Commercial Driver Safety Risk Factors (CDSRF)

U.S. Department of Transportation
Federal Motor Carrier Safety Administration

June 2020

FOREWORD

The objective of this study was to examine a wide array of driver and situational factors that impact commercial motor vehicle (CMV) safety. The study evaluated the prevalence of these factors as well as their relationship to being involved in a crash or moving violation in a diverse sample of over 21,000 truck drivers. The goal was to identify and prioritize driver individual differences with respect to risk factors. Primarily, these 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, during the duration of the study. The prospective study design afforded the opportunity to observe these drivers for up to 3 years using a combined dataset from carrier and national sources. This report documents the methods, data analyses, results, and conclusions involved in successfully conducting this study and evaluating the data.

NOTICE

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16. Abstract
The objective of this study was to prospectively examine a wide array of driver personal and situational factors to determine the prevalence of these factors as well as their relationship to being involved in a crash. This study involved the collection of driver medical, demographic, and other personal factors to examine the relationship between these factors with various safety outcomes. Interested drivers completed initial study materials during a driver orientation session with the participating carrier at one of eight different recruitment sites across the United States. Safety outcomes included crash data from the participating carrier and crashes and moving violation convictions from national datasets. Depending on the analysis, exposure included the driver's tenure at the participating carrier during the study or the amount of time under observation during the study. Data from over 21,000 drivers were collected, and 20,753 of these drivers were included in the analyses. Many of the prevalence rates for several of the medical conditions were similar to or above the U.S. averages. In general, those receiving treatment for a medical condition were no riskier in terms of safety outcomes than drivers without the medial condition and, in several cases, were less risky than those who did not have the medical condition. When there was an increase in risk in one or more of the safety outcomes, it was usually associated with the driver not receiving treatment or the driver not being clinically diagnosed with the medical condition (and thus not receiving treatment).

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SI* (MODERN METRIC) CONVERSION FACTORS

Approximate Conversions to SI Units				
Symbol	**When You Know**	**Multiply By**	**To Find**	**Symbol**
		Length		
in	inches	25.4	millimeters	mm
ft	feet	0.305	meters	m
yd	yards	0.914	meters	m
mi	miles	1.61	kilometers	km
		Area		
in^2	square inches	645.2	square millimeters	mm^2
ft^2	square feet	0.093	square meters	m^2
yd^2	square yards	0.836	square meters	m^2
ac	Acres	0.405	hectares	ha
mi^2	square miles	2.59	square kilometers	km^2
		Volume (volumes greater than 1,000L shall be shown in m^3)		
fl oz	fluid ounces	29.57	milliliters	mL
gal	gallons	3.785	liters	L
ft^3	cubic feet	0.028	cubic meters	m^3
yd^3	cubic yards	0.765	cubic meters	m^3
		Mass		
oz	ounces	28.35	grams	g
lb	pounds	0.454	kilograms	kg
T	short tons (2,000 lb)	0.907	megagrams (or “metric ton”)	Mg (or “t”)
		Temperature (exact degrees)		
°F	Fahrenheit	5(F-32)/9 or (F-32)/1.8	Celsius	°C
		Illumination		
fc	foot-candles	10.76	lux	lx
fl	foot-Lamberts	3.426	candela/m^2	cd/m^2
		Force and Pressure or Stress		
lbf	poundforce	4.45	newtons	N
lbf/in^2	poundforce per square inch	6.89	kilopascals	kPa

Approximate Conversions from SI Units				
Symbol	**When You Know**	**Multiply By**	**To Find**	**Symbol**
		Length		
mm	millimeters	0.039	inches	in
m	meters	3.28	feet	ft
m	meters	1.09	yards	yd
km	kilometers	0.621	miles	mi
		Area		
mm^2	square millimeters	0.0016	square inches	in^2
m^2	square meters	10.764	square feet	ft^2
m^2	square meters	1.195	square yards	yd^2
Ha	hectares	2.47	acres	ac
km^2	square kilometers	0.386	square miles	mi^2
		Volume		
mL	milliliters	0.034	fluid ounces	fl oz
L	liters	0.264	gallons	gal
m^3	cubic meters	35.314	cubic feet	ft^3
m^3	cubic meters	1.307	cubic yards	yd^3
		Mass		
g	grams	0.035	ounces	oz
kg	kilograms	2.202	pounds	lb
Mg (or “t”)	megagrams (or “metric ton”)	1.103	short tons (2,000 lb)	T
		Temperature (exact degrees)		
°C	Celsius	1.8c+32	Fahrenheit	°F
		Illumination		
lx	lux	0.0929	foot-candles	fc
cd/m^2	candela/m^2	0.2919	foot-Lamberts	fl
		Force and Pressure or Stress		
N	newtons	0.225	poundforce	lbf
kPa	kilopascals	0.145	poundforce per square inch	lbf/in^2

* SI is the symbol for the International System of Units. Appropriate rounding should be made to comply with Section 4 of ASTM E380. (Revised March 2003, Section 508-accessible version September 2009.)

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LIST OF ACRONYMS, ABBREVIATIONS, AND SYMBOLS

AIC	Akaike Information Criteria
ATRI	American Transportation Research Institute
BLS	Bureau of Labor Statistics
BMI	Body Mass Index
BQ	Berlin Questionnaire
CDIDS	Commercial Driver Individual Differences Study
CDSRF	Commercial Driver Safety Risk Factors
CDL	Commercial Driver's License
CDLIS	Commercial Driver's License Information System
CMV	Commercial Motor Vehicle
CI	Confidence Interval
DDDI	Dula Dangerous Driving Index
DOT	Department of Transportation
ESS	Epworth Sleepiness Scale
FMCSA	Federal Motor Carrier Safety Administration
GED	General Educational Development
ICF	Informed Consent Form
IRB	Institutional Review Board
JIG	Job in General
LTCCS	Large Truck Crash Causation Study
LHTDS	Long-haul Truck Driver Survey
MCMIS	Motor Carrier Management Information System
NHTSA	National Highway Traffic Safety Administration
OR	Odds Ratio
OSA	Obstructive Sleep Apnea
OOS	Out-of-service
OOIDA	Owner-Operator Independent Drivers Association
PAP	Positive Airway Pressure
RR	Risk Ratio
SDS	Social Desirability Scale
SRLE	Survey of Recent Life Experiences
USDOT	U.S. Department of Transportation
VTTI	Virginia Tech Transportation Institute

EXECUTIVE SUMMARY

The goal of the Commercial Driver Safety Risk Factors (CDSRF) study was to identify and prioritize commercial motor vehicle (CMV) driver individual differences with respect to risk factors. Primarily, these risk factors consisted of personal factors, such as demographic characteristics, medical conditions, personal attitudes, and behavioral history; however, they also included work environmental conditions. The CDSRF study identified risk factors by linking individual characteristics of drivers with their driving records, especially the occurrence of a crash or moving violation, over the course of the study. Note that this was previously titled the Commercial Driver Individual Differences Study (CDIDS).

The prospective study design afforded the opportunity to observe participant drivers for up to 3 years using a combined dataset from carrier and national sources. There were four primary objectives of this study:

1. Examine the prevalence of CMV driver demographic characteristics, work experience, lifestyle and behavioral habits, and medical conditions.
2. Determine whether individual factors (e.g., demographic characteristics, work experience, lifestyle and behavioral habits, driving behaviors, medical conditions, etc.) and/or contributing situational and environmental factors, result in increased risk for a crash or moving violation.
3. Identify factors associated with the presence of obstructive sleep apnea (OSA).
4. Follow CMV drivers for up to 3 years after entry into the study to identify additional crash data and conduct validation of study results.

DATA COLLECTION MEASURES

Table 1 shows the data collection measures used in the CDSRF study.

Table 1. Data collection measures used in the CDSRF study.

Questionnaire	Description
Medical Examination Report for Commercial Driver Fitness Determination	A qualifying Medical Examination Report for Commercial Driver Fitness Determination is required of all non-exempt drivers with a commercial driver's license (CDL). The examination form consists of biographical information, such as name, date of birth, weight, height and gender, as well as 64 items related to medical health.
Brief Medical Exam	Collected demographic information (driver's license number, gender, and date of birth) as well as two pieces of objective medical information (blood pressure and heart rate). Only collected for those drivers without a Medical Examination Report.
Demographic Questionnaire	Basic demographic information that was not covered in the Medical Examination Report.
Epworth Sleepiness Scale (ESS)	A self-report screening tool for daytime sleepiness.
Berlin Questionnaire (BQ)	A self-report screening tool for OSA.
Survey of Recent Life Experiences (SRLE)	This survey lists recent life experiences that contribute to stress or "daily hassles."

Questionnaire	Description
Dula Dangerous Driving Index (DDDI)	Assesses various aspects of driving behavior, including hostility felt and expressed while driving.
Social Desirability Scale (SDS)	Items which help determine if a respondent is attempting to appear in a favorable light or is otherwise not responding truthfully.
Job in General (JIG)	Sub-scale related to overall satisfaction at work. Research suggests that individuals who are disgruntled or otherwise unsatisfied with their work may be more prone to crash involvement than those who are satisfied with their work.

SAFETY OUTCOMES

There were three different safety outcomes in the CDSRF study. The participating carrier provided the research team with monthly crash files for the duration of the study. Additionally, the research team obtained monthly Motor Carrier Management Information System (MCMIS) reports. At the end of the study, the research team received a record of moving violation convictions for each driver in the Commercial Driver's License Information System (CDLIS).

METHODS

There were eight recruitment sites. Seven locations were associated with a single carrier and one was an occupational health clinic (not aligned with the participating carrier). The eight recruitment sites were located across the continental United States, with locations in the western, southern, central, southeastern, and eastern United States. Drivers were recruited by fleet staff during the driver orientation program at each carrier location. During driver orientation, drivers who were new hires or rehires were given safety and administrative training and a Department of Transportation (DOT) medical examination (i.e., Medical Examination Report) by Road Ready, Inc. Fleet personnel distributed study materials (provided by researchers) on the first day of each driver orientation program.

Data Entry and Reduction

Upon receipt of the Initial Driver Survey and Follow-up Survey, members of the research team removed any personally identifying information that participants may have inadvertently included on the questionnaires. Each questionnaire was entered into a database using a unique participant number. Upon receipt of the Medical Examination Report, members of the research team used the participant key, consisting of the driver's commercial driver's license (CDL) code and name code, to assign the anonymous participant number to the Medical Examination Report. Some sections of the Medical Examination Report included open-ended comments from the driver and medical examiner regarding prior and current medical conditions, treatment for existing conditions, recommendations for future testing/specialists, etc. These comments were transcribed and coded by members of the research team.

Using the CDL code, name code, and the date of entry in the study, the research team developed algorithms to search the carrier crash data, MCMIS crash files, and CDLIS files to identify matching events for drivers in the study. When searching these files, the research team defined

the date range using entry into the study as the begin date and end of data collection as the end date (May 30, 2016) for each driver. Each match was verified via a manual review to confirm that the driver in the crash and/or violation was a driver in the study.

Tenure at the participating carrier was used as a measure of exposure. Tenure was defined as the length of time between the date of entry in the study and the end of data collection or the date they left the participating carrier (if that occurred before May 30, 2016). Driver tenure was unavailable for independent contractors. Once a driver left the participating carrier, the study team could not verify if that driver was employed and/or driving a truck/bus for a living. Driver exposure from the national analyses was defined as the length of time between the date of entry in the study and the end of data collection.

DATA ANALYSIS

Several study designs were used to evaluate the different research questions. With different safety outputs (e.g., crashes from the participating carrier, national crashes, and national violations), each associated with different exposure/tenure, several analyses were performed within each study design (if necessary). The national crash database, MCMIS, only included DOT-recordable crashes, whereas the carrier data included crashes from all severity levels. However, the carrier database only captured crashes while a driver was employed at the participating carrier. Given the high turnover rate and short employment period for drivers at the participating carrier, the observation period was relatively short. Thus, to fully use the collected data, three separate analyses were conducted:

1. The first analysis only used the national crash databases (MCMIS), where exposure was date of entry in the study until May 30, 2016.
2. The second analysis only used the national violation databases (CDLIS), where exposure was date of entry in the study until May 30, 2016.
3. The third analysis only used the carrier crash files, where tenure was the length of employment at the participating carrier up to May 30, 2016.

With no evidence of overdispersion, a Poisson regression model was used to model the frequency of crashes with the Initial Driver Survey and Medical Examination Report during the observation period. Preliminary analyses found that drivers' age strongly correlated with the number of crashes, but also with most of the medical outcomes. To adjust for this potential confounding and interacting effect, the regression models were stratified by age using quartiles. After stratification, each variable was evaluated individually in the regression model with adjustment to age and body mass index (BMI). In addition to evaluating each individual variable, stepwise regression was used to examine the joint effect of multiple variables on drivers' risk estimation. A nested case-control approach was used to examine variables collected in the Follow-up Survey with their effect on risk. Lastly, the OSA predictive analysis calculated the odds that a driver with each predictor variable (e.g., obese class III, male, high blood pressure, etc.) would be diagnosed with OSA. A stepwise regression was used for the generalized linear model with a logit link; following, a classification tree was applied to find the hierarchical structure of the covariates in explaining the presence of OSA.

STUDY FINDINGS

Error! Reference source not found. and Table 3 provide a sample of key findings for the research domains examined in the CDSRF study and some specific findings in the CDSRF study, respectively.

Table 2. Sample of key findings for the CDSRF study research domains.

Research Question	Study Finding
Crash Risk for Medical Conditions: Which medical conditions and treatments had an impact on future crash and/or moving violation risk?	Overall, drivers being *treated* for certain medical conditions, such as diabetes/elevated blood sugar, high blood pressure, and OSA, were no riskier than drivers without that same medical condition. In some age groups, treated drivers were less risky than those who did not have the medical condition.
Crash Risk by Prior Moving Violation: Did prior moving violations have an impact on future crash and/or moving violation risk?	Prior moving violation convictions in the last 3 years were associated with increased crash and moving violation risk.
Crash Risk by Age and Driving Experience: Did driver age and driving experience have an impact on future crash and/or moving violation risk?	In general, more experienced drivers in the study sample age 52 and older were less likely to be involved in crashes or moving violation convictions compared to less experienced drivers in the study sample age 20-33. Note there was 1 driver that was age 20 out of over 21,000 drivers in the study.
Obstructive Sleep Apnea Predictors: Which predictors were associated with a diagnosis of OSA?	For drivers in the study sample, body mass index (BMI > 35.03) was the best predictor, followed by being male, diagnosed high blood pressure, and age (>33.5 years), and to a lesser extent the Berlin Questionnaire (multiple choice self-assessment for OSA based on snoring, apneas, daytime sleepiness, and blood pressure).

Table 3. Some specific findings in the CDSRF study (listed in no particular order of importance or magnitude).

Variable	Specific Study Findings
BMI	In general, higher BMI was found to reduce crash and moving violation conviction risk in younger drivers. Increasing BMI was highly correlated with increasing age. Thus, older, safer drivers were more likely to have a high BMI.
OSA	Untreated OSA or potential OSA, which was undiagnosed and untreated, was associated with an increased crash and moving violation conviction risk. This suggests the need for treating this condition.
Elevated Blood Pressure	Untreated elevated blood pressure or potential high blood pressure, which was undiagnosed and untreated, was associated with an increased crash and moving violation conviction risk. This suggests the need for treating this condition.
Nervous/Psychiatric Condition	Treated and untreated nervous/psychiatric conditions were associated with an increase in crash risk. Many specific conditions (e.g., anxiety, depression, etc.) were included in this grouping, so it could be that one or more of these conditions is associated with the increase in crash risk. This suggests that wellness programs that target driver wellbeing should be made available to drivers.
Seat Belt Use	Drivers who reported they did not always wear their seat belt while driving a CMV were associated with an increased crash and moving violation conviction risk. This suggests the need for a robust seat belt policy and enforcement of that policy.

Variable	Specific Study Findings
Tobacco Use and Obesity	Almost two-thirds of drivers reported tobacco use and over 50 percent were considered obese. Tobacco use and obesity are associated with various comorbid health conditions, such as OSA and elevated blood pressure. Thus, health and wellness programs that target tobacco use and obesity can have positive health and safety implications.

One of the more striking findings was the profound effect of age and driving experience on future crash risk. Younger and less experienced truck drivers were far more likely to be involved in the safety outcomes compared to older and more experienced truck drivers. Moreover, older drivers in the current study were more likely than their younger counterparts to have one or more medical conditions. To address this issue, many of the analyses were stratified by age quartiles so that the effects of medical conditions and treatment status could be analyzed by separate age quartiles. Drivers in each age quartile were compared to other drivers in the same age quartile. CMV driving experience was highly correlated with age and was thus not included in the modeling approach. Moreover, CMV driving experience was available only for those drivers who completed the Initial Driver Survey, whereas age was available for every driver in the current study. Age therefore provided a more complete, consistent dataset for the drivers studied.

Another interesting finding was the degree to which drivers responded on the Initial Driver Survey in a socially desirable way (i.e., trying to present themselves in a good light). Almost all drivers who completed the Initial Driver Survey scored high on the SDS (99.1 percent), and the mean scores on the DDDI and SRLE were well below the norms for those questionnaires.

Although the research team recruited truck drivers from across the United States, 20,745 participants were recruited from one large for-hire truck fleet. Moreover, those who completed the Initial Driver Survey can be considered a convenience sample. Compared to other studies,[1,2] the current sample was slightly younger and contained fewer females and independent contractors. The latter was expected given that the majority of the sample was recruited from a for-hire carrier. Most of the drivers (58.4 percent) in the current study were obese, almost twice the national prevalence of obesity in the U.S. working population (30.5 percent).[3]

The current study only found a significant trend between obesity and the safety outcomes for drivers aged 20–33 in the individual regression analyses. Drivers with a BMI that classified them as overweight or above were significantly less likely to be involved in a total carrier crash and a carrier preventable crash compared to normal weight drivers. This was an interesting finding, as this group of drivers had far fewer medical conditions compared to the other age quartiles. It appears obesity itself does not increase crash risk; rather, the risk is increased by the comorbid health conditions associated with obesity (the current study found several of these conditions significantly increase risk if not treated). Over 60 percent of drivers who completed the Initial Driver Survey in the current study reported using tobacco. Tobacco use rates in this population remain significantly elevated compared to working adults in the United States (19 percent).[4]

Turnover, or driver churn, is problematic in the trucking industry, especially in the for-hire truckload industry. The data in the current study seemed to support this issue, as the median and mean number of days employed at the participating carrier were 114 days and 213 days, respectively. However, these numbers are somewhat misleading for two reasons. First, they include driver tenure from drivers who were employed at the participating carrier multiple times

over the course of data collection (this would increase driver tenure). Second, they include a cutoff of May 30, 2016, and many drivers likely remained at the participating carrier beyond this date (this would decrease driver tenure).

Caffeine consumption is ubiquitous in the U.S. population, with almost 95 percent of the U.S. population above the age of 18 consuming at least one caffeinated beverage each day.[5] The results in the current study suggest CMV drivers may consume more than the U.S. population. Almost all the drivers in the current study (99.6 percent) reported drinking at least one caffeinated drink per day, and most drivers (77.2 percent) reported consuming two or more caffeinated drinks per day.

