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Research Article

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Fall Risk Factors for Commercial Truck Drivers

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Abstract

Background: Fall related injuries are common in the commercial trucking industry. Falls from three specific locations constitute 83% of reported falls: the back of truck/trailer, cargo handling and truck cab. Nearly one quarter of all injuries in truck drivers resulting in days away from work occur from mounting and dismounting a vehicle.

Purpose: This study aims to identify risk factors associated with falls and near falls among a population of commercial truck drivers.

Methods: Data from a large cross sectional study of 797 commercial truck drivers were analyzed. Questions about health and behavior were correlated with self-reported data regarding falls from mounting and dismounting activities. Self-reported factors believed to have contributed to a fall are also analyzed.

Results: Falls were reported by many truck drivers in this large, cross sectional study. Two thirds of drivers experiencing falls in the 12-month period prior to enrollment indicated that an environmental factor, e.g., ice, snow, mud influenced their fall and the majority of the falls occurred around the cab. The average BMI in this study population was 33.2 kg/m^2 (SD=5.5), thus most drivers were obese. Self-reported health status and BMI were associated with higher odds of lifetime reported falls during both mounting and dismounting the cab. Other factors that were associated with falls included feeling mentally and physically exhausted.

Conclusions: This study's findings suggest that truck, environmental conditions and personal factors are all significantly associated with reported falls during mounting and dismounting.

Keywords: Truck driver falls; Fall risk factors; BMI; Cross-sectional survey

Introduction

Heavy and tractor-trailer truck drivers, also referred to as commercial truck drivers including short and long haul, constitute 1.6 million US workers [1]. Truck drivers experience falls while mounting and dismounting vehicle cabs that may result in serious injuries. According to the US Bureau of Labor Statistic (BLS), truck drivers experienced 41,840 injuries and illnesses in 2013 that resulted in lost workdays [1]. The median lost workdays among truck drivers was 19 days, which was highest among all reported occupations [1]. More than a third of the cases (40%) resulted in a median of 29 days away from work, implying high severity [1]. Slips, trips, and falls among truck drivers was the second leading event or exposure accounting for 30% of the cases, only preceded by overexertion and bodily reaction at 36% [1].

Falls while mounting and dismounting trucks account for nearly 25% of all injuries in commercial trucking [2]. A three year study of commercial truck drivers from one large US fleet reported direct costs due to slips and falls on and around trucks annually exceeded $20M (US) [3]. Reed [3] also noted that 50% of those falls occurred while dismounting the vehicle.

In several related industries, data suggest that mounting/dismounting large vehicles may be hazardous. Among firefighters, 16% of all compensable injuries are related to emergency vehicles, of which 37% involved stepping down from the vehicle [4]. In the agricultural sector, a large proportion of injuries are also associated with mounting and dismounting tractors [1,5].

Spielholz et al. conducted a self-reported survey of perceived injury risks among trucking companies in Washington state and found that worker behavior frequently contributes to musculoskeletal and slip/trip/fall injuries [6]. Nearly a quarter of drivers identified slippery conditions as an environmental factor. In another study, one-half of the participants reported that they could not see where they placed their feet during dismounting; other problems included steps that were contaminated by ice/snow, water or mud [7]. These findings suggest the need for systematic interventions to control the risks of work-related slip, trip, or fall injuries in the trucking industry [6].

Helmkamp et al. conducted a Survey of Occupational Injuries and Illnesses (SOII) that utilized data from two independent sources – the National Health Interview Survey (NHIS) and the Bureau of Labor Statistics (BLS). They reported that in the trucking, warehouse, and utilities (TWU) sector, overexertion (28%), contact with objects (21%) and falls (21%) are the most common events contributing to higher injury rates.

Important factors influencing trips and falls include driver fatigue, environmental factors, step and handhold configurations, technique, coordination, and physique [3]. Understanding the relationship between commercial truck operators' health and physical behavior during mounting/dismounting is an important step in mitigating injuries from fatal and non-fatal falls among truck drivers. In a recent study conducted by Turner and Reed [8] , a high prevalence of obesity was found in a sample of 300 commercial truck drivers, with 93.3% of

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study participants having a body mass index (BMI) of 25 or higher. Results from Patenaude et al. [7] show that truck driver's weight influences the ground impact force during the descent from the cab, which may be problematic due to an imbalance between lower limb strength and driver's weight.

This cross sectional study of commercial truck drivers was designed to measure health status indicators, chronic illness risk factors, fall risk factors, self-reported falls and crash data. The goal of this article was to identify potential factors associated with mounting and dismounting cabs that are associated with falls. Data from the questionnaire also include possible interactions between these factors to better understand truck driver safety and other health factors associated with falls.

Methods

Study recruitment strategy

Recruitment of truck drivers for this cross sectional study was conducted through a variety of methods including: industry newsletters, meeting with trucking companies, flyers at trucking shows, and direct contacts with potential participants at truck stops and trucking shows. The latter two methods yielded the most enrollees. The majority of drivers were enrolled at truck shows at six nationwide locations (IL, IA, KY, TX, NV, and UT). Drivers were also recruited at three truck stops in Utah and Wisconsin. A few additional recruits were enrolled distance-based (on-line). The inclusion criteria were that subjects had a current United States Commercial Driver's License (CDL), at least 1 year of driving experience, and the ability to read English.

