the forklift at the warehouse while unloading the truck at the dock. he said it came to a stop then quickly accelerated, knocking him off. he landed on his back. unloading the truck
2040832	cutting cabbage - knife went through cabbage into palm of hand prepping food in restaurant kitchen prepping food in restaurant kitchen
2041939	puncture wound while preparing shrimp. food prep
2044534	xxxx came in with his back hurting and says he spent a good amount of time stretching before his shift. as he was wrapping pallets, he felt a shooting pain go down his back and into his right leg. wrapping pallet
2044983	prepping food in the kitchen cutting
2047641	slipped walking downstairs from administrative offices to the restaurant. slipped down 7 stairs walking
2050413	the employee was loading pallets onto a truck when he slipped and fell onto his knee. loading pallets
2053719	employee was removing a bottle from the packaging line when it exploded in his hand. packaging
2058140	sharp pinching xxxxxxxxxxxxxxxxx. standing
2062859	overuse and repetitive stress - ladders, crouching, kneeling
2065015	xxxxx was changing the oil in the fryer. while trying to step over the pot, he accidentally stepped in it. prepping the fryer for the day's business
2066609	cutting cheese, knife slipped and cut left index finger
2067190	tripped on a pallet jack and landed on right hand/wrist wrapping a pallet
2067194	he was tightening a machine bolt on a packaging machine with a socket wrench. when applying force to the wrench, the socket slipped off of the bolt. the wrench jerked back an hit him on bridge of nose tightening bolt
2069386	"she was pulling some kegs and twisted her ankle" carrying empty kegs
2070821	turning a valve on the hot liquor tank. pressure built and hot water (190 degrees) splashed out and onto xxxxx's back and neck. turning valve
2071571	xxxxx has experienced rash the last few days upon changing gloves cooking
2071695	stepping onto platform to troubleshoot machine 6 pack erector

2071764	taking down a tent, one of the braces broke and snapped back and hit thumb, pulling it back. taking down a festival tent
2072884	hot liquor poured out of the top of the hopper while backflushing macerator
2073231	knife work cutting an onion
2074234	xxxx was lifting a tray of food in the walk-in cooler and slipped and felt a pull in his back. prepping food
2075370	xxxxx says he is having heavy joint pain from pinching/crimping the sprayer on the sink to wash dishes. washing dishes
2076861	rolled his ankle stepping over a pallet walking
2076929	xxx was wrapping pallets and said it hurt to bend over at the waist. wrapping a pallet
2081503	caustic splashed into eye while wearing safety glasses cip fermenter
2081585	reaching for a case of beer to move it, slipped into the forklift hurting right forearm moving beer
2081708	she was carrying a bucket of hot water and the bucket slipped and hot water splashed on her right foot helping brew
2082474	xxxxx was climbing a ladder that slipped from under him. tank cleaning
2082935	dropped a keg on it changing a keg
2084484	as another team member was in the process of moving a keg into our cooler in the taproom, the keg came loose, hit the door to the cooler, jarred it loose, and the door fell from its hinges onto xxxxx. bartending .
2084659	moving a hose and twisting it and felt a pop in arm moving hose
2087897	going down short stairs into brewery, slipped and fell cleaning
2089324	caught finger under empty keg while transporting moving empty kegs
2090996	she was serving food in the patio area outfront and the pavement was wet and slipped on the water.
2092302	fell on ice got worse at time went on leaving work
2094098	he was stung by wasps xxxx was working on the spent yeast tank when he was stung.
2094159	employee ran to car from the restaurant, it had started to rain and the windows of her car were down. she ran into the parking lot and slipped and tweaked her knee. she returned to work limping. running to car from restaurant building
2095259	xxxxxxxxxxxxxxxx, xxxxxx was doing cellar work (re-arranging kegs in the cold room) and felt he had pulled something in his abdominal area. moving and filling kegs.
2095733	washing dishes and slipped and wend down on rear hand catch dishwashing
2096319	a filter for xxxxxxxxxxxxxx broke, and plastic housing for filter hit him in the arm and chest packaging
2096805	splashed lye in right eye while dipping pretzel dough in the lye/water solution. preparing handmade pretzels
2097746	xxxxxx was emptying beer out of wooden barrels and his back began to hurt him after a long day of this work. moving wooden barrels
2097911	cut hand while scrubbing dishes in a sink washing dishes
2101147	employee was adding fruit puree to a keg and slipped on lime puree on the floor injuring his knee adding fruit to beer
2101401	crush/pinch finger between plates while carrying a stack. carrying stacked plates in kitchen
2103592	regular work duties - walking. walking through production floor.

2104259	pushing bottles on the depalatizer, caused a laceration. pushing bottles on depalatizer
2104570	the employee was performing regular job duties in the packaging hall and began to have respiratory issues. box shop
2104737	the employee was using a quality testing device on a beer bottle when the bottle broke and cut the employee's finger. quality testing on the bottling line.
2105073	standing on top of keg then stepped off onto concrete floor stocking shelves
2107254	stepping off of a ladder onto a hose cleaning
2108213	employee was hand-tightening union onto a pipe and cut his left thumb on the threads. xxxx was present on the pipe. replacing steam line union
2108524	i was coming around the corner between the kitchen and the dish pit and slipped. my feet flew up from beneath me and i hit the ground. walking through the dish out to get to the office.
2108966	xxxx was working overhead to fix a garage door in the tap room. he lost balance and fell to the ground and when he got up saw that his thumb was bleeding. attempting to fix a garage door
2111459	employee was filling water carafes in the sink behind the bar. sliced tip of finger on piece of metal used as a splash guard in that area. filling water carafes, serving guests in tap room/restaurant filling water carafes,
2113010	the employee was moving kegs off a pallet when one fell off the side. the employee tried to grab the keg but it impacted her hand against the wall. moving kegs to be emptied
2113699	the employee was walking back to their hotel for a work event and tripped on train tracks. walking back to their hotel.
2114912	cleaning solution splashed around protective eyewear and into eye adding cleaner to the tank cleaning cycle
2115634	he slipped on a piece of chicken and fell cleaning chicken
2116457	xxxx was cleaning the slicer and his thumb went into the blade cleaning the slicer
2116984	door hinge was stuck and he was struck by the door when he was exiting the bathroom opening a door
2117065	xxxxxx (a kitchen employee) was transferring gumbo to the steam pot. gumbo spilled over and burned her on the right forearm transferring gumbo from soup pot to steam pot
2118155	put hand in moving object, did not hit stop making boxes
2118358	employee was loading up a cart at an event. he was lifting ice bins and cement anchors used to secure the tents for this event. felt a "pop" when lifting lifting supplies to set up for a sales event that evening
2120747	she was sharpening a knife and her pinky slipped in front of the knife on the second pull through of the knife. sharpening a knife to use in the kitchen
2122163	she was rear ended by another driver while making a tap handle delivery. driving
2122261	employee was collecting and organizing garbage cans at the end of his shift. when lifting one can, a piece of glass which was stuck under the handle (and out of sight) sliced his right palm. collecting trash after packaging run
2122315	cutting lettuce at hyperspeed
2122322	cut tip of of thumb off using a knife prepping bread for dinner
2122729	the employee was getting out of a forklift and bumped his head on an overhead handle. moving pallets with the forklift.
2123761	stacking a glass from glass rack one glass shattered and split her webbing between her fingers. stocking glasses for close at the end of the night.

