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RISK OF INJURY BY UNIONIZATION: SURVIVAL ANALYSIS OF A LARGE INDUSTRIAL COHORT

Khaled Abdulrahman Altassan, MD, MPH,
Department of Occupational and Environmental Medicine, Yale University School of Medicine, 367 Cedar St, ESHA 2nd Fl., New Haven, CT 06510, USA

Carine J Sakr, MD, MPH,
Department of Occupational and Environmental Medicine, Yale University School of Medicine, New Haven, CT, USA

Deron Galusha, MS,
Department of Occupational and Environmental Medicine, Yale University School of Medicine, New Haven, CT, USA

Martin D Slade, MPH,
Department of Occupational and Environmental Medicine, Yale University School of Medicine, New Haven, CT, USA

Baylah Tessier-Sherman, MPH, and
Department of Occupational and Environmental Medicine, Yale University School of Medicine, New Haven, CT, USA

Linda F Cantley, PT, MS
Department of Occupational and Environmental Medicine, Yale University School of Medicine, New Haven, CT, USA

Abstract

Objective—To investigate the effect of union status on injury risk among a large industrial cohort.

Methods—The cohort included hourly employees at 19 U.S. plants between 2000–2007. Plants were classified by union status, and injuries were classified by severity. Cox-proportional hazard shared frailty model was used to determine time to first reportable injury.

Results—A total of 26,462 workers were included: 18,955 (72%) unionized and 7,507 (28%) non-unionized. Union workers incurred 3,194 injuries (16.9%) compared to 618 injuries for non-union workers (8.2%). After adjusting for multiple covariates, union workers had a 51% higher risk of reportable injury.

khaled.altassan@aya.yale.edu; Telephone number: +1 203-785-6434; Fax number: +1 203-785-5713.

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Author Contributions: In the preparation of this manuscript, KAA, MDS, CJS and LFC conceived of and developed the study design. DG compiled the data for analysis; MDS, BTS and LFC conducted the data analysis; KAA, LFC, MDS and CJS participated in data interpretation. KAA conducted the literature review and drafted the initial manuscript. All authors participated in reviewing, critically revising and finalizing the manuscript.

Conclusions—Our results provide evidence for higher risk of reportable injuries in union workers; explanations for this increased risk remain unclear.

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.(1–7) 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.(5) Other studies suggest the opposite, reporting that union workers are more likely to encounter work-related injuries, and higher rates of absenteeism have been observed in plants having a large union presence.(8–15) Several explanations have been proposed as possible reasons for this unexpected association between unions and higher risk of injury. Differences in injury reporting is one of the most commonly described explanations, with union workers more likely to report work-related injuries without fear of reprimand or reprisal.(11) Another explanation is self-selection, also called the effect of endogeneity, which refers to the idea that unions typically organize workplaces that are inherently hazardous and thus are endogenously associated with higher injuries.(10) 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. An 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.(6) Another study investigated the difference between workers' compensation claim rates in unionized and non-unionized construction firms in Canada from 2006 until 2012. 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.(7) Support for a union safety effect was also found in a United States (U.S.) based study that examined the effect of unionization on the safety of coal miners between 1992–2010; 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.(5)

Conversely, a number of studies suggest that union workers are more likely to encounter occupational injuries. For example, a 1983 US based cross sectional study found that unionized blue collar workers had a 12% higher likelihood of having a health condition related to workplace accident.(8) In addition, a 2012 study of underground coal mines in the United States, found that union workers had a 17 % increased incidence rate of all reported injuries compared to non-union workers.(14) Additionally, a Canadian 2002 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.(11)

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 cohort study is unique in that it is longitudinal and combines plant-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. Our hypothesis was that union status is associated with lower risk of injury.

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 by person using a unique encrypted identification number.

Databases

The Human Resources (HR) 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 HR database includes socio-demographic information such as age, gender, and ethnicity for each employee. Each HR job title was assigned to a standardized job category. This allowed distinct job titles with similar work functions, hazards, and exposures across plants to be collapsed into broader standardized job categories 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.(16, 17)

The second database used in this study was 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 required for reporting to the U.S. Occupational Safety and Health Administration (OSHA) and therefore comprise reportable injuries. The details of this database have been explained in previously published articles.(16, 17) Job histories from the HR database and first reportable injury occurring in the first standardized job category from the IMS database were compiled for each hourly worker in the cohort using the unique

encrypted identifier. This resulted in a compiled dataset that included only the first reportable injury in the first standardized job held during the study period. Recurrent injuries in the same job as well injuries requiring first aid treatment only were not included in the compiled dataset.

Outcomes

The main outcome for this study was the individual's time to first reportable injury in the first job held during the study period. Standard job category, sex, age, race, and job tenure were each considered potential confounders of the relationship between union status and risk of injuries and were included as covariates in the statistical models. Plant was included as a random effect to account for shared frailty among workers within each plant. As the risk of injury after one year of employment has been shown to decrease,(16) job tenure was binomially categorized into greater than one year and less than one year and also added to models as a covariate.

