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Injuries Among Distillery Workers: Workers' Compensation First Reports of Injury, 2010-2019

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INJURIES AMONG DISTILLERY WORKERS: WORKERS' COMPENSATION FIRST REPORTS OF INJURY, 2010-2019

CAPSTONE PROJECT PAPER

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ABSTRACT OF CAPSTONE

INJURIES AMONG DISTILLERY WORKERS: WORKERS' COMPENSATION FIRST REPORTS OF INJURY, 2010-2019

AIMS: To identify the most frequent type, nature, and cause of work-related injury amongst distillery workers as well as contributing factors to the injurious event in an effort to inform potential intervention.

METHODS: Workers' Compensation First Reports of Injury (FROI) from the years 2010-2019 (N=974) were obtained. Variables were created for 'occupational category' and 'accident description' to assist in the elucidation of the injurious event. The Ratchet Circular Scan Test was used to assess seasonal variation in injury. Kernal Density Analysis was conducted to assess rates of injury by calendar year.

RESULTS: Amongst injured distillery workers, 908 of the injuries resulted in lost-time, 65 resulted in no-lost time, and 1 resulted in a worker fatality. The common injuries reported were strains or tears, lacerations, and contusions (33.4%, 14.7%, and 13.5% respectively. The most frequent anatomical sites of injury were the shoulder(s), fingers, and low back area (11.8%, 11.4%, and 8.9% respectively). Barreling experienced the greatest frequency of work-related injury at 28.5% of FROI. Through the Ratchet Circular Scan Test it was determined that there was a 2-month seasonal peak of injury between May and June.

CONCLUSIONS: The distillery occupation with the greatest number of work-related injury is barreling. The most common cause of injury for barreling employees was strain or tear through repetitive motion and the most common accident category was contact with objects or machinery. Based on the findings of this study, improving and implementing ergonomic solutions to everyday work tasks including the pushing, pulling, and in general transportation of bourbon barrels may positively influence the rate of work-related injury in the proceeding years of production

KEYWORDS: Occupational Injury, Injury Prevention. Distilling, Kentucky, Bourbon Production

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I. INTRODUCTION

The Kentucky distillery industry is a robust network of 68 licensed distilleries which cumulatively produce 95% of the world's supply of bourbon whiskey, resulting in an estimated $8.6 billion industry (Coomes & Kornstein, 2019). In 2018, there were 12,026 persons employed under the North American Industry Classification System (NAICS) distillery classification code (NAICS = 312140) in Kentucky (United States Census Bureau, 2019). At the federal level, the Occupational Safety and Health Administration (OSHA) defines a distillery as "a plant [or portion of a plant] where flammable liquids produced by fermentation are concentrated and where the concentrated products may also be mixed, stored, or packaged" (Occupational Safety and Health Administration, 2021b). All industries involved in the production of goods face certain hazards that increase the risk of injury, illness, and mortality amongst their workers; industrial fermentation included.

Industrial fermentation, specifically, the distilling of bourbon whiskey is a multi-step process taking several years and extensive manpower (Raitz, 2020). A brief summary of the distilling process begins with the most common ingredients used in the creation of distillable mash: corn, rye, and malted barley (Jim Beam, 2021; Raitz, 2020). These ingredients are first added to a cooker, then transferred to a fermenter or 'still' where yeast is added and the mixture is then cooled down (Jim Beam, 2021; Raitz, 2020). When the produced liquid is cooled in the still, the mixture begins to ferment, changing the sugars in the grain into alcohol (Jim Beam, 2021; Raitz, 2020). The produced clear spirit is known as "distillers beer" and may be distilled again and/or proceeds to barreling where it is transferred into a charred 53-gallon white oak barrel then moved to multi-story

maturation warehouses for a period of at least two years (Jim Beam, 2021; Raitz, 2020). From there the produced bourbon is then bottled, processed, and shipped out to the consumer (Raitz, 2020). Due to the multistep intensive nature of bourbon production, those involved in the industry must be aware of the occupational hazards present in order to circumvent work-related injury or illness.

Occupational injury, or an injury or illness perpetuated by a person's specific job task or a requirement of one's occupation, accounts for a considerable number of injury-related disabilities and fatalities in the United States (Smith, 2001; Varacallo & Knoblauch, 2019). According to the Bureau of Labor Statistics (BLS) Survey of Occupational Injuries and Illness (SOII) findings, approximately 2.8 million private industry employees were non-fatally injured in 2019, a rate of 2.8 per 100,000 full-time equivalent (FTE) workers; the same rate was reported in both 2017 and 2018 (Bureau of Labor Statistics, 2020b). According to the BLS 2019 Census of Fatal Occupational Injuries (CFOI), 5,333 workers died as a result of work-related injury in 2019, the largest annual number of work-related fatalities since 2007 (Bureau of Labor Statistics, 2020a). BLS findings suggest that a worker died every 99 seconds from a work-related injury in 2019 (Bureau of Labor Statistics, 2020a).

Not much data exists publicly pertaining to the enumeration of worker injury, illness, and mortality in the distillery industry, however, amongst general beverage manufacturers the BLS reports that workers experience an increased rate of work-related injury and illness at 5.2 per 100 FTE workers in 2017, 68% higher than the national average (Occupational Safety and Health Administration, 2019). Some of the most prevalent occupational hazards associated with beverage manufacturing, and in turn

distilling, include proximity to hazardous equipment, noise, and chemicals as well as ergonomic, confined space, and explosion hazards (Occupational Safety and Health Administration, 2019; WorkSafeBC, 2018). Along with BLS CFOI data, one of the most common sources of occupational injury and illness data is what is extracted from workers' compensation claims (Bureau of Labor Statistics, 2020a; The National Institute for Occupational Safety and Health (NIOSH), 2013).

Workers compensation' is the medical and financial support allotted to employees for medical expenses and lost wages, through their employers worker's compensation insurance coverage, following an injury or fatality sustained while the employee was on the job (Cornell Law School, 2021; The National Institute for Occupational Safety and Health (NIOSH), 2013). Following the initial illness or injury, employers are required to complete a report detailing the cause of work-related injury or illness, resulting lost-time, and key demographic characteristics of the injured employee, for this report to formally become a claim; in Kentucky it must be formally adjudicated (Commonwealth of Kentucky, 2010; Pompeii et al., 2013). Although the information gathered through workers' compensation insurance claims is administrative in nature, the standardized data collected across various industries has culminated in a database of key injury and occupational health surveillance data, which may be used by public health professionals in the analysis of work-related injury and the framing of prevention strategies (Cornell Law School, 2021; Pompeii et al., 2013).

No known study has been conducted utilizing workers' compensation data to assess work-related injury amongst distillery workers. However, other studies have sought to examine frequency of injury, cost of injury, lost-time, task performed prior to

injury, and percent of disability through the use of workers compensation data (Flunker, Clouser, & Swanberg, 2020; Madigan, Forst, & Friedman, 2017; Syron, Lucas, Bovbjerg, & Kincl, 2019; Yamin, Bejan, Parker, Xi, & Brosseau, 2016). Such studies were conducted in an effort to identify the factors associated with the occupational injury and the subsequent monetary and physical consequences, and put forth recommendations for prevention.

The purpose of this study is to identify the most frequent type, nature, and cause of work-related injury amongst distillery workers as well as what factors may have contributed to the injurious event in an effort to inform potential intervention specifically targeted towards workers in the distillery industry.