Although only 12.6 percent of drivers in the current study who completed the Initial Driver Survey reported a regular sleep schedule, 72.9 percent of the drivers reported 7 or more hours of sleep each night. The proportion of truck drivers reporting more than 8 hours of sleep in the last 24 hours was more than four times greater than the U.S. working population (5 percent).[6] It is possible that drivers may be self-reporting a picture of their sleep that is rosier than the actuality. Truck drivers work extended hours and shifts that can start at various times of the day and night and the conditions in the truck cab are not conducive to good quality sleep (due to noise, comfort level, and temperature). All of these factors can adversely affect the amount and quality of sleep.

More than 95 percent of drivers in the current study reported "always" wearing their seat belt while driving a CMV. Several of the analyses showed that drivers who wore their seat belt less than always were significantly more likely to be convicted of a moving violation (45 percent to 234 percent more likely). Only 5 percent of the moving violation convictions in the current study were related to lack of restraint use, indicating that the majority of drivers were being convicted of other moving violations.

Drivers in the current study who reported a prior moving violation were significantly more likely to be involved in a carrier preventable crash (54 percent more likely) or a national crash (58 percent more likely) or convicted of a moving violation (45–62 percent more likely) in the individual regression analyses. They were also 26 percent more likely to be involved in a national crash or convicted of a moving violation in the stepwise regression analyses.

Even with the likely underreporting and under diagnosis of medical conditions, many of the prevalence rates for several of the medical conditions were similar to or greater than the U.S. average. The prevalence of elevated blood sugar (9.4 percent versus 6.8 percent), hypertension (24.4 percent versus 24 percent), and OSA (7.2 percent versus 4 percent) were similar to or greater than those in the general population and other occupational cohorts, whereas heart disease was lower (2.4 percent versus 6.7 percent).

The current study found protective effects for several medical conditions when those medical conditions were being treated, but largely found that diagnosed drivers who received treatment were no different than drivers without the medical condition. When there was an increased risk in one of the safety outcomes, it meant the driver was not treating the medical condition or the driver potentially had the medical condition (but wasn't being treated, as the medical condition was undiagnosed at this stage).

In certain age groups, drivers receiving treatment for OSA, high blood pressure, and diabetes/elevated blood sugar were less risky than drivers who did not have the condition. Drivers aged 34–42 with OSA who were currently being treated were significantly less likely to be involved in a carrier preventable crash compared to drivers without OSA (95.9 percent reduction), whereas drivers aged 34–42 who had OSA and weren't being treated were significantly more likely to be convicted of a moving violation (66.2 percent increase). Drivers with potential OSA (thus untreated) were more likely to be involved in a carrier preventable crash and moving violations. "Potential" OSA counts were based on driver self-reports and physician comments in the Medical Examination Report.

Drivers aged 34–42 who had high blood pressure and received treatment were less likely to be convicted of a moving violation (40 percent reduction). However, drivers aged 34–42 with high blood pressure who weren't being treated were significantly more likely to be convicted of a moving violation (twofold increase), and drivers who potentially had high blood pressure were significantly more likely to be involved in a total carrier crash (70 percent increase) or be convicted of a moving violation (almost threefold increase).

Drivers aged 43–51 with treated diabetes/elevated blood sugar were 50 percent less likely to be involved in a national crash compared to drivers aged 43–51 who did not have diabetes/elevated blood sugar. Drivers with treated diabetes/elevated blood sugar were 38.7 percent more likely to be convicted of a moving violation compared to drivers who did not have diabetes/elevated blood sugar.

Post-hoc analyses were completed for these three medical conditions (i.e., OSA, high blood pressure, and diabetes/elevated blood sugar) comparing treated and untreated drivers. As shown in Table 4, in certain age groups, drivers receiving treatment for high blood pressure and OSA were less risky than untreated, diagnosed drivers.

Table 4. Post-hoc analysis: safety outcomes (adjusted for age and BMI) of drivers treated for diabetes/elevated blood sugar, OSA, or high blood pressure compared to drivers with the condition who were not receiving treatment.

Crash/Moving Violation Category	Treated Drivers versus Untreated Drivers
Carrier-Defined Preventable Crashes	**Treated OSA:** • Drivers aged 34–42 with treated OSA were **92.2% less likely** to be involved in a carrier preventable crash than untreated drivers with OSA. • Drivers aged 43–51 with treated OSA were **68.9% less likely** to be involved in a carrier preventable crash than untreated drivers with OSA. In all other age groups, there were no statistically significant differences in this safety outcome between drivers with treated OSA and drivers with untreated OSA. **Treated Diabetes/Elevated Blood Sugar and Treated High Blood Pressure:** There were no statistically significant findings in this category for these conditions.

Crash/Moving Violation Category	Treated Drivers versus Untreated Drivers
National Crashes as Reported to MCMIS	**Treated OSA:** • Drivers aged 43–51 with treated OSA were **59.7% less likely** to be involved in a MCMIS-reportable* crash compared to untreated drivers with OSA. In all other age groups, there were no statistically significant differences in this safety outcome between drivers with treated OSA and drivers with untreated OSA. **Treated Diabetes/Elevated Blood Sugar and Treated High Blood Pressure:** There were no statistically significant findings in this category for these conditions.
Moving Violation Convictions found in CDLIS	**Treated High Blood Pressure:** • Drivers aged 20–33 with treated high blood pressure were **69.3% less likely** to be convicted of a moving violation compared to untreated drivers with high blood pressure. • Drivers aged 34–42 with treated high blood pressure were **72.6% less likely** to be convicted of a moving violation compared to untreated drivers with high blood pressure. • Drivers aged 52 or older with treated high blood pressure were **51.5% less likely** to be convicted of a moving violation compared to untreated drivers with high blood pressure. In the 43–51 age group, there were no statistically significant differences in this safety outcome between drivers with treated high blood pressure and drivers with untreated high blood pressure. **Treated OSA:** • Drivers aged 52 or older with treated OSA were **71.9% less likely** to be convicted of a moving violation compared to untreated drivers with OSA. In all other age groups, there were no statistically significant differences in this safety outcome between drivers with treated OSA and drivers with untreated OSA. **Treated Diabetes/Elevated Blood Sugar:** There were no statistically significant findings in this category for these conditions.

*A crash is MCMIS-reportable if it involves a vehicle meeting certain thresholds (i.e., a CMV) and results in a minimum grade of damage or injury, or in a fatality.

The data in the current study support the use of objective criteria to screen drivers for OSA, as BMI was the best predictor of those diagnosed with OSA, with the first split at a BMI of 35 or greater. Some have argued this cutoff will impose a significant financial hardship on CMV carriers and drivers, given that 25 percent of CMV drivers will meet this criterion. The current study also found that high blood pressure was predictive of those diagnosed with OSA, and that blood pressure measurements could possibly be added to the screening criteria to reduce the number of false positive OSA diagnoses.

CONCLUSIONS

One of the more important findings with respect to future research in this domain was the effect of age and experience on safety outcomes and the relationship of age with BMI and medical

conditions. Older drivers age 52 and older who had more CMV driving experience were safer drivers (as they exhibited lower rates of safety outcomes). These older, safer, and more experienced drivers were more likely to have a higher BMI and be diagnosed with one or more medical conditions compared to their younger (age 20-33), less safe, and inexperienced counterparts. Note there was only 1 driver that was age 20 out of over 21,000 drivers in the study. Thus, controlling for age and BMI as a covariate was not enough to overcome this safety selection.

From a regulatory perspective, the results suggest that the requirements for CMV drivers being medically certified to drive are working with respect to safety outcomes. As noted, those receiving treatment for a medical condition were no riskier than drivers without the medial condition, and, in several cases, were less risky than those without a diagnosis of the medical condition. When there was an increase in risk in one or more of the safety outcomes, it was usually associated with the driver not receiving treatment or the driver not being officially diagnosed with the medical condition (thus, not receiving treatment). A nervous/psychiatric disorder was the only medical condition that consistently showed a trend for a significant increase in risk for those being treated. The nervous/psychiatric disorder was comprised of a variety of psychological conditions (mostly depression and anxiety).

Given that one of the more robust findings in the current study was that drivers being treated for a medical condition were no riskier than drivers without that same medical condition, and, in several cases, were less risky than those who did not have the medical condition, the benefits of attending to drivers' health become clear. Given the high rates of obesity and tobacco use, which are both associated with a variety of adverse health outcomes, fleets should focus their efforts on identifying solutions to address these two issues. The results also highlight the importance of successfully recruiting, selecting, and retaining qualified safe drivers, as prior convictions for moving violations were also predictive of future safety outcomes.

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1. INTRODUCTION

1.1 BACKGROUND

Approximately 3.5 million professional truck drivers transport more than 10 billion tons of freight annually in the United States, grossing more than $700 billion in freight revenues, according to estimates by the American Trucking Associations.[7] Since 2010, there has been an increasing demand for freight services and truck drivers to move goods throughout the country. As of 2017, 543,061 interstate motor carriers had recent activity operating in the United States.[8] The trucking industry contributes significantly to the U.S. economic portfolio, employing approximately 8.7 million people and moving more than two-thirds of the total freight transported in the country. From 2016 on, it is anticipated that approximately 115,000 truck driver job openings will be created annually by U.S. companies to address the demand for new truck drivers.[9]

1.1.1 Commercial Motor Vehicle Driver Demographics

The median age of over-the-road truck drivers is 49 years,[10] compared to 42 years for all U.S. workers.[11] Private fleet drivers have an even higher median age of 52 years.[12] Data from the American Transportation Research Institute (ATRI) show the aging of the trucking industry does not match changes in the general U.S. workforce.[13] Nearly 30 percent of the truck transportation workforce is between 45 to 54 years of age and there has been a growth in the proportion of trucking employees who are 55 years and older. The industry is seeing an influx of post-retirement drivers entering the trucking workforce; accordingly, the median age is likely to increase in coming years. Approximately 94 percent of commercial motor vehicle (CMV) drivers are male,[14] compared to 53 percent of all U.S. workers.[15] Minorities represented 39 percent of CMV drivers in 2014.[16] Over the next decade, the trucking industry will likely hire nearly 90,000 new drivers per year in response to driver shortage issues due to industry growth, driver retirement, and driver turnover.[17] State and Federal laws dictate specific qualifications in order to become a CMV driver, including obtaining a commercial driver's license (CDL), a medical card, and a variety of endorsements. Obtaining a CDL typically requires multiple weeks of training and testing, which can cost as much as $6,500.[18]

1.1.2 Crashes and Violations

Large truck and bus crashes placed an estimated $134 billion burden on the U.S. economy in 2016,[19] including costs related to fatalities, lost productivity, property damage, medical and rehabilitation costs, travel delays, legal costs, emergency services, insurance, and costs to employers.[20] In 2016, large trucks were involved in 367,000 property-damage-only crashes, 3,864 fatal crashes, and 104,000 injury crashes.[21] Heavy and tractor-trailer truck drivers were found to be 12 times more likely to die on the job[22] and 3 times more likely to suffer an injury involving time off work than the general U.S. worker population.[23]

Two studies by ATRI found that previous crashes and violations are predictive of future crashes.[24,25] In one study, the authors sampled data from 587,772 U.S. truck drivers from 2008 to 2009 to determine the future crash predictability of prior violations, convictions, and crashes. This study concluded that drivers who had a past crash had an 88 percent increased likelihood of

being involved in a future crash.[26] Violations that were highly predictive of a future crash included convictions for failure to use/improper signal, improper passing and turning, improper lane/location or erratic lane change, failure to obey traffic signs, and speeding. Interestingly, any prior conviction was associated with a 65 percent increased likelihood of future crash involvement. A key take away from both ATRI studies was that being aware of at-risk driving behaviors can enable carriers and regulatory agencies to proactively address future crash risk.

1.1.3 Driver Factors and Crash Risk

Many different factors interact to impact crash risk, including driver factors, vehicle or environmental factors, and situational factors. Research indicates a strong relationship between driver factors and an increase in crash risk. Individual factors, including age,[27,28,29] gender,[30,31,32] personality traits, including risk-taking and sensation-seeking,[33,34] and driving behaviors, such as seat belt use, distraction, speeding, and moving violations have all been associated with an increase in crash risk (see references 35, 36, 37, 38, 39, 40, 41, and 42). Health and medical conditions, including obesity, cardiovascular disease, diabetes, obstructive sleep apnea (OSA), and musculoskeletal injuries have also been demonstrated to increase crash risk (see references 43, 44, 45, 46, 47, 48, 49, and 50). Weigand and colleagues found that obese CMV drivers were 1.37 times more likely than non-obese drivers to be involved in a safety-critical event and were nearly twice as likely to be fatigued while involved in an at-fault safety-critical event.[51]

A case-control analysis of 4,448 drivers found that participants with non-medicated diabetes had a threefold increased crash risk; stroke (odds ratio [OR] estimate = 1.93), history of myocardial infarction (OR estimate = 1.77), depression (OR estimate = 2.43), and anxiety (OR estimate = 3.15) were also significantly associated with greater crash risk.[52] A recent cross-sectional study with nearly 800 CMV drivers found that conditions including low back pain, heart disease, stress, and alcohol use were associated with crashes.[53] A recent study by Burks et al. concluded that CMV drivers with diagnosed OSA who did not adhere to positive airway pressure (PAP) treatment had a fivefold greater risk of serious preventable crashes.[54] Another interesting finding from the Burks study was that drivers with diagnosed OSA who partially or fully complied with PAP treatment had crash rates similar to those of drivers without OSA. Fatigue has been shown to be a particularly prevalent factor in work-related crashes through reduced alertness and impaired cognitive function, reaction time, and performance capabilities (see references 55, 56, 57, 58, 59, 60, 61, and 62). Driver lifestyle and behavioral factors may also play a role in crash risk. Obesity and comorbid diseases associated with poor nutrition and sedentary behavior, including diabetes, cardiovascular diseases, and OSA, have been shown to increase crash risk in truck drivers (see references 63, 64, 65, and 66). Short or inadequate sleep[67] and alcohol use[68,69] also increase crash risk, and caffeine has shown a protective effect on crash risk for CMV drivers.[70]

1.1.4 Environmental and Work Factors and Crash Risk

Several work and environmental factors have been shown to impact crash risk, including long work hours;[71] pay, compensation, and benefits;[72] traffic conditions;[73] irregular breaks, tight delivery schedules, and lack of vehicle technology and safety devices;[74] driver training;[75] and driving experience.[76,77] Job satisfaction may also impact crash risk indirectly through driver retention and decreased turnover.[78] Safety policies and the culture within the workplace can also

influence CMV driver behaviors that are risk factors for crashes.[79,80] For example, health programs initiated by carriers to address issues faced by drivers, including overweight conditions and obesity, hypertension, and OSA, have been show to decrease driver turnover,[81,82] which is linked to crash risk.[83]

1.1.5 Situational Factors and Crash Risk

Situational factors and life events or experiences that cause stress, anxiety, depression, and other strong emotions have also been linked to an increase in crash risk. Norris et al. observed that job stress was highly predictive of future crashes and that financial stress has been shown to increase the likelihood of more serious crashes.[84] Interestingly, minor crashes were found to be associated with high levels of stress whereas major crashes or the absence of crashes were associated with low levels of stress.[85] In addition to stress, Dobson et al. found that lower life satisfaction scores were associated with increased rates of crashes.[86] Having a relationship partner was associated with fewer violations and lower crash risk. Studies have reported relationships between aggressive driving and having an emotional or professional setback and legal difficulties. [87,88] Stress has also been associated with risky driving behaviors. A study of young drivers found that anxiety and depression were associated with risky driving behaviors, such as speeding, not wearing a seat belt, and cell phone use while driving.[89] Mental health issues have not been extensively studied in the CMV population. A recent survey of 316 CMV drivers reported the following prevalence estimates: loneliness (28 percent), depression (27 percent), chronic sleep disturbances (21 percent), anxiety (15 percent), and other emotional problems (13 percent).[90]

1.2 SUMMARY

As shown above, many different factors impact crash risk. However, while the studies referenced above investigated various specific factors, most did not consider the multitude of interactions and how these interactions affect crash risk. Additionally, most of the studies use a retrospective approach, which may be biased, as the crash may alter the driver's perception or condition. For example, Mayou and colleagues found that approximately 30 percent of drivers involved in a crash that required an emergency room visit were likely to develop symptoms resembling post-traumatic stress disorder, phobic travel anxiety, general anxiety, and depression.[91] Lastly, many of the studies reported above used self-reports of crash history and did not include a measure of exposure (e.g., miles traveled). There is some evidence that self-reported crashes are suspect and may not reflect actual behavior.[92] Further, crashes independent of exposure are misleading (e.g., one crash after 1 month of driving compared to one crash after 3 years of driving).

The Commercial Driver Safety Risk Factors (CDSRF) study, reported herein, addressed many of these issues. The comparison of crash-involved drivers to controls quantified the increased probability of being involved in a crash associated with various driver and situational factors. These personal and situational factors were selected at the onset of the study, and included some

questionnaires[i] that were eliminated by the Office of Management and Budget and are thus not included in this report. Each factor was evaluated in terms of its likely importance with regard to crash risk and feasibility for inclusion in the CDSRF study. Not only was the crash risk associated with driver and situational factors determined, but assessments of these risk factors were also combined. These crash risk predictions, whether based on single or multiple combined factors, have important near-term applications in improving CMV safety management.

Thus, the objective of the CDSRF study was to examine a wide array of driver and situational factors and determine the prevalence of these factors as well as their relationship to being involved in a crash or moving violation in a diverse sample of more than 21,000 CMV drivers. The CDSRF study sought to identify and prioritize CMV driver individual differences with respect to risk factors. Primarily, these risk factors consisted of personal factors, such as demographic characteristics, medical conditions, personal attitudes, and behavioral history. The CDSRF study identified risk factors by linking the characteristics of individual drivers with their driving records over the course of the study, especially the occurrence or absence of crashes. The prospective study design afforded the opportunity to observe these drivers for up to 3 years using a combined dataset from carrier and Federal sources. There were four primary objectives of this study:

1. Examine the prevalence of CMV driver demographic characteristics, work experience, lifestyle and behavioral habits, and medical conditions.
2. Determine whether individual factors (i.e., demographic characteristics, work experience, lifestyle and behavioral habits, driving behaviors, medical conditions, etc.) and/or contributing situational and environmental factors, result in increased risk for a CMV crash or moving violation.
3. Identify factors associated with presence of OSA.
4. Follow CMV drivers for up to 3 years after entry into study to identify additional crash data and conduct validation of study results.

[i] The following questionnaires were eliminated by the Office of Management and Budget, and were related to personality correlates: International Personality Item Pool (which measures Agreeableness, Conscientiousness, Extraversion, Neuroticism, and Openness to Experience), Sensation Seeking Scale, and Internal Control Index.

2. DATA COLLECTION MATERIALS

2.1 MEDICAL EXAMINATION REPORT FOR COMMERCIAL DRIVER FITNESS DETERMINATION

A qualifying Medical Examination Report for Commercial Driver Fitness Determination is required of all drivers with a CDL.[ii] The examination form consists of biographical information, such as name, date of birth, weight, height and gender, as well as 64 items related to medical health. The major targeted areas in the medical examination are listed below.

