Published in final edited form as:
J Agromedicine. 2019 April ; 24(2): 177–185. doi:10.1080/1059924X.2019.1567422.

Single Vehicle Logging-Related Traffic Crashes in Louisiana from 2010–2015

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Abstract

Objectives: According to the Centers for Disease Control and Prevention (CDC), highway transportation crashes are the number one cause of fatal occupational injuries in the United States. The rate of fatal crashes in logging far exceeds the average annual rate for all sectors combined, yet few studies examine logging-related transportation crashes, and little is known about factors influencing the frequency of these crashes. The purpose of this study was to identify factors associated with fatal and nonfatal injuries among drivers involved in a single vehicle logging-related crash in Louisiana.

Methods: All crashes involving a single logging vehicle from 2010 to 2015 were extracted from a dataset provided by the Louisiana Department of Transportation and Development. Descriptive statistics were computed to characterize crashes by person, vehicle, and environmental factors. A multiple logistic regression model was constructed to identify variables associated with driver injury (fatal and non-fatal).

Results: There were 361 crashes involving a single logging vehicle from 2010 to 2015 in Louisiana. Variables associated with driver injury included no seat belt use (OR = 3.23; 95% CI = 1.47–7.10), a violation issued for careless operation of the vehicle (OR = 3.23; 95% CI = 1.40–7.46), a harmful event classified as cargo or equipment loss or shift (OR = 2.47; 95% CI = 1.27–4.82), and a harmful event classified as the vehicle running off the road to the left (OR = 2.29; 95% CI = 1.12–4.70).

Conclusion: Injury prevention efforts in the logging industry in Louisiana, including commercial vehicle licensing procedures, could benefit from additional driver training to improve crash avoidance skills and careless driving, seat belt use, and methods for securing loads.

Keywords

Logging; motor vehicle crashes; occupational health

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Disclosure statement
No potential conflict of interest was reported by the authors.

Introduction

As a group and on a daily basis, logging workers confront a number of occupational hazards, including strenuous activities, heavy logging equipment and large vehicles, and adverse or harsh weather conditions.[1] In 2016, logging workers had the highest fatal injury rate compared to the U.S. workforce. The rate for logging workers was 135.9 per 100,000 full-time equivalent (FTE) workers compared to 3.6 per 100,000 FTEs for the workforce overall.[2] An overwhelming proportion (40%) of fatal occupational injuries in the U.S. were transportation related in 2016. In this same year, over half of fatal occupational injuries among logging equipment operators were transportation related.[2]

Logging plays a particularly important role in the economy of Louisiana given that it is the second largest manufacturing industry in the state.[3] Forestlands cover almost half of the state, which amounts to 13.8 million acres.[3] About one-third of this land is owned by forest product companies.[3] Although this industry provides numerous employment opportunities in Louisiana, a number of its workers are also injured each year.[2,4] In 2016, the Agriculture, Forestry, Fishing, and Hunting sector, which includes logging, experienced a fatal work-related injury rate of 55.3 per 100,000 full-time workers in the sector compared to 5.0 per 100,000 FTEs overall in Louisiana.[4] Transportation-related crashes and resulting injuries and fatalities make a large contribution to this high rate. In 2016 in Louisiana, nearly 60% of fatalities in this sector resulted from transportation-related incidents.[5]

Logging trucks are the primary method for transporting logs to processing facilities. Logging trucks are large vehicles that are classified as heavy trucks (gross vehicle weight greater than 10,000 lbs). Logging trucks present a unique challenge to transportation safety because of their large size, weight, and cargo. These vehicles can limit roadway visibility for other roadway users. They can be more difficult to control including the ability to come to a sudden stop or complete an evasive action. Finally, their cargo load, usually consisting of heavy logs, can be difficult to secure properly.