II. METHODOLODY

DATA SOURCE

This study utilized injury and occupational disease data from Kentucky workers' compensation first reports of injury (FROI), to be used for research and administrative purposes, and contains information on injury, both severe and non-severe, from the years 2010-2019. This data was obtained from the Kentucky Injury Prevention and Research Center (KIPRC) in collaboration with the Kentucky Department of Workers' Claims (DWC).

The produced dataset contains 974 workers' compensation FROI data, and is devoid of personal identifiers – per KIPRC's Memorandum of Understanding with the DWC. Demographic information provided in the dataset includes age, sex, marital status, and number of dependents, state of residence, hire date, last work date, and occupational

description. Information pertaining to the injury or illness event includes injury date, return to work date, and date of death. The variables pertaining to specific injury: nature of injury, standard cause of injury, and body part injured are coded based on Workers' Compensation Insurance Organization (WCIO) coding schema under the International Association of Accident Boards and Commissions (IAIABC) FROI umbrella; a brief narrative description of the reported event was also included in the dataset ("Workers Compensation Insurance Organizations," 2021).

The Wage and Wage Period variables were not included in the analysis, as they were not viewed as relevant for the purposes of this research. Additionally, the county of injury variable was excluded in the interest of worker confidentiality. The variables associated with the reimbursement payout or level of impairment associated with the injury or illness event were excluded from analysis due to data missingness (> 99%); these variables include: award date, disability percent, impairment percent, payment amount, code description, number of payment, total payment amount, and award type. Additionally, the workers' compensation 'claim disposition' variable was excluded from analysis due to 89.8% of claimants not filing a claim disposition agreement (*TABLE 9*).

STUDY DESIGN

This study is cross-sectional and epidemiologically descriptive in design. Study inclusion criteria comprised of: 1) All workers' compensation FROI for Kentucky distillery workers both public and private, specified under the NAICS industry code: 312140, who had sustained an occupational injury or illness between the years 2010 to 2019; 2) FROI both open and closed, 3) Includes individuals who reside out of state

and/or experienced an injury while out of state; 3) Includes male and female claimants of all ages. This study excluded individuals specified under the NAICS industry code '312140' who were self-employed, employed in agriculture, or persons' employed in domestic services.

Variables: job tenure, season of injury, month of injury, day of week [injury occurred], and year of injury were created using the hire date, injury date, and last work date variables. Utilizing the 'occupational description' category and insight from leaders in the distillery industry, fifteen occupational categories (including missing values) were created based on manual assessment of occupational descriptors. Similar job tasks were grouped into more generalized categories; for example, the category 'Barreling' included 'Barrel Raisers', 'Stave Operators', and 'Bilge Operators' amongst other related occupational descriptors (*TABLE 4*). Additionally, manual narrative assessment of the accident description was conducted in order to assess the frequency of described injury/illness types through the creation of ten accident categories, which were adapted from the BLS Occupational Injury and Illness Classification Manual Event or Exposure Code (*TABLE 5*) (U.S. Bureau of Labor Statistics, 2012).

Employing the use of an economic report prepared by Dr. Paul Coomes and Barry Kornstein in collaboration with the Kentucky Distillers' Association in 2019, number of distillery employees and number of bourbon barrels produced in Kentucky from the years 2010 to 2017 were assessed (Coomes & Kornstein, 2019). To account for missing data, linear regression analysis was conducted in order to ascertain slope, which was then utilized in the extrapolation of 2018 and 2019 data.

STATISTICAL ANALYSIS

Statistical analysis was conducted through the use of Statistical Analysis System (SAS) version 9.4, Microsoft Excel, and the statistical package PEPI-for-Windows (WINPEPI) (Abramson, 2021; SAS, 2020) Continuous variables of interest include age and job tenure, both of these were divided into quartiles in order to assist in analysis. Categorical variables of interest include: season of injury, month of injury, day of week [injury occurred], year of injury, occupational category, nature of injury, body part injured, injury cause, county of injury, state of residence, gender, accident category, and extent of injury.

Descriptive statistics were obtained for categorical variables of interest, including frequency and percent injured within established subgroups. To assess the ten most frequent causes of injury, nature of injury, and body part injured; variables were first sorted by frequency, then the amount and percent for the top 10 most frequent values were obtained (*TABLE 3*). The corresponding graphical illustrations for body part injured and nature of injury were created (*FIGURE 1 and 2*). For continuous variables, the mean, standard deviation, median, and range were found through statistical means, in addition to frequency and percent of distribution within created subgroups (*TABLE 1*). Distribution of tenure was further assessed through the creation of a histogram (*FIGURE 3 and 4*). Additionally the frequency distribution and seasonal variation of worker injury by month of injury was assessed through both graphical means and through the use of the Ratchet Circular Scan Test, conduced through WINPEPI (*FIGURE 5*). The frequencies of missing values were also identified in order to inform analysis.

The proportion of injuries, and the corresponding confidence intervals were determined in order to assess the range of injury within demographic and injury-event subgroups; the associated confidence level was 95% and these values were found through the use of SAS 9.4. The Chi-Square Goodness of Fit Test was then used to categorically assess the variance of observed injury frequencies from expected values, through the use of SAS 9.4, the Chi-Sq. statistic, degrees of freedom, and P-value were obtained from this assessment (*TABLE 2*). The days 'Saturday' and 'Sunday' were excluded from Chi-Square analysis due to the low values for these categories skewing the data.

Categories for occupation and accident descriptions were manually created and responses were sorted, the subsequent frequency and percent for these categories was ascertained (*TABLE 4 and 5*). Furthermore, mechanisms of injury, including the accident category, and body part injured were stratified by the four most frequent occupational categories cited in the data, the frequency and percent of the categories were then found (*TABLE 6*). Additionally, worker lost time was descriptively assessed by the most frequent mechanisms of injury, occupational category, and body part injured (*TABLE 7*).

The rate of injury calculated from an estimate of number of persons employed in distillery industry and number of bourbon barrels produced by calendar year was assessed through Microsoft Excel and WINPEPI; the resulting rate and confidence interval with a confidence level of 95% are displayed (*TABLE 8*). Yearly rate of injury was further assessed graphically through Kernal density analysis, conducted through WINPEPI; however, the year '2010' was excluded from analysis due to the small numerator of workers compensation FROI (n = 3) skewing the data (*FIGURE 6 and 7*).

III. RESULTS

DEMOGRAPHIC CHARACTERISTICS

Between 2010 and 2019 there were 974 FROIs recorded in Kentucky workers' compensation under the distillery industry classification (NAICS=312140). The ages of claimants ranged from 18-77 years of age, with a mean age of 42 years (SD: ± 13.4). The greatest frequency of FROI is in the age range 45-64 with 388 claims (39.8%). Job tenure ranged from 0-46 years with a mean of 11.3 years (SD: ± 10.7), indicative of a right-skewed distribution (*FIGURE 3*). However, there were 214 (22%) missing values for the job tenure variable. The number of dependents ranged from 0-6, but the average number of dependents was 0. Most claimants were male with a frequency of 775 (79.6%). In regards to marital status, 438 (45.0%) of claimants were married, however, there were 166 (17.04%) missing values for this variable (*TABLE 1*).

A majority of claimants, 880 (90.4%) were residents of Kentucky. The greatest proportion of injuries occurred during the summer at a frequency of 279 (28.7%), additionally, in regards to the day of injury, 220 (22.6%) claimants were injured on a Monday with a confidence interval of 0.2 to 0.3. The month of the year that exhibited the peak number of FROI is June at a frequency of 106 (10.9%). Through the Ratchet circular scan test a 2-month seasonal peak was identified in May and June in which 19.9% of the injury events occurred, however, this seasonal variation was not statistically significant (P = 0.1) (*FIGURE 4*). Assessing frequency of injury through an annual perspective, the year with the greatest number of FROI was 2016 with 152 FROI (15.6%). With respect to extent of injury, 908 (93.2%) FROI resulted in lost time, and amongst the 974 FROI there was 1 (0.1%) reported worker fatality (*TABLE 1*).