- General Information: includes driver information and health history.
- Testing: includes vision, hearing, blood pressure/pulse rate, and laboratory and other test findings.
- Physical Examination: includes general appearance, eyes, ears, mouth and throat, lungs and chest (not including breast examination), abdomen and viscera, vascular systems, genitourinary system, extremities, spine and other musculoskeletal, and neurological.

In addition to the 64 mandatory items, there are three sections in the Medical Examination Report that are dedicated to open comments. The first section is completed by the driver for a more detailed description of his/her health history (e.g., past cancers, heart attacks, current medications, etc.). The second section is completed by the medical examiner and is based on the medical examiner's discussion with the driver regarding his/her health history. The third section is completed by the medical examiner to discuss anything noted during the physical examination and whether the findings would affect the driver's ability to safely operate a CMV.

In the current study, Road Ready, Inc. was responsible for collecting and recording all Medical Examination Report information from the participating carrier who held participant data.

2.2 BRIEF MEDICAL EXAM

Prior to January 2015, the participating carrier required all newly hired drivers to obtain a complete medical examination regardless of their current and valid medical card. However, in January 2015, the participating carrier eliminated this requirement and accepted existing medical certifications that had been completed within the previous 6 months from hire. Road Ready, Inc. began to conduct brief medical exams for any new hire who, upon hire, had a current and valid medical card within the prior 6 months. The brief medical exam consisted of CDL number, gender, date of birth blood pressure, and heart rate.

[ii] At the time this study was conducted, FMCSA had not yet implemented its Medical Examination Report (MER Form), MCSA-5875. Thus, data collected during this study may differ from data currently collected via FMCSA's MER Form.

2.3 INITIAL DRIVER SURVEY

The Initial Driver Survey was comprised of five main sections: 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). The Initial Driver Survey was made available to all participants in either English or Spanish and took 30–45 minutes to complete. See Appendix A for the Initial Driver Survey packet.

2.3.1 Demographic Information

The first five alpha-numeric characters of the driver's CDL number were recorded, as were the first two letters of their first name and the first six letters of their last name (name code). These codes were used for identification and matching drivers with their medical and safety information. This section collected demographic information, such as age; marital status; types of trucking licenses and endorsements held; crashes and violations in the past 3 years; truck driver training history; napping behavior; diet; and alcohol, caffeine, and tobacco use. Self-reported height and weight were added to the Initial Driver Survey in January 2015, as these measurements were no longer collected on the medical examination from drivers who had a current and valid medical certification and were only required to complete a brief medical examination. This information enabled the research team to calculate body mass index (BMI) for each driver regardless of the type of medical examination conducted.

2.3.2 Epworth Sleepiness Scale

The ESS is a validated subjective tool to assess sleepiness. Drivers were asked to rate their chances of dozing off or falling asleep while engaged in eight different activities, such as sitting and reading or laying down to rest in the afternoon. Drivers would respond with selecting one of four responses: no chance (0), slight chance (1), moderate chance (2), or high chance of dozing (3). The sum of the ratings was then used to determine their level of sleepiness as being: lower normal (0–5), higher normal (6–10), mild excessive (11–12), moderate excessive (13–15), or severe excessive sleepiness (16–24).[93]

2.3.3 Berlin Questionnaire

The BQ is a validated screening tool to evaluate the risk of an individual having OSA. The sensitivity of the BQ (i.e., the ability of the test to correctly identify patients with the disease, known as the "true positive rate") ranges from 54 percent to 86 percent, and the specificity (i.e., the ability of the test to correctly identify patients without the disease, known as the "true negative rate") ranges from 43 percent to 87 percent among primary care patients who are seeking treatment.[94, 95, 96] In the current study, drivers were asked to respond to 10 questions regarding their blood pressure, snoring, and frequency of events, such as not breathing while sleeping or feeling tired, fatigued, or not up to par during waking time. Drivers responded by choosing the frequency of these events happening: nearly every day, three to four times a week, one to two times a week, one to two times a month, or never or nearly never. The questions were separated into three categories (blood pressure, snoring, and fatigue) and rated for risk of OSA. Each category was calculated as being either positive or negative based on the scores from individual responses. A driver was determined to be at high risk for having OSA if two or more categories were scored positive, whereas a participant was determined to be at low risk for OSA if one or no categories were scored as positive.[97]

2.3.4 Survey of Recent Life Experiences

The SRLE lists 41 life experiences that contribute to stress or "daily hassles."[98] Drivers responded the extent to which each life experience has been a factor in their life in the previous month. Drivers indicated whether the specific life experience was: (1) not at all part of my life, (2) only slightly part of my life, (3) distinctly part of my life, or (4) very much part of my life. Higher scores indicated greater stress. Drivers' responses were summed and categorized by stress level: very high stress, high stress, average stress, low stress, or very low stress. The 41 life experiences are grouped into six subscales with a range of scores for each, including:

- *Social and cultural difficulties*: items relating to close interpersonal relationships, such as friendship, family, and romance (e.g., "Gossip about yourself or been taken advantage of"; range of 11 to 44).
- *Work*: items relating to dissatisfaction, conflict, and appreciation with your work (e.g., "Finding work uninteresting"; range of 7 to 28).
- *Time pressure*: items relating to complete work, insufficient leisure time, and too many things to do (e.g., "Too many things to do at once"; range of 8 to 32).
- *Finances*: items related to one's financial situation and troubles (e.g., "Failing to get money you expected"; range of 6 to 24).
- *Social acceptability*: items relating to social rejection or dissatisfaction with one's attractiveness (e.g., "Being ignored"; range of 5 to 20).
- *Social victimization*: social mistreatment by others (e.g., "Being taken advantage of"; range of 4 to 16).

2.3.5 Dula Dangerous Driving Index

The DDDI measures one's likelihood of driving dangerously.[99] Drivers were asked to respond to how often they engage in 31 different driving events, such as driving when angry or upset or illegally passing a car/truck that is going too slowly. Drivers responded to these driving events with one of five responses: (1) never, (2) rarely, (3) sometimes, (4) often, or (5) always. Higher scores indicate a high propensity to drive dangerously. Each driver received an overall score of risky driving behavior (28–140) as well as a score in three subcategories (based on 28 of the 31 items), including:

- *Aggressive driving*: items reflecting behaviors intentionally meant to annoy, irritate, or punish other drivers (e.g., "I deliberately use my car/truck to block drivers who tailgate me"; ranging from 7 to 35).
- *Negative emotional driving*: items gauging irritability and anger while driving and the tendency to be become annoyed with other drivers (e.g., "I lose my temper when driving"; ranging from 9 to 45).
- *Risky driving*: items gauging willingness to engage in unsafe driving behaviors (e.g., "I will race a slow-moving train to a railroad crossing"; ranging from 12 to 60).

2.3.6 Social Desirability Scale

Seven questions from the SDS[100] were embedded in the DDDI. These questions were used to measure a driver's intention to present themselves as socially desirable. Some examples of these questions are: I am always courteous, even to people who are disagreeable; I am always willing to admit when I've made a mistake. Drivers had the same response choices as for the DDDI, as noted above. Each question was scored between zero and four, with four being the response for high desirability. Total scores were computed for all seven questions for a total score ranging from 0 to 28. Higher scores reflect higher social desirability, with total scores above 16 reflecting an individual presenting themselves in a socially desirable way.

2.4 FOLLOW-UP SURVEY

The Follow-up Survey included six sections (see Appendix B): compensation (pay rate per mile, trip, load, hour or other), SRLE, Job in General (JIG) Scale, ESS, BQ, and questions regarding OSA or other sleep disorders (tested or diagnosed with OSA or any other sleep disorder, and if he/she received treatment for OSA). The Follow-up Survey took approximately 15 minutes to complete.

2.4.1 Job in General

The JIG was used to determine overall job satisfaction, including the potential of the responding driver to quit his/her job.[101] Drivers were presented with 18 adjectives that could be used to describe one's job in a positive or negative light, such as: "worthwhile," "acceptable," and "waste of time." The participant responded with a "Yes," "No," or "Not Sure" if the word was a description of their job. Standard Job Descriptive Index scoring procedures were used for all scales (i.e., using 0 for "no," 1 for "?" and 3 for "yes" with negative adjectives being reverse scored). The total JIG score was the sum of all 18 items, with high values indicating greater overall job satisfaction. Mean scores on the JIG for non-managers was 39.79.[102]

2.5 SAFETY DATA

2.5.1 Carrier Crash Files

The single carrier provided the research team with monthly crash files for the duration of the study. There were 40 variables associated with each crash, including name; employee ID number; CDL number; incident date; location; road type; number of injuries; number of fatalities; and crash type, cause, and cost. The data also indicated whether the crash was DOT recordable, preventable, and if the driver was wearing their seatbelt. A DOT-recordable crash is an occurrence where the crash resulted in a fatality, an injury requiring immediate medical attention away from the scene, and/or one or more vehicles requiring tow-away from the scene. The data also included driver tenure (i.e., termination date), which was used as a measure of exposure.

2.5.2 Motor Carrier Management Information System

The Motor Carrier Management Information System (MCMIS) is an information system that captures data on FMCSA inspection, crash, compliance review, safety audit, and registration data

from various field offices and States and compiles them into one source. States are required to report crashes that meet the criteria of a DOT-recordable crash. The research team received monthly downloads of the MCMIS crash files. These crash files had 22 variables associated with the crash, including driver name, date of birth, CDL, employing carrier, crash date, location, and first harmful event.

2.5.3 Commercial Driver's License Information System

The Commercial Driver's License Information System (CDLIS) is a nationwide computer system that provides a complete record of convictions and crashes as well as personal driver's license and CDL information. At the conclusion of data collection, the research team received CDLIS files on all drivers in the study. Variables of interest to the research team included driver demographics (name, medical information, height and weight, commercial status), CMV crash information (date, severity, etc.), and moving violation convictions (e.g., improper lane change, failure to yield, etc.).

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3. METHODS AND APPROACH

Following is a description of the procedures and methods used to complete this study. The aim was to provide these methods in chronological order (as they were initiated in this study), but there may be some overlap of activities.

3.1 INSTITUTIONAL REVIEW BOARD

As required for all studies involving human subjects, the research team submitted an application to the Virginia Tech Institutional Review Board (IRB) for their review and approval. The application included the research protocol, which provided a detailed description of all study tasks, data confidentiality, and data access. The application also contained an Informed Consent Form (ICF) to be signed by each participating driver. See Appendix C for one of the ICFs used in the study. The ICF outlined the study objectives and methods, data confidentiality, any possible risks, compensation, and the rights of the participant (including freedom to withdraw from the study at any time, for any reason). No human subject activities were conducted until IRB approval was received on May 3, 2011, and Office of Management and Budget approval (control number 2126-0052) was received on May 7, 2013.

3.2 RECRUITMENT

Although the study team recruited truck drivers from across the United States, 20,745 participants were recruited from one large for-hire truck fleet. Moreover, those who completed the Initial Driver Survey can be considered a convenience sample. As such, the results are not generalizable to the national truck driver population.

There were eight recruitment sites. Seven locations were associated with a single carrier and one was an occupational health clinic (not aligned with a carrier). As shown in Figure 1, the eight recruitment sites were located across the continental United States, with locations in the western, southern, central, southeastern, and eastern regions.

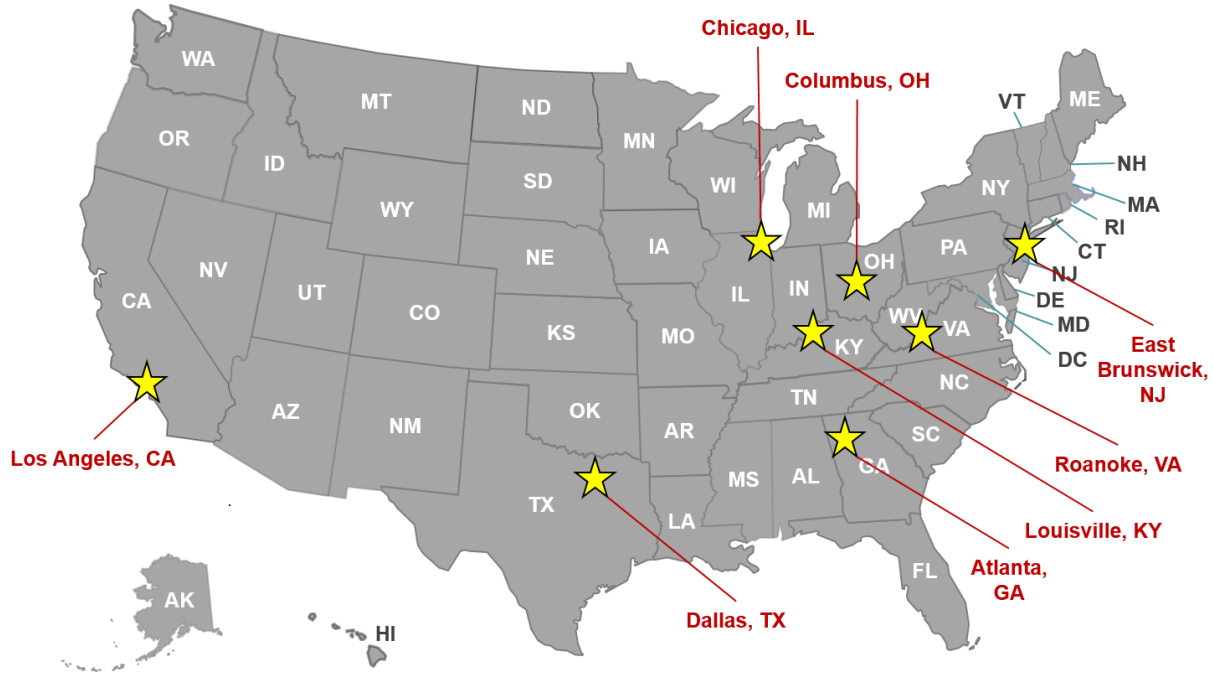

Figure 1. Image. Locations of the eight recruitment sites.

Drivers were recruited by fleet staff during the driver orientation program at each carrier location. During driver orientation, drivers who were new hires or rehires were given safety and administrative training and a DOT medical examination (i.e., Medical Examination Report) by Road Ready, Inc. Fleet personnel distributed study materials (provided by researchers) on the first day of each driver orientation program. Each packet of study materials included a summary of the study's purpose and requirements for participation, two copies of the ICF (one kept by participants, the other returned to the research team), contact information for the lead researcher, and the Initial Driver Survey.

During the first day of orientation, the orientation instructor read a script provided by the research team (see Appendix D for the script). Drivers were instructed to review the study materials on their own time (down time was available to drivers between their skills test, medical examination, and general training and education). Drivers were also shown a 5-minute video prepared by the research team that included information about the study (see Appendix E for the video script). The same procedures were employed at the occupational health clinic; however, a member of the medical staff was responsible for the procedures noted above.

3.3 INITIAL DRIVER SURVEY METHODS

Interested drivers were instructed to complete the materials during their own time and given two options to complete and return the Initial Driver Survey. One option was for drivers to return their completed materials to the front office staff at their terminal (or the medical staff at the occupational health clinic). The office staff ensured the ICF was signed and then sealed the completed Initial Driver Survey in a tamper-proof envelope. If the ICF was not signed, the front office staff would instruct the driver to sign the ICF. At no time were office staff allowed to review drivers' responses on the Initial Driver Survey. After sealing the Initial Driver Survey in

the tamper-proof envelope, front office staff recorded the CDL code (the first five alpha-numeric characters of the driver's CDL number) and the participant name code (the first two characters of the first name and first six characters of the last name) on the front of the envelope. This step was a backup process for cross referencing data sources (e.g., matching crash and violations files, Initial Driver Survey, and Medical Examination Report) in case the driver failed to write the correct information on the Initial Driver Survey. The participant was immediately given $20 (cash or gift card) for completing the Initial Driver Survey and a business card that included information on being contacted in the future for an additional questionnaire (i.e., Follow-up Questionnaire).

Drivers also had the option to mail their completed Initial Driver Survey and ICF directly to the Virginia Tech Transportation Institute (VTTI) in a self-addressed, postage-paid, tamper-proof envelope. Upon receipt, researchers identified the drivers by matching their CDL code and participant name code with their medical information from the Medical Examination Report (which included their mailing address). Upon an accurate match, a $20 check was mailed to the mailing address noted in the Medical Examination Report supplied by Road Ready, Inc.

3.4 CARRIER CRASH FILES, MCMIS, CDLIS, MEDICAL EXAMINATION REPORT, AND BRIEF MEDICAL SCREEN METHODS

Each month, the participating carrier sent electronic files to the research team that contained the monthly crash files for all carrier drivers. Every 4–8 weeks, the research team received the MCMIS crash files for the entire United States carrier population via FMCSA's Volpe Database. At the conclusion of data collection, CDLIS files for all drivers in the study were requested. This request was made by a member of the research team, using drivers' names and CDL numbers.

The occupational health clinic sent a paper copy of consented drivers' Medical Examination Report with the Initial Driver Survey in the tamper-proof envelope. Road Ready, Inc. sent electronic files to the research team that contained the Medical Examination Report and Brief Medical Screen for all drivers who attended the participating carrier's orientation. The drivers' Medical Examination Report and Brief Medical Screens were collected and maintained by the participating carrier, and thus were not protected health information and were not subject to the Health Information Privacy and Portability Act. These forms were existing business records that were collected for business purposes pursuant to the drivers' employment at the participating carrier.

To summarize, drivers were included in the study if they had one or more pieces of data: Medical Examination Report or a Brief Medical Screen (all drivers who attended orientation at the participating carrier) and/or an Initial Driver Survey (consented drivers).

3.5 FOLLOW-UP SURVEY METHODS

The carrier crash files and MCMIS files were scanned each month using drivers' CDL numbers and names. Each crash file match was reviewed to determine:

- If the identity of the driver in the crash matched the driver in the study.

- Whether the crash was a preventable on-road crash (when employed at the participating carrier) or a DOT-recordable crash for drivers not employed at the participating carrier (excluding weather-related and vehicle-related crashes).
- Whether the crash was not a "property-claim only" crash (only in the participating carrier crash files).
- Whether the driver was a consented driver (i.e., had signed an ICF).

An attempt to contact the driver to complete a Follow-up Survey was conducted if the driver met all four criteria. For each of these identified "high-risk" drivers, five random control drivers were contacted to complete a Follow-up Survey. A control driver was a driver who did not have any preventable crashes at the time of his/her selection and was also a consented driver.

A member of the research team contacted these drivers via phone to complete the Follow-up Survey. Contact information was retrieved from the Medical Examination Report; however, this information was not always correct or complete. The research team had access to Accurint to receive updated contact information. Accurint is a program offered by LexisNexis that enables government agencies to locate people, detect fraud, uncover assets, verify identity, perform due diligence, and visualize complex relationships. For the purpose of this research, Accurint was only used to find current contact information for participating drivers. No other personal information that could be made available through this program (such as social security number) was disclosed to the research team. By using information such as name and previous address or phone number, Accurint gave up-to-date public records on last known addresses and phone numbers associated with the participating driver.

