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### The Effect Of Union Status On Injury Risk And Severity In A Manufacturing Cohort

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**The Effect of Union Status on Injury Risk and Severity  
in a Manufacturing Cohort**

Khaled Abdulrahman M Altassan, MD

### **Abstract**

**Objective:** This study aimed to investigate the effect of union status on risk of injury among a cohort of aluminum manufacturing workers.

**Methods:** This cohort study included all hourly employees at 19 U.S. plants, which were in operation between 2000 and 2007. Workers were classified into unionized and non-unionized groups. The final dataset combined a human resources database, which includes information about job history and socio-demographic information, and an incident management system, which includes information on work-related injuries. Injuries were classified by severity into four mutually exclusive categories: injuries requiring first aid, medical treatment, work restriction, and lost work time. Descriptive statistics using Chi-square and student's t-test were calculated. Survival curves and cox-proportional hazard models were used to determine the outcome, which was the individual's time to first injury within a standardized job category.

**Results:** A total of 27,600 hourly workers included; 19,115 (71%) were unionized while 8,485 (29%) were non-unionized. The cohort of 27,600 persons contributed a total of 41,522 person-jobs (30,360 unionized vs. 11,162 non-unionized). Looking at first injury of any type, union person-jobs incurred 9,290 injuries (30% of union person-jobs) compared to 2,599 injuries in non-union person-jobs (23% of non-union person-jobs). A similar relationship was observed when considering only first OSHA recordable injuries. After adjusting for multiple covariates, union workers had a 27% higher risk of early injury of any type and a 34% higher risk of earlier first recordable injury compared to non-union workers.

**Conclusion:** Our results provide evidence associating union status with higher risk of earlier injuries, whether these injuries were OSHA recordable or first aid only.

### **Acknowledgment**

I must dedicate this work to my lovely wife, Dr. Nada Ghoneim Altassan, whom without her love, constant encouragement, and her countless hours in reviewing and editing this manuscript, this thesis would not be possible. She endured many nights and evenings without an available husband, while I am reviewing the literature and inscribing this thesis. She inspires me to be a better writer.

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Lastly, my love and gratitude goes to the ones from whom I gain strength and life: my mother, Nuzha; my son, Abdulrahman; my sister Asma; and my three brothers, Naif, Fawaz and Mohammed. They have been my source of energy and blessing in life.

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### **SPECIFIC AIM & HYPOTHESES**

This study aimed to investigate the effect of union status on risk of injury among a cohort of aluminum manufacturing workers. We hypothesized that although unionized workers might have a higher overall number of documented injuries, they have a lower risk of severe injury than non-unionized workers. Covariates previously shown to predict injury risk in similar cohorts, including age, sex, ethnicity, job tenure, standardized job category, and plant location were included in the analytic models to better refine risk estimates attributed to union status.

### **BACKGROUND & RATIONALE**

Evidence has shown conflicting results regarding the relationship between unionization and work-related injuries. Some studies argue that unionized workers are less likely to suffer injuries than their non-unionized counterparts[1-8]. Several explanatory factors have been suggested for this observed “union safety effect”. Unions may be instrumental in educating workers about job hazards, providing incentives for safe workers, urging employers to reduce or substitute hazardous tasks, fostering regulatory policies that promote worker safety, and encouraging injury reporting, thereby intervening early to prevent further injuries[6]. Other studies suggest the opposite, reporting that union workers are more likely to encounter work-related injuries[9-16], and higher rates of absenteeism have been observed in plants having a large union presence[17]. Several explanations have been proposed as possible reasons for this unexpected association between unions and high risk of injury. Over-reporting was one of the most commonly described explanations, which refers to the tendency of union workers to report work-related injuries without fear of reprimand. Another explanation is self-

selection, which refers to the idea that unions typically organize workplaces that are inherently hazardous and thus are associated with higher injuries[18]. Therefore, the current evidence is equivocal regarding the relationship between union status and injury rates.