2124561	xxx was soldering behind keg filler. excessive solder dropped onto water puddle. solder splashed back burning his shirt and hitting his eye. soldering xxxxxx pipe
2125152	moving hold wheeled-centrifuge pump to a different part of the cellar. also moving hoses out of low storage area under tanks moving old wheeled-centrifuge pump and lifting hoses
2125232	mr. xxxxx kicked the fryer filter machine to move it a bit, spilling oil onto his foot. filtering the fryer.
2125261	sliced finger open while cutting lemons cutting lemons
2126984	walking with keg, tripped on unknown object moving kegs
2127824	repetitive motion . employee was lifting 1/6 barrel kegs from keg line onto pallets during a regular packaging shift. motion from lifting injured shoulder over time. lifting 1/6 bbl kegs onto pallets.
2127920	worker was moving chemicals and the hose broke lose causing chemicals to spray. working in the cip room for brewing.
2131930	on 11/1 ee was working a regular shift and felt irritation of this previous injury. originally was climbing a ladder and hit top of left knee while climbing - date unknown by ee adjusting can line in packaging hall
2131954	was cleaning the side of the grill and swiped inside of bicep along the side of it. was cleaning the grill
2136033	i was cleaning a tank and he fell off the ladder i was cleaning a tank
2138894	xxxx was taking out our trash when two dogs got into a scuffle at the end of our property. he intervened to separate the two dogs. as the dogs separated, one of the dogs bit him in the arm. initially, taking out the trash
2140121	stood up and hit head on an open tank door moving a hose
2140658	employee slipped on brew hose in cellar (on production floor) and twisted his left ankle. fell to the ground and noticed swelling around ankle. looking for parts and purging/cleaning hop cannon
2141406	lifting a container of mayonnaise. the container is basically a xxxxx plastic bucket with a handle (strap) attached to it for lifting. it is 25 pounds when completely full. monthly inventory
2141609	xxxxx was picking up a keg to put on a pallet lifting keg - staging order for breakthru lifting keg
2141708	slipped while moving pallet. moving a pallet
2141889	was stacking cases and began to feel pain was stacking cases
2143038	he put his hand into a filler drain to remove glass holder and got fluid on his glove. when he removed glove, his hand was shiny so he washed it but by the next day skin on hand was peeling reached into filler drain to remove glass holder
2143171	attempting to force swing bend into place and wrist was injured by applying too much force against the pipe see above
2143520	replacing metal door frame and finger was smashed between metal frame and door. replacing metal door frame and finger was smashed between me
2144354	he tripped over a hose. he fractured his radial head. making beer.
2144380	holding dumpster lid open with left hand throwing garbage in in with right hand, felt pinch in right wrist, sprain. throwing away garbage.
2146059	using box cutter to cut plastic zip tie to remove xxxxxxxxx decoration. the knife slipped and cut into xxxxxx's left calf muscle. removing xxxxxxxxx decoration with box cutter.

2146314	tightening the drill chuck on my drill and the torque rip my finger hanging point of sale at an account.
2146423	tripped coming out of kitchen and fell on some glass and cut finger walking out the xxxxxxxxxxxx.
2148924	moving kegs and pinched right hand pinky finger moving kegs
2148933	replaced metal door frame after removing it to relocate new cooler. cut happened when finger was smashed between metal frame and door moving frame
2149350	was working on drain gate, coming up from squat position head caught edge of piece of stainless steel connected to pipe fence and ripped open skin on head. working on drain gate
2149670	was drinking water and choked, started coughing and got dizzy and fell forward and hit head and fell on left arm. mopping bar area
2149980	040 moving pallets of cans during can run in packaging hall
2151128	can ruptured in my hand while in the process of being emptied. emptying low fill cans
2151172	slipped on the stairs leaving the building to go to parking lot see above
2151990	hit head on smoker door cooking
2152762	the employee injured his back in xxxx outside of work. while on light duty, he experienced back pain due to his prior injury. the employee stated that this was not due to work duty. walking
2153723	the employee was pushing boxes into the drop packer on the bottling line and accidentally placed his finger between a brake pad that moves back and forth to the stop boxes. moving boxes on the packaging line.
2155536	two hoses were taken apart and a small amount of cleaning solution spilled onto the floor. his wrench dropped into the cleaning solution and the solution splashed under his safety goggles in his eyes in the process of cleaning hoses
2156785	lifting boxes moving boxes from one area to another for packaging.
2156968	carrying lettuce bin, stepped on edge of mat, rolled ankle, heard it pop and almost fell carrying lettuce bin
2159148	slipped and fell on back steps. coming into work
2159559	flipping glass bottles from boxes onto bottling line. boxes are flipped upside down to remove glassware properly. running the glass station on the bottling line
2160076	hurt back lifting bin even though he states he was using safety techniques. lifting bin
2162213	moving boxes and squished finger
2162432	ee operating a forklift, unloading a truck of barrels. one of the barrels, which was wrapped to a pallet, came loose and rolled back towards the forklift. ee's hand was caught between barrel and cage unloading barrels from distributor using forklift.
2163050	stood up and top of head hit corner of open window taking recycling out doors and leaned over to tie the bag
2164908	xxxxx was polishing a martini glass and the glass broke, the stem of the glass cut the palm of his hand polishing glassware
2165292	empty keg fell from 3 kegs high and fell on his toe bringing empty kegs back to his truck
2166974	repetitive motion - moving and carrying cans from case flats into 12-pack can boxes. stacking cases and packing boxes. packing 12-pack can boxes.
2167562	the employee was driving home and was rear ended by another vehicle while driving on the highway. driving

2168989	rolling yeast brink through annex door and it tipped, he tried to save it, it smashed finger between the door frame and brink. rolling yeast brink
2171914	the employee was moving a hose and suddenly felt pain in their lower back. dry hopping/filtering
2173941	while grinding caught finger in grinder
2177035	the employee slipped on a wood board while removing snow from hops and handrails.
2178681	she smashed her finger in the cardboard compactor operating our cardboard compactor
2178726	clearing a stuck pallet, reaching in to pull up pallet see above
2178793	he touched a power switch on the power supply and received an electric shock he was testing the power to each panel
2179434	repetitive use from driving a fork lift
2180970	fell off a ladder, landed on his head fixing a garage door
2181564	he was putting a tray of dishes in the dishwasher and strained back loading dishwasher
2181889	the employee was moving patio tables and felt a sudden pain in their mid back and left shoulder. moving patio tables.
2182016	scraper fell off waist high table on ankle and sliced
2184288	ee was picking up trash under glass rack in upstairs restaurant closet. hit head on corner of glass rack, cutting top of head cleaning restaurant, taking out trash cleaning restaurant,
2186083	employees was lifting chicken out of the pressure fryer and tweaked his mid to lower back lifting chicken
2186766	repetitive pipetting in our qa/qc lab, repetitive carrying of sample cups to-and-from production floor, various fine motor work taking and analyzing samples from our beer tanks - over time taking and analyzing samples from our beer tanks
2188255	slipped pulling loaded grain cart, shins lacerated to bone, both left and rights, as legs slipped under cart pulling loaded grain cart
2191490	tripped over the curb while running back to the packaging hall running back and forth to his car since he forgot water bottle
2191549	strain to arm as he moved a rack of glasses moving a rack of glasses
2191736	ee was measuring nitric acid from acid bucket. when pouring the chemical out of bucket and into pitcher, small amount splashed up under safety glasses, into eye. measuring chemicals
2191813	xxxxx was tightening a nut with a nut driver on a piece of equipment call a hydrator. the nut driver slipped and the handle hit her on the lip. tightening a nut with a nut driver
2191930	labels were slipping out of labler tried to replace them with machine running packaging
2192082	ee was exiting his work area, located on the top of engineering station. while descending , slipped & fell down approx. 4 steps on the steel, mobile staircase leading to the work area(facing forward). leaving desk/work area to assist in another area.
2192521	equipment failure rinsing beer lines
2192644	while attempting to disassemble a pressurized rootbeer bottle, it blew up against his xxxxxxxxxxxxxxxxxxxxxxx was breaking down a pressurized plastic bottle
2195051	rushing down stairs and hit hip on hand rail going downstairs from second floor to first floor
2198003	washing bar glasses - w/rotating brushes- glass broke. holding glass w/ left hand in sink. washing dishes
2198231	regular walking up stairs - mis-stepped one stair and fell onto one knee against edge of stair walking up stairs

