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RESEARCH ARTICLE

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Occupational medicine clinical practice data reveal increased injury rates among Hispanic workers

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Background: Minnesota has an ethnically diverse labor force, with the largest number of refugees per capita in the United States. In recent years, Minnesota has been and continues to be a major site for immigrant and refugee resettlement in the United States, with a large population of both immigrant and native born Hmong, Hispanic, and East Africans. This study seeks to evaluate the injury risk among the evolving minority workforce in the Minnesota Twin Cities region.

Methods: A retrospective cohort study identifying work-related injuries following pre-employment examinations was performed using electronic health records from a large multi-clinic occupational medicine practice. Preplacement examinations and subsequent work-related injuries were pulled from the electronic health record using representative ICD-10 codes for surveillance examinations and injuries. This study included patient records collected over a 2-year period from January 1, 2015, through December, 2016. The patients in this cohort worked in a wide-array of occupations including production, assembly, construction, law enforcement, among others.

Results: Hispanic minority workers were twice as likely to be injured at work compared with White workers. Hispanics were 2.89 times more likely to develop back injuries compared with non-Hispanic workers, and 1.86 times more likely to develop upper extremity injuries involving the hand, wrist, or elbow.

Conclusion: Clinical practice data shows that Hispanic workers are at increased risk for work-related injuries in Minnesota. They were especially susceptible to back and upper extremity injuries. Lower injury rates in non-Hispanic minority workers, may be the result of injury underreporting and require further investigation.

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KEYWORDS
immigrant, injury, minority, occupation, refugee, worker

1 | INTRODUCTION

Minnesota has a diverse labor force with its own unique ethnic and cultural considerations.[1,2] There is a wide array of industries in Minnesota, among the most common being those involving the biosciences, banking and finance, agriculture, healthcare, clean and renewable energy, and data centers. The top five employment categories include, office and administrative support, sales and related occupations, food preparation and serving-related occupations, production operations, and business and financial operations.[3] Since 1990, the Asian and Black population has tripled in Minnesota, while the Hispanic population has quadrupled. It is also estimated that about 7% of the Minnesota population is foreign born.[4] The minority population in Minnesota consists of foreign born immigrants as well as native born individuals who identify with minority racial/ethnic groups. Previous studies have shown that minority workers are often at increased risk for occupational injury.[5–12] The rapid increase in the minority population in recent years could lead to an increase in occupational injury rates in Minnesota.

The reasons for increased injury rates among minority workers are multi-factorial and may include discrimination, participating in higher risk occupations, language and communication barriers, differences in cultural attitudes toward safety, and apprehension about seeking medical care, among other factors.[5,6,9,10,13] This investigation serves as an initial screening study, using readily available clinical data, to identify populations that may be most impacted by occupational health disparities in Minnesota. It also provides novel information on the types of injuries that are most frequently impacting minority workers and can help to guide future investigations and possible interventions for injury prevention.

2 | METHODS

To determine if minority workers may be at increased risk of work-related injuries, a review of clinical data from a high-volume occupational medicine practice was performed. The practice includes four occupational medicine clinics covering the Twin Cities greater metropolitan region. The department partners with companies and organizations across the state, both public and private, for which they provide services such as pre-placement examinations for job clearance, drug screens, surveillance examinations, and primary treatment for work-related injuries. The care team consists predominantly of physicians that are board certified in occupational medicine.

For this investigation, encounters for preplacement examinations and subsequent work-related injuries were extracted from the electronic health record (EHR) using representative International Statistical Classification of Disease and Related Health Problems (ICD)-10 codes for each encounter (Supplemental Table S1). This study included all patient records collected over a 2-year period from January 1, 2015, through December 31, 2016. The patients in this cohort worked in a wide array of occupations including production, assembly, construction, law enforcement, firefighting, healthcare, commercial motor vehicle driving, maintenance and custodial work, among others. Over the study period, all employees who had been seen for a pre-placement evaluation were followed over time to see if they returned to clinic for evaluation and treatment of an injury. If a patient returned to clinic for a visit classified under an injury code, this was considered an injury event. Subsequent follow-up visits for injury treatment were not considered as injury events.

