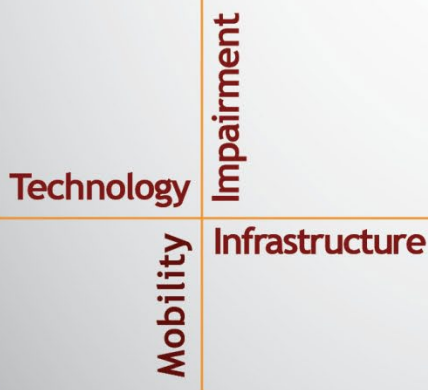


NSTSCCE

National Surface Transportation
Safety Center for Excellence

Investigating Attributes of Young, Inexperienced Commercial Motor Vehicle Drivers

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EXECUTIVE SUMMARY

For years, the trucking industry has been concerned with a potential lack of qualified, safe drivers to meet the future demand of the supply chain. The typical age of a truck driver in the United States is higher than the typical age of other workers (Day & Hait, 2019), and industry leaders have been investigating likely impacts of an aging workforce on the ability of carriers to meet future predicted demand. The current minimum age at which a driver with a commercial driver's license (CDL) can operate interstate is 21 years old (49 CFR 391.11). However, recent developments have expanded driver licensing age requirements through the Federal Motor Carrier Safety Administration's (FMCSA) young driver apprenticeship programs and initiatives for young military veterans (FMCSA, 2018, 2020a, 2020b).

Previous research studies investigating the age of commercial drivers and potential impact on safety risk have found mixed results (Hickman et al., 2020; Duke et al., 2010; Dunn et al., 2020; Thiese et al., 2015). These studies either binned young drivers with drivers over 25 years old in analysis stratified by age group or did not investigate any driver factors outside of age and driving experience. The current study used the Commercial Driver Safety Risk Factors (CDSRF) study data (Hickman et al., 2020) to investigate the attributes of safe and unsafe young, inexperienced drivers (ages 21 to 25). The study used data collected in the CDSRF study to compare young commercial drivers with and without carrier-recorded crashes, carrier-recorded preventable crashes, nationally recorded crashes, and moving violations for differences in demographic characteristics, driving-related factors, and health-related variables such as medical conditions and treatment status.

Overall, most young drivers in the current study did not have a safety-related event. The proportion of drivers with a safety-related event included 14% with at least one carrier-recorded crash, 8% with at least one carrier-recorded preventable crash, 8% with at least one nationally recorded crash, and 10% with at least one moving violation. The study found young drivers who reported an out-of-service (OOS) placement in the past 3 years were at 3 times increased risk of nationally recorded crash involvement. Young drivers with a double/triple trailer endorsement had higher odds of both carrier-recorded and nationally recorded crash involvement compared to drivers without this endorsement. Approximately 80% of the sampled young drivers in the current study had a high school (HS) diploma or higher degree—a higher proportion than observed in an analysis of drivers of all ages (Hickman et al., 2020). Drivers showed lower odds of carrier-recorded crash involvement when their academic degree was another degree not listed compared to drivers with a HS diploma or bachelor's degree. Finally, drivers with diagnosed and treated allergies showed higher risk of crash involvement compared to drivers without this diagnosis; however, it is important to note that very few drivers in the sample had allergies and were receiving treatment.

Although the study found few statistically significant factors associated with increased safety event risk, the study did provide more insight into the typical young driver. This driver age group is one with limited published information. As younger drivers have more opportunities to join the career field, through multiple initiatives by FMCSA and career promotion by industry leaders seeking to address driver shortage concerns, it is important to better understand this driver age group, their potential risk factors, what factors need further research, and how this driver age group compares to other driver age groups in their demographics and risk.

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LIST OF ABBREVIATIONS AND SYMBOLS

ATA	American Trucking Associations
BMI	body mass index
BQ	Berlin Questionnaire
CDL	commercial driver's license
CDLIS	Commercial Driver's License Information System
CDSRF	Commercial Driver Safety Risk Factors
CI	confidence interval
CLP	commercial learner's permit
CMV	commercial motor vehicle
CRSS	Crash Reporting Sampling System
DC	District of Columbia
DDDI	Dula Dangerous Driving Index
DOT	Department of Transportation
DF	degrees of freedom
ESS	Epworth Sleepiness Scale
FARS	Fatality Analysis Reporting System
FMCSA	Federal Motor Carrier Safety Administration
GED	general educational development
HAZMAT	hazardous materials
HS	high school
MCMIS	Motor Carrier Management Information System
MVMT	million vehicle miles traveled
NHTSA	National Highway Traffic Safety Administration
OODA	Owner-Operator Independent Drivers Association
OOS	out-of-service
OR	odds ratio
OSA	obstructive sleep apnea
SD	standard deviation
SDAP	Safe Driver Apprenticeship Pilot Program
SDS	Social Desirability Scale
SRLE	Survey of Recent Life Experiences
VTTI	Virginia Tech Transportation Institute

CHAPTER 1. INTRODUCTION

For years, the trucking industry has been concerned with a potential lack of qualified, safe drivers to meet the future demand of the supply chain. The typical age of a truck driver in the United States is higher than the typical age of other workers (Day & Hait, 2019), and industry leaders have been investigating likely impacts of an aging workforce on the ability for carriers to meet future predicted demand. The American Trucking Associations (ATA) has routinely analyzed whether, and to what degree, there is a truck driver shortage using up-to-date statistics (Costello & Karickhoff, 2019). However, other industry leaders believe shortage concerns have been exaggerated and that the true issues relate to driver recruitment and retention and operational characteristics persistent in the industry (Fuller, 2023). Truck driver shortage predictions have been affected by several factors, including economic growth. One factor that may be influencing truck driver counts is the ability to recruit young people into the industry and into truck driving as a career.

According to the U.S. Census Bureau (2019), the median age of truck drivers is 46 years old, approximately 5 years older than the median age for all workers. A 2015 study of 858 truck drivers found a median age of 47.2 years old (Thiese et al., 2015). The Commercial Driver Safety Risk Factors (CDSRF) study collected a wealth of information from more than 21,000 drivers of all ages, including driver demographic data, medical exam data, and safety event data (Hickman et al., 2020). Approximately 25% of drivers in the CDSRF study were 33 years old or younger (25.40%), and 50% were 43 years old or older.

The Federal Motor Carrier Safety Administration (FMCSA) sets regulations regarding interstate licensing requirements. Generally, drivers can obtain a commercial learner's permit (CLP) or commercial driver's license (CDL) at 18 years old (49 CFR 383.71; FMCSA, 2018). The current minimum age at which a driver with a CDL can operate interstate is 21 years old (49 CFR 391.11). Drivers are eligible to operate intrastate with a CLP or CDL at an earlier age of 18 years old in 48 states and D.C. (49 CFR 383.71; FMCSA, 2018). However, there have been recent developments that expand previously established driver licensing age requirements. In 2020, FMCSA and the Department of Labor proposed a pilot program to allow drivers 18 to 20 years old to operate interstate under certain training and experience conditions (FMCSA, 2020a). The program, called FMCSA's Safe Driver Apprenticeship Pilot Program, or SDAP program, was implemented starting in 2023. Carriers and apprentice drivers must meet specific safety criteria to be eligible (FMCSA, 2023). Participation criteria include histories of safe driving, vehicles installed with specific safety-related features, following a graduated probationary driving schedule featuring teaming apprentice drivers with experienced drivers, and limitations on the freight transported by apprentice drivers (FMCSA, 2023). The SDAP program anticipated training up to 3,000 apprentice drivers to drive commercial trucks interstate (FMCSA, 2024). In a recent quarterly report, FMCSA reported 34 carriers and 36 apprentice drivers have received approval to participate in the SDAP program (FMCSA, 2024).

An additional FMCSA initiative targeting younger drivers offers options based on military experience to waive the skills and knowledge tests required to obtain a CDL (FMCSA, 2020b). The skills test waiver requirements are state dependent, but the program is available in all states. The knowledge test waiver, called the Even Exchange Program, is not available in all states.

Military veteran drivers 18 to 20 years old can also participate in the SDAP program if they meet specific safety criteria and are sponsored by a participating carrier (FMCSA, 2018).

Some carriers even set their own driver minimum age requirement at ages above 21. For example, Camden et al. (2019) reported two carriers had a minimum requirement for drivers to be at least 23 years old. This may be in place to lower driver risk and reduce insurance costs (Kibby, 2022; Silva, 2022). In fact, the Owner-Operator Independent Drivers Association (OOIDA) expressed concern over the ability of drivers ages 18 to 20 who are participating in the FMCSA SDAP program to obtain insurance (Kingston, 2022). Others in the industry have noted this issue, stating that large carriers may be more likely to self-insure, while smaller carriers may be more likely to use outside insurance with limitations on driver age and experience levels (Lockie, 2023).

Published national driver safety statistics by age include crash counts but not driver counts or mileage exposure. The proportion of large truck (defined as greater than 10,000 pounds) drivers in fatal crashes who were 25 years old or younger was 7.4% in 2021, 6.6% in 2020, and 7.2% in 2019 (FMCSA Analysis Division, 2023). However, several studies have investigated driver age and potential impact on safety risk. The CDSRF study found drivers 21 to 25 years old were more likely to be involved in a carrier-recorded crash compared to drivers 36 to 55 years old. The Age and Experience study (Dunn et al., 2020) found that younger drivers 21 to 24 years old with less experience were at higher risk compared to drivers the same age with more experience. However, drivers 21 to 24 years old were at lower or equal risk of involvement in a carrier-recorded crash compared to older drivers, when experience for both age groups was 2 years or less. Thiese et al. (2015) found increased driver age was associated with an increase in reportable crash risk. In a 2010 study of Australian drivers, using data collected from 1985 through 2007, drivers under 27 years old were found to be at increased risk compared to drivers 27 to 63 years old (Duke et al., 2010).

Younger, non-commercial drivers have been studied extensively for safety performance and risk factors. Drivers ages 16 to 24 have shown increased crash rates per 100 million vehicle miles traveled (MVMT) compared to 25- to 29-year-old drivers (Insurance Institute for Highway Safety, 2023). In 2021, the proportion of drivers ages 18 to 20 involved in fatal crashes was 1.11 times the proportion observed for drivers ages 21 to 24, 1.25 times the proportion observed for drivers ages 25 to 29, and 1.40 times the proportion observed for drivers ages 30 to 34, according to data obtained from multiple sources (Office of Highway Policy Information, 2022; National Center for Statistics and Analysis, 2024; National Highway Traffic Safety Administration [NHTSA], 2023a, 2023b, 2024). Analyses of injury-only crashes and property-damage-only crashes revealed even greater differences between drivers 18 to 20 years old and drivers 21 to 34 years old. Interestingly, a report by the Governors Highway Safety Association (2023) found that although drivers under 21 have higher crash rates per licensed driver compared to drivers at least 21 years old, the younger driver group actually had a larger reduction in crash rates over the last 20 years. Several risk factors have been shown to influence crash risk in teen drivers: history of multiple violations (O'Neal et al., 2023), propensity to speed or perform other risky driving behaviors (Bureau of Transportation Statistics, 2023; Curry et al., 2011; National Center for Statistics and Analysis, 2022), demographic factors such as gender (National Center for Statistics and Analysis, 2022; Shope, 2006), driving with passengers (Williams et al., 2003), making driver

errors (Curry et al., 2011), personality factors (Shope, 2006), driver education (Shell et al., 2015), and driving experience (Shope, 2006).

Understanding young commercial drivers is important given the above. Although the CDSRF study did investigate and identify driver risk factors in stratified age groupings, the youngest age group included 20- to 33-year-old drivers in a single group. However, the drivers most affected by age-related federal and state CDL policies and carrier hiring guidelines are drivers 21 to 25 years old. The Age and Experience study (Dunn et al., 2020) also analyzed driver safety data by stratified age groupings, including a young driver group of 21- to 24-year-old drivers. However, this study did not investigate any driver factors outside of age and driving experience. Other studies exploring the impact of driver age on risk used younger driver age stratifications that included ages beyond 25 years (Bunn et al., 2009; Duke et al., 2010).

The current study used the rich CDSRF study data to investigate the attributes of safe and unsafe inexperienced drivers (ages 25 years or younger). There were over 1,000 drivers ages 25 or younger in the original CDSRF data set. The assessed risk factors consisted of personal factors, such as demographic characteristics, medical conditions, personal attitudes, and behavioral history. The study identified risk factors by linking the characteristics of individual drivers with their driving records, especially the occurrence or absence of crashes and moving violations, during the duration of the study. The current study aimed to expand understanding of young drivers with the goal of identifying factors associated with safe and unsafe driving records.

CHAPTER 2. METHODS

2.1 DATA SOURCE

The data for this study was originally collected in the CDSRF study (Hickman et al., 2020). The CDSRF study collected information from drivers at a single large carrier. These participants were recruited at eight sites at various locations in the continental United States. Participant recruitment occurred during driver orientation at these carrier sites.

The data collected in the CDSRF study included:

- Medical exam data, from carrier-required Medical Examination Reports or brief medical exams;
- Initial Driver Survey data, which collected demographic information, Epworth Sleepiness Scale (ESS), Berlin Questionnaire (BQ), Survey of Recent Life Experiences (SRLE), Dula Dangerous Driving Index (DDDI), and the Social Desirability Scale (SDS); and
- Safety data, comprised of crash and violation data from carrier crash data, Motor Carrier Management Information System (MCMIS) data, and the Commercial Driver's License Information System (CDLIS).

Exposure per driver was measured in two ways: a carrier exposure value and national exposure value. Carrier exposure was a measure of tenure with the study carrier. Carrier exposure was calculated per driver as the number of days between their date of study enrollment and their date of employment termination with the carrier. If the driver's employment with the study carrier was not terminated during the study, carrier exposure was instead measured as the time in days between their date of study enrollment and the study end date of May 30, 2016. National exposure was calculated per driver as the time in days between the driver's date of study enrollment and the study end date of May 30, 2016, regardless of carrier employment.

In the CDSRF study, the medical exam data set, Initial Driver Survey data sets, safety data sets, and exposure data set were matched and organized by driver, removing identifying information. Not all drivers had fully complete data sets. Further details regarding participant recruitment and data collection and management techniques are included in the CDSRF final report.

2.2 DRIVER SELECTION

The current study focused on drivers who were 21 to 25 years old at the time of recruitment. The CDSRF data were filtered by driver age, which was collected in the medical exam data, and all medical exam data, Initial Driver Survey data, and safety data were pulled for this subset of younger drivers.

2.2.1 Driver Sample Distributional Statistics

The CDSRF data included 1,318 drivers 21 to 25 years old with carrier exposure data and 1,415 drivers 21 to 25 years old with national exposure data. The breakdown of driver counts by driver age is shown in Table 1. Drivers who were 25 years old made up the largest portion of the sample (28.60% and 28.13% of the sample with carrier exposure data and national exposure

data, respectively), followed by 24-year-old drivers (24.81% of the sample with carrier exposure data and national exposure data). Approximately one fifth of the sample was comprised of 23-year-old drivers (22.00% and 22.26% of the sample with carrier exposure data and national exposure data, respectively). The remaining quarter of the sample included drivers who were 22 years old (at just over 18% of the sample in both exposure groups) and 21 years old (at about 6% of the sample in both exposure groups).

Table 1. Count and percentage of drivers ages 21-25 with carrier or national exposure data.

Driver Age (years)	Driver Count with Carrier Exposure	Drivers with Carrier Exposure (%)	Driver Count with National Exposure	Drivers with National Exposure (%)
21	80	6.07	90	6.36
22	244	18.51	261	18.45
23	290	22.00	315	22.26
24	327	24.81	351	24.81
25	377	28.60	398	28.13

The distribution of carrier exposure for the younger driver sample is shown in Figure 1. The sample included 467 younger drivers with exposure of 60 days or less and 219 drivers with exposure of 61 to 120 days. The carrier exposure distribution is right skewed. The distribution of national exposure for the younger driver sample is presented in Figure 2. The national exposure distribution shows a different pattern, with no strong skew to the right or left. The distribution shows consistent representation between 181 days and 1,020 days (1,276 drivers), with much smaller portions of drivers with national exposure less than 181 days (91 drivers) or more than 1,020 days (48 drivers). Descriptive statistics for exposure are included in Table 33 in Appendix A, for reference.

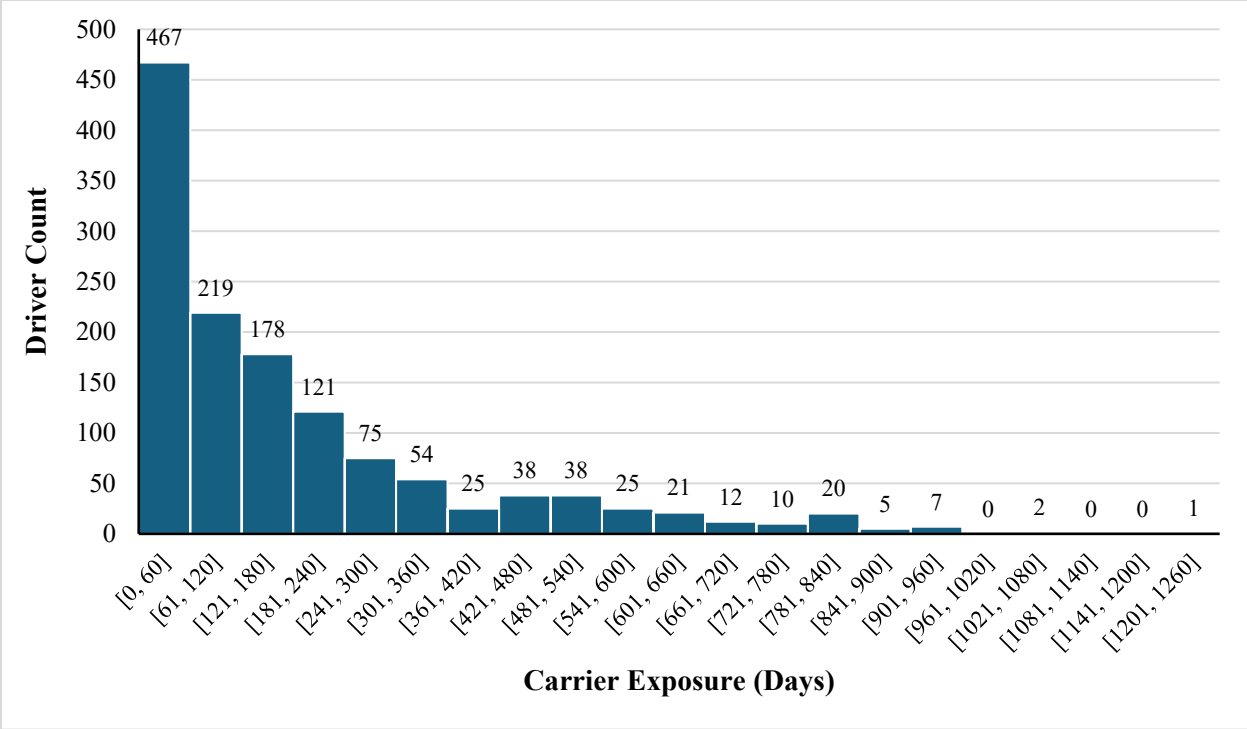


Figure 1. Histogram. Carrier exposure in days for drivers ages 21-25.

