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RESEARCH ARTICLE

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Work-related injury factors and safety climate perception in truck drivers

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Introduction: The trucking industry has a high burden of work-related injuries. This study examined factors, such as safety climate perceptions, that may impact injury risk.
Method: A random sample of 9800 commercial driver's license holders (CDL) were sent surveys, only 4360 were eligible truck drivers. Descriptive statistics and logistic regression models were developed to describe the population and identify variables associated with work-related injury.
Results: 2189 drivers completed the pertinent interview questions. Driving less-than-truckload, daytime sleepiness, pressure to work faster, and having a poor composite score for safety perceptions were all associated with increased likelihood of work-related injury. Positive safety perception score was protective for odds of work-related injury, and increased claim filing when injured.
Conclusions: Positive psychological safety climate is associated with decreased likelihood of work-related injury and increased likelihood that a driver injured on the job files a workers' compensation claim.

KEYWORDS
occupational health, injury, safety climate, surveillance, survey

1 | INTRODUCTION

The purpose of this study was to identify whether or not a general measure of perceived psychological safety climate could be associated with work-related injury occurrence in a large statewide sample of truck drivers. Results can help guide the future of trucking industry injury prevention in Washington State and beyond.

The trucking industry in the United States has some of the highest rates and costs of work-related injuries,[1,2] and, for 2014, driver/sales workers and truck drivers had the highest number of fatal injuries and one of the ten highest fatality rates (23.4 per 100 000 full-time equivalent worker [FTE])[3] of civilian occupations in the United States. The 2014 Bureau of Labor Statistics Occupational Employment Statistics estimate that were 1.6 million heavy and tractor-trailer truck drivers in the United States as a whole,[4] with a projected growth of 11.3% between 2012 and 2022,[5] and as of 2014, it was the 16th largest occupation in Washington State.[6] In Washington State, truck driving has been identified as an occupation with a high prevalence of work-related injuries.[7–10] Previous work in WA[7–10] has focused on describing the injury burden of the WA trucking industry and the associated costs, as well as surveillance efforts to identify the main activities that account for the most common injuries. Between 2005 and 2010 in Washington, there were 10 171 compensable claims in the trucking industry, with associated costs of over $295 million dollars.[9]

The trucking industry is comprised of a variety of types of trucking and driving assignments (eg, long haul, local, less-than-truckload, truckload, specialized freight) and while roles and tasks may differ across these, several common factors regarding the nature of the work (physical, often alone, time constraints) can have negative implications for worker health. These include: high numbers

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and rates of work-related musculoskeletal disorders[10,11] and slips/trips/falls[12,13]; fatigue and sleepiness[13–17] and overweight and obesity[14,17–22] among others.

Specific occupational risk factors associated with truck drivers include: working independently as either "lone workers" or working in the absence of coworkers and supervisors for the majority of the work day; dynamic, ever changing worksites, not tailored to the health and safety of drivers that include highways, city roads, diverse customer or supplier worksites; physical and cognitive strain due to hyper-vigilant driving practices; extraneous factors such as weather, traffic congestion, road quality and other traffic safety factors that can impact truck driver safety. It is also important to note that while all of these factors are associated with truck driver health and safety, due to the nature of the occupation, these factors may also impact the health and safety of clients and other drivers on the road. Thus, it is imperative to better understand what contextual factors impact the health and safety of workers in the truck driving industry.

1.1 | Safety climate

One possible avenue to address the complex health and safety needs of trucking industry workers is safety climate. Safety climate has been defined as the shared perceptions among workers of how their organization prioritizes safety.[23] There is a distinction between individual level perceptions of safety climate (psychological safety climate) and group level perceptions of safety climate (organizational safety climate).[24] Further, it is important to note that the impact of safety climate on work-related injuries is most commonly assessed retrospectively. Clarke[25] made a distinction between retrospective designs (safety assessment post injury) and prospective designs (safety climate assessment pre-injury), and suggested that design type moderated the impact of safety climate on workplace injuries. Building upon the work of Clarke [2006], Beus et al posit that rather than two distinct designs that capture safety climate, there are theoretical differences that result in two competing frameworks that underpin the relationship between safety climate and injury, 1) that injury impacts safety climate, and 2) that safety climate impacts injuries and that these processes may be cyclic in their nature.[24]

Recent work in the development of industry specific safety climate scales have categorized truck drivers as lone workers, that is, workers who do their jobs without direct supervision and in the absence of co-workers.[26] Huang et al found that not only are truck drivers lone workers, but that they have what is termed "psychological safety climate"; an individual rather than a shared perception of safety culture,[26,27] which may be due to their higher levels of job independence and limited social interaction with their co-workers.[26] Positive psychological safety climate has been identified as a predictor of safety-related outcomes[28,29] and has been linked to fewer total work-related injuries and better reporting of these injuries.[30] In this study, we tested a general measure of psychological safety climate perceptions with a validated six item safety climate scale developed by Hahn and Murphy.[31]

1.2 | Theoretical Framework

Potential explanations of why poor psychological safety climate may lead to work-related injuries include: Conservation of Resources (COR) theory,[32,33] which posits that individuals will act in order to minimize their net loss of resources; the concept of "practical drift,"[34] where there exists "the slow steady uncoupling of local practice from written procedure"; and social exchange theory, which highlights the importance of perceived organizational support and leader-member exchange,[28,35] with high quality interactions leading to positive behaviors.

In the context of safety climate and work-related injury, workers may face myriad competing demands. When encountering pressure at work to be more productive (eg, working hard enough, long enough, fast enough), a worker may be faced with job loss or job status loss (resources), and will act to minimize resource loss (including potentially working unsafely) to live up to management pressure or expectation. Or workers may face situations where performing well or keeping ones job may be perceived as being the more important, immediate concern, and the threat of potential work-related injury (a relatively rare event) is seen as more distant, and so everyday practice (eg, faster, longer work) may differ from a company's written or stated safety policy. These individual perceptions, especially of management commitment,[23,36,37] can influence behavior and "safety performance depends on management personnel as much as it does on front-line employees."[37] Safety communication in the workplace is also linked to management safety commitment "which ultimately is predictive of accidents."[28] While truck drivers may be considered lone workers, they are still involved in social exchange, and the quality of their perceptions of their organization, leaders, and coworkers influence their perceived roles and obligations. If workers are faced with management whose interactions consist of pressure to produce, this may lead to role conflict about their expected behavior, and increase the likelihood of poor psychological safety climate perceptions and work-related injuries.