Pre-employment examinations were performed in person at one of the four clinic sites, and could include a wide array of evaluations depending on the job and the employer needs. Evaluations most commonly included one or more of the following elements: physical examination, drug screen, spirometry, blood tests, immunizations, tuberculosis screening, and respirator fit testing. Patients were referred to our clinic for pre-employment examinations by their prospective employer. After pre-employment evaluations, patients were educated about the services provided in the occupational medicine clinic and were encouraged to follow-up with us if they were to develop any work-related injuries. Returning to an occupational medicine clinic for treatment of a work related injury was ultimately at the patient's own discretion, as the state of Minnesota allows workers to choose their treating provider for work-related injuries.

The Cox proportional hazards models were used to calculate hazard ratios for injury risk and study variables including race/ethnicity. Models included the additional covariates, age, gender, and body mass index (BMI), as these data were readily available in the electronic medical record. The Cox proportional hazard assumption was evaluated by examining Schoenfeld residuals and by using the aareg function in the R package "survival" (Supplemental Figure S1).[14,15] Although survival analysis is traditionally used to evaluate survival and death, in this investigation it was applied to evaluate injured and non-injured workers. There were no fatal injuries included in our data set. All models were considered to be suitable for analysis using a Cox proportional hazards model. Additionally, the Aalen's additive model was used to evaluate the statistical significance of each variable as well as the time varying effects of the covariates.[14–18] The Aalen's additive model is similar to the Cox proportional hazards model, but can be used regardless of whether or not a model meets the proportional hazard assumption, making it a useful adjunct to the Cox proportional hazards model.

Missing information for patient race/ethnicity was estimated by performing surname analysis with the R package "wru," using

Minnesota census data.[19] Missing values for height and weight were imputed using the R package "mice."[20–22] The validity of imputation was assessed using a sensitivity analysis in which BMI was separately minimized and maximized. Study findings regarding race/ethnicity, age, and gender were not found to be significantly influenced by imputation. Statistical significance was evaluated using 95% confidence intervals and *P*-values with statistical significance set at $P < 0.05$.

3 | RESULTS

Over the 2-year period of this study, 20 050 preplacement/surveillance examinations were identified. The baseline characteristics of the study participants are summarized in Table 1. The racial/ethnic makeup of the study population closely mirrors that of the local counties that make up the Twin Cities Metropolitan region.[23] This region consists of a larger percentage of minorities than the rest of the Minnesota. A comprehensive evaluation of injuries revealed 581 injury events, giving a total injury proportion of approximately 3%, which is in line with worker injury rates reported in other studies.[24,25]

Hazard ratios and association of injury risk with each variable were calculated for race/ethnicity after simultaneously correcting for age, gender, and BMI (Tables 2 and 3). Survival curves stratified by race/ethnicity, age, gender, and BMI are also presented. In each case, the generated curves are corrected for the non-stratified covariates (Figure 1). A 1.17 increase in injury risk was observed for each 10-year increase in age. Males were 1.35 times more likely to be injured than female workers within the 2-year period. Hispanic workers had nearly double the injury rate of non-minority White workers.

An examination of the covariates and time-varying effects using the Aalen's additive model also support these findings (Figure 2). Aalen's plots demonstrate that both older workers and Hispanic workers have their highest risk of injury immediately after starting a new position. In contrast, the risk for male injury remains relatively constant over time and does not appear to have a strong association with a new work environment.

A breakdown of covariates by most common injury types showed that Hispanic workers were more than three times as likely to develop back injuries compared with non-Hispanic workers, and almost two times more likely to develop upper extremity injuries involving the hand, wrist, or elbow. We did not observe an increase in injury risk among Hispanic workers for injuries involving the lower extremities and shoulders (Table 4). Age had a statistically significant association with upper extremity, shoulder, and lower extremity injuries. We did not observe a statistically significant association between back injuries and age. Male gender was associated with increased risk for back and upper extremity injuries involving the hand, wrist, and elbow.