The majority of research with respect to logging safety is on incidents among logging operators on the worksite. Only a handful of studies specifically target logging–related crashes. The body of literature that pertains to logging-related crashes includes descriptive statistics based on workers' compensation data or surveillance data (e.g., National Traumatic Occupational Fatality Surveillance System), as well as qualitative assessments that pinpoint the role that transportation plays in logging safety.[6–11] In terms of individual states, the greatest amount of information is available for Georgia. The research studies in Georgia are largely based on crash records. The studies include in-depth analyses designed to examine the impact of rules requiring vehicle inspections of logging trucks on crashes involving logging trucks with a mechanical failure.[12–14] Additional research in Georgia involved analyses of crash records to estimate the magnitude of crashes over time in terms of numbers, proportions, and rates, along with comparing the causes of crashes involving logging vehicles (logging tractor-trailers and logging trucks combined) with other heavy trucks.[12,14] One recent national descriptive study is available based on 2011–2015 data from the Fatality Analysis Reporting System (FARS), a census of fatal crashes in the United

States.[15] This study illustrated that rollovers and older vehicle age were more common among logging trucks compared to other trucks involved in fatal crashes.[15]

As illustrated above, very little research exists on logging-related crashes in the United States overall and in individual states with high logging activity. The most recent study for Louisiana was published in 2003.[16] In addition, few studies have sought to identify variables associated with fatal and nonfatal injury among logging truck drivers. The purpose of this study was twofold: to describe single vehicle (SV) logging-related crashes in Louisiana from 2010–2015 and to identify variables associated with nonfatal and fatal injuries among logging truck drivers involved in these crashes. This study focused on SV crashes since prior research indicates that SV and multi-vehicle truck crashes can differ with respect to potential risk factors at the driver, vehicle, and environmental levels especially within the context of injury severity.[17] An emphasis was placed on identifying factors related to the driver or logging truck that could be targeted by traditional traffic safety countermeasures or other preventive measures.

Methods

Data source

Louisiana crash data from 2010 to 2015 was obtained from the Louisiana Department of Transportation and Development (LaDOTD). Louisiana collects information on all crashes that result in a fatality, injury, or property damage greater than $500.[18] Crash data include information on the crash, vehicle, and people involved (e.g., drivers, occupants, pedestrians, pedal-cyclists). Crash data are reported by the investigating police officer.

Variables

Logging-related crashes were identified based on the cargo body type variable. A code of “H” for the cargo body type variable in Louisiana is used for logging vehicles, which the state defines as “a vehicle designed to transport forestry products in their natural state”.[18] Logging vehicles are classified as such even if they are not carrying forestry products at the time of the crash. All of the logging vehicles were further classified as a single unit truck with three or more axles, a truck/tractor/trailer, or tractor semi-trailer. Crashes involving only a logging vehicle and no other vehicles were selected for the present analysis. Driver injury severity was defined based on the KABCO Injury Classification Scale, commonly used in crash records. The officer on scene classifies the injury severity for each person involved in the crash as: fatal (K), incapacitating/severe injury (A), non-incapacitating/moderate injury (B), possible injury/complaint (C), and no injury (O) at the crash level. For the present analysis, drivers were coded as injured if their assigned injury severity was K, A, or B. They were coded as not-injured if their injury severity was a C or O. The rationale for this dichotomization is that police officers are relatively reliable in their identification of a fatality or when no injury occurs.[19] However, police officers are not as good at rating gradations of non-fatal injury severity when compared to a clinician’s assessment.[19]

Independent variables included driver, vehicle and environmental characteristics. Driver variables included age, gender, race, impairment due to drugs or alcohol while driving (based on variables assessing the driver's suspected use of alcohol or drugs and the driver's condition), distraction, inattention, seat belt use, a violation of careless operation of the vehicle, and a violation of disregarding a traffic control. Vehicle and vehicle movement variables included headlight status, vehicle condition, vehicle age, three movements prior to crash (e.g., making a left turn, crossing the median or centerline into the opposite lane, and running off the road), and five harmful events including overturning, crossing the median or centerline, running off the road to the left (into the oncoming traffic lane if it is a two-way roadway), running off the road to the right, crossing the median centerline, and cargo or equipment loss of shift. Cargo or equipment loss or shift is when an unsecured or improperly secured load shifts or falls from the vehicle. Environmental and roadway variables included highway type, road type, relation to roadway, road alignment, intersection related, presence of traffic controls, kind of location, weather and lighting conditions and road surface condition.