Truck drivers, like other occupations, have competing demands between doing the job safely and getting the job done on time. A strong safety climate is likely to alter the salience of these demands for workers, however, unlike most other occupational groups, truck drivers work without the direct physical presence of supervisors and co-workers. Research regarding the relationship between safety climate and work-related injuries among lone workers is not well studied. We hypothesize that positive psychological safety climate will be associated with lower prevalence of work-related injuries in Washington State truck drivers.

2 | MATERIALS AND METHODS

2.1 | Trucking industry group definition

For this study, the definition of "trucking industry" follows what has been described previously in Washington trucking industry injury surveillance,[9,38] which includes workers in the North American

Industrial Classification System (NAICS)[39] industry group and subgroup codes: 4841 (General Freight Trucking), 4842 (Specialized Freight Trucking), 492 (Couriers and Messengers), and 562 (Waste Collection).

2.2 | Survey participants

A random sample of 9800 truck drivers in Washington State was drawn from the Washington State Department of Licensing driver license database. Truck drivers in this study were defined as holding a Washington State commercial driver license (CDL) with a class B (towing a trailer with weight rating of 10 000 or less) or class C (vehicles carrying hazardous materials or towing a trailer with a weight rating of 26001 pounds or less) certification. CDL holders were cross-matched to data from the Washington State Employment Security Department to identify those who worked within a trucking NAICS industry group (NAICS 484, 492, 5621). Potential research participants were drawn from the driver license database in 2010 and 2012 for the two surveys. A professional survey research group conducted the surveys, thus the investigators were blind to the identity of the respondents. To assess the possibility of duplicate respondents in the two survey years, probability calculations using Washington State CDL population data were run, resulting in an 11% probability of duplicates.[1]

Of the 9800 CDL-holders in the sample, 4360 respondents were eligible for the survey (eg, reachable via phone or address, currently driving a truck, or working in Washington) and of those, 2189 completed the interview questions pertinent to this study, a response rate of 44.4% (Fig. 1). The majority (82%) of ineligible potential participants were unreachable (bad address or no or wrong phone number) and 13.9% were not current commercial truck drivers.

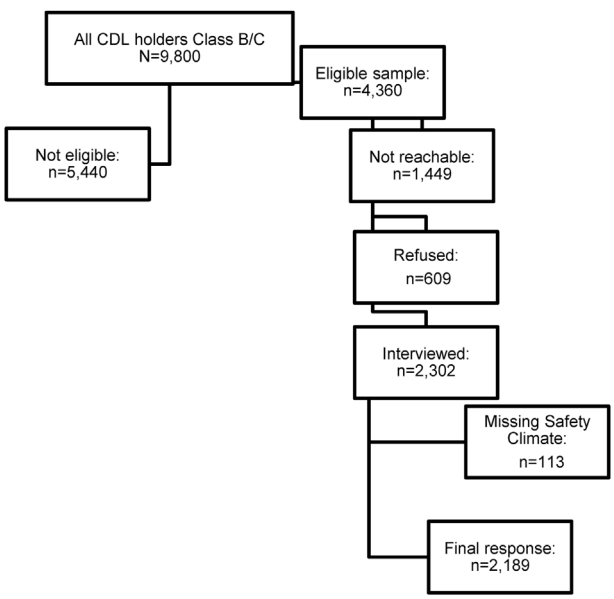

FIGURE 1 Response rate for survey of Washington state truck drivers, 2010 and 2012

2.3 | Survey design and procedures

Two state-wide surveys of truck drivers were administered, one in 2010 and one in 2012. Introduction letters describing the study and providing the phone numbers to obtain further information or to opt out of the study were sent out to all 9800 potential participants by the survey research group. The surveys were sent via postal mail a week after the introduction letters, with a cover letter that included a survey pin number and a website address if they chose to complete the interview online. Telephone follow-up was conducted by the survey research group to reach those who had not responded to either the mail or the internet survey options. Telephone follow-up was conducted by calling each potential respondent up to a total of five times at different hours of the day and different days of the week. Approximately 81% of respondents completed the survey by mail, with 11% responding via phone and 9% responding via the web survey.

Data sharing agreements were in place with the State Licensing and Employment Security Departments to assure security and confidentiality of the data. Survey documents and methods were approved by an Institutional Review Board prior to the beginning of each wave of the statewide truck driver surveys, and participants gave informed consent.

2.4 | Survey materials

Although the data come from two different surveys of truck drivers, they share many common demographic and job-related variables. The primary independent variable of interest in this study is the composite score for safety perception, adapted from a validated safety climate scale[31] which was included on both surveys. The instrument captures the following dimensions: coworker norms, safety feedback, management commitment (three of the six items on the scale), and worker involvement in safety.[31] The composite score (or "safety perceptions score") is the average of the responses to the six items of the scale. Additional variables of interest include age, sex, years on the job, type of driving assignment (eg, long-haul, less-than-truckload, specialized freight), and whether drivers were pressured to work long hours or pressured to work faster.