TABLE 1 Baseline characteristics of patients seen for preplacement examinations

Patients *N* = 20 050			
Total	***N* = 20 050**	***N* = 581**	***N* = 19 469**
Gender	All workers	Injured	Non-injured
Male	13 210 (65.9%)	430 (74.0%)	12 780 (65.6%)
Female	6840 (34.1%)	151 (25.1%)	6689 (34.4%)
Missing	0	0	0
Age (years)			
Median	34	38	34
Mean	36.82	40.07	36.72
Range	14-86	18-77	14-86
0-29	8002 (39.9%)	158 (27.2%)	7844 (40.3%)
30-49	8288 (41.3%)	282 (48.5%)	8006 (41.1%)
50-100	3760 (18.8%)	141 (24.3%	3619 (18.6%)
Missing	0	0	0
BMI			
Median	28.59	29.52	28.56
Mean	29.58	30.51	29.56
Range	14.76-69.53	19.45-60.20	14.76-69.53
Normal (<25)	2165 (23.8%)	37 (6.4%)	2128 (10.9%)
Overweight (25-30)	3298 (36.2%)	63 (10.8%)	3235 (16.6%)
Obese (>30)	3649 (40.1%)	87 (15.0%	3562 (18.3%)
Missing	10 938	394 (67.8%)	10 544 (54.2%)
Race/ethnicity			
Asian	568 (6.2%)	22 (3.8%)	546 (2.8%)
Black	1690 (18.4%)	52 (9.0%)	1638 (8.4%)
Hispanic	351 (3.8%)	28 (4.8%)	323 (1.7%)
Other	258 (2.8%)	14 (2.4%)	244 (1.3%)
White	6328 (68.8%)	216 (37.2%)	6112 (31.4%)
Missing	10 855	249 (42.9%)	10 606 (54.5%)

TABLE 2 Cox proportional hazards model for all injuries

	Hazard ratio	**95%CI**	***P*-value**
Gender (*N* = 20 050)			
Female (*N* = 6840)	-	-	-
Male (*N* = 13 210)	1.35	1.12-1.63	0.002*
Race/ethnicity (*N* = 20 050)			
White (*N* = 13 954)	-	-	-
Asian (*N* = 1638)	0.99	0.72-1.39	0.999
Black (*N* = 2748)	0.96	0.74-1.24	0.746
Hispanic (*N* = 1185)	1.95	1.49-2.55	<0.001*
Other (*N* = 525)	1.18	0.73-1.92	0.498
Age	1.02	1.01-1.02	<0.001*
BMI	1.01	0.99-1.02	0.383

TABLE 3 Aalen's additive model for all injuries

	P-value
Gender (*N* = 20 050)	
Female (*N* = 6840)	-
Male (*N* = 13 210)	<0.001*
Race/ethnicity (*N* = 20 050)	
White (*N* = 13 954)	-
Asian (*N* = 1638)	0.976
Black (*N* = 2748)	0.713
Hispanic (*N* = 1185)	<0.001*
Other (*N* = 525)	0.534
Age	<0.001*
BMI	0.412

4 | DISCUSSION

The Twin Cities region of Minnesota has a growing minority workforce consisting largely of both immigrant and native born Hispanic, African, and Hmong workers. Furthermore, Minnesota is a major immigration site for refugees, and as much as 7% of the state population is estimated to be foreign born.[4] This study which uses readily available EHR data, identifies a potential health disparity in which Hispanic workers exhibit higher rates of back and upper extremity injuries compared with non-Hispanic workers.