The “union safety effect” has been supported by multiple studies. A large ecological study examined the effect of union density on fatal and non-fatal work related injuries in multiple European countries between 1982 and 2006. An increase in union density in each country was found to be significantly associated with lower fatal and non-fatal occupational injuries after controlling for multiple covariates including average gross domestic product[7]. Another study investigated the difference between workers’ compensation claim rates in unionized and non-unionized construction firms in Canada from 2006 until 2012. Despite 13% higher total worker compensation claim rates, unionized firms had 14% lower lost-time claim rates than non-unionized firms. The authors concluded that unions contribute significantly to worker safety and injury prevention and encourage early reporting[19]. Support for a union safety effect was also found in a U.S. based study that examined the effect of unionization on the safety of coal miners; the study found that unionization was associated with a 14 to 32% drop in traumatic injuries and a 29 to 83% drop in fatalities in coal mining workers [6].

Conversely, a number of studies suggest that union workers are more likely to encounter occupational injuries. For example, a longitudinal study that used a self-administered survey between 1988 and 2000 to examine the effect of union membership on risk of injury found that union members were at least 34% more likely to have a non-fatal occupational injury than non-union personnel[18]. Another U.S. based cross sectional study found that unionized blue collar workers had a 23% higher likelihood of reporting a health condition

related to workplace accidents[9]. In addition, a study of underground coal mines in the U.S. found that union workers had a 12.6 % increased incidence rate of all reported injuries compared to non-union workers[16]. Lastly, a Canadian cross-sectional population-based study examined the rate of workers' compensation claims among various firms in Quebec; unionized firms experienced higher worker compensation claim rates and higher injury rates with about 4 more injuries per 100 workers[13].

Unlike most previous studies that were based on either prospective industrial-level or company-level data, where ecological fallacy is a concern, or self-administered cross-sectional surveys, where longitudinal analysis is not feasible, this study is the first of its kind to combine company-level and individual-level data with the primary objective of examining the effect of union status on the individual risk of injuries among a manufacturing cohort.

## **METHODS**

### **Study Population:**

This cohort study used data that is available through a longstanding collaboration between the investigators and a multi-national aluminum production corporation. Data was included for all hourly employees at 19 U.S. aluminum-manufacturing plants, which were in operation between 2000 and 2007. Both production and maintenance employees were included in each arm of the study, the unionized group and the non-unionized group. The union status at an individual level was determined by plant, as each plant was either a unionized or a non-unionized facility. Two different databases, explained below, were merged using a unique encrypted employee ID number.

#### Databases:

The Human Resources Database includes complete job histories with dates of job change for all employees and includes information such as: job title, plant location, employment status (active or retired), and date of disability and return, if applicable. In addition, the Human Resources Database includes basic socio-demographic information such as age, gender, and ethnicity for each employee. Each human resource job title was assigned to a standardized job category. This allowed distinct job titles with similar work functions and exposures across plants to be collapsed into broader standardized jobs for the purpose of analysis. The combining of job titles was performed in collaboration with a highly experienced industrial hygienist who worked with this population for many years. The details of this database and job standardization have been explained in previous publications[20, 21].

The second database is the real-time Incident Management System (IMS), which was established in 1989 and modified over time. It includes information on all employee work-related injuries and illnesses. Data includes date of injury, type of injury, body part injured, and circumstances of the injury. All injuries sustained by hourly workers employed by the 19 plants during the 8-year study period (2000-2007) were included for analysis; illnesses were excluded. Each injury was classified by severity into four mutually exclusive categories: injuries requiring first aid only, injuries requiring medical treatment, injuries resulting in work restriction, and injuries resulting in lost work time. The latter three categories are recordable to the Occupational Safety and Health Administration (OSHA). The details of this database have been explained in previously published articles[20, 21]. Job histories from the Human Resource

Database and first injury occurring in each job from IMS database were compiled for each hourly worker in the cohort using the unique encrypted identifier. This resulted in two compiled databases: the first database included the first occurring injury of any type in each job, and the second database included only the first OSHA recordable injury in each job.