While our chosen safety climate scale is not comprehensive, nor specific to remote or lone workers, such as those developed after our surveys were administrated by Huang et al,[26] it is intentionally brief and suited for a general assessment in a time-sensitive population.[31]

2.5 | Statistical analyses

Descriptive statistics were computed to describe the study population characteristics including reporting a work-related injury and, among those respondents with a work-related injury, whether they filed a workers' compensation claim. Logistic regression models were run using survey procedures (svy) in Stata version 14 (StataCorp. 2015. *Stata Statistical Software: Release 14*. College Station, TX: StataCorp LP) to identify variables associated with filing a workers' compensation claim. The primary independent variable of interest, the composite

score for safety perceptions, was reverse coded so that a higher score equals higher (more positive) psychological safety climate. Post-stratification weights were calculated to adjust for population characteristics of age and sex. Weights were only used in multivariable models, not descriptive tables.

Body Mass Index (BMI) was calculated using self-reported height and weight using the formula (weight [in pounds]/height [in feet] squared and multiplied by 703). BMI is categorized into four groups: Underweight (BMI <18.5), Normal (18.5-24.9), Overweight (25-29.9), and Obese (>30).

Logistic regression models were created to identify variables associated with self-reported work-related injuries. Based on prior research, we tested all available covariates of interest in bivariate logistic regression models. We retained variables with a *P*-value of ≤0.15 in bivariate regression, for testing in the multivariable logistic regression model. We used standard list-wise deletion (ie, full case analysis) to fit the full logistic regression model. While list-wise deletion is not usually recommended, this was done with consideration to both statistical as well as case significance (ie, does × variable have a reported relationship with y outcome), as well as the high probability value of 0.15, we were able to assess the most parsimonious models while still retaining literature-based significance of variables entered and removed from the models.

We computed post-hoc chi-square tests between the 2010 and 2012 survey samples to compare differences in both the dependent and independent variables in the logistic regression models. No statistically significant differences were found.

3 | RESULTS

There were 2189 truck drivers who completed the survey, and of these, 473 (21.6%) had a work-related injury in the past 12 months. Of those who had a work-related injury in the past 12 months, 284 (60%) filed a claim for the injury (or for the most severe injury, if they had more than one), and 250 (52.8%) missed work due to their injury. Table 1 presents the demographic and health characteristics of the drivers in the survey, by injury and claim status. The majority of drivers (92.3%) were male, and 75.1% were 45 years of age or older (Table 1); these proportions were similar in drivers who were injured in the last year (91.8% male, 72.1% 45 or older). In general, drivers were overweight or obese (80.7%), and rated their health as good or very good (78.3%).

There were several significant differences in proportions between drivers with a work-related injury and those who did not report having an injury (Table 1); particularly, drivers with work-related injuries had a lower proportion of those rating their health as "excellent" or "very good." Additionally, drivers with a work-related injury had a higher proportion reporting that they got less than 7 h of sleep and a much higher proportion reporting they sought the care of a health-care provider (HCP) for work-related pain, symptoms, and/or discomfort (76% vs 25.8% of drivers without injury; Table 1).

The questions on sleep (ability to get adequate sleep; average hours of sleep; not enough sleep; having driven while drowsy; excessive sleepiness during the day; Tables 1 and 2) had significant ($P < 0.05$) differences in proportion in all questions between those who had work-related injuries and those who did not. The proportion of drivers with a work-related injury reporting that their schedule did not impact their ability to get adequate sleep ("not at all, I get plenty of sleep") was much less (26%, Table 1) than that of drivers without a work-related injury (43%, not shown); drivers who did not have a work-related injury also had a significantly higher proportion of getting enough sleep during the past 30 days (uninjured 41% [not shown], injured 23%, Table 1). The differences in proportion were also significant for driving their truck while feeling drowsy—for those reporting a work-related injury, 14% reported that they drove drowsy 3 or more times a week during the past 12 months (Table 2), compared to less than 6% of those without a work-related injury (not shown); 32% of those with a work-related injury reported having excessive daytime sleepiness in the past 12 months (Table 2), compared to those without an injury (15%, not shown).

The majority of drivers in the sample were employed in larger fleets (25 trucks or more), worked more than 40 hours a week, and were based in Washington State (Table 2). Drivers reporting average miles driven per week were split into fairly even categories (about 25% each), but those driving less than 500 miles per week were significantly more likely to have a work-related injury ($P < 0.01$, Table 2).

There were 2111 drivers who completed all the safety climate perception scale questions and for whom a composite score for safety perception was calculated; the mean was 3.07 and had a range of 1-4 (Table 3). All of the climate scale questions were significantly different in proportion injured ($P < 0.0001$) and in mean climate score ($P < 0.0001$) between workers who had a work-related injury (mean score 2.8) and those who did not have a work-related injury (mean score 3.1) (Table 3).

Those who had a good (higher) perceived safety environment (combined score ≥3.0), were less likely have a work-related injury ($P < 0.01$) and more likely to file a claim for work-related injury when injured ($P < 0.02$, Table 3) than those that had a poor composite score for safety perceptions (combined score <3).

For the logistic regression model, 473 survey respondents indicated they had suffered a work-related injury in the past 12 months. Age and sex were not significantly associated with having a work-related injury in this study. Safety perceptions score (continuous) was significant and protective with an odds ratio (OR) of 0.65 (95%CI 0.48-0.89) (Table 4), which was consistent with our hypothesis. For every one-point increase in the composite safety perceptions score, there was about a 35% lower odds of having a work-related injury (Table 4). Additional covariates of interest include sleepiness, feeling pressure to work faster and type of driving assignment. Covariates were chosen that were potentially related to increased odds of having a work-related injury based upon prior literature, and were significant in the cross tabulations in Tables 1 and 2. Participants who reported they regularly had excessive sleepiness during the day had an increased risk of having a work-related injury, OR 1.65 (95% CI 1.05-2.59) (Table 4). Respondents who reported feeling pressured to work faster were also at increased risk for an injury, OR

TABLE 1 Demographic and health characteristics of current drivers, by injury and claim status, survey of Washington state truck drivers, 2010 and 2012