Analysis

STATA 14 software (StataCorp LP, College Station, TX) was used for the analysis. Descriptive statistics were calculated for crash characteristics by injury status for SV logging-related crashes. Univariate analyses were performed to evaluate the distribution of each independent variable by driver injury status. A multiple logistic regression model was constructed to identify variables relating to the driver, truck, and environment that were associated with injury among drivers. Variables were selected using a forward selection procedure. Candidate variables were variables with a cell size ≥5 based on bivariate analysis with each independent variable and the outcome variable. Model selection criteria was based on choosing the model with the lowest Akaike Information Criterion (AIC) and Bayesian Information Criterion (BIC) values. All variables in the final model were statistically significant at the 0.05 level based on the Wald test and the likelihood-ratio test. First order interaction terms also were evaluated. Appropriate model diagnostics were also performed on the selected model, including evaluation of multicollinearity, evaluation of influential observations and outliers, and assessment of global model fit. Multicollinearity was examined using variance inflation factors (VIF). Influential observations and outliers were identified by plotting the following diagnostics: Pearson Residual, delta-beta, delta-G^2, and delta-chi-squared. Global model fit was evaluated with the Hosmer-Lemeshow Goodness-of-Fit test.

Results

There were 939 logging-related crashes identified as occurring on or near roadways in Louisiana from 2010 to 2015. Of the 939 logging-related crashes, 361 (38.4%) involved only a logging truck and no other vehicles. The annual frequency of single logging truck crashes was similar over time: 68 (18.8%) in 2010, 64 (17.7%) in 2011, 57 (15.8%) in 2012, 46 (12.7%) in 2013, 59 (16.3%) in 2014, and 67 (18.6%) in 2015. Of the 361 SV logging truck crashes from 2010 to 1015, 14.4% were classified as resulting in a fatal or nonfatal injury (K, A, or B) to the driver while the majority (85.6%) were classified as possible or no injury (C or O). Overall, 2.2% of driver injuries were fatal, 1.1% incapacitating, 11.1%

non-incapacitating, 36.6% possible, and 49.0% were non-injury. The distribution of driver injury severity over time did not vary markedly.

Tables 1–3 present the frequency of independent variables stratified by injury status along with the unadjusted odds ratio, 95% confidence intervals and *P*-values. With respect to driver characteristics (Table 1), the majority of crashes occurred among drivers aged 41 years and older (59.3%), males (98.1%), and Caucasians (66.5%). Approximately, 8% of drivers were identified as distracted. Impairment due to drugs or alcohol was higher among injured compared to uninjured drivers (3.9% versus 0.3%; OR = 12.3; 95% CI = 1.1–138.4), but the overall frequency was very low. Overall, driver distraction was low (8.3%), while driver inattention was prevalent at 57.6%, but the proportion did not vary substantially by injury status. Approximately, 11.9% of drivers were not wearing their seat belt at the time of the crash. The proportion differed by injury status, with a larger percentage of drivers injured in a crash identified as improperly or not wearing their seat belt compared to non-injury crashes, 23.1% and 10.0%, respectively. The unadjusted odds ratio was statistically significant (OR = 3.10; 95% CI = 1.45–6.59) for not wearing a seat belt compared to wearing a seat belt. A majority of drivers were cited with careless operation of their vehicle (67.6%) with the proportion higher among those sustaining an injury, 84.6% for injured drivers versus 64.7% for non-injured drivers (OR = 3.00; 95% CI = 1.36–6.60). Very few drivers were cited with other types of violations. Only 1.1% were cited with a violation of disregarding traffic control, as an example.

With respect to vehicle and vehicle movement characteristics (Table 2), 15.0% of trucks had a defect that contributed to the crash, including a tire, braking, steering, suspension, and/or other defect. About one-third (31.9%) had their headlights on when they crashed. Approximately, three-quarters of the trucks were 10 years or older. The three most common reported movements prior to a crash were ran off road (48.5%), crossed median or centerline into opposite lane (11.1%), and making a left turn (9.4%). The most common harmful event was overturn or rollover (77.8%), followed by run off road to the right (45.7%), cargo or equipment loss or shift (22.7%), crossed median or centerline (21.3%), and run off road to the left (18.6%). The two most harmful events that were more common among injured drivers, included cargo or equipment loss or shift (OR = 2.25; 95% CI = 1.20–4.22) and run off to the left (OR = 2.25; 95% CI = 1.16–4.36).

For environmental and roadway characteristics (Table 3), the majority of crashes occurred on two-way roadways without a physical separation (88.6%), state highways (70.1%), relation to roadway classified as other (e.g., off the roadway versus on the roadway) (54.0%), on a curve (52.6%), not at or related to an intersection (82.5%), in open country (48.5%), and with a traffic control present (e.g., stop sign, traffic light) (89.5%). The majority of crashes also occurred in daylight (85.6%), under clear weather conditions (77.0%), and with a dry road surface (93.1%). There were no large differences in the frequency of these characteristics among injured versus non-injured drivers.