Statistical analysis

Descriptive statistics were calculated for the two populations (union workers vs. non-union workers). 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 reportable injury within the first standardized job held during the study period 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, a Cox-proportional hazard shared frailty model was used, adjusting for the previously described covariates. A frailty model fitted with a plant-specific random intercept was utilized to account for the clustering of workers within the same location and to allow separation of within-plant and between-plant variation after adjustment for worker characteristics. The frailty model utilized is defined as:

$$\lambda_{ij}(t) = \lambda_0(t) u_i e^{\boldsymbol{\beta}' \mathbf{Z}_{ij}(t)}$$

where:

$\lambda_{ij}(t)$ is the hazard rate for the j^{th} individual in the ith location,

$\lambda_0(t)$ is the baseline hazard rate,

$\mathbf{Z}_{ij}$ is the vector of fixed effect covariates,

$\boldsymbol{\beta}$ is the vector of regression coefficients,

$\mu_i = \exp(\gamma_i)$, and

γ_i is the random effect for location i and $\gamma_1, \ldots, \gamma_n$ are independent and identically distributed as a normal random variable with mean 0 and constant variance.

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 26,462 hourly workers contributed active work-time between 2000 until 2007 and were included in the study cohort; among those, 18,955 (72%) were union workers while 7,507 (28%) were non-union workers. The cohort represented 19 plants distributed throughout the United States (12 Union plants vs. 7 Non-union plants).

Table 1 provides descriptive analysis of the cohort by union status. During the study period, 3, 194 (16.9%) union workers experienced injuries requiring medical treatment, restricted work-time, or lost work-time (reportable injuries) compared to 618 (8.2%) non-union workers. Union workers had higher averages for age and job tenure (43.3 years and 13.0 years) compared to non-union workers (39.8 years and 8.0 years). Distribution of race was significantly different between the two populations with White being the predominant race for both union and non-union workers (84.2% vs 68.1%, respectively). Sex was associated with union status with males predominating both union (85.8%) and non-union groups of workers (71.6%). All of the described results were statistically significant (p value <0.001).

Table 2 displays the distribution of injuries by US OSHA reportable categories (injuries requiring medical treatment, restricted work-time, or lost work-time) among union and non-union workers; there was no significant difference in distribution of injury severity by union status (p value = 0.236).

Table 3 displays the results of the Cox proportional hazard model for time to first reportable injury in the first standardized job held. After adjusting for standardized job category, sex, age, race, job tenure, and shared frailty within each plant, union workers had a 51 % higher risk of reportable injury compared to non-union workers (HR 1.51, 95% CI 1.125–1.840).

Other significant associations were observed as well. A one-year increase in age was associated with 0.06% risk reduction in injuries (HR= 0.994, 95% CI: 0.990–0.998). Workers who had job tenure of less than one year had a 24% higher risk of injury compared to those with job tenure of more than one year (HR= 1.24, 95% CI: 1.137–1.355). Although female workers were a minority in this population, 14.2% in union and 28.4% among non-union workers, they displayed a 36% increased risk of injury (HR= 1.36, 95% CI: 1.230–1.504).

DISCUSSION

This longitudinal study examined the effect of union status on risk of injuries among a U.S. manufacturing cohort using individual-level data. Contrary to our hypothesis, which stated that union status was associated with lower risk of injury, our study provided evidence for a higher risk of reportable injuries among unionized workers in this cohort compared to non-unionized workers. Our final model (Table 3) was adjusted for multiple covariates including: standardized job category, age, sex, race, job tenure, and shared frailty by plant. Our results

suggest that being a union worker was associated with a 51% higher risk of reportable injuries, i.e. those which require medical treatment, lost work-time, or restricted work-time. This result is contrary to findings from a previous study that examined a similar population in 2006 and found that being a union worker was associated with 60% lower injury rates.(18) However, unlike the previously reported study, which used only one year of data and was unable to control for potentially important covariates including standardized job category and plant shared frailty, our study included several years of longitudinal data allowing us to perform Cox proportional hazard shared frailty analysis and control for additional covariates recognized as conferring injury risk. Additionally, our results corroborated previously observed associations between union status and higher risk of injury in similar cohorts.(19, 20)

Other covariates showed statistically significant associations with injury risk, some of which confirmed previous observations in similar cohorts. Specifically, there was a higher risk of injury among female workers, and workers with a short time since hire (less than 1 year).(16)

The concept of endogenous hazard has been described as one possible explanation for the association between unionization and the high rate of reported injury because workers in hazardous plants or jobs may be more likely to form or join a union in order to have legal protection, assistance with workers' compensation claims, and a more powerful wage bargain.(12) If so, union status would be inherently associated with higher injury risk. Although a previous British study attempted to control for the effect of endogeneity, a positive association between unionization and risk of injury was still observed.(12) In contrast, a 2015 U.S. based study attempted to control for multiple covariates including the concept of endogeneity and concluded that the effect of union status on nonfatal injury was not significant at best.(21) In our study cohort, such an endogenous effect might not 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 manufacturing processes. 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 standardized job category and plant shared frailty to the final model. Controlling for these covariates did not modify observed associations between union status and higher risk of injury.