Description	Respondents *n* (%)	Of those who had work-related injury; *n* (%)	Of those w/WRI who filed a claim for work-related injury; *n* (%)	Of those w/WRI whose injury required them to miss any work; *n* (%)
Total	2189	473 (21.6)	284 (60.0)	250 (52.8)
Gender				
Female	168 (7.7)	39 (8.2)	19 (6.7)	**13 (5.2)**
Male	2021 (92.3)	434 (91.8)	265 (93.3)	**237 (94.8)**
Age				
18-34	168 (7.7)	**33 (7.0)**	16 (5.6)	16 (6.4)
35-44	376 (17.2)	**99 (20.9)**	57 (20.1)	52 (20.8)
45-64	1446 (66.0)	**321 (67.9)**	195 (68.7)	171 (68.4)
65+	199 (9.1)	**20 (4.2)**	16 (5.6)	11 (4.4)
Marital status				
Married	1,546 (71.4)	327 (69.9)	200 (71.2)	172 (69.6)
Not married	619 (28.6)	141 (30.1)	81 (28.8)	75 (30.4)
Children (<18 years old) living at home				
Yes	685 (32.8)	305 (67.0)	88 (32.5)	84 (35.3)
No	1,406 (67.2)	150 (33.0)	183 (67.5)	154 (64.7)
Have health insurance				
Yes	1,862 (87.6)	410 (87.2)	251 (89.0)	210 (85.0)
No	264 (12.4)	60 (12.8)	31 (11.0)	37 (15.0)
BMI*				
Underweight	89 (4.1)	23 (4.9)	15 (5.3)	87 (34.8)
Normal	333 (15.2)	77 (16.3)	48 (16.9)	44 (17.6)
Overweight	870 (39.7)	182 (40.4)	101 (35.6)	87 (34.8)
Obese	897 (41.0)	191 (40.4)	120 (42.3)	107 (42.8)
Self-rated health				
Excellent	264 (12.1)	**32 (6.8)**	19 (6.7)	17 (6.8)
Very good	777 (35.6)	**144 (30.5)**	79 (27.9)	65 (26.1)
Good	932 (42.7)	**225 (47.7)**	137 (48.4)	125 (26.1)
Fair	191 (8.8)	**61 (12.9)**	43 (15.2)	35 (14.1)
Poor	19 (0.9)	**10 (2.1)**	5 (1.8)	7 (2.8)
Work schedule impact your ability to get adequate sleep?				
Not at all, I get plenty of sleep	862 (39.6)	**123 (26.2)**	**81 (28.8)**	65 (26.1)
Some, I am tired sometimes	987 (45.4)	**225 (48.0)**	**138 (49.1)**	122 (49.0)
A lot, I often feel fatigued	327 (15.0)	**121 (25.8)**	**62 (22.1)**	62 (24.9)
On average, how many hours of sleep do you get in a 24 h period?				
Less than 7 h	860 (39.5)	**220 (47.0)**	125 (44.8)	115 (46.8)
7-9 h	1250 (57.5)	**239 (51.1)**	148 (53.1)	125 (50.8)
More than 9 h	65 (3.0)	**9 (1.9)**	6 (2.1)	6 (2.4)
During the past 30 days, how many days did you feel you did not get enough rest/sleep?				
None, I get enough sleep	768 (37.7)	**100 (23.2)**	67 (26.3)	55 (24.1)

(Continues)

TABLE 1 (Continued)

Description	Respondents *n* (%)	Of those who had work-related injury; *n* (%)	Of those w/WRI who filed a claim for work-related injury; *n* (%)	Of those w/WRI whose injury required them to miss any work; *n* (%)
1-13 days	915 (44.9)	**207 (47.9)**	122 (47.8)	104 (45.6)
14-29 days	297 (14.5)	**102 (23.6)**	54 (21.2)	58 (25.4)
All 30 days	59 (2.9)	**23 (5.3)**	12 (4.7)	11 (4.8)
In past year, sought care of health-care provider (HCP) for work-related pain, symptoms, and/or discomfort?				
Yes	557 (25.8)	**357 (76.0)**	**242 (86.1)**	**215 (87.0)**
No	1,599 (74.2)	**113 (24.0)**	**39 (13.9)**	**32 (13.0)**

WRI, work-related injury. Bold font indicates significant difference at $P < 0.05$ (chisq) versus other respondents (drivers with a WRI vs drivers without a work-related injury, work-injured drivers who filed a claim vs work-injured drivers who did not file a claim, work-injured drivers who had to miss work vs work injured drivers who did not miss work). Questions reference most severe injury if respondent has had more than one in last 12 months.

1.68 (95% CI 1.14-2.49), and those whose primary driving assignment was less-than-truckload (LTL), had higher odds of suffering a work-related injury than long haul drivers (Table 4).

4 | DISCUSSION

Truck driving is characterized by long periods of sedentary driving interspersed with intense physical tasks, and truck drivers face high rates of work-related injuries as well as high rates of other health conditions such as obesity. We found that positive perceived safety climate score was associated with lower prevalence of work-related injuries in this population, as hypothesized.

4.1 | Survey results

A positive safety perceptions score (Table 4) was found to be protective against work-related injury in this population of Washington State truck drivers. The 35% reduction in odds of work-related injury per 1-point increase in climate score reflects a significant protective effect (Table 4).

These findings suggest that positive safety climate perceptions are related to a reduction in the probability of experiencing a work-related injury and that other factors such as excessive daytime sleepiness, regularly feeling pressured to work faster and having a less-than-truckload driving assignment increased the probability of experiencing a work-related injury in truck drivers. These results broaden our existing knowledge of the relationship between psychological safety climate and occupational health and safety and more specifically, the nature of this relationship in this population of truck drivers by demonstrating a relationship between positive psychological safety climate and work-related injury in an industry-specific sample. Exploring and identifying the explanatory mechanisms of the identified relationship between safety climate perceptions and work-related injuries is a critical next step for study (eg, safety production conflict, production pressure, overwork, mental fatigue, etc.).