2198617	the employee was carrying a container of chemicals through the indoor cellar and tripped on a hose line. carrying chemicals for packaging
2199858	moving kegs in the walk-in cooler in the tasting room moving kegs.
2201648	while kegging in the packaging hall, a full half-barrel of beer fell off vacculux to the ground, causing the xxxxxxxx to jerk up and hit her in the chin. packaging/kegging half-barrels
2202268	picked up a dish tray that had caustic spilled in it and his arm and fingers came into contact with it picking up dish tray.
2202832	slipped on beer, behind the bar getting ice
2202848	he was adjusting tarp on malt trailer and the handle kicked back strained his left shoulder and upper back adjusting tarp on malt trailer
2202995	smashed between 2 full kegs inventory
2204408	in xx-workers car coming back from show in xxxxxx, hit some ice and hit guard rail , whiplash riding in car
2204990	got fryer oil in his eye during service. working the fryer station
2206090	xxxxxxx stepped on a grate and twisted his right ankle serving
2206096	employee was crouching under a hanging shelf to pick up various pieces of trash. hit head on piece of sheet metal that was laying on the shelf with a small overhang. moving barrels, cleaning garbage
2206124	plastic nozzle cracked so it allowed caustic to spray onto his face using the caustic foamer to clean
2206438	xxxx was cleaning the bright tank, which uses hoses. he forgot to close the valve on the blowoff hose for the tank and undid the hose. hot water got all over his feet and shins. cleaning the bright tank
2207049	stabbed a hold in keg to release/ drain beer. keg exploded draining international kegs
2207208	xxxx was adjusting the pallet topper and slipped off the stepping stool and fell into the metal bar. putting the pallet topper on a pallet of cans
2208127	slipped in grease on floor fell on wrist and felt snap walking
2208205	stepping off of a ladder cleaning a tank
2208789	xxxxxxx was standing in the kitchen by the sink. xxxxx was dumping hot water into the sink. he rested the pan on the edge of the sink and some of the hot water splashed up & hit xxxxxxx. xxxxxxx was standing by the sink talking to the manager.
2208801	lifting an approximately 40# pan of pork butt off the floor. employee turned left to place the pork butt pan on the bottom shelf and felt a sharp pain right of her belly button. employee was properly moving and storing food in a cooler
2208948	strained lower right back lifting pump out of the barrel using a pump to pump barrels of juice to be dumped.
2213384	xxxxxxxx was changing a keg in the walk in cooler of bristol brewing company, when another keg began to fall, xxxxxxxx attempted to catch the keg with his left leg and was hit pretty hard by the keg. changing a keg of beer in our walk in cooler while on duty
2213614	over pressurized can popped open dumping cans of beer, top opened in reverse dumping cans of beer
2213687	while dose bulking caustic tank for cip - when attempting to add caustic, some splashed back on his face. his mask had been pulled back due to the pipe work. adding caustic to the caustic tank.
2215468	washing a test tube and it broke and cut her thumb

2215717	walking through box shop and stepped on air hose walking
2215817	seam inspecting on a can
2216333	pinched hand between keg and feed rail moving keg
2216839	entering into a building, a swarm of wasps by the 1270 warehouse door were there, one of them stung her. walking into a building
2217855	pulled a cast iron pan out of the oven, and there was oil in there and it spilled on his hand. xxxxxxxxxxxxxxxxxxxxx from the wood fired oven. pulling pan from the wood fired oven.
2218074	i was setting up a losen table and it fell on his left foot big toe
2219997	while the employee was wrapping a pallet of bad kegs, his leg brushed up against some scrap metal. wrapping a pallet.
2220021	hot water splashed up into boots while draining blow off buckets in cellar, used while crashing beer tanks cleaning blow off buckets during brew cycle
2222338	tripped going up stairs, caught herself with her right arm and strained the right shoulder
2222439	was standing on a window sill and it broke, landed on a dolly. trying to reach an ethernet cable and was not on a ladder
2224019	employee states she was walking and accidentally stepped and slipped on a potato. washing dishes
2226993	xxxxx was dumping a box of crowns down the crown chute and the step stool moved from under her causing her to fall towards the chute and pinch her pinky between the crown chute and a box of crowns. pouring crowns in crown chute
2227336	he was putting away third pans and one fell and chipped his front tooth running the dish pit
2227767	strained his back while participating in our production olympics he was playing corn hole during our production olympics
2227987	loading boxes in the shrink wrap bundler stacking boxes
2228696	pouring caustic cleaner into a container when it splashed up and into my left eye not specified
2228896	strained back from repeated lifting while packing mixed-pack can cartons. lifting
2229251	loading cases onto a pallet packing off
2229850	bottling beer disconnected hose. hand slipped striking metal table cutting his left thumb bottling beer
2232795	while putting away dishes in the kitchen/dish pit area, xxxx shifted some lexan tubs to slide other dishes underneath. tubs fell from the shelf over head and hit xxxx on the top of the head putting away clean dishes and kitchen tools
2233109	driving too many hours each day driving driving
2233704	was filling caustic bucket with f-364. tilted jug which did not have cap on, caustic splashed up directly into his right eye. rinsed for 20 minutes at eye washing station. filling caustic bucket
2233984	while kegging, there was caustic residue left on the hose reel and zwikle valve from caustic being manually pumped out of the drum, which he grabbed. kegging
2234012	on insulated gloves caused inflammation filtration
2234111	carrying two boxes of fries around grill side corner & the smoker door was open and smashed finger / hand on the door under the fries walking
2234173	removing waste bin with assistance. down back steps to alley caught off balance fell against wall

2234877	was prying wood off of the wall, wood came look unexpectedly and hit him on the bridge of the nose removing cedar siding
2235827	scrapped his knuckle while loading stage decking
2235835	opened a new bottle of beer line cleaner and when he set it down a small amount of chemical splashed up into his eye cleaning beer lines in an account
2236913	xxxxx was reaching for a metal chicken rack and it slipped out of his hand and hit the back of xxxxx's head. standing, prepping butter for service.
2237070	i was driving to xxxxxxxxxxxxxxx to do a beer promo. i was in a line on traffic on alamedia ave at dead stop when i was hit from behind which launched me into the truck in front of me. i was in my car heading to a beer promo
2237087	playing dart warz for employee moral day playing dart warz(nerf game)"tweaked her knee while running"
2237692	packing can mixers and hit elbow several times on steel railing that is raised up by sensor that controls accumulation table. packing mixed can packs by hand.
2238249	bacon grease on cooking sheet dripped on the arm normal serving duties
2238520	tripped going up the stairs walking upstairs
2238588	car accident driving
2238782	went under conveyor and hit head getting up on electrical cabinet
2239890	holding two pint glasses, one slipped, crashing into the other, breaking both. glasses were wet. putting away glassware from dishwasher to shelves
2239892	operating joy stick and heard pop in wrist see above
2243196	he was stepping off the brew stand, which has textured and slip resistant surface, and he rolled his ankle. stepping off the brew stand stairs.
2243240	car accident driving
2244106	arm and shoulder pain due to repetitive motion with computer work
2244659	removing manway door from fermenter, twisted wrist. wrist hurts. removing manway door for cleaning.
2245789	repetitive use of hand and arm knife work, heavy lifting, stirring, etc.
2246580	at the end of the work day and back froze up. work day included lifting and moving beer in tight quarters
2247030	safety glasses broke while he was removing them removing his safety glasses
2247931	chemical splashed under safety glasses washing kegger
2249068	debris in eye cleaning burner tubes
2253615	he was reaching into tripple sink. burned fingers on hot dish. left hand
2254511	while opening a case of tap handles, her finger got smashed between the box and hand and it popped. packaging orders
2255662	when sanitizing the sample cock a small amount of chemical sprayed under her safety glasses
2255765	pry bar slipped and made contact with upper cheek, just below right eye. prying open a crate.
2255781	felt a "pop" in wrist while closing valve on cip arm attached to bright tank in cellar. losing valve during cip process.
2256396	he was putting a glass in the dishwasher, it hit the side of the dishwasher, shattered and cut his pinky finger dishes in the sensory lab dishes
2256453	tripped over pallet was moving a tent with a hand truck

