Safety Climate and the Distracted Driving Experiences of Truck Drivers

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Background *For truck drivers, distracted driving is a workplace behavior that increases occupational injury risk. We propose safety climate as an appropriate lens through which researchers can examine occupational distracted driving.*

Methods *Using a mixed methods study design, we surveyed truck drivers using the Safety Climate Questionnaire (SCQ) complemented by semi-structured interviews of experts on distracted driving and truck safety. Safety climate was assessed by using the entire SCQ as an overall climate score, followed by factor analysis that identified the following safety climate factors: Communications and Procedures; Management Commitment; and Work Pressure.*

Results *In multivariate regression, the overall safety climate scale was associated with having ever experienced a crash and/or distraction-involved swerving. Interview participants described how these SCQ constructs could affect occupational distracted driving.*

Conclusion *To reduce distraction-related crashes in their organizations, management can adhere to safe policies and procedures, invest in engineering controls, and develop safer communication procedures. Am. J. Ind. Med.* © *2015 Wiley Periodicals, Inc.*

KEY WORDS: commercial trucks; cell phone use; texting; motor vehicle crash; hard braking; near-crash; mixed methods; occupational safety

INTRODUCTION

Motor vehicle crashes (MVCs) are the leading cause of occupational fatalities in the United States for all workers and account for more than half of the occupational fatalities to U.S. truck drivers [Bureau of Labor Statistics, 2012]. While overall MCV fatality rates have been decreasing dramatically since the 1970s [Lyman and Braver, 2003], the truck driver MVC fatality rate of 31.8/100,000 workers in 2010 is 10-times higher than the national average (3.4/100,000 workers) [Bureau of Labor Statistics, 2012]. Distracted driving has long been a hazard for truck drivers; however, the emergence of portable electronic communication devices is thought to have increased their crash risk [Olson et al., 2009; Hickman et al., 2010]. This study examined the relationship between workplace safety climate, distracted driving, and distraction-related outcomes in commercial truck drivers.

Distracted Driving by Commercial Truck Drivers

While operating their vehicles, truck drivers are confronted with several distractions from various sources. In general, motor vehicle drivers are affected by distractions in four ways: 1) visual distractions that take the driver's eyes off the forward roadway; 2) auditory distractions that take the driver's aural perception away from relevant driving cues; 3)

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cognitive distractions that take the driver's mind off the driving task; and 4) manual distractions that take the driver's hands off the wheel [Ablassmeier et al., 2007; Governors Highway Safety Association, 2011]. Visual and auditory distractions could interfere with the driver receiving necessary information relevant to the driving task, while cognitive distractions affect the processing of new information, and manual distractions delay the driver from taking corrective action necessitated by the situation [Pettitt et al., 2005]. Tasks that drivers can undertake have been categorized into a taxonomy of three types of tasks: *primary tasks* are those that only control vehicle speed and direction; *secondary tasks* support the primary tasks and include actions such as turning on headlights or checking mirrors; and *tertiary tasks* include any activities that the driver undertakes that are unrelated to driving [Ablassmeier et al., 2007]. Our definition of distracted driving is the practice of driving a motor vehicle while engaged in any secondary or tertiary task that takes the driver's eyes, hands, or concentration away from the primary driving task.

Studies of truck driver behavior using in-vehicle cameras have identified more than two dozen secondary and tertiary tasks as sources of distraction [Stutts et al., 2003; Klauer et al., 2006; Olson et al., 2009; Hickman et al., 2010]. The term "cell phone use while driving" (CPWD) encompasses any task involving a cell phone, including dialing a phone, talking on the phone, and reading or writing messages [Hafetz et al., 2010]. CPWD has increased in recent years because of the proliferation of cell phones in the U.S. and elsewhere [Eby et al., 2006; Collet et al., 2010a]. Two of the most dangerous CPWD tasks are dialing the phone and sending, reading, and writing short message service text messages (also known as texting) [Olson et al., 2009; Klauer et al., 2014]. These tasks involve manual, visual, and cognitive distractions [Governors Highway Safety Association 2011]. Both in the laboratory setting [Crisler et al., 2008; Hosking et al., 2009] and during on-road driving [Olson et al., 2009; Hickman et al., 2010], texting has been shown to be the greatest hazard for crash or near crash.