Data collection

The study was approved by the University of Utah and University of Wisconsin at Milwaukee Institutional Review Boards (IRB# 22252 and #07.02.297 respectively). After obtaining informed consent, drivers completed a computerized laptop-administered questionnaire (Filemaker® Pro version 9, Santa Clara, California, USA). The enrollment process included measured Height, Weight, Neck/Waist/Hip circumferences, blood pressure and pulse. Laboratory measures included total cholesterol, low density lipoprotein, high density lipoprotein, triglycerides, non-fasting glucose, and hemoglobin A1C.

The computerized questionnaire was comprised of 864 items covering many domains. These domains included: (a) fall history with corresponding self-reported factors and conditions, (b) demographics (e.g., age, gender, and history of maximum body weight), (c) frequencies and durations of hobbies and outside of work activities, (d) medical history including diseases (e.g., diabetes mellitus, high blood pressure, high cholesterol, and musculoskeletal disorders) (e) psychosocial questions (e.g., depression, job satisfaction, family problems, supervisory and coworker support), (f) occupational specific questions (e.g. miles driven, history of crashes, near-miss events in the past year, manual loading/unloading, securing loads, etc.), and (g) other questions (e.g., sleeping patterns, smoking, alcohol consumption). Computerization was used to improve quality control, including assuring data capture and eliminating out of range answers.

Data on falls were self-reported by drivers and included: (1) lifetime number of falls when (a) mounting a truck or (b) dismounting a truck, (2) falls within the past 12 months when (a) mounting a truck or (b) dismounting a truck, (3) specific factors that drivers felt contributed to causing the fall their most recent fall, (4) lost time due to a fall, and (5) seeing a health care provider because of a fall. Variables analyzed in this article (Table 3) were specifically asked regarding their fall, these variables include environmental factors involved and season, location, and time of fall reflecting the driver's self-attribution to the fall incident. While other variables, including ratings of physical or mental exhaustion, manual material handling, job physically demand, low back pain reporting, and health status reporting are global questions, not specifically related to a fall incidence.

The environmental factor is a dichotomous variable, that includes ice, snow, rain, mud, and/or heat (weather), indicated by the driver to have contributed to a fall within the last 12 months. Footwear is a categorical variable with four levels (athletic, cowboy, work boots, or other). The location of a fall is a self-reported categorical variable that includes cab, trailer, box, away, and other categories. Season of the year is a categorical variable that includes four levels (fall, spring, summer, and winter). Manual loading is a dichotomous variable reported by the truck drivers to have usually manually loaded or unloaded a truck. Additionally, time of fall is a categorical variable (morning, afternoon, evening, and night). BMI is a categorical variable categorized into five levels based on the following criteria: underweight (BMI<18.5), normal weight (18.5 ≤ BMI<25), overweight (25 ≤ BMI<30), obese (30 ≤ BMI<35), and morbidly obese (35 ≤ BMI). The Heath status was a four level self-scoring system from the drivers' health rating as excellent, good, fair, or poor. Finally, feeling mental exhaustion and feeling physical exhaustion ratings include four levels (never, seldom, often, and always).

Statistical methods

Hypotheses: (1) Truck driver health and wellness as measured through self-reported questionnaires are significantly correlated with reported falls during mounting and dismounting.

(2) Truck, environmental, and driver personal factors, such as location around the truck, frequency and time of cab access, footwear, and environmental factors such as ice, rain, and mud are significantly correlated with reported falls during mounting and dismounting.

Statistical analyses were performed using SPSS 19.0 (SPSS; IL, USA; www.spss.com). The self-reported 12-month and lifetime fall counts (outcome variables) were dichotomized to represent driver self-reports of having ever fallen or not. Univariate logistic regression was used to explore possible predictors of falls. Statistical significance was determined *a priori* at α=0.05. Finally, potential factors (Tables 2 and 3) were chosen *a priori* out of the items included in the questionnaire based on previously published data relating these variables to potential relationship(s) with balance, strength, slips, and/or falls.

Results

A total of 797 participants (14.1% female, 85.9% male) were included in these analyses. The mean age was 47.2 years (range 21–75) and the mean (standard deviation) height and weight were 177.4 (9.0) cm and 103.5 (24.2) kg respectively. Table 1 provides details of the population's demographics, including means and standard deviations of the count of self-reported 12-month and count of lifetime falls.

Table 2 summarizes results from the logistic regression analysis of potential truck drivers' personal factors related to falls. Table 2 includes the total number of driver self-reported ever falling, organized by either mounting or dismounting falls within 12-month or lifetime durations, along with respective odds ratio. Results indicate that, compared to male truck drivers. Compared to males, females have protective odds of falling while mounting the cab for both 12-month (OR, 0.43, 95% CI 0.22 to 0.84) and lifetime reports (OR, 0.46, 95% CI 0.3 to 0.71).