The retrospective nature of this study limits inference regarding the direction of the psychological safety climate and work-related injury association; it was not possible to determine whether the injuries reported were caused by poor perceived safety climate, or whether the occurrence of injuries caused a poor perceived safety climate. It is plausible that there is association in both directions between psychological safety climate and work-related injuries. Following a work-related injury, beliefs and perceptions may change, and one clear possible change would be an increasingly negative psychological safety climate perception following a work-related injury.

One mechanism that likely plays a role in the relationship of how psychological safety climate may lead to a work-related injury is pressure to work faster, which may be related to both safety climate perception score and to management and dispatcher roles, which have been shown to be critical to truck drivers.[37] Thirty-eight percent (38%) of truck drivers in these surveys reported feeling pressured to work faster (Table 3), which echoes perceptions from the NIOSH long-haul survey where many drivers perceived their schedules to be unrealistically tight (16% often and 58% sometimes).[40] One third (32%) of drivers also reported regularly feeling pressure to work longer hours (Table 3). In drivers who had a work-related injury in the past 12 months, the proportion of those who reported regularly feeling these pressures increased to approximately 50% (Table 3). Perceived pressure to work longer hours and faster may be indicative of the fact that "management statements that safety is the primary goal are often belied by pressures on employees to bend safety rules in order to increase production or to meet tight deadlines."[41] This highlights the importance of management commitment and the importance of high quality leader-employee interactions.[28] Of the individual items, the question with the highest proportion of disagree/strongly disagree responses was "Workers and Management work together to ensure the safest possible conditions." This suggests a mismatch between worker perceptions and management efforts.

In addition to safety perceptions, many of the lifestyle factors characterized in this survey (Table 1) are particularly vulnerable to the impact of management commitment to safety, including pressure to

TABLE 2 Employment characteristics of current drivers, by injury and claim status, survey of Washington state truck drivers, 2010 and 2012

Description	Respondents; *n* (%)	Of those who had work-related injury; *n* (%)	Of those w/WRI who filed a claim for work-related injury; *n* (%)	Of those w/WRI whose injury required them to miss any work; *n* (%)
What is your employment status?				
Owner/Operator	104 (4.9)	15 (3.3)	6 (2.2)	9 (3.8)
Employee in small fleet (<25 trucks)	840 (39.5)	182 (39.8)	106 (38.4)	90 (37.7)
Employee in large fleet (25 trucks or more)	1,182 (55.6)	260 (56.9)	164 (59.4)	140 (58.6)
Years worked as a truck driver				
1 year or less	22 (1.0)	< 5	**0**	0
2-10 years	560 (26.1)	132 (28.5)	**71 (25.4)**	72 (29.5)
11 or more years	1,563 (72.9)	329 (70.9)	**209 (74.6)**	172 (70.5)
How many hours a week do you usually work (incl. driving & maintenance)?				
Under 24 hours per week	47 (2.2)	**< 5**	< 5	< 5
24-40 hours per week	356 (16.4)	**65 (13.9)**	36 (12.8)	32 (13.0)
41-55 hours per week	1,027 (47.3)	**231 (49.3)**	146 (52.0)	119 (48.2)
56-70 hours per week	683 (31.5)	**154 (32.8)**	92 (32.7)	85 (34.4)
More than 70 hours per week	57 (2.6)	**16 (3.4)**	6 (2.1)	10 (4.0)
Trucking Type				
General Freight	921 (43.3)	187 (40.4)	111 (39.5)	96 (38.9)
Specialized Freight	713 (33.5)	171 (36.9)	99 (35.2)	97 (39.3)
Couriers and Messengers	244 (11.5)	53 (11.5)	37 (13.2)	30 (12.2)
Waste Haul	248 (11.7)	52 (11.2)	34 (12.1)	24 (9.7)
Driving type				
Less-than-Load (LTL)	481 (22.7)	**130 (28.5)**	80 (29.3)	70 (29.3)
Long Haul	228 (10.7)	**33 (7.2)**	18 (6.6)	18 (7.5)
Other	1,413 (66.6)	**294 (64.3)**	175 (64.1)	151 (63.2)
Carrier state				
Washington	1,706 (88.6)	382 (89.7)	231 (89.2)	200 (90.5)
California	29 (1.5)	5 (1.2)	5 (1.9)	< 5
Oregon	74 (3.8)	15 (3.5)	8 (3.1)	7 (3.2)
Other	116 (6.0)	24 (5.6)	15 (5.8)	11 (5.0)
In the past 12 months, how often have you driven your truck while feeling drowsy?				
Never	804 (40.4)	**127 (30.8)**	86 (34.1)	75 (33.6)
Less than once a month	409 (20.6)	**68 (16.5)**	42 (16.7)	33 (14.8)
1 to 2 times a month	374 (18.8)	**90 (21.8)**	55 (21.8)	45 (20.2)
1 to 2 times a week	257 (12.9)	**70 (17.0)**	40 (15.9)	41 (18.4)
3 or more times a week	145 (7.3)	**57 (13.8)**	29 (11.5)	29 (13.0)
In the past 12 months, have you regularly had excessive sleepiness during the day?				
Yes	352 (18.3)	**127 (32.0)**	**65 (27.3)**	69 (32.2)
No	1,566 (81.7)	**270 (68.0)**	**173 (72.7)**	145 (67.8)

WRI, work-related injury. Bold font indicates significant difference at $P < 0.05$ (chisq) versus other respondents (drivers with a WRI vs drivers without a work-related injury, work-injured drivers who filed a claim vs work-injured drivers who did not file a claim, work-injured drivers who had to miss work vs work injured drivers who did not miss work). Questions reference most severe injury if respondent has had more than one in last 12 months. Full text of survey questions available upon request.