Safety Climate and Occupational Driving

For commercial truck drivers, the vehicle cab is their workplace; thus, distraction on the job is an occupational hazard that must be a concern for management and may be influenced by organizational factors. Safety climate is a framework for characterizing how highly the members of an organization value safe worker behavior. Safety climate describes the shared perceptions among employees of those practices and behaviors that are prioritized and rewarded regarding safe operations, such as workplace communication, training, and management commitment to safety [Zohar, 1980; Zohar, 2010]. Positive safety climate has been shown to be associated with safe driving behavior on the job [Wills et al., 2006].

Safety climate is comprised of various sub-factors. Commonly assessed safety climate factors include employee perceptions of work pressure, safety systems, and worker competence, as well as their perception of management commitment to safety, which is thought by some to be the most important component of safety climate for injury risk [Flin et al., 2000; Zohar, 2008; Huang et al., 2012]. We hypothesized that these factors, either independently or combined as an overall summary measure, impact safe behaviors related to distracted driving among commercial drivers. A better understanding of the association between specific components of safety climate and distracted driving outcomes may inform interventions at the organizational level to enhance the safety of commercial drivers.

MATERIALS AND METHODS

This study was conducted using a sequential mixed methods design. The qualitative and quantitative data were collected from separate populations, and the methods for the quantitative and qualitative analyses are described in subsequent sections. In mixed methods study notation, this manuscript follows a QUAN→qual design for the purposes of complementarity evaluation—that is, elaborating and illustrating quantitative results with the qualitative data [Greene et al., 2008; Morse, 2008]. This process allows us to further clarify the effects of the different aspects of safety climate on driving behavior [Morse, 2008]. Furthermore, by using qualitative data from a population that is separate from that of the drivers, we have "between-method" triangulation that enhances the study's external validity [Jick, 2008]. We first identified the specific factors that comprise overall safety climate, and then incorporated these into regression analyses to identify factors that were related to the distracted driving outcomes. The results of the interviews were then used to describe how these factors affect driver safety with regard to distracted driving. The Johns Hopkins Bloomberg School of Public Health Institutional Review Board approved all study procedures.

Quantitative Data Collection and Analysis

Quantitative data were collected via online survey. Members of the International Brotherhood of Teamsters (IBT) in the U.S. were the target population for the survey. The IBT, which represents more than one million truck drivers and members in other occupations in the U.S. and Canada [International Brotherhood of Teamsters, 2013], was selected due to its size and nationwide reach. A business representative from an IBT Local who was familiar with the project assisted the study team in finalizing the exact wording of the survey. The final survey took 10 min to complete upon pilot testing. With the assistance of personnel in the office of health and safety at IBT headquarters, we confined our sample to relevant classes of vehicles in which drivers were most likely to experience the distractions under study [International Brotherhood of Teamsters, 2012], i.e., the carhaul, express, freight, motion picture, package, and tankhaul divisions. At the beginning of the survey, participants were asked to select the type of truck that they drove (using accompanying images), and those who did not identify one of the selected vehicles were directed to a disqualification page and thanked for their time. Based on their responses to this question, participants were grouped into two general vehicle configurations: "package trucks" (for those who identified "package" as their primary vehicle), and "semi-trucks" (for those who selected any other vehicle type). The distribution of responses for package versus semi-trucks is presented in the Results; the distribution by specific type of vehicle can be found in the Supplemental Materials.

Survey participants were recruited via an announcement posted to the IBT Web site, www.teamster.org. The survey was administered online using www.SurveyMonkey.com [SurveyMonkey Inc, 2013] and was open between April 2 and May 19, 2013. The number of items on the survey was used as a guide for the required sample size for the factor analysis [MacCallum et al., 1999]. For the 35-item questionnaire, we sought 350 subjects, for a 10:1 participant:item ratio. A ratio of 7:1 or 6:1, necessitating 245 or 210 participants, was the minimum acceptable sample size that we sought [MacCallum et al., 1999]. The Results section discusses the number of participants and the derivation of the final sample size.