2256825	kegs were falling off the keg machine and out of doors. he saw one falling and tried to catch it. he missed the keg and it fell on the top of his foot. kegging.
2257140	pulling conveyor and it slipped and his hand was cut by the metal railing working on the conveyor on can line
2257204	cut finger while slicing limes cutting limes
2257591	went to grab the stopper on the dolly and got a metal sliver in her right pinky finger using the dolly
2261399	walking
2263199	after dumping sanitizer from the hop doser, the lid was open and i reached to grab a bag of hops to start filling it then the lid fell down on my finger. brewing beer.
2263642	lifting kegs
2263874	xxxx was cleaning a fermenter tank when the valve cap came loose and fell on his head xxxx was using a hose to clean a fermenter tank
2265235	picking up food for ales for xxxxxxx. picked up a hot pan of baked ziti after she was told by the restaurant's staff that it wasn't hot enough to need oven mits/protection. picking up food.
2265613	lifting crown boxes into hopper loading 50lb xxxxx
2265656	cut finger when it slid across the cardboard clearing out a cardboard jam of a machine
2265863	employee was walking in authorized area and a pin hole in a pipe allowed caustic chemical to spray onto the employee's face just walking through the production area just walking through the production area
2268047	broken glass washing glassware
2268319	putting bags of hops into the chiller pulled a muscle loading bags of hops into the chiller
2272174	walking onto palletizer to mop floors in machine, tripped climbing up onto turn table, fell full force on knees on rollers. cleaning palletizer
2272182	while placing/rolling/pushing a full barrel of beer onto a barrel rack, xxxxx felt a sharp, quick pain in his neck. pain returned later and has persisted intermittently pushing/rolling barrels of beer onto barrel racks
2273778	lifting and twisting constantly throughout his shift with heavy objects. lifting
2273919	stocking kegs in cooler lifting kegs
2274371	lifting full cases of beer from kickoff conveyor to floor. shoulder started to hurt lifting full cases of beer off of the conveyor
2274400	opened valve on the racking arm to provide an air inlet while cooling tank. forgot the racking arm was pointed up and full of hot liquor, which sprayed the right thigh. cleaning fermenter.
2274786	xxxxxxxx tripped on the corner of the anti-fatigue floor mat and she fell down. walking behind the bar. regular duties.
2275771	bent over to pick up a box and strained his back while lifting it. picking up a box.
2276191	drop packer stopped from backup. turned the cycle off. fixed case sealer and ran back to drop packer, turned cycle on instead of reset. dropped and exploded 24 bottles and one piece sliced forearm. n/a
2276417	cleaning the bar line, xxxxxxxxxxxxxxxxxxxxxxxxxxx from cleaning line - cleaning solution got in her eye
2276913	he was lifting a full keg off the kickoff lane. removing a keg off the line for sensory

2276964	he was tightening the round plate that come in contact with the bottle tops. the light curtain broke and didn't release air pressure so his hands were caught under the round plate. tightening the round plate on bottling line
2280586	stepped on a broken pallet with rusty nail in it opening the bay door
2283343	walking downstairs and slipped and landed on side
2283829	cut finger on the track of the garage door. closing the garage door.
2284580	slipped and fell on ice in alley sales - walking out of an account sales
2285040	electric shock from outlet. plugging in a sign.
2285369	cutting a zip tie off a keg with a safety blade. missed the zip tie and cut his arm. cutting a zip tie off a keg
2285828	got hand caught between sliding plates on meura filter; caused contusion and small cut manually moving filter plates within the machine frame
2285830	stepped over a red rope and tripped and fell stepping over a rope that is there to prevent foot traffic
2286258	while loading and unloading boxes of glassware out of his car, he strained his lower back. loading his vehicle
2287010	employee was moving a 50# grain bag and injured his lower back. moving a 50# grain bag in restaurant
2288174	while filling kegs on the keg line, xxxx began to feel pain in her right elbow after repeated lifting and moving of full and empty kegs working the keg line, filling kegs during a run working the keg line
2288579	repetitive lifting sorting/lifting
2288831	employee was lifting/carrying full bags of coconut shavings while dosing a batch of beer. felt pain in back/spine after finishing task. dosing beer, living bags of coconut shavings
2289043	xxxxxx lost his footing descending brew house platform stairs descending stairs
2289524	while stacking kegs 3 high, he felt a shooting pain through his hand. throughout the evening the pain continued to come and go up through his right arm and still in his hand as well. stacking kegs
2289863	xxxx was unloading restaurant supplies from his vehicle when he turned into his car door and split his forehead just above his eyebrow.
2291028	after finishing my shift i was having a beer by the canning line. i hadn't eaten all day and the room had high levels of co2. passed out and fell back and hit head on the ground. not working. standing having a beer after my shift. not working.
2292401	the employee was cleaning beer lines. he ran from the taps to the cold room and slipped and fell . cleaning beer lines
2292522	slipped on ice walking up the ramp to the entrance of kegging walking over to kegging area
2294491	caught his foot on the stair causing him to come down on the side of his foot and roll his ankle walking down the stairs
2294992	moving large hoses/pumps using hand truck, felt pain in forearm moving pumps in cellar
2295497	walking through kitchen to dining dimly/not lit properly couldn't see black cart in doorway walking
2295928	arm placed on side of hot keg removed keg from filler
2297140	1/4 bbl keg slipped out and fell on foot taking a keg out for a customer