Occupational Category was assessed in order to ascertain which job tasks experienced the most frequent workers' compensation injuries. Barreling was the most frequently cited distillery occupation amongst the claimants with a frequency of 258 (28.5%), with general laborer being the second most frequent occupation with 115 FROI (12.7%), and general operator being the third most frequently cited occupation at 114 FROI (12.6%). The fourth most recurrent occupational category was bottling with a frequency of 115 (12.7%) (*TABLE 4*).

INJURY EVENT CHARACTERISTICS

In regards to the nature of injury, the most common injury was strains or tears with a frequency of 325 (33.4%). The second most common injury was laceration with a frequency of 142 (14.7%). The third most common nature of injury was contusion, experiencing a frequency of 131 (13.5%) (*FIGURE 1; TABLE 3*). In terms to the anatomical site of injury, the shoulder was most frequently injured at 115 FROIs (11.8%). Fingers were the second most frequent body part injured at 111 claims (11.4%). The third most frequently injured body part was the low back area, including the lumbar and lumbo-sacral region, at a frequency of 87 (8.9%) (*FIGURE 2; TABLE 3*). Strain or injury, not otherwise classified (NOC) was the most frequent cause of injury at 96 claimants (9.9%). Strain or injury by pushing or pulling was the second most common cause of injury with 91 (9.3%) claimants, and strain or injury by lifting represented the third most frequent cause of injury with a respective frequency of 71 (7.3%) workers (*TABLE 3*).

An assessment of categories of the illness or injury event from the provided narrative description revealed that the three most frequent accident categories were

contact with objects/machinery with 351 persons (36.2%), bodily reaction and overexertion at a frequency of 317 (32.7%), and slips, trips, and falls at 138 claimants (14.2%) (*TABLE 5*).

Mechanisms of injury and body part injured were stratified by the four most frequently cited occupations. The results are in line with the most common natures of injury, which most often involve strains or tears, contusions, and lacerations. Accident category revealed that for all four occupations, contact with objects/machinery and bodily reaction and exertion were amongst the most common accident categories. Barreling experienced strains or tears at twice the percentage of laborers, operators, and bottlers (10.3% compared to 5.1%, 4.3%, and 3.9% respectively). Additionally, barreling experienced double the percentage of injury by contact with objects and machinery as well as bodily reaction and overexertion when compared to other stratified occupational categories (*TABLE 6*).

CHI-SQUARE ANALYSIS

In order to assess whether there was a significant difference in the number of injuries within specified variable categories, a Chi-Square Goodness of Fit test was conducted. Amongst all of the descriptive variables analyzed, season of injury was the only one that did not exhibit statistical significance at a level of 0.05 ($P = 0.0663$). Marital status was slightly significant with a P-value of 0.0167, as well as day of week, which was slightly more statistically significant ($P = 0.0074$).

RATE OF INJURY

The rate of injury per 10,000 distillery workers as well as the rate of injury per 100,000 barrels produced indicated a marked increase in the number of occupational injuries over the 9 years of study. In 2010 the rate of injury was 9.7 per 10,000 distillery workers with a confidence interval of 2.0 - 28.3. In 2015 this rate increased by more than 3500% to 354.7 per 10,000 distillery workers (CI: 299.7 to 416.9). From 2016 to 2019 the rate of injury decreased to approximately 263.5 per 10,000 distillery workers (CI: 220.4 – 312.4). The rate of worker injury per 100,000 barrels produced exhibited a different pattern, with an increase in the rate of injury from 2010 to 2013, in which the rate rose from 4.5 to 14.7 per 100,000 barrels produced (CI: 0.9 – 13.2 and 11.7 -18.3 respectively), followed by a steady decline to 2019 in which the rate of injury was 6.8 per 100,000 barrels produced (CI: 5.7 – 8.1) (*TABLE 8*).

Through Kernal density analysis the uniform distribution for both rates of injury are displayed (*FIGURE 5 and 6*). As exhibited in *TABLE 8*, the rate of injury per 10,000 workers increases along with the number of distillery employees from 2011 until the rate plateaus from 2015 to 2016, where it then decreases until 2019 (*FIGURE 5*). The rate of injury per 100,000 barrels produced shows an increase in the rate of injury from 2011 to 2013, it then exhibits a decrease for the remaining years of interest; this pattern is in direct opposition of the number of barrels produced which steadily increased from 2011 to 2019.

IV. DISCUSSION

This study determined that the most common injuries cited by workers' compensation claimants in the distillery industry include strains or tears, lacerations, and contusions, and through the narrative analysis of the accident description, it was illuminated that many of the injuries analyzed occur due to contact with objects or machinery, such as barrels, and bodily reaction and overexertion in which the employee pushes beyond their physical capabilities in order to complete a work task. The most frequent body parts injured include the shoulders, fingers, low back area, and knees, all of which are involved in the physiological task of lifting, pushing, and pulling objects. These types of bodily injuries are in line with the most frequent causes of injury, which include strain or injury by pushing and pulling, lifting, and repetitive motion tasks.

The distillery occupation with the greatest number of work-related injury is barreling, involved in the cleaning, filling, and transportation of bourbon barrels as well as other maturation warehouse tasks. The most common cause of injury for barreling employees was strain or tear through repetitive motion and the most common accident category was contact with objects or machinery. Barreling also represents the leading occupational category in the frequency of lost time.

This study included 974 first-reports of injury, 908 of which were a result of a lost-time injury, 66 were a result of no lost-time, and 1 was the result of a worker fatality. The mean age of injured distillery workers was 42 years, and an assessment of job tenure revealed the greatest proportion of injuries amongst those who had worked at their current place of employment from 5 to 14 years. Nearly 80% of the claimants were male, and 90.4% were residents of Kentucky.

The occupational category with the lowest frequency of injury was laboratory services, additionally; the accident category with the lowest frequency was weather-related illness, such as heat stroke and heat exhaustion, with a frequency of 5 claims (0.5%).

Yearly analysis of workers' compensation claims revealed the greatest number of injuries during the years of interest being in 2016 with a corresponding rate of injury at 353.7 per 10,000 distillery workers. In this study it was found that there are peak months of injury in the distilling industry, consisting of May and June, though this seasonal distribution does not exhibit clear statistical significance (Test Statistic: 2.6; $P < 0.1$) it does suggest that seasonality does play a small role in the proliferation of work-related injury and illness.

Potential solutions that could be implemented at distilleries to control for the most common injury events include the equipping of engineering controls such as a lift or pulley system to assist in the handling of heavy objects such as barrels and other elements to cut down on bodily exertion injury (Occupational Safety and Health Administration, 2021a). Additionally, providing workers with adequate rest breaks and encouraging job rotation where applicable could assist in reducing the frequency of repetitive motion injury (Occupational Safety and Health Administration, 2021a). In regards to accounting for the frequency of workers who had suffered an injury due to contact with objects or machinery, continuing education training could be implemented to assist workers in identifying hazards and mitigation strategies.