Demographic data collected in the anonymous online survey were gender, age, years of driving experience, and approximate hours of driving per week. The 35-item Safety Climate Questionnaire (SCQ) had been modified and validated for professional drivers by Wills and colleagues [Wills et al., 2005; Wills et al., 2009]. Drivers were asked to what degree they agreed with each SCQ question on a Likert scale where 1 represented "strongly agree," 4 represented "neutral," and 7 represented "strongly disagree." An overall safety climate score was calculated by averaging all 35 items on the SCQ for each participant [Baysari et al., 2008]. This general score could account for lower-order factors that we describe in the factor analysis below [Baysari et al., 2008; Zohar and Polachek, 2013].

Participants also self-reported whether they ever had experienced a crash while on the job, then—following a reminder of the definition of distracted driving—they reported whether they had experienced the following three crash or near-crash outcomes while on the job: 1) had a crash while distracted; 2) had to brake hard to avoid a crash while distracted; or 3) had to swerve to avoid a crash while distracted. Near-crash events are used in studies of distracted driving in truck drivers because actual crashes due to distraction are very rare [Olson et al., 2009; Hickman et al., 2010]. Including these near-crashes increased the number of outcome events for analyses.

An exploratory factor analysis was conducted to determine whether the six factors of the SCQ as determined by Wills *et al.* were appropriate for this population. Details of the factor analysis are included in the Supplemental Materials found online with this article. Twelve items with high uniqueness (greater than 0.5) were removed in an iterative fashion until we arrived at a model with three factors that loaded on SCQ items 1 through 12, 14 through 20, and 21 through 24, as shown in Table SI in the Supplemental Materials. Of note is the fact that these three factors are the same as the first three factors described by Wills *et al.* [Wills et al., 2005]. To test the strength of the three-factor structure, we also generated the full six-factor model from the original Wills studies.

The overall safety climate score, the mean factor scores, and demographic data were entered first into univariate regression equations for each of the four crash and near-crash outcomes. To test the effects of safety climate on distraction-related driving outcomes, we ran two separate sets of multivariate regressions. First, the overall safety climate score constituted the independent variable of interest while controlling for demographic variables with P-values ≤ 0.10 in univariate regression. Second, the three individual safety climate factors were entered into multivariate models, again including significant demographic variables. As a sensitivity analysis, we compared the results of the regressions using the three-factor structure obtained from the factor analysis to regression analyses using the full six-factor structure from the original Wills *et al* manuscripts. All quantitative analyses were conducted using Stata v.12.1 [Stata Corp, 2012].

Qualitative Data Collection and Analysis

A purposive sample of experts in truck driver safety and distracted driving were recruited from the list of attendees at the Symposium on Prevention of Occupationally-Related Distracted Driving sponsored by the Johns Hopkins Education and Research Center for Occupational Safety and Health on April 18, 2011 in Laurel, Maryland [JHSPH, 2011]. Additional interviewees were recruited using a snowball sampling technique [Lofland et al., 2006]. An interview guide was developed and refined by the study team. The interview script was finalized after pilot testing with a former driver who now works as a motor carrier safety advocate. Data collection was ceased after 11 interviews, when data saturation was reached (i.e., when repeated interviews yielded no new data) [Guest et al., 2006; Francis et al., 2010]. Interviews were semi-structured and lasted between 35 and 55 min. Each interview was framed by asking participants: how drivers would view selected distractions; who would affect their decisions to undertake these distractions; and how much control they had concerning avoiding or not avoiding each distraction. Interviews were conducted via telephone using Skype [Microsoft Corp, 2012] and were recorded using MP3 Skype Recorder [VOIPCallRecording, 2013]. Audio files of the interviews were transcribed by an independent transcription company.

Ten interviews were recorded and transcribed. Because of a recording mishap, interviewer notes, which were included in the analysis, were used in lieu of a transcript for one participant. Data collection began in December 2012 and ended in January 2013. Data were open-coded line by line to label the themes in participants' responses [Emerson, 2001; Yin, 2011]. A codebook was developed during the focused coding process, and a second individual coded a subset of three randomly-selected interviews to evaluate the reliability of the coding process. The two coders met to discuss their results and the adequacy of the codebook for describing the categorizations of the data [Frattaroli et al., 2012], and no substantive differences were identified.