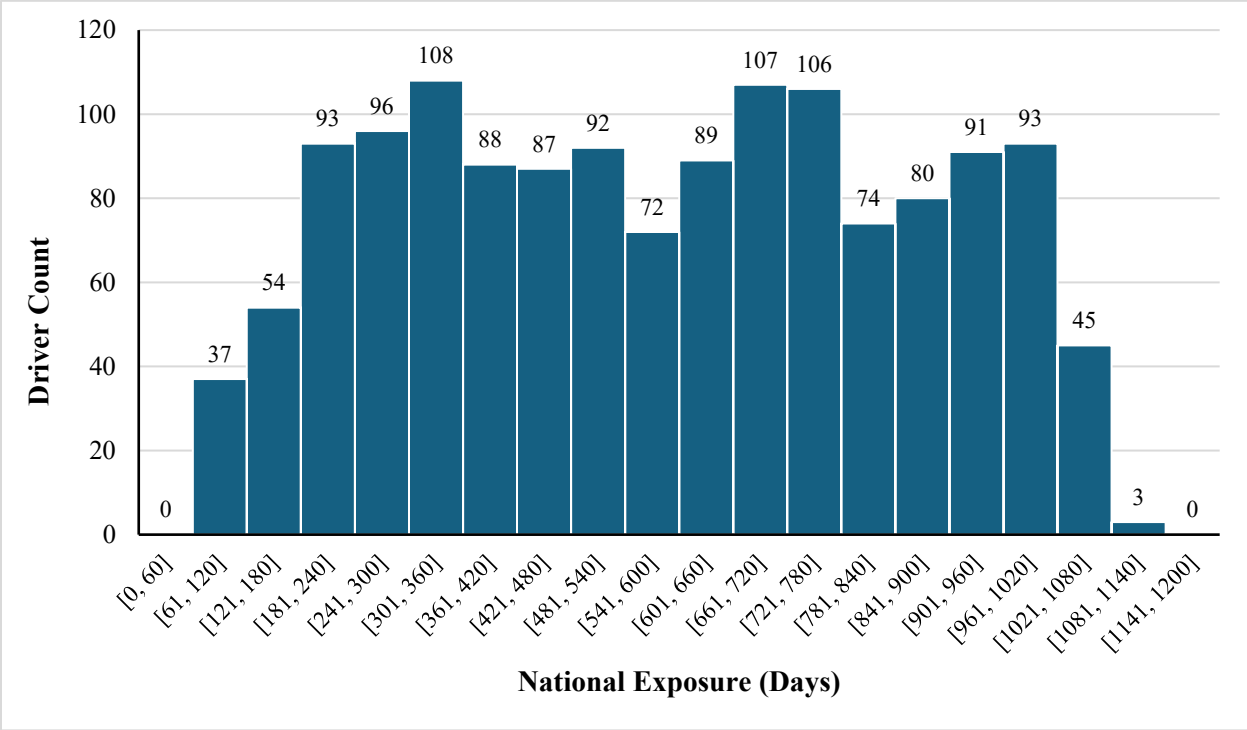


Figure 2. Histogram. National exposure in days for drivers ages 21-25.

For each driver, the total number of carrier-recorded crashes, carrier-recorded preventable crashes, MCMIS-recorded crashes (referred to as national crashes in this report) and moving violations (CDLIS recorded) were tallied. Table 2 presents the driver distribution by safety event count for each of the safety event types. Over 85% of young drivers did not have a carrier-recorded crash, 12% had one carrier-recorded crash, and 2% had more than one carrier-recorded crash. More than 92% of young drivers did not have a carrier-recorded preventable crash. Nearly 7% of the sample did have one carrier-recorded preventable crash, and 1% had two or more carrier-recorded preventable crashes. National crashes showed a similar distribution: 92% of drivers had no nationally recorded crashes, over 6.5% had one nationally recorded crash, and 1% had two or more nationally recorded crashes. The sample included 8% of drivers with one moving violation, 2% with two or more moving violations, and almost 90% of drivers without a moving violation.

Table 2. Count and percentage of drivers ages 21-25 with carrier-recorded crashes, carrier-recorded preventable crashes, national crashes, and moving violations.

Safety Event Type	Safety-Event Count	Number of Young Drivers	Young Drivers (%)
Carrier-recorded crash	0	1,113	85.75
Carrier-recorded crash	1	160	12.33
Carrier-recorded crash	2 or more	25	1.93
Carrier-recorded preventable crash	0	1,214	92.11
Carrier-recorded preventable crash	1	90	6.83
Carrier-recorded preventable crash	2 or more	14	1.06
Nationally recorded crash	0	1,307	92.37
Nationally recorded crash	1	93	6.57
Nationally recorded crash	2 or more	15	1.06
Moving violation	0	1,269	89.68
Moving violation	1	115	8.13
Moving violation	2 or more	31	2.19

Safety event rates were calculated per driver, for each safety event type. For carrier-recorded crashes and carrier-recorded preventable crashes, rates were calculated as the driver total number of safety events over the driver total carrier exposure in years. For nationally recorded crashes and moving violations, rates were calculated as the driver total number of safety events over the driver total national exposure in years. Table 3 presents event rate descriptive statistics over all young drivers, by safety event type.

Table 3. Descriptive statistics for safety event rates per year for drivers ages 21-25.

Safety Event Type for Rate Calculations	Mean Rate	Rate SD	Minimum Rate	25 th Perc. Rate	Median Rate	75 th Perc. Rate	Maximum Rate
Carrier-recorded crash	0.51	2.41	0.00	0.00	0.00	0.00	34.76
Carrier-recorded preventable crash	0.39	2.23	0.00	0.00	0.00	0.00	34.76
Nationally recorded crash	0.05	0.22	0.00	0.00	0.00	0.00	3.51
Moving violation	0.08	0.27	0.00	0.00	0.00	0.00	2.90

2.2.1 Identifying Safe and Unsafe Young Drivers

The exploratory analyses presented above revealed that few drivers were involved in multiple safety events, either of the same type or different types. Initially, the study aimed to group drivers into one of multiple safety classifications (e.g., safe, unsafe but lower risk, unsafe but higher risk). The original study plan was to perform a cluster analysis, using safety event rate data for each safety event type, to classify drivers. The driver clusters would then be compared to identify significant differences in driver demographic, work-related, and health factors and determine which factors are associated with increased risk of safety event involvement. A cluster analysis, based on safety event rates over exposure in days, identified a safe group of drivers with no safety event involvement (cluster 1), a lower level unsafe group of drivers with one safety event and lower safety event rates (cluster 2), and a higher level unsafe group of drivers with multiple safety events and higher safety event rates (cluster 3). However, cluster 3 had few drivers, with insufficient counts for further meaningful analysis, and the cluster analysis approach was unsuccessful.

Instead, the study approach was adapted to stratify the analyses by safety event type and focus comparisons between drivers with the safety event type and drivers without the safety event type. In this approach, the analysis might reveal factors associated with increased risk of involvement in the specific safety event type. Drivers with at least one carrier-recorded crash were labeled as carrier-recorded crash involved, and drivers without any carrier-recorded crashes were labeled as non-involved (using a binary variable for carrier-recorded crash involvement). This same process was followed for the other safety event types.

A comparison of exposure in days for drivers with no safety event involvement and drivers with safety event involvement showed statistically significant differences (Table 4). In the analyses by each safety event type, young drivers with the safety event had significantly longer exposure times compared to young drivers without the safety event. All four *t*-tests resulted in *p*-values of 0.0002 or lower. Drivers with carrier crashes had on average 313.3 days in the study (SD = 231.4); drivers without carrier crashes had an average of 159.0 days in the study (SD = 191.9). Drivers with carrier-recorded preventable crashes had on average 251.7 days in the study (SD = 217.4); drivers without carrier-recorded preventable crashes had an average of 174.6 days in the study (SD = 202.8). Drivers with nationally recorded crashes had an average exposure time of 724.7 days (SD = 230.8), while drivers without a nationally recorded crash had an average

exposure time of 565.6 days (SD = 275.2). Drivers with a moving violation had an average exposure time of 721.2 days (SD = 234.7), while drivers without a moving violation had an average exposure time of 561.3 days (SD = 274.8).

Table 4. Comparison of exposure in safety event-involved and non-involved young drivers, by safety event type.

Safety Event Type	<i>N</i> for Involved Group	Average (SD) for Involved Group	<i>N</i> for Non-Involved Group	Average (SD) for Non-Involved Group	<i>t</i> -Test Method due to Variance Equality	<i>df</i>	<i>t</i> -value	<i>p</i> -value
Carrier-recorded crashes	185	313.3 (231.4)	1,133	159.0 (191.9)	Satterthwaite	227.19	-8.60	<0.0001
Carrier-recorded preventable crashes	104	251.7 (217.4)	1,214	174.6 (202.8)	Pooled	1,316	-3.70	0.0002
Nationally recorded crashes	108	724.7 (230.8)	1,307	565.6 (275.2)	Satterthwaite	133.47	-6.78	<0.0001
Moving violations	146	721.2 (234.7)	1,269	561.3 (274.8)	Satterthwaite	193.80	-7.65	<0.0001

To reduce the impact of exposure length and the risk of any possible confounding variables, a sample of drivers without the safety event were selected for analysis using a matched selection approach. All drivers included in the final analysis had exposure values of at least 2 weeks. Drivers with and without safety events were matched by age (in years, exact match) and exposure (within ± 2 months). For each unsafe driver, four safe drivers who met these criteria were randomly selected as a match. If fewer than four safe drivers met the matching criteria, all one to three drivers were selected for the matched sample. Each safe driver could be matched to multiple unsafe drivers if the matching criteria were met and they were randomly selected in each of the matches. This process was performed for each safety event, using carrier exposure for carrier-recorded crashes (all and preventable) and national exposure for nationally recorded crashes and moving violations. The final matched sample, with exposure data, is summarized in Table 5.

Table 5. Comparison of exposure in young drivers with safety event and matched sample without safety event, by safety event type.

Safety Event Type	<i>N</i> for Drivers with Safety Event	Average (SD) Exposure for Drivers with Safety Event	<i>N</i> for Matched Drivers without Safety Event	Average (SD) Exposure for Matched Drivers without Safety Event
Carrier-recorded crashes	184	311.74 (231.05)	716	295.97 (217.75)
Carrier-recorded preventable crashes	104	251.73 (217.41)	411	245.82 (208.75)

Safety Event Type	N for Drivers with Safety Event	Average (SD) Exposure for Drivers with Safety Event	N for Matched Drivers without Safety Event	Average (SD) Exposure for Matched Drivers without Safety Event
Nationally recorded crashes	108	724.74 (230.76)	431	723.41 (225.54)
Moving violations	146	721.25 (234.72)	583	718.98 (232.17)

2.3 ANALYSIS APPROACH

The study investigated safe and unsafe young drivers for differences in various driver-related factors. These factors included driver demographic factors, driving-related factors, and health-related factors. The variables are shown in Figure 3, Figure 4, and Figure 5. Detailed explanations of these driver factors are provided in the CDSRF report (Hickman et al., 2020), including an overview of the DDDI, SDS, ESS, and SRLE. At a very high level, higher scores on the DDDI indicate riskier driving tendencies; higher SDS scores indicate greater social desirability, especially scores above an established threshold of 16; and higher SRLE scores indicate higher driver stress in the SRLE subscale.

Driver factor distributions were calculated by safety event type, for drivers with and without safety event involvement. For categorical variables, the distributions are presented in terms of factor level counts and proportions; for continuous variables, the distributions are presented in terms of summary statistics by factor level.

• Gender	• Weekly Exercise Frequency	• SRLE Subscale: Social and Cultural
• Marital Status	• Epworth Sleepiness Scale (ESS) – Excessive Daytime Sleepiness	• SRLE Subscale: Work
• Highest Academic Degree	• DDDI Subscale: Negative Emotion	• SRLE Subscale: Time Pressure
• Regular Sleep Schedule	• DDDI Subscale: Aggressive Driving	• SRLE Subscale: Finances
• Nap During the Day	• DDDI Subscale: Risky Driving	• SRLE Subscale: Social Acceptability
• Exercise Off Work	• Social Desirability Scale (SDS) Score	• SRLE Subscale: Social Victimization

Figure 3. List. Driver demographic factors assessed in the current study.

• Months of Experience Driving Commercial Vehicles	• Personal Vehicle Seatbelt Use	• Roadside Departure Crash in Previous 3 Years	• Head-On Crash in Previous 3 Years
• CDL Type	• Commercial Vehicle Seatbelt Use	• Rear-End Crash in Previous 3 Years	• Other Crash in Previous 3 Years
• Endorsement: HazMat	• Crash in Previous 3 Years	• Sideswipe Crash in Previous 3 Years	• Formal Training
• Endorsement: Bus Passenger	• Moving Violation in Previous 3 Years	• Hit Fixed Object Crash in Previous 3 Years	• Weeks of Formal Training
• Endorsement: School Bus	• OOS Placement in Previous 3 Years	• Hit Moving Object Crash in Previous 3 Years	• Informal Training
• Endorsement: Tanker Vehicle	• Commercial Vehicle Crash in Previous 3 Years	• Backing Crash in Previous 3 Years	• Weeks of Informal Training
• Endorsement: Double/Triple Trailer	• At Fault Crash in Previous 3 Years	• Parking Lot Crash in Previous 3 Years	• On-the-Job Training
• Endorsement: Combination HazMat/Trailer	• Personal Vehicle Crash in Previous 3 Years	• T-Bone Crash in Previous 3 Years	• Weeks of On-the-Job Training

Figure 4. List. Driving-related factors assessed in the current study.

• Body Mass Index (BMI) Classification	• Abdomen and Viscera Condition	• Alcohol Use	• Allergies
• Cancer	• Digestive Problems	• Dyslipidemia	• High Blood Pressure
• Elevated Blood Sugar	• Eye Disorder	• Genitourinary	• Head/Brain Injury
• Heart/Cardiovascular Disease	• Ear/Hearing/Balance Disorder	• Spine/Other Musculoskeletal Disorder	• Hormone Therapy
• Inflammatory Disease	• Kidney Disease	• Loss of Consciousness	• Lung/Chest Condition
• Metabolic Syndrome	• Missing Limb	• Mouth and Throat Condition	• Muscular Disease
• Nervous/Psychiatric Disorder	• Neurological Condition	• Hormone Dysfunction	• Other Sleep Disorders
• Seizures/Epilepsy	• Skin Disease	• Obstructive Sleep Apnea (OSA)	• Stroke or Paralysis
• Thyroid Disorder	• Tobacco Use	• Vascular Condition	• Viral Infection
• Vitamin Deficiency	• Weight Control	• Diet Quality	

Figure 5. List. Health-related factors assessed in the current study.

Individual logistic regression models were calculated for each driver factor and safety event type. Each model was generally structured as follows:

$$Y_i = \begin{cases} 1 & \text{if driver was involved in a safety event of Type } j \\ 0 & \text{if driver was not involved in a safety event of Type } j \end{cases}, \text{ for } i = 1, \dots, l$$

where:

- Y_i is assumed to follow a Bernoulli (p_i) distribution;

- p_i is the probability of a driver being involved in the safety event of type j ;
- j is carrier-recorded crashes, carrier-recorded preventable crashes, nationally recorded crashes, or moving violations; and
- l is the number of drivers in the analysis subset for safety event type j .

The regression model is then:

$$\text{Logit}(p_i) = \ln\left(\frac{p_i}{1 - p_i}\right) = \beta X_i$$

where X_i is the vector of observed covariates for driver l and β is the vector of parameters. The results of the logistic regression models are presented in odds ratios (ORs) and corresponding 95% confidence intervals (CIs), predicting changes in odds of safety event involvement by levels of the assessed driver factor. Statistically significant differences in odds are indicated by a 95% CI that does not include the value 1.00 (both the upper and lower CI limits are either entirely above 1.00 or below 1.00). A significant OR greater than 1 indicates an increased risk of safety event involvement in one level of the driver factor compared to another level in the same factor. Conversely, a significant OR below 1 indicates a decreased risk of safety event involvement in one level of the driver factor compared to another level in the same factor. A useful reference to discuss the general approach is Guo (2019).

It is important to note that the data collection methodology and analysis approach allow the study to measure differences in risk between variable levels but do not determine causation for unsafe driving performance by driver demographic, driving-related variables, or health-related variables.

CHAPTER 3. RESULTS

The results section presents distributions of demographic factors, work-related factors, and health-related factors for younger drivers as well as the results of the logistic regression models. Analysis results present differences in risk between variable levels but do not imply causation for driving safety performance by driver demographic, driving-related variables, or health-related variables.

3.1 DRIVER DEMOGRAPHIC FACTORS

The following section presents the analysis results for driver demographic variables, collected from the demographic questionnaire data. These variables include information regarding personal driver characteristics, lifestyle factors, and scores from various driver assessments.

3.1.1 Carrier-Recorded Crashes

Table 6 presents the distributions of demographic questionnaire categorical variables for drivers with a carrier-recorded crash and matched drivers without a carrier-recorded crash. Both the event-involved group and matched non-involved group were predominantly male (97.62% and 96.86%, respectively), single (78.05%; 74.23%), and had a high school (HS) diploma (74.59%; 70.54%). Drivers with a carrier-recorded crash were split in sleep schedule regularity, with 43.64% reporting a regular sleep schedule, 48.18% reporting sometimes having a regular sleep schedule, and 8.18% reporting no regular sleep schedule. Drivers without a carrier-recorded crash showed similar patterns (41.51% with regular sleep schedule, 45.75% with a regular sleep schedule sometimes, 12.74% with no regular sleep schedule). Approximately 27% of event-involved drivers and 37% of non-involved drivers reported napping during the day. The majority of respondents in both driver groups reported exercising (76.03% of drivers with a carrier-recorded crash; 73.42% of matched drivers without a carrier-recorded crash), at moderate frequency (46.72% of drivers with a carrier-recorded crash; 42.79% of matched drivers without a carrier-recorded crash). Nearly half of each group showed lower normal ratings on the ESS (49.59% and 49.78% of drivers with and without a carrier-recorded crash, respectively).

Table 6. Carrier-recorded crashes: Distribution of demographic questionnaire categorical variables for younger drivers with and without safety event.

Demographic Characteristic	Number of Drivers with Event	Drivers with Event (%)	Number of Matched Drivers without Event	Matched Drivers without Event (%)
Gender: Male	164	97.62	616	96.86
Gender: Female	4	2.38	20	3.14
Marital Status: Single	96	78.05	337	74.23
Marital Status: Married	26	21.14	94	20.70
Marital Status: Divorced	1	0.81	23	5.07
Highest Academic Degree: None listed	3	2.46	36	8.04
Highest Academic Degree: GED	17	13.93	56	12.50
Highest Academic Degree: HS diploma	91	74.59	316	70.54
Highest Academic Degree: Associate's	8	6.56	35	7.81

Demographic Characteristic	Number of Drivers with Event	Drivers with Event (%)	Number of Matched Drivers without Event	Matched Drivers without Event (%)
Highest Academic Degree: Bachelor's	3	2.46	5	1.12
Regular Sleep Schedule: No	9	8.18	54	12.74
Regular Sleep Schedule: Yes	48	43.64	176	41.51
Regular Sleep Schedule: Sometimes	53	48.18	194	45.75
Nap During the Day: No, not usually	89	72.95	277	62.53
Nap During the Day: Yes, usually	33	27.05	166	37.47
Exercise Off Work: No	29	23.97	118	26.58
Exercise Off Work: Yes	92	76.03	326	73.42
Weekly Exercise Frequency: None	29	23.77	114	25.68
Weekly Exercise Frequency: Moderate	57	46.72	190	42.79
Weekly Exercise Frequency: Substantial	36	29.51	140	31.53
ESS: Lower normal	60	49.59	226	49.78
ESS: Higher normal	47	38.84	175	38.55
ESS: Mild excessive	8	6.61	23	5.07
ESS: Moderate excessive	4	3.31	23	5.07
ESS: Severe excessive	2	1.65	7	1.54

Table 7 presents summary statistics for demographic questionnaire continuous variables for drivers with a carrier-recorded crash and matched drivers without a carrier-recorded crash. The scores do reflect missing response items within each questionnaire, and scores for both driver groups may be low compared to scores found in other research studies. Drivers with and without involvement in a carrier-recorded crash scored similarly on all DDDI subscales, with average scores of 17 for negative emotion, 9 for aggressive driving, and 15 for risky driving. The range for DDDI subscales can be 9 to 45 for negative emotion, 7 to 35 for aggressive driving, and 12 to 60 for risky driving, with higher scores indicating riskier driving tendencies. Average SDS scores for both groups were above 16, which indicates generally higher social desirability in both groups. For SRLE subscales, higher scores indicate higher driver stress. Across all SRLE subscales, average scores for drivers with carrier-recorded crashes were within 0.50 points of the average scores for drivers without carrier-involved crashes.

Table 7. Carrier-recorded crashes: Distribution of demographic questionnaire continuous variables for younger drivers with and without a safety event.