Limitations of this study include lack of FROI data between the years 2010 to 2013, a potential result of a sharp increase in distillery industry activity in Kentucky

between the years 2012 to 2018, impacted the calculation of the rate of distillery injury over time (Coomes & Kornstein, 2019). Additionally, the stratification of rates by occupational category or job tenure was unable to be performed due to lack of publicly available denominator data. Another limitation is the ambiguity of the 'occupational description' variable, which for example, classified some claimants as 'operator' or 'laborer' without specifying the type of work tasks they were involved in and which part of the distillery their work resided.

Many studies have utilized workers' compensation claim reports in the context of injury cause and monetary impact (Flunker et al., 2020; Madigan et al., 2017; Syron et al., 2019). However, no known study has used worker's compensation data to assess occupational injury in the distillery industry. Future study of distillery injury should assess the elements involved in the injury event, which are described in the narrative accident description.

What was gleaned from this study was the most frequent type, nature, and mechanism of distillery injury as well as a general exploration of factors that may have contributed to the precipitation of the illness or injurious event. These findings may serve as a research to practice base for occupational health professionals in their pursuance of interventions or continuing education subject matter. As the bourbon distilling industry of Kentucky continues to expand, focusing on distillery worker health must remain a priority. As evidenced by the occupational category, accident description, and mechanism of injury, improving and implementing ergonomic solutions to everyday work tasks including the pushing, pulling, and in general transporting of barrels may have a positive influence on the rate of work-related injury in the proceeding years of production.

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VII. APPENDIX

TABLE 1. Characteristics of Injured Distillery Workers in Kentucky, 2010-2019 (**N=974**)

		n	Percent (%)	Mean (SD)	Median	Range	Missing (*n*)
Age, years				42.1 ± 13.4	41.0	18 - 77	
	18-29	178	18.2				
	30-44	381	39.1				
	45-64	388	39.8				
	65+	27	2.8				
Tenure, years				11.3 ± 10.7	8	0 - 46	214
	0-4	230	30.3				
	5-14	340	44.7				
	15-29	122	16.1				
	30+	68	9.0				
Number of Dependents				0.1 ± 0.6	0	0 - 6	
	0-1	928	95.3				
	2+	46	4.7				
Gender							3
	Male	775	79.6				
	Female	196	20.1				
Marital Status							166
	Married	438	45.0				
	Unmarried	370	38.0				
State of Residence							
	KY	880	90.4				
	IN	90	9.2				
	Other	4	0.4				
Season of Injury							
	Spring	234	24.0				
	Summer	279	28.7				
	Autumn	236	24.2				
	Winter	225	23.1				
Day of Week							
	Sunday	20	2.1				
	Monday	220	22.6				
	Tuesday	172	17.7				
	Wednesday	187	19.2				
	Thursday	171	17.6				
	Friday	153	15.7				

TABLE 1. Characteristics of Injured Distillery Workers in Kentucky (**Cont.**)

		n	Percent (%)	Mean (SD)	Median	Range	Missing (*n*)
	Saturday	51	5.2				
Year of Injury							
	2010	3	0.3				
	2011	21	2.2				
	2012	38	3.9				
	2013	81	8.3				
	2014	130	13.4				
	2015	147	15.1				
	2016	152	15.6				
	2017	129	13.2				
	2018	141	14.5				
	2019	132	13.6				
Extent*							
	Lost Time	908	93.2				
	No Lost Time	65	6.7				
	Fatality	1	0.1				

**Extent refers to 'extent of injury'; 'lost time' and 'no lost time' refers to first report, but not a permanent partial disability*
SD: Standard Deviation

TABLE 2. Descriptive Statistics of Injured Distillery Workers in Kentucky, 2010-2019 (**N=974**)

		Proportion	CI	Chi-Sq.	DF	Pr > Chi-Sq.
Age				373.5	3	*<0.0001*
	18-29	0.2	(0.2 – 0.2)			
	30-44	0.4	(0.4 – 0.4)			
	45-64	0.4	(0.4 – 0.4)			
	65+	0.0	(0.2 – 0.4)			
Tenure				229.5	3	*<0.0001*
	0-4	0.3	(0.3 – 0.3)			
	5-14	0.5	(0.4 – 0.5)			
	15-29	0.2	(0.1 – 0.2)			
	65+	0.1	(0.1 – 0.1)			
Number of Dependents				798.7	1	*<0.0001*
	0-1	1.0	(0.9 – 1.0)			
	2+	0.1	(0.0 – 0.1)			
Gender				345.3	1	*<0.0001*
	Male	0.8	(0.8 – 0.8)			
	Female	0.2	(0.2 – 0.2)			
Marital Status				5.7	1	*0.0167*
	Married	0.5	(0.5 – 0.6)			
	Unmarried	0.5	(0.4 – 0.5)			
State of Residence				1436.2	2	*<0.0001*
	KY	0.9	(0.9 – 0.9)			
	IN	0.1	(0.8 – 0.1)			
	Other	0.0	(0.0 – 0.0)			
Season of Injury				7.2	3	*0.0663*
	Spring	0.2	(0.2 – 0.3)			
	Summer	0.3	(0.3 – 0.3)			
	Autumn	0.2	(0.2 – 0.3)			
	Winter	0.2	(0.2 – 0.3)			
Day of Week*				14.0	4	*0.0074*
	Sunday	0.0	(0.0 – 0.0)			
	Monday	0.2	(0.2 – 0.3)			
	Tuesday	0.2	(0.2 – 0.2)			
	Wednesday	0.2	(0.2 – 0.2)			
	Thursday	0.2	(0.2 – 0.2)			
	Friday	0.2	(0.1 – 0.2)			
	Saturday	0.0	(0.0 – 0.7)			
Year of Injury**						
	2010	0.0	(0.0 – 0.0)			
	2011	0.0	(0.0 – 0.0)			
	2012	0.0	(0.0 – 0.1)			
	2013	0.1	(0.1 – 0.1)			
	2014	0.1	(0.1 – 0.2)			

TABLE 2. Descriptive Statistics of Injured Distillery Workers in Kentucky (**Cont.**)

		Proportion	CI	Chi-Sq.	DF	Pr > Chi-Sq.
	2015	0.2	(0.1 – 0.2)			
	2016	0.2	(0.1 – 0.2)			
	2017	0.1	(0.1 – 0.2)			
	2018	0.1	(0.1 – 0.2)			
	2019	0.1	(0.1 – 0.2)			
Extent						
	Lost Time	0.9	(0.9 – 1.0)			
	No Lost Time	0.1	(0.1 – 0.1)			
	Fatality	0.0	(0.0 – 0.0)			

**Saturday and Sunday excluded from Chi-Square Analysis*
NOTE: Proportions assume P= 0.05; Confidence level of 95.0%; Chi-Square Test for Equal Proportions used
DF: Degrees of Freedom

TABLE 3. Ten Most Frequent Nature, Body Part Injured, and Cause of Injury Amongst Injured Distillery Workers, 2010-2019 (**N=974**)

		n	**Percent (%)**
Nature of Injury			
	Strain or Tear	325	33.4
	Laceration	142	14.6
	Contusion	131	13.5
	Sprain or Tear	86	8.8
	Foreign Body	49	5.0
	Fracture	48	4.9
	All Other Specific Injuries, NOC	28	2.9
	Burn	25	2.6
	Crushing	25	2.6
	All Other Cumulative Injuries	22	2.3
	Other Nature Categories	**93**	**9.5**
Body Part Injured			
	Shoulder(s)	115	11.8
	Finger(s)	111	11.4
	*Low Back Area**	87	8.9
	Knee	68	7.0
	Hand	66	6.8
	Eye(s)	45	4.6
	Lower Leg	45	4.6
	Wrist	45	4.6
	Lower Arm	39	4.0
	Ankle	33	3.4
	Other Injured Body Part Categories	**320**	**67.1**
Cause of Injury	*Strain or Injury, NOC*	96	9.9
	Strain or Injury by Pushing or Pulling	91	9.3
	Strain or Injury by Lifting	71	7.3
	Strain or Injury by Repetitive Motion	63	6.5
	Caught in, under or between Object Handled	42	4.3
	Fall, Slip, or Trip, NOC	39	4.0
	Fall, Slip, Trip on Same Level	37	3.8
	Cut, Puncture, Scrape, NOC	36	3.7
	Foreign Body in Eye	36	3.7
	Struck or Injured by Falling or Flying Object	34	3.5
	Other Causes of Injury	**429**	**44.1**