RESULTS

Study Population

Of the 440 drivers who replied to the survey, 79 (18%) were excluded because they did not drive one of the vehicles of interest. Over the course of the survey, 122 of the remaining 361 (34%) left the survey before completion. Demographic data for the final sample of 239 respondents are presented in Table I. Seventy-five percent (n = 179) of the respondents reported driving semi-trucks; the remaining 60 respondents reported driving package trucks. Self-reported crash and near-crash outcomes, used as dependent variables in regression analyses, are also reported in Table I. Because 96% (n = 228) of the sample was male, we did not explore differences by gender.

TABLE I. Descriptive Data and Self-Reported Distracted Driving (DD)-Related Outcomes. n = 239

	Mean	SD	Minimum-Maximum
Age (years)	48.0	8.9	21–69
Driving experience (years)	22.7	10.1	1–45
Weekly driving (hours)	47.6	11.4	6–70
Outcomes of interest	Yes	No	Not reported
Ever crash	130	107	2
DD-involved crash	41	197	1
DD-involved braking	112	124	3
DD-involved swerving	108	129	2

Survey Results

The mean score for overall safety climate was 3.9 (standard deviation [SD] = 1.4) with a Chronbach's α of 0.95. To see the details of the factor analysis that produced the three individual safety climate sub-factors, please refer to the Supplemental Materials. Mean scores for the three factors were 3.44 (1.6) for Communications and Procedures, 4.21 (1.8) for Work Pressures, and 3.90 (1.9) for Management Commitment. Chronbach's α for these three factors were between 0.93 and 0.95. In this analysis, lower scores indicate better safety climate. Using the original six-factor structure from Wills *et al.* [Wills et al., 2009], the mean (SD) scores for the six factors were 3.42 (1.6) for Communications and Procedures, 4.21 (1.8) for Work Pressure, 3.90 (1.9) for Management Commitment, 4.80 (1.6) for Relationships, 3.80 (1.7) for Driver Training, and 4.14 (1.8) for Safety Rules.

Results of univariate logistic regressions for age, self-reported driving experience, truck type, overall safety climate score, and the three factors identified in factor analysis and their associations with the four distracted driving outcomes are presented in Table II. Univariate associations for the age and driving variables are also presented in Table II. Those that were significant at $P \leq 0.10$ for each respective outcome are in bold in Table II. The covariates in bold were retained in multivariate regressions with the safety climate variables, first with the overall safety climate score modeled as the independent variable and next with the three specific safety climate factors. As shown in Table III, lower safety climate rating (i.e., increased overall safety climate score) was significantly associated with ever experiencing a crash on the job. Both lower safety climate rating and driving a semi-truck were associated with distraction-related swerving. Results shown in Table IV for multivariate regressions that included the three separate safety climate factors as independent variables, indicate that the only significant finding was a negative relationship between hours driven weekly and the experience of distraction-related hard braking.

To test the validity of our factor analysis compared to the original six-factor model presented by Wills *et al.*, we ran the same analyses presented in Table IV using all six factors. In multivariate regressions, all of the *P*-values for all these covariates were 0.2 or greater. Thus, although none of the three-factors in the hypothesized multivariate regression model were significant, those in the six-factor model based on Wills's results did not perform better.

TABLE II. Results of Univariate Regressions for Demographic, Driving, Truck Type, and Safety Climate Factors on Negative Driving Outcomes While Working. Variables with OR of $P < .10$ are Shown in Bold. When Demographic Variables and Truck Type Are in Bold, They Were Selected for the Respective Multivariate Regressions