Clinical data provide an inexpensive way to screen for health disparities that can be missed by other data collection systems.[26] Although the exact cause of the racial/ethnic health disparity could not be clearly identified in this study, Hispanic workers appear to be experiencing a greater injury burden compared with other working populations. One possible explanation for these findings is that the increased injury rates could be the result of Hispanic workers taking on higher risk jobs. National survey data on minority workers has previously shown that both Hispanic and non-Hispanic minority workers tend to take on higher risk occupations.[27,28] In this investigation, each patient's specific job demands were not known, as this information is not routinely collected within the clinical EHR.

Other possible explanations for the study findings include lack of training and/or training materials, with some only being offered in English.[29–31] Studies suggest that even within the same occupational category, some racial/ethnic groups are often being given the riskier and heavier work than their white counterparts.[26,27] Other research suggests that some minority employees may not be receiving opportunities for job advancements/promotions through their employers, thus remaining in the same position for longer periods of time, which could result in higher rates of injury especially when considering physically demanding occupations.[29,32]

In addition to the findings regarding injuries in the Hispanic workforce, these clinical data also support the established association between injury risk and increasing age, which has been well described in the literature.[32] Back injuries were the only injury type

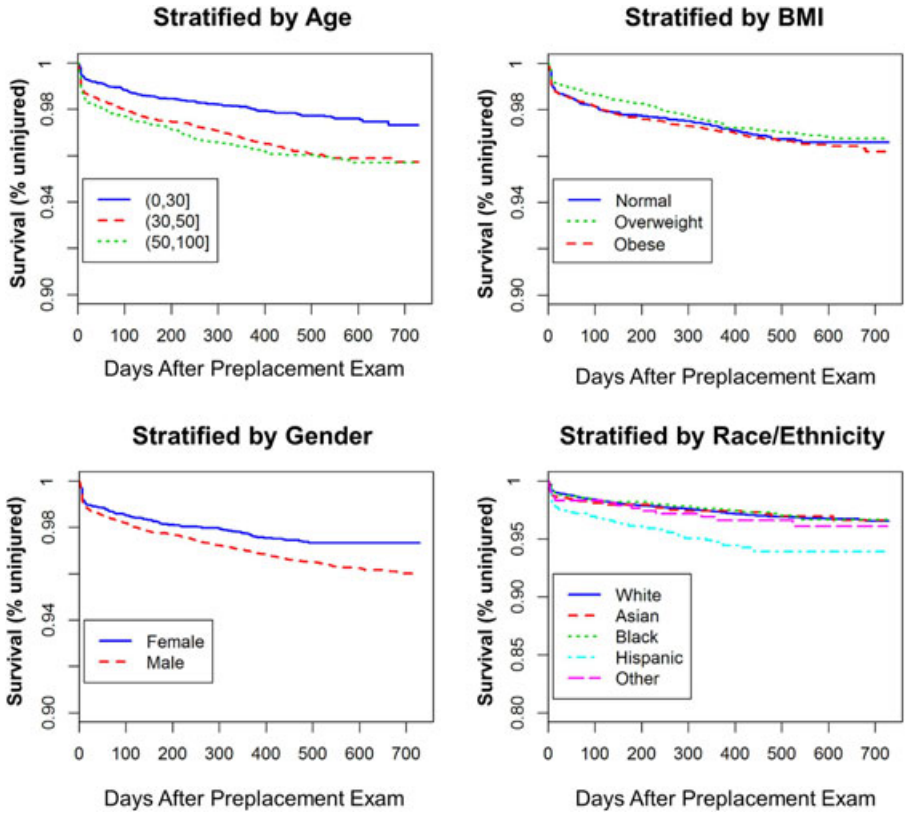

FIGURE 1 Hazard curves showing injury risk: Hazard curves are shown stratified by age, BMI, gender, and race/ethnicity. These curves show increased injury risk for older workers, male workers, and Hispanic workers