Description		All Drivers	12-month Falls		Lifetime Falls	
			Dismount	Mount	Dismount	Mount
		N (% of total)	N (% of total)	N (% of total)	N (% of total)	N (% of total)
Gender	Male	685 (85.9)	156 (22.8)	129 (18.8)	382 (55.8)	317 (46.3)
	Female	112 (14.1)	18 (16.1)	10 (8.9)	57 (50.9)	32 (28.6)
Age Range (yrs)	20-29	26 (3.3)	8 (30.8)	5 (19.2)	12 (46.2)	8 (30.8)
	30-39	95 (11.9)	25 (26.3)	21 (22.1)	54 (56.8)	45 (47.4)
	40-49	219 (27.5)	41 (18.7)	38 (17.4)	114 (52.1)	91 (41.6)
	50-59	294 (36.9)	70 (23.8)	55 (18.7)	163 (55.4)	132 (44.9)
	60-69	142 (17.8)	27 (19)	18 (12.7)	85 (59.9)	67 (47.2)
	70-79	21 (2.6)	3 (14.3)	2 (9.5)	11 (52.4)	6 (28.6)
Hand Dominance	Left-handed	96 (12)	25 (26)	19 (19.8)	53 (55.2)	39 (40.6)
	Right-handed	669 (83.9)	139 (20.8)	110 (16.4)	366 (54.7)	292 (43.6)
	Use both hands equally	32 (4)	10 (31.3)	10 (31.3)	20 (62.5)	18 (56.3)
Race	White	685 (85.9)	155 (22.6)	120 (17.5)	388 (56.6)	303 (44.2)
	Hispanic	48 (6)	12 (25)	12 (25)	21 (43.8)	19 (39.6)
	Black	37 (4.6)	4 (10.8)	3 (8.1)	19 (51.4)	15 (40.5)
	Other	24 (3)	3 (12.5)	4 (16.7)	9 (37.5)	10 (41.7)
	Decline	3 (0.4)	0 (0)	0 (0)	2 (66.7)	2 (66.7)
Haul Type	Short	227 (28.5)	53 (23.3)	41 (18.1)	131 (57.7)	111 (48.9)
	Long	531 (66.6)	112 (21.1)	90 (16.9)	286 (53.9)	224 (42.2)
	Both	26 (3.3)	9 (34.6)	7 (26.9)	17 (65.4)	12 (46.2)
	Other	13 (1.6)	0 (0)	1 (7.7)	5 (38.5)	2 (15.4)
Shift Work	Day Shift	288 (36.1)	63 (21.9)	53 (18.4)	155 (53.8)	125 (43.4)
	Night Shift	62 (7.8)	14 (22.6)	10 (16.1)	36 (58.1)	25 (40.3)
	Swing Shift	249 (31.2)	47 (18.9)	37 (14.9)	131 (52.6)	107 (43)
	Variable Shift	198 (24.8)	50 (25.3)	39 (19.7)	117 (59.1)	92 (46.5)
Career Mileage	1/4 Million Miles	94 (11.8)	24 (25.5)	14 (14.9)	37 (39.4)	25 (26.6)
	1/2 Million Miles	65 (8.2)	10 (15.4)	9 (13.8)	30 (46.2)	22 (33.8)
	3/4 Million Miles	63 (7.9)	13 (20.6)	12 (19)	36 (57.1)	27 (42.9)
	1 Million Miles	141 (17.7)	34 (24.1)	26 (18.4)	83 (58.9)	59 (41.8)
	2 Million Miles	125 (15.7)	22 (17.6)	18 (14.4)	67 (53.6)	58 (46.4)
	3 Million Miles	112 (14.1)	36 (32.1)	26 (23.2)	77 (68.8)	63 (56.3)
	4 Million Miles	54 (6.8)	9 (16.7)	11 (20.4)	37 (68.5)	31 (57.4)
	5 Million Miles or more	45 (5.6)	8 (17.8)	7 (15.6)	24 (53.3)	25 (55.6)
	Unknown	98 (12.3)	18 (18.4)	16 (16.3)	48 (49)	39 (39.8)

Table 1: Demographic Characteristics.

Although not statistically significant, similar results are seen with dismounting falls. While, analyses conducted on truck driver BMI associations with falls were not statistically significant, results in Table 2 shows that being overweight, obese, or morbidly obese have higher odds of lifetime falls when compared to the normal weighted truck driver category. Interestingly, in comparing drivers' fall reports for different truck driver reported health status, a consistent (statistically non-significant) trend was found indicating that improving the health status decreases the likelihood of falls both mounting and discounting a truck cab. Finally, experiencing low back pain was significantly associated with falls for 12-month fall reports during dismounting a truck cab ($p<0.05$) with odds ratio of 1.62, and lifetime fall reports ($p<0.05$) with odds ratio of 1.58 during dismounting a truck cab. Similarly, individuals experiencing LBP are at increased odds of falling while mounting a cab as well (Table 2).