Demographic Characteristic	Average for Drivers with Event (SD)	Average for Matched Drivers without Event (SD)
DDDI Subscale: Negative Emotion Score	17.574 (6.058)	17.764 (5.631)
DDDI Subscale: Aggressive Driving Score	9.092 (2.931)	9.166 (3.097)
DDDI Subscale: Risky Driving Score	15.026 (3.376)	15.371 (4.060)
SDS Score	23.009 (3.356)	22.541 (3.952)
SRLE Subscale: Social and Cultural	15.924 (4.427)	16.415 (4.899)

Demographic Characteristic	Average for Drivers with Event (SD)	Average for Matched Drivers without Event (SD)
SRLE Subscale: Work	10.992 (3.649)	10.729 (3.388)
SRLE Subscale: Time Pressure	14.092 (4.640)	14.153 (4.878)
SRLE Subscale: Finances	10.849 (4.098)	11.097 (4.387)
SRLE Subscale: Social Acceptability	8.000 (2.861)	8.121 (3.215)
SRLE Subscale: Social Victimization	6.653 (2.489)	7.143 (2.935)

3.1.2 Carrier-Recorded Preventable Crashes

Table 8 presents the distributions of demographic questionnaire categorical variables for drivers with a carrier-recorded preventable crash and matched drivers without a carrier-recorded preventable crash. As with the previous driver subset, both the event-involved group and matched non-involved group were predominantly male (96.77% and 97.41%, respectively), single (79.41%; 71.48%), and had a HS diploma (73.53%; 67.55%). Approximately one third of carrier-recorded preventable crash-involved drivers and non-involved drivers reported napping during the day (34.33% and 33.83%, respectively). Drivers with a carrier-recorded preventable crash were split in sleep schedule regularity, with half reporting sometimes having a regular sleep schedule (50.88%), 42.11% reporting a regular sleep schedule, and 7.02% reporting no regular sleep schedule. Half of drivers without a carrier-recorded preventable crash reported a regular sleep schedule (48.16%), 42.04% reported a regular sleep schedule sometimes, and 9.80% reported no regular sleep schedule. A majority of respondents in both driver groups reported exercising (74.63% of event-involved drivers; 70.77% of matched non-involved drivers) at moderate frequency (44.12% of event-involved drivers; 46.36% of matched non-involved drivers). Just over half of each group showed lower normal ratings on the ESS (50.75% and 54.10% of drivers with and without a carrier-recorded preventable crash, respectively).

Table 8. Carrier-recorded preventable crashes: Distribution of demographic questionnaire categorical variables for younger drivers with and without a safety event.

Demographic Characteristic	Number of Drivers with Event	Drivers with Event (%)	Number of Matched Drivers without Event	Matched Drivers without Event (%)
Gender: Male	90	96.77	339	97.41
Gender: Female	3	3.23	9	2.59
Marital Status: Single	54	79.41	193	71.48
Marital Status: Married	13	19.12	66	24.44
Marital Status: Divorced	1	1.47	11	4.07
Highest Academic Degree: None listed	3	4.41	19	7.17
Highest Academic Degree: GED	10	14.71	40	15.09
Highest Academic Degree: HS diploma	50	73.53	179	67.55
Highest Academic Degree: Associate's	4	5.88	20	7.55
Highest Academic Degree: Bachelor's	1	1.47	7	2.64
Regular Sleep Schedule: No	4	7.02	24	9.80

Demographic Characteristic	Number of Drivers with Event	Drivers with Event (%)	Number of Matched Drivers without Event	Matched Drivers without Event (%)
Regular Sleep Schedule: Yes	24	42.11	118	48.16
Regular Sleep Schedule: Sometimes	29	50.88	103	42.04
Nap During the Day: No, not usually	44	65.67	178	66.17
Nap During the Day: Yes, usually	23	34.33	91	33.83
Exercise Off Work: No	17	25.37	76	29.23
Exercise Off Work: Yes	50	74.63	184	70.77
Weekly Exercise Frequency: None	17	25.00	74	28.35
Weekly Exercise Frequency: Moderate	30	44.12	121	46.36
Weekly Exercise Frequency: Substantial	21	30.88	66	25.29
ESS: Lower normal	34	50.75	145	54.10
ESS: Higher normal	23	34.33	94	35.07
ESS: Mild excessive	5	7.46	18	6.72
ESS: Moderate excessive	3	4.48	8	2.99
ESS: Severe excessive	2	2.99	3	1.12

Table 9 presents summary statistics for demographic questionnaire continuous variables for drivers with a carrier-recorded preventable crash and matched drivers without a carrier-recorded preventable crash. It is important to note the scores do reflect missing response items within each questionnaire, and scores for both driver groups may be low compared to scores found in other research studies. On the DDDI, drivers with and without involvement in a carrier-recorded preventable crash had average scores of 17 for negative emotion, 9 for aggressive driving, and 15 for risky driving. On the SDS, drivers with a carrier-recorded preventable crash had an average score of 22.556, and matched drivers had an average score of 23.054. Both groups had average SDS scores above 16 (which is the threshold for generally higher social desirability). Across all SRLE subscales, average scores for drivers with carrier-recorded preventable crashes were within one point of the average scores for drivers without carrier-recorded preventable crashes. The subscale with the largest average score difference was the time pressure score, which was 0.614 points higher for drivers with a carrier-recorded preventable crash.

Table 9. Carrier-recorded preventable crashes: Distribution of demographic questionnaire continuous variables for younger drivers with and without a safety event.

Demographic Characteristic	Average for Drivers with Event (SD)	Average for Matched Drivers without Event (SD)
DDDI Subscale: Negative Emotion Score	17.787 (5.759)	17.620 (6.306)
DDDI Subscale: Aggressive Driving Score	9.231 (2.517)	9.108 (3.459)
DDDI Subscale: Risky Driving Score	15.565 (3.656)	15.092 (3.941)
SDS Score	22.556 (3.130)	23.054 (4.132)
SRLE Subscale: Social and Cultural	16.318 (4.247)	15.841 (4.437)
SRLE Subscale: Work	11.136 (3.560)	10.548 (3.402)

Demographic Characteristic	Average for Drivers with Event (SD)	Average for Matched Drivers without Event (SD)
SRLE Subscale: Time Pressure	14.299 (4.452)	13.685 (4.753)
SRLE Subscale: Finances	11.182 (4.128)	10.821 (4.552)
SRLE Subscale: Social Acceptability	8.152 (2.936)	7.851 (3.005)
SRLE Subscale: Social Victimization	6.881 (2.453)	7.046 (2.907)

3.1.3 Nationally Recorded Crashes

Table 10 presents the distributions of demographic questionnaire categorical variables for drivers with a nationally recorded crash and matched drivers without a nationally recorded crash. As with the previous driver subsets, both the event-involved group and matched non-involved group were predominantly male (94.79% and 96.04%, respectively), single (73.33%; 74.36%), and had a HS diploma (71.67%; 75.66%). Nearly half of drivers with a carrier-recorded preventable crash reported sometimes having a regular sleep schedule (49.09%), with the remaining reporting a regular sleep schedule (38.18%) and no regular sleep schedule (12.73%). Half of drivers without a carrier-recorded preventable crash reported a regular sleep schedule (48.02%), with the remaining drivers reporting a regular sleep schedule sometimes (42.86%) and no regular sleep schedule (9.13%). Approximately 27% of event-involved drivers and 37% of non-involved drivers reported napping during the day. The majority of respondents in both driver groups reported exercising (76.03% of drivers with a carrier-recorded crash; 73.42% of matched drivers without a carrier-recorded crash), at moderate frequency (46.72% of drivers with a carrier-recorded crash; 42.79% of matched drivers without a carrier-recorded crash). Nearly half of each group showed lower normal ratings on the ESS (49.59% and 49.78% of drivers with and without a carrier-recorded crash, respectively).

Table 10. Nationally recorded crashes: Distribution of demographic questionnaire categorical variables for younger drivers with and without a safety event.

Demographic Characteristic	Number of Drivers with Event	Drivers with Event (%)	Number of Matched Drivers without Event	Matched Drivers without Event (%)
Gender: Male	91	94.79	388	96.04
Gender: Female	5	5.21	16	3.96
Marital Status: Single	44	73.33	203	74.36
Marital Status: Married	14	23.33	57	20.88
Marital Status: Divorced	2	3.33	13	4.76
Highest Academic Degree: None listed	4	6.67	11	4.12
Highest Academic Degree: GED	8	13.33	27	10.11
Highest Academic Degree: HS diploma	43	71.67	202	75.66
Highest Academic Degree: Associate's	3	5.00	21	7.87
Highest Academic Degree: Bachelor's	2	3.33	6	2.25
Regular Sleep Schedule: No	7	12.73	23	9.13
Regular Sleep Schedule: Yes	21	38.18	121	48.02

Demographic Characteristic	Number of Drivers with Event	Drivers with Event (%)	Number of Matched Drivers without Event	Matched Drivers without Event (%)
Regular Sleep Schedule: Sometimes	27	49.09	108	42.86
Nap During the Day: No, not usually	42	72.41	189	70.52
Nap During the Day: Yes, usually	16	27.59	79	29.48
Exercise Off Work: No	11	19.64	64	23.79
Exercise Off Work: Yes	45	80.36	205	76.21
Weekly Exercise Frequency: None	11	19.30	64	23.70
Weekly Exercise Frequency: Moderate	33	57.89	108	40.00
Weekly Exercise Frequency: Substantial	13	22.81	98	36.30
ESS: Lower normal	31	51.67	146	53.48
ESS: Higher normal	23	38.33	104	38.10
ESS: Mild excessive	3	5.00	11	4.03
ESS: Moderate excessive	2	3.33	9	3.30
ESS: Severe excessive	1	1.67	3	1.10

Table 11 presents summary statistics for demographic questionnaire continuous variables for drivers with a nationally recorded crash and matched drivers without a nationally recorded crash. It is important to again note the scores do reflect missing response items within each questionnaire, and scores for both driver groups may be low compared to scores found in other research studies. Score patterns on the DDDI were similar to those observed above—drivers with and without involvement in a nationally recorded crash had average scores of approximately 17 for negative emotion, 9 for aggressive driving, and 15 for risky driving. Drivers with a nationally recorded crash had an average SDS score of 22.552, and matched drivers had an average score of 23.860. Across all SRLE subscales, average scores for drivers with nationally recorded crashes ranged between 0.041 and 0.641 points within the average scores for drivers without nationally recorded crashes. The subscale with the largest average score difference was the social victimization score, which was 0.641 points higher for drivers with a nationally recorded crash.

Table 11. Nationally recorded crashes: Distribution of demographic questionnaire continuous variables for younger drivers with and without a safety event.

Demographic Characteristic	Average for Drivers with Event (SD)	Average for Matched Drivers without Event (SD)
DDDI Subscale: Negative Emotion Score	17.783 (6.012)	17.502 (5.342)
DDDI Subscale: Aggressive Driving Score	9.271 (3.513)	8.996 (2.951)
DDDI Subscale: Risky Driving Score	15.533 (5.176)	15.039 (4.135)
SDS Score	22.552 (3.871)	22.860 (4.026)
SRLE Subscale: Social and Cultural	16.741 (4.233)	16.700 (4.666)
SRLE Subscale: Work	10.596 (3.321)	10.889 (3.445)
SRLE Subscale: Time Pressure	14.140 (4.438)	13.816 (4.534)
SRLE Subscale: Finances	11.390 (3.987)	10.942 (3.952)

Demographic Characteristic	Average for Drivers with Event (SD)	Average for Matched Drivers without Event (SD)
SRLE Subscale: Social Acceptability	8.211 (3.222)	8.088 (2.938)
SRLE Subscale: Social Victimization	7.475 (2.926)	6.834 (2.682)

3.1.4 Moving Violations

Table 12 presents the distributions of demographic questionnaire categorical variables for drivers with a moving violation and matched drivers without a moving violation. Once again, the event-involved group and matched non-involved group were predominantly male (96.35% and 96.64%, respectively), single (86.35%; 73.10%), and had a HS diploma (73.26%; 71.81%). Both driver groups most often reported a regular sleep schedule (46.25% of moving-violation-involved drivers and 45.11% of matched drivers without a moving violation). Approximately 15% of event-involved drivers and 11% of non-involved drivers reported no regular sleep schedule. Approximately 30% of event-involved drivers and non-involved drivers reported napping during the day. A majority of respondents in both driver groups reported exercising (78.16% of drivers with a moving violation; 70.06% of matched drivers without a moving violation), at moderate frequency (47.13% of drivers with a moving violation; 39.17% of matched drivers without a moving violation). Over half of each group showed lower normal ratings on the ESS (58.62% and 57.31% of drivers with and without a moving violation, respectively).

Table 12. Moving violations: Distribution of demographic questionnaire categorical variables for younger drivers with and without a safety event.

Demographic Characteristic	Number of Drivers with Event	Drivers with Event (%)	Number of Matched Drivers without Event	Matched Drivers without Event (%)
Gender: Male	132	96.35	517	96.64
Gender: Female	5	3.65	18	3.36
Marital Status: Single	76	86.35	250	73.10
Marital Status: Married	9	10.23	85	24.85
Marital Status: Divorced	3	3.41	7	2.05
Highest Academic Degree: None listed	5	5.81	19	5.64
Highest Academic Degree: GED	10	11.63	53	15.73
Highest Academic Degree: HS diploma	63	73.26	242	71.81
Highest Academic Degree: Associate's	7	8.14	19	5.64
Highest Academic Degree: Bachelor's	1	1.16	4	1.19
Regular Sleep Schedule: No	12	15.00	36	11.36
Regular Sleep Schedule: Yes	37	46.25	143	45.11
Regular Sleep Schedule: Sometimes	31	38.75	138	43.53
Nap During the Day: No, not usually	59	70.24	232	69.05
Nap During the Day: Yes, usually	25	29.76	104	30.95
Exercise Off Work: No	19	21.84	100	29.94
Exercise Off Work: Yes	68	78.16	234	70.06

Demographic Characteristic	Number of Drivers with Event	Drivers with Event (%)	Number of Matched Drivers without Event	Matched Drivers without Event (%)
Weekly Exercise Frequency: None	18	20.69	99	29.38
Weekly Exercise Frequency: Moderate	41	47.13	132	39.17
Weekly Exercise Frequency: Substantial	28	32.18	106	31.45
ESS: Lower normal	51	58.62	196	57.31
ESS: Higher normal	25	28.74	113	33.33
ESS: Mild excessive	5	5.75	16	4.68
ESS: Moderate excessive	3	3.45	13	3.80
ESS: Severe excessive	3	3.45	3	0.88

Table 13 presents summary statistics for demographic questionnaire continuous variables for drivers with a moving violation and matched drivers without a moving violation. Once again, the scores reflect missing response items within each questionnaire and may be low compared to scores found in other research studies. Drivers with and without involvement in a moving violation had an average DDDI negative emotion subscale score of approximately 17 and an average DDDI aggressive driving subscale score of more than 8.8. Drivers with a moving violation had DDDI risky driving subscale scores of 15.798; drivers without a moving violation had scores of 14.942. Drivers with a moving violation had an average SDS score of 22.417, and matched drivers had an average score of 23.206. Across all SRLE subscales, average scores for drivers with moving violations ranged within 0.003 and 0.569 points of the average scores for drivers without moving violations. The subscale with the largest average score difference was the social and cultural score, which was 0.569 points higher for drivers with a moving violation.

Table 13. Moving violations: Distribution of demographic questionnaire continuous variables for younger drivers with and without a safety event.

Demographic Characteristic	Average for Drivers with Event (SD)	Average for Matched Drivers without Event (SD)
DDDI Subscale: Negative Emotion Score	17.412 (5.722)	17.300 (5.877)
DDDI Subscale: Aggressive Driving Score	8.894 (2.659)	8.831 (2.749)
DDDI Subscale: Risky Driving Score	15.798 (3.874)	14.942 (4.502)
SDS Score	22.417 (3.398)	23.206 (3.860)
SRLE Subscale: Social and Cultural	16.655 (4.995)	16.086 (4.564)
SRLE Subscale: Work	10.699 (3.378)	10.529 (3.258)
SRLE Subscale: Time Pressure	14.119 (4.614)	13.813 (4.600)
SRLE Subscale: Finances	10.560 (4.001)	10.897 (4.155)
SRLE Subscale: Social Acceptability	7.810 (2.722)	7.807 (2.998)
SRLE Subscale: Social Victimization	7.012 (2.988)	7.042 (2.761)

3.1.5 Individual Regression Model Results

Table 14 presents the statistically significant logistic regression modeling results for driver demographic questionnaire variables. The table includes the model outcome in terms of ORs and 95% CIs. The ORs indicate how the odds of involvement in a safety event change when in variable comparison level A compared to level B. Few comparisons showed statistical significance. A full table of significant and non-significant results is included in Appendix A. Comparisons with insufficient counts for meaningful analysis were excluded from Table 34 in Appendix A. The odds of being involved in a carrier-recorded crash were lower for drivers with their highest academic degree not listed compared to drivers with a HS diploma, OR = 0.289, 95% CI = (0.081, 0.961), or bachelor's degree, OR = 0.139, 95% CI = (0.022, 0.887). Drivers who reported moderate weekly exercise were more likely to be involved in a nationally recorded crash compared to drivers with substantial weekly exercise, OR = 2.303, 95% CI = (1.137, 4.627). All other comparisons were either not statistically significant or did not have sufficient counts in the compared variable levels for analysis.

Table 14. Odds ratios and 95% confidence interval results for safety event involvement by demographic questionnaire variables.

Variable	Comparison Level A	Comparison Level B	Carrier-Recorded Crash	Carrier-Recorded Preventable Crash	Nationally Recorded Crash	Moving Violation
Highest Academic Degree	None listed	GED	0.275 (0.075, 1.004)	0.632 (0.156, 2.564)	1.227 (0.306, 4.927)	1.394 (0.422, 4.605)
Highest Academic Degree	None listed	HS diploma	0.289* (0.087, 0.961)	0.565 (0.161, 1.988)	1.708 (0.519, 5.619)	1.011 (0.363, 2.813)
Highest Academic Degree	None listed	Associate's degree	0.365 (0.089, 1.488)	0.789 (0.156, 4.002)	2.545 (0.481, 13.458)	0.714 (0.192, 2.652)
Highest Academic Degree	None listed	Bachelor's degree	0.139* (0.022, 0.887)	1.105 (0.098, 12.472)	1.091 (0.153, 7.802)	1.053 (0.095, 11.633)
Highest Academic Degree	HS diploma	GED	0.949 (0.525, 1.713)	1.117 (0.522, 2.391)	0.718 (0.306, 1.689)	1.379 (0.665, 2.863)
Highest Academic Degree	Associate's degree	GED	0.753 (0.294, 1.928)	0.800 (0.223, 2.871)	0.482 (0.114, 2.044)	1.953 (0.651, 5.860)
Highest Academic Degree	Bachelor's degree	GED	1.976 (0.428, 9.135)	0.571 (0.063, 5.193)	1.125 (0.189, 6.699)	1.325 (0.134, 13.122)
Highest Academic Degree	HS diploma	Associate's degree	1.260 (0.565, 2.811)	1.397 (0.456, 4.274)	1.490 (0.425, 5.220)	0.706 (0.284, 1.754)
Highest Academic Degree	HS diploma	Bachelor's degree	0.480 (0.113, 2.047)	1.955 (0.235, 16.267)	0.639 (0.125, 3.272)	1.041 (0.114, 9.481)
Highest Academic Degree	Associate's degree	Bachelor's degree	0.381 (0.075, 1.933)	1.400 (0.133, 14.743)	0.429 (0.058, 3.186)	1.474 (0.140, 15.557)
Weekly Exercise Frequency	Moderate weekly exercise	No weekly exercise	1.179 (0.713, 1.952)	1.079 (0.557, 2.091)	1.778 (0.840, 3.760)	1.708 (0.926, 3.152)
Weekly Exercise Frequency	Moderate weekly exercise	Substantial weekly exercise	1.167 (0.729, 1.868)	0.779 (0.414, 1.468)	2.303* (1.137, 4.627)	1.176 (0.682, 2.026)
Weekly Exercise Frequency	Substantial weekly exercise	No weekly exercise	1.011 (0.584, 1.749)	1.385 (0.674, 2.847)	0.772 (0.326, 1.828)	1.453 (0.757, 2.790)

* indicates statistically significant result at $\alpha = 0.05$.