	Ever experience a crash on the job		Ever experience a distraction-related crash on the job		Ever undertake hard braking while distracted on the job		Ever have to swerve while distracted on the job	
Variable	OR	p-value	OR	p-value	OR	p-value	OR	p-value
Age	1.02	0.25	**1.05**	**0.03**	0.98	0.27	1.02	0.27
Driving experience	1.02	0.13	**1.04**	**0.03**	0.99	0.66	1.01	0.28
Weekly driving	0.99	0.66	1.01	0.45	**0.98**	**0.06**	1.00	0.73
Truck type*	**1.76**	**0.07**	0.81	0.60	0.73	0.30	**0.56**	**0.06**
General safety climate[a]	**1.27**	**0.02**	0.94	0.62	1.13	0.18	**1.19**	**0.06**
Communications and Procedures	**1.19**	**0.03**	0.98	0.84	**1.15**	**0.09**	**1.21**	**0.02**
Work Pressure	**1.19**	**0.02**	0.94	0.51	1.05	0.54	1.00	0.97
Management Commitment	**1.15**	**0.04**	0.98	0.90	1.08	0.25	**1.14**	**0.05**

[a]Increased safety climate score indicated lower rating of organizational safety climate.
* Odds ratio for truck type indicates odds of outcome for package/semi-trucks.

Interview Results

The $n = 11$ interview participants held the following positions: five were researchers at academic institutions with expertise in distracted driving among the general population and/or truck drivers, specifically; three were researchers at private research institutions with expertise in behavioral sciences and distracted driving; one was involved in union leadership at a national union representing truck drivers; one worked in fleet logistics for a company with a fleet of more than 1,000 company-owned trucks of varying sizes; and the final participant worked for the National Transportation Safety Board investigating fatal crashes involving commercial vehicles. Because participants were guaranteed anonymity, no further identifying information will be reported.

From the interview data, themes emerged that were consistent with the SCQ factors that related to how the different aspects of safety climate would affect distracted driving behaviors by commercial truck drivers. Two participants described how climate is affected by messages received from all levels of the company: from fellow drivers, from dispatchers, from supervisors, and from upper management. Consistent with the three factors represented in the SCQ, participants identified many ways—both positive and negative—by which managers and supervisors can influence employee distracted driving. Participants felt that drivers should not be given an explicit policy from management while at the same time perceiving contradictory implicit expectations from the company. For example, when asked about expectations for dispatch device use, one participant expressed concern that company policy might direct drivers not to use the dispatch device while driving, yet drivers may be subject to the "[i]mplicit expectation that they use the device while driving so that they can respond in a

TABLE III. Results of Multivariate Analyses on Negative Driving Outcomes in the Workplace With Safety Climate Modeled as a Single, Overall Score

	Ever experience a crash on the job		Ever experience a distraction-related crash on the job		Ever undertake hard braking while distracted on the job		Ever have to swerve while distracted on the job	
Variable	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI
Age	1.02	0.99–1.05	1.02	0.95–1.10				
Driving experience			1.03	0.96–1.08				
Weekly driving					**0.98**	**0.95–1.00**		
Truck type*	1.78	0.95–3.36					**0.51**	**0.27–0.94**
Safety climate[a]	**1.26**	**1.02–1.50**	0.93	0.73–1.19	1.18	0.97–1.42	**1.22**	**1.02–1.49**

Results significant at $P < 0.05$ are in bold.
[a]Increased safety climate score indicated lower rating of organizational safety climate.
*Odds ratio for truck type indicates odds of outcome for package/semi-trucks.

TABLE IV. Results of Multivariate Analyses on Negative Driving Outcomes in the Workplace with Safety Climate Modeled Using the Three Factors of Communications and Procedures, Work Pressure, and Management Commitment

	Ever experience a crash on the job		Ever experience a distraction-related crash on the job		Ever undertake hard braking while distracted on the job		Ever have to swerve while distracted on the job	
Variable	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI
Age	1.02	0.99–1.06	1.03	0.96–1.11				
Driving experience			1.02	0.96–1.08				
Weekly driving					**0.98**	**0.95–1.00**		
Truck type*	1.77	0.90–3.48					0.62	0.32–1.20
Communications and Procedures	1.10	0.88–1.38	0.96	0.71–1.29	1.15	0.92–1.43	1.16	0.92–1.45
Work Pressure	1.07	0.87–1.32	0.94	0.73–1.21	0.98	0.81–1.19	0.89	0.72–1.10
Management Commitment	1.05	0.85–1.30	1.05	0.80–1.38	1.04	0.84–1.28	1.13	0.91–1.40

Results significant at $P < 0.05$ are in bold.
*Odds ratio for truck type indicates odds of outcome for package/semi-trucks.

timely fashion to requests from the company." This action on the part of management—setting a policy, but enabling lack of compliance—exemplifies the factor that addresses Communication and Procedures.