A summary of results from the logistic regression analysis of truck driver's job related professional factors are presented in Table 3. This Table summarizes self-reported odds ratio of reported 12-month and lifetime reported falls. Table 3 describes select questions related to driver physical exertion on the job as well as factors that are suspected to contribute to a fall event based on non-parametric tests (Table 3). Professional job demands variables considered included reports of mental exhaustion, physical exhaustion, driving-related low back pain (LBP) (Table 3). These variables were considered because of potential relationship(s) with balance and strength.

The logistic regression results conducted between the haul type and reported falls were not statistically significant (Table 3). However, long haul truck drivers showed reduced odds of falls when compared to short haul. Additionally, drivers performing both haul (long and short) have higher odds of falls when compared to the short haul truck driver category (Table 3).

Reports of "always" feeling mentally exhausted was found to [significantly] increase the likelihood of falls for 12-months reported falls dismounting (OR, 2.52, , 95% CI 1.28 to 4.99) and mounting a truck cab (OR, 3.42, 95% CI 1.66 to 7.03), as well as lifetime reported falls dismounting (OR, 5.12, , 95% CI 2.46 to 10.66) and mounting a truck cab (OR, 7.25, $p<0.00$, 95% CI 3.46 to 15.18). Furthermore, a trend of increased odds of falls is seen between the different categories when compared to the "never" group (Table 3). Similarly, reports of "always"

Description		12-month Falls		Lifetime Falls	
		Dismount	Mount	Dismount	Mount
		OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)
Gender	Male	(Reference)	(Reference)	(Reference)	(Reference)
	Female	0.65 (0.38 to 1.11)	0.43 (0.22 to 0.84)*	0.81 (0.55 to 1.21)	0.46 (0.3 to 0.71)**
Age Range (yrs)	20-29	2.67 (0.61 to 11.7)	2.14 (0.37 to 12.41)	0.7 (0.22 to 2.26)	1.04 (0.29 to 3.69)
	30-39	2.14 (0.58 to 7.9)	2.55 (0.55 to 11.9)	1.08 (0.41 to 2.84)	2.1 (0.74 to 5.93)
	40-49	1.38 (0.39 to 4.91)	1.89 (0.42 to 8.49)	0.89 (0.35 to 2.23)	1.66 (0.61 to 4.48)
	50-59	1.87 (0.54 to 6.55)	2.07 (0.47 to 9.19)	1.03 (0.42 to 2.57)	1.91 (0.72 to 5.12)
	60-69	1.41 (0.39 to 5.13)	1.31 (0.28 to 6.11)	1.22 (0.48 to 3.13)	2.08 (0.76 to 5.73)
	70-79	(Reference)	(Reference)	(Reference)	(Reference)
Hand Dominance	Left-handed	1.34 (0.82 to 2.2)	1.25 (0.73 to 2.15)	1.04 (0.67 to 1.6)	0.9 (0.58 to 1.39)
	Right-handed	(Reference)	(Reference)	(Reference)	(Reference)
	Use both hands equally	1 (0.8 to 3.75)	1 (1.065)*	1 (0.66 to 2.85)	1 (0.81 to 3.38)
Race	White	(Reference)	(Reference)	(Reference)	(Reference)
	Hispanic	1.14 (0.58 to 2.24)	1.57 (0.79 to 3.1)	0.59 (0.33 to 1.06)	0.82 (0.45 to 1.49)
	Black	0.41 (0.14 to 1.19)	0.41 (0.13 to 1.37)	0.8 (0.41 to 1.55)	0.86 (0.44 to 1.68)
	Other	0.49 (0.14 to 1.66)	0.94 (0.32 to 2.8)	0.45 (0.2 to 1.05)	0.9 (0.39 to 2.04)
	Decline	0 (0 to 0)	0 (0 to 0)	1.52 (0.14 to 16.79)	2.51 (0.23 to 27.79)
BMI Category	Underweight	0.93 (0.1 to 8.84)	0 (0 to 0)	1.5 (0.24 to 9.46)	1 (0.16 to 6.32)
	Normal Weight	(Reference)	(Reference)	(Reference)	(Reference)
	Overweight	1 (0.59 to 2.04)	1 (0.52 to 1.93)	1 (0.66 to 1.85)	1 (0.69 to 1.97)
	Obese	1.1 (0.59 to 1.9)	1 (0.5 to 1.73)	1.11 (0.86 to 2.26)	1.17 (0.77 to 2.06)
	Morbidly Obese	1.06 (0.44 to 1.8)	0.93 (0.33 to 1.53)	1.39 (0.67 to 2.11)	1.26 (0.59 to 1.88)
Health Status	Excellent	0.43 (0.15 to 1.18)	0.37 (0.13 to 1.09)	0.51 (0.2 to 1.3)	0.49 (0.19 to 1.26)*
	Good	0.46 (0.2 to 1.07)	0.42 (0.17 to 1.01)	1.01 (0.45 to 2.27)	0.76 (0.34 to 1.71)*
	Fair	0.54 (0.23 to 1.29)	0.48 (0.2 to 1.17)	1.08 (0.47 to 2.47)	0.7 (0.31 to 1.6)*
	Poor	(Reference)	(Reference)	(Reference)	(Reference)
Low Back Pain	No	(Reference)	(Reference)	(Reference)	(Reference)
	Yes	1.62 (1.03 to 2.55)*	1.61 (0.99 to 2.62)	1.58 (1.03 to 2.41)*	1.38 (0.92 to 2.08)
Career Mileage	1/4 Million Miles	1.59 (0.65 to 3.88)	0.95 (0.35 to 2.55)	0.57 (0.28 to 1.16)	0.29 (0.14 to 0.61)**
	1/2 Million Miles	0.84 (0.3 to 2.33)	0.87 (0.3 to 2.54)	0.75 (0.35 to 1.61)	0.41 (0.19 to 0.89)*
	3/4 Million Miles	1.2 (0.45 to 3.2)	1.28 (0.46 to 3.55)	1.17 (0.54 to 2.52)	0.6 (0.28 to 1.3)
	1 Million Miles	1.47 (0.62 to 3.46)	1.24(0.5 to 3.08)	1.27 (0.65 to 2.5)	0.58 (0.29 to 1.13)
	2 Million Miles	0.99 (0.4 to 2.41)	0.91 (0.35 to 2.36)	1.03 (0.52 to 2.04)	0.7 (0.35 to 1.4)
	3 Million Miles	2.19 (0.93 to 5.18)	1.64 (0.66 to 4.11)	1.98 (0.97 to 4.04)	1.05 (0.52 to 2.11)
	4 Million Miles	0.93 (0.32 to 2.64)	1.39 (0.49 to 3.94)	1.9 (0.84 to 4.32)	1.08 (0.49 to 2.39)
	5 M. Miles or more	(Reference)	(Reference)	(Reference)	(Reference)
	Unknown	1 (0.41 to 2.61)	1 (0.4 to 2.79)	1 (0.41 to 1.7)	1 (0.26 to 1.08)