Potential Follow-up Survey participants were contacted as soon as possible after the identifying event (or being selected as a control). This was typically 1–3 months after the crash (due to the reporting lag in receiving carrier and MCMIS data). Each driver was called three times in an attempt to complete the Follow-up Survey over the phone. Upon contact, drivers were reminded of the original study and given the option to complete the survey over the phone, via email, or via regular mail (using a self-addressed, postage-paid envelope). After three phone call attempts, if the driver was not reached over the phone, a packet containing an overview of the study and the Follow-up Survey was mailed to the driver (including a self-addressed, postage-paid and tamper-proof envelope for returning the completed survey back to researchers). All drivers who completed and returned the Follow-up Survey were sent a $10 check via mail.

There were 1,134 case events where the driver involved in the event had signed an ICF. The research team was able to contact 1,046 of these drivers (no contact information was available for 88 of them) and 300 completed the Follow-up Questionnaire (28.7 percent response rate). The research team identified 4,821 control drivers to complete the Follow-up Questionnaire. Of these, 1,045 completed the Follow-up Questionnaire (21.7 percent response rate).

3.6 DATA ENTRY, FORMATTING, AND REDUCTION

3.6.1 Questionnaire Data

Upon receipt of the Initial Driver Survey and Follow-up Survey, the research team removed any personally identifying information that participants may have inadvertently included on the questionnaires. Each questionnaire was entered into a database using a unique participant number. Two different members of the research team entered the responses from each questionnaire into the two different but identical databases. Any discrepancies between the two databases were reconciled by viewing the original questionnaire. After reconciliation, the questionnaire was scanned and stored in a secure, password-protected server and the original paper questionnaire was shredded.

3.6.2 Medical Examination Report Data

Upon receipt of the Medical Examination Report, members of the research team used the participant key—the CDL code and name code—to assign the anonymous participant number to the Medical Examination Report. In situations where there were identical CDL numbers and name codes, the research team referred to the recruitment rosters for all orientation drivers provided by the participating carrier. All Medical Examination Report data were delivered to researchers in an electronic database; no manual data entry was required. Several sections of the Medical Examination Report were binary responses (yes/no), indicating the presence or absence of various medical conditions. These were recoded as "1" (yes) and "0" (no). Other sections of the Medical Examination Report included open-ended comments from the driver and medical examiner regarding prior and current medical conditions, treatment for existing conditions, recommendations for future testing/specialists, etc., and physician indications about whether a driver's ability to safely operate a CMV might be affected by these conditions. These comments were transcribed and coded by the research team. The research team reviewed the comments on each Medical Examination Report and recorded the following: (1) current diagnosed medical condition, (2) treatment for current diagnosed medical conditions (yes, no, unsure), and (3) potential medical conditions (i.e., a formal diagnosis was not made by the medical examiner; however, the driver was referred to another physician to confirm diagnosis). Each specific medical condition was grouped into a general medical category (see Appendix F for categories). No treatment was defined as no indication of treatment for the diagnosed medical condition or non-compliant treatment (i.e., partial treatment) for the diagnosed medical condition.

3.6.3 Crash and Violation Data

Using the CDL code, name code, and the date of entry in the study (i.e., date of driver orientation at the participating carrier or date they completed the Initial Driver Survey at the occupational health clinic), the research team developed algorithms to search the carrier crash data, MCMIS crash files, and CDLIS crash and violation files to identify matching events with participants in the study (only those matches after the date of entry in the study were included). The date range used when searching these files for each driver was the date of entry into the study as the begin date and the end of data collection as the end date (May 30, 2016; MCMIS crash files were collected after this date, but only included crashes up to May 30, 2016, due to delays in reporting). Each match was verified via a manual review to confirm that the driver in the crash and/or violation was a driver in the study. Although CDLIS contains crash and moving violation conviction files for each driver's personal vehicle and CMV, only the latter were included.

The participating carrier included claims data in the supplied crash files, and the property-only claims were identified and removed. Using the same procedures in Hickman et al.,[103,104] the research team reviewed the crash narrative and crash type (e.g., truck scratched mirror on client's building versus rear-end striking on a two-lane divided highway). Those incidents that were considered "property-only claims" were curb strikes, mechanical failure, non-vehicle-to-vehicle crashes in a parking lot, non-contact, backing into a dock, truck hit while parked, and vandalism.

The participating carrier determined whether the crash was "preventable." A "preventable" crash is one in which the driver failed to exercise every reasonable precaution to prevent the crash. This is not the same as "at-fault," which is a legal determination. This is irrespective of whether there was property damage or personal injury, the extent of the loss of injury, to whom it occurred, and the location of the crash. Carrier personnel used the police crash report, driver and/or witness testimony, and their own investigative findings to make this determination. MCMIS data did not contain enough detail to make a determination of preventability; however, if the identical crash was in the MCMIS and carrier crash files, the carrier's determination of preventability was used. Otherwise, no determination of preventability was made unless it was coded as an animal strike, vehicle malfunction, or weather related (all non-preventable). CDLIS crashes were coded as preventable if the crash had one or more of several identified moving violations associated with the crash (see Appendix G) or the identical crash was coded as preventable in the carrier crash files. Given that there were many crashes that overlapped two or more of the crash databases, a mutually exclusive master crash database was created. Priority was given to the carrier crash file, as it contained the most detailed information.

The matched moving violation convictions (using the list of moving violations in Appendix G) were further filtered to exclude all those moving violation convictions that were associated with a crash. The goal was to identify moving violation convictions independent of crashes, with the rationale being that the moving violation convictions in the crashes were only included because of the crash. Had the crash not occurred, it is likely that the moving violation conviction would not have been coded by enforcement personnel.

3.6.4 Driver Exposure

Tenure at the participating carrier was used as a measure of exposure. Tenure was defined as the length of time between the date of entry in the study and the end of data collection or the date a driver left the participating carrier (if that occurred before May 30, 2016). Many drivers left the participating company after entry into the study and were rehired at a later date (sometimes several times). The length of time for this additional tenure was calculated for each driver up to May 30, 2016. Driver tenure was unavailable for independent contractors. As shown in Figure 2, driver tenure at the participating carrier was relatively short; thus, the analysis approach detailed in Section 4 considered two types of driver exposure: tenure at the participating carrier (using crashes collected by the participating carrier) and national exposure (using crashes and violations from the national datasets). The mean number of days that a driver was employed at the participating carrier was 231.9 days; however, the mode was 3 days and the median was 114 days. Once a driver left the participating carrier, the study team could not verify if that driver was employed and/or driving a truck/bus for a living. As shown in Figure 3, national exposure for drivers was the length of time between their date of entry into the study and the end of data

collection on May 30, 2016. The mean number of days a driver was followed by the research team was 616.5 days (the mode was 516 days and the median was 636 days).

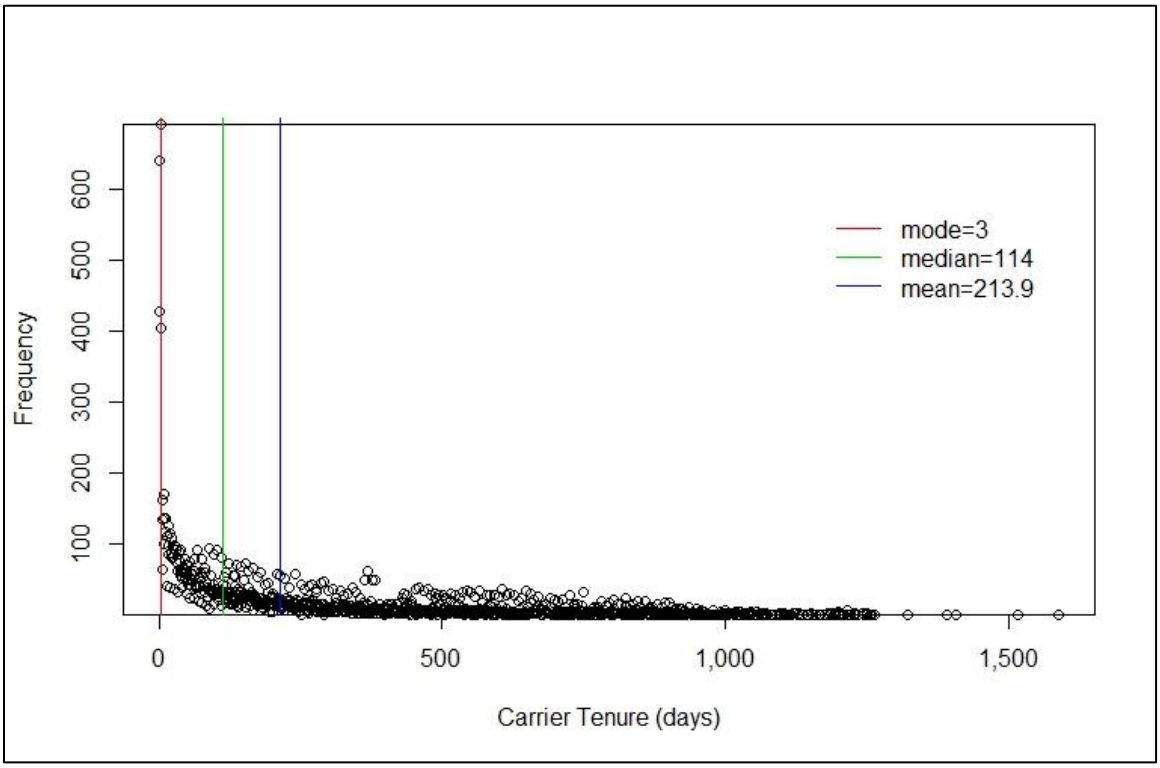

Figure 2. Graph. Number of drivers by carrier tenure (in days) at the participating carrier.

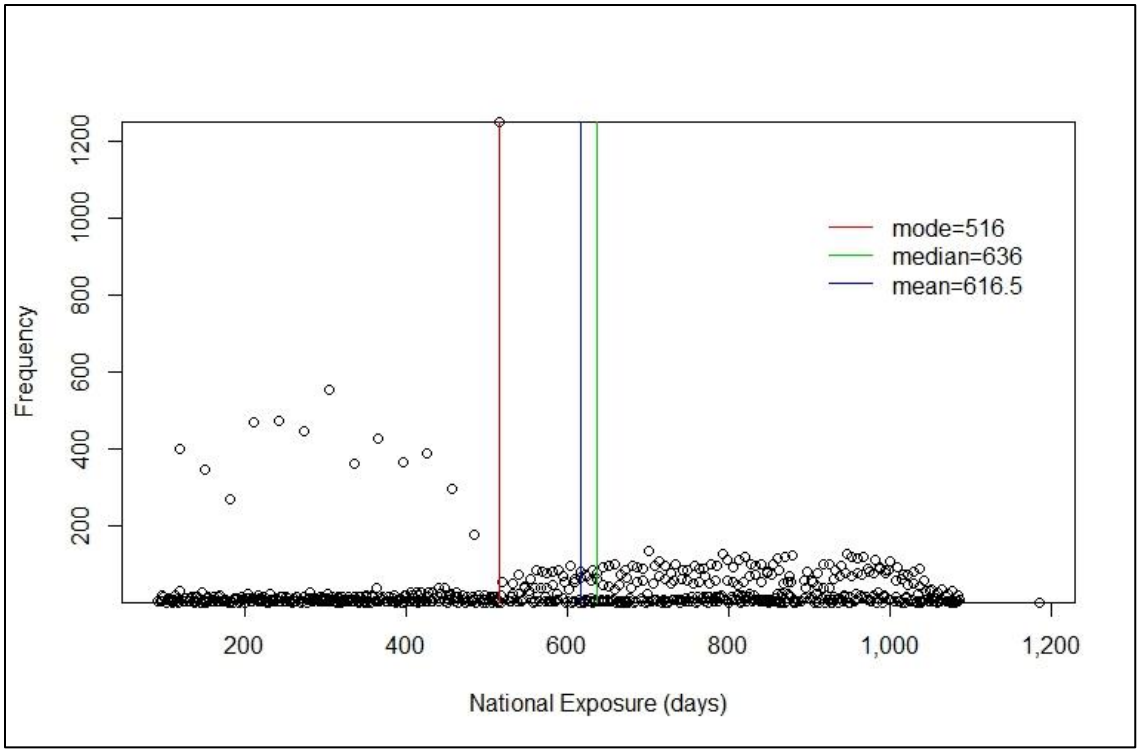

Figure 3. Graph. Number of drivers by national exposure (in days) in the national dataset.

4. DATA ANALYSIS APPROACH

Several analytic approaches were used to evaluate the different research questions. With different safety outputs (e.g., crashes from the participating carrier, national crashes, and national violations), each associated with different exposure/tenure, several analyses were performed within each study design (if necessary). For example, the safety outcomes were from three different sources: the participating carrier's crash files and two national crash databases (MCMIS and CDLIS). There were distinct characteristics among these three sources. The national crash database, MCMIS, only included DOT-recordable crashes, whereas the carrier data included crashes from all severity levels. However, the carrier database only captured crashes while a driver was employed at the participating carrier. Given the high turnover rate and short employment period for drivers at the participating carrier (as shown in Figure 2), the observation period was relatively short. Thus, to fully use the collected data, three separate analyses were conducted:

1. In the first analysis, only the national crash database (MCMIS) was used and exposure was date of entry in the study until May 30, 2016.
2. In the second analysis, only the national violation database (CDLIS) was used and exposure was date of entry in the study until May 30, 2016.
3. In the third analysis, only the carrier crash files were used and tenure was the length of employment at the participating carrier up to May 30, 2016.

Analyses using the carrier crash data included all crashes and only those identified by the carrier as preventable.

4.1 PROSPECTIVE COHORT

The questionnaire and medical data (via Medical Examination Report) were collected at the time of recruitment. Each driver was observed (crashes and exposure/tenure) after entry into the study. With no evidence of overdispersion, a Poisson regression model was used to model the frequency of crashes and moving violations with the Initial Driver Survey and Medical Examination Report during the observation period. The model specification, as shown in Figure 4, was:

$$Y_i \sim Poisson(E_i, \lambda_i)$$

Figure 4. Formula. Poisson regression model used to model the safety outcomes.

where Y_i was the number of crashes for driver i; E_i was the total exposure/tenure for driver i; and λ_i was the expected crash rate for driver i. Preliminary analyses found that drivers' age correlated with the number of crashes, but also with most of the medical outcomes. Figure 5 shows the relative risk or risk ratio (RR) estimates for crashes by age groupings with the comparison group being 21- to 25-year-olds. For example, the left image in Figure 5 shows that drivers aged 36–55 were 25 percent less likely to be involved in a total carrier crash than drivers aged 21–25. To adjust for these potential confounding and interacting effects, the regression models were stratified by age using quartiles, which was approved by independent peer

reviewers. That is, the research team divided all the drivers into four groups using quartiles, then ran a Poisson regression within each age quartile.

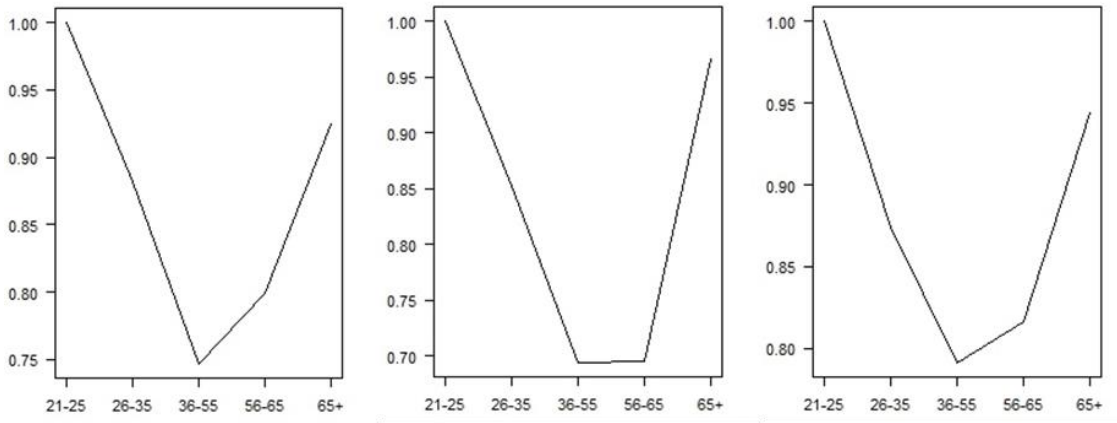

Figure 5. Graphs. RRs for crashes by age groupings: left image shows total carrier crashes, center image shows carrier preventable crash, and right image shows national crashes.

After stratification, each variable was evaluated individually in the regression model with adjustment to age and BMI. Drivers' age was kept in the models, as it was a confounding factor within each stratum, especially as the age bins are relatively wide. For each age stratum, log link function was used to link the expected crash or moving violation rate with the explanatory variables (e.g., Initial Driver Survey and Medical Examination Report) using the formula shown in Figure 6:

$$\log(\lambda_i) = \beta_0 + \beta_k X_i^k + \beta_{\text{age}} X_i^{\text{age}} + \beta_{\text{BMI}} X_i^{\text{BMI}}$$

Figure 6. Formula. Log link function used to link the expected crash or moving violation rate with the explanatory variables.

where X_i^k was the value of variable k for driver i; X_i^{age} and X_i^{BMI} were the age and BMI for driver i respectively; and β's are the regression coefficients. If X_i was a categorical variable, then each non-reference level had β as a coefficient, and $\exp(\beta)$ measured the relative risk of the corresponding level compared to the reference level. If X_i was a continuous variable, then the variable had only one β coefficient, and $\exp(\beta)$ measured the relative risk of the current value compared to one unit less.

In addition to evaluating each individual variable, stepwise regression was used to examine the joint effect of multiple variables on drivers' risk estimation. All candidate variables in the model were checked to see if their significance had been reduced below the specified tolerance level. If a nonsignificant variable was found, it was removed from the model. However, this approach had two main drawbacks: (1) the interaction between the variables could influence the coefficients estimation, changing the direction of the sign compared to the individual regression result, and (2) the missing value problem. As every driver who completed an Initial Driver Survey did not also have a Medical Examination Report (or vice versa), the stepwise regression was performed with all medical conditions in the Medical Examination Report and a separate step-wise regression was performed for all the variables in the Initial Driver Survey. Missing

data within each of these "bundles" was still an issue. The Akaike information criterion (AIC) was used for variable selection in the step-wise regression. Given that age has a curvilinear relationship with crashes, age was added as a quadratic term in the model.

4.2 NESTED CASE-CONTROL STUDY

A nested case-control approach was used to examine variables collected in the Follow-up Survey with regard to their effect on risk. After a case-crash was identified (described above), up to five consented non-crash drivers were contacted to complete a Follow-up Survey. In this analysis, each crash (case) had up to five matched controls that didn't experience a crash at the time of the case's crash. A mixed effect regression model was used to evaluate the risk factors. As shown in Figure 7, the model setup was as follows:

$$\text{logit}\big(P(Y_{it} = 1|\mu_i)\big) = \beta_0 + \beta_k X_i^k + \beta_{\text{age}} X_i^{\text{age}}$$

Figure 7. Formula. Mixed effect regression model used to evaluate the risk factors.

where μ_i was the random effect for samples from the same reference date i; Y_{it} represents observation t from reference date i; X_i^k, $X_{\text{i}}^{\text{age}}$ and the βs were defined as in the prospective cohort study, except X^k were variables collected from the Follow-up Survey. The nested case-control approach was based on a clear definition of case-crashes (described above); thus, there was no need to distinguish between the national and carrier crash databases.