Participants identified additional organizational procedures by which managers can influence an increase or decrease in distracted driving. For example, three interview participants questioned why managers might contact their drivers when the former knew that the latter were driving. This exemplifies prioritization of convenience and expediency over worker safety, a Management Commitment issue. Two participants suggested that a better procedure for communicating would be to deliver a non-invasive signal (i.e., not repetitive or not requiring immediate response) over the dispatch device, indicating that the driver had received a message for him or her to check when it was safe to do so. When comparing positive and negative company climates, one participant said, "We might see that drivers are under the impression that they need to be very responsive to anything that comes from the office. Whether it's from dispatch or from a supervisor—things like that. Whereas, other companies might have policies where that feeling is a little less intense."

Interview participants identified enforcing bans on distracted driving as another component of the Communications and Procedures and Management Commitment factors; yet, enforcement was not always described as being solely for the purpose of protecting the worker. One participant noted that employers would have to consider legal liability if a driver was in a distraction-related crash. Interview participants described technological means by which enforcement might take place. Two participants identified one specific video-monitoring product as one way that management could observe whether drivers were undertaking any distracting activities. Management could readily monitor cell phone usage if the drivers were equipped with a company-provided phone. Finally, management could invest in other engineering solutions to prevent or reduce driver distraction, including "locking out" the dispatch device while the truck is in motion and equipping trucks with a global positioning system (GPS) device, which multiple participants described as a safer alternative to requiring the drivers to use a paper map.

The Work Pressure factor—specifically, time pressure—was commonly discussed as an important aspect of driver safety. If management prioritizes delivery times over safe driving, this can lead drivers to choose to multitask while driving with the goal of increasing their efficiency. While participants agreed that drivers should not attempt to multitask while driving, they expressed concern that little spare time was built into a driver's schedule to allow for safe communications. The following quote is telling, as the participant describes his/her experience in riding along with a delivery driver:

"I rode with a truck driver and you know his schedule meant that he had to eat lunch in the truck, you know, he didn't have time to stop, go to the bathroom and you know, that schedule didn't allow it. If he wanted to go to the bathroom he had to find a restroom at one of his stops and there was no time to go to like a restaurant or a fast food restaurant or a Subway or anything like that."

This participant told us that all routing information for these delivery drivers was automatically updated to the individual driver's computer that he/she would use to collect signatures upon pickups or deliveries.

Yet, while all these workplace factors could affect drivers' perceptions of safety climate concerning distracted driving, participants said that it was ultimately up to each driver to make the final decision whether to engage in a given distracting activity while driving. Freely allowing drivers to pull over might sound ideal, yet multiple participants described how this could put an onus on drivers to weigh the pros (safety) and cons (lost time) of pulling the vehicle over, reading and possibly responding to the message, then re-entering traffic. Because we did not interview truck drivers directly, we were unable to get their views on how specific company policies would affect their decision-making regarding distracted driving.

DISCUSSION

Organizational safety climate has previously been shown to be associated with safe workplace behaviors and injury rates [Clarke, 2006; Johnson, 2007; Beus et al., 2010]. This study applied measures of safety climate to the evaluation of distracted driving behaviors in U.S. truck drivers. We found that drivers who rated their overall organizational safety climate as poor—compared to drivers who rated their organizational safety climate as better—were at increased risk of experiencing a crash or a distraction-related near crash on the job. These survey results, combined with the qualitative interviews, suggest how safety climate could affect distracted driving in commercial truck drivers.

A review of the origins of safety climate defines it as the social manifestation of organizational culture as construed collectively by workers [Guldenmund, 2000]. While the previous literature on safety climate found that truck drivers have weak within-group perceptions of climate, interview participants described how management within an organization could greatly influence safety climate by supporting consistent practices regarding driver safe communication procedures. A Virginia Tech Transportation Institute study found that truck drivers who drove for organizations with cell phone policies had a lower prevalence of distracted driving, as well as reduced odds for crash and near-crash, compared with truck drivers who drove for organizations without such policies [Hickman et al., 2010]. By committing to and enforcing safe work procedures, organizational leadership can address the different factors involved in generating good safety climate.