3.2 DRIVING-RELATED FACTORS

The following section presents the analysis results for driving-related variables, collected from the demographic questionnaire data. These variables include information regarding driver licensing, training, and behavior while driving.

3.2.1 Carrier-Recorded Crashes

Table 15 presents the distributions of driving-related categorical variables from the demographic questionnaire for drivers with a carrier-recorded crash and matched drivers without a carrier-recorded crash. For both groups of drivers, the most common CDL type was Class A (96.19% of drivers with a carrier-recorded crash and 98.78% of matched drivers without a carrier-recorded crash). Drivers reported various endorsements, including tanker vehicle (30.08% of drivers with the event; 26.34% of drivers without the event), double/triple trailers (23.58% with; 15.85% without), and hazardous materials (18.70% with; 13.39% without). The following endorsements were reported by less than 10% of drivers each: combination HazMat/trailer, bus passenger, and school bus. Drivers reported high rates of seat belt use in passenger vehicles (86.89% of drivers with a carrier-recorded crash and 87.02% of drivers without a carrier-recorded crash reported “always” using their seat belt in a personal vehicle). Rates of reported seat belt use were even higher in commercial vehicles (99.18% of drivers with a carrier-recorded crash and 95.54% of drivers without a carrier-recorded crash reported “always” using their seat belt in a commercial vehicle).

Less than one quarter of drivers reported involvement in any crash in the previous 3 years (21.95% of drivers with event; 24.66% of matched drivers). The proportion of drivers reporting involvement in a moving violation in the previous 3 years was 27.68% of drivers with a carrier-recorded crash and 32.70% of drivers without a carrier-recorded crash. Nearly 8% of drivers in both groups reported being placed out-of-service (OOS) in the previous 3 years. Drivers reported varying experiences with training—in both groups, approximately 80% of drivers attended formal truck driving training school, over 95% of drivers reported receiving on-the-job training, and one third or fewer drivers received informal training.

Table 15. Carrier-recorded crashes: Distribution of driving-related, demographic questionnaire categorical variables for younger drivers with and without a safety event.

Driving-Related Characteristic	Number of Drivers with Event	Drivers with Event (%)	Number of Matched Drivers without Event	Matched Drivers without Event (%)
CDL Type: Class A	101	96.19	404	98.78
CDL Type: Class B	1	0.95	1	0.24
CDL Type: Class C	0	0.00	0	0.00
CDL Type: Other	3	2.86	4	0.98
Endorsement: Hazardous Materials	23	18.70	60	13.39
Endorsement: Bus Passenger	3	2.44	19	4.24
Endorsement: School Bus	2	1.63	1	2.01
Endorsement: Tanker Vehicle	37	30.08	118	26.34

Driving-Related Characteristic	Number of Drivers with Event	Drivers with Event (%)	Number of Matched Drivers without Event	Matched Drivers without Event (%)
Endorsement: Double/Triple Trailers	29	23.58	71	15.85
Endorsement: Combination HazMat/Trailer	33	7.37	9	7.32
Personal Vehicle Seat Belt Use: Never	1	0.82	2	0.45
Personal Vehicle Seat Belt Use: Rarely	2	1.64	8	1.79
Personal Vehicle Seat Belt Use: Sometimes	3	2.46	12	2.68
Personal Vehicle Seat Belt Use: Often	10	8.20	36	8.05
Personal Vehicle Seat Belt Use: Always	106	86.89	389	87.02
Commercial Vehicle Seat Belt Use: Never	0	0.00	0	0.00
Commercial Vehicle Seat Belt Use: Rarely	0	0.00	3	0.67
Commercial Vehicle Seat Belt Use: Sometimes	0	0.00	7	1.56
Commercial Vehicle Seat Belt Use: Often	1	0.82	10	2.23
Commercial Vehicle Seat Belt Use: Always	121	99.18	428	95.54
Any Crash in Previous 3 Years: Yes	27	21.95	110	24.66
Any Moving Violation in Previous 3 Years: Yes	31	27.68	138	32.70
Any OOS Placement in Previous 3 Years: Yes	9	7.50	34	7.74
Commercial Vehicle Crash in Previous 3 Years	20	10.81	75	10.46
At Fault Crash in Previous 3 Years	9	4.86	42	5.86
Personal Vehicle Crash in Previous 3 Years	10	5.41	42	5.86
Roadside Departure Crash in Previous 3 Years	2	1.08	0	0.00
Rear-End Crash in Previous 3 Years	3	1.62	12	1.67
Sideswipe Crash in Previous 3 Years	6	3.24	28	3.91
Hit Fixed Object Crash in Previous 3 Years	5	2.70	16	2.23
Hit Moving Object Crash in Previous 3 Years	2	1.08	2	0.28
Backing Crash in Previous 3 Years	5	2.70	20	2.79
Parking Lot Crash in Previous 3 Years	1	0.54	10	1.39
Rollover Crash in Previous 3 Years	0	0.00	8	1.12
Jackknife Crash in Previous 3 years	0	0.00	0	0.00
T-Bone Crash in Previous 3 Years	1	0.54	12	1.67
Head-On Crash in Previous 3 Years	0	0.00	3	0.42
Pedestrian Crash in Previous 3 Years	0	0.00	0	0.00
Other Crash in Previous 3 Years	4	2.16	23	3.21
Attended formal truck driving training school: Yes	91	82.73	329	79.66
Received informal training: Yes	34	27.87	151	33.41
Received on-the-job training: Yes	101	95.28	385	97.72

Table 16 presents the distributions of driving-related continuous variables from the demographic questionnaire for drivers with a carrier-recorded crash and matched drivers without a carrier-recorded crash. Drivers with a carrier-recorded crash reported an average of 16.37 months of experience driving commercial vehicles, and the matched drivers reported an average of 16.88

months of experience. Drivers with a carrier-recorded crash reported an average of 3 weeks of formal training, 9 weeks of informal training, and 11 weeks of on-the-job training. Drivers without a carrier-recorded crash reported an average of 3 weeks of formal training, 8 weeks of informal training, and 15 weeks of on-the-job training.

Table 16. Carrier-recorded crashes: Distribution of driving-related, demographic questionnaire continuous variables for younger drivers with and without safety event.

Driving-Related Characteristic	Average for Drivers with Event (SD)	Average for Matched Drivers without Event (SD)
Months of Experience Driving Commercial Vehicles	16.37 (15.43)	16.88 (15.76)
Weeks of Formal Training	3.25 (3.62)	3.33 (2.71)
Weeks of Informal Training	9.50 (25.82)	8.00 (16.83)
Weeks of On-the-Job Training	11.16 (24.31)	15.20 (28.28)

3.2.2 Carrier-Recorded Preventable Crashes

Table 17 presents the distributions of driving-related categorical variables from the demographic questionnaire for drivers with a carrier-recorded preventable crash and matched drivers without a carrier-recorded preventable crash. In each driver group, the most common CDL type was Class A (96.36% of drivers with a carrier-recorded preventable crash and 98.78% of matched drivers without a carrier-recorded preventable crash). The most frequently reported endorsements included tanker vehicle (27.94% of drivers with the event; 25.19% of drivers without the event), double/triple trailers (23.53% with; 17.29% without), and hazardous materials (16.18% with; 18.05% without). A majority of drivers with carrier-recorded preventable crashes reported always using their seat belt (88.25% in personal vehicles and 100% in commercial vehicles). The same was true for drivers with a carrier-recorded preventable crash (85.34 % in personal vehicles and 95.11% in commercial vehicles).

Crash involvement in the previous 3 years was reported by 20.59% of drivers with a carrier-recorded preventable crash and 26.49% of matched drivers. The proportion of drivers reporting involvement in a moving violation in the previous 3 years was 29.03% of drivers with a carrier-recorded crash and 32.39% of matched drivers without a carrier-recorded crash. OOS placement in the previous 3 years was reported by nearly 8% of drivers with a carrier-recorded preventable crash and nearly 6% of matched drivers. Nearly all drivers reported receiving on-the-job training (94.64% and 97.10% of drivers with and without a carrier-recorded preventable crash, respectively). In both groups, just over 80% of drivers attended formal truck driving training school, and one third or fewer drivers received informal training.

Table 17. Carrier-recorded preventable crashes: Distribution of driving-related, demographic questionnaire categorical variables for younger drivers with and without a safety event.

Driving-Related Characteristic	Number of Drivers with Event	Drivers with Event (%)	Number of Matched Drivers without Event	Matched Drivers without Event (%)
CDL Type: Class A	53	96.36	243	98.78
CDL Type: Class B	0	0.00	0	0.00
CDL Type: Class C	0	0.00	0	0.00
CDL Type: Other	2	3.64	3	1.22
Endorsement: Hazardous Materials	11	16.18	48	18.05
Endorsement: Bus Passenger	2	2.94	8	3.01
Endorsement: School Bus	1	1.47	4	1.50
Endorsement: Tanker Vehicle	19	27.94	67	25.19
Endorsement: Double/Triple Trailers	16	23.53	46	17.29
Endorsement: Combination HazMat/Trailer	19	7.14	5	7.35
Personal Vehicle Seat Belt Use: Never	0	0.00	1	0.38
Personal Vehicle Seat Belt Use: Rarely	1	1.47	3	1.13
Personal Vehicle Seat Belt Use: Sometimes	0	0.00	12	4.51
Personal Vehicle Seat Belt Use: Often	7	10.29	23	8.65
Personal Vehicle Seat Belt Use: Always	60	88.24	227	85.34
Commercial Vehicle Seat Belt Use: Never	0	0.00	1	0.38
Commercial Vehicle Seat Belt Use: Rarely	0	0.00	0	0.00
Commercial Vehicle Seat Belt Use: Sometimes	0	0.00	3	1.13
Commercial Vehicle Seat Belt Use: Often	0	0.00	9	3.38
Commercial Vehicle Seat Belt Use: Always	68	100.00	253	95.11
Any Crash in Previous 3 Years: Yes	14	20.59	71	26.49
Any Moving Violation in Previous 3 Years: Yes	18	29.03	80	32.39
Any OOS Placement in Previous 3 Years: Yes	5	7.58	15	5.75
Commercial Vehicle Crash in Previous 3 Years	11	10.58	55	13.38
At Fault Crash in Previous 3 Years	3	2.88	29	7.06
Personal Vehicle Crash in Previous 3 Years	5	4.81	22	5.35
Roadside Departure Crash in Previous 3 Years	0	0.00	1	0.24
Rear-End Crash in Previous 3 Years	1	0.96	14	3.41
Sideswipe Crash in Previous 3 Years	2	1.92	22	5.35
Hit Fixed Object Crash in Previous 3 Years	4	3.85	15	3.65
Hit Moving Object Crash in Previous 3 Years	2	1.92	0	0.00
Backing Crash in Previous 3 Years	2	1.92	9	2.19
Parking Lot Crash in Previous 3 Years	1	0.96	6	1.46
Rollover Crash in Previous 3 Years	0	0.00	4	0.97
Jackknife Crash in Previous 3 years	0	0.00	0	0.00
T-Bone Crash in Previous 3 Years	1	0.96	5	1.22

Driving-Related Characteristic	Number of Drivers with Event	Drivers with Event (%)	Number of Matched Drivers without Event	Matched Drivers without Event (%)
Head-On Crash in Previous 3 Years	0	0.00	0	0.00
Pedestrian Crash in Previous 3 Years	0	0.00	0	0.00
Other Crash in Previous 3 Years	1	0.96	9	2.19
Attended formal truck driving training school: Yes	49	83.05	195	80.25
Received informal training: Yes	20	29.85	86	31.73
Received on-the-job training: Yes	53	94.64	234	97.10

Table 18 presents the distributions of driving-related continuous variables from the demographic questionnaire for drivers with a carrier-recorded preventable crash and matched drivers without a carrier-recorded preventable crash. Drivers with a carrier-recorded preventable crash reported an average of 15.26 months of experience driving commercial vehicles, while the matched drivers reported an average of 16.68 months of experience. Drivers with a carrier-recorded preventable crash reported an average of 2.79 weeks of formal training, 5.52 weeks of informal training, and 13.04 weeks of on-the-job training. Drivers without a carrier-recorded preventable crash reported an average of 3.23 weeks of formal training, 14.48 weeks of informal training, and 13.43 weeks of on-the-job training.

Table 18. Carrier-recorded preventable crashes: Distribution of driving-related, demographic questionnaire continuous variables for younger drivers with and without a safety event.

Driving-Related Characteristic	Average for Drivers with Event (SD)	Average for Matched Drivers without Event (SD)
Months of Experience Driving Commercial Vehicles	15.26 (15.5)	16.68 (16.28)
Weeks of Formal Training	2.79 (2.37)	3.23 (3.04)
Weeks of Informal Training	5.52 (4.29)	14.48 (68.17)
Weeks of On-the-Job Training	13.04 (34.27)	13.43 (50.69)

3.2.3 Nationally Recorded Crashes

Table 19 presents the distributions of driving-related categorical variables from the demographic questionnaire for drivers with a nationally recorded crash and matched drivers without a nationally recorded crash. As in the previous driver subsets, the most common CDL type was Class A (98.00% of drivers with a nationally recorded crash and 99.18% of matched drivers without a nationally recorded crash). The most frequently reported endorsements for drivers with a nationally recorded crash included tanker vehicle (38.33%), double/triple trailers (33.33%), hazardous materials (25.00%), and combination HazMat/trailer (11.67%). The most frequently reported endorsements for drivers without a nationally recorded crash included tanker vehicle (26.12%), double/triple trailers (19.78%), and hazardous materials (17.91%). A majority of drivers in both groups reported always using their seat belt (85.00% in personal vehicles and

100% in commercial vehicles for drivers with a nationally recorded crash; 86.47% in personal vehicles and 95.51% in commercial vehicles for matched drivers).

Crash involvement in the previous 3 years was reported by 30.51% of drivers with a nationally recorded crash and 22.85% of matched drivers. Moving violation involvement in the previous 3 years was reported by 38.00% of drivers with a nationally recorded crash and 35.74% of matched drivers. OOS placement in the previous 3 years was reported by 12.50% of drivers with a nationally recorded crash and less than 5% of matched drivers. As seen in the previous driver subsets, most drivers had on-the-job training (91.67% and 96.36% of drivers with and without a nationally recorded crash, respectively). In both groups, nearly 80% of drivers attended formal truck driving training school. Informal training was reported by 31.67% of drivers with a nationally recorded crash and 35.06% of matched drivers.

Table 19. Nationally recorded crashes: Distribution of driving-related, demographic questionnaire categorical variables for younger drivers with and without a safety event.

Driving-Related Characteristic	Number of Drivers with Event	Drivers with Event (%)	Number of Matched Drivers without Event	Matched Drivers without Event (%)
CDL Type: Class A	49	98.00	242	99.18
CDL Type: Class B	0	0.00	1	0.41
CDL Type: Class C	0	0.00	0	0.00
CDL Type: Other	1	2.00	1	0.41
Endorsement: Hazardous Materials	15	25.00	48	17.91
Endorsement: Bus Passenger	1	1.67	6	2.24
Endorsement: School Bus	1	1.67	5	1.87
Endorsement: Tanker Vehicle	23	38.33	70	26.12
Endorsement: Double/Triple Trailers	20	33.33	53	19.78
Endorsement: Combination HazMat/Trailer	7	11.67	24	8.95
Personal Vehicle Seat Belt Use: Never	1	1.67	1	0.38
Personal Vehicle Seat Belt Use: Rarely	0	0.00	3	1.13
Personal Vehicle Seat Belt Use: Sometimes	2	3.33	14	5.26
Personal Vehicle Seat Belt Use: Often	6	10.00	18	6.77
Personal Vehicle Seat Belt Use: Always	51	85.00	230	86.47
Commercial Vehicle Seat Belt Use: Never	0	0.00	0	0.00
Commercial Vehicle Seat Belt Use: Rarely	0	0.00	0	0.00
Commercial Vehicle Seat Belt Use: Sometimes	0	0.00	3	1.12
Commercial Vehicle Seat Belt Use: Often	0	0.00	9	3.37
Commercial Vehicle Seat Belt Use: Always	60	100.00	255	95.51
Any Crash in Previous 3 Years: Yes	18	30.51	61	22.85
Any Moving Violation in Previous 3 Years: Yes	19	38.00	89	35.74
Any OOS Placement in Previous 3 Years: Yes	7	12.50	12	4.53
Commercial Vehicle Crash in Previous 3 Years	15	13.89	47	10.90
At Fault Crash in Previous 3 Years	8	7.41	26	6.03

Driving-Related Characteristic	Number of Drivers with Event	Drivers with Event (%)	Number of Matched Drivers without Event	Matched Drivers without Event (%)
Personal Vehicle Crash in Previous 3 Years	3	2.78	18	4.18
Roadside Departure Crash in Previous 3 Years	1	0.93	1	0.23
Rear-End Crash in Previous 3 Years	3	2.78	7	1.62
Sideswipe Crash in Previous 3 Years	4	3.70	21	4.87
Hit Fixed Object Crash in Previous 3 Years	5	4.63	11	2.55
Hit Moving Object Crash in Previous 3 Years	0	0.00	1	0.23
Backing Crash in Previous 3 Years	5	4.63	7	1.62
Parking Lot Crash in Previous 3 Years	2	1.85	5	1.16
Rollover Crash in Previous 3 Years	0	0.00	0	0.00
Jackknife Crash in Previous 3 years	0	0.00	0	0.00
T-Bone Crash in Previous 3 Years	0	0.00	3	0.70
Head-On Crash in Previous 3 Years	0	0.00	0	0.00
Pedestrian Crash in Previous 3 Years	0	0.00	0	0.00
Other Crash in Previous 3 Years	4	3.70	8	1.86
Attended formal truck driving training school: Yes	39	78.00	190	79.50
Received informal training: Yes	19	31.67	95	35.06
Received on-the-job training: Yes	44	91.67	238	96.36

Table 20 presents the distributions of driving-related continuous variables from the demographic questionnaire for drivers with a nationally recorded crash and matched drivers without a nationally recorded crash. Drivers with a nationally recorded crash reported an average of 18.48 months of experience driving commercial vehicles. These drivers reported an average of 2.65 weeks of formal training, 16.45 weeks of informal training, and 17.64 weeks of on-the-job training. Drivers without a nationally recorded crash reported an average of 14 months of experience driving commercial vehicles. These matched drivers reported an average of 3.03 weeks of formal training, 20.17 weeks of informal training, and 32.47 weeks of on-the-job training.

Table 20. Nationally recorded crashes: Distribution of driving-related, demographic questionnaire continuous variables for younger drivers with and without a safety event.

Driving-Related Characteristic	Average for Drivers with Event (SD)	Average for Matched Drivers without Event (SD)
Months of Experience Driving Commercial Vehicles	18.48 (10.34)	14.00 (12.94)
Weeks of Formal Training	2.65 (2.43)	3.03 (2.56)
Weeks of Informal Training	16.45 (39.79)	20.17 (0.80)
Weeks of On-the-Job Training	17.64 (31.79)	32.47 (130.86)

3.2.4 Moving Violations

Table 21 presents the distributions of driving-related categorical variables from the demographic questionnaire for drivers with a moving violation and matched drivers without a moving violation. As with the previous driver subsets, the most common CDL type was Class A (98.70% of drivers with a moving violation and 98.03% of matched drivers without a moving violation). In both driver groups, the most frequently reported endorsements included tanker vehicle (17.44% of drivers with a moving violation; 23.67% of matched drivers), double/triple trailers (17.44% with; 18.93% without), and hazardous materials (12.79% with; 16.27% without). Once again, a majority of drivers in both groups reported always using their seat belt (87.21% in personal vehicles and 98.84% in commercial vehicles for drivers with a moving violation; 86.05% in personal vehicles and 97.92% in commercial vehicles for matched drivers).