#### Outcomes:

The main outcome for this study was the individual's time to first injury in a standardized job. Standard job category, sex, age, race, job tenure, plant type, and geographic location were all considered as potential confounders of the relationship between union status and risk of injuries. As the hazard of injury after one year of employment has been shown to decrease[20], job tenure was binomially categorized into greater than one year and less than one year.

#### Statistical analysis:

Descriptive statistics were calculated for the two populations (unionized vs. non-unionized). To determine statistically significant differences in categorical and continuous variables, the Chi-square test and student's t-test were used, respectively. A two-tailed p-value at the level of 0.05 was deemed significant.

Survival analysis to determine the time to first injury within a standardized job category was performed. Kaplan-Meier survival curves were developed in order to compare the log (-log) of survival versus log (time) relationship between union and non-union groups to determine if the assumption of proportional hazards was met. Subsequently, Cox-proportional hazard

analysis was used. Since an individual may have worked in more than one standardized job during the period of this study, each individual was included as a random effect in the Cox proportional hazard analyses. We used separate models to examine two outcomes: 1) time to first injury occurring in each job for each worker, and 2) time to first OSHA recordable injury in each job for each worker. Standardized job category was also added as a random effect to both models.

Statistical analyses were performed using SAS V.9.3 (SAS Institute, Cary, North Carolina, USA). This study was approved by the Yale University School of Medicine Human Investigations Committee.

### **RESULTS:**

A total of 27,600 hourly workers contributed active work-time between 2000 until 2007 and were included in the study cohort; among those, 19,115 (71%) were union members while 8,485 (29%) were non-union workers (Figure 1). This cohort represented 19 plants distributed all over the U.S. (12 Union plants vs. 7 Non-union plants).

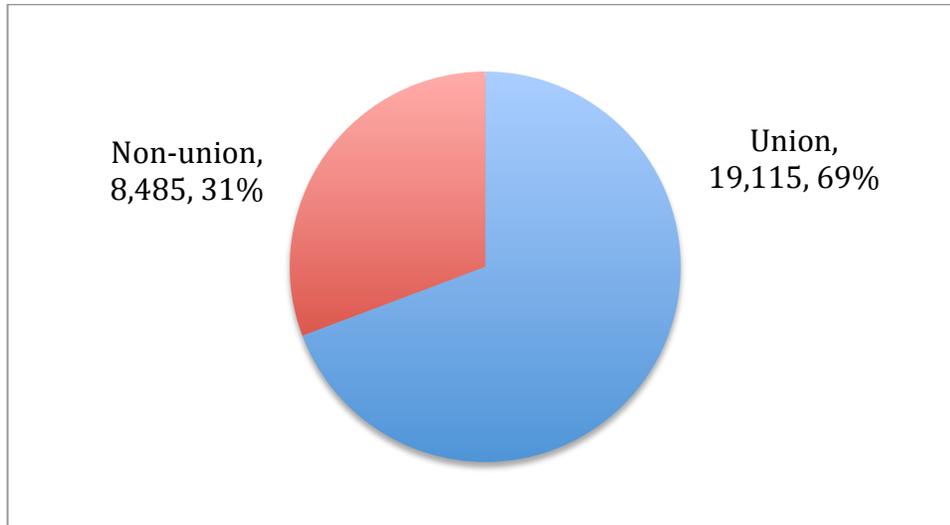


Figure 1. Distribution of the cohort by union status.