TABLE 3 Safety perceptions of current drivers, by injury and claim status, survey of Washington state truck drivers, 2010 and 2012

Description	Respondents; *n* (%)	Of those who had work-related injury; *n* (%)	Of those w/WRI who filed a claim for work-related injury; *n* (%)	Of those w/WRI whose injury required them to miss any work; *n* (%)
Do you regularly feel pressured to work longer hours?				
Yes	700 (32.2)	**226 (48.1)**	139 (48.9)	**138 (55.2)**
No	1,473 (67.8)	**244 (51.9)**	145 (51.1)	**112 (44.8)**
Do you regularly feel pressured to work faster?				
Yes	827 (38.0)	**250 (53.2)**	146 (51.8)	**144 (57.8)**
No	1,348 (62.0)	**220 (46.8)**	136 (48.2)	**105 (42.2)**
These six questions comprise a composite "Safety Perception" score (see below):				
New employees learn quickly that they are expected to follow good health & safety practices:				
Strongly agree	547 (25.4)	**85 (18.3)**	56 (20.0)	45 (18.1)
Agree	1,170 (54.4)	**238 (51.3)**	149 (53.2)	119 (48.0)
Disagree	350 (16.3)	**107 (23.1)**	59 (21.1)	61 (24.6)
Strongly disagree	84 (3.9)	**34 (7.3)**	16 (5.7)	23 (9.3)
Employees are told when they do not follow good safety practices:				
Strongly agree	550 (25.4)	**89 (19.1)**	56 (20.1)	48 (19.4)
Agree	1,179 (54.5)	**233 (50.1)**	148 (53.1)	122 (49.4)
Disagree	364 (16.8)	**119 (25.6)**	64 (22.9)	64 (25.9)
Strongly disagree	69 (3.2)	**24 (5.2)**	11 (3.9)	13 (5.3)
Workers and management work together to ensure the safest possible conditions:				
Strongly agree	534 (24.6)	**71 (15.1)**	46 (16.3)	**39 (15.6)**
Agree	1,058 (48.7)	**208 (44.2)**	130 (46.1)	**111 (44.4)**
Disagree	443 (20.4)	**139 (29.6)**	78 (27.7)	**64 (25.6)**
Strongly disagree	136 (6.3)	**52 (11.1)**	28 (9.9)	**36 (14.4)**
There are no major shortcuts taken when worker health and safety are at stake:				
Strongly agree	741 (34.3)	**130 (27.9)**	85 (30.3)	66 (26.7)
Agree	1,001 (46.4)	**185 (39.8)**	115 (40.9)	96 (38.9)
Disagree	345 (16.0)	**118 (25.4)**	61 (21.7)	62 (25.1)
Strongly disagree	72 (3.3)	**32 (6.9)**	20 (7.1)	23 (9.3)
The health and safety of workers is a high priority with management where I work:				
Strongly agree	726 (33.5)	**112 (24.1)**	72 (25.8)	60 (24.4)
Agree	995 (46.0)	**193 (41.6)**	121 (43.4)	102 (41.4)
Disagree	349 (16.1)	**117 (25.2)**	63 (22.6)	58 (23.6)
Strongly disagree	96 (4.4)	**42 (9.1)**	23 (8.2)	26 (10.6)
I feel free to report safety problems where I work:				
Strongly agree	939 (43.2)	**162 (34.5)**	100 (35.5)	89 (35.7)
Agree	1,001 (46.1)	**212 (45.2)**	130 (46.1)	103 (41.4)
Disagree	172 (7.9)	**68 (14.5)**	41 (14.5)	40 (16.1)

(Continues)

TABLE 3 (Continued)

Description	Respondents; *n* (%)	Of those who had work-related injury; *n* (%)	Of those w/WRI who filed a claim for work-related injury; *n* (%)	Of those w/WRI whose injury required them to miss any work; *n* (%)
Strongly disagree	61 (2.8)	**27 (5.8)**	11 (3.9)	17 (6.8)
Combined safety perception measure	*N* (%)	Mean, Median	SD	Range
Safety Perception	2,111	3.07, 3.00	0.62	1-4
	Respondents; *n* (%)	Of those who had work-related injury; *n* (%)	Of those who Filed a claim for work-related injury; *n* (%)	Of those whose injury required them to miss any work; *n* (%)
Good safety environment (comb. score ≥3.0)	1,405 (66.6)	**226 (49.6)**	**148 (53.8)**	121 (50.0)
Poor safety environment (comb. score <3)	706 (33.4)	**230 (50.4)**	**127 (46.2)**	121 (50.0)

WRI, work-related injury. Bold font indicates significant difference at $P < 0.05$ (chisq, *t*-test) versus other respondents (drivers with a WRI vs drivers without a work-related injury, work-injured drivers who filed a claim vs work-injured drivers who did not file a claim, work-injured drivers who had to miss work vs work injured drivers who did not miss work). Questions reference most severe injury if respondent has had more than one in last 12 months. Full text of survey questions available upon request. A combined safety perception score was only calculated for respondents who had answered all six of the items on the scale (there were 78 respondents who did not answer at least 1 item). The score is the average of the six items.

work faster/longer, schedule conflicts, and adverse working conditions, which can in turn contribute to health problems.[42] These factors are relevant to the health and safety of truck drivers and warrant discussion.

Washington truck drivers were predominately male and over 45 years of age, which is similar to previous studies of truck drivers.[17,22] Being over 40 years of age has also been associated with increased risk of obesity in truck drivers.[21] When looking at calculated BMI, WA truck drivers had a higher percentage of underweight (4.1%) compared to previous work with truck drivers which reported less than 1% underweight.[17,22] WA truck drivers also had a higher percentage of overweight (but not obese) truck drivers, 39.7% compared to other truck driver surveys/administrative data (22-27%)[17,22] and lower percentage obese drivers (41.0%) than reported by those studies (61-68%). However, the earlier studies[17,22] were focused primarily on long-haul truck drivers, and our results suggest that truck drivers in WA (of whom a majority have driving assignments other than long haul), may have healthier metrics. While obesity was not associated with likelihood of work-related injury in this study, though it may be related to conditions that affect excessive daytime sleepiness, which did increase odds of work-related injury. One such condition, obstructive sleep apnea (OSA), is associated with obesity,

TABLE 4 Logistic regression model for work-related injury risk ($n = 1782$)