2297373	at this time, suspect this to be a medical event that happened at work. xxxxxx was beginning to mop floors, when she stood straight up, and either fainted or had a seizure, falling backwards. beginning to mop floors, standing up. in closing process.
2298632	hit knuckles on a metal railing near handle loosening a bolt
2298922	he was moving a hose that had caustic in it. he accidently put pressure on the hand valve level and was sprayed with caustic moving a hose filled with caustic
2299326	slipped on ice and fell on back at south side of bldg checking levels on slurry tank
2299551	stepped incorrectly off of a step-ladder and landed hard on left leg. vdk sampling
2299718	went to loading dock, hotel worker distracted mr. xxxx when taking keg out of vehicle and the keg fell out and hit left leg, possibly hyperextension knee, down scrapping his shin delivering beer to restaurant
2300230	adjusting set point 8 on switchback. hand rubbed against underside of ruler and cut open finger.
2300232	tweeked neck & back picking up a tray with food on it
2300737	while grinding a piece of metal, employee believes a small particle got into his left eye using a grinding wheel to grind burrs off a piece of metal
2301582	taking keg off back of truck, clipped edge of foot & toe pulling a keg off the back of the truck
2301902	keg fell on top of the bridge of the left foot. moving kegs.
2303587	started to hurt off and on about xxxxxxxxxxxx. mouse work at the computer for long periods of time computer work
2304438	xxxxxxx felt pain in his back xxxxxxxxxxx after working and wrapping pallets xxxxxxxxx wrapping pallets with stretch wrap
2304601	stepped into a wet area while mopping and slipped and fell. mop was leaning against the counter and fell. she leaned over to get the fallen mop and her foot slipped and she fell. mopping the floor at the end of the night
2305120	fixing a bent pan, his hand slipped and cut his thumb addressing service needs
2306520	he was stopped at a traffic light. the car behind him didn't stop & ran into him at full speed. when xxxxx pulled over to exchange information, the other driver drove off. driving
2306903	he was working on a piece of equipment and cut his and cut his hand with a box cutter repair
2307678	impact injury between two full 55 gal steel drums. manually handling drums.
2307910	lifting 50lb bags of sugar & 5 gallon buckets of honey adding sugar and honey to the merlin dosing vessels
2308220	was walking between ut 26 & ut 25 on the ramp, which is on an incline, while carrying a 5-gallon bucket of caustic. slipped on ice and fell on his side/back. no caustic spilled on him. walking
2308753	she was driving towards an account down a hill listening to google maps. she thought she had a yellow light, the other guy thought he had a green light. he turned and t-boned her front driver wheel. driving a car.
2308823	repetitive lifting lifting kegs with a keg lift
2309327	thermometer was misplaced so he was looking for it under the cooler and his xxxxxxxx opened the drawer and he hit his head on the drawer looking for thermometer
2311584	stocking cans and dry goods/putting away order, large can fell and struck forearm

2312315	stepped down without looking and landed wrong teaching a new employee on how to load a pallet
2313394	the employee has been working in a basement office for a few months and has been experiencing respiratory problems while working. typing
2316096	employee began to feel pain in shoulder after a shift if working on the bottle line and flipping glass onto the conveyor belt. flipping glass from boxes to conveyor belt on bottle line.
2316209	stepping down from brew deck stairs and stepping on a hose. brewing
2316274	felt a pop after moving empty, metal barrel racks a short distance. pain intensified after further moving the racks to their proper placement. moving metal racks used to hold wooden barrels.
2316627	employee was cutting the plastic around a pallet of beer cans and cut toward himself and hit is forearm. cutting slits in the shrink wrap around a pallet.
2317161	delivering five 1/2 bbl kegs down 2 flights of stairs. end of the stairway has a step up. after pulling the 4th keg up the step, felt a pulling sensation in the lower back. aching & burning feeling.
2317641	became sore after working a solo shift on the keg line, lifting 1/6 barrel kegs (weighing ~58 lbs)and stacking them onto pallets. stacking pallets, filling 1/6 barrel kegs stacking pallets,
2318329	rear-ended stopped at a light
2318409	xxxxxxxx was cleaning glassware with the barmaid glass washer. upon washing the glass with the barmaid, the glass broke in xxxxxxxx's hand and a glass shard cut his finger open. xxxxxxxx was washing glassware
2318997	poured glass into bin. felt and heard glass pop upon hitting bin. felt arm was injured and saw cuts from glass. xxxxxxxxxxxxxxxxxxxxxxxxxxxxxx. emptying glass bin.
2321057	we were moving a rack of barrels. the top rack only had one barrel on the rack and it got jammed up by another barrel on the rack behind it causing the barrel to be pushed off the rack. moving a rack of whiskey barrels. (see above).
2321130	employee cut finger while working prepping food
2321254	kneeling preparing filter
2321496	xxxxxxxxx was helping expo and wasn't aware that burrito plates are put in the oven...and she grabbed it to help tray on a very busy day and burned her fingers. helping expo food.
2321970	lower back pain on and off. started gradually after we started using more 50lb sugars into our beers lifting 50lb bags of sugar
2325312	while removing bad cases from global pack continuously with lifting and twisting motions pulled back. moving cases of beer
2325841	slipped outside walking to his car on the pathway walking to his car at the end of the night.
2326074	he was pulling on a pump to level it and he felt his right should muscle pop pulling on a pump to pull it into place
2327306	while moving a piece of equipment, a knife fell and landed in her leg. moving equipment.
2329409	picking up broken glass bottle capping bottles
2329865	lifting a pallet and felt tweak lifting a pallet
2330177	shoveling spent grain into a tote and awkwardly slipped while shoveling

2330448	twisted/tweaked ankle/foot while taking out trash after a packaging run. taking out trash left over from packaging run.
2351026	xxxxx was ducking under a conveyor and stood up too soon, striking the underside of the conveyor with his back. xxxxxxx/xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx/operating
2351063	employee was prepping bacon and cut his finger with a knife cutting bacon
2351240	he was working and a big lexan of fries filled with water for rinsing, he had multiple stacked and one of the containers became unstable and went to reach to save the fries and felt a pop in his back he was trying to save the loss of product that was falling.
2351476	was punching potatoes into xxxxxx fries in a fry cutter and had his hand on the top of the potato stabilizing it, and brought the cutter down and caught the top of his finger & fingernail. cutting xxxxxx fries with xxxxxx fry cutter
2351786	unknown - aggravation of former injury xxxxxxxxxxxxxxxxxxxxxxxxxxxx
2352048	lifting 50 pound bags of malt grain milling
2353157	pulling the gripper cylinder from the labeler working on a change over on the labeler
2357520	smashed it cleaning
2357997	she was rinsing a glass behind the bar when it broke and cut her hand. rinsing glasses prior to filling for a customer
2359165	using knife to cut open a bag, lacerated finger opening a plastic bag covering to service item
2375538	an employee soaked some kitchen equipment overnight in oven cleaner. xxxxx immersed his hands in the oven cleaner the next morning. setting up the kitchen for the day
2375647	back pain from scrubbing floors and placing / removing links throughout the cellar scrubbing floors and bending down to adjust links.
2376267	while opening a large gate that was stuck pushing a gate
2394567	hot water splashed on legs brewing beer
2399600	tripped going down the stairs. there was a brush on the stairs he didn't see going down stairs
2410612	picked up hot pan

8.15A. Details on injury characteristics for Claimant Identifiers specified in Dissertation

Claimant Identifier	Anatomical Region	Body Part	Total Cost	Injury Nature	Injury Event	Lost time (Days)	Age Group	Tenure Group
1686350	Upper Limb	Finger(s)	616.6	Laceration	Exposure to harmful substances or environments	0	< 24 years old	< 1 year
1737098	Trunk	Eye(s)	916.9	Other	Exposure to harmful substances or	0	35-44 years old	< 1 year

					environments			
1749190	Lower_Limb	Ankle	0	Sprain_strain	Overexertion & bodily reaction	0	35-44 years old	4-5 years
1756367	Lower_Limb	Ankle	418.6	Sprain_strain	Overexertion & bodily reaction	0	25-34 years old	1-2 years
1759041	Upper_Limb	Finger(S)	0	Contusion	Contact with objects and equipment	0	25-34 years old	< 1 year
1789812	Trunk region	Buttocks	0	Burn	Exposure to harmful substances or environments	0	25-34 years old	< 1 year
1813450	Lower_Limb	Foot	10948.1	Burn	Exposure to harmful substances or environments	48	35-44 years old	< 1 year
1840542	Upper_Limb	Lower Arm	584	Other	Other	0	25-34 years old	1-2 years
1892072	Trunk region	Multiple Head Injury	1743.7	Other	Exposure to harmful substances or environments	0	NA	NA
1910007	Upper_Limb	Shoulder(S)	36538.9	Sprain_strain	Overexertion & bodily reaction	0	35-44 years old	over 5 years
1932313	Upper_Limb	Hand	0	Other	Contact with objects and equipment	0	25-34 years old	< 1 year
1956770	Other	Multiple Body Parts	0	Other	Other	0	25-34 years old	< 1 year
1978336	Lower_Limb	Foot	2193.8	Other	Contact with objects and equipment	11	25-34 years old	< 1 year