Table 1 provides descriptive analysis of the cohort by union status. During the study period, 8,104 unionized workers (42.4 %) incurred a first aid or recordable injury in comparison to 2,437 non-unionized workers (28.7%). Considering only recordable injuries, 3,576 (18.7%) unionized workers experienced injuries requiring medical treatment, restricted work-time, or lost work-time compared to 688 (8.1%) non-unionized workers. Unionized workers had higher averages for age, job tenure, and number of jobs held (42.8, 13.0, and 1.59, respectively) compared to non-unionized workers (38.7, 7.4, and 1.32, respectively). Distribution of race was significantly different between the two populations with White being the predominant race in both unionized and non-unionized workers (84% vs 66.8%, respectively). Sex was also significantly associated with union status with males predominating both unionized (85.5%) and non-unionized workers (71.4%). Plant type was also significantly associated with union status; the highest frequency (33.4%) of unionized workers came from smelter plants, while the majority of non-unionized workers came from casting plants. Finally, unionized workers were

primarily in the Midwest (41.8%), while non-unionized workers were primarily in the South (44.7%). All of the described results were statistically significant.

Table 1. Descriptive analysis of the cohort <sup>a</sup>

Characteristic	Union		p <sup>b</sup>
	Yes (N = 19,115)	No (N = 8,485)	
Age (years)	42.8 ± 11.1	38.7 ± 11.3	<0.001
Tenure (years)	13.0 ± 12.9	7.4 ± 9.2	<0.001
Average number of job	1.59 ± 1.01	1.32 ± 0.60	<0.001
Race			<0.001
Asian	65 (0.3)	164 (1.9)	
Black	1747(9.1)	1656 (19.5)	
Hispanic	1054 (5.5)	944 (11.1)	
White	16055 (84.0)	5670 (66.8)	
Other	194 (1.0)	51 (0.6)	
Sex			<0.001
Male	16341 (85.5)	6056 (71.4)	
Female	2774 (14.5)	2429 (28.6)	
Plant type			<0.001
Fabrication	5079 (26.6)	2145 (25.3)	
Casting	2911 (15.2)	5763 (67.9)	
Smelter	6374 (33.4)	577 (6.8)	
Smelter and Fabrication	4751 (24.9))	0 (0)	
Geographic region			<0.001
South	7591 (39.7)	3789 (44.7)	
Mid Atlantic	0 (0.0)	2145 (25.3)	
Midwest	7990 (41.8)	1039 (12.2)	
Northeast	1755 (9.2)	1512 (17.8)	
Northwest	1779 (9.1)	0 (0.00)	
Injured workers (Any injury)			<0.001
No	11011 (57.6)	6048 (71.3)	
Yes	8104 (42.4)	2437 (28.7)	
Injured workers (Recordable)			<0.001
No	15539 (81.3)	7797 (91.9)	
Yes	3576 (18.7)	688 (8.1)	

<sup>a</sup> Table values are mean ±SD for continuous and n (column %) for categorical variables.

<sup>b</sup> P-value is for t-test (continuous variables) or for  $\chi^2$  test (categorical variables).

Since workers may have held more than one job during the study period, the cohort of 27,600 persons contributed a total of 41,522 person-jobs; 30,360 were unionized while 11,162 were non-unionized. Figure 2a and 2b display the distribution of injuries among all person-jobs included in the study cohort. Figure 2a displays the distribution of first injury of any type among union and non-union person-jobs; union person-jobs incurred 9,290 injuries (30% of union person-jobs) compared to 2,599 injuries in non-union person-jobs (23% of non-union person-jobs). When considering only first OSHA recordable injuries (Figure 2b), a similar relationship was observed, with the highest frequency of injuries occurring among union person-jobs in comparison to non-union person-jobs; 3,752 recordable injuries occurred in union person-jobs (12.4% of total union person-jobs) vs. 699 recordable injuries among non-unionized person-jobs (6.3% of total non-union person-jobs).