Variable	Odds ratio	[95% Conf.	Interval]
Age in years			
18-34 years old	1.00	–	–
35-44 years old	1.39	0.72	2.67
45-64 years old	1.22	0.68	2.17
65+ years old	0.87	0.33	2.29
Female	0.78	0.40	1.52
Safety perceptions score	0.65	0.48	0.89
Primary driving assignment			
Long haul	1.00	–	–
Less than truck load	2.12	1.02	4.43
Other type (eg, garbage route)	1.79	0.90	3.57
In the past 12 months have you regularly had excessive sleepiness during the day?			
Yes	1.65	1.05	2.59
Do you regularly feel pressured to work faster?			
Yes	1.68	1.14	2.49

Bold font indicates statistical significance at $P < 0.05$. Model weighted for non-response.

and also with age and male sex.[43] A previous study found 14% of truck drivers self-reported a diagnosis of sleep apnea,[17] while other estimates range from 28% in commercial drivers[44] to 42% in long-haul drivers in Western Australia.[45] Treating sleep apnea in drivers has been shown to reduce health and disability costs and result in fewer missed work days.[46] Weight loss may also be beneficial in treating or reducing apnea severity in some cases.[47]

Despite age, obesity, and reported impacts of scheduling on healthy eating, regular exercise, and sleep adequacy (Table 1), 90.4% of drivers self-reported that their perceived health status was Good, Very Good, or Excellent, which is higher than reported elsewhere.[14,22] Truck drivers may feel this way because they can still do their job well. This is an emerging cultural norm, with a national survey reporting 27% of employed adults in the United States were obese in 2008,[48] and in 2011-2012, another national health study found 34.9% of adults aged 20 and over were obese.[49] This may be especially true in transportation, with studies of truck drivers reporting high proportions of overweight and obese individuals,[17,22] and thus truck drivers may underestimate the health risks of being overweight or obese. In Washington State, truck drivers were one of the two occupational groups with the highest risk of obesity.[19] This important finding merits further study.

Drowsiness or excessive daytime sleepiness can have serious impacts on driving. In this sample, 39% of drivers reported driving their truck while feeling drowsy 1 or more times a month (Table 2), and there were significant differences between drivers with a work-related injury and those without work-related injury, in regards to all the questions on sleep/drowsiness (Tables 1 and 2); this may be comparable to recent work in which 54.9% of respondents reported driving while sleepy, dozing off, or falling asleep and that poor sleep quality was associated with negative impact on job performance.[15] These results indicate that a focus on improving adequate sleep may be an important factor in any efforts to reduce work-related injuries in truck driving. While we did not ask questions about specific shift hours, which may significantly have affected daytime sleepiness, we do know that the majority of truck drivers (81%) interviewed worked over 40 hs a week (Table 1), and over 60% of drivers indicated that their work schedules impacted their ability to get adequate sleep "Some" or "A lot" (Table 1), which may address the same types of issues captured in shift type.

While the associations with sleepiness and feeling pressure to work faster are logical, there is less clarity as to why less-than-truckload (LTL) driving would increase risk of injury—possible reasons include that LTL drivers are more likely to spend a significant portion of their day loading/unloading cargo, connecting/disconnecting trailers from trucks and that their routes involve more frequent stops and travel in busy areas, as opposed to long stretches of highway driving in long-haul trucking.[38]

The percentage of truck drivers reporting at least one work-related injury in the previous year in our sample was 21.6%, which is almost three times higher than the percentage of drivers reporting non-crash related injuries in the previous year (7.3%) in the NIOSH national survey of long-haul truck drivers.[40] This percentage is also higher than a previous health survey of long-haul drivers that had 3.9% reporting accident or injury in past 12 months,[14] but lower than that reported by a survey of light/short haul transport drivers in Australia (41.4%).[11] The Washington surveys did not differentiate between injury mechanisms (crash vs non-crash), and included drivers with several types of driving assignments, which may account for some of the differences. Friswell and Williamson reported that of the injured drivers, only 61.3% of cases were reported formally, and 45% required time off[11] which was similar to the results of these surveys, with 60% filing a claim and 52.8% that missed work due to their injury (Table 1).

Of note, in the NIOSH survey, the majority (68%) of company drivers who lost work days did not report their injury to their employers.[40] The questions on the Washington surveys were different, but 20.6% of the injured drivers who reported that they missed work did not file a workers' compensation claim ($P < 0.0001$, data not shown). The role of safety climate in improving the appropriate reporting of workers' compensation claims is valuable, and our results confirm work that links better safety climate with better reporting,[30,50] with a significantly larger proportion of injured drivers in our surveys filing for workers' compensation for their injuries of those with good safety climate perception (66.4%) than of those with poor safety climate perception scores (55.7%) ($P < 0.02$, data not shown). Improving safety climate perceptions is likely to improve reporting of work-related injuries, which could improve knowledge of risks/hazards and help identify prevention strategies.

Drivers with a work-related injury also had a higher proportion reporting that they sought the care of a HCP for work-related pain, symptoms and/or discomfort (Table 1); this is logical given the retrospective nature of the survey—an injury may lead one to seek health care. However, it is interesting to note that a quarter of drivers who reported a work-related injury did not seek care, despite their injury (Table 1) and 12% of drivers who did not have a work-related injury also sought health care for a work-related issue (data not shown). Improving safety climate perceptions which lead to increased reporting of work-related injuries may then also lead to increased access to healthcare and an improvement in health for these workers (eg, weight loss, excessive daytime sleepiness) and prevention of work-related injuries. The concept of a safe and healthy workplace should include the ability of an employee to seek care.

Translating these implications into practice can be done by recognizing the importance and the existence the relationship between psychological safety climate and work-related injuries in truck drivers. Practically speaking, safety climate perceptions in themselves do not improve safety, but they can give a company a good indication of how their safety policies and practices are perceived by their drivers. Having a gauge with which to measure safety climate perceptions could be very important in determining what may need to change in terms of the safety plan. The short (six item) survey was intentionally selected for its brevity and its successful usability in time-sensitive industries,[31] and should be feasible for companies to easily administer; subsequent safety meetings or trainings could be focused on addressing areas of concern identified by the results. Safety programs could be written to include special emphasis on management commitment to safety, and to address steps employees can take to report hazards and improve safety.