From the forward selection procedure, four variables emerged as important with respect to injury among drivers in the multiple logistic regression model (Table 4). These variables included not wearing a seat belt (OR = 3.23; 95% CI = 1.47–7.10), a violation of careless operation of their vehicle (OR = 3.23; 95% CI = 1.40–7.46), cargo or equipment loss or shift (OR = 2.47; 95% CI = 1.27–4.82), and a harmful event of run off the road to left (OR = 2.29; 95% CI = 1.12–4.70, respectively). None of the first order interactions terms were statistically significant. The Hosmer Lemeshow Goodness-of-Fit test suggested the final model fit the data well. No single observations were identified as highly influential.

Discussion

Since nearly 40% of crashes involved only the logging truck and that single and multi-vehicle crashes may differ in terms of causal factors, the present analysis focused only on the single logging truck crashes in Louisiana from 2010 to 2015. During this time, these crashes resulted in over 50 fatal and nonfatal injuries among logging truck drivers. This is a great concern given the cost of these crashes for the drivers, as well as their family and employer. Zaloshnja and Miller[20] estimated the economic impact of medium and heavy truck crashes in terms of loss of life and productivity, medical costs, emergency services costs, property damage, and impact on the family of the injured person in terms of pain, suffering, and quality of life. Overall the average cost of a fatal crash involving a medium or large truck was $3,604,518, $195,258 per non-fatal crash, and $15,114 for a property damage only crash (in 2005 dollars).[20] Although these estimates are not specific to logging trucks or single motor vehicle crashes, they provide a reference point of the potential positive impact of preventing these crashes.[20]

Based on the results of the multiple logistic regression model, at least three driver behaviors, seat belt use, careless operation of the vehicle and ensuring secured cargo loads, could be addressed in order to reduce SV logging crashes altogether or at least minimize their severity. It is widely accepted that seat belt use is one of the most effective countermeasures for reducing injury severity in a crash.[21] Yet, seat belt use is not ubiquitous among motorists including professional drivers. A survey conducted by the National Institute for Occupational Safety and Health (NIOSH) illustrated that over 13% of 1,265 long-haul drivers that took part in a truck stop survey reported never or only sometimes wearing their seat belt while on-the-job.[22] This finding supports a lack of compliance with federal regulations which require seat belt use among large truck drivers,[23] as well as laws in Louisiana.[24] A similar proportion (11.9%) of drivers involved in the present study either were not wearing their seat belt at the time of the crash and injuries were much more common among these drivers.

The NIOSH survey found other factors associated with long-haul truck drivers not wearing their seat belts included other high risk behaviors, such as often driving 10+ miles per hour over the speed limit, as well as having at least one moving violation in the past year.[22] In addition, lack of seat belt use was also associated with living in a state without a primary seat belt law.[22] Louisiana is among the 34 states with a law in place wherein police officers can pull over and ticket occupants simply for not wearing a seat belt.[24] Louisiana and other states with primary laws may benefit from increased enforcement, but this requires additional resources and personnel and may not be feasible.

Finally, the NIOSH long-haul driver survey found working for an employer without a written safety program was also an issue with respect to a lack of seat belt use in the long-haul truck driver survey.[22] The extent to which logging employers create written safety programs for crash prevention or promote a culture of safe driving is not widely known in Louisiana. Resources are available to help employers develop written safety programs from federal and state agencies including NIOSH and the Occupational Safety and Health Administration (OSHA), but also through employer-led efforts through the Network of Employers for Traffic Safety (NETS) and other organizations.

The results of the present study highlight a need for promoting safe driving behaviors beyond seat belt use that could be targeted through training and re-training programs. For example, careless operation of logging trucks was an important contributor to driver injury. Further research could help elucidate the exact ways and reasons that drivers are not being as responsible as possible on the roadway. These behaviors could then be targeted in employee safety programs. Similarly, the role that cargo or equipment loss of shifting played in injury deserves further study to determine why and how loads are not being properly secured. This knowledge would also be an important component of driver training courses, as well as the development of engineering-based countermeasures that target the design of truck beds or devices used to secure loads.