*Underweight category excluded from this table (N=2).
**Participants not attributing the fall factor (in bold) as a contributor to the reported fall.

Table 2: Logistic Regression of Potential Personal Factors Related to Falls.

physically exhausted was a significant predictor of self-reported falls for the lifetime period while mounting (OR, 3.97, 95% CI 2.03 to 7.79) and dismounting the cab (OR, 2.7, 95% CI 1.42 to 5.14) (Table 3). Table 3 shows a trend of increase in odds of reported lifetime falls from the "never" (reference) to the "always" category having an odds ratio of 2.7.

Table 3 presents results for the job physically hard variable showing an increased odds of reported falls within individual's rating of "seldom", "often", or "always" when compared to the "never" category. The truck drivers' category rating their job being "often" physically hard, was found to have the highest increase in the likelihood of falls for 12-months reported falls dismounting ($p<0.01$) and mounting a truck cab ($p<0.01$), as well as lifetime reported falls dismounting ($p<0.01$) and mounting a truck cab ($p<0.01$) with all odds ratios reported in Table 3.

Compared to the "never" category, truck drivers experiencing "always" driving-related LBP were 5.75 times more likely to report a fall within 12-month while dismounting (OR, 5.75, 95% CI 2.6 to 12.7) and 5.6 times more likely while mounting a truck cab (OR, 5.6, 95% CI 2.51 to 12.49) and were 5.47 times more likely to report a lifetime fall while dismounting (OR, 5.47 , 95% CI 2.03 to 14.71) and mounting a truck cab (OR, 4.74 , 95% CI 2.03 to 11.07). The results from the logistic regression for the driving-related LBP summarized in Table 3 also shows an increase (a trend) in odds of reporting a fall as individuals experience higher levels of driving-related LBP.

Many truck drivers perform MMH, manually loading or unloading their truck, as part of their job. Compared to the group not performing MMH, the group reporting MMH had a significantly higher odds