Crash involvement in the previous 3 years was reported by 20.93% of drivers with a moving violation and 23.53% of matched drivers. Moving violation involvement in the previous 3 years was reported by 29.17% of drivers with a moving violation and 28.66% of matched drivers. Few drivers reported OOS placement in the previous 3 years (4.71% of drivers with a moving violation and 3.63% of matched drivers). Nearly all drivers had on-the-job training (97.44% and 96.39% of drivers with and without a moving violation, respectively). Attendance at a formal truck driving training school was reported by 79.73% of drivers with a moving violation and 78.93% of matched drivers, while informal training was reported by 31.03% of drivers with a moving violation and 35.78% of matched drivers.

Table 21. Moving violations: Distribution of driving-related, demographic questionnaire categorical variables for younger drivers with and without a safety event.

Driving-Related Characteristic	Number of Drivers with Event	Drivers with Event (%)	Number of Matched Drivers without Event	Matched Drivers without Event (%)
CDL Type: Class A	76	98.70	299	98.03
CDL Type: Class B	0	0.00	0	0.00
CDL Type: Class C	0	0.00	0	0.00
CDL Type: Other	1	1.30	6	1.97
Endorsement: Hazardous Materials	11	12.79	55	16.27
Endorsement: Bus Passenger	3	3.49	6	1.78
Endorsement: School Bus	2	2.33	3	0.89
Endorsement: Tanker Vehicle	15	17.44	80	23.67
Endorsement: Double/Triple Trailers	15	17.44	64	18.93
Endorsement: Combination HazMat/Trailer	5	5.81	22	6.51
Personal Vehicle Seat Belt Use: Never	1	1.16	3	0.89
Personal Vehicle Seat Belt Use: Rarely	0	0.00	8	2.37
Personal Vehicle Seat Belt Use: Sometimes	1	1.16	11	3.26
Personal Vehicle Seat Belt Use: Often	9	10.47	25	7.42
Personal Vehicle Seat Belt Use: Always	75	87.21	290	86.05
Commercial Vehicle Seat Belt Use: Never	0	0.00	0	0.00

Driving-Related Characteristic	Number of Drivers with Event	Drivers with Event (%)	Number of Matched Drivers without Event	Matched Drivers without Event (%)
Commercial Vehicle Seat Belt Use: Rarely	0	0.00	1	0.30
Commercial Vehicle Seat Belt Use: Sometimes	0	0.00	4	1.19
Commercial Vehicle Seat Belt Use: Often	1	1.16	2	0.59
Commercial Vehicle Seat Belt Use: Always	85	98.84	330	97.92
Any Crash in Previous 3 Years: Yes	18	20.93	80	23.53
Any Moving Violation in Previous 3 Years: Yes	21	29.17	92	28.66
Any OOS Placement in Previous 3 Years: Yes	4	4.71	12	3.363
Commercial Vehicle Crash in Previous 3 Years	13	8.90	50	8.58
At Fault Crash in Previous 3 Years	8	5.48	30	5.15
Personal Vehicle Crash in Previous 3 Years	5	3.42	33	5.66
Roadside Departure Crash in Previous 3 Years	0	0.00	1	0.17
Rear-End Crash in Previous 3 Years	3	2.05	13	2.23
Sideswipe Crash in Previous 3 Years	3	2.05	22	3.77
Hit Fixed Object Crash in Previous 3 Years	4	2.74	13	2.23
Hit Moving Object Crash in Previous 3 Years	1	0.68	1	0.17
Backing Crash in Previous 3 Years	6	1.03	4	2.74
Parking Lot Crash in Previous 3 Years	3	2.05	11	1.89
Rollover Crash in Previous 3 Years	1	0.68	0	0.00
Jackknife Crash in Previous 3 years	0	0.00	0	0.00
T-Bone Crash in Previous 3 Years	1	0.68	3	0.51
Head-On Crash in Previous 3 Years	1	0.68	2	0.34
Pedestrian Crash in Previous 3 Years	0	0.00	0	0.00
Other Crash in Previous 3 Years	2	1.37	15	2.57
Attended formal truck driving training school: Yes	59	79.73	236	78.93
Received informal training: Yes	27	31.03	122	35.78
Received on-the-job training: Yes	76	97.44	294	96.39

Table 22 presents the distributions of driving-related continuous variables from the demographic questionnaire for drivers with a moving violation and matched drivers without a moving violation. Drivers with a moving violation reported an average of 16.08 months of experience driving commercial vehicles. These drivers reported an average of 3 weeks of formal training, 7 weeks of informal training, and 15 weeks of on-the-job training. Drivers without a moving violation reported an average of 15.74 months of experience driving commercial vehicles. These matched drivers reported an average of 3 weeks of formal training, 9 weeks of informal training, and 18 weeks of on-the-job training.

Table 22. Moving violations: Distribution of driving-related, demographic questionnaire continuous variables for younger drivers with and without a safety event.

Driving-Related Characteristic	Average for Drivers with Event (SD)	Average for Matched Drivers without Event (SD)
Months of Experience Driving Commercial Vehicles	16.08 (14.96)	15.74 (15.38)
Weeks of Formal Training	3.11 (3.83)	3.13 (2.72)
Weeks of Informal Training	7.16 (10.18)	9.33 (21.82)
Weeks of On-the-Job Training	15.15 (28.71)	18.14 (36.28)

3.2.5 Individual Regression Model Results

Table 23 presents the statistically significant individual logistic regression model results for driving-related variables from the demographic questionnaire. Few variables showed statistically significant differences between variable levels. A full table of significant and non-significant results is included in Appendix A. Comparisons with insufficient counts for meaningful analysis were excluded from Table 35 in Appendix A. The odds of being involved in a nationally recorded crash were slightly, but significantly, higher when reported months of experience driving commercial vehicles was increased by 1 month compared to baseline months of experience, OR = 1.024, 95% CI = (1.004, 1.045). The odds of being involved in a carrier-recorded crash were higher for drivers with a double/triple trailer endorsement compared to drivers without this endorsement, OR = 1.638, 95% CI = (1.000, 2.667). Having a double/triple trailer endorsement was also associated with higher odds of involvement in a nationally recorded crash, OR = 2.028, 95% CI = (1.096, 3.752). The odds of being involved in a nationally recorded crash were 3 times higher for drivers who had been placed OOS at least once in the 3 years prior to study enrollment, OR = 3.012, 95% CI = (1.129, 8.034). All other comparisons were either not statistically significant (the odds of safety event involvement did not significantly differ between variable levels) or did not have sufficient counts in the compared variable levels for analysis.

Table 23. Odds ratios and 95% confidence interval results for safety event involvement by driving-related variables.

Variable	Comparison Level A	Comparison Level B	Carrier-Recorded Crash	Carrier-Recorded Preventable Crash	Nationally Recorded Crash	Moving Violation
Months of Experience Driving Commercial Vehicles	Baseline	1 month unit increase	0.998 (0.985, 1.011)	0.994 (0.976, 1.012)	1.024* (1.004, 1.045)	1.001 (0.986, 1.017)
Endorsement: HazMat	Yes	No	1.488 (0.877, 2.524)	0.876 (0.428, 1.795)	1.528 (0.788, 2.964)	0.755 (0.376, 1.513)
Endorsement: Bus Passenger	Yes	No	0.564 (0.164, 1.940)	0.977 (0.203, 4.711)	0.740 (0.087, 6.264)	2.000 (0.490, 8.164)
Endorsement: School Bus	Yes	No	0.806 (0.172, 3.781)	0.978 (0.108, 8.891)	0.892 (0.102, 7.773)	2.659 (0.437, 16.167)
Endorsement: Tanker Vehicle	Yes	No	1.203 (0.776, 1.866)	1.152 (0.634, 2.094)	1.758 (0.977, 3.164)	0.682 (0.370, 1.255)
Endorsement: Double/Triple Trailer	Yes	No	1.638* (1.006, 2.667)	1.472 (0.773, 2.803)	2.028* (1.096, 3.752)	0.904 (0.487, 1.681)
Endorsement: Combination HazMat/Trailer	Yes	No	0.993 (0.462, 2.135)	1.032 (0.371, 2.871)	1.343 (0.550, 3.279)	0.887 (0.326, 2.413)
Crash in Previous 3 Years	Yes	No	0.859 (0.533, 1.386)	0.719 (0.377, 1.375)	1.483 (0.795, 2.766)	0.860 (0.483, 1.532)
Moving Violation in Previous 3 Years	Yes	No	0.788 (0.497, 1.249)	0.854 (0.464, 1.571)	1.102 (0.589, 2.063)	1.025 (0.584, 1.800)
OOS Placement in Previous 3 Years	Yes	No	0.966 (0.450, 2.074)	1.344 (0.470, 3.843)	3.012* (1.129, 8.034)	1.313 (0.413, 4.178)

* indicates statistically significant result at alpha = 0.05.

3.3 HEALTH-RELATED FACTORS

The following section presents the analysis results for health-related variables, collected from the demographic questionnaire data or from the medical exam data.

3.3.1 Carrier-Recorded Crashes

Table 24 presents the distribution of diet quality and body mass index (BMI) classification for drivers involved in a carrier-recorded crash and the matched drivers without a carrier-recorded crash. More than half of each driver group reported a diet quality rated average (59.84% of drivers with a crash; 54.04% of matched drivers). Over 48% of drivers with a carrier-recorded crash had an obese BMI classification (19.48% obese class I, 9.74% obese class II, and 18.83% obese class III). More than one in four drivers with a carrier-recorded crash had a normal BMI classification (27.92%). Similar patterns were observed for matched drivers without a carrier-recorded crash. These drivers included 48.67% with obese classifications (20.68% obese class I, 15.33% obese class II, and 12.66% obese class III) and another 26.74% with normal classifications.

Table 24. Carrier-recorded crashes: Distribution of health-related characteristics for younger drivers with and without a safety event.

Health-Related Characteristic	Number of Drivers with Event	Drivers with Event (%)	Number of Matched Drivers without Event	Matched Drivers without Event (%)
Diet Quality: Poor	7	5.74	43	9.64
Diet Quality: Below Average	29	23.77	99	22.20
Diet Quality: Average	73	59.84	241	54.04
Diet Quality: Above Average	10	8.20	50	11.21
Diet Quality: Excellent	3	2.46	13	2.91
BMI Classification: Underweight	4	2.60	7	1.25
BMI Classification: Normal	43	27.92	150	26.74
BMI Classification: Overweight	33	21.43	131	23.35
BMI Classification: Obese Class I	30	19.48	116	20.68
BMI Classification: Obese Class II	15	9.74	86	15.33
BMI Classification: Obese Class III	29	18.83	71	12.66

For drivers with a carrier-recorded crash and the matched drivers without a carrier-recorded crash, Table 25 lists all medical conditions with at least one driver diagnosed with the condition or marked as potentially having the condition. Driver counts are broken down by diagnosis and treatment status. Few younger driver groups had diagnosed medical conditions. The more common diagnoses included obstructive sleep apnea (OSA; diagnosed and treated in 4.17% of drivers with a carrier-recorded crash and 1.73% of matched drivers; potential in 7.64% of drivers with a carrier-recorded crash and 6.36% of matched drivers), tobacco use (diagnosed but untreated in 4.86% of drivers with a carrier-recorded crash and 3.66% of matched drivers), lung/chest conditions (diagnosed and treated in 3.47% of drivers with a carrier-recorded crash and 3.66% of matched drivers), and high blood pressure (diagnosed and treated in 1.39% of

drivers with a carrier-recorded crash and 2.70% of matched drivers; potential in 2.08% of drivers with a carrier-recorded crash and 1.35% of matched drivers). Allergies were diagnosed and treated in 2.78% of drivers with a carrier-recorded crash but just 0.39% of matched drivers.

Not listed in Table 25 are medical conditions without any diagnoses or potential diagnoses in either driver group. These conditions included: alcohol use, cancer, eye disorder, hormone dysfunction, hormone therapy, inflammatory disease, metabolic syndrome, mouth and throat condition, neurological condition, organ failure, seizures/epilepsy, skin disease, stroke or paralysis, thyroid disorder, vascular condition, viral infection, vitamin deficiency, and weight control.

Table 25. Carrier-recorded crashes: Distribution of health-condition diagnoses and treatments for younger drivers with and without a safety event.

Medical Condition	Driver Group	Diagnosed: Treated	Diagnosed: Untreated	Diagnosed: Unsure	Potential
Abdomen and Viscera Condition	With event	0 (0.00%)	0 (0.00%)	0 (0.00%)	0 (0.00%)
Abdomen and Viscera Condition	Without event	0 (0.00%)	2 (0.39%)	0 (0.00%)	0 (0.00%)
Allergies	With event	4 (2.78%)	0 (0.00%)	0 (0.00%)	0 (0.00%)
Allergies	Without event	2 (0.39%)	0 (0.00%)	0 (0.00%)	0 (0.00%)
Elevated Blood Sugar	With event	1 (0.69%)	2 (1.39%)	0 (0.00%)	0 (0.00%)
Elevated Blood Sugar	Without event	3 (0.58%)	6 (1.16%)	0 (0.00%)	0 (0.00%)
Digestive Problems	With event	2 (1.39%)	1 (0.69%)	0 (0.00%)	0 (0.00%)
Digestive Problems	Without event	1 (0.19%)	0 (0.00%)	0 (0.00%)	1 (0.19%)
Dyslipidemia	With event	0 (0.00%)	0 (0.00%)	0 (0.00%)	0 (0.00%)
Dyslipidemia	Without event	2 (0.39%)	0 (0.00%)	0 (0.00%)	0 (0.00%)
Ear/Hearing/Balance Disorder	With event	0 (0.00%)	0 (0.00%)	1 (0.69%)	0 (0.00%)
Ear/Hearing/Balance Disorder	Without event	2 (0.39%)	0 (0.00%)	2 (0.39%)	0 (0.00%)
Genitourinary	With event	0 (0.00%)	1 (0.69%)	0 (0.00%)	1 (0.69%)
Genitourinary	Without event	0 (0.00%)	2 (0.39%)	0 (0.00%)	1 (0.19%)
Head/Brain Injury	With event	0 (0.00%)	0 (0.00%)	1 (0.69%)	0 (0.00%)
Head/Brain Injury	Without event	0 (0.00%)	0 (0.00%)	2 (0.39%)	0 (0.00%)
Heart/Cardiovascular Disease	With event	0 (0.00%)	0 (0.00%)	2 (1.39%)	0 (0.00%)
Heart/Cardiovascular Disease	Without event	0 (0.00%)	3 (0.58%)	2 (0.39%)	3 (0.58%)
High Blood Pressure	With event	2 (1.39%)	2 (1.39%)	0 (0.00%)	3 (2.08%)
High Blood Pressure	Without event	14 (2.70%)	0 (0.00%)	0 (0.00%)	7 (1.35%)
Kidney Disease	With event	0 (0.00%)	0 (0.00%)	0 (0.00%)	3 (2.08%)
Kidney Disease	Without event	1 (0.19%)	0 (0.00%)	0 (0.00%)	9 (1.73%)
Loss of Consciousness	With event	0 (0.00%)	0 (0.00%)	0 (0.00%)	0 (0.00%)
Loss of Consciousness	Without event	0 (0.00%)	0 (0.00%)	1 (0.19%)	0 (0.00%)
Lung/Chest Condition	With event	5 (3.47%)	0 (0.00%)	1 (0.69%)	0 (0.00%)
Lung/Chest Condition	Without event	19 (3.66%)	0 (0.00%)	6 (1.16%)	0 (0.00%)
Missing Limb	With event	0 (0.00%)	0 (0.00%)	2 (1.39%)	0 (0.00%)
Missing Limb	Without event	0 (0.00%)	0 (0.00%)	1 (0.19%)	0 (0.00%)
Muscular Disease	With event	1 (0.69%)	0 (0.00%)	0 (0.00%)	0 (0.00%)
Muscular Disease	Without event	0 (0.00%)	0 (0.00%)	0 (0.00%)	0 (0.00%)

Medical Condition	Driver Group	Diagnosed: Treated	Diagnosed: Untreated	Diagnosed: Unsure	Potential
Nervous/Psychiatric Disorder	With event	1 (0.69%)	0 (0.00%)	0 (0.00%)	0 (0.00%)
Nervous/Psychiatric Disorder	Without event	10 (1.93%)	2 (0.39%)	2 (0.39%)	0 (0.00%)
OSA	With event	6 (4.17%)	0 (0.00%)	0 (0.00%)	11 (7.64%)
OSA	Without event	9 (1.73%)	0 (0.00%)	0 (0.00%)	33 (6.36%)
Other Sleep Disorders	With event	0 (0.00%)	0 (0.00%)	0 (0.00%)	0 (0.00%)
Other Sleep Disorders	Without event	2 (0.39%)	0 (0.00%)	0 (0.00%)	0 (0.00%)
Spine/Other Musculoskeletal Disorder	With event	0 (0.00%)	0 (0.00%)	0 (0.00%)	0 (0.00%)
Spine/Other Musculoskeletal Disorder	Without event	0 (0.00%)	4 (0.77%)	1 (0.19%)	0 (0.00%)
Tobacco Use	With event	1 (0.69%)	7 (4.86%)	0 (0.00%)	0 (0.00%)
Tobacco Use	Without event	0 (0.00%)	19 (3.66%)	0 (0.00%)	0 (0.00%)

3.3.2 Carrier-Recorded Preventable Crashes

Table 26 presents the distribution of diet quality and BMI classification for drivers involved in a carrier-recorded preventable crash and the matched drivers without a carrier-recorded preventable crash. Approximately 60% of both driver groups reported a diet quality rated average (60.29% of drivers with a crash; 59.62% of matched drivers). Nearly half of both driver groups had obese BMI classifications (for those with a preventable crash: 21.84% obese class I, 9.20% obese class II, and 17.24% obese class III; for matched drivers: 16.45% obese class I, 13.87% obese class II, and 18.71% obese class III). Drivers with preventable crashes included 26.44% with normal BMI classifications and 21.84% with overweight BMI classifications. Matched drivers without a preventable crash included 29.03% with normal BMI classifications and 20.32% with overweight BMI classifications.

Table 26. Carrier-recorded preventable crashes: Distribution of health-related characteristics for younger drivers with and without a safety event.

Health-Related Characteristic	Number of Drivers with Event	Drivers with Event (%)	Number of Matched Drivers without Event	Matched Drivers without Event (%)
Diet Quality: Poor	4	5.88	24	9.06
Diet Quality: Below Average	17	25.00	59	22.26
Diet Quality: Average	41	60.29	158	59.62
Diet Quality: Above Average	4	5.88	17	6.42
Diet Quality: Excellent	2	2.94	7	2.64
BMI Classification: Underweight	3	3.45	5	1.61
BMI Classification: Normal	23	26.44	90	29.03
BMI Classification: Overweight	19	21.84	63	20.32
BMI Classification: Obese Class I	19	21.84	51	16.45
BMI Classification: Obese Class II	8	9.20	43	13.87
BMI Classification: Obese Class III	15	17.24	58	18.71

For drivers with a carrier-recorded preventable crash and the matched drivers without a carrier-recorded preventable crash, Table 27 lists all medical conditions with at least one driver diagnosed with the condition or marked as potentially having the condition. Driver counts are broken down by diagnosis and treatment status. Few drivers were diagnosed or potentially diagnosed with medical conditions in either group. The most commonly observed conditions were the following. OSA was marked as potential in 6.25% of drivers with a carrier-recorded preventable crash and 8.46% of matched drivers. OSA was diagnosed and treated in 2.57% of matched drivers, but not in any drivers with a carrier-recorded preventable crash. Other observed conditions included lung/chest condition (diagnosed and treated in 3.75% of drivers with a carrier-recorded preventable crash and 3.31% of matched drivers), tobacco use (diagnosed and untreated in 3.75% of drivers with a crash and 5.51% of matched drivers), kidney disease (potential in 2.50% of drivers with a crash and 2.21% of matched drivers), high blood pressure (diagnosed and treated in 1.25% of drivers with a crash and 2.57% of matched drivers; potential in 2.50% of drivers with a crash and 2.21% of matched drivers), and allergies (diagnosed and treated in 3.75% of drivers with a crash and 0.37% of matched drivers).