Crashes involving running off the road to the left resulted in greater injury in this study while running off the road to the right did not. Logging trucks involved in SV crashes that run off the road can hit fixed objects, such as a barrier, guardrail, trees and utility poles, and fixed objects on the opposite side of the road, but this true for running off the road in both the left and right directions. However, the fear of entering into opposite direction traffic can lead to over-corrective evasive action. Spainhour et al.[25] found a positive association between overcorrection and running off the road to the left or straight. The drivers of these vehicles may be less able to control their vehicle and have greater difficulty in reducing their speed prior to the crash and/or more likely to strike a fixed object thereby sustaining more severe injuries.

Based on the descriptive data, and from an overall crash prevention perspective, it may be beneficial to address other issues given their high frequency among crashes regardless of severity. These issues need further study within the context of logging drivers in order to be able to address these issues appropriately. For example, over half of the crashes involved a curved roadway. Curves present unique challenges for drivers including speed variation and poor sight distance. Approximately, 15% of crashes involved a vehicle with defects including worn or smooth tires, tire failure, defective brakes, defective headlights, defective steering, defective suspension, and other defects. Nearly 60% of drivers were cited with inattention in the current analysis. Although it did not impact injury severity of the drivers, this could be an issue in overall crash frequency and should be examined further in studies on multi-vehicle crashes. All of these issues could be addressed during driver training regarding safe negotiation of curves, as well as how to ensure vehicle maintenance and limit driver distraction and inattention. These topics could also be the focus of further research to identify engineering countermeasures.

Vehicle age, a proxy for crash worthiness, was not a significant variable in the analysis. It was hypothesized that this variable would be an important contributor based on crash worthiness improvements in vehicles overall,[26] and evidence suggests that logging trucks are older than other heavy trucks in the fleet.[14,15,27] In addition, Greene and colleagues[14] found that in Georgia, loggers often bought used trucks, which would explain an older fleet. Although manufacturers have increased the availability of devices to improve cab crashworthiness for all large trucks, sales have not matched their availability.[28]

Studies based on crash records have inherent limitations that need to be considered when interpreting findings. Crashes not reported to police are excluded from the crash records database. It is hypothesized that this leads to an undercount of less severe crashes, particularly those that may result in property damage only. Another concern is that some variables included in crash reports are subject to an individual's perspective or training. Consequently, two police officers could code variables differently for the same crash as a function of their personality or training. An example situation is when a driver is impaired by drugs. A police officer who has completed Drug Recognition Expert (DRE) training may be more likely to code the driver as impaired by drugs. The potential for misclassification needs to be considered when interpreting statistical results. With respect to injury severity, police officers can only rate injury severity by what they observe on scene. Consequently, severe internal injuries (e.g., traumatic brain injuries) that are not readily visible may be coded as a less severe or non-injury. The only exception are fatal injuries, which are usually updated up to 30 days post-crash. Consequently, there is the potential for misclassification of injury severity within the KABCO categories other than K (fatal). To limit misclassification, traffic safety studies often collapse nonfatal injury categories as done in the current study. Certain factors such as distracted driving may be particularly difficult for police officers to observe and drivers may be unlikely to admit they were engaging in risky behaviors. The sample size for the present analysis was relatively small. There may be additional important variables related to injury, but statistical power was not sufficient to detect them.

Conclusion

SV logging vehicle crashes comprised nearly 40% of crashes involving logging vehicles in Louisiana from 2010–2015. These events were likely to be costly to the driver, their family, and their employer. Given that logging is a prominent part of Louisiana's economy, it is unlikely that logging production and related crashes will wane in the future without increased implementation of countermeasures, more effective driver training or retraining, and other preventive actions. Results of the present study indicate that injuries among logging truck drivers involved in SV crashes could be addressed by focusing traffic safety efforts on improving seatbelt use, improving how well cargo and equipment are secured, preparing drivers to use defensive actions to avoid running off the road, and helping drivers to avoid careless operation of their vehicle. Further research to understand the root causes of these behaviors would be particularly beneficial towards reducing severe crashes among logging truck drivers in Louisiana. In terms of overall crash prevention, it also may be fruitful to support future research designed to examine the impact of efforts that address safe maneuvers on curves, reducing driver inattention or distraction, and improving vehicle maintenance. Given that crash records are a complete census, these data could be a key component of an occupational injury surveillance system that is tailored to logging workers and could be used to monitor the impact of crash and injury prevention efforts.