4.3 OBSTRUCTIVE SLEEP APNEA PREDICTIVE ANALYSIS

This analysis evaluated the factors that significantly influenced the presence of OSA. Ten covariates were selected into the candidate pool based on domain knowledge, including age, BMI, gender, ESS, BQ, diagnosed high blood pressure, diagnosed high blood sugar, and self-reported sleep schedule and average sleep per night. Then, two analysis tools were involved in variable selection. First, a stepwise regression was used for the generalized linear model with a logit link, as shown in Figure 8:

$$\text{logit}(\text{P}(Y_i = 1)) = X_i^T \beta$$

Figure 8. Formula. Stepwise regression used for the generalized linear model with a logit link.

where $Y_i = 1$ indicates the presence of OSA for the ith driver, X_i were the corresponding covariates, and the β's were the regression coefficients. AIC was used as the selection criterion. Second, a classification tree was applied to find the hierarchical structure of the covariates in explaining the presence of OSA. We first fit a full tree by maximizing the Gini gain in every split, then pruned the tree based on the cross-validation error. The Gini gain was defined as:

$$\text{Gini}(t) = 1 - \sum_j [p(j|t)]^2$$

Figure 9. Formula. Tree fit using Gini gain.

where $p(j|t)$ was the relative frequency of class j at split t, $j = 0,1$.

5. RESULTS

This section presents the results of the various analyses identified in Section 4. As discussed in the Executive Summary and in Section 3, this study relied on a convenience sample, so findings presented in this section are not generalizable to the entire national truck driving population. First, the descriptive results, which characterize the general makeup of the drivers who participated in the study, are presented. Second, the prospective cohort results for the Initial Driver Survey are presented. Third, the prospective cohort results for the Medical Examination Reports are presented. Fourth, the nested case-control analysis results for the Follow-up Questionnaire are presented. Lastly, the OSA predictive analysis results are presented. Each of these analyses are presented in turn.

5.1 DESCRIPTIVE ANALYSES

The descriptive analyses presented in this section, and subsequent analyses, include data from drivers in the study. Figure 10 shows the number of completed Initial Driver Surveys, Medical Examination Reports, and Brief Medical Screens (total of 20,753 drivers). For example, 7,296 drivers completed the Initial Driver Survey and Medical Examination, 2,879 drivers completed the Initial Driver Survey and the Brief Medical Screen, etc. Thus, the number of drivers that completed each data collection instrument determines the total number of drivers with data for that instrument. For example, medical information was only available for drivers who completed the Medical Examination Report (13,724 drivers), data from the Initial Driver Survey was only available from 11,314 drivers, etc. Drivers who only completed an Initial Driver Survey were likely at a location that did not have staff to conduct the Brief Medical Screen, or left orientation after completing the Initial Driver Survey, but before the medical certification exam. Some drivers had multiple Initial Driver Surveys, Medical Examination Reports, and/or Brief Medical Screens for various reasons (e.g., rehire at the participating carrier, attended multiple driver orientations, or used carrier medical staff for the medical certification). Only the first completed measure (i.e., Initial Driver Survey, Brief Medical, or Medical Examination Report) was used in the analyses.

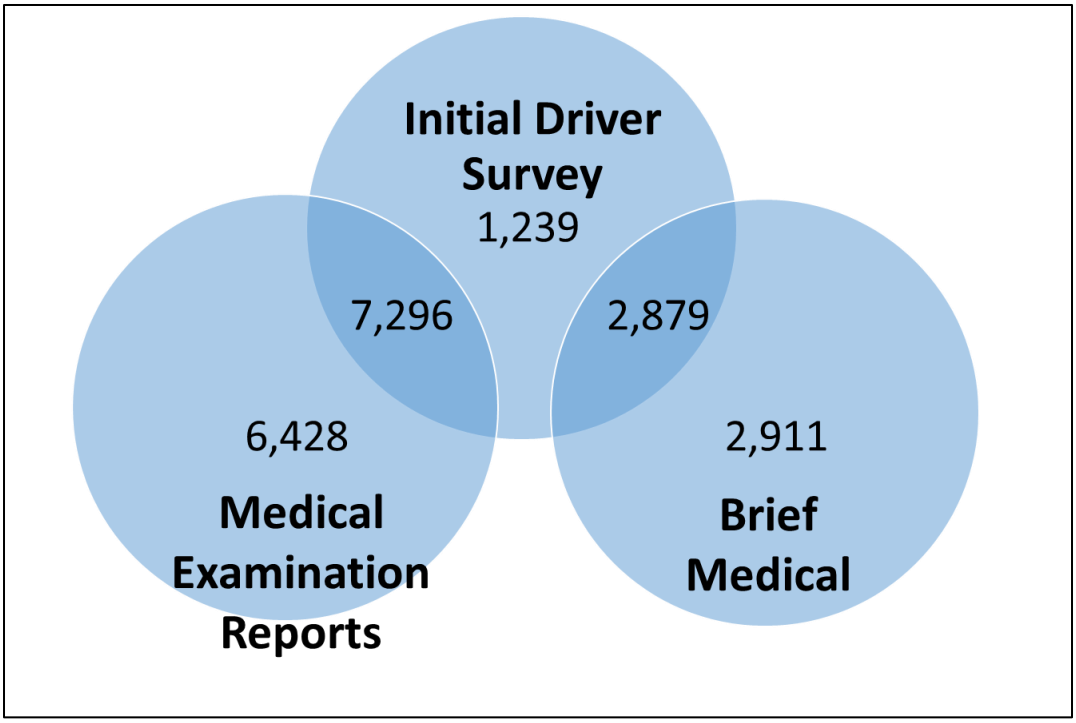

Figure 10. Diagram. Number of completed Initial Driver Surveys, Medical Examination Reports, and Brief Medical Screens.

5.1.1 Driver Demographic Characteristics

Table 5 shows drivers' demographic characteristics, including gender, age quartiles, BMI, marital status, academic degree, English as a primary language, and employment status (company driver or independent contractor). Gender was completed on the Medical Examination Report and the Brief Medical Screen; age was completed on the Medical Examination Report, Initial Driver Survey, and Brief Medical Screen; BMI was calculated from the driver's height and weight from the Medical Examination Report, CDLIS, or Initial Driver Survey; and marital status, academic degree, and English as a primary language were self-reported on the Initial Driver Survey. Independent contractors were identified by their lack of tenure information supplied by the participating carrier, as not all drivers completed the Initial Driver Survey. Please note the frequencies in the tables and figures below may not be equal due to missing data or driver non-response on items. As indicated above, most of these variables were collected from the Initial Driver Survey and/or Medical Examination Report. The Brief Medical Screen contained a few variables. The percentages reflect the distribution of responses for drivers where data was available (excluding missing data or driver non-response on items) and does not reflect the distribution of all 20,753 drivers. As shown in Table 5, most drivers were male (95.87 percent), obese (58.45 percent), married (47.72 percent), had obtained an associate's degree (58.44 percent), spoke English as a primary language (92.26 percent), and were company drivers (88.93 percent). Thus, the interpretation of these distributions would be as follows: 14.73 percent of drivers had a BMI greater than 40 for those drivers where we could calculate BMI; it does not reflect the entire sample of 20,753 drivers.

Table 5. Drivers' demographic characteristics.

Demographic Characteristic	Number	Percent
Driver Sex: Male	15,827	95.87%
Driver Sex: Female	682	4.13%
Subtotal	**16,509**	**100%**
Driver Age: 20–33[ǂ]	4,956	25.40%
Driver Age: 34–42	4,697	24.07%
Driver Age: 43–51	5,174	26.52%
Driver Age: >52	4,684	24.01%
Subtotal	**19,511**	**100%**
BMI > 40 (Obese Class III)	2,008	14.73%
35 ≤ BMI < 40 (Obese Class II)	2,176	15.96%
30 ≤ BMI < 35 (Obese Class I)	3,786	27.76%
25 ≤ BMI < 30 (Overweight)	3,922	28.76%
18.5 ≤ BMI < 25 (Normal)	1,693	12.42%
BMI < 18.50 (Underweight)	51	0.37%
Subtotal	**13,636**	**100%**
Marital Status: Single	4,443	39.00%
Marital Status: Married	5,436	47.72%
Marital Status: Divorced	1,419	12.46%
Marital Status: Widowed	93	0.82%
Subtotal	**11,391***	**100%**
Academic Degree: General Education Development (GED)	722	6.43%
Academic Degree: High School	2,017	17.97%
Academic Degree: Associate's Degree	6,558	58.44%
Academic Degree: Bachelor's Degree	1,237	11.02%
Academic Degree: Master's Degree	577	5.14%
Academic Degree: Doctorate	94	0.84%
Academic Degree: Medical Degree	14	0.12%
Academic Degree: None Previous	3	0.03%
Subtotal	**11,222**	**100%**
English as a Primary Language: Yes	10,392	92.26%
English as a Primary Language: No	872	7.74%
Subtotal	**11,264**	**100%**
Independent Contractor: Yes	2,221	11.07%
Independent Contractor: No	17,844	88.93%
Subtotal	**20,065**	**100%**

ǂOf the roughly 21,000 drivers sampled, 1 was age 20.

*Some drivers selected more than one option.

5.1.2 Commercial Vehicle Driving Experience

Figure 11 shows the frequency of self-reported CMV driving experience (i.e., total experience driving a commercial vehicle for a living). As shown in Figure 11, the mean of CMV driving experience was 102.1 months (the mode was 12 months and the median was 60 months).

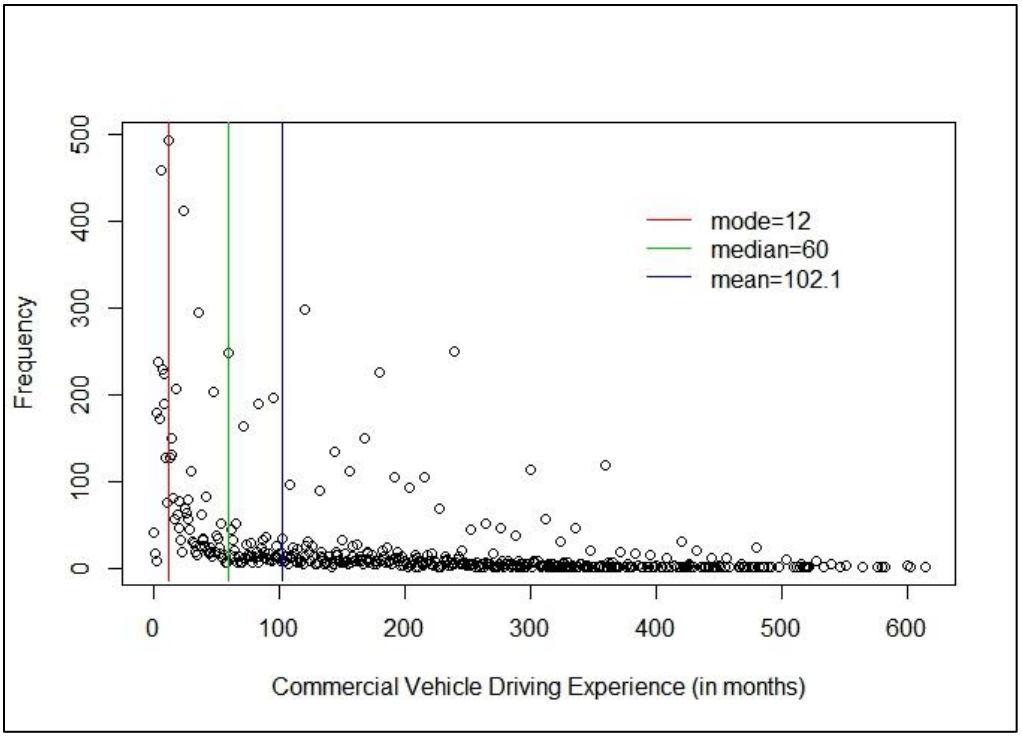

Figure 11. Graph. Number of drivers by self-reported CMV driving experience in months.

5.1.3 Self-Reported CDL Endorsements

Table 6 shows the frequency and percent of self-reported CDL endorsements (drivers could indicate more than one endorsement). To drive certain types of vehicles with a CDL, it may be necessary to add an endorsement or remove a restriction. Of the drivers who completed the Initial Driver Survey, most were rated to operate a tank vehicle (47.1 percent), double or triple trailer (35.3 percent), or a vehicle containing hazardous materials (32.6 percent).

Table 6. Frequency and percent of self-reported CDL endorsements.

Endorsement	N	Percent
Hazardous Materials	3,683	32.6%
Tank Vehicle	5,324	47.1%
Passengers	1,145	10.1%
School Bus	486	4.3%
Double/Triple Trailers	3,997	35.3%
Combination HazMat/Tank	1,730	15.3%

5.1.4 Self-Reported Seat Belt Use

Figure 12 shows self-reported seat belt use in the driver's personal vehicle or CMV (via the Initial Driver Survey). Most drivers who completed the Initial Driver Survey indicated they always used their seat belt as they operated their personal vehicle or CMV (90.2 percent and 96.8 percent, respectively).

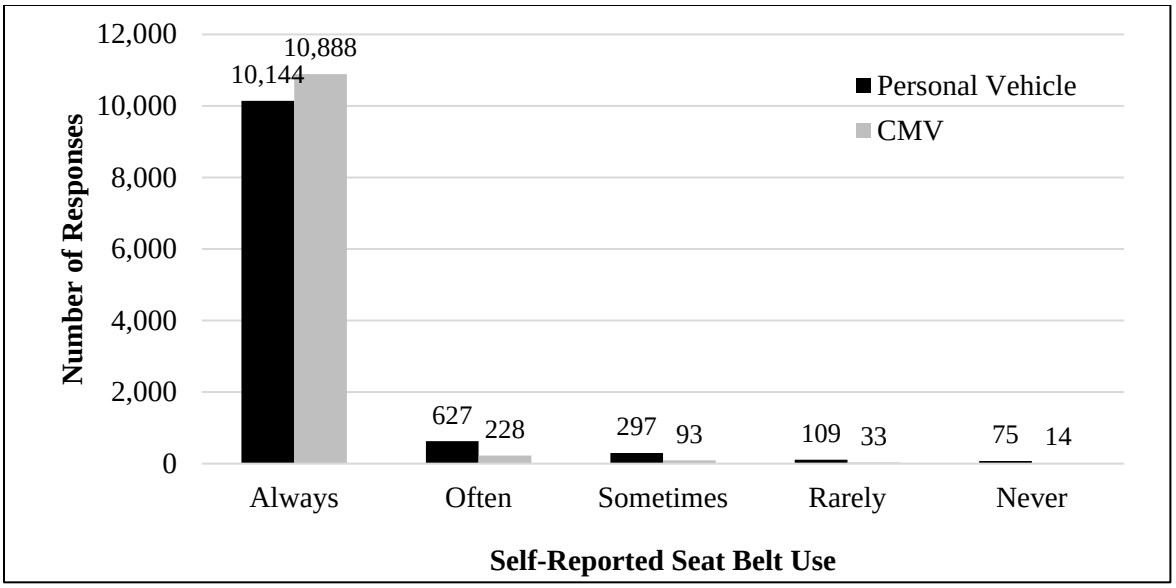

Figure 12. Chart. Self-reported seat belt use in personal vehicle and CMV.

5.1.5 Truck Training Experience

Table 7 shows the self-reported amount (in weeks) of formal truck driver training (e.g., truck driving school), informal truck driver training (training with a friend or relative), and on-the-job training (training performed while employed driving a truck) via the Initial Driver Survey. It appears drivers may have misunderstood this question, as a large number of drivers indicated no prior formal training or on-the-job training, despite the fact that the participating carrier only hired drivers with at least 6 months of prior CMV driving experience.

Table 7. Self-reported amount of truck driver training.

Weeks	Formal Training	Informal Training	On-the-job Training
0	3,098	7,398	1,307
<1	144	147	487
1	126	234	834
2	799	489	904
3	1,778	595	661
4	1,717	696	1,162
5	344	127	266
6	787	403	728
7	116	37	113
8+	1,484	1,118	2,430
Unknown*	100	100	864

*Training indicated, but no amount given.

5.1.6 Prior Safety Record

Table 8 shows the number of self-reported crashes (for those who indicated a crash), by fault, in the driver's personal vehicle or CMV in the prior 3 years. The last two columns are responses where the driver indicated a crash, but did not indicate fault. For example, 107 drivers indicated

they had two CMV at-fault crashes in the prior 3 years. Few drivers self-reported a crash in the prior 3 years. However, for those who did indicate a prior crash, most indicated one prior crash in the prior 3 years.

Table 8. Self-reported crashes in prior 3 years.

Crashes	CMV Vehicle At-Fault	CMV Vehicle Non-Fault	CMV Vehicle Fault Not Specified	Personal Vehicle At-Fault	Personal Vehicle Non-Fault	Personal Vehicle Fault Not Specified	Fault Vehicle Not Specified	Non-Fault Vehicle Not Specified
1	542	839	303	133	469	91	14	44
2	107	79	58	2	27	7	1	1
3	21	12	12	0	7	1	1	1
4	6	1	2	0	1	0	0	0
5	0	1	1	0	0	0	0	0
6+	0	1	0	0	0	0	0	0

Table 9 shows the number of self-reported moving violations (for those who reported a moving violation) in the driver's personal vehicle or CMV in the prior 3 years. A moving violation could include a conviction for speeding, following too closely, failure to obey traffic signal, etc. For example, 220 drivers indicated they had two moving violations in a CMV in the prior 3 years. For those drivers who indicated a prior moving violation, most self-reported one prior moving violation in the prior 3 years.

Table 9. Self-reported moving violations in prior 3 years.

Moving Violations	Commercial Vehicle	Personal Vehicle
1	1,469	1,319
2	220	220
3	34	29
4	4	4
5	3	0
6+	3	0

Table 10 shows the number of drivers' self-reported out-of-service (OOS) violations (for those who reported an OOS violation) in a CMV in the prior 3 years. Vehicle violations can include violations for brakes, tires, etc., and driver violations can include violations for hours of service, log violations, etc. For example, five drivers indicated they had three driver violations in the prior 3 years. Few drivers indicated a prior OOS violation in the prior 3 years. However, for those drivers who indicated a prior OOS violation, most self-reported one OOS violation in the prior 3 years.

Table 10. Self-reported OOS violations in prior 3 years.

OOS Violations	Driver Violations	Vehicle Violations
1	339	491
2	21	94

OOS Violations	Driver Violations	Vehicle Violations
3	5	18
4	3	10
5	1	2
6+	2	4

5.1.7 Self-Reported Diet, Exercise, Tobacco Use, Caffeine Use, Alcohol Use, and Sleep Habits

Table 11 shows the self-reported diet, exercise per week, tobacco use, caffeine use per day, alcohol use per week, and sleep habits from the Initial Driver Survey. Some drivers reported a range (e.g., 4–5 hours) regarding their self-reported average sleep per night. If a range was reported, the mean was used (rounding down from 0.5) to the nearest whole number. Reponses greater than 10 hours of sleep per night were excluded, as they did not appear feasible. Most drivers self-reported an average diet (60.57 percent), no exercise each week (28.63 percent), use of tobacco products (63.26 percent), consuming two servings of caffeine per day (33.11 percent), consuming zero servings of alcohol per week (69.55 percent), napping during the day (72.5 percent), having a somewhat regular sleep schedule (52.98 percent), and sleeping 8 hours per night (32.31 percent).