Differential reporting between union and non-union plants could be another possible explanation for the observed effect of union status on risk of injuries. Inaccurate reporting of occupational injury is a substantial concern with evidence suggesting varying degrees of under-reporting.(22) Recent evidence suggests that pressures to under-report may extend to the ranks of union workers.(23) However, there exists a general belief that union workers, perhaps fearing less chance of reprisal or because of their contribution to the health and safety committee, may be more likely to report or even over-report injuries compared to their non-union counterparts.(13, 24) This was illustrated in a British study that found union presence in the private sector was associated with higher reporting of work-related injuries; the author described that this could be a reflection of the greater willingness for union members to report injuries or illness under the protection of the unions.(13) Another U.S.-

based study used workers' compensation claims and conducted random telephone interviews, and found that unionized workplaces are more likely to file musculoskeletal workers' compensation claims than non-unionized workplaces, despite the fact that both unionized and non-unionized workplaces have comparable musculoskeletal injury rates.(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, the later finding was not statistically significant.(14) 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.(5) Because we used injury surveillance data from a company that requires reporting of any injury regardless of severity and management policies purportedly extend consistently across plants, reporting bias should theoretically have been minimized; however, it cannot be completely removed.(16) To investigate the possibility that a single plant might drive these results, sensitivity analysis was conducted. Removing any plant from our statistical model failed to modify results (data not shown), providing confidence in our findings.

Our study has several limitations. First, we were unable to adjust for the variability in hours worked among the study cohort. 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) Data limitations precluded incorporation of weekly hours worked into our models; however, we did not find any evidence to suggest discrepancy in hours worked between union and non-union workers. Second, although it is recognized 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 into our analysis. Third, this cohort consisted of workers from a single corporation with a strong safety culture, which may limit generalizability. Finally, due to a major cut in the labor force in 2008, which resulted in closing multiple plants in the corporation, our data were limited to the period before 2008; however, the controversy about the effect of union status on injury risk is still current and our longitudinal study is the first to use cox proportional hazard shared frailty analysis on injury data extending for several years to help answer this controversy.

In comparison to most previous studies on union status and injury risk that were either retrospective or cross-sectional with heavy reliance on self-administered surveys and therefore subject to possible recall bias,(21) 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 several years 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 study 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 category 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 additional evidence associating union status with higher risk of reportable injuries. Additionally, our findings confirm previously reported findings that female sex, age and short company tenure are also predictors of work-place injury. Because the cohort represented workers from a single corporation with a strong safety culture, we had no mechanism to investigate potential impacts of cultural and behavioral differences between unionized and non-unionized plants in reporting workplace injuries. Future studies should explore potential reporting discrepancies by comparing confidential surveys of self-reported injuries and data from work place injury surveillance systems among union and non-union workers.

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Table 1

Descriptive analysis of the cohort[a]

	Union		
Characteristic	**Yes (N = 18,995)**	**No (N = 7,507)**	**p[b]**
Age (years)	43.3 ± 10.9	39.8 ± 11.1	<0.001
Tenure (years)	13.0 ± 12.9	8.0 ± 9.4	<0.001
Race			<0.001
Asian	67 (0.4)	140 (1.9)	
Black	1730 (9.1)	1412 (18.8)	
White	15966 (84.2)	5113 (68.1)	
Other	1192 (6.3)	842 (11.2)	
Sex			<0.001
Male	16267 (85.8)	5376 (71.6)	
Female	2688 (14.2)	2131 (28.4)	
Injured worker			<0.001
No	15761 (83.1)	6889 (91.8)	
Yes	3194 (16.9)	618 (8.2)	

[a] Table values are mean ±SD for continuous and n (column %) for categorical variables.

[b] P-value is for t-test (continuous variables) or for χ^2 test (categorical variables).

Table 2

Distribution of injuries by OSHA reportable categories and union status among workers

Characteristic	Union		P[a]
	Yes n (%)	No n (%)	
			0.236
Injuries requiring medical treatment	1489 (46.6)	267 (43.2)	
Injuries resulting in restricted work days	1531 (47.9)	311 (50.3)	
Injuries resulting in lost work days	174 (5.5)	40 (6.5)	

[a]P-value is for χ^2 test.

Table 3

Fully adjusted shared frailty model showing the effect union status and other covariates on risk of reportable injuries[a] [b]

	Reportable injuries		
	HR	**95% CI**	**p value**
Union			<0.001
No	1		
Yes	1.51	(1.125–1.840)	
Age (1-year increase)	0.994	(0.990–0.998)	0.001
Tenure			<0.001
>1 year	1		
<1 year	1.24	(1.137–1.355)	
Sex			<0.001
Male	1		
Female	1.36	(1.230–1.504)	
Race			0.137
White	1		
Asian	0.85	(0.517–1.392)	
Black	1.01	(0.901–1.123)	
Other	1.16	(1.017–1.320)	

[a] Standard job category was included as a fixed effect (result not shown).

[b] Plant was included as a random effect to account for shared frailty among workers within each plant.