Not listed in Table 27 are the medical conditions without any diagnoses or potential diagnoses in either driver group. These included: abdomen and viscera condition, alcohol use, cancer, hormone dysfunction, hormone therapy, inflammatory disease, metabolic syndrome, mouth and throat condition, neurological condition, organ failure, other sleep disorders, seizures/epilepsy, skin disease, stroke or paralysis, thyroid disorder, vascular condition, viral infection, vitamin deficiency, and weight control.

Table 27. Carrier-recorded preventable crashes: Distribution of health-condition diagnoses and treatments for younger drivers with and without a safety event.

Medical Condition	Driver Group	Diagnosed: Treated	Diagnosed: Untreated	Diagnosed: Unsure	Potential
Allergies	With event	3 (3.75%)	0 (0.00%)	0 (0.00%)	0 (0.00%)
Allergies	Without event	1 (0.37%)	0 (0.00%)	0 (0.00%)	0 (0.00%)
Elevated Blood Sugar	With event	0 (0.00%)	1 (1.25%)	0 (0.00%)	0 (0.00%)
Elevated Blood Sugar	Without event	3 (1.10%)	1 (0.37%)	0 (0.00%)	0 (0.00%)
Digestive Problems	With event	1 (1.25%)	0 (0.00%)	0 (0.00%)	0 (0.00%)
Digestive Problems	Without event	0 (0.00%)	0 (0.00%)	0 (0.00%)	0 (0.00%)
Dyslipidemia	With event	0 (0.00%)	0 (0.00%)	0 (0.00%)	0 (0.00%)
Dyslipidemia	Without event	1 (0.37%)	0 (0.00%)	0 (0.00%)	0 (0.00%)
Ear/Hearing/Balance Disorder	With event	0 (0.00%)	0 (0.00%)	0 (0.00%)	0 (0.00%)
Ear/Hearing/Balance Disorder	Without event	1 (0.37%)	0 (0.00%)	0 (0.00%)	0 (0.00%)
Eye Disorder	With event	0 (0.00%)	0 (0.00%)	0 (0.00%)	0 (0.00%)
Eye Disorder	Without event	2 (0.74%)	0 (0.00%)	0 (0.00%)	0 (0.00%)
Genitourinary	With event	0 (0.00%)	1 (1.25%)	0 (0.00%)	0 (0.00%)
Genitourinary	Without event	0 (0.00%)	1 (0.37%)	0 (0.00%)	0 (0.00%)
Head/Brain Injury	With event	0 (0.00%)	0 (0.00%)	0 (0.00%)	0 (0.00%)
Head/Brain Injury	Without event	0 (0.00%)	0 (0.00%)	4 (1.47%)	0 (0.00%)
Heart/Cardiovascular Disease	With event	0 (0.00%)	0 (0.00%)	0 (0.00%)	0 (0.00%)
Heart/Cardiovascular Disease	Without event	0 (0.00%)	2 (0.74%)	2 (0.74%)	1 (0.37%)

Medical Condition	Driver Group	Diagnosed: Treated	Diagnosed: Untreated	Diagnosed: Unsure	Potential
High Blood Pressure	With event	1 (1.25%)	1 (1.25%)	0 (0.00%)	2 (2.50%)
High Blood Pressure	Without event	7 (2.57%)	0 (0.00%)	0 (0.00%)	6 (2.21%)
Kidney Disease	With event	0 (0.00%)	0 (0.00%)	0 (0.00%)	2 (2.50%)
Kidney Disease	Without event	0 (0.00%)	1 (0.37%)	0 (0.00%)	6 (2.21%)
Loss of Consciousness	With event	0 (0.00%)	0 (0.00%)	0 (0.00%)	0 (0.00%)
Loss of Consciousness	Without event	0 (0.00%)	0 (0.00%)	1 (0.37%)	0 (0.00%)
Lung/Chest Condition	With event	3 (3.75%)	0 (0.00%)	0 (0.00%)	0 (0.00%)
Lung/Chest Condition	Without event	9 (3.31%)	0 (0.00%)	3 (1.10%)	0 (0.00%)
Missing Limb	With event	0 (0.00%)	0 (0.00%)	2 (2.50%)	0 (0.00%)
Missing Limb	Without event	0 (0.00%)	0 (0.00%)	0 (0.00%)	0 (0.00%)
Muscular Disease	With event	1 (1.25%)	0 (0.00%)	0 (0.00%)	0 (0.00%)
Muscular Disease	Without event	0 (0.00%)	0 (0.00%)	0 (0.00%)	0 (0.00%)
Nervous/Psychiatric Disorder	With event	0 (0.00%)	0 (0.00%)	0 (0.00%)	0 (0.00%)
Nervous/Psychiatric Disorder	Without event	7 (2.57%)	0 (0.00%)	2 (0.74%)	0 (0.00%)
OSA	With event	0 (0.00%)	0 (0.00%)	0 (0.00%)	5 (6.25%)
OSA	Without event	7 (2.57%)	0 (0.00%)	0 (0.00%)	23 (8.46%)
Spine/Other Musculoskeletal Disorder	With event	0 (0.00%)	0 (0.00%)	0 (0.00%)	0 (0.00%)
Spine/Other Musculoskeletal Disorder	Without event	0 (0.00%)	2 (0.74%)	1 (0.37%)	0 (0.00%)
Tobacco Use	With event	0 (0.00%)	3 (3.75%)	0 (0.00%)	0 (0.00%)
Tobacco Use	Without event	2 (0.74%)	15 (5.51%)	0 (0.00%)	0 (0.00%)

3.3.3 Nationally Recorded Crashes

Table 28 presents the distribution of diet quality and BMI classification for drivers involved in a nationally recorded crash and the matched drivers without a nationally recorded crash. An average diet quality was reported by 62.71% of drivers with a nationally recorded crash and 56.67% of matched drivers. Approximately 60% of both driver groups reported a diet quality rated average (60.29% of drivers with a crash; 59.62% of matched drivers). Slightly more than half of both driver groups had obese BMI classifications (for those with a preventable crash: 17.98% obese class I, 15.73% obese class II, and 19.10% obese class III; for matched drivers: 21.63% obese class I, 12.36% obese class II, and 17.13% obese class III). One in four drivers had overweight BMI classifications (24.72% of drivers with nationally recorded crashes; 25.56% of matched drivers), and one in five had normal BMI classifications (22.47% of drivers with nationally recorded crashes; 21.91% of matched drivers).

Table 28. Nationally recorded crashes: Distribution of health-related characteristics for younger drivers with and without a safety event.

Health-Related Characteristic	Number of Drivers with Event	Drivers with Event (%)	Number of Matched Drivers without Event	Matched Drivers without Event (%)
Diet Quality: Poor	5	8.47	38	14.07
Diet Quality: Below Average	12	20.34	47	17.41

Health-Related Characteristic	Number of Drivers with Event	Drivers with Event (%)	Number of Matched Drivers without Event	Matched Drivers without Event (%)
Diet Quality: Average	37	62.71	153	56.67
Diet Quality: Above Average	4	6.78	25	9.26
Diet Quality: Excellent	1	1.69	7	2.59
BMI Classification: Underweight	0	0	5	1.40
BMI Classification: Normal	20	22.47	78	21.91
BMI Classification: Overweight	22	24.72	91	25.56
BMI Classification: Obese Class I	16	17.98	77	21.63
BMI Classification: Obese Class II	14	15.73	44	12.36
BMI Classification: Obese Class III	17	19.10	61	17.13

For drivers with a nationally recorded crash and the matched drivers without a nationally recorded crash, Table 29 lists all medical conditions with at least one driver diagnosed with the condition or marked as potentially having the condition. Driver counts are broken down by diagnosis and treatment status. Few medical conditions were observed in either group. Some of the most commonly observed conditions were the following. OSA was marked as potential in 8.99% of drivers with a nationally recorded crash and 7.18% of matched drivers, but OSA was diagnosed and treated in 3.31% of matched drivers and no drivers with a crash. Other common conditions included lung/chest condition (diagnosed and treated in 4.14% of matched drivers), tobacco use (diagnosed and untreated in 2.25% of drivers with a nationally recorded crash and 7.46% of matched drivers), kidney disease (potential in 2.25% of drivers with a crash and 1.66% of matched drivers), high blood pressure (potential in 2.25% of drivers with a crash and 1.38% of matched drivers), and elevated blood sugar (diagnosed and treated in 2.25% of drivers with a crash and 1.10% of matched drivers).

Medical conditions without any diagnoses or potential diagnoses in either driver group have been excluded from Table 29. These conditions were alcohol use, cancer, hormone dysfunction, hormone therapy, inflammatory disease, metabolic syndrome, mouth and throat condition, neurological condition, organ failure, seizures/epilepsy, skin disease, stroke or paralysis, thyroid disorder, vascular condition, viral infection, vitamin deficiency, and weight control.

Table 29. Nationally recorded crashes: Distribution of health-condition diagnoses and treatments for younger drivers with and without a safety event.

Medical Condition	Driver Group	Diagnosed: Treated	Diagnosed: Untreated	Diagnosed: Unsure	Potential
Abdomen and Viscera	With event	0 (0.00%)	0 (0.00%)	0 (0.00%)	0 (0.00%)
Abdomen and Viscera	Without event	0 (0.00%)	1 (0.28%)	1 (0.28%)	0 (0.00%)
Allergies	With event	1 (1.12%)	0 (0.00%)	0 (0.00%)	0 (0.00%)
Allergies	Without event	4 (1.10%)	0 (0.00%)	0 (0.00%)	0 (0.00%)
Elevated Blood Sugar	With event	2 (2.25%)	1 (1.12%)	0 (0.00%)	0 (0.00%)
Elevated Blood Sugar	Without event	4 (1.10%)	4 (1.10%)	0 (0.00%)	1 (0.28%)

Medical Condition	Driver Group	Diagnosed: Treated	Diagnosed: Untreated	Diagnosed: Unsure	Potential
Digestive Problems	With event	0 (0.00%)	0 (0.00%)	0 (0.00%)	0 (0.00%)
Digestive Problems	Without event	1 (0.28%)	1 (0.28%)	0 (0.00%)	0 (0.00%)
Dyslipidemia	With event	0 (0.00%)	0 (0.00%)	0 (0.00%)	0 (0.00%)
Dyslipidemia	Without event	1 (0.28%)	0 (0.00%)	0 (0.00%)	0 (0.00%)
Ear/Hearing/Balance Disorder	With event	0 (0.00%)	0 (0.00%)	1 (1.12%)	0 (0.00%)
Ear/Hearing/Balance Disorder	Without event	1 (0.28%)	0 (0.00%)	4 (1.10%)	0 (0.00%)
Eye Disorder	With event	0 (0.00%)	0 (0.00%)	0 (0.00%)	0 (0.00%)
Eye Disorder	Without event	1 (0.28%)	0 (0.00%)	0 (0.00%)	0 (0.00%)
Genitourinary	With event	0 (0.00%)	0 (0.00%)	0 (0.00%)	0 (0.00%)
Genitourinary	Without event	0 (0.00%)	0 (0.00%)	0 (0.00%)	1 (0.28%)
Head/Brain Injury	With event	0 (0.00%)	0 (0.00%)	0 (0.00%)	0 (0.00%)
Head/Brain Injury	Without event	0 (0.00%)	0 (0.00%)	2 (0.55%)	0 (0.00%)
Heart/Cardiovascular Disease	With event	0 (0.00%)	0 (0.00%)	1 (1.12%)	0 (0.00%)
Heart/Cardiovascular Disease	Without event	0 (0.00%)	0 (0.00%)	3 (0.83%)	0 (0.00%)
High Blood Pressure	With event	0 (0.00%)	0 (0.00%)	0 (0.00%)	2 (2.25%)
High Blood Pressure	Without event	5 (1.38%)	0 (0.00%)	0 (0.00%)	5 (1.38%)
Kidney Disease	With event	0 (0.00%)	0 (0.00%)	0 (0.00%)	2 (2.25%)
Kidney Disease	Without event	0 (0.00%)	2 (0.55%)	0 (0.00%)	6 (1.66%)
Loss of Consciousness	With event	0 (0.00%)	0 (0.00%)	0 (0.00%)	0 (0.00%)
Loss of Consciousness	Without event	0 (0.00%)	0 (0.00%)	2 (0.55%)	0 (0.00%)
Lung/Chest Condition	With event	0 (0.00%)	0 (0.00%)	1 (1.12%)	0 (0.00%)
Lung/Chest Condition	Without event	15 (4.14%)	0 (0.00%)	6 (1.66%)	0 (0.00%)
Missing Limb	With event	0 (0.00%)	0 (0.00%)	0 (0.00%)	0 (0.00%)
Missing Limb	Without event	0 (0.00%)	0 (0.00%)	3 (0.83%)	0 (0.00%)
Muscular Disease	With event	0 (0.00%)	0 (0.00%)	0 (0.00%)	0 (0.00%)
Muscular Disease	Without event	2 (0.55%)	0 (0.00%)	0 (0.00%)	0 (0.00%)
Nervous/Psychiatric Disorder	With event	1 (1.12%)	0 (0.00%)	0 (0.00%)	0 (0.00%)
Nervous/Psychiatric Disorder	Without event	3 (0.83%)	3 (0.83%)	0 (0.00%)	0 (0.00%)
OSA	With event	0 (0.00%)	0 (0.00%)	0 (0.00%)	8 (8.99%)
OSA	Without event	12 (3.31%)	0 (0.00%)	1 (0.28%)	26 (7.18%)
Other Sleep Disorders	With event	0 (0.00%)	0 (0.00%)	0 (0.00%)	0 (0.00%)
Other Sleep Disorders	Without event	1 (0.28%)	0 (0.00%)	0 (0.00%)	0 (0.00%)
Spine/Other Musculoskeletal Disorder	With event	0 (0.00%)	1 (1.12%)	0 (0.00%)	0 (0.00%)
Spine/Other Musculoskeletal Disorder	Without event	0 (0.00%)	2 (0.55%)	2 (0.55%)	0 (0.00%)
Tobacco Use	With event	1 (1.12%)	2 (2.25%)	0 (0.00%)	0 (0.00%)
Tobacco Use	Without event	0 (0.00%)	27 (7.46%)	0 (0.00%)	0 (0.00%)

3.3.4 Moving Violations

Table 30 presents the distribution of diet quality and BMI classification for drivers with a moving violation and the matched drivers without a moving violation. A diet of average quality was reported by 60.23% of drivers with a moving violation and 54.01% of matched drivers. Drivers with a moving violation included 52.45% with an obese BMI classification (20.49%

obese class I, 17.21% obese class II, and 14.75% obese class III), 21.31% with an overweight BMI classification, and 24.59% with a normal BMI classification. Matched drivers without a moving violation included 49.59% with an obese BMI classification (20.89% obese class I, 12.03% obese class II, and 16.67% obese class III), 25.11% with an overweight BMI classification, and 24.05% with a normal BMI classification.

Table 30. Moving violations: Distribution of health-related characteristics for younger drivers with and without a safety event.

Health-Related Characteristic	Number of Drivers with Event	Drivers with Event (%)	Number of Matched Drivers without Event	Matched Drivers without Event (%)
Diet Quality: Poor	11	12.50	46	13.65
Diet Quality: Below Average	14	15.91	66	19.58
Diet Quality: Average	53	60.23	182	54.01
Diet Quality: Above Average	9	10.23	25	7.42
Diet Quality: Excellent	1	1.14	18	5.34
BMI Classification: Underweight	2	1.64	6	1.27
BMI Classification: Normal	30	24.59	114	24.05
BMI Classification: Overweight	26	21.31	119	25.11
BMI Classification: Obese Class I	25	20.49	99	20.89
BMI Classification: Obese Class II	21	17.21	57	12.03
BMI Classification: Obese Class III	18	14.75	79	16.67

For drivers with a moving violation and the matched drivers without a moving violation, Table 31 lists all medical conditions with at least one driver diagnosed with the condition or marked as potentially having the condition. Driver counts are broken down by diagnosis and treatment status. These younger driver groups had few medical conditions diagnosed. OSA was diagnosed and treated in 1.65% of drivers with a moving violation and 1.43% of matched drivers and marked as potential in 7.44% of drivers with a moving violation and 6.15% of matched drivers. Tobacco use was diagnosed but untreated in 3.31% of drivers with a moving violation and 5.53% of matched drivers. Lung/chest conditions were diagnosed and treated in 1.65% of drivers with a moving violation and 2.46% of matched drivers. High blood pressure was marked as potential for 0.83% of drivers with a moving violation and 3.07% of matched drivers. Finally, elevated blood sugar was diagnosed and treated for 1.65% and 1.43% of drivers with and without moving violations, respectively.

Not listed in Table 31 are medical conditions without any diagnoses or potential diagnoses in either driver group. These conditions included alcohol use, cancer, eye disorder, hormone dysfunction, hormone therapy, metabolic syndrome, mouth and throat condition, neurological condition, organ failure, seizures/epilepsy, skin disease, stroke or paralysis, thyroid disorder, vascular condition, viral infection, vitamin deficiency, and weight control.

Table 31. Moving violations: Distribution of health-condition diagnoses and treatments for younger drivers with and without a safety event.