1980709	Lower_Limb	Knee	734.2	Contusion	Falls, trips, slips	0	25-34 years old	3-4 years
2011144	Upper_Limb	Finger(S)	528.6	Laceration	Exposure to harmful substances or environments	0	< 24 years old	NA
2067190	Upper_Limb	Hand	724.8	Contusion	Falls, trips, slips	0	25-34 years old	1-2 years
2074234	Trunk region	Low_Back	8612.9	Sprain_strain	Falls, trips, slips	0	35-44 years old	< 1 year
2084484	Trunk region	Upper Back Area	194.9	Sprain_strain	Contact with objects and equipment	0	35-44 years old	< 1 year
2089324	Upper_Limb	Finger(S)	625.2	Contusion	Contact with objects and equipment	0	25-34 years old	< 1 year
2101401	Upper_Limb	Finger(S)	413.5	Contusion	Contact with objects and equipment	0	< 24 years old	< 1 year
2144354	Upper_Limb	Lower Arm	1578.9	Other	Falls, trips, slips	0	25-34 years old	1-2 years
2151128	Upper_Limb	Thumb	462.3	Laceration	Exposure to harmful substances or environments	0	25-34 years old	NA
2153723	Upper_Limb	Finger(S)	2906.2	Laceration	Contact with objects and equipment	0	35-44 years old	1-2 years
2168989	Upper_Limb	Finger(S)	715	Contusion	Contact with objects and equipment	0	25-34 years old	1-2 years
2204408	Trunk region	Neck Vertebrae	16208.6	Sprain_strain	Other	0	25-34 years old	1-2 years
2213384	Lower_Limb	Lower Leg	0	Contusion	Contact with	0	< 24 years old	1-2 years

					objects and equipment			
2228696	Trunk region	Eye(S)	141	Other	Contact with objects and equipment	0	25-34 years old	< 1 year
2263642	Trunk region	Abdomen/Groin	12332.9	Other	Overexertion & bodily reaction	14	25-34 years old	NA
2268047	Upper_Limb	Finger(S)	772.6	Laceration	Exposure to harmful substances or environments	0	25-34 years old	1-2 years
2304438	Trunk region	Low_Back	55579.7	Sprain_strain	Overexertion & bodily reaction	579	35-44 years old	< 1 year
2307678	Upper_Limb	Finger(S)	328.3	Contusion	Contact with objects and equipment	0	35-44 years old	2-3 years
2325312	Trunk region	Upper Back Area	15427.3	Sprain_strain	Overexertion & bodily reaction	103	45-54 years old	over 5 years

8.16. Distribution of injuries by characteristics among breweries represented in BLS SOII data (2013-2018)

Injury Characteristic	Detail	Count (%)
Anatomical Region		
	Upper Limb	980 (38.28)
	Trunk region	720 (28.12)
	Lower Limb	660 (25.78)
	Other	180 (7.03)
Injury nature		
	Burn	290 (10.47)
	Sprain/Strain	920 (33.21)
	Laceration	540 (19.49)
	Contusion	120 (4.33)
	Other	900 (32.49)
Injury event		
	Overexertion and bodily reaction	1320 (33.17)
	Slips, trips, or falls	1150 (28.89)

	Contact with objects and equipment	1110 (27.89)
	Exposure to harmful substances or environments	380 (9.55)
	Other	20 (0.5)
Age category		
	≤ 24 years old	160 (6.2)
	25-34 years old	560 (21.6)
	35-44 years old	670 (25.9)
	45-54 years old	520 (20.1)
	≥ 55 years old	400 (15.4)
	NA	180 (6.9)
Tenure (see Appendix 6.18.)		
Sex		
	Male	1530 (58.62)
	Female	1080 (41.38)

8.16A. Distribution of burns by craft breweries in present study and breweries represented by BLS SOII data (2013-2018)

Burns	Craft breweries (count, %)	BLS SOII breweries (count, %)
Thermal burns	42 (76.8)	170 (58.6)
Chemical burns	13 (23.2)	120 (41.4)

8.17. Distribution of injured worker tenure in present study and among BLS SOII breweries (2013-2018)

Tenure	**BLS SOII, count (%)**	**Present study, count (%)**
< 1 year	730 (28.19)	237 (41.58)
≥1 to <5 years	1080 (41.7)	217 (38.07)
≥5 years	780 (30.12)	56 (9.82)
NA	0 (0)	60 (10.53)

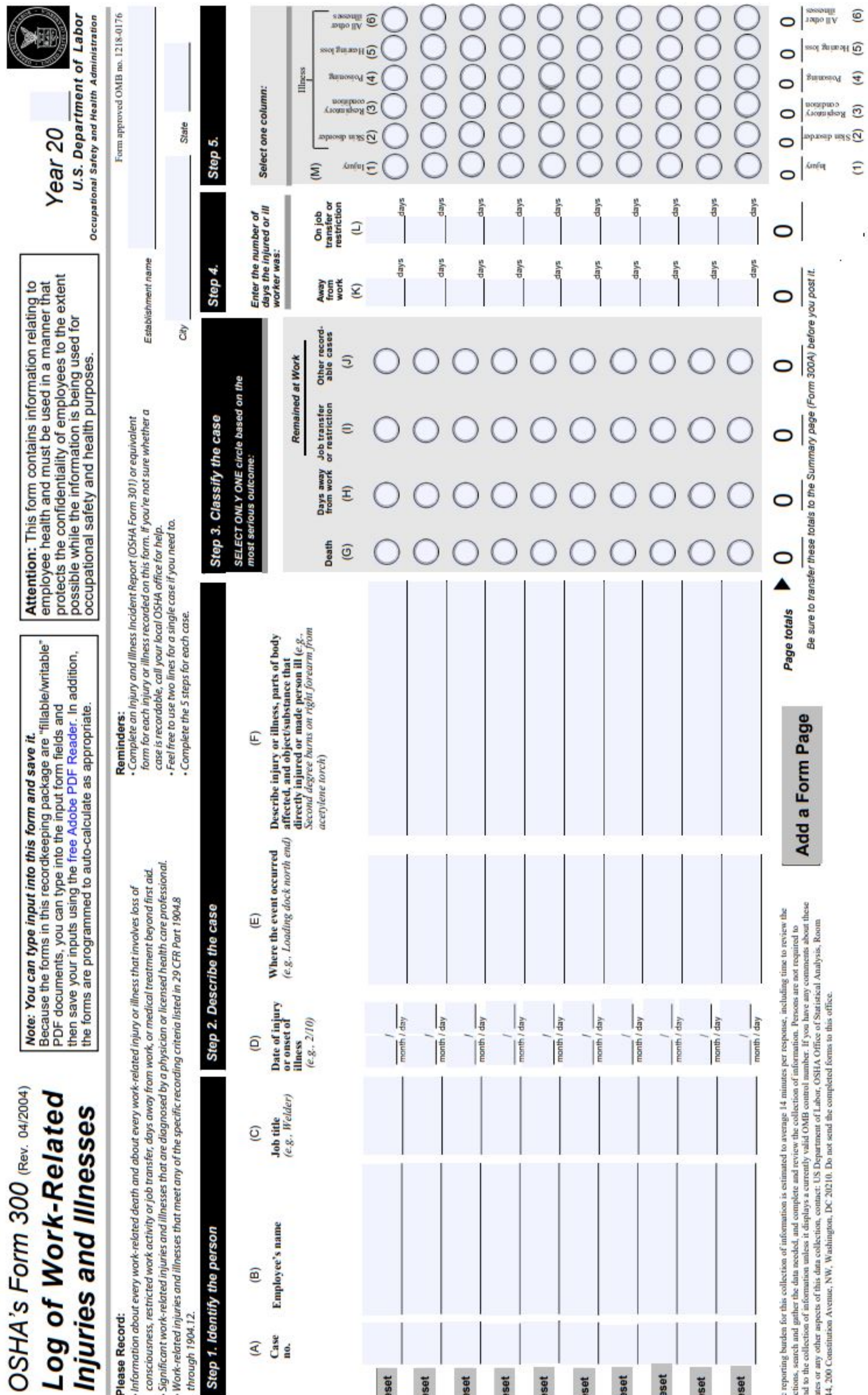
8.18. Selected findings from the Brewers Association health and safety survey