Description	12-month Fall Counts		Lifetime Fall Counts	
	Dismount	Mount	Dismount	Mount
	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)
Haul Type				
Short	(Reference)	(Reference)	(Reference)	(Reference)
Long	0.88(0.61 to 1.27)	0.93(0.62 to 1.39)	0.76(0.62 to 1.16)	0.93(0.55 to 1.03)
Both	1.74(0.73 to 4.13)	1.67(0.66 to 4.24)	0.89(0.59 to 3.2)	1.67(0.39 to 2)
Other	0(0 to 0)	0.38(0.05 to 2.99)	0.21(0.16 to 1.68)	0.38(0.04 to 0.97)*
Shift Work				
Day Shift	(Reference)	(Reference)	(Reference)	(Reference)
Night Shift	1.04(0.54 to 2.01)	0.85(0.41 to 1.79)	1.17(0.67 to 2.04)*	0.88(0.5 to 1.53)
Swing Shift	0.83(0.54 to 1.27)	0.77(0.49 to 1.22)	0.95(0.67 to 1.33)*	0.98(0.7 to 1.39)
Variable Shift	1.21(0.79 to 1.85)	1.09(0.69 to 1.73)	1.22(0.85 to 1.76)*	1.12(0.78 to 1.62)
Mental Exhaustion				
Always	2.52(1.28 to 4.99)**	3.42(1.66 to 7.03)**	5.12(2.46 to 10.66)**	7.25(3.46 to 15.18)**
Often	1.49(0.9 to 2.48)	1.82(1.03 to 3.19)*	1.78(1.17 to 2.7)**	1.72(1.12 to 2.63)*
Seldom	1.05(0.65 to 1.69)	1.07(0.62 to 1.84)	1.63(1.12 to 2.38)*	1.24(0.84 to 1.83)
Never	(Reference)	(Reference)	(Reference)	(Reference)
Physical Exhaustion				
Always	2.11(0.98 to 4.52)	1.19(0.55 to 2.56)	3.97(2.03 to 7.79)**	2.7(1.42 to 5.14)**
Often	2.21(1.224.03)**	1.11(0.62 to 1.99)	2.8(1.73 to 4.51)**	1.69(1.05 to 2.71)*
Seldom	1.46(0.842.53)	0.74(0.44 to 1.26)	1.92(1.27 to 2.91)**	1.22(0.8 to 1.85)
Never	(Reference)	(Reference)	(Reference)	(Reference)
Job Physically Hard				
Always	1.72(0.86 to 3.45)	2.28(1.06 to 4.89)*	1.55(0.87 to 2.76)	1.55(0.86 to 2.77)
Often	2.14(1.25 to 3.69)**	2.54(1.37 to 4.7)**	2.44(1.56 to 3.83)**	2.07(1.32 to 3.25)**
Seldom	1.32(0.81 to 2.15)	1.59(0.9 to 2.8)	1.73(1.19 to 2.51)**	1.5(1.02 to 2.2)*
Never	(Reference)	(Reference)	(Reference)	(Reference)
MMH				
No	(Reference)	(Reference)	(Reference)	(Reference)
Yes	1.43(0.98 to 2.09)	1.81(1.21 to 2.7)**	1.94(1.37 to 2.74)**	1.75(1.26 to 2.44)**
Driving-related LBP				
Always	5.75(2.6 to 12.7)**	5.6(2.51 to 12.49)**	5.47(2.03 to 14.71)**	4.74(2.03 to 11.07)**
Often	2.26(1.29 to 3.94)**	1.83(0.99 to 3.4)	2.33(1.39 to 3.91)**	2.53(1.53 to 4.17)**
Seldom	1.46(1 to 2.13)*	1.46(0.97 to 2.2)	1.86(1.37 to 2.52)**	1.79(1.32 to 2.44)**
Never	(Reference)	(Reference)	(Reference)	(Reference)
Footwear				
Work Boots	(Reference)	(Reference)	(Reference)	(Reference)
Athletic Shoes	1(0.47 to 1.08)	1(0.66 to 1.57)	1(0.25 to 0.98)*	1(0.5 to 1.23)
Cowboy Boots	0.71(0.18 to 1.23)	1.02(0.15 to 1.34)	0.5(0.15 to 2.05)	0.79(0.15 to 0.82)*
Other	0.48(0.55 to 4.15)	0.44(0.15 to 1.94)	0.56(0.14 to 9.14)	0.36(0.24 to 2.17)
Location of Fall				
Cab	1.49(0.9 to 2.47)	1.47(0.86 to 2.51)	0.61(0.25 to 1.49)	1.02(0.61 to 1.71)
Trailer	(Reference)	(Reference)	(Reference)	(Reference)
Other	1(0.32 to 6.53)	1(0.05 to 3.98)	1(0.05 to 4.82)	1(0.09 to 1.68)
Season of Fall				
Summer	(Reference)	(Reference)	(Reference)	(Reference)
Fall	1(0.64 to 2.61)	1(0.5 to 2.4)	1(0.21 to 1.6)	1(0.54 to 2.23)
Winter	1.29(0.63 to 1.72)	1.09(0.8 to 2.41)	0.58(0.43 to 2.18)	1.1(1.1 to 3.04)*
Spring	1.04(1.3 to 4.68)**	1.39(1.09 to 4.26)*	0.97(0.41 to 4.06)	1.83(0.86 to 3.42)
Environmental Factors				
No	(Reference)	(Reference)	(Reference)	(Reference)
Yes	7.94(5.14 to 12.26)**	7.81(4.78 to 12.73)**	43.13(28 to 66.42)**	16.58(11.6 to 23.68)**

*representing relationships that are significant to 0.05 level.
**representing relationships that are significant to 0.01 level.

Table 3: Logistic Regression of Potential Professional Factors Related to Falls.

of lifetime reported falls while dismounting (OR, 1.75, 95% CI 1.26 to 2.44) and higher odds that are significant while mounting the cab (OR, 1.94, 95% CI 1.37 to 2.74) as well as [significant] higher odds of reporting falls within the 12-month period while mounting the cab (OR, 1.81, 95% CI 1.21 to 2.7) and higher odds [not significant] while dismounting the cab (OR, 1.43, 95% CI 0.98 to 2.09).