NOTE: NOC refers to 'Not Otherwise Classified' in reference to injury event

** Including Lumbar and Lumbo-Sacral*

TABLE 4. Categories of Occupation for Injured Kentucky Distillery Workers, 2010-2019

Occupation	*n*	Percent (%)
Administration	33	3.6
Barreling*	258	28.5
Bottling	113	12.5
Cooperage**	76	8.4
Customer Service	24	2.7
Driver	22	2.4
Food/Beverage Services	17	1.9
Inspection	20	2.2
Laboratory Services	7	0.8
Laborer	115	12.7
Maintenance	82	9.1
Operator	114	12.6
Security/Fire Prevention	9	1.0
Shipping/Receiving	16	1.8

NOTE: 68 missing values
** Involved in the cleaning, filling, inspection and transport of barrels and warehouse operation*
*** Involved in the production and repair of barrels and staves*
(Coomes & Kornstein, 2019).

TABLE 5. Categories of Illness/Injury Event Derived From Narrative Description, 2010-2019

Accident Categories	*n*	Percent (%)
Bodily Reaction/Overexertion	317	32.7
Burn	15	1.5
Contact with Objects/Machinery	351	36.2
Exposure to Harmful Substances	53	5.5
Hearing Loss	7	0.7
Insect/Animal Bite	15	1.54
Repetitive Motion	62	6.4
Slips/Trips/Falls	138	14.2
Weather-Related Illness	5	0.5
Other Event	8	0.8

NOTE: 3 missing values; Adapted from BLS Occupational Injury And Illness Classification Manual Event or Exposure Code (U.S. Bureau of Labor Statistics, 2012).

TABLE 6. Top Four Occupational Categories by Most Frequent Mechanisms of Injury and Body Part Injured, 2010-2019 (**N=974**)

	Barreling			Laborer		
		n	**%**		***n***	**%**
Nature of Injury						
	Strain or Tear	93	10.3	Strain or Tear	46	5.1
	Contusion	33	3.6	Laceration	15	1.7
	Laceration	30	3.3	Contusion	11	1.2
Body Part Injured						
	Shoulder(s)	34	3.8	Shoulder(s)	17	1.9
	Finger(s)	29	3.2	Low Back Area*	12	1.3
	Low Back Area*	27	3.0	Finger(s)	10	1.1
Cause of Injury						
	Strain or Injury by Repetitive Motion	29	3.2	Strain or Injury by, NOC	18	2.0
	Strain or Injury by Pushing or Pulling	28	3.1	Strain or Injury by Pushing or Pulling	14	1.6
	Strain or Injury by, NOC	22	2.4	Strain or Injury by Lifting	13	1.4
Accident Category						
	Contact With Object/Machinery	104	11.5	Bodily Reaction and Exertion	48	5.3
	Bodily Reaction and Exertion	82	9.1	Contact with Objects/Machinery	33	3.7
	Repetitive Motion	28	3.1	Slips/Trips/Falls	10	1.1

	Operator			Bottling		
		n	**%**		***n***	**%**
Nature of Injury						
	Strain or Tear	39	4.3	Strain or Tear	35	3.9
	Sprain or Tear	14	1.6	Contusion	24	2.7
	Laceration	13	1.4	Laceration	19	2.10
Body Part Injured						
	Shoulder(s)	14	1.6	Finger(s)	20	2.2
	Finger(s)	12	1.3	Shoulder(s)	12	1.3
	Low Back Area*	12	1.3	Knee	9	0.99
Cause of Injury						
	Strain or Injury by, NOC	17	1.9	Strain or Injury by, NOC	9	0.99
	Strain or Injury By Pushing/Pulling	14	1.6	Strain or Injury by Pushing/Pulling	9	0.99
	Strain or Injury by Lifting	10	1.1	Strain or Injury by Lifting	5	0.55

TABLE 6. Top Four Occupational Categories by Most Frequent Mechanisms of Injury and Body Part Injured (**Cont.)**

Accident Category						
				Contact with		
	Bodily Reaction and Exertion	47	5.2	Objects/Machinery	45	5.0
	Contact with Objects/Machinery	36	4.0	Bodily Reaction and Exertion	29	3.2
	Repetitive Motion	9	1.0	Slips/Trips/Falls	24	2.7

NOTE: % refers to percent of total injuries (N=974)

*****_Including Lumbar and Lumbo-Sacral_

TABLE 7. Most Frequent Mechanisms of Injury, Occupational Categories, and Body Part Injured by Lost Time – First Report, 2010-2019 **(n=908)**

		n	%			*n*	%
Occupational Category							
	Barreling	257	28.7				
	Operator	113	12.6				
	Bottling	112	12.5				
				Cause of Injury			
Nature of Injury					Strain or Injury by, NOC	93	10.2
	Strain or Tear	303	33.4				
					Strain or Injury by Pushing or Pulling	85	9.4
	Laceration	132	14.5				
					Strain or Injury by Lifting	60	6.6
	Contusion	116	12.8				
				Accident Category			
					Contact with Objects/Machinery	326	36.0
Body Part Injured							
					Bodily Reaction and Exertion	296	32.7
	Shoulder(s)	108	11.9				
	Finger(s)	103	10.6		Slips/Falls	127	14.0
	Low Back Area*	78	8.6				

NOTE: % refers to the percent of lost-time injuries
**Including Lumbar and Lumbo-Sacral*

TABLE 8. Estimates for Number of Persons Employed in the Distillery Industry and Bourbon Barrels Produced in Kentucky by Year and Corresponding Rate of Injury, 2010-2019

Year	n	Number of Distillery Workers	Rate of Injury Per 10,000 Workers	CI**	Number of Barrels Produced	Rate of Injury Per 100,000 Barrels Produced	CI**
2010	3	3103	9.7	(2.0 – 28.3)	66,321	4.5	(0.9 – 13.2)
2011	21	3208	65.5	(40.5 – 100.1)	187,765	11.2	(6.9 – 17.1)
2012	38	3260	116.6	(82.5 – 160.0)	300,607	12.6	(8.9 – 17.4)
2013	81	3594	225.4	(197.3 – 308.8)	549,737	14.7	(11.7 – 18.3)
2014	130	4003	324.8	(302.2 – 429.5)	942,990	13.8	(11.5 – 16.4)
2015	147	4144	354.7	(299.7 – 416.9)	1,176,216	12.5	(10.6 – 14.7)
2016	152	4297	353.7	(310.8 – 430.0)	1,371,965	11.1	(9.4 – 13.0)
2017	129	4564	282.7	(250.6 – 356.7)	1,483,969	8.7	(7.3 – 10.3)
2018*	141	4787	294.6	(260.0 – 364.3)	1,708,548	8.3	(6.9 – 9.7)
2019*	132	5010	263.5	(220.4 – 312.4)	1,933,127	6.8	(5.7 – 8.1)