		All respondents	Injured employees (only employees asked)
Tenure (years)	Sample size	606	154
	Median (IQR)	3 (2, 5)	3 (1.5, 5)
	Mean (SD)	4.29 (4.39)	3.57 (2.63);
	Minimum	0	0
	Maximum	31	13
Experience (years)	Sample size	154	45
	Median (IQR)	5 (3,8),	4 (2.4, 6.1),
	Mean (SD)	6.84 (6.37),	4.96 (4.3)

	Minimum	0	0
	Maximum	35	25
Numbers of breweries previously worked at (only employees asked)	Sample size	154	45
	None, this is the first	63.6%	62.2%
	Two	27.9%	26.7%
	Three	4.5%	8.9%
	Four or more	1.95%	0
	NA	1.9%	2.2%

8.19. OSHA Form 300 (A) and OSHA Form 301 (B)

A) OSHA Form 300



OSHA's Form 300 (Rev. 04/2004)

Log of Work-Related Injuries and Illnesses

Note: You can type input into this form and save it. Because the forms in this recordkeeping package are "fillable/writable" PDF documents, you can type into the input form fields and then save your inputs using the free Adobe PDF Reader. In addition, the forms are programmed to auto-calculate as appropriate.

Attention: This form contains information relating to employee health and must be used in a manner that protects the confidentiality of employees to the extent possible while the information is being used for occupational safety and health purposes.

Year 20

U.S. Department of Labor

Occupational Safety and Health Administration

Form approved OMB no. 1218-0176

Please Record:

- *Information about every work-related death and about every work-related injury or illness that involves loss of consciousness, restricted work activity or job transfer, days away from work, or medical treatment beyond first aid.*
- *Significant work-related injuries and illnesses that are diagnosed by a physician or licensed health care professional.*
- *Work-related injuries and illnesses that meet any of the specific recording criteria listed in 29 CFR Part 1904.8 through 1904.12.*

Reminders:

- *Complete an Injury and Illness Incident Report (OSHA Form 301) or equivalent form for each injury or illness recorded on this form. If you're not sure whether a case is recordable, call your local OSHA office for help.*
- *Feel free to use two lines for a single case if you need to.*
- *Complete the 5 steps for each case.*

Establishment name

City State

Step 1. Identify the person | **Step 2. Describe the case** | **Step 3. Classify the case** (SELECT ONLY ONE circle based on the most serious outcome:) | **Step 4.** (Enter the number of days the injured or ill worker was:) | **Step 5.** (Select one column:)

(A) Case no.	(B) Employee's name	(C) Job title (e.g., Welder)	(D) Date of injury or onset of illness (e.g., 2/10)	(E) Where the event occurred (e.g., Loading dock north end)	(F) Describe injury or illness, parts of body affected, and object/substance that directly injured or made person ill (e.g., Second degree burns on right forearm from acetylene torch)	Death (G)	Days away from work (H)	Remained at Work: Job transfer or restriction (I)	Remained at Work: Other record-able cases (J)	Away from work (K)	On job transfer or restriction (L)	(M) (1) Injury	Illness: (2) Skin disorder	(3) Respiratory condition	(4) Poisoning	(5) Hearing loss	(6) All other illnesses
Reset			month / day							days	days						
Reset			month / day							days	days						
Reset			month / day							days	days						
Reset			month / day							days	days						
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Reset			month / day							days	days						
					Page totals ▶	0	0	0	0	0	0	0	0	0	0	0	0

Add a Form Page

Be sure to transfer these totals to the Summary page (Form 300A) before you post it.

Public reporting burden for this collection of information is estimated to average 14 minutes per response, including time to review the instructions, search and gather the data needed, and complete and review the collection of information. Persons are not required to respond to the collection of information unless it displays a currently valid OMB control number. If you have any comments about these estimates or any other aspects of this data collection, contact: US Department of Labor, OSHA Office of Statistical Analysis, Room N-3644, 200 Constitution Avenue, NW, Washington, DC 20210. Do not send the completed forms to this office.

OSHA's Form 301 (Rev. 04/2004)

Injury and Illness Incident Report

Note: You can type input into this form and save it. Because the forms in this recordkeeping package are "fillable/writable" PDF documents, you can type into the input form fields and then save your inputs using the free Adobe PDF Reader. In addition, the forms are programmed to auto-calculate as appropriate.

Attention: This form contains information relating to employee health and must be used in a manner that protects the confidentiality of employees to the extent possible while the information is being used for occupational safety and health purposes.

U.S. Department of Labor
Occupational Safety and Health Administration

Form approved OMB no. 1218-0176

This *Injury and Illness Incident Report* is one of the first forms you must fill out when a recordable work-related injury or illness has occurred. Together with the *Log of Work-Related Injuries and Illnesses* and the accompanying *Summary*, these forms help the employer and OSHA develop a picture of the extent and severity of work-related incidents.

Within 7 calendar days after you receive information that a recordable work-related injury or illness has occurred, you must fill out this form or an equivalent. Some state workers' compensation, insurance, or other reports may be acceptable substitutes. To be considered an equivalent form, any substitute must contain all the information asked for on this form.

According to Public Law 91-596 and 29 CFR 1904, OSHA's recordkeeping rule, you must keep this form on file for 5 years following the year to which it pertains.

If you need additional copies of this form, you may photocopy the printout or insert additional form pages in the PDF, and then use as many as you need.

Completed by _____

Title _____

Phone _____ **Date** _____ (Month Day Year)

Information about the employee

1) **Full name** _____

2) **Street** _____

City _____ **State** _____ **ZIP** _____

3) **Date of birth** _____ (Month Day Year)

4) **Date hired** _____ (Month Day Year)

5) ○ **Male** ○ **Female**

Information about the physician or other health care professional

6) **Name of physician or other health care professional** _____

7) **If treatment was given away from the worksite, where was it given?**

Facility _____

Street _____

City _____ **State** _____ **ZIP** _____

8) **Was employee treated in an emergency room?**
○ **Yes**
○ **No**

9) **Was employee hospitalized overnight as an in-patient?**
○ **Yes**
○ **No**

Information about the case

10) **Case number from the *Log*** _____ *(Transfer the case number from the Log after you record the case.)*

11) **Date of injury or illness** _____ (Month Day Year)

12) **Time employee began work** (HH:MM) _____ ○ **AM** ○ **PM**

13) **Time of event** (HH:MM) _____ ○ **AM** ○ **PM** ○ **Check if time cannot be determined**

*** Re fields 14 to 17:** Please do not include any personally identifiable information (PII) pertaining to worker(s) involved in the incident (e.g., no names, phone numbers, or Social Security numbers).