The associations between footwear and reported falls were assessed and results are presented in Table 3. The associations (odds ratios)

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Falls from the Cab				
Haul Type	12 Month		Lifetime	
	Mounting	Dismounting	Mounting	Dismounting
Long Haul	1.1	1.1	5.1	6.0
Short Haul	0.9	1.0	8.7	9.8
Both	1.1	2.1	15.6	19.2
Other	1.0	0.0	30.0	12.5
Falls from the Trailer				
	12 Month		Lifetime	
	Mounting	Dismounting	Mounting	Dismounting
Long Haul	2.3	2.4	8.7	8.7
Short Haul	0.6	0.6	4.4	5.4
Both	0.0	0.0	1.0	2.5
Other	0.0	0.0	0.0	1.0

Table 4: Comparison of the mean counts falls by location.

between the footwear as reported by the participants show lower odds of reported falls (both 12-month and lifetime while mounting or dismounting) when reporting athletic or cowboy shoes when compared to work boots. Compared to work boots category (the reference category), the odds of reports of lifetime falls dismounting the cab were significantly lower for the athletic category (OR, 0.5, 95% CI 0.25 to 0.98) and also significantly lower for the cowboy boots category (OR, 0.36, 95% CI 0.15 to 0.82).

The majority of falls occurred around the cab (80.6%), while 19.4% occurred on the trailer, and the remaining 2.5% occurred elsewhere (catwalk, box, ground, etc.) Table 4. This is consistent between haul types, as illustrated in Figure 1. Results from the logistic regression do not show a significant relationship between the location of fall and 12-month reports of falls while mounting, (OR, 1.47, 95% CI 0.86 to 2.51), and dismounting, (OR, 1.49, 95% CI 0.9 to 2.47) as well as lifetime reports of falls mounting, (OR, 1.02, 95% CI 0.61 to 1.71), and dismounting the vehicle, (OR, 0.61, 95% CI 0.25 to 1.49).

Of the truck drivers who indicated a fall within the last year while dismounting the truck cab, two thirds (68.8%) indicated that an environmental factor influenced the fall. Similar results were found in fall reports during mounting the truck cab (64.4%). Results of those who indicated that the fall resulted from one or more environmental factors, (ice, snow, mud, rain, sun or heat) are displayed in Figure 2. Of those drivers reporting falls, 53.3% indicated the fall occurring during winter months.

The average number of falls in the past 12 months stratified by haulage type and location indicate that LH drivers experienced more falls from the Trailer (2.3) than the Cab (1.1), while SH reported more falls from the Cab (0.85 and 0.55 respectively). Haulage types listed as Both and Other reported only falls from the cab (1.1 and 1 respectively).

No relationship was found between falls (12-month and lifetime) and the following factors: shiftwork (day, night, or swing), job characteristic (driver, or owner), exercise (whether the drivers did exercise outside of work), vision (whether they wore glasses or not), hand dominance (right handed, left handed, or ambidextrous), age, or feeling rested in the morning.

Discussion

The demographic characteristics of the study sample (Table 2) are consistent with results from another national survey targeting illness and injury data within long haul truck drivers (n=1670), sampled from truck stops across 48 contiguous United States [9]. Falls were reported by many truck drivers in this large, cross sectional study (N=797), having affected 55.4% of drivers dismounting and 44.0% mounting. A better understanding of the interactions between commercial truck operators' health and physical behaviors during mounting/dismounting is an important step in the efforts to mitigate injuries from falls among these workers. Results from this study are consistent with previous research suggesting falls during dismounting more likely than falls during mounting [10].

Other factors, including whole body vibration (WBV) from prolonged driving has been shown to influence postural stability, which suggests that there is a time dependent increase in postural sway over the course of a driving shift [11]. These specific data were unavailable in this study, however survey data suggest that "Driving time until break" was not significantly correlated with reported falls from dismounting p=0.7, nor was there a correlation with mileage driven in the prior year. Future work is needed to determine if exposure to WBV while driving is associated with risk of falling.

Patenaude et al. [7] reports that, based on the results from interviews, truck driver participants appear to be satisfied with the layout of the cab. On the other hand, half of the study participants reported their inability to see where they placed their feet during truck cab dismount. The risk of fall presented from foot placement uncertainty may be further amplified with the presence of environmental contaminants on the steps. In our study, 68.8% of drivers indicated that environmental

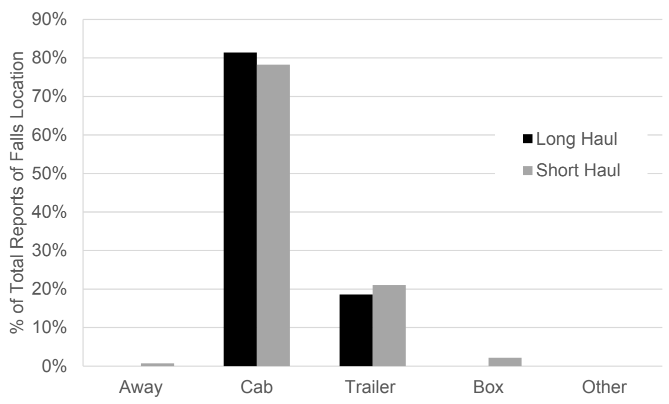

Figure 1: Reported location of falls.