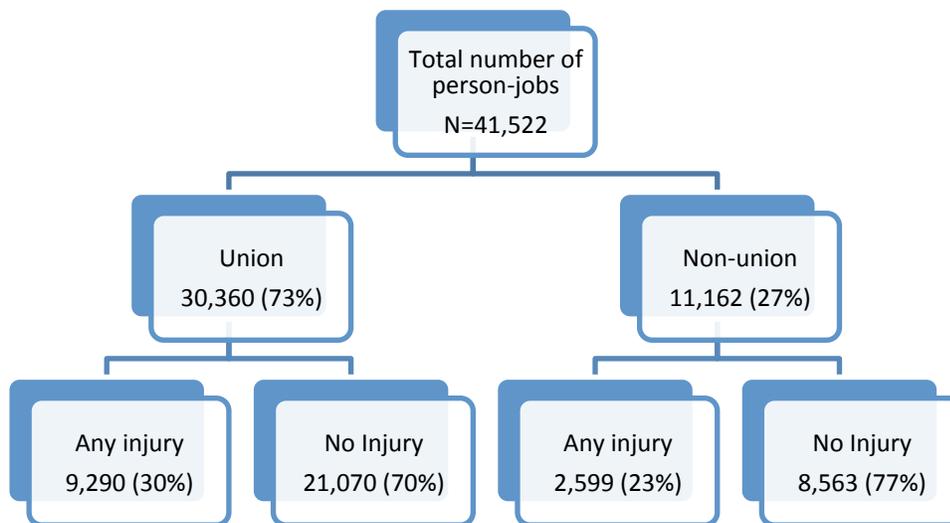


Figure 2a. The distribution of first injury among union and non-union person-jobs.

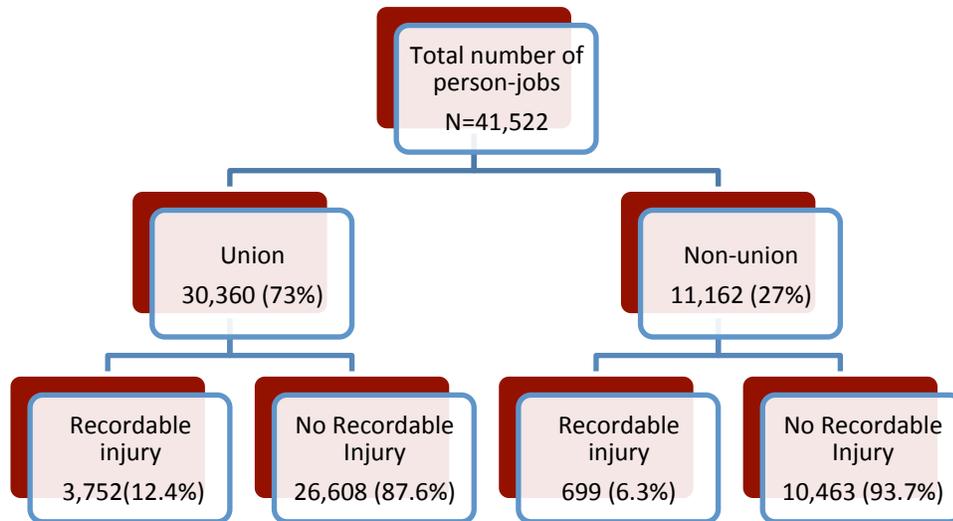


Figure 2b. The distribution of first OSHA recordable injury among union and non-union person-jobs.

Table 2a and 2b display the distribution of injuries among all person-jobs by union status and severity of injury for the any injury (Table 2a) and OSHA recordable injury outcomes (Table 2b). When looking at first reported injury of any type, non-unionized workers had a higher frequency of reported injuries requiring first aid compared to unionized workers (80.0% vs 68.7%). However, unionized workers had higher frequencies of injuries requiring medical treatment, restricted work-time and lost work-time (14.9%, 14.9%, and 1.5%, respectively) in comparison to non-unionized workers (9.1%, 9.7%, and 1.2%, respectively) (p value <0.001). Looking at first reported OSHA recordable injuries among all person-jobs (Table 2b), there was no significant difference in distribution of injury severity by union status (p value 0.442).