Consistent safety messaging with regard to explicit and implicit expectations (as demonstrated by the above direct quote of the interview participant) is an important factor in keeping drivers free from distractions. Organizational policies that lead drivers to be conflicted about their expected work procedures are defined by organizational psychologist James Reason as "inadvisable rules" [Reason, 1990]. Reason and colleagues further describe how organizations can prevent driver errors and policy violations with good organizational management and planning [Reason et al., 1990; Reason, 2000]. The importance of good safety planning is reinforced in Zohar's review of the history of safety climate research, in which he describes Management Commitment as the most important factor affecting worker perceptions of organizational safety climate [Zohar, 2008].

Management Commitment is demonstrated by concrete actions and policies that, despite potential costs to the organization, promote safe driving. When discussing how the Work Pressures and Communications and Procedures factors might affect distracted driving, interview participants described them in terms of management commitment. This may mean that the Management Commitment factor alone cannot easily be separated from the effect of the other safety climate factors, despite the ability to distinguish them in factor analysis. This may account for the finding that, in the models that included all SCQ components as well as potential confounders, only the composite safety climate measure was significantly associated with crash and near-crash outcomes, whereas the individual climate factors on their own were not significantly associated. Additionally, the diminished power associated with the larger model that divided safety climate into three components may have reduced the ability to detect a statistically significant relationship for any single component.

Interview data pointed to several specific suggestions for workplace protocols that could reduce driver distractions. Allowing for some driver autonomy over personal time, such as that used for eating or using the restroom while on the job, would be a step towards improving occupational safety outcomes [MacDavitt et al., 2007]. Management could further commit to driver safety by keeping the driver's work space (i.e., vehicle cab) free from distractions, equipping vehicles with GPS devices rather than paper maps, and by programming electronic devices so that drivers hear a signal when a message has arrived but can only deal with messages once the vehicle is safely stopped.

We did not expect to find that increased weekly driving exposure was associated with decreased odds of reporting distraction-related hard braking on the job. According to our findings, a one-hour increase in weekly driving exposure was associated with a two-percent decrease in odds of distraction-related hard braking (OR = 0.98; CI = 0.95–1.00). Because the interviews were conducted before the surveys, we did not have the opportunity to explore this finding in further depth. The potential association between driving time and near crash should be further examined.

Drivers of package trucks were less likely to experience distraction-related swerving than semi-truck drivers. The same trend was also seen for hard-braking and distraction-related crashes, but these were not statistically significant. This suggests that semi-truck drivers may be of greatest concern with regard to the reduction of distractions. There are inherent differences in the nature of these two types of occupational driving. For example, package pickup and delivery service requires that routing must be planned and updated by computers for optimal driver routes [Zhong et al., 2007; Smilowitz et al., 2013]. If package delivery drivers' routes are rigidly scheduled and require fast-paced stops and starts, as relayed in the quote at the end of the interview results, then it is possible that package drivers have less opportunity to be distracted by non-work distractions such as phone calls or texting with family and friends. Automatically updating package delivery drivers' routes through a portable computer also removes a potential work-related distraction in which the driver would have to make decisions about scheduling and routing. Differences in causes of distracted driving by types of vehicles and specific driving tasks should be further investigated.

Strengths and Limitations

Since the survey was anonymous, we did not ask IBT members to reveal the organization for which they drove. We therefore could not examine the impact of policies within a given organization and we could not control for clustering within organizations, as seen in some types of occupations. However, as mentioned, safety climate does not cluster very highly for lone workers like truck drivers [Huang et al., 2013a; Huang et al., 2013b]. We recognize that safety climate is a "shared perception" of workplace features, but because we did not ask workers to report their organization, we could not examine safety climate at the group level. Nevertheless, other studies of safety climate [Glendon and Litherland, 2001; O'Toole, 2002], including those that validated the version of the SCQ used in this study [Wills et al., 2006; Wills et al., 2009], have examined the effects of individual perceptions of safety climate on safety outcomes.