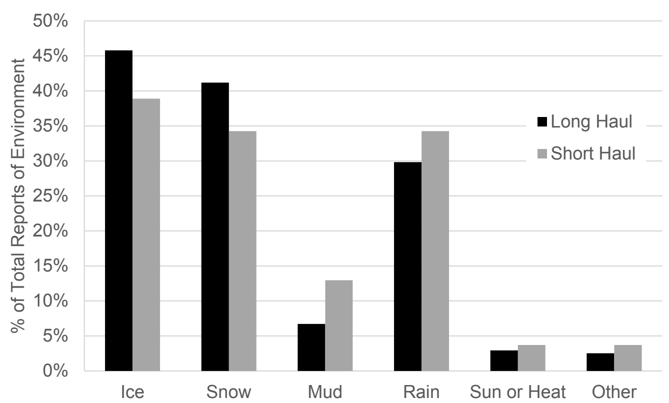

Figure 2: Reported environmental factors influencing falls.

contaminants were factors that influenced their fall. These results suggest that the layout of the cab combined with environmental factors may not be suitable to support dismounting the truck cab safely [7].

Results from this study show being overweight, obese, or morbidly obese have higher odds of lifetime falls when compared to the normal weighted truck driver category. While, these findings were not statistically significant, it trended towards significance. The truck driver population is heavier than the general U.S. population. The average BMI of our study population was 33.2 kg/m^2 (SD=5.5) which is considered obese, and is consistent with other reports (Guan et al. [12] reported a mean of 33.2 kg/m^2 and Sieber et al. [9] reported 33.4 kg/m^2). This is important because results from Patenaude et al. [7] show that truck operator's weight influences the ground impact force during descent from the cab. Lower-limb strength may be inadequate to support the required joint torque caused by this increased reaction force, and represents the imbalance between lower limb strength and a person's weight. Further investigation into lower limb strength of truck drivers and fall risk is needed to understand this relationship.

The effect of fatigue from driving on falls remains understudied. In this study, feelings of mental and physical exhaustions and reports of manual loading and unloading the truck were correlated with fall events. Fatigue may be induced from multiple sources. Although commercial truck drivers' primary task involves driving trucks on roads, driving is not the only task they perform. Truck drivers' tasks include, in many cases, handling of goods that need to be collected, loaded, unloaded, and delivered. These are typical examples of manual material handling (MMH) tasks that require human strength for which many truck drivers are responsible. Thus, some truck drivers may experience fatigue from considerable physical exertions. Mental fatigue may be related to the time demands plus monotony punctuated by hypervigilance.

Finally, physical factors of the truck may have an effect on driver falls. In this study the location of falls was associated with the frequency of falls, with the majority of falls occurring around the cab (80.6%) and 19.4% occurred on the trailer. This implies that future studies should assess cab features that may influence falls. Patenaude et al. [7] reported that half of their study participants reported an inability to see where they placed their feet during truck cab dismount.

Limitations of these findings include the cross-sectional nature of the study that precludes analysis of causal factors. The survey responses are subjective and also subject to recall biases and errors. Finally, the survey questions not including questions targeting the mounting/dismounting activity limits this study from attributing the falls to a certain physical aspect of the cab or behavioral aspect of the truck driver while accessing the truck cab.

Conclusion

Our findings suggest that several aspects of the truck (trailer or cab), environmental conditions (such as ice, rain, and mud), and driver personal factors (driver health, frequency of cab mounting/dismounting, footwear) are related to reported falls during mounting and dismounting in the past year as well as over the driver's lifetime. Data also suggest that the proportionally more of falls occurred during dismounting the cab than mounting the cab. Findings suggest that reports of feeling physically exhausted or mentally exhausted were associated with the number of falls.

Future Work

This study provides evidence suggesting that perhaps targeting cab design changes and worker training may help reduce the number of fall injuries to commercial truck drivers. Modifications to truck steps and or choice of footwear that improve the "quality of contact" and provide additional frictional characteristics, provide better visibility to help with targeting, and technology to prevent water, snow and ice build-up could also reduce the chance of a fall while mounting/dismounting truck cabs.

The effect of driving related LBP appears to be another important physical factor that was significantly correlated with falls in this study. Prolonged whole body vibration (WBV) exposure from driving has been shown to impact postural stability [11]. This results from vehicular vibrations that are theorized to lead to back muscle fatigue [13]. The risks of muscle fatigue from MMH may increase among long-distance truck drivers that have also been exposed to vehicle vibrations while driving [14-16]. Future research focused on the effect of fatigue on truck driver fall potential, particularly including objective measures of vibration and back pain is needed [17]. Finally, the current study was focused on the truck driver health and safety in an effort to pinpoint the key factors that influence falls to provide areas of much needed research consideration. A detailed research focused on the truck cab-driver interaction and cab design would be valuable to better understand the factors involved during mounting and dismounting the truck cab. Such research should include key factors most likely to ameliorate the cab access experience such as types of steps/handrail designs, drivers' behavior (facing the cab or facing away) and driver training.

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