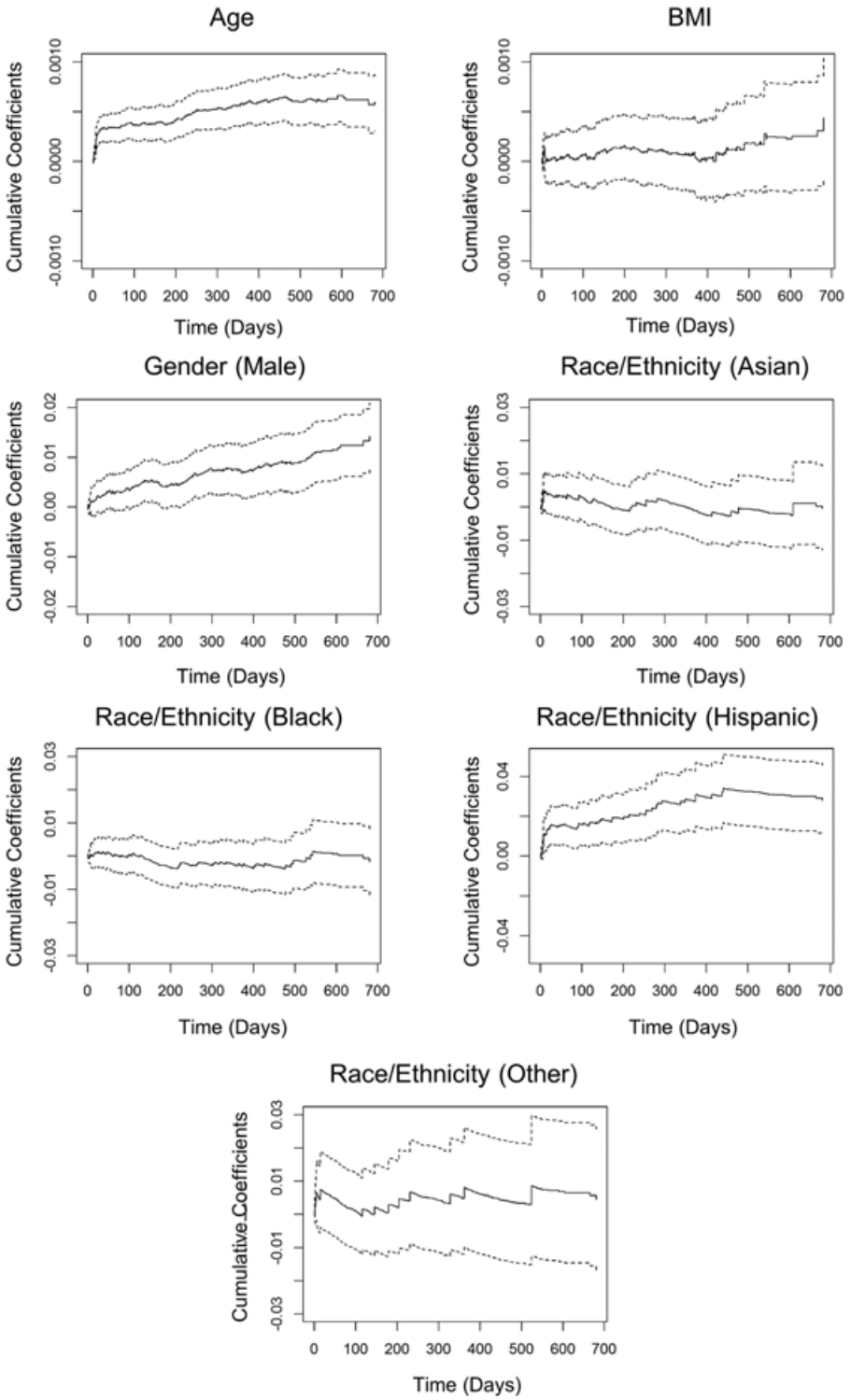

FIGURE 2 Aalen plots showing time-varying effects: Aalen plots display a cumulative coefficient representing time-varying effects. The coefficient is relative and does not represent a discrete value such as relative risk. An increasing slope of the line correlates with an increasing change in the variable within the designated time interval. These plots show that older workers and Hispanic workers experience the greatest injury risk in the period shortly after beginning their job. In contrast, male workers have an injury risk that remains relatively constant over time. The white and female groups are the reference groups and are not plotted in this figure. 95% confidence intervals are represented by the dotted lines