****Extrapolated values though Linear Regression analysis*

NOTE: Estimate for Number of Distillery Employees (NAICS = 31214) provided by U.S. Census Bureau; Estimate for Number of Bourbon Barrels Produced provided by Kentucky Department of Revenue (Coomes & Kornstein, 2019)

*****CI: Confidence Interval; derived from a confidence level of 95.0%*

TABLE 9. Variables Excluded from Analysis Due to Data Missingness

Variable	Percent Available (%)	Percent Missing (%)
Award Date	0.9	99.1
Disability Percent	0.8	99.2
Impairment Percent	0.8	99.2
Payment Amount	0.9	99.1
Code Description	0.9	99.1
Number of Payment	0.8	99.2
Total Payment Amount	0.9	99.1
Award Type	0.9	99.1
Disposition	10.2	89.8

FIGURE 1. Kentucky Injured Distillery Workers by Injured Body Part, 2010-2019

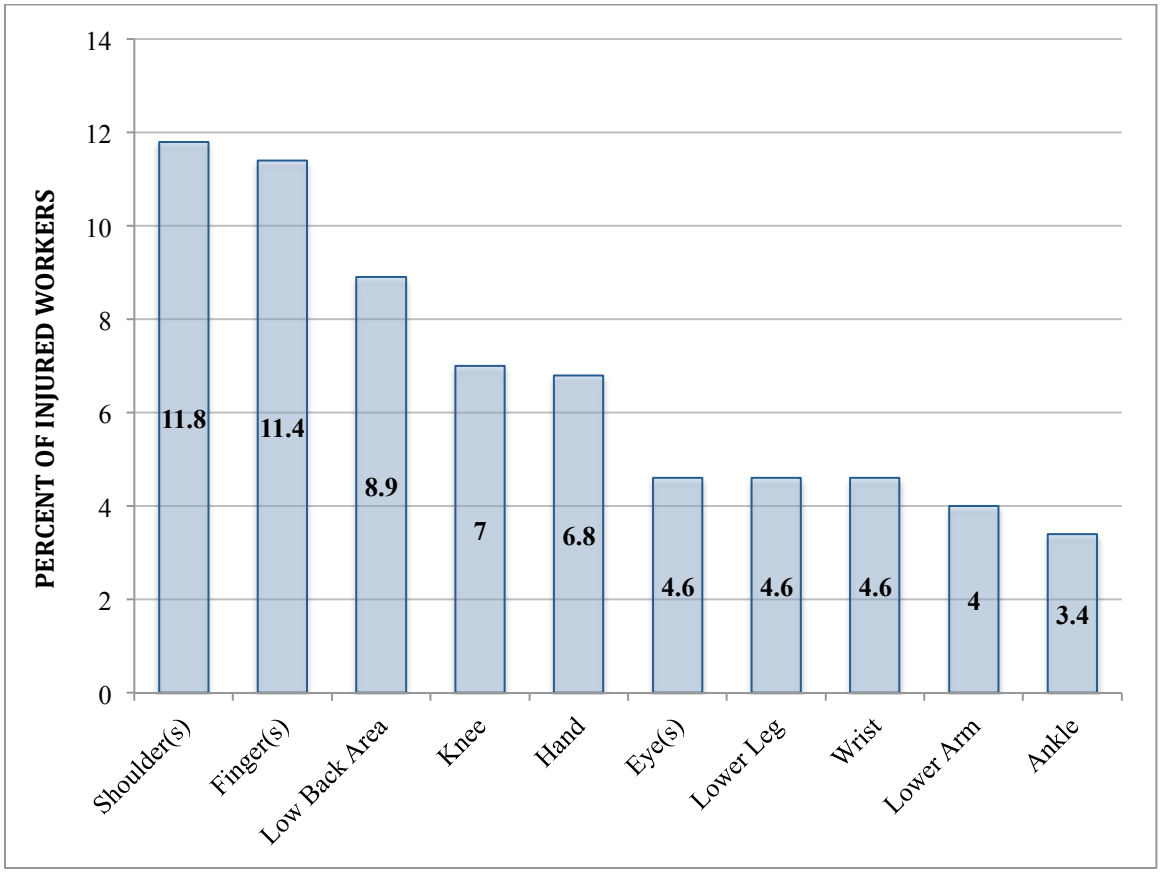


FIGURE 2. Kentucky Injured Distillery Workers by Nature of Injury, 2010-2019

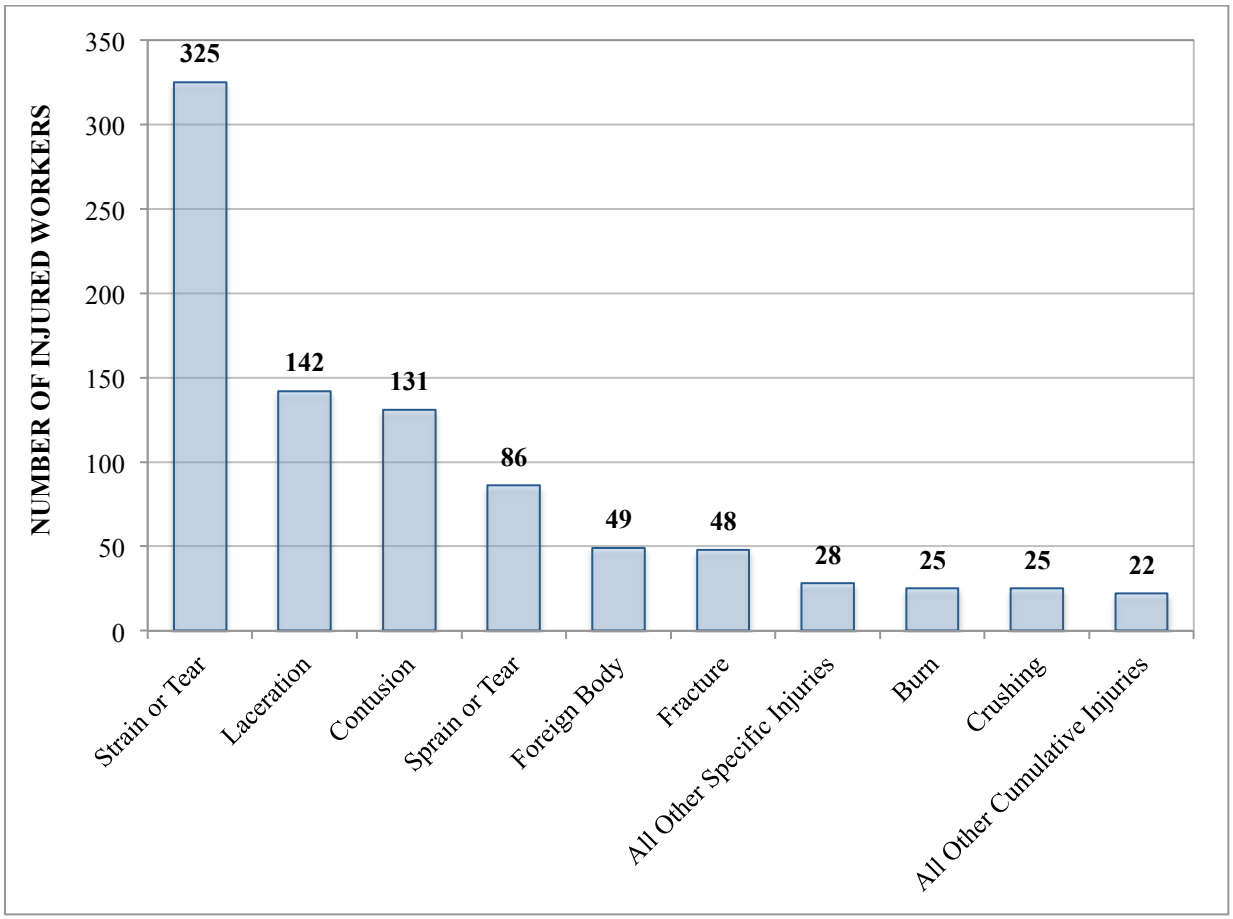
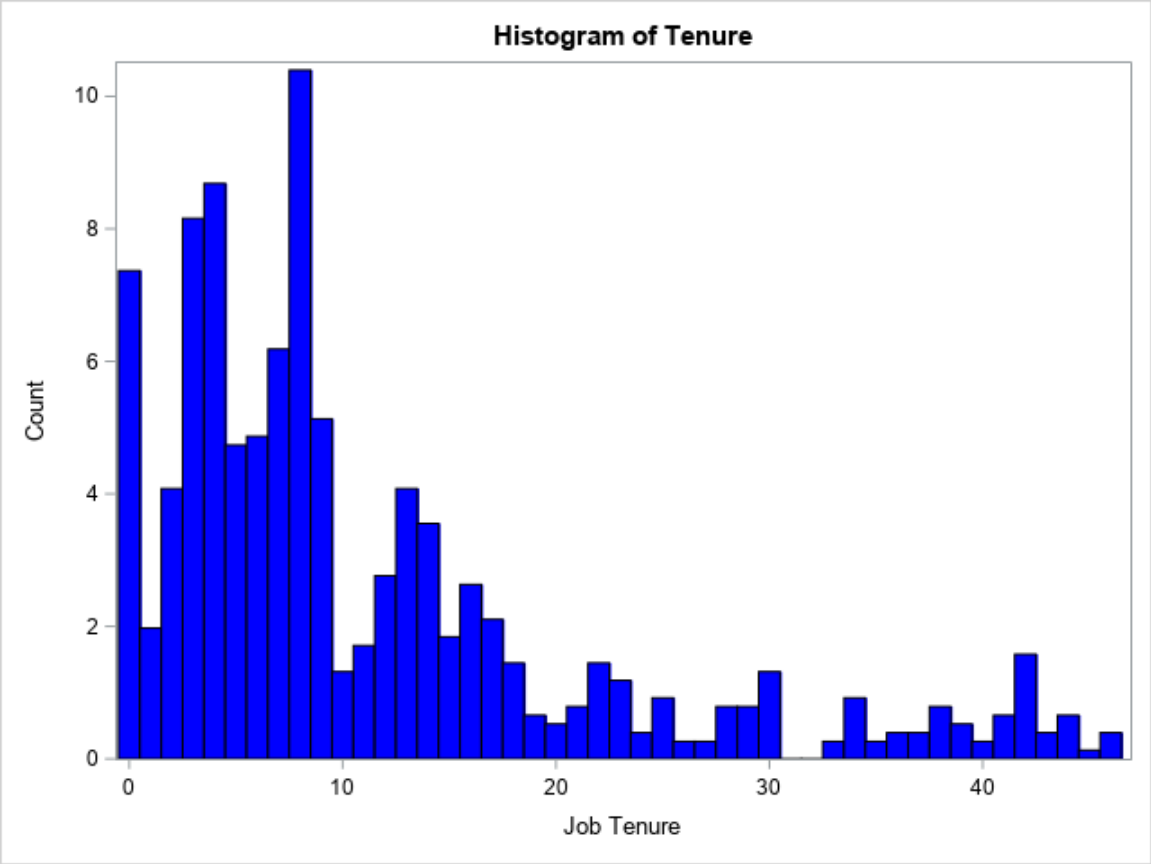
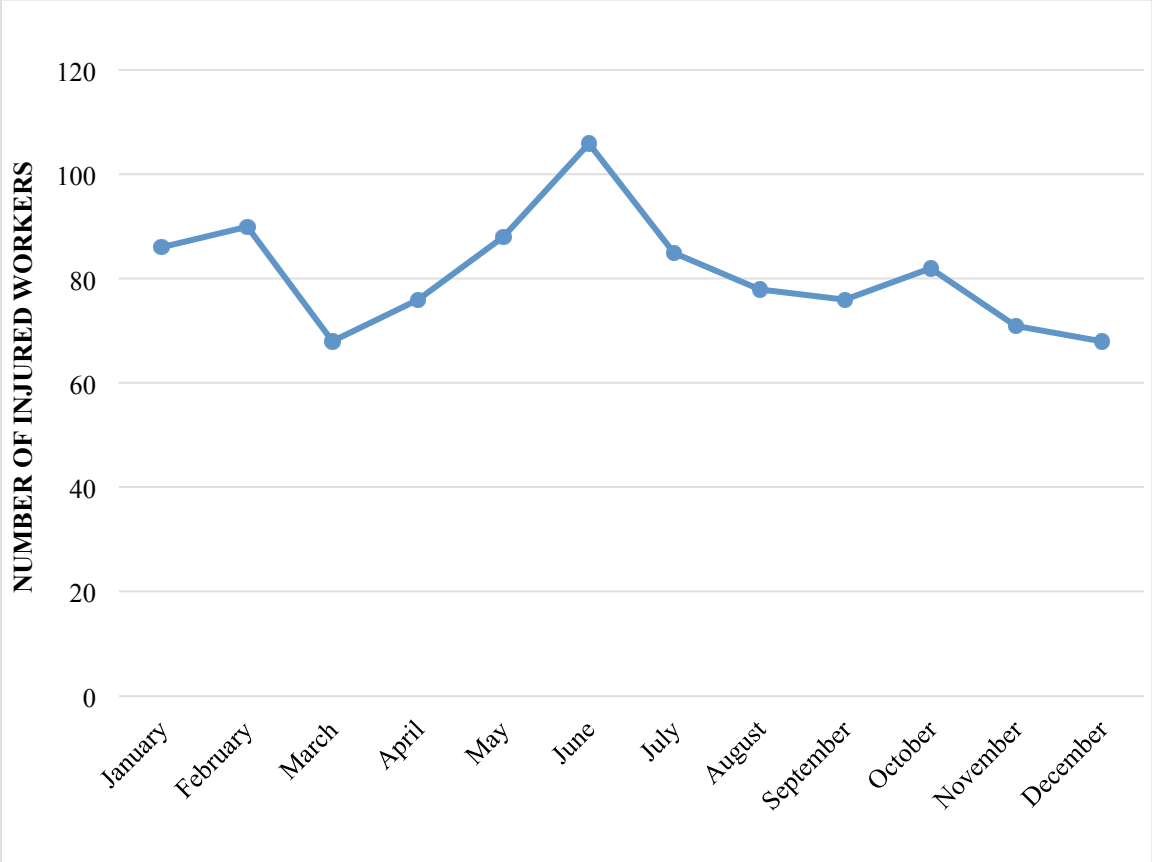


FIGURE 3. Distribution of Job Tenure Amongst Injured Distillery Workers in Kentucky, 2010-2019