Table 11. Drivers' diet, exercise, tobacco use, caffeine use, alcohol use, and sleep habits.

Response	N	Percent
Diet: Poor	704	6.26%
Diet: Below Average	1,977	17.57%
Diet: Average	6,817	60.57%
Diet: Above Average	1,373	12.20%
Diet: Excellent	383	3.40%
Subtotal	**11,254**	**100%**
Exercise per week: 0 times	3,161	28.63%
Exercise per week: 1 time	777	7.04%
Exercise per week: 2 times	1,870	16.94%
Exercise per week: 3 times	2,349	21.28%
Exercise per week: 4 times	1,177	10.66%
Exercise per week: 5 times	887	8.04%
Exercise per week: 6 times	219	1.99%
Exercise per week: 7 times	305	2.76%
Exercise per week: 7+ times	294	2.66%
Subtotal	**11,039**	**100%**
Use Tobacco Products: Yes	7,181	63.26%
Use Tobacco Products: No	4,171	36.74%
Subtotal	**11,352***	**100%**
Caffeine per day: 0 drinks	26	0.35%
Caffeine per day: 1 drink	1,646	22.40%
Caffeine per day: 2 drinks	2,433	33.11%
Caffeine per day: 3 drinks	1,223	16.64%
Caffeine per day: 4 drinks	668	9.09%

Response	N	Percent
Caffeine per day: 5 drinks	475	6.46%
Caffeine per day: 6+ drinks	877	11.94%
Subtotal	**7,348**	**100%**
Alcoholic Drinks per Week: 0 drinks	7,740	69.55%
Alcoholic Drinks per Week: 1 drink	3,350	30.10%
Alcoholic Drinks per Week: 2 drinks	39	0.35%
Subtotal	**11,129**	**100%**
Nap during the Day: Yes	8,100	72.5%
Nap during the Day: No	3,072	27.5%
Subtotal	**11,172**	**100%**
Regular Sleep Schedule: Yes	1,343	12.55%
Regular Sleep Schedule: Sometimes	5,669	52.98%
Regular Sleep Schedule: No	3,688	34.47%
Subtotal	**11,172**	**100%**
Average Sleep per Night: >8 hours	1,382	12.92%
Average Sleep per Night: 8 hours	3,456	32.31%
Average Sleep per Night: 7 hours	2,955	27.62%
Average Sleep per Night: 6 hours	2,284	21.35%
Average Sleep per Night: 5 hours	517	4.83%
Average Sleep per Night: ≤ 4 hours	103	0.96%
Subtotal	**10,697**	**100%**

*Includes tobacco use on the Medical Examination Report.

5.1.8 Epworth Sleepiness Scale

Figure 13 shows the results from drivers' responses to the ESS. The ESS is a validated subjective tool to assess daytime sleepiness with higher scores indicating greater likelihood of daytime sleepiness. Most drivers scored in the normal range (91 percent), whereas 9 percent would be at increased risk for daytime sleepiness.

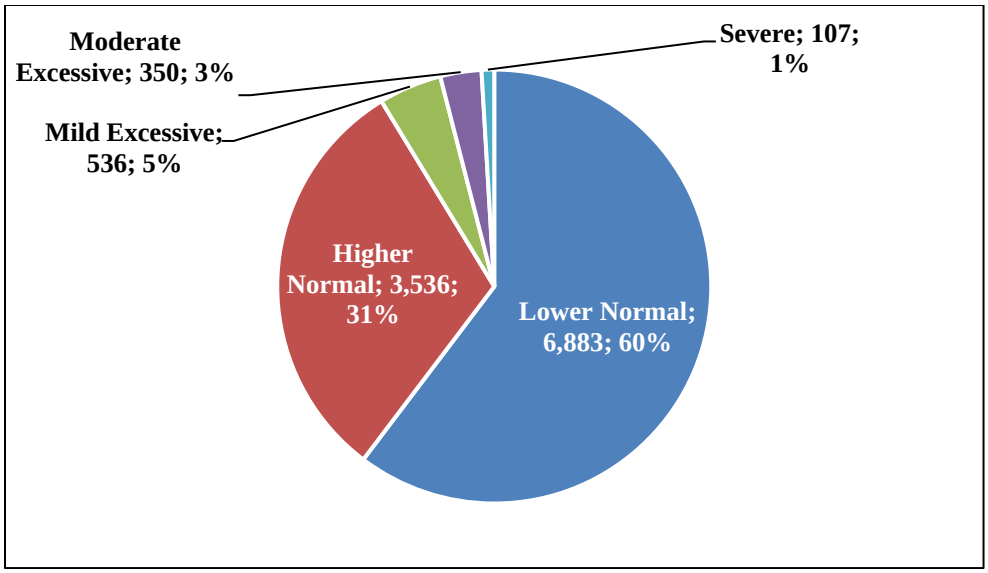

Figure 13. Chart. ESS groupings.

5.1.9 Berlin Questionnaire

Figure 14 shows the results from drivers' responses on the BQ. The BQ is a validated screening tool to evaluate the risk of an individual having OSA. Results showed that 81.4 percent of the drivers screened low risk for OSA, while 18.6 percent of the drivers scored high-risk.

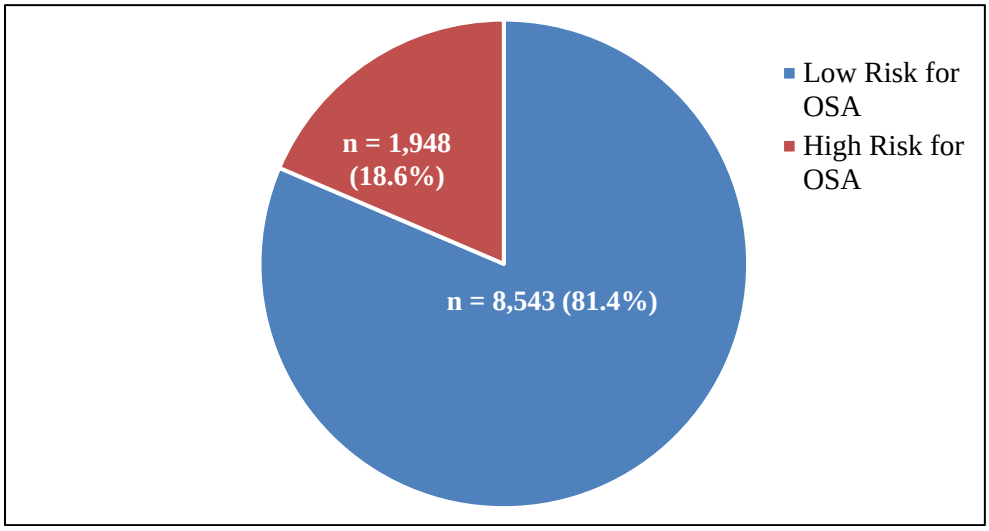

Figure 14. Chart. Berlin groupings.

5.1.10 Survey of Recent Life Experiences

Table 12 shows overall mean and subscale means on the SRLE. The SRLE lists 41 life experiences that contribute to stress or "daily hassles." Higher scores indicate greater stress. Participants' responses were summed and categorized by stress level: very high stress, high stress, average stress, low stress, or very low stress. Although the mean scores in Table 12 appear low, these scores also include missing responses, which were somewhat prevalent on the SRLE.

Table 12. Subscale results on the SRLE.

SRLE Subscales	Mean	Subscale Range[105]
Social and Cultural	16.2	11–44
Work	11.1	7–28
Time Pressure	14.3	8–32
Finances	11.1	6–24
Social Acceptability	7.8	5–20
Social Victimization	6.9	4–16

5.1.11 Dula Dangerous Driving Index

Table 13 shows mean scores on the DDDI by gender as well as the mean scores in Dula et al.[106] The DDDI measures one's likelihood of driving dangerously. Higher scores indicate a high propensity to drive dangerously. Each participant received an overall score of risky driving behavior (28–140) as well as a score in three subcategories. As with the SRLE, drivers skipped several of the items on the DDDI, which explains the low mean scores for males and females reflected in Table 13 (compared to the norms).

Table 13. Mean scores by gender on the DDDI.

DDDI Scales	Males	Females	Males in Dula et al.[107]	Females in Dula et al.[108]
Total Score	40.66	39.05	70.73	65.68
Aggressive Driving	8.93	8.49	17.40	15.26
Negative Emotion	17.03	16.53	26.76	26.53
Risky Driving	14.70	14.03	34.53	31.19

5.1.12 Social Desirability Scale

Figure 15 shows the number and percent of drivers who presented themselves in a socially desirable way on the SDS. These questions were used to measure the participant's intention to present themselves as socially desirable. Higher scores reflect higher social desirability, with total scores above 16 reflecting an individual presenting themselves in a socially desirable way. All but 99 drivers who completed the SDS scored high on it (0.9 percent). This is not surprising given that drivers completed the Initial Driver Survey during an orientation meeting, and thus may have felt heightened pressure to depict themselves in a favorable manner.

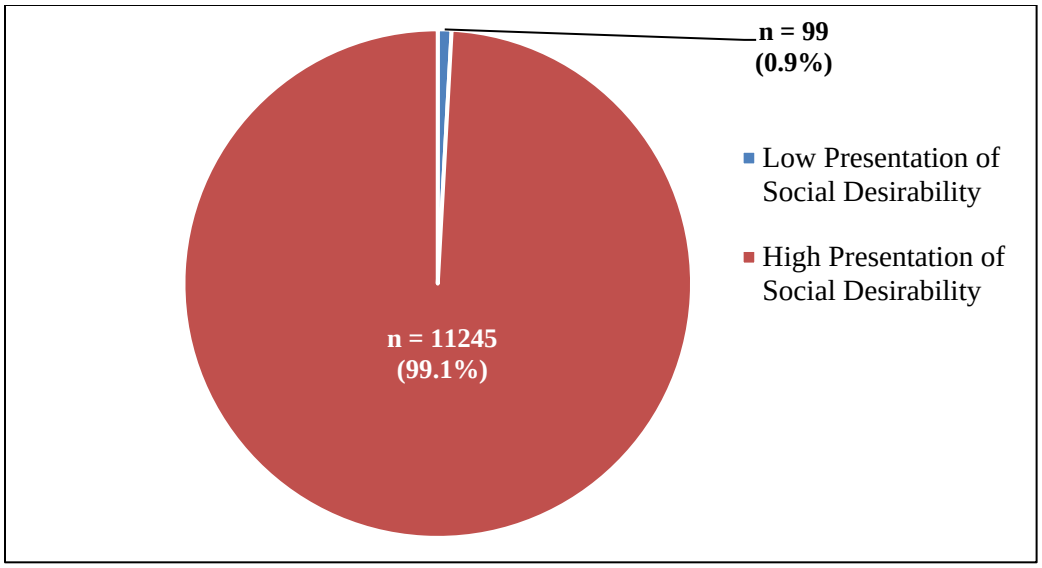

Figure 15. Chart. Percent of drivers' responding in a socially desirable way on the SDS.

5.1.13 Medical Information via the Medical Examination Report

Table 14 shows the number and percent of diagnosed medical groupings, followed by the frequency of treatment for the diagnosed medical groupings (yes, no, unsure), and the frequency and percent of potential medical groupings (i.e., a formal diagnosis was not made by the medical examiner). A total of 13,724 drivers completed the Medical Examination Report; thus, the percentages reflect that total. For example, 216 drivers were diagnosed with allergies (1.57 percent of drivers). Of these, 209 were treated, 4 were untreated, and the research team was unsure if 3 drivers were treated. Twelve drivers had a potential allergy diagnosis (0.09 percent of drivers). These counts were based on lab results, driver self-reports, and physician comments in the Medical Examination Report. The three most commonly diagnosed medical groupings were high blood pressure (24.39 percent), diabetes/elevated blood sugar (9.38 percent), and OSA (7.15 percent). The three most common potential medical groupings were OSA (6.40 percent), high blood pressure (4.07 percent), and kidney disease (1.59 percent). See Appendix F for the counts of each specific medical condition in the medical groupings.[iii]

Table 14. Frequency of diagnosed medical groupings, treatment for diagnosed medical groupings, and potential medical groupings, for all drivers.

Medical Grouping	Total Diagnosed (%)	Diagnosed: Treated	Diagnosed: Untreated	Diagnosed: Unsure	Potential (%)
Abdomen and Viscera	133 (0.97%)	9	51	73	13 (0.09%)
Alcohol use	48 (0.35%)	1	0	47	0 (0%)

[iii] Table 12 lists the total frequencies for the medical groupings, whereas Appendix F lists the specific medical conditions within those groupings. The Medical Examination Report lists general medical groupings; a medical examiner can check a box for a medical grouping, but not indicate the specific medical condition (the specific medical conditions are listed in the comments). Thus, a medical examiner could check Abdomen and Viscera, but never indicate the specific medical condition.

Medical Grouping	Total Diagnosed (%)	Diagnosed: Treated	Diagnosed: Untreated	Diagnosed: Unsure	Potential (%)
Allergies	216 (1.57%)	209	4	3	12 (0.09%)
Blood Disorder	17 (0.12%)	13	4	0	1 (0.01%)
Cancer	25 (0.18%)	16	6	3	18 (0.13%)
Diabetes/Elevated Blood Sugar	1,287 (9.38%)	1,118	147	22	105 (0.77%)
Digestive Problems	479 (3.49%)	415	23	41	9 (0.07%)
Dyslipidemia	796 (5.8%)	791	3	2	9 (0.07%)
Ear Disorder/ Hearing/Balance	949 (6.91%)	791	3	155	9 (0.07%)
Eye Disorder	112 (0.82%)	26	16	70	14 (0.10%)
Genitourinary	286 (2.08%)	114	117	55	77 (0.56%)
Head/Brain Injuries	128 (0.93%)	38	2	88	3 (0.02%)
Heart/Cardiovascular Disease	330 (2.4%)	224	47	59	90 (0.66%)
High Blood Pressure	3,347 (24.39%)	3,105	178	64	559 (4.07%)
Hormone Dysfunction	34 (0.25%)	34	0	0	3 (0.02%)
Hormone Therapy	11 (0.08%)	11	0	0	1 (0.01%)
Inflammatory Disease	7 (0.05%)	3	3	1	0 (0%)
Kidney Disease/Disorder	131 (0.95%)	14	95	22	218 (1.59%)
Loss/Altered Consciousness	13 (0.09%)	0	0	13	1 (0.01%)
Lung and Chest	367 (2.67%)	274	28	65	13 (0.09%)
Missing/Impaired Limb	117 (0.85%)	4	5	108	0 (0%)
Mouth and Throat	16 (0.12%)	4	0	12	0 (0%)
Muscular Disease	151 (1.10%)	61	14	76	14 (0.10%)
Nervous/Psychiatric Disorder	401 (2.92%)	325	34	42	18 (0.13%)
Neurological	93 (0.68%)	17	17	59	9 (0.07%)
Organ Failure	3 (0.02%)	2	0	1	0 (0%)
Seizures/Epilepsy	5 (0.04%)	1	0	4	0 (0%)
Skin Disease/Disorder	66 (0.48%)	38	14	14	6 (0.04%)
OSA	981 (7.15%)	724	139	118	879 (6.40%)
Other Sleep Disorders	42 (0.31%)	36	4	2	0 (0%)
Spine/Other Musculoskeletal	488 (3.56%)	232	54	202	15 (0.11%)
Stroke or Paralysis	20 (0.15%)	1	0	19	0 (0%)
Thyroid Disorder	164 (1.19%)	162	1	1	2 (0.01%)
Tobacco Use	664 (4.84%)	17	639	8	7 (0.05%)
Vascular	89 (0.65%)	66	13	10	9 (0.07%)
Viral Infection	25 (0.18%)	20	3	2	2 (0.01%)
Vitamin Deficiency/Excess	10 (0.07%)	9	0	1	1 (0.01%)

Medical Grouping	Total Diagnosed (%)	Diagnosed: Treated	Diagnosed: Untreated	Diagnosed: Unsure	Potential (%)
Weight Control	8 (0.06%)	7	1	0	26 (0.19%)

Table 15, Table 16, Table 17, and Table 18 show the frequency of diagnosed medical groupings, treatment for diagnosed medical groupings, and potential medical groupings for drivers in the 20–33, 34–42, 43–51, and 52 and older age quartiles, respectively.

Table 15. Frequency of diagnosed medical groupings, treatment for diagnosed medical groupings, and potential medical groupings for drivers in the 20–33 age quartile.

Medical Grouping	Diagnosed: Treated	Diagnosed: Untreated	Diagnosed: Unsure	Potential
Abdomen and Viscera	2	4	7	0
Alcohol Use	0	0	5	0
Allergies	36	2	1	1
Blood Disorder	2	0	0	0
Cancer	2	0	0	1
Diabetes/Elevated Blood Sugar	43	16	2	15
Digestive Problems	32	2	6	3
Dyslipidemia	18	0	0	0
Ear Disorder/ Hearing/Balance	18	0	22	0
Eye Disorder	2	5	10	2
Genitourinary	4	18	4	8
Head/Brain Injuries	11	0	14	1
Heart/Cardiovascular Disease	6	7	7	19
High Blood Pressure	158	19	7	109
Hormone Dysfunction	1	0	0	0
Hormone Therapy	3	0	0	0
Inflammatory Disease	0	2	0	0
Kidney Disease/Disorder	2	10	4	55
Loss/Altered Consciousness	0	0	2	0
Lung and Chest	69	8	19	1
Missing/Impaired Limb	1	3	16	0
Mouth and Throat	1	0	0	0
Muscular Disease	11	3	17	3
Nervous/Psychiatric Disorder	37	14	11	3
Neurological	0	3	9	0
Organ Failure	0	0	0	0
Seizures/Epilepsy	0	0	1	0
Skin Disease/Disorder	1	4	2	0

Medical Grouping	Diagnosed: Treated	Diagnosed: Untreated	Diagnosed: Unsure	Potential
OSA	104	24	11	254
Other Sleep Disorders	2	0	0	0
Spine/Other Musculoskeletal	7	7	24	0
Stroke or Paralysis	0	0	0	0
Thyroid Disorder	11	0	0	0
Tobacco Use	3	163	3	0
Vascular	2	0	0	0
Viral Infection	3	0	0	0
Vitamin Deficiency/Excess	0	0	0	0
Weight Control	0	0	0	6

Table 16. Frequency of diagnosed medical groupings, treatment for diagnosed medical groupings, and potential medical groupings for drivers in the 34–42 age quartile.