Medical Condition	Driver Group	Diagnosed: Treated	Diagnosed: Untreated	Diagnosed: Unsure	Potential
Abdomen and Viscera	With event	0 (0.00%)	0 (0.00%)	1 (0.83%)	0 (0.00%)
Abdomen and Viscera	Without event	0 (0.00%)	1 (0.20%)	0 (0.00%)	0 (0.00%)
Allergies	With event	1 (0.83%)	0 (0.00%)	0 (0.00%)	0 (0.00%)
Allergies	Without event	3 (0.61%)	0 (0.00%)	0 (0.00%)	0 (0.00%)
Elevated Blood Sugar	With event	2 (1.65%)	0 (0.00%)	0 (0.00%)	1 (0.83%)
Elevated Blood Sugar	Without event	7 (1.43%)	5 (1.02%)	0 (0.00%)	0 (0.00%)
Digestive Problems	With event	0 (0.00%)	0 (0.00%)	0 (0.00%)	0 (0.00%)
Digestive Problems	Without event	4 (0.82%)	0 (0.00%)	0 (0.00%)	0 (0.00%)
Dyslipidemia	With event	1 (0.83%)	0 (0.00%)	0 (0.00%)	0 (0.00%)
Dyslipidemia	Without event	1 (0.20%)	0 (0.00%)	0 (0.00%)	0 (0.00%)
Ear/Hearing/Balance Disorder	With event	1 (0.83%)	0 (0.00%)	0 (0.00%)	0 (0.00%)
Ear/Hearing/Balance Disorder	Without event	1 (0.20%)	0 (0.00%)	2 (0.41%)	0 (0.00%)
Genitourinary	With event	0 (0.00%)	0 (0.00%)	0 (0.00%)	0 (0.00%)
Genitourinary	Without event	1 (0.20%)	1 (0.20%)	0 (0.00%)	1 (0.20%)
Head/Brain Injury	With event	0 (0.00%)	0 (0.00%)	0 (0.00%)	0 (0.00%)
Head/Brain Injury	Without event	1 (0.20%)	0 (0.00%)	2 (0.41%)	0 (0.00%)
Heart/Cardiovascular Disease	With event	0 (0.00%)	1 (0.83%)	0 (0.00%)	0 (0.00%)
Heart/Cardiovascular Disease	Without event	0 (0.00%)	1 (0.20%)	3 (0.61%)	0 (0.00%)
High Blood Pressure	With event	1 (0.83%)	2 (1.65%)	0 (0.00%)	1 (0.83%)
High Blood Pressure	Without event	9 (1.84%)	0 (0.00%)	1 (0.20%)	15 (3.07%)
Inflammatory Disease	With event	0 (0.00%)	0 (0.00%)	0 (0.00%)	0 (0.00%)
Inflammatory Disease	Without event	0 (0.00%)	1 (0.20%)	0 (0.00%)	0 (0.00%)
Kidney Disease	With event	0 (0.00%)	0 (0.00%)	0 (0.00%)	2 (1.65%)
Kidney Disease	Without event	2 (0.41%)	1 (0.20%)	0 (0.00%)	7 (1.43%)
Loss of Consciousness	With event	0 (0.00%)	0 (0.00%)	0 (0.00%)	0 (0.00%)
Loss of Consciousness	Without event	0 (0.00%)	0 (0.00%)	1 (0.20%)	0 (0.00%)
Lung/Chest Condition	With event	2 (1.65%)	0 (0.00%)	0 (0.00%)	0 (0.00%)
Lung/Chest Condition	Without event	12 (2.46%)	0 (0.00%)	5 (1.02%)	0 (0.00%)
Missing Limb	With event	0 (0.00%)	0 (0.00%)	0 (0.00%)	0 (0.00%)
Missing Limb	Without event	0 (0.00%)	0 (0.00%)	3 (0.61%)	0 (0.00%)
Muscular Disease	With event	0 (0.00%)	0 (0.00%)	0 (0.00%)	0 (0.00%)
Muscular Disease	Without event	0 (0.00%)	0 (0.00%)	1 (0.20%)	0 (0.00%)
Nervous/Psychiatric Disorder	With event	0 (0.00%)	0 (0.00%)	0 (0.00%)	0 (0.00%)
Nervous/Psychiatric Disorder	Without event	3 (0.61%)	1 (0.20%)	1 (0.20%)	0 (0.00%)
OSA	With event	2 (1.65%)	0 (0.00%)	0 (0.00%)	9 (7.44%)
OSA	Without event	7 (1.43%)	1 (0.20%)	0 (0.00%)	30 (6.15%)
Other Sleep Disorders	With event	0 (0.00%)	0 (0.00%)	0 (0.00%)	0 (0.00%)
Other Sleep Disorders	Without event	2 (0.41%)	0 (0.00%)	0 (0.00%)	0 (0.00%)
Spine/Other Musculoskeletal Disorder	With event	0 (0.00%)	0 (0.00%)	0 (0.00%)	0 (0.00%)
Spine/Other Musculoskeletal Disorder	Without event	0 (0.00%)	2 (0.41%)	0 (0.00%)	0 (0.00%)
Tobacco Use	With event	0 (0.00%)	4 (3.31%)	0 (0.00%)	0 (0.00%)
Tobacco Use	Without event	1 (0.20%)	27 (5.53%)	0 (0.00%)	0 (0.00%)

3.3.5 Individual Regression Model Results

Table 32 presents the statistically significant individual logistic regression model results for health-related variables from the questionnaire and medical exam data. A full table of significant and non-significant results is included in Appendix A. Comparisons with insufficient counts for meaningful analysis were excluded from Table 36 in Appendix A. Only one health-related variable showed a statistically significant relationship to crash involvement. The odds of being involved in a carrier-recorded crash were significantly higher for drivers with diagnosed and treated allergies compared to drivers without an allergy diagnosis, OR = 7.386, 95% CI = (1.339, 40.738). The analysis of carrier-recorded preventable crashes showed the same relationship: drivers with diagnosed and treated allergies were at significantly higher risk of preventable crash involvement compared to drivers without an allergy diagnosis, OR = 10.558, 95% CI = (1.083, 102.945). It is important to consider these significant ORs in context with the frequency of allergy diagnoses—the total number of drivers receiving treatment for an allergy diagnosis and with a safety event was four (carrier-recorded crashes) and three (carrier-recorded preventable crashes). All other comparisons were either not statistically significant (the odds of safety event involvement did not significantly differ between variable levels) or did not have sufficient counts in the compared variable levels for analysis.

Table 32. Odds ratios and 95% confidence interval results for safety event involvement by driver health-related variables.

Variable	Comparison Level A	Comparison Level B	Carrier-Recorded Crash	Carrier-Recorded Preventable Crash	Nationally Recorded Crash	Moving Violation
Allergies	Diagnosed: Treated	Not diagnosed	7.386* (1.339, 40.738)	10.558* (1.083, 102.945)	1.017 (0.112, 9.213)	1.347 (0.139, 13.067)

* indicates statistically significant result at alpha = 0.05.

CHAPTER 4. DISCUSSION

The current study investigated driver factors associated with increased risk of involvement in safety-related events in younger drivers ages 21 to 25. The study used data collected in the CDSRF study to compare and contrast young commercial drivers with and without carrier-recorded crashes, carrier-recorded preventable crashes, nationally recorded crashes, and moving violations. Overall, most young drivers did not have a safety-related event. The proportion of drivers with a safety-related event included 14% with at least one carrier-recorded crash, 8% with at least one carrier-recorded preventable crash, 8% with at least one nationally recorded crash, and 10% with at least one moving violation.

The current study analyzed safe and unsafe driver groups for differences in driver demographic factors, driving-related factors, and health-related factors. The analyses were performed for each individual safety-related event type. One statistically significant demographic factor was academic degree. Approximately 80% of the sampled young drivers in the current study had a HS diploma or higher degree; this finding is slightly higher than the rate found in the full CDSRF dataset with drivers of all ages (Hickman et al., 2020). For younger drivers, it appears many are entering the trucking career with a HS education, its equivalent (GED), or higher academic degree. This may be a promising sign that the career is appealing to young people out of HS or college. Academic degree did show a significant relationship with crash involvement. In the analysis of carrier-recorded crash involvement, drivers showed lower odds of crash involvement when their academic degree was another degree not listed compared to drivers with a HS diploma or bachelor's degree. Interestingly, the CDSRF study analysis found drivers 43 and older with higher academic degrees had lower risks of carrier-recorded and nationally recorded crash involvement compared to drivers with lower academic degrees (Hickman et al., 2020).

Young drivers in the current analysis reported weekly exercise rates in a distribution similar to all drivers in the CDSRF study. Moderate weekly exercise was reported by 39% to 58% of young drivers and 45% of all drivers in the CDSRF; substantial weekly exercise was reported by 23% to 36% of young drivers and 26% of all drivers in the CDSRF. Young drivers who reported moderate weekly exercise were more likely to be involved in a nationally recorded crash compared to drivers with substantial weekly exercise. The CDSRF study did find a significant difference in moving violation risk for drivers over 52 who reported substantial or moderate exercise compared to drivers over 52 who did not exercise. In a survey of 1,670 long haul truckers, no moderate or vigorous weekly exercise was reported by 27% of drivers (Sieber et al., 2014). This finding aligns with the younger driver sample in the current study. Interestingly, Wipfli et al. (2023) used actigraphs instead of self-report data to measure physical activity in truck drivers and found two thirds of drivers had no physical activity periods lasting 10 minutes or longer. Wipfli et al. also found drivers overestimated their weekly physical activity. The truck driver lifestyle can mean inconsistent schedules and spending days away from a home base, with limited access to gyms. This may affect drivers' ability to obtain moderate to substantial physical activity during the week.

The current study found that young drivers with a double/triple trailer endorsement had higher odds of both carrier-recorded and nationally recorded crash involvement compared to drivers without this endorsement. No other endorsements were found to be associated with a change in

safety event risk in this younger driver sample. Drivers must take an exam to obtain a double/triple trailer endorsement. In 2021, the most recent year with updated national crash statistics, trucks with double and triple trailers were involved in 2.1% of fatal truck crashes (FMCSA Analysis Division, 2023). An analysis of truck configurations by the Federal Highway Administration (2015) found that while trucks operating with double and triple trailers showed similar vehicle stability compared to trucks with a single trailer, safety data indicated higher rates of crashes and violations. The CDSRF study analysis found several endorsements to be associated with changes in safety event risk for drivers 43 to 51 years old, including double/triple trailer endorsements, which were associated with lower odds of carrier-recorded crashes (all and preventable; Hickman et al., 2020). FMCSA's SDAP program for apprentice drivers ages 18 to 20 specifically prohibits operation of double/triple trailer vehicles by this age group during apprenticeship (FMCSA, 2023).

Other driving-related factors associated with changes in safety event risk included months of experience and previous OOS placement. As self-reported experience increased in young drivers, odds of involvement in a nationally recorded crash also increased. In addition, young drivers who reported an OOS placement in the past 3 years were at 3 times increased risk of nationally recorded crash involvement. The CDSRF study found drivers ages 34 to 42 with a previous OOS violation were at increased risk of involvement in a moving violation during the study (Hickman et al., 2020).

The analysis of health-related factors was limited by the low prevalence of medical conditions in the younger driver sample. However, it is interesting to compare health factor patterns in young drivers compared to older drivers. Approximately 29% to 32% of young drivers reported a diet of below average or poor quality; when considering all drivers, 24% reported a below average or poor diet quality (Hickman et al., 2020). Young drivers had higher rates of normal BMI compared to drivers of all ages (28% of young drivers and 12% of all drivers; Hickman et al., 2020). Sieber et al. (2014) estimated 7.9% of long-haul truck drivers had a normal BMI. These et al. (2017) found 15.9% of participating drivers had a normal BMI. Finally, drivers with diagnosed and treated allergies showed higher risk of crash involvement compared to drivers without this diagnosis. Some antihistamines can cause drowsiness, and the Food and Drug Administration (2024) cautions their use during driving. The CDSRF study found an increased risk associated with untreated allergies compared to no allergies for drivers 34 to 42 years old. These drivers were at higher risk of a carrier-recorded crash and carrier-recorded preventable crash.

4.1 LIMITATIONS

The current study was limited by a few important issues. First, the sample of drivers ages 21 to 25 was sufficient; however, poor survey response rates on several factors affected analysis options and the resulting findings. Data collected from the demographic questionnaire were self-reported. Certain survey questions included responses with varying units, which made the variables difficult to use without researcher interpretation. Examples include caffeine consumption and alcohol use, which had wide-ranging response terms. A further limitation of the data was the difficulty in capturing accurate driver exposure. Drivers were assumed to be working as truck drivers during their exposure period, without data reflecting mileage or days driving. If a study participant was no longer driving a truck, their lack of safety data would

reflect their career change and not their safe driving behavior. Lastly, the drivers in the current study were all employed at the same large for-hire carrier and had been recruited for participation at orientation. It is possible these recruitment factors impact the generalizability of study findings to all young commercial drivers.

4.2 FUTURE RESEARCH

The current study could be further expanded, through an investigation of inexperienced drivers across all age groups, to identify factors associated with safe and unsafe drivers beginning their carrier as commercial truck drivers. Future research on safe and unsafe young drivers could use naturalistic driving data to assess these two groups for differences in driving behavior-related variables, such as propensity to speed above the posted speed limit or in work zones, severity of hard turns, and frequency of rapid decelerations. In addition, FARS and CRSS federal crash databases could be used to understand differences in crashes for young commercial drivers compared to older commercial drivers, such as crash factors, time of day, seat belt use, etc. Additional analyses, using federal crash databases, carrier-collected data, or insurance data, could compare young drivers operating intrastate versus those operating interstate. Future research using CDSRF data could investigate detailed crash and moving violation data for safe and unsafe young drivers to assess the likelihood of engaging in specific unsafe behaviors, such as speeding or driving while distracted.

Important future research will need to track drivers participating in the SDAP program to understand their crash risk during and after the apprenticeship period is complete and compare their performance to novice older drivers. In addition, analyses could investigate further by considering each age (18-, 19-, and 20-year-olds) in the apprenticeship program and differences in crash risk. These analyses would expand on the Dunn et al. (2020) study of how age, experience, and risk interact for commercial drivers.

4.3 CONCLUSIONS

The study provided a detailed investigation of young, inexperienced commercial drivers ages 21 to 25. Key findings include:

- A majority of young drivers in the current study did not have a safety-related event; 86% of drivers did not have a carrier-recorded crash, 92% did not have a carrier-recorded preventable crash, 92% did not have a nationally recorded crash, and 90% did not have a moving violation.
- Young drivers who reported an OOS placement in the past 3 years were at 3 times increased risk of nationally recorded crash involvement.
- Young drivers with a double/triple trailer endorsement had higher odds of both carrier-recorded and nationally recorded crash involvement compared to drivers without this endorsement.
- Young drivers showed lower odds of carrier-recorded crash involvement when their academic degree was another degree not listed compared to drivers with a HS diploma or bachelor's degree.

- Young drivers with diagnosed and treated allergies showed higher risk of carrier-recorded crash (all and preventable) involvement compared to drivers without this diagnosis.

In understanding the results, it is important to note that the study did not assess causation between driver demographic, driving-related, or health-related variables and driver safety performance. In addition, many variables had low driver counts across variable levels (e.g., health conditions such as allergy diagnosis).

The study found few statistically significant factors associated with increased safety event risk; the study did provide more insight into the typical young driver. This driver age group is one with limited published information, as many previous research studies have combined this age group with slightly older driver ages in stratified analyses. As younger drivers have more opportunities to join the career field, through the multiple initiatives by FMCSA and the career promotion by industry leaders seeking to address driver shortage concerns, it is important to better understand this driver age group, their potential risk factors, what factors need further research, and how this driver age group compares to other driver age groups in their demographics and risk.

APPENDIX A. ADDITIONAL ANALYSIS RESULTS

Table 33. Descriptive statistics for carrier and national exposure for drivers ages 21-25.

Exposure Term	N	Mean	Std Dev	Minimum	25th Percentile	Median	75th Percentile	Maximum
Carrier Exposure	1,318	180.69	205.00	0.00	30.00	109.50	241.00	1234.00
National Exposure	1,415	577.78	275.24	98.00	335.00	582.00	820.00	1086.00

Table 34. Odds ratios and 95% confidence interval results for safety event involvement by demographic questionnaire variables.

Variable	Comparison Level A	Comparison Level B	Carrier-Recorded Crash	Carrier-Recorded Preventable Crash	Nationally Recorded Crash	Moving Violation
Gender	Gender: Male	Gender: Female	1.331 (0.449, 3.947)	0.796 (0.211, 3.003)	0.750 (0.268, 2.101)	0.919 (0.335, 2.521)
Marital Status	Married	Single	0.971 (0.595, 1.585)	0.704 (0.361, 1.371)	1.133 (0.580, 2.213)	0.348 (0.167, 0.725)
Marital Status	Divorced	Single	0.153 (0.020, 1.145)	0.325 (0.041, 2.573)	0.710 (0.155, 3.259)	1.410 (0.356, 5.585)
Marital Status	Married	Divorced	6.360 (0.820, 49.333)	2.166 (0.257, 18.252)	1.596 (0.322, 7.896)	0.247 (0.054, 1.126)
Highest Academic Degree	None listed	GED	0.275 (0.075, 1.004)	0.632 (0.156, 2.564)	1.227 (0.306, 4.927)	1.394 (0.422, 4.605)
Highest Academic Degree	None listed	HS diploma	0.289* (0.087, 0.961)	0.565 (0.161, 1.988)	1.708 (0.519, 5.619)	1.011 (0.363, 2.813)
Highest Academic Degree	None listed	Associate's degree	0.365 (0.089, 1.488)	0.789 (0.156, 4.002)	2.545 (0.481, 13.458)	0.714 (0.192, 2.652)
Highest Academic Degree	None listed	Bachelor's degree	0.139* (0.022, 0.887)	1.105 (0.098, 12.472)	1.091 (0.153, 7.802)	1.053 (0.095, 11.633)
Highest Academic Degree	HS diploma	GED	0.949 (0.525, 1.713)	1.117 (0.522, 2.391)	0.718 (0.306, 1.689)	1.379 (0.665, 2.863)
Highest Academic Degree	Associate's degree	GED	0.753 (0.294, 1.928)	0.800 (0.223, 2.871)	0.482 (0.114, 2.044)	1.953 (0.651, 5.860)
Highest Academic Degree	Bachelor's degree	GED	1.976 (0.428, 9.135)	0.571 (0.063, 5.193)	1.125 (0.189, 6.699)	1.325 (0.134, 13.122)
Highest Academic Degree	HS diploma	Associate's degree	1.260 (0.565, 2.811)	1.397 (0.456, 4.274)	1.490 (0.425, 5.220)	0.706 (0.284, 1.754)
Highest Academic Degree	HS diploma	Bachelor's degree	0.480 (0.113, 2.047)	1.955 (0.235, 16.267)	0.639 (0.125, 3.272)	1.041 (0.114, 9.481)

Variable	Comparison Level A	Comparison Level B	Carrier-Recorded Crash	Carrier-Recorded Preventable Crash	Nationally Recorded Crash	Moving Violation
Highest Academic Degree	Associate's degree	Bachelor's degree	0.381 (0.075, 1.933)	1.400 (0.133, 14.743)	0.429 (0.058, 3.186)	1.474 (0.140, 15.557)
Regular Sleep Schedule	Yes	No	1.636 (0.754, 3.550)	1.220 (.388, 3.836)	0.570 (0.217, 1.496)	0.776 (0.368, 1.638)
Regular Sleep Schedule	Sometimes	No	1.639 (0.760, 3.534)	1.689 (0.542, 5.258)	0.821 (0.319, 2.113)	0.674 (0.315, 1.442)
Regular Sleep Schedule	Yes	Sometimes	0.998 (0.643, 1.551)	0.722 (0.396, 1.319)	0.694 (0.371, 1.299)	1.152 (0.677, 1.960)
Nap During the Day	No	Yes	1.616 (1.037, 2.517)	0.978 (0.556, 1.719)	1.097 (0.583, 2.066)	1.058 (0.628, 1.783)
Exercise Off Work	Regular exercise	No exercise	1.148 (0.719, 1.833)	1.215 (0.659, 2.240)	1.277 (0.624, 2.614)	1.529 (0.874, 2.677)
Weekly Exercise Frequency	Moderate weekly exercise	No weekly exercise	1.179 (0.713, 1.952)	1.079 (0.557, 2.091)	1.778 (0.840, 3.760)	1.708 (0.926, 3.152)
Weekly Exercise Frequency	Moderate weekly exercise	Substantial weekly exercise	1.167 (0.729, 1.868)	0.779 (0.414, 1.468)	2.303* (1.137, 4.627)	1.176 (0.682, 2.026)
Weekly Exercise Frequency	Substantial weekly exercise	No weekly exercise	1.011 (0.584, 1.749)	1.385 (0.674, 2.847)	0.772 (0.326, 1.828)	1.453 (0.757, 2.790)
ESS	Higher Normal	Lower Normal	0.989 (0.643, 1.519)	1.043 (0.579, 1.881)	1.042 (0.574, 1.889)	0.843 (0.495, 1.434)
ESS	Higher Normal	Mild	1.295 (0.544, 3.081)	0.881 (0.296, 2.622)	0.811 (0.209, 3.141)	0.702 (0.235, 2.095)
ESS	Higher Normal	Moderate	0.648 (0.214, 1.964)	0.652 (0.160, 2.654)	0.995 (0.201, 4.916)	0.950 (0.252, 3.586)
ESS	Higher Normal	Severe	1.064 (0.214, 5.291)	0.367 (0.058, 2.326)	0.663 (0.066, 6.661)	0.219 (0.042, 1.151)
ESS	Mild	Lower	0.763 (0.325, 1.792)	1.185 (0.411, 3.415)	1.285 (0.338, 4.877)	1.201 (0.420, 1.151)

Variable	Comparison Level A	Comparison Level B	Carrier-Recorded Crash	Carrier-Recorded Preventable Crash	Nationally Recorded Crash	Moving Violation
ESS	Moderate	Lower	1.527 (0.509, 4.583)	1.599 (0.403, 6.347)	1.047 (0.215, 5.083)	0.887 (0.243, 3.230)
ESS	Severe	Lower	0.929 (0.188, 4.589)	2.843 (0.457, 17.684)	1.571 (0.158, 15.603)	3.843 (0.753, 19.609)
ESS	Mild	Moderate	0.500 (0.132, 1.895)	0.741 (0.141, 3.880)	1.227 (0.167, 9.017)	1.354 (0.271, 6.758)
ESS	Mild	Severe	0.821 (0.141, 4.800)	0.417 (0.054, 3.221)	0.818 (0.061, 10.986)	0.312 (0.047, 2.067)
ESS	Moderate	Severe	1.643 (0.247, 10.946)	0.562 (0.061, 5.218)	0.666 (0.043, 10.242)	0.231 (0.030, 1.764)
DDDI Subscale: Negative Emotion	Baseline	Increase score by 1 point	0.994 (0.959, 1.031)	1.004 (0.960, 1.050)	1.009 (0.959, 1.062)	1.003 (0.963, 1.045)
DDDI Subscale: Aggressive Driving	Baseline	Increase score by 1 point	0.992 (0.928, 1.061)	1.011 (0.933, 1.096)	1.028 (0.942, 1.122)	1.008 (0.925, 1.099)
DDDI Subscale: Risky Driving	Baseline	Increase score by 1 point	0.976 (0.923, 1.033)	1.029 (0.963, 1.100)	1.024 (0.965, 1.088)	1.040 (0.990, 1.093)
SDS Score	Baseline	Increase score by 1 point	1.033 (0.978, 1.091)	0.969 (0.905, 1.038)	0.981 (0.914, 1.053)	0.948 (0.891, 1.008)
SRLE Subscale: Social and Cultural	Baseline	Increase score by 1 point	0.978 (0.936, 1.022)	1.024 (0.965, 1.088)	1.002 (0.942, 1.066)	1.026 (0.976, 1.078)
SRLE Subscale: Work	Baseline	Increase score by 1 point	1.022 (0.965, 1.083)	1.050 (0.72, 1.133)	0.975 (0.895, 1.062)	1.016 (0.945, 1.092)
SRLE Subscale: Time Pressure	Baseline	Increase score by 1 point	0.997 (0.956, 1.040)	1.028 (0.972, 1.087)	1.016 (0.954, 1.082)	1.014 (0.963, 1.068)
SRLE Subscale: Finances	Baseline	Increase score by 1 point	0.987 (0.941, 1.035)	1.018 (0.959, 1.080)	1.028 (0.959, 1.103)	0.980 (0.923, 1.040)
SRLE Subscale: Social Acceptability	Baseline	Increase score by 1 point	0.988 (0.925, 1.054)	1.033 (0.947, 1.128)	1.014 (0.922, 1.114)	1.000 (0.922, 1.085)

Variable	Comparison Level A	Comparison Level B	Carrier-Recorded Crash	Carrier-Recorded Preventable Crash	Nationally Recorded Crash	Moving Violation
SRLE Subscale: Social Victimization	Baseline	Increase score by 1 point	0.939 (0.872, 1.011)	0.979 (0.889, 1.079)	1.085 (0.983, 1.197)	0.996 (0.914, 1.085)

* indicates statistically significant result at $\alpha = 0.05$.