Table 2a. Distribution of first reported injuries of any type by union status among all person-jobs

Characteristic	Union		p <sup>a</sup>
	Yes	No	
Injuries requiring first aid only	6386 (68.7)	2078 (80.0)	<0.001
Injuries requiring medical treatment	1382 (14.9)	237 (9.1)	
Injuries resulting in restricted work days	1380 (14.9)	252 (9.7)	
Injuries resulting in lost work days	142 (1.5)	32 (1.2)	

<sup>a</sup> P-value is for  $\chi^2$  test.

Table 2b. Distribution of first reported OSHA recordable injuries by union status among all person-jobs

Characteristic	Union		p <sup>a</sup>
	Yes	No	
Injuries requiring medical treatment	1751 (46.7)	316 (45.2)	0.4424
Injuries resulting in restricted work days	1816 (48.4)	341 (48.8)	
Injuries resulting in lost work days	185 (4.9)	42 (6.0)	

<sup>a</sup> P-value is for  $\chi^2$  test.

Table 3 displays the results of the Cox proportional hazard models for both outcomes: 1) first injuries of any type and 2) first OSHA recordable injuries. After adjusting for standardized job category (included as random effect variable), sex, age, race, job tenure, plant type, and geographic location, union workers had a 27% higher risk of early injury of any type compared to non-union workers (HR 1.27, 95% CI 1.149-1.407). A similar association was observed when examining only first OSHA recordable injuries; union workers had a 34% higher risk earlier first recordable injury compared to non-union workers after adjusting for the same covariates (HR 1.34, 95% CI 1.121-1.602).

Other significant associations were observed as well. A one-year increase in age was associated with 0.07 % risk reduction in first injury of any type (HR= 0.993, 95% CI: 0.991-0.995) and with 0.05% risk reduction in first recordable injuries (HR= 0.995, 95% CI: 0.992-0.999). Workers who had job tenure of less than one year had a 38% higher risk of any injury compared to those with job tenure of more than one year (HR= 1.382, 95% CI: 1.314-1.454); this association decreased to 20% when considering only OSHA recordable injuries (HR= 1.199, 95% CI: 1.101-1.307). Although female workers were a minority in this population, 14.5% in union and 28.6% among non-union workers, they displayed a 63% increased risk of any injury (HR= 1.632, 95% CI: 1.543-1.726) and a 45% increased risk of recordable injury (HR= 1.445, 95% CI: 1.314-1.589). Compared to Whites and after adjusting for other covariates, Hispanics had a 24% higher risk of any injury (HR= 1.242, 95% CI= 1.154-1.336) and a 23% higher risk of recordable injury (HR= 1.232, 95% CI: 1.086-1.397). Looking at type of manufacturing process, casting plants were associated with a 35% lower risk of any or recordable injuries compared to smelter plants (HR= 0.686, 95% CI: 0.600-0.784; HR= 0.64, 95% CI: 0.506-0.810; respectively). Finally, plant geographical location contributed to differences in injury risk with workers located in the Northwest showing a 30% lower risk of any injury (HR= 0.7, 95% CI: 0.638-0.767) and 26% lower risk of recordable injury (HR= 0.743, 95% CI: 0.640-0.862) in comparison to workers located in the Southern part of the U.S.

Table 3. Full adjusted model showing the effect union status and other covariates on risk of injuries <sup>a</sup>.