TABLE 4 Cox proportional hazard model by injury type

	Hazard ratio	95%CI	*P*-value
Back (*N* = 108)			
Gender			
Female	-	-	-
Male	1.75	1.10-2.78	0.018*
Race/ethnicity			
White	-	-	-
Asian	0.89	0.38-2.06	0.782
Black	1.47	0.87-2.48	0.148
Hispanic	3.17	1.85-5.41	<0.001*
Other	0.82	0.20-3.34	0.778
Age	1.01	0.99-1.03	0.142
BMI	1.02	0.99-1.05	0.229
Shoulder (*N* = 62)			
Gender			
Female	-	-	-
Male	1.18	0.67-2.06	0.576
Race/ethnicity			
White	-	-	-
Asian	2.00	0.88-4.51	0.097
Black	0.65	0.26-1.64	0.362
Hispanic	1.23	0.44-3.43	0.696
Other	1.97	0.61-6.36	0.257
Age	1.04	1.02-1.06	<0.001*
BMI	1.04	1.01-1.08	0.026*
Upper extremity (*N* = 339)			
Gender			
Female	-	-	-
Male	1.41	1.10-1.80	0.007*
Race/ethnicity			
White	-	-	-
Asian	1.02	0.66-1.55	0.945
Black	0.79	0.55-1.13	0.191
Hispanic	1.85	1.30-2.64	<0.001*
Other	1.05	0.54-2.04	0.894
Age	1.02	1.01-1.03	<0.001*
BMI	1.00	0.99-1.02	0.640
Lower extremity (*N* = 122)			
Gender			
Female	-	-	-
Male	1.18	0.79-1.75	0.414
Race/ethnicity			
White	-	-	-
Asian	0.68	0.29-1.55	0.355
Black	1.17	0.71-1.92	0.541
Hispanic	1.30	0.65-2.59	0.456
Other	0.63	0.15-2.55	0.514
Age	1.01	1.00-1.03	0.033*
BMI	1.01	0.98-1.04	0.467

that did not show a significant association with increasing age. This may be due to the fact that younger workers may be performing more of the heavy lifting tasks that put them at risk for disc herniation and muscle strains compared with older workers. The increased injury rates in male workers may be due to greater physical job demands compared with female workers, and the gender-based risk may be alleviated if occupational job demand data were incorporated into these statistical models.

Although it is widely accepted that being overweight is a risk for musculoskeletal injury, demonstrating an association between BMI and injury risk has been difficult, with studies reporting conflicting results.[33–35] In this study, there was no significant association between BMI and injury risk, even when independently considering injury to various areas of the body. If BMI is indeed associated with injury risk, the effect is likely small. Adjusting for occupational job demands and increasing the power of the study may be able to reveal an association if it exists. The association between BMI and injury risk is likely job-dependent and probably only has a small effect, if any, for most occupations. These findings indicate that employers are unlikely to benefit from discriminatory practices that disqualify employees based on their weight or BMI. As such, policies preventing weight-based job discrimination based should be strongly supported.

This study, which serves primarily as an initial screening investigation to identify potential racial health disparities in Minnesota, has several well-recognized limitations that are associated with the use of clinical EHR data. The primary limitation of this study is that these data rely heavily on the ICD-10 coding system. These codes are generated for each patient visit by either the treating care provider or a medical biller and coder. Variation in coding practice between individuals can lead to non-specific categorization of injuries, making specific injury types difficult to identify and categorize. In the context of this study, it probably leads to an underreporting of specific injury types compared with other data capture systems.

Another important limitation of this study is that despite having an existing relationship with occupational medicine clinics that were studied, patients may choose to seek care for their injuries outside of the health system associated with these clinics. In some cases, individuals may not even seek treatment at all. It is therefore inevitable that some injuries will not be captured by this study. However, the fact that the observed injury rates of 3% are congruent with what has been reported in other studies investigating work-related injuries[24,25] suggests that these data are likely capturing the majority of injuries in our study population.