Table 35. Odds ratios and 95% confidence interval results for safety event involvement by driving-related variables.

Variable	Comparison Level A	Comparison Level B	Carrier-Recorded Crash	Carrier-Recorded Preventable Crash	Nationally Recorded Crash	Moving Violation
Months of Experience Driving Commercial Vehicles	Baseline	1 month unit increase	0.998 (0.985, 1.011)	0.994 (0.976, 1.012)	1.024* (1.004, 1.045)	1.001 (0.986, 1.017)
CDL Type	Class A CDL	Class B CDL	0.250 (0.016, 4.031)	0 (0, Inf)	0 (0, Inf)	
CDL Type	Class A CDL	Other	0.333 (0.073, 1.513)	0.327 (0.053, 2.006)	0.202 (0.012, 3.292)	1.524 (0.181, 12.838)
CDL Type	Class B CDL	Other	1.333 (0.057, 31.121)	0 (0, Inf)	0 (0, Inf)	
Endorsement: HazMat	Yes	No	1.488 (0.877, 2.524)	0.876 (0.428, 1.795)	1.528 (0.788, 2.964)	0.755 (0.376, 1.513)
Endorsement: Bus Passenger	Yes	No	0.564 (0.164, 1.940)	0.977 (0.203, 4.711)	0.740 (0.087, 6.264)	2.000 (0.490, 8.164)
Endorsement: School Bus	Yes	No	0.806 (0.172, 3.781)	0.978 (0.108, 8.891)	0.892 (0.102, 7.773)	2.659 (0.437, 16.167)
Endorsement: Tanker Vehicle	Yes	No	1.203 (0.776, 1.866)	1.152 (0.634, 2.094)	1.758 (0.977, 3.164)	0.682 (0.370, 1.255)
Endorsement: Double/Triple Trailer	Yes	No	1.638* (1.006, 2.667)	1.472 (0.773, 2.803)	2.028* (1.096, 3.752)	0.904 (0.487, 1.681)
Endorsement: Combination HazMat/Trailer	Yes	No	0.993 (0.462, 2.135)	1.032 (0.371, 2.871)	1.343 (0.550, 3.279)	0.887 (0.326, 2.413)
Personal Vehicle Seatbelt Use	Never	Rarely	2.003 (0.115, 34.858)	0 (0, Inf)	0 (0, Inf)	0 (0, Inf)
Personal Vehicle Seatbelt Use	Never	Sometimes	2.003 (0.133, 30.192)	0 (0, Inf)	7.000 (0.302, 162.202)	3.667 (0.173, 77.552)
Personal Vehicle Seatbelt Use	Never	Often	1.803 (0.148, 21.962)	0 (0, Inf)	3.000 (0.162, 55.721)	0.926 (0.085, 10.085)
Personal Vehicle Seatbelt Use	Never	Always	1.838 (0.165, 20.449)	0 (0, Inf)	4.510 (0.277, 73.304)	1.289 (0.132, 12.568)

Variable	Comparison Level A	Comparison Level B	Carrier-Recorded Crash	Carrier-Recorded Preventable Crash	Nationally Recorded Crash	Moving Violation
Personal Vehicle Seatbelt Use	Rarely	Sometimes	1.000 (0.135, 7.392)	0 (0, Inf)	0 (0, Inf)	0 (0, Inf)
Personal Vehicle Seatbelt Use	Rarely	Often	0.900 (0.164, 4.929)	1.095 (0.098, 12.269)	0 (0, Inf)	0 (0, Inf)
Personal Vehicle Seatbelt Use	Rarely	Always	0.917 (0.192, 4.385)	1.261 (0.129, 12.342)	0 (0, Inf)	0 (0, Inf)
Personal Vehicle Seatbelt Use	Sometimes	Often	0.900 (0.212, 3.822)	0 (0, Inf)	0.429 (0.075, 2.457)	0.253 (0.028, 2.244)
Personal Vehicle Seatbelt Use	Sometimes	Always	0.917 (0.253, 3.310)	0 (0, Inf)	0.644 (0.142, 2.923)	0.352 (0.045, 2.766)
Personal Vehicle Seatbelt Use	Often	Always	1.019 (0.490, 2.121)	1.151 (0.472, 2.811)	1.503 (0.568, 3.975)	1.392 (0.624, 3.108)
Commercial Vehicle Seatbelt Use	Often	Always	0.354 (0.045, 2.791)	0 (0, Inf)	0 (0, Inf)	1.941 (0.174, 21.662)
Crash in Previous 3 Years	Yes	No	0.859 (0.533, 1.386)	0.719 (0.377, 1.375)	1.483 (0.795, 2.766)	0.860 (0.483, 1.532)
Moving Violation in Previous 3 Years	Yes	No	0.788 (0.497, 1.249)	0.854 (0.464, 1.571)	1.102 (0.589, 2.063)	1.025 (0.584, 1.800)
OOS Placement in Previous 3 Years	Yes	No	0.966 (0.450, 2.074)	1.344 (0.470, 3.843)	3.012* (1.129, 8.034)	1.313 (0.413, 4.178)
Commercial Vehicle Crash in Previous 3 Years	Yes	No	1.038 (0.616, 1.749)	0.766 (0.385, 1.521)	1.318 (0.706, 2.459)	1.042 (0.550, 1.975)
At Fault Crash in Previous 3 Years	Yes	No	0.822 (0.393, 1.720)	0.391 (0.117, 1.311)	1.246 (0.548, 2.835)	1.069 (0.479, 2.383)
Personal Vehicle Crash in Previous 3 Years	Yes	No	0.918 (0.452, 1.867)	0.893 (0.330, 2.417)	0.656 (0.190, 2.268)	0.591 (0.227, 1.541)
Roadside Departure Crash in Previous 3 Years	Yes	No	0 (0, Inf)	0 (0, Inf)	4.019 (0.249, 64.770)	0 (0, Inf)

Variable	Comparison Level A	Comparison Level B	Carrier-Recorded Crash	Carrier-Recorded Preventable Crash	Nationally Recorded Crash	Moving Violation
Rear-End Crash in Previous 3 Years	Yes	No	0.969 (0.271, 3.468)	0.275 (0.036, 2.118)	1.731 (0.440, 6.806)	0.920 (0.259, 3.271)
Sideswipe Crash in Previous 3 Years	Yes	No	0.825 (0.336, 2.023)	0.347 (0.080, 1.499)	0.751 (0.252, 2.235)	0.535 (0.158, 1.812)
Hit Fixed Object Crash in Previous 3 Years	Yes	No	1.217 (0.440, 3.366)	1.057 (0.343, 3.253)	1.853 (0.630, 5.452)	1.235 (0.397, 3.845)
Hit Moving Object Crash in Previous 3 Years	Yes	No	3.907 (0.547, 27.924)	0 (0, Inf)	0 (0, Inf)	4.014 (0.250, 64.554)
Backing Crash in Previous 3 Years	Yes	No	0.968 (0.359, 2.615)	0.876 (0.186, 4.116)	2.490 (0.915, 9.452)	2.709 (0.754, 9.727)
Parking Lot Crash in Previous 3 Years	Yes	No	0.384 (0.049, 3.021)	0.656 (0.078, 5.505)	1.609 (0.308, 8.405)	1.091 (0.300, 3.962)
T-Bone Crash in Previous 3 Years	Yes	No	0.320 (0.041, 2.472)	0.788 (0.091, 6.822)	0 (0, Inf)	1.334 (0.138, 12.913)
Head-On Crash in Previous 3 Years	Yes	No	0 (0, Inf)	NA	NA	2.003 (0.180, 22.247)
Other Crash in Previous 3 Years	Yes	No	0.667 (0.228, 1.953)	0.434 (0.054, 3.462)	2.034 (0.601, 6.883)	0.526 (0.119, 2.326)
Formal Training	Yes	No	1.223 (0.706, 2.118)	1.206 (0.570, 2.553)	0.914 (0.437, 1.915)	1.050 (0.559, 1.974)
Weeks of Formal Training	Baseline	Increase by 1 week	0.990 (0.924, 1.061)	0.994 (0.852, 1.046)	0.945 (0.844, 1.059)	0.998 (0.922, 1.080)
Informal Training	Yes	No	0.770 (0.495, 1.198)	0.915 (0.511, 1.639)	0.859 (0.472, 1.562)	0.808 (0.487, 1.339)
Weeks of Informal Training	Baseline	Increase by 1 week	1.004 (0.986, 1.021)	0.983 (0.914, 1.057)	0.999 (0.993, 1.006)	0.993 (0.964, 1.022)
On-the-Job Training	Yes	No	0.472 (0.155, 1.440)	0.528 (0.132, 2.111)	0.416 (0.123, 1.410)	1.421 (0.309, 6.546)

Variable	Comparison Level A	Comparison Level B	Carrier-Recorded Crash	Carrier-Recorded Preventable Crash	Nationally Recorded Crash	Moving Violation
Weeks of On-the-Job Training	Baseline	Increase by 1 week	0.993 (0.981, 1.005)	1.000 (0.992, 1.008)	0.998 (0.991, 1.005)	0.997 (0.987, 1.007)

** indicates statistically significant result at alpha = 0.05.*

Table 36. Odds ratios and 95% confidence interval results for safety event involvement by driver health-related variables.

Variable	Comparison Level A	Comparison Level B	Carrier-Recorded Crash	Carrier-Recorded Preventable Crash	Nationally Recorded Crash	Moving Violation
BMI Classification	Obese Class I	Normal	0.902 (0.533, 1.526)	1.458 (0.725, 2.930)	0.810 (0.391, 1.680)	0.960 (0.529, 1.740)
BMI Classification	Obese Class II	Normal	0.608 (0.319, 1.159)	0.728 (0.301, 1.760)	1.241 (0.571, 2.698)	1.400 (0.737, 2.661)
BMI Classification	Obese Class III	Normal	1.425 (0.823, 2.467)	1.012 (0.488, 2.099)	1.087 (0.525, 2.251)	0.866 (0.452, 1.660)
BMI Classification	Overweight	Normal	0.879 (0.527, 1.464)	1.180 (0.593, 2.347)	0.943 (0.479, 1.855)	0.830 (0.463, 1.490)
BMI Classification	Underweight	Normal	1.993 (0.557, 7.129)	2.348 (0.522, 10.552)	0 (0, Inf)	1.267 (0.243, 6.596)
Allergies	Diagnosed: Treated	Not diagnosed	7.386* (1.339, 40.738)	10.558* (1.083, 102.945)	1.017 (0.112, 9.213)	1.347 (0.139, 13.067)
Elevated Blood Sugar	Diagnosed: Treated	Diagnosed: Untreated	1.000 (0.063, 15.987)	0 (0, Inf)	2.000 (0.125, 31.975)	0 (0, Inf)
Elevated Blood Sugar	Diagnosed: Treated	Not diagnosed	1.206 (0.124, 11.680)	0 (0, Inf)	2.052 (0.370, 11.389)	1.153 (0.236, 5.620)
Elevated Blood Sugar	Diagnosed: Untreated	Not diagnosed	1.206 (0.241, 6.039)	3.392 (0.210, 54.854)	1.026 (0.113, 9.298)	0 (0, Inf)
Digestive Problems	Diagnosed: Treated	Not diagnosed	7.333 (0.660, 81.459)	0 (0, Inf)	0 (0, Inf)	0 (0, Inf)
Dyslipidemia	Diagnosed: Treated	Not diagnosed	0 (0, Inf)	0 (0, Inf)	0 (0, Inf)	4.058 (0.252, 65.351)
Ear/Hearing/Balance Disorder	Diagnosed: Unsure	Not diagnosed	1.801 (0.162, 20.001)	0 (0, Inf)	1.014 (0.112, 9.187)	0 (0, Inf)
Ear/Hearing/Balance Disorder	Diagnosed: Treated	Not diagnosed	0 (0, Inf)	0 (0, Inf)	0 (0, Inf)	4.042 (0.251, 65.083)

Variable	Comparison Level A	Comparison Level B	Carrier-Recorded Crash	Carrier-Recorded Preventable Crash	Nationally Recorded Crash	Moving Violation
Genitourinary	Diagnosed: Untreated	Not diagnosed	1.817 (0.164, 20.181)	3.430 (0.212, 55.467)	NA	0 (0, Inf)
Genitourinary	Diagnosed: Untreated	Potential	0.500 (0.013, 19.562)	NA	NA	0 (0, Inf)
Genitourinary	Potential	Not diagnosed	3.634 (0.226, 58.458)	NA	0 (0, Inf)	0 (0, Inf)
Head/Brain Injury	Diagnosed: Unsure	Not diagnosed	1.810 (0.163, 20.094)	0 (0, Inf)	0 (0, Inf)	0 (0, Inf)
Heart/Cardiovascular Disease	Diagnosed: Unsure	Not diagnosed	3.599 (0.502, 25.772)	0 (0, Inf)	1.360 (0.140, 13.232)	0 (0, Inf)
Heart/Cardiovascular Disease	Diagnosed: Untreated	Not diagnosed	NA	NA	NA	4.033 (0.250, 64.949)
High Blood Pressure	Diagnosed: Treated	Not diagnosed	0.519 (0.117, 2.312)	0.487 (0.059, 4.019)	0 (0, Inf)	0.440 (0.055, 3.505)
High Blood Pressure	Diagnosed: Treated	Potential	0.333 (0.045, 2.478)	0.429 (0.031, 5.985)	0 (0, Inf)	1.667 (0.092, 30.060)
High Blood Pressure	Potential	Not diagnosed	1.558 (0.398, 6.104)	1.136 (0.225, 5.744)	1.618 (0.309, 8.482)	0.264 (0.034, 2.018)
Kidney Disease	Potential	Not diagnosed	1.203 (0.321, 4.504)	1.132 (0.224, 5.723)	1.356 (0.269, 6.836)	1.148 (0.235, 5.596)
Lung/Chest Condition	Diagnosed: Treated	Diagnosed: Unsure	1.576 (0.153, 16.260)	0 (0, Inf)	0 (0, Inf)	0 (0, Inf)
Lung/Chest Condition	Diagnosed: Treated	Not diagnosed	0.942 (0.346, 2.568)	1.126 (0.297, 4.261)	0 (0, Inf)	0.660 (0.146, 2.987)
Lung/Chest Condition	Diagnosed: Unsure	Not diagnosed	0.598 (0.071, 5.000)	0 (0, Inf)	0.646 (0.077, 5.434)	0 (0, Inf)
Missing Limb	Diagnosed: Unsure	Not diagnosed	7.296 (0.657, 81.038)	0 (0, Inf)	0 (0, Inf)	0 (0, Inf)

Variable	Comparison Level A	Comparison Level B	Carrier-Recorded Crash	Carrier-Recorded Preventable Crash	Nationally Recorded Crash	Moving Violation
Nervous/Psychiatric Disorder	Diagnosed: Treated	Not diagnosed	0.353 (0.045, 2.782)	0 (0, Inf)	1.348 (0.139, 13.120)	0 (0, Inf)
OSA	Diagnosed: Treated	Not diagnosed	2.504 (0.875, 7.165)	0 (0, Inf)	0 (0, Inf)	1.169 (0.239, 5.704)
OSA	Diagnosed: Treated	Potential	2.000 (0.580, 6.898)	0 (0, Inf)	0 (0, Inf)	0.952 (0.167, 5.421)
OSA	Potential	Not diagnosed	1.252 (0.616, 2.546)	0.701 (0.258, 1.909)	1.227 (0.536, 2.811)	1.227 (0.566, 2.660)
Spine/Other Musculoskeletal Disorder	Diagnosed: Untreated	Not diagnosed	0 (0, Inf)	0 (0, Inf)	2.034 (0.182, 22.687)	0 (0, Inf)
Tobacco Use	Diagnosed: Untreated	Not diagnosed	1.354 (0.558, 3.289)	0.662 (0.187, 2.348)	0.289 (0.067, 1.237)	0.582 (0.200, 1.697)
Diet	Poor	Below Average	0.556 (0.226, 1.366)	0.578 (0.176, 1.898)	0.515 (0.167, 1.591)	1.127 (0.470, 2.704)
Diet	Poor	Average	0.537 (0.232, 1.246)	0.642 (0.211, 1.954)	0.544 (0.200, 1.478)	0.821 (0.398, 1.696)
Diet	Poor	Above Average	0.814 (0.285, 3.322)	0.708 (0.155, 3.235)	0.822 (0.201, 3.363)	0.664 (0.243, 1.818)
Diet	Poor	Excellent	0.705 (0.159, 3.124)	0.583 (0.088, 3.880)	0.921 (0.093, 9.126)	4.304 (0.517, 35.801)
Diet	Below Average	Average	0.967 (0.593, 1.578)	1.110 (0.586, 2.105)	1.056 (0.510, 2.188)	0.728 (0.379, 1.399)
Diet	Below Average	Above Average	1.465 (0.661, 3.244)	1.225 (0.363, 4.129)	1.596 (0.466, 5.466)	0.589 (0.227, 1.532)
Diet	Below Average	Excellent	1.269 (0.338, 4.760)	1.008 (0.191, 5.312)	1.787 (0.200, 15.955)	3.818 (0.470, 31.011)
Diet	Average	Above Average	1.515 (0.732, 3.136)	1.103 (0.352, 3.456)	1.511 (0.496, 4.609)	0.809 (0.356, 1.839)

Variable	Comparison Level A	Comparison Level B	Carrier-Recorded Crash	Carrier-Recorded Preventable Crash	Nationally Recorded Crash	Moving Violation
Diet	Average	Excellent	1.313 (0.364, 4.732)	0.908 (0.182, 4.537)	1.693 (0.202, 14.186)	5.242 (0.684, 40.181)
Diet	Above Average	Excellent	0.867 (0.208, 3.611)	0.824 (0.122, 5.573)	1.120 (0.107, 11.698)	6.480 (0.753, 55.794)

* indicates statistically significant result at alpha = 0.05.

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