While we did know what vehicles respondents drove, we did not ask details about specific driving tasks. However, we were able to sample drivers in a variety of industries, thus improving the external validity of our results. Sampling IBT drivers allowed us to reach drivers nationwide, thus covering a broad range of vehicle types. The distribution of vehicle configurations we saw does not differ greatly from the most recent U.S. Census Bureau report on the national truck fleet [Census Bureau, 2004]. The annual Highway Statistics reports from the Federal Highway Administration report vehicle fleet composition by state [Federal Highway Administration, 2013]; however, these data are not comparable to the IBT vehicle classifications. Although the IBT assisted us in conducting this study, we have no information specific to drivers, such as demographic data, that would allow us to gauge the representativeness of our sample.

We relied on driver recall for reporting crash and near-crash events. Although self-reported incident reports have been validated by previous studies [West et al., 1993; Adams and Webley, 1996], methodological issues still remain. We did not ask drivers about previous occupational crash experience, or whether such crashes or crash-related behavior occurred while working for their current organization. Misclassification of outcomes would bias results toward the null and thus diminish our ability to detect associations. Also, social desirability bias might bring drivers to underreport crashes or near crashes; however, anonymous surveys reduce the likelihood of such bias [McEvoy et al., 2006]. The study population is dominated by men, and since only seven women responded to the survey, we were unable to fully explore differences by gender. Although men are approximately eight times more likely to experience a fatal crash while driving on the job compared to women [Centers for Disease Control and Prevention, 2011], there is no evidence that one gender or the other is more likely to be affected by distracted driving [Collet et al., 2010b]. Future studies of distracted driving in the workplace should consider whether differences exist by gender.

Although the current study had almost 100 fewer respondents than the Wills *et al.* studies in which this version of the SCQ was developed and validated [Wills et al., 2005; Wills et al., 2006; Wills et al., 2009], our factor analysis showed that the safety climate data were best described by the same three factors that accounted for the greatest variation in the Wills *et al.* six-factor analyses. Furthermore, aside from eliminating item 13 from the SCQ, our confirmatory factor analysis produced three factors that exactly matched the exploratory factor analysis of Wills *et al.* [Wills et al., 2005; Wills et al., 2006]. Our exploratory factor analysis produced three latent factors of safety climate, suggesting that this instrument could be useful for future analyses in this population. Because of the small sample size, we were unable to analyze different semi-trucks; however, a bivariate analysis of vehicle type by semi- and package trucks did demonstrate an increased risk of experiencing distraction-related swerving in the former group. Future vehicle type-specific studies could be useful in elaborating how vehicle and job type affect distracted driving.

In our complementarity evaluation study design, the interview data were analyzed after the survey data for the purpose of elaborating on the results of the surveys. This study is part of a larger mixed-methods project on distracted driving in the occupational setting, and as such, the qualitative data collection preceded that of the quantitative data. We were therefore limited in exploring unexpected findings that emerged from the survey results, such as the relationship between weekly driving exposure and distraction-related hard braking This also limited our exploration of the Communications and Procedures factor. While the selected interview population was able to describe the general impacts of organizational policies, we were unable to hear directly from drivers as to how specific features of distracted driving policies affected their behavior.

CONCLUSION

In a population of unionized drivers in the U.S., a general measure of safety climate was associated with self-reported motor vehicle crash and distraction-related near crash while driving on the job. While we were able to identify safety climate factors from a validated questionnaire on driver safety, these sub-factors of safety climate were not independently associated with distraction-related outcomes. Interviews with safety experts described the role that management plays in creating a safe driving environment free from distractions: supervisors should use non-distracting procedures for communicating with drivers; drivers' schedules should allow for safe communication when production pressures increase; and explicit safety policies should be established and not overridden by implicit expectations to communicate with supervisors regardless of the safety of the driving situation. This research should lead to further investigations of how organizational characteristics can affect distracted driving among professional truck drivers.

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Additional supporting information may be found in the online version of this article at the publisher's web-site.

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