Medical Grouping	Diagnosed: Treated	Diagnosed: Untreated	Diagnosed: Unsure	Potential
Abdomen and Viscera	1	10	14	2
Alcohol use	0	0	13	0
Allergies	42	1	0	4
Blood Disorder	5	2	0	0
Cancer	0	2	0	1
Diabetes/Elevated Blood Sugar	185	32	6	26
Digestive Problems	83	7	7	4
Dyslipidemia	85	0	0	1
Ear Disorder/ Hearing/Balance	85	0	27	1
Eye Disorder	4	1	13	2
Genitourinary	7	30	12	15
Head/Brain Injuries	10	0	23	1
Heart/Cardiovascular Disease	19	4	11	15
High Blood Pressure	505	37	7	152
Hormone Dysfunction	10	0	0	0
Hormone Therapy	2	0	0	0
Inflammatory Disease	1	0	0	0
Kidney Disease/Disorder	3	17	4	38
Loss/Altered Consciousness	0	0	6	1
Lung and Chest	61	5	12	4
Missing/Impaired Limb	0	0	21	0
Mouth and Throat	0	0	0	0
Muscular Disease	15	1	16	2

Medical Grouping	Diagnosed: Treated	Diagnosed: Untreated	Diagnosed: Unsure	Potential
Nervous/Psychiatric Disorder	84	9	7	3
Neurological	0	5	10	2
Organ Failure	1	0	1	0
Seizures/Epilepsy	0	0	2	0
Skin Disease/Disorder	8	2	5	1
OSA	170	38	27	278
Other Sleep Disorders	5	1	0	0
Spine/Other Musculoskeletal	36	8	43	2
Stroke or Paralysis	0	0	2	0
Thyroid Disorder	23	0	0	1
Tobacco Use	6	173	2	4
Vascular	3	3	1	0
Viral Infection	2	0	0	0
Vitamin Deficiency/Excess	0	0	0	0
Weight Control	2	0	1	8

Table 17. Frequency of diagnosed medical groupings, treatment for diagnosed medical groupings, and potential medical groupings for drivers in the 43–51 age quartile.

Medical Grouping	Diagnosed: Treated	Diagnosed: Untreated	Diagnosed: Unsure	Potential
Abdomen and Viscera	2	12	13	3
Alcohol use	0	0	18	0
Allergies	68	1	2	2
Blood Disorder	1	2	0	1
Cancer	2	1	1	7
Diabetes/Elevated Blood Sugar	377	46	6	33
Digestive Problems	148	5	11	1
Dyslipidemia	257	2	1	0
Ear Disorder/ Hearing/Balance	257	2	37	0
Eye Disorder	7	4	18	7
Genitourinary	21	37	16	26
Head/Brain Injuries	9	1	29	0
Heart/Cardiovascular Disease	56	18	12	22
High Blood Pressure	1,003	67	27	169
Hormone Dysfunction	13	0	0	0
Hormone Therapy	6	0	0	0
Inflammatory Disease	0	1	0	0

Medical Grouping	Diagnosed: Treated	Diagnosed: Untreated	Diagnosed: Unsure	Potential
Kidney Disease/Disorder	4	32	4	55
Loss/Altered Consciousness	0	0	2	0
Lung and Chest	80	5	18	2
Missing/Impaired Limb	0	0	23	0
Mouth and Throat	2	0	2	0
Muscular Disease	14	8	15	4
Nervous/Psychiatric Disorder	102	8	12	8
Neurological	6	4	15	5
Organ Failure	0	0	0	0
Seizures/Epilepsy	1	0	1	0
Skin Disease/Disorder	13	2	4	4
OSA	207	43	28	269
Other Sleep Disorders	15	3	0	0
Spine/Other Musculoskeletal	69	18	62	2
Stroke or Paralysis	0	0	5	0
Thyroid Disorder	49	1	1	0
Tobacco Use	2	156	2	2
Vascular	21	0	3	7
Viral Infection	7	0	1	0
Vitamin Deficiency/Excess	5	0	1	0
Weight Control	3	0	0	5

Table 18. Frequency of diagnosed medical groupings, treatment for diagnosed medical groupings, and potential medical groupings for drivers in the 52 and older age quartile.

Medical Grouping	Diagnosed: Treated	Diagnosed: Untreated	Diagnosed: Unsure	Potential
Abdomen and Viscera	4	25	39	8
Alcohol use	1	0	11	0
Allergies	63	0	0	4
Blood Disorder	5	0	0	0
Cancer	12	3	2	9
Diabetes/Elevated Blood Sugar	511	54	8	31
Digestive Problems	152	9	17	6
Dyslipidemia	431	1	1	8
Ear Disorder/ Hearing/Balance	431	1	69	8
Eye Disorder	13	6	29	3
Genitourinary	82	33	23	28
Head/Brain Injuries	8	1	22	1

Medical Grouping	Diagnosed: Treated	Diagnosed: Untreated	Diagnosed: Unsure	Potential
Heart/Cardiovascular Disease	143	18	29	34
High Blood Pressure	1,439	55	23	129
Hormone Dysfunction	10	0	0	3
Hormone Therapy	0	0	0	1
Inflammatory Disease	2	0	1	0
Kidney Disease/Disorder	5	37	10	70
Loss/Altered Consciousness	0	0	3	0
Lung and Chest	64	10	16	6
Missing/Impaired Limb	3	2	48	0
Mouth and Throat	1	0	10	0
Muscular Disease	21	2	28	5
Nervous/Psychiatric Disorder	102	3	12	3
Neurological	11	5	25	2
Organ Failure	1	0	0	0
Seizures/Epilepsy	0	0	0	0
Skin Disease/Disorder	16	6	3	1
OSA	215	29	54	175
Other Sleep Disorders	14	0	2	0
Spine/Other Musculoskeletal	120	21	73	11
Stroke or Paralysis	1	0	12	0
Thyroid Disorder	79	0	0	1
Tobacco Use	6	148	1	1
Vascular	40	10	6	2
Viral Infection	8	3	1	2
Vitamin Deficiency/Excess	4	0	0	1
Weight Control	2	1	0	7

Table 19 shows the percentage and number of drivers who required vision correction (must have visual acuity of at least 20/40 with or without corrective lenses). Most drivers (64.02 percent) did not require corrective lenses while driving.

Table 19. Percent and number of drivers who required corrective lenses.

Count/Percent	Requires Corrective Lenses	No Corrective Lenses
Count	4,912	8,739
Percent	35.98%	64.02%

Figure 16 shows the number and percent of drivers who failed an eye exam (i.e., did not have visual acuity of at least 20/40 with or without corrective lenses, did not have field of vision of at least 70 degrees in the horizontal meridian in each eye, and/or were unable to recognize the red,

amber, and green traffic signal colors). Only 175 (1.3 percent) of the drivers failed the eye exam. Waiver information for driver exemptions for the vision standard are not reflected in these results.

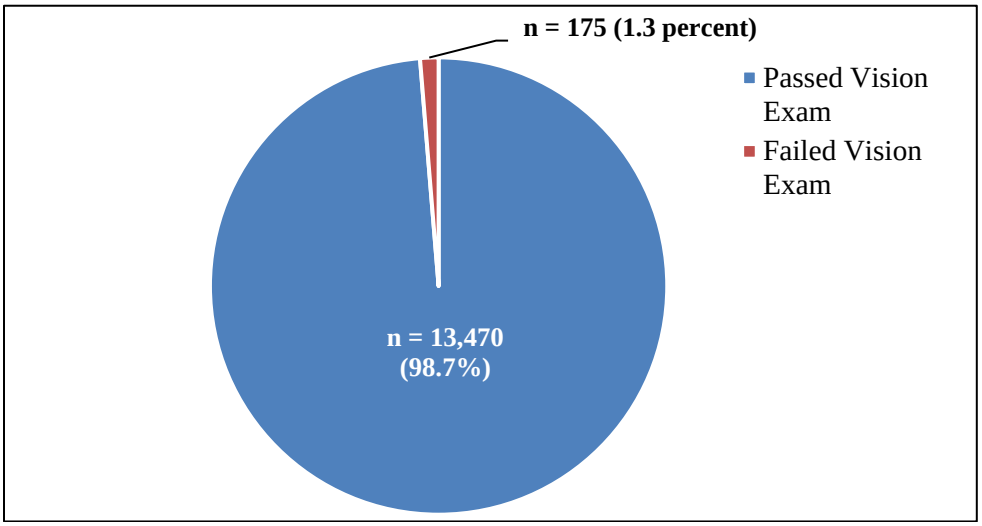

Figure 16. Percent of drivers who failed an eye exam.

Figure 17 shows the number and percent of drivers who failed a hearing exam (i.e., were unable to perceive a forced whispered voice in the better ear at not less than 5 feet with or without the use of a hearing aid or if tested by use of an audiometric device, and/or did not have an average hearing loss in the better ear greater than 40 decibels at 500 Hz, 1000 Hz, and 2,000 Hz with or without a hearing aid). Only 72 drivers (0.5 percent) failed the hearing exam. Waiver information for driver exemptions for the hearing standard are not reflected in these results.

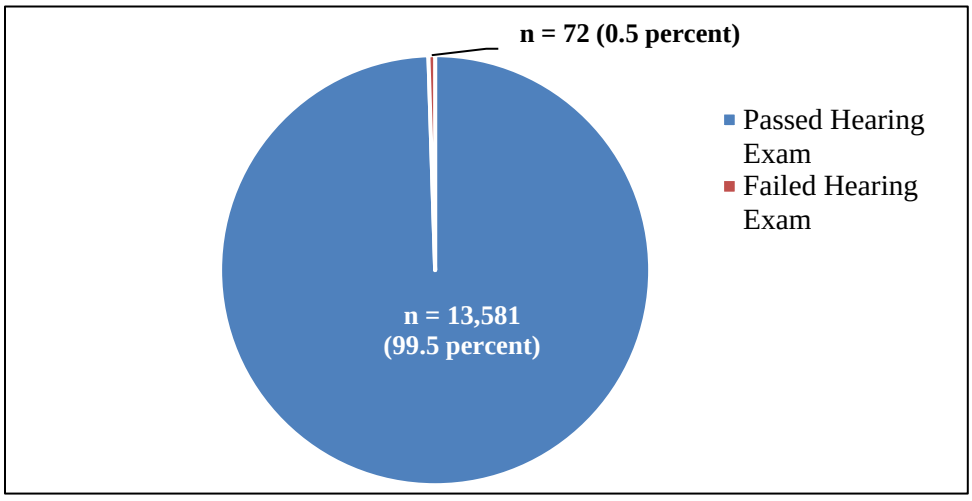

Figure 17. Percent of drivers who failed a hearing exam.

Table 20 shows the frequency and percentage of drivers in each medical grouping across BMI categories. Some of the medical grouping totals in Table 20 may not sum to the medical grouping totals in Table 14 due to missing data.

Table 20. Medical groupings by BMI categories.

Medical Grouping	Underweight	Normal Weight	Overweight	Obese Class I	Obese Class II	Obese Class III
Abdomen and Viscera	0 (0%)	15 (0.89%)	37 (0.95%)	37 (0.98%)	14 (0.64%)	30 (1.5%)
Alcohol use	0 (0%)	6 (0.35%)	17 (0.43%)	13 (0.34%)	5 (0.23%)	7 (0.35%)
Allergies	0 (0%)	16 (0.95%)	61 (1.56%)	56 (1.48%)	35 (1.61%)	48 (2.39%)
Blood Disorder	1 (1.96%)	2 (0.12%)	5 (0.13%)	1 (0.03%)	3 (0.14%)	5 (0.25%)
Cancer	0 (0%)	2 (0.12%)	8 (0.2%)	5 (0.13%)	6 (0.28%)	4 (0.2%)
Diabetes/Elevated Blood Sugar	1 (1.96%)	49 (2.91%)	275 (7.05%)	383 (10.2%)	307 (14.27%)	267 (13.52%)
Digestive Problems	1 (1.96%)	38 (2.25%)	116 (2.96%)	152 (4.03%)	98 (4.51%)	74 (3.69%)
Dyslipidemia	2 (3.92%)	25 (1.48%)	186 (4.75%)	262 (6.93%)	199 (9.16%)	122 (6.08%)
Ear Disorder/ Hearing/Balance	2 (3.92%)	38 (2.24%)	233 (5.95%)	302 (7.99%)	232 (10.68%)	142 (7.08%)
Eye Disorder	0 (0%)	9 (0.53%)	34 (0.87%)	34 (0.9%)	21 (0.97%)	14 (0.7%)
Genitourinary	0 (0%)	27 (1.6%)	90 (2.31%)	88 (2.34%)	47 (2.17%)	35 (1.76%)
Head/Brain Injuries	0 (0%)	18 (1.06%)	36 (0.92%)	32 (0.85%)	24 (1.1%)	17 (0.85%)
Hear/Cardiovascular Disease	2 (3.92%)	26 (1.55%)	89 (2.28%)	100 (2.66%)	63 (2.91%)	46 (2.31%)
High Blood Pressure	6 (11.76%)	177 (10.67%)	738 (19.59%)	999 (27.55%)	737 (35.64%)	680 (35.86%)
Hormone Dysfunction	0 (0%)	0 (0%)	7 (0.18%)	14 (0.37%)	4 (0.18%)	9 (0.45%)
Hormone Therapy	0 (0%)	3 (0.18%)	3 (0.08%)	3 (0.08%)	1 (0.05%)	1 (0.05%)
Inflammatory Disease	0 (0%)	2 (0.12%)	2 (0.05%)	3 (0.08%)	0 (0%)	0 (0%)
Kidney Disease/Disorder	0 (0%)	14 (0.84%)	32 (0.83%)	40 (1.08%)	26 (1.21%)	20 (1.02%)
Loss/Altered Consciousness	0 (0%)	4 (0.24%)	4 (0.1%)	2 (0.05%)	2 (0.09%)	1 (0.05%)
Lung and Chest	2 (3.92%)	43 (2.54%)	78 (1.99%)	100 (2.65%)	64 (2.95%)	80 (3.99%)
Missing/Impaired Limb	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Mouth and Throat	1 (1.96%)	9 (0.53%)	35 (0.89%)	38 (1.01%)	17 (0.78%)	17 (0.85%)
Muscular Disease	0 (0%)	3 (0.18%)	3 (0.08%)	3 (0.08%)	4 (0.18%)	3 (0.15%)
Nervous/Psychiatric Disorder	1 (1.96%)	20 (1.18%)	33 (0.84%)	46 (1.22%)	25 (1.15%)	26 (1.3%)
Neurological	2 (3.92%)	37 (2.19%)	93 (2.37%)	120 (3.18%)	89 (4.09%)	58 (2.9%)
Organ Failure	0 (0%)	10 (0.59%)	23 (0.59%)	25 (0.66%)	18 (0.83%)	17 (0.85%)
Seizures/Epilepsy	0 (0%)	2 (0.12%)	1 (0.03%)	0 (0%)	0 (0%)	0 (0%)
Skin Disease/Disorder	0 (0%)	0 (0%)	2 (0.05%)	2 (0.05%)	0 (0%)	1 (0.05%)
OSA	0 (0%)	8 (0.47%)	17 (0.43%)	10 (0.26%)	18 (0.83%)	13 (0.65%)
Other Sleep Disorders	0 (0%)	10 (0.59%)	35 (0.89%)	104 (2.78%)	261 (13.88%)	568 (38.51%)
Spine/Other Musculoskeletal	0 (0%)	1 (0.06%)	9 (0.23%)	16 (0.42%)	9 (0.41%)	7 (0.35%)
Stroke or Paralysis	1 (1.96%)	36 (2.13%)	117 (2.99%)	136 (3.6%)	103 (4.75%)	95 (4.74%)
Thyroid Disorder	0 (0%)	3 (0.18%)	3 (0.08%)	5 (0.13%)	5 (0.23%)	4 (0.2%)
Tobacco Use	0 (0%)	12 (0.71%)	41 (1.05%)	49 (1.3%)	34 (1.56%)	28 (1.4%)
Vascular	3 (5.88%)	108 (6.38%)	188 (4.8%)	179 (4.74%)	112 (5.15%)	74 (3.69%)

Medical Grouping	Underweight	Normal Weight	Overweight	Obese Class I	Obese Class II	Obese Class III
Viral Infection	0 (0%)	2 (0.12%)	14 (0.36%)	20 (0.53%)	21 (0.97%)	32 (1.6%)
Vitamin Deficiency/Excess	0 (0%)	3 (0.18%)	8 (0.2%)	7 (0.19%)	5 (0.23%)	2 (0.1%)
Weight Control	0 (0%)	0 (0%)	1 (0.03%)	5 (0.13%)	2 (0.09%)	2 (0.1%)

Table 21 shows the medical examiner's recommended length of medical certification. Only 53.98 percent of the drivers received a full 2-year medical certification; the remaining drivers received a periodic medical certification (12 months, 6 months, or 3 months) or were disqualified.

Table 21. Length of medical certification.

	Qualified	Periodic	Temporarily Disqualified	Failed
N	7,331	5,281	522	446
Percent	53.98%	38.89%	3.84%	3.28%

Table 22 shows the likelihood of each driver variable resulting in a periodic medical certification or medical disqualification (failed or temporarily disqualified) compared to a full 2-year certification. A logistic regression was used to calculate OR estimates and 95-percent confidence intervals (CIs) for each variable. The OR estimates were adjusted for age and gender when indicated. For example, obese class I drivers were 3.03 and 1.88 times more likely than a normal weight driver to have a periodic medical certification or to be medically disqualified, respectively, compared to normal weight drivers with a full 2-year certification (adjusting for age and gender). The same relationship was found with obese class II and III drivers. Females were 27 percent less likely than males to have a periodic medical certification compared to a full 2-year certification (adjusting for age). Significant OR estimates are denoted with an asterisk.

Table 22. Adjusted OR estimates and 95-percent CIs for the relationships between driver variables and periodic medical certification or medical disqualification (failed or temporarily disqualified) compared to a full 2-year certification.

Driver Variable	Odds Ratio Estimates for Periodic Certification (95% CI)	Odds Ratio Estimates for Medically Disqualified (95% CI)
Age[g]	1.06* (1.06,1.06)	1.06* (1.06,1.07)
BMI[+g]	1.13* (1.123,1.137)	1.12* (1.11,1.132)
Normal weight	1.00 (reference)	1.00 (reference)
Underweight[+g]	0.89 (0.41,1.92)	0.37 (0.05,2.75)
Overweight[+g]	2.0* (1.73,2.32)	1.15 (0.88,1.5)
Obese class I[+g]	3.03* (2.62,3.5)	1.88* (1.45,2.43)
Obese class I[+g]	6.58* (5.62,7.69)	3.36* (2.56,4.42)
Obese class III[+g]	15.32* (12.93,18.16)	10.02* (7.65,13.12)
Male	1.00 (reference)	1.00 (reference)
Female[+]	0.73* (0.61,0.88)	0.87 (0.62,1.21)

[+] = adjusted for age

[g] = adjusted for gender

Table 23 shows the likelihood of each medical grouping resulting in a periodic medical certification or medical disqualification (failed or temporarily disqualified) compared to a full 2-year certification. A logistic regression was used to calculate OR estimates and 95-percent CIs for each variable. The OR estimates were adjusted for age and gender. This analysis replicates an analysis performed by Thiese et al.;[109] the research team replicated the medical groupings Thiese et al. used for a direct comparison. As shown in Table 23, many of the medical groupings had significant OR estimates. The medical groupings that were most likely to result in a periodic or medical disqualification were sleep disorders, high blood pressure, diabetes, and heart disease. Significant OR estimates are denoted with an asterisk.

Table 23. Adjusted OR estimates and 95-percent CIs for the relationships between medical groupings and periodic medical certification or medical disqualification (failed or temporarily disqualified) compared to a full 2-year certification).