Acknowledgments

The authors would like to thank the Louisiana Department of Transportation and Development for assistance with providing the data used in this analysis, as well as assisting with data clarification questions.

Funding

This review was supported by CDC/NIOSH under Cooperative Agreement No. [U50 OH07541] to the Southwest Center for Agricultural Health, Injury Prevention, and Education at the University of Texas Health Science Center at Tyler. Additional support was provided by the National Institute of Neurological Disorders and Stroke (NINDS) under Grant No. [K01 NS099343]. Its contents are solely the responsibility of the authors and do not necessarily represent the official views of CDC/NIOSH or NIH/NINDS.

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Table 1.

Unadjusted associations between person variables and injury status among drivers involved in single logging truck crashes in Louisiana (2010–2015).

Variable (*n* = 361)	Categories	Injury (*n*)	Injury (%)	No injury (*n*)	No injury (%)	Unadjusted odds ratio	95% Confidence interval	*P*-value
Driver age (years)	16–30	6	11.5	47	15.2	1.00	Ref	
	31–40	10	19.2	84	27.2	0.93	0.32–2.72	0.899
	41–50	17	32.7	93	30.1	1.43	0.53–3.87	0.479
	51+	19	36.5	85	27.5	1.75	0.65–4.69	0.265
Driver gender[a]	Female	1	1.9	6	1.9	1.00	Ref	
	Male	51	98.1	303	98.1	1.01	0.12–8.56	0.993
Driver race	Black and Other	18	34.6	103	33.3	1.00	Ref	
	Caucasian	34	65.4	206	66.7	0.94	0.51–1.75	0.856
Driver impairment[a]	No	50	96.2	308	99.7	1.00	Ref	
	Yes	2	3.9	1	0.3	12.32	1.10–138.41	0.042
Driver distraction[a]	No	49	94.2	282	91.3	1.00	Ref	
	Yes	3	5.8	27	8.7	0.64	0.19–2.20	0.476
Driver inattention	No	24	46.2	129	41.8	1.00	Ref	
	Yes	28	53.9	180	58.3	0.84	0.46–1.51	0.552
Driver seat belt use	Used	34	65.4	272	88.0	1.00	Ref	
	None	12	23.1	31	10.0	3.10	1.45–6.59	0.003
	Unknown	6	11.5	6	1.9	8.00	2.44–26.20	0.001
Violation – Careless operation	No	8	15.4	109	35.3	1.00	Ref	
	Yes	44	84.6	200	64.7	3.00	1.36–6.60	0.006
Violation – Disregard traffic control[a]	No	50	96.2	307	99.4	1.00	Ref	
	Yes	2	3.9	2	0.7	6.14	0.85–44.59	0.073

[a]Insufficient sample size to compute additional statistics.

Table 2.

Unadjusted associations between vehicle and vehicle movement variables and injury status among drivers involved in single logging truck crashes in Louisiana (2010–2015).

Variable (*n* = 361)	Categories	Injury (*n*)	Injury (%)	No injury (*n*)	No injury (%)	Unadjusted odds ratio	95% Confidence interval	*P*-value
Vehicle headlight status	Headlights	11	21.2	104	33.7	1.00	Ref	
	On							
	Other	41	78.9	205	66.3	1.89	0.93–3.83	0.077
Vehicle condition[a]	No Defect	45	86.5	253	81.9	1.00	Ref	
	Defective	3	5.8	51	16.5	0.33	0.10–1.11	0.072
	Unknown	4	7.7	5	1.6	4.50	1.16–17.39	0.029
Vehicle age (years)	<10	18	34.6	85	27.5	1.00		
	10–15	17	32.7	77	24.9	1.04	0.50–2.17	0.911
	16–18	10	19.2	64	20.7	0.74	0.32–1.71	0.477
	19–49	7	13.5	83	26.9	0.40	0.16–1.00	0.051
Prior movement – Run off road	No	22	42.3	164	53.1	1.00	Ref	
	Yes	30	57.7	145	46.9	1.54	0.85–2.79	0.153
Prior movement – Making left turn	No	47	90.3	280	90.6	1.00	Ref	
	Yes	5	9.6	29	9.4	1.03	0.38–2.79	0.958
Prior movement – Crossed median or central line into opposite lane	No	44	84.6	277	89.6	1.00	Ref	
	Yes	8	15.4	32	10.4	1.57	0.68–3.64	0.289
Harmful event –Overturn/Rollover	No	10	19.2	70	22.7	1.00	Ref	
	Yes	42	80.8	239	77.4	1.23	0.59–2.58	0.583
Harmful event –Cargo/equipment loss or shift	No	33	63.5	246	79.6	1.00	Ref	
	Yes	19	36.5	63	20.4	2.25	1.20–4.22	0.012
Harmful event – Crossed median/centerline	No	42	80.8	242	78.3	1.00	Ref	
	Yes	10	19.2	67	21.7	0.86	0.41–1.80	0.690
Harmful event – Ran off road right	No	27	51.9	169	54.7	1.00	Ref	
	Yes	25	48.1	140	45.3	1.12	0.62–2.01	0.711
Harmful event – Ran off road left	No	36	69.2	258	83.5	1.00	Ref	
	Yes	16	30.8	51	16.5	2.25	1.16–4.36	0.016