14)* ***What was the employee doing just before the incident occurred?*** Describe the activity, as well as the tools, equipment, or material the employee was using. Be specific. *Examples:* "climbing a ladder while carrying roofing materials"; "spraying chlorine from hand sprayer"; "daily computer key-entry."

15)* ***What Happened?*** **Tell us how the injury 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."

16)* ***What was the injury or illness?*** Tell us the part of the body that was affected and how it was affected. *Examples:* "strained back"; "chemical burn, hand"; "carpal tunnel syndrome."

17)* ***What object or substance directly harmed the employee?*** *Examples:* "concrete floor"; "chlorine"; "radial arm saw." *If this question does not apply to the incident, leave it blank.*

18) ***If the employee died, when did death occur?*** **Date of death** _____ (Month Day Year)

Add a Form Page | Reset

(B) OSHA 301 injury report form (with injured worker information)

8.20 Detailed distribution of claims by injured anatomical region, body part, and injury nature

Anatomical Region	Detailed Region	Body Part	Burn	Contusion	Laceration	Other	Sprain/strain	*Anatomical Region sum*	*Detailed Region Sum*	*Body Part Sum*
Trunk Region								*190*		
	Head								*78*	
		Ear(S)	NA	NA	NA	1	NA			*1*
		Eye(S)	3	2	1	20	NA			*26*
		Facial Bones	7	6	2	1	NA			*16*
		Mouth	NA	2	NA	1	NA			*3*
		Nose	NA	1	2	NA	NA			*3*
		Head/Skull	NA	16	8	5	NA			*29*
	Torso								*118*	
		Abdomen/Groin	1	1	NA	3	5			*10*
		Buttocks	1	NA	NA	NA	NA			*1*
		Chest	1	4	NA	1	1			*7*
		Low_Back	NA	10	NA	2	61			*73*
		Lung	NA	NA	NA	1	NA			*1*
		Neck Vertebrae	NA	NA	NA	NA	5			*5*
		Upper Back Area	NA	1	1	3	10			*15*
Upper limb								*244*		
	Arm								*80*	
		Elbow	NA	4	NA	2	2			*8*
		Lower Arm	13	7	7	7	4			*38*
		Shoulder(S)	NA	6	NA	5	17			*28*
		Upper_Arm	2	NA	NA	NA	4			*6*
	Hand/fingers/wrist								*164*	

		Finger(S)	5	27	38	4	1			*75*
		Hand	7	13	17	11	2			*50*
		Thumb	2	NA	15	NA	1			*18*
		Wrist	1	3	4	5	8			*21*
Lower limb								*126*		
	Leg								*62*	
		Hip	NA	3	NA	NA	NA			*3*
		Knee	NA	24	2	3	15			*44*
		Lower Leg	2	3	7	2	NA			*14*
		Upper Leg	1	NA	NA	NA	NA			*1*
	Foot/ankle								*64*	
		Ankle	1	1	1	NA	24			*27*
		Foot	8	19	2	5	3			*37*
sum			*55*	*153*	*107*	*82*	*163*	*560*	*560*	*560*

8.21. Detailed cost, mean(SD), of claims by injured anatomical region, body part, and injury nature

Injured anatomical region	Body part	Burn, mean (SD) ($)	Contusion, mean (SD) ($)	Laceration, mean (SD) ($)	"Other," mean (SD) ($)	Sprain/strain, mean (SD) ($)
Trunk	Abdomen/ Groin	0 (NaN)	144.9 (NaN)	NA	4505.57 (6778.93)	2736.4 (5418.9)
	Buttocks	0 (NaN)	NA	NA	NA	NA
	Chest	578.2 (NaN)	1373.3 (1869.36)	NA	6894.1 (NaN)	0 (NaN)
	Ear(S)	NA	NA	NA	908.4 (NaN)	NA
	Eye(S)	302.4 (54.04)	259.4 (366.85)	584 (NaN)	490.83 (555.66)	NA
	Facial Bones	291.51 (632.07)	597.17 (604.12)	248.15 (350.94)	0 (NaN)	NA
	Head/Skull	NA	237.43 (321.68)	351.27 (334.10)	1852.18 (1385.38)	NA
	Low Back	NA	347.9 (674.34)	NA	9895.35 (12391.41)	1758.18 (7151.31)
	Lung	NA	NA	NA	195.4 (NaN)	NA
	Mouth	NA	435.05 (615.25)	NA	327.2 (NaN)	NA

	Neck Vertebrae	NA	NA	NA	NA	9839 (12384.89)
	Nose	NA	0 (NaN)	828 (202.52)	NA	NA
	Upper Back Area	NA	0 (NaN)	0 (NaN)	4208.23 (4939.78)	1895.8 (4767.98)
Upper_Limb	Elbow	NA	48.35 (96.7)	NA	1200.15 (1098.49)	2102.85 (999.92)
	Finger(S)	167.68 (229.61)	338.2 (321.35)	621.17 (878.07)	468.88 (481.13)	1181.5 (NaN)
	Hand	482.39 (641.25)	1080.39 (2979.53)	427.27 (383.66)	1059.4 (2067.59)	172.5 (243.95)
	Hip	NA	219.63 (380.42)	NA	NA	NA
	Lower Arm	374.11 (450.21)	280.76 (494.41)	349.8 (339.63)	561.46 (552.95)	3239.72 (5355.79)
	Shoulder(S)	NA	7362.38 (11218.23)	NA	2470.96 (1267.92)	3121.55 (8707.62)
	Thumb	0 (0)	NA	1391.03 (2987.41)	NA	16338.4 (NaN)
	Upper_Arm	106.65 (150.83)	NA	NA	NA	593.2 (902.65)
	Wrist	145.1 (NaN)	520.67 (533.32)	471.45 (361.55)	3035.14 (5611.79)	700.23 (880.78)
Lower_Limb	Ankle	0 (NaN)	743 (NaN)	571.6 (NaN)	NA	984.08 (2229.1)
	Foot	1695.94 (3760.52)	765.31 (1189.59)	360.25 (509.47)	888.86 (924.16)	222.13 (384.75)
	Knee	NA	1373.67 (4299.36)	682.1 (112.85)	7622.2 (7626.4)	1318.18 (1553.73)
	Lower Leg	27381.9 (38214.88)	0 (0)	355.91 (317.98)	725.15 (695.3)	NA
	Upper Leg	1124.3 (NaN)	NA	NA	NA	NA
Other	Multiple Body Parts	1313.8 (NaN)	0 (NaN)	NA	0 (NaN)	NA
	No Physical Injury	NA	NA	NA	570.95 (1141.9)	NA
	Unclassified	NA	NA	NA	847.53 (934.74)	NA

LIST OF ABBREVIATIONS

BLS	Bureau of Labor Statistics
CI	Confidence interval
FROI	First Report of Injury form
GLM	Generalized linear model
IR	Incidence rate
MMH	Manual materials handling
NAICS	North American Industry Classification System
NCCI	National Council on Compensation Insurance
NIOSH	National Institute for Occupational Safety and Health
OIICS	Occupational Injury and Illness Classification
OSHA	Occupational Safety and Health Administration
SOII	Survey of Occupational Injuries and Illnesses
STF	Slips, trips, or falls
TTB	Alcohol and Tobacco Tax and Trade Bureau
U.S.	United States
WC	Workers' compensation