The potential for underreporting of injuries is an important consideration for minority populations who may not trust the United States healthcare system and may choose to seek medical treatment outside of the established health care system. The fact that these results did not show increased injury rates in either Asian or Black populations could be the result of injury underreporting. This may be caused by worker mistrust or poor access to the United States healthcare system, as previous studies have shown that minority populations generally have more missed days of work due to injury.[36] Although there were increased injury rates in Hispanic workers,

underreporting may also be a factor here as well. If this is the case then the magnitude of problem could be even greater than this investigation shows.

Other limitations of this study include lack of data on the number of hours each individual worked per week. Some individuals may only work part-time, in which case their exposure to the work environment is diminished relative to other workers. Workers may also have more than one job exposing them to additional risks. Some workers may have either left their job or moved out of the area prior to completion of the study, in which case workplace exposure among the non-injury controls would be overestimated. This study also does not incorporate patient past medical history information prior to starting employment. An individual employee may have a history of pre-existing medical conditions (eg, osteoarthritis) that may predispose them to injury. Individuals may also have prior job experience that decreases their injury risk.

Future investigations into race/ethnicity and work-related injuries would benefit from an approach that is customized to the racial/ethnic makeup of the community under study. In this study, the data were not granular enough to specifically classify patient's racial/ethnic status beyond their reported race/ethnicity as either Asian, Black, White, Hispanic, or Other. In Minnesota, where there is a larger proportion of immigrants, these categories do not necessarily capture the true population diversity. For example, there could be large cultural differences between African-Americans and East African immigrants. In future studies, it will be essential to look at additional factors such as country of origin or birth, length of time in the United States, and language proficiency among other factors.

At this time it is not clear if the results of this investigation are generalizable to populations outside of Minnesota, as the region under study has unique social and demographic features. It would be interesting to compare these study results against occupational medicine clinic data in other areas of the country. Differences in worker compensation laws could potentially result in unique findings between regions. Minnesota for example allows workers to choose their own medical provider for care, while other states allow employers to choose their employee's medical provider for work-related injuries. The results of this and future studies may be especially important for planning in other states that are looking to promote immigration now or in the future to help meet growing job demands.

5 | CONCLUSION

This study identifies an occupational health disparity in the Minnesota workforce. The limitations of this study restrict the ability to identify the definitive cause of the observed disparities. Further evaluation of health disparities in the Minnesota community, especially in the Hispanic population, is warranted to better understand the factors impacting minority worker injury rates.

AUTHORS' CONTRIBUTIONS

This study was conceived and designed collectively by SR, KL, AM, WW, JS, PA, EB, RB, KK, AN, HK, ZM, and FA. The data were acquired by SR and ZM. The analysis and interpretation of the data were carried out by SR, KL, HK, ZM. The draft manuscript was prepared by SR. The final manuscript was critically edited by SR, KL, AM, WW, JS, PA, EB, RB, KK, AN, HK, ZM, and FA. The final manuscript was approved by SR, KL, AM, WW, JS, PA, EB, RB, KK, AN, HK, ZM, and FA. All authors SR, KL, AM, WW, JS, PA, EB, RB, KK, AN, HK, ZM, and FA, agree to be accountable for all aspects of the work and for ensuring that questions related to accuracy or integrity of the work are appropriately investigated and resolved.

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ETHICS APPROVAL AND INFORMED CONSENT

This work was performed at HealthPartners. This study was approved by the HealthPartners Institutional Review Board (IRB# A17-391). This study was considered minimal risk and was carried out with a waiver for informed consent.

DISCLOSURE (AUTHORS)

The authors report no conflicts of interest.

DISCLOSURE BY AJIM EDITOR OF RECORD

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

DISCLAIMER

None.

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SUPPORTING INFORMATION

Additional supporting information may be found online in the Supporting Information section at the end of the article.

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