[a]Insufficient sample size to compute additional statistics.

Table 3.

Unadjusted associations between environmental and roadway variables and injury status among drivers involved in single logging truck crashes in Louisiana (2010–2015).

Variable (n = 361)	Categories	Injury (n)	Injury %	No injury (n)	No injury (%)	Unadjusted odds ratio	95% Confidence interval	P-value
Highway type	Interstate & US Hwy	11	21.2	57	18.5	1.00	Ref	
	State Hwy	32	61.5	221	71.5	0.75	0.36–1.58	0.449
	Parish Road	9	17.3	31	10.0	1.50	0.56–4.02	0.416
Road type[a]	One way	1	1.9	7	2.3			
	Two-way, no physical barrier	47	90.4	273	88.4			
	Two-way, physical barrier	4	7.7	28	9.1			
	Other	0	0.0	1	0.3			
Relation to roadway	On Roadway	20	38.5	146	47.3	1.00	Ref	
	Other	32	61.5	163	52.8	1.43	0.79–2.62	0.241
Road alignment	Straight Level	19	36.5	152	49.2	1.00	Ref	
	Curved Level	33	63.5	157	50.8	1.68	0.92–3.09	0.093
Intersection related	No	47	90.4	251	81.2		Ref	
	Yes	5	9.6	58	18.8	0.46	0.18–1.21	0.115
Traffic control	No control	9	17.3	29	9.4	1.00	Ref	
	Control present	43	82.7	280	90.6	0.50	0.22–1.12	0.090
Kind of location[a]	Manufacturing, industrial or business area	4	7.7	22	7.7	1.00	Ref	
	Residential related area	23	44.2	137	44.2	0.92	0.29–2.93	0.892
	Open country	25	48.1	150	48.1	0.92	0.29–2.89	0.882
Daylight[a]	No	2	3.9	50	16.2	0.21	0.05–0.88	0.033
	Yes	50	96.2	259	83.8	1.00	Ref	
Weather condition	Clear	45	86.5	233	75.4	1.00	Ref	
	Other	7	13.5	76	24.6	0.48	0.21–1.10	0.083
Road surface condition[a]	Dry	50	96.2	286	92.6	1.00	Ref	
	Other	2	3.9	23	7.4	0.50	0.11–2.18	0.354

[a]Insufficient sample size to compute additional statistics.

Table 4.

Association between crash characteristics and KAB injury crashes in single log truck crashes in Louisiana (2010–2015).

Crash characteristics (*n* = 361)	**Categories**	**KAB injury *n* (%)**	**No injury *n* (%)**	**Adjusted odds ratio**	**95% Confidence interval**	***P*-value**
Driver seat belt use	Used	34 (65.4)	272 (88.0)	1.00	Ref	
	None	12 (23.2)	31 (10.0)	3.23	1.47–7.10	0.004
	Unknown	6 (11.5)	6 (1.9)	8.73	2.43–31.39	0.001
Violation – Careless operation	No	8 (15.4)	109 (35.3)	1.00	Ref	
	Yes	44 (84.6)	200 (64.7)	3.23	1.40–7.46	0.006
Harmful event – Cargo/equipment loss or shift	No	33 (63.5)	246 (79.6)	1.00	Ref	
	Yes	19 (36.5)	63 (20.4)	2.47	1.27–4.82	0.008
Harmful event-Run off road to the left	No	36 (69.2)	258 (83.5)	1.00	Ref	
	Yes	16 (30.8)	51 (16.5)	2.29	1.12–4.70	0.023