	Any injuries			Recordable injuries		
	HR	95% CI	p value	HR	95% CI	p value
<b>Union</b>						
No	1			1		
Yes	1.271	(1.149-1.407)	<0.001	1.34	(1.121-1.602)	0.001
Age (1 year increase)	0.993	(0.991-0.995)	<0.001	0.995	(0.992-0.999)	0.007
<b>Tenure</b>						
>1 year	1			1		
<1 year	1.382	(1.314-1.454)	<0.001	1.199	(1.101-1.307)	<0.001
<b>Sex</b>						
Male	1			1		
Female	1.632	(1.543-1.726)	<0.001	1.445	(1.314-1.589)	<0.001
<b>Race</b>						
White	1			1		
Asian	0.776	(0.598-1.008)	0.057	0.956	(0.607-1.505)	0.845
Black	0.912	(0.855-0.971)	0.004	0.999	(0.902-1.105)	0.979
Hispanic	1.242	(1.154-1.336)	<0.001	1.232	(1.086-1.397)	0.001
Other	1.143	(0.958-1.364)	0.138	1.212	(0.903-1.627)	0.201
<b>Plant type</b>						
Smelter	1			1		
Fabrication	0.898	(0.788-1.024)	0.108	1.142	(0.902-1.446)	0.27
Casting	0.686	(0.600-0.784)	<0.001	0.64	(0.506-0.810)	<0.001
Smelter & Fabrication	0.958	(0.897-1.024)	0.212	1.08	(0.971-1.201)	0.154
<b>Geographic region</b>						
South	1			1		
Mid Atlantic	1.052	(0.922-1.200)	0.452	0.86	(0.680-1.086)	0.205
Midwest	0.875	(0.773-0.989)	0.033	1.048	(0.832-1.322)	0.688
Northeast	1.011	(0.938-1.090)	0.768	0.887	(0.777-1.012)	0.074
Northwest	0.7	(0.638-0.767)	<0.001	0.743	(0.640-0.862)	<.001

<sup>a</sup> Mixed effect analysis was used to adjust for the repeated measure for individual; standard job category was included as a random effect.

### Discussion

This longitudinal study examined the effect of union status on risk of injuries among a U.S. aluminum-manufacturing cohort using individual-level data. Although we hypothesized that unionization was associated with a higher risk of overall injury but lower risk of severe injury, our study provided evidence for a higher risk of earlier first injury of any type as well as a higher risk of earlier more severe injuries, leading us to reject the second part of our hypothesis that union workers have lower risk of severe injuries. We examined two different models and adjusted for multiple covariates including: plant type by manufacturing process, standardized job category, age, sex, race, job tenure, and geographic location. Our results suggest that being a union worker was, indeed, associated with a 27% higher risk of earlier first injury of any severity including injuries requiring first aid only. The same association held when we considered only OSHA recordable injuries, which are injuries requiring medical treatment, lost work-time, or restricted work-time; being a union worker was associated with a 34% higher risk of earlier recordable injuries. This result is contrary to a previous study that looked at the same population in 2006 and found that unionization was associated with 60% lower injury rates [8]. However, unlike the previously reported study, which used only one year of data and was not able to control for other covariates such as geographic location and standardized job category, our study included several years of longitudinal data allowing us to perform Cox proportional hazard analyses and control for multiple covariates recognized as conferring injury risk. Additionally, our results corroborated previously observed associations between union status and higher risk of injury on a subset of this work population[22, 23].

Other covariates showed statistically significant associations with injury risk, some of which confirmed what has been previously observed in a subset of this population; specifically, there was a higher risk of injury among female workers, Hispanics (compared to Whites), and workers with a short time since hire (less than one year)[20]. Conversely, workers at casting plants were found to have a lower injury risk in comparison to workers at smelters; this was also observed in previous studies and was explained by the heaviest physical demands at those smelters[8, 20]. Additionally, discrepancies in injury risk were associated with certain geographic locations; specifically, in comparison to the workers in the South, workers located in Northwest were found to have a lower risk of any injuries and recordable injuries.

The concept of endogenous hazard has been described as a possible explanation for this unexpected association of union membership with a higher risk of injury. The concept of endogeneity refers to the tendency for employees with injuries to join unions in order to take advantage of services such as legal counsel or assistance with worker compensation claims[14]. It also refers to the notion that workers in hazardous plants/jobs are more likely to form or join a union in order to have legal protection and better wage bargaining power[11, 14]. In both cases, union status is inherently associated with higher injury risk. Although previous studies attempted to control for the effect of endogeneity, they still found a positive association between unionization and risk of injury[11, 14]. In our study cohort, such an endogenous effect might have had an impact, since the cohort represents union and non-union plants from the same corporation with standardized management and safety policies and with similar work responsibilities. Nonetheless, we attempted to control for the effect of endogeneity, whether it was a job category with higher inherent risks or a plant work environment with overall

increased hazards, by adding employee standardized job category and the type of work facility (plant type) to the final model. Controlling for these covariates did not modify observed associations between union status and higher risk of injury.