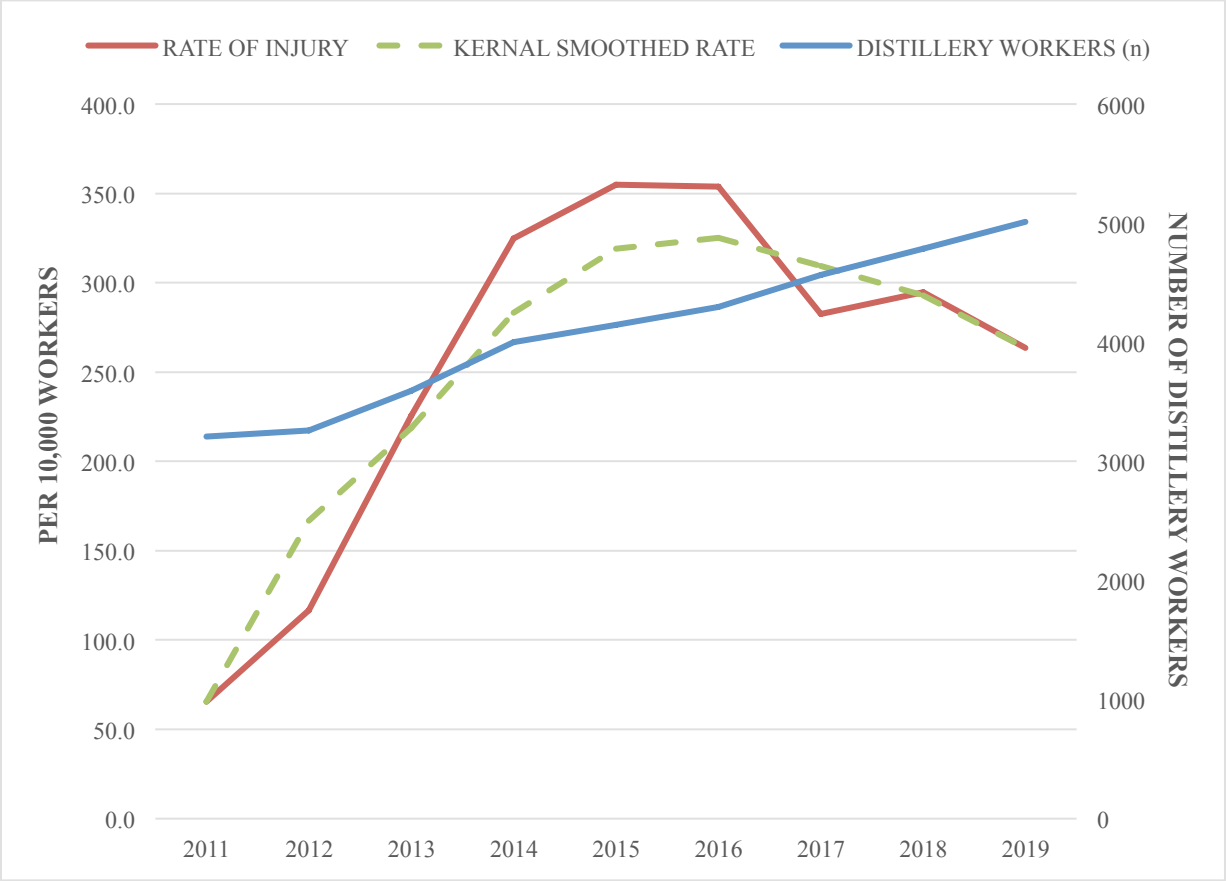
NOTE: 214 missing values

FIGURE 4. Monthly Distribution of Worker Injury, 2010-2019 (**N=974**)



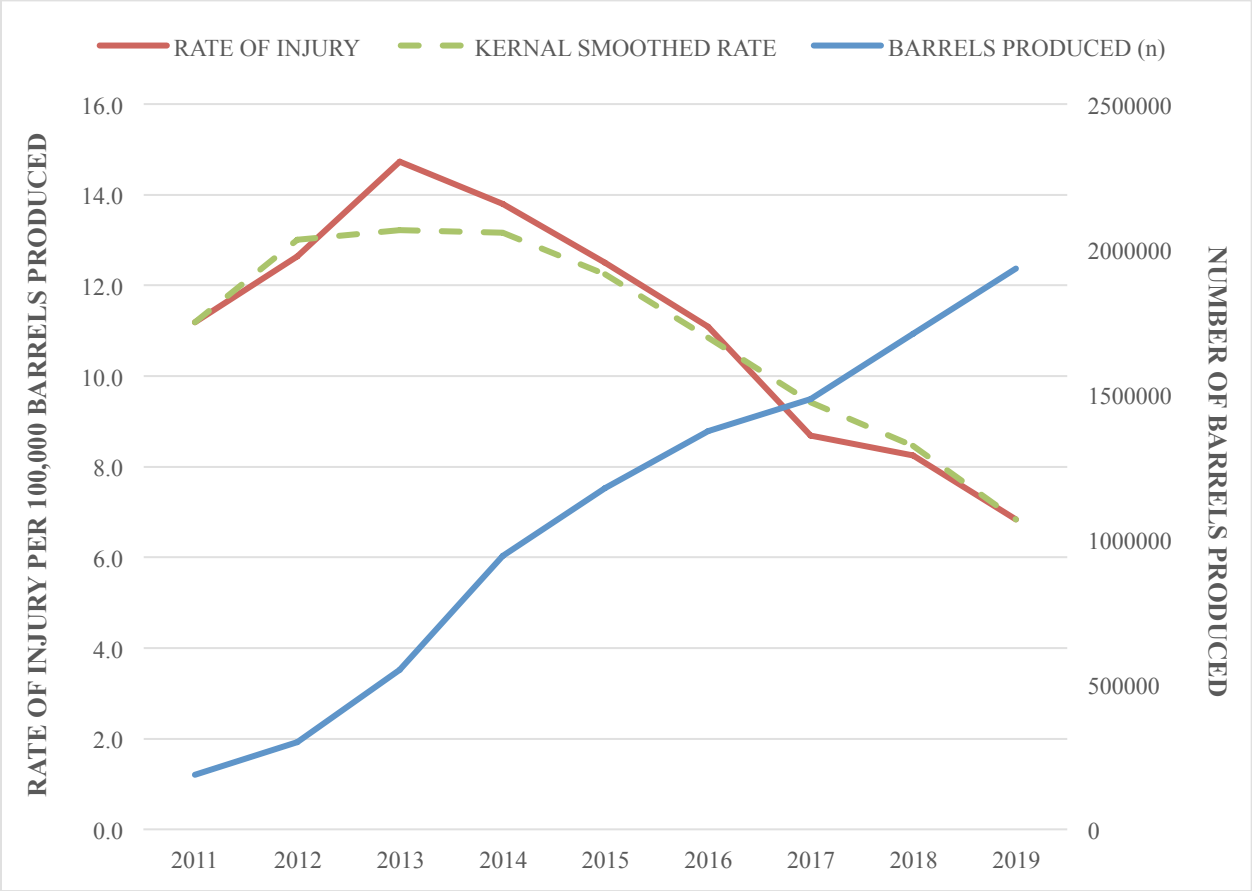
NOTE: Ratchet circular scan test used to assess short seasonal peak -
2 – month peak : May to June
19.9% of events; Test Statistic = 2.6; P <0.1

FIGURE 5. Rate of Distillery Injury Per 10,000 Workers and Number of Distillery Workers by Calendar Year, 2011-2019



NOTE: Rates are unadjusted; Kernal density analysis: averages of values in a radius of 3.0 score units

FIGURE 6. Rate of Distillery Injury Per 100,000 Bourbon Barrels Produced and Number of Barrels Produced by Calendar Year, 2011-2019



NOTE: Rates are unadjusted; Kernal density analysis: averages of values in a radius of 3.0 score units

VITA

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