4.2 | Strengths and limitations

There are several limitations to this study. First, this study relies upon self-reported retrospective data, which may reflect some recall bias and limits causal inference. Second, although these are Washington State injured workers, due to the survey design (researchers blind to participants' identities), we were unable to confirm or provide numbers regarding true filing of workers' compensation claims. The report of injuries and report of filings may be under or over estimated. Third, we used a generic organizational level scale for safety climate perceptions across an industry sector in Washington State, which is not how the scale was intended to be used. At the time the surveys were conducted, there was no readily available scale that was more suited to truck drivers; a safety-climate scale intended for remote workers, Huang et al., was not published until 2013. However, the safety climate perception scale used was significantly related to the risk of having a work-related injury in the past year. We believe that this scale was appropriate to assess psychological safety climate, and that psychological safety climate is associated with higher risk of work-related injury, as well as filing a workers' compensation claim.

In addition, we lost a meaningful proportion of respondents in multivariable models due to missing data. Post-hoc analyses of differences between those who were retained for the model and those who were dropped, showed no significant differences in the covariates retained, except for the safety climate perception scale, where those in the model had a mean score of 3.08 and those not retained had a mean score of 2.96 ($P = 0.005$). This may have introduced some bias into the model.

Caution should be taken when interpreting the logistic regression model for populations outside this study. While the probability of duplicate responses from 2010 to the 2012 survey was low (11%), there were some differences when the logistic regression models were run separately by survey year. Although post hoc Chi-square tests revealed no significant differences in the variables for excessive sleepiness and feeling pressure to work faster, these variables were significantly different between the two survey years in the full model. The reasons for this may be due to sample size ($n = 1406$ in 2010, $n = 783$ in 2012), resulting in the low number of work-related injury cases ($n = 295$ in 2010, $n = 178$ in 2012). There may also be some interaction with the covariates and the survey year, although post hoc tests did not indicate any. Regardless, the primary independent variable, safety climate perceptions, did not change significantly by year, and this model presents the overall experience of truck drivers in Washington State, specifically in relation to safety climate perceptions and risk of work-related injury, and is not meant to serve as a predictive model for injury prevention.

Despite these limitations, there are also several strengths to this study. First, this is an underserved, aging population that faces a confluence of employment and lifestyle factors that contribute to their health and injury risks and need prevention efforts that are tailored to their risks. Previous work on truck drivers focuses primarily on long-haul drivers, which does not represent the majority of Washington State truck-drivers (10.7%, Table 1;[38]). Less-than-truckload driving assignment in particular is highlighted by this study as being at increased risk of work-related injury that warrants further investigation. To reduce work-related injuries in truck-drivers in Washington, surveys such as these, which engage the voices of a locally representative sample and characterize the population, are needed. The mix of trucking types varies by state across the U.S., and to best target prevention efforts, state-focused studies are valuable whether they produce new findings or not. Secondly, drawing the sample from the population of WA CDL holders and cross-matching with ESD data were an efficient strategy to reach eligible respondents. Finally, improving safety climate perceptions is likely to improve reporting of work-related injuries, and through this, potentially access to care. While other studies have also demonstrated the link between positive safety climate/management interactions and improved reporting of work-related injuries,[30,50,51] our study is the first, to our knowledge, to do so on an individual level with truck-drivers psychological safety climate perceptions, as opposed to organizational level climate in construction and other industries. Under-reporting to workers' compensation leads to the shifting of cost from the employer to the worker and the general public health care system. Reducing under-reporting of injuries is valuable as it would lead to more accurate assessment of the substantial personal, social, and economic burden of work-related injuries and the needs of individual workplaces and truck drivers, as well as informing more efficient prevention strategies.

5 | CONCLUSIONS

This study suggests that positive psychological safety climate perception was correlated with reduced odds of having a work-related injury, while having a less-than-truckload driving assignment, excessive daytime sleepiness, and regularly feeling pressured to work faster all increased the odds of work-related injury. Work-related injuries are not disconnected events that occur at random and health promotion and injury prevention work to improve truck driver health and safety should broaden in focus to take into account psychological safety climate and management roles (who may have control over essential work organization factors such as job design, work schedules, shift work, and work hours). The results further demonstrate the utility of a safety climate perception score in assessing occupational health and safety in truck driving. The role of management in safety climate, both as a whole, and in particular contexts such as pressure to work faster, appears to be a potentially valuable focus for future prevention and intervention efforts.

AUTHORS' CONTRIBUTIONS

NA and CS participated in the conception of the work and study design. CS managed the original acquisition of the data, and participated with NA in the analysis of the data for the work. NA, CS, and JB all participated in the interpretation of the data, as well as drafting and revision of the work for important intellectual content, final approval, and agreement to be accountable for all aspects of the work in ensuring

that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

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ETHICS APPROVAL AND INFORMED CONSENT

The work was performed at Safety and Health Assessment and Research for Prevention (SHARP) Program, Washington State Department of Labor & Industries. All survey work was approved by the Washington State Institutional Review and participants gave verbal or written informed consent, depending on their method of survey completion.

DISCLOSURE (AUTHORS)

The authors report no conflicts of interest.

DISCLOSURE BY AJIM EDITOR OF RECORD

Steven Markowitz declares that he has no conflict of interest in the review and publication decision regarding this article.

DISCLAIMER

The contents are solely the responsibility of the authors and do not necessarily reflect the official views of the Washington State Department of Labor and Industries or NIOSH.

ENDNOTE

[1] Probability of duplicates was simply the sample drawn divided by the total possible number of subjects (population of drivers in that year [2010 and 2012]), then multiplying the two probabilities together.

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