Over-reporting has been described to be higher in industries with a strong union presence, which could be another possible explanation for the observed effect of union status on risk of injuries[14, 15, 18]. A cross-sectional study using a self-administered survey among the working population in the U.K. concluded that workplaces with higher union membership were associated with higher reported injuries[14]. This was supported by another British study that found union presence in the private sector was associated with higher reporting of work-related injuries; the author explained that this could be a reflection of the greater willingness for union members to report injuries or illness under the protection of the unions[15]. Another U.S.-based longitudinal study using a self-administered survey reiterated similar findings in which union members were found to have a higher frequency of injury reporting than non-union personnel (10.5% vs 5.5%)[18]. This was previously explained by the assumption that accident reporting systems and health and safety committees are more advanced and commonly used in heavily unionized workplaces where employees are encouraged to report any work-related injury or illness[24].

In order to control for the potential of greater reporting among union workers, previous studies have attempted to distinguish between different types of reported injuries. A study among the US coal mining industry found that unionization is associated with a 17% higher incident rate of injuries resulting in lost workdays but with 4% lower severe injury incident rate; however, this finding was not statistically significant[16]. This was confirmed by another study

among the same U.S. coal mining population, in which the investigators concluded that unionization predicts greater overall injury reporting but also predicts a significant decline in traumatic and fatal injuries[6]. Because we used injury surveillance data from a company that requires reporting of any injury regardless of severity by the plant safety managers or onsite health clinics, reporting bias should theoretically have been minimized [20]. Additionally, we examined the data using two models: first, by looking at overall injuries including first aid which may be more likely to be reported, and second, by looking at only OSHA recordable injuries, which is often used as a proxy for workplace safety.

Our study has several limitations. First, we were unable to adjust for the variability in hours worked among the different workers. We expect from previous studies that variability in scheduled work-time and in overtime exists in this population and that this variability is, indeed, associated with risk of injury. It has been reported that workers who work more than 64 hours in a week have about an 88% increased risk of injury than those who work less than 40 hours[25]. We were unable to incorporate weekly hours in our models because of data limitations. Second, although it is known from the literature that about half of employees with work-related injuries are expected to report repeat injuries in the subsequent 3 years[26], we were not able to incorporate repeat accidents at the same job in our analysis. However, we included repeated injuries in different jobs for the same employee in the final models. Third, this cohort consisted of workers from a single corporation with a strong safety culture, which may limit generalizability.

In comparison to most of the previous studies on union status and injury risk that were either retrospective or cross-sectional with heavy reliance on self-administered surveys with possible recall bias[18], or ecological in nature with possible fallacy, a prominent strength of this study is the use of longitudinal data that allowed us to follow workers over time and use a time to injury analysis. Additionally, availability of human resource and incident management data rather than relying on self-reported data, increases confidence in our findings. Another important advantage of this study was the availability of a large cohort, lending power to detect differences. Finally, we were able to adjust for plant type and job in the statistical models, which helped to control for the endogenous hazards that are typically associated with union status and previously described in the literature.

### **Conclusion**

In conclusion, our results provide evidence associating union status with higher risk of earlier injuries, whether these injuries were OSHA recordable or first aid only. Additionally, the study showed that female sex, Hispanic race, smelter plants and short company tenure are also predictors of work-place injury. Because the cohort represented employees from a single corporation with a high safety culture, we could not investigate potential impacts of cultural and behavioral differences between unionized and non-unionized plants in reporting workplace injuries. Future studies should explore potential discrepancies between confidential surveys of self-reported injuries and data from work place incident management systems.

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