Medical Groupings	Odds Ratio Estimates for Periodic Certification (95% CI)	Odds Ratio Estimates for Medically Disqualified (95% CI)
Illness/Injury Last 5 Years	1.54* (1.41,1.68)	2.24* (1.93,2.59)
Head/Brain Injuries	1.52 (0.92,2.52)	4.15* (2.29,7.52)
Seizure Epilepsy	3.47 (0.29,41.04)	20.19* (1.69,241.83)
Seizure Epilepsy w/Meds	N/A	N/A
Eye Disorders	1.41 (0.86,2.31)	2.32* (1.15,4.7)
Ear Disorders	1.13 (0.81,1.59)	1.41 (0.85,2.33)
Heart Disease	23.58* (10.99,50.59)	31.44* (13.91,71.05)
Heart Disease w/Meds	23.33* (7.34,74.21)	45.21* (13.55,150.91)
Heart Surgery	50.52* (12.46,204.77)	96.51* (22.78,408.86)
High Blood Pressure	216.81* (148.88,315.71)	136.61* (91.97,202.93)
High Blood Pressure w/Meds	160.82* (98.07,263.74)	127.89* (76.49,213.85)
Muscular Disease	0.23 (0.02,2.59)	0 (0,1.97e190)
Shortness of Breath	2.22* (1.37,3.57)	2.82* (1.48,5.35)
Lung Disease	1.72* (1.34,2.21)	2.3* (1.58,3.36)
Kidney Disease	2.21 (0.8,6.16)	14.23* (4.91,41.24)
Liver Disease	6.43 (0.81,51.07)	2.19 (0.13,35.87)
Digestive Problems	2.0* (1.49,2.69)	2.38* (1.5,3.77)
Diabetes	166.75* (83.02,334.95)	144.41* (70.53,295.68)
Diabetes Control w/Diet	126.58* (56.53,283.45)	96.72* (42.02,222.62)
Diabetes Control w/Pills	221.62* (91.92,534.37)	193.36* (78.8,474.49)
Diabetes Control w/Insulin	317,005.36 (0,7.29e93)	4,094,320.6 (0,3.94e199)
Nervous Disorders	6.02* (4.34,8.35)	12.31* (8.35,18.16)
Nervous Disorders w/Meds	6.69* (4.39,10.2)	14.43* (8.88,23.46)
Altered Consciousness	1.16 (0.32,4.26)	3.69 (0.86,15.87)
Fainting Dizziness	2.73 (0.96,7.74)	8.97* (2.67,30.19)
Sleep Disorders	198.21* (88.55,443.66)	250.22* (109.5,571.78)
Stroke Paralysis	189,224.75 (0,3.12e116)	10,549,452.38 (0,8.51e211)
Missing Extremities	1.55 (0.99,2.42)	3.85* (2.21,6.69)
Spinal Injury Disease	1.3(0.94,1.81)	3.54* (2.36,5.31)

Medical Groupings	Odds Ratio Estimates for Periodic Certification (95% CI)	Odds Ratio Estimates for Medically Disqualified (95% CI)
Chronic Low Back Pain	1.13(0.66,1.95)	6.39* (3.66,11.18)
Frequent Alcohol Use	1.03(0.55,1.91)	1.15 (0.39,3.38)
Drug Use	1.1(0.41,2.97)	5.78* (2.1,15.9)
Requires Vision Correction	1.24*(1.14,1.34)	1.11(0.96,1.29)
Monocular Vision	0.21(0.05,0.93)	2.49 (0.81,7.66)

Table 24 shows the likelihood of each physical exam abnormality resulting in a periodic medical certification or medical disqualification (failed or temporarily disqualified) compared to a full 2-year certification. A logistic regression was used to calculate OR estimates and 95-percent CIs for each variable. The OR estimates were adjusted for age and gender. As shown in Table 24, many of the physical exam abnormalities had significant OR estimates. The physical exam abnormalities that were most likely to result in a periodic or medical disqualification (after adjusting for age and gender) were lungs, heart, genitourinary (only for medical disqualification), and general appearance (physician observes marked overweight, tremors [shakes], signs of drinking/drug abuse or problems). Significant OR estimates are denoted with an asterisk.

Table 24. Adjusted ORs and 95-percent CIs for the relationships between physical exam abnormalities and periodic medical certification or medical disqualification (failed or temporarily disqualified) compared to a full 2-year certification).

Physical Exam Abnormality	Odds Ratio Estimates for Periodic Certification (95% CI)	Odds Ratio Estimates for Medically Disqualified (95% CI)
General Appearance	4.88* (4.45,5.36)	5.27* (4.53,6.13)
Ear	0.67 (0.38,1.18)	1.23 (0.56,2.74)
Extremities	1.8* (1.21,2.68)	11.93* (8.05,17.69)
Eyes	1.02 (0.51,2.04)	6.63* (3.33,13.2)
Heart	9.95* (5.33,18.57)	37.86* (19.96,71.83)
Lungs	8.65* (2.92,25.65)	17.29* (5.32,56.26)
Mouth	2.01 (0.4,10.13)	5.5 (0.95,31.76)
Neurological	1.56 (0.71,3.44)	18.01* (8.97,36.19)
Spinal	1.35 (0.94,1.94)	5.09* (3.38,7.67)
Genitourinary	0.95 (0.39,2.29)	13.59* (6.5,28.39)
Vascular	1.49 (0.14,15.29)	9.24 (0.83,103.35)

5.1.14 Safety Data

Figure 18 shows the frequency of crashes and preventable crashes (carrier dataset only) from each crash database. Analyses using the carrier crash data and national crash data were mutually exclusive. As shown in Figure 18, there were a total of 2,775 crashes (1,438 preventable crashes) in the analyses using the carrier data, and 1,073 crashes in the analyses using the national data. The Venn diagram in Figure 18 also shows the overlap of the three crashes data sets (e.g., 14 crashes were found in all 3 datasets).

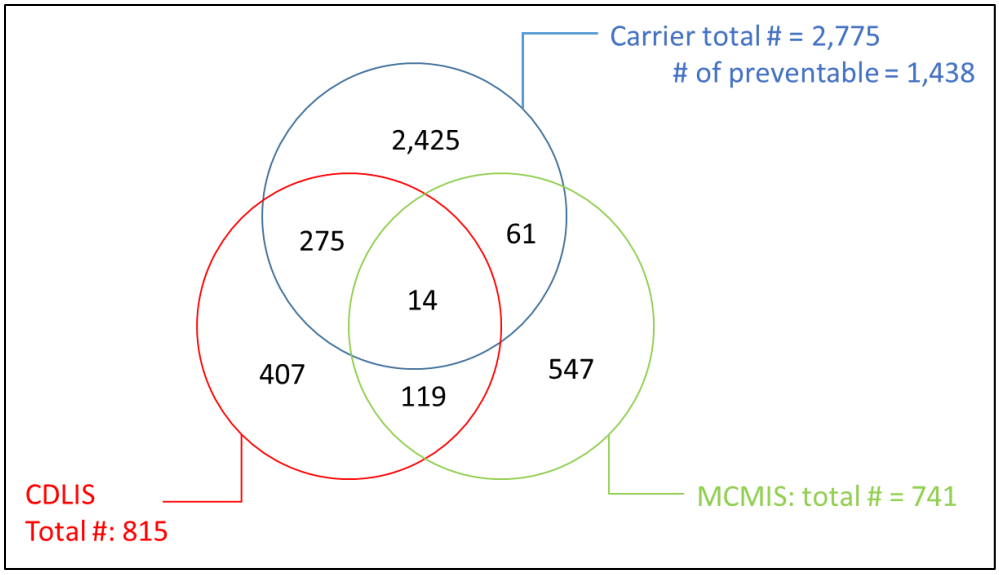

Figure 18. Diagram. Frequency of crashes in each crash database.

Table 25 shows the frequency of moving violation convictions from CDLIS. The most prevalent moving violation convictions were speeding (30.05 percent), failure to obey (22.8 percent), improper lane or location (12.02 percent), and operating without, failure to use, or improper use of equipment required (9.79 percent).

Table 25. Frequency of moving violation convictions from CDLIS.

Moving Violation	N (%)
DUI, drugs and/or alcohol, impaired driving, administrative per se DUI	4 (0.25%)
Refused test for alcohol	2 (0.12%)
Hit and run, behaviors after accidents	2 (0.12%)
Driving after withdrawal	8 (0.50%)
Driver license/vehicle registration and title, miscellaneous duties	17 (1.05%)
Misrepresentations	3 (0.19%)
Miscellaneous duty failure	11 (0.68%)
Operating without, failure to use, or improper use of equipment required	158 (9.79%)
Protective equipment not used (safety belt, helmet, etc.)	86 (5.33%)
Obstructing or impeding traffic with motor vehicle	53 (3.28%)
Failure to obey (driving/on road)	368 (22.80%)
Following improperly	21 (1.30%)
Improper lane or location	194 (12.02%)
Improper passing	15 (0.93%)
Reckless, careless, negligent driving	26 (1.61%)
Texting, handheld phone while driving	23 (1.43%)
Failure to yield	25 (1.55%)
Failure to signal or wrong signal	5 (0.31%)
Improper turn	22 (1.36%)
Wrong way driving	3 (0.19%)
Miscellaneous maneuvers	40 (2.48%)
Speeding	485 (30.05%)
Other	43 (2.66%)
Total	**1,614 (100%)**

5.2 PROSPECTIVE COHORT WITH INITIAL DRIVER SURVEY

The prospective cohort analyses using the Initial Driver Survey included many analyses. Separate analyses were performed for each safety outcome, with results stratified by age quartiles in the individual regression model. The safety outcomes included total carrier crashes (i.e., preventable and non-preventable crashes), carrier preventable crashes, national crashes (i.e., DOT-recordable crashes from MCMIS), and national moving violations (i.e., moving violation convictions in CDLIS). The total carrier crashes and carrier preventable crashes used carrier tenure at the participating carrier as the measure of exposure, whereas the national crashes and moving violations used national exposure as the measure of exposure. Although many of the variables had one significant finding, it is best to look for consistent findings across the age quartiles and/or the different safety outcomes when interpreting the results.

5.2.1 Individual Regression Model for Initial Driver Survey

The individual regression model results were adjusted for age and BMI. RR estimates and 95-percent CIs are shown for each analysis.

5.2.1.1 Marital Status

Table 26 shows participating drivers' self-reported marital status.

Table 26. Driver demographics: self-reported marital status.

Marital Status	Number	Percent
Single	4,443	39.00%
Married	5,436	47.72%
Divorced	1,419	12.46%
Widowed	93	0.82%
Total	**11,391***	**100%**

*Some drivers selected more than one option.

Table 27 shows the RR estimates and 95-percent CIs for the marital status variable. The comparison marital status was "single" (i.e., married, divorced, and widowed drivers were compared to drivers who were single). Significant RR estimates ($p < 0.05$) are denoted with an asterisk. Cells with "NA" indicate no driver was in the cell and/or no driver was in the reference cell; thus, no RR estimates could be calculated. Cells with a RR estimate of zero ("0") indicate that at least one driver was in the cell, but no crashes or violations were associated with that driver(s). There was one significant finding in Table 27. Divorced drivers aged 34–42 were 85 percent more likely to be involved in a national crash compared to single drivers aged 34–42.

Table 27. RR estimates and 95-percent CIs for marital status.

Safety Outcome and Age Quartile	Single	Married	Divorced	Widowed
Total Carrier: 20–33	1.00	1.059 (0.850,1.320)	0.598 (0.333,1.073)	0 (0,Inf)
Total Carrier: 34–42	1.00	0.819 (0.650,1.031)	0.916 (0.631,1.331)	1.036 (0.256,4.187)
Total Carrier: 43–51	1.00	0.991 (0.774,1.269)	1.103 (0.791,1.540)	1.201 (0.380,3.793)
Total Carrier: 52+	1.00	0.995 (0.734,1.349)	0.992 (0.670,1.469)	1.587 (0.804,3.131)
Carrier Preventable: 20–33	1.00	0.899 (0.658,1.229)	0.447 (0.182,1.098)	0 (0,Inf)
Carrier Preventable: 34–42	1.00	0.744 (0.542,1.021)	0.945 (0.576,1.550)	0.966 (0.134,6.957)
Carrier Preventable: 43–51	1.00	1.027 (0.721,1.462)	1.249 (0.787,1.983)	0.829 (0.114,6.017)
Carrier Preventable: 52+	1.00	0.703 (0.477,1.035)	0.609 (0.351,1.056)	1.387 (0.581,3.316)
National Crashes: 20–33	1.00	1.156 (0.843,1.587)	0.997 (0.517,1.921)	0 (0,Inf)

Safety Outcome and Age Quartile	Single	Married	Divorced	Widowed
National Crashes: 34–42	1.00	1.052 (0.743,1.489)	1.850* (1.199,2.855)	0 (0,Inf)
National Crashes: 43–51	1.00	1.015 (0.731,1.410)	0.601 (0.344,1.050)	0 (0,Inf)
National Crashes: 52+	1.00	1.302 (0.867,1.956)	0.943 (0.540,1.648)	1.122 (0.340,3.705)
Violations: 20–33	1.00	0.770 (0.588,1.010)	1.242 (0.793,1.945)	3.598 (0.498,25.982)
Violations: 34–42	1.00	0.817 (0.603,1.108)	0.884 (0.556,1.407)	0 (0,Inf)
Violations: 43–51	1.00	1.114 (0.781,1.587)	1.132 (0.695,1.844)	1.545 (0.374,6.377)
Violations: 52+	1.00	0.866 (0.585,1.282)	0.999 (0.607,1.646)	1.423 (0.503,4.026)

5.2.1.2 Academic Degree

Table 28 shows drivers' self-reported highest achieved academic degree.

Table 28. Driver demographics: self-reported highest achieved academic degree.

Academic Degree	Number	Percent
General Education Development (GED)	722	6.43%
High School	2,017	17.97%
Associate's Degree	6,558	58.44%
Bachelor's Degree	1,237	11.02%
Master's Degree	577	5.14%
Doctorate	94	0.84%
Medical Degree	14	0.12%
None Previous	3	0.03%
Total	**11,222**	**100%**

Table 29 shows the RR estimates and 95-percent CIs for the academic degree variable. The comparison to academic degree was "GED." Significant RR estimates ($p < 0.05$) are denoted with an asterisk. Cells with "NA" indicate no driver was in the cell and/or no driver was in the reference cell; thus, no RR estimates could be calculated. Cells with a RR estimate of zero ("0") indicate that at least one driver was in the cell, but no crashes or violations were associated with that driver(s). There were five significant findings in Table 29:

- Drivers aged 43–51 with a high school degree were 51.1 percent more likely to be involved in a total carrier crash compared drivers aged 43–51 with a GED.
- Drivers aged 43–51 with a bachelor's degree were 91.7 percent more likely to be involved in a total carrier crash compared to drivers aged 43–51 with a GED.
- Drivers aged 43–51 with a doctorate degree were 2.68 times more likely to be involved in a total carrier crash compared to drivers aged 43–51 with a GED.

- Drivers over 52 with a high school degree were 33.4 percent less likely to be involved in a national crash compared to drivers over 52 with a GED.
- Drivers over 52 with a doctorate degree were 5.28 times more likely to be involved in a national crash compared to drivers over 52 with a GED.

Table 29. RR estimates and 95-percent CIs for academic degree.

Safety Outcome and Age Quartile	GED	High School	Bachelor's	Master's	Doctorate	Medical Degree
Total Carrier: 20–33	1.00	1.038 (0.765,1.408)	0.859 (0.534,1.383)	1.353 (0.719,2.545)	0 (0,Inf)	NA
Total Carrier: 34–42	1.00	0.855 (0.650,1.126)	0.833 (0.554,1.254)	1.250 (0.761,2.055)	1.579 (0.685,3.640)	0 (0,Inf)
Total Carrier: 43–51	1.00	1.511* (1.077,2.122)	1.917* (1.264,2.906)	0.862 (0.452,1.646)	2.685* (1.303,5.533)	0 (0,Inf)
Total Carrier: 52+	1.00	0.945 (0.683,1.307)	0.888 (0.565,1.395)	1.287 (0.797,2.078)	0.535 (0.130,2.199)	2.243 (0.309,16.293)
Carrier Preventable: 20–33	1.00	1.134 (0.735,1.75)	1.083 (0.575,2.039)	0.916 (0.318,2.642)	0 (0,Inf)	NA
Carrier Preventable: 34–42	1.00	0.842 (0.578,1.228)	0.781 (0.441,1.383)	1.430 (0.747,2.739)	0.930 (0.224,3.864)	0 (0,Inf)
Carrier Preventable: 43–51	1.00	1.448 (0.895,2.344)	2.226 (1.259,3.938)	0.720 (0.270,1.923)	2.387 (0.816,6.985)	1^{e-04} (0,Inf)
Carrier Preventable: 52+	1.00	1.005 (0.631,1.602)	0.955 (0.505,1.809)	1.440 (0.740,2.806)	1.118 (0.263,4.742)	4.633 (0.623,34.476)
National Crashes: 20–33	1.00	0.924 (0.609,1.400)	1.010 (0.540,1.892)	1.530 (0.697,3.358)	0 (0,Inf)	NA
National Crashes: 34–42	1.00	0.840 (0.579,1.218)	1.071 (0.636,1.802)	0.665 (0.282,1.569)	0 (0,Inf)	0 (0,Inf)
National Crashes: 43–51	1.00	0.936 (0.631,1.389)	0.946 (0.543,1.650)	1.232 (0.622,2.441)	1.595 (0.489,5.205)	0 (0,Inf)
National Crashes: 52+	1.00	0.666* (0.452,0.981)	0.648 (0.361,1.162)	0.742 (0.387,1.421)	0.407 (0.056,2.967)	5.284* (1.832,15.241)
Violations: 20–33	1.00	0.686 (0.507,0.927)	0.791 (0.491,1.274)	0.947 (0.484,1.856)	0 (0,Inf)	NA
Violations: 34–42	1.00	1.390 (0.929,2.080)	1.293 (0.734,2.277)	1.435 (0.701,2.937)	0.704 (0.096,5.166)	0 (0,Inf)
Violations: 43–51	1.00	0.909 (0.600,1.379)	0.856 (0.466,1.572)	1.198 (0.585,2.454)	1.692 (0.516,5.547)	0 (0,Inf)
Violations: 52+	1.00	1.555 (0.949,2.550)	1.231 (0.625,2.423)	1.789 (0.896,3.573)	0.801 (0.107,5.986)	0 (0,Inf)

5.2.1.3 English as a Primary Language

Table 30 provides counts and percentages of drivers who reported whether English was their primary language or not.

Table 30. Driver demographics: English as a primary language (self-reported).

English as a Primary Language	Number	Percent
Yes	10,392	92.26%
No	872	7.74%
Total	**11,264**	**100%**

Table 31 shows the RR estimates and 95-percent CIs for the English as a primary language degree variable. The comparison was drivers who indicated "no" for English as a primary language. Significant RR estimates ($p < 0.05$) are denoted with an asterisk. Cells with "NA" indicate no driver was in the cell and/or no driver was in the reference cell; thus, no RR estimates could be calculated. Cells with a RR estimate of zero ("0") indicate that at least one driver was in the cell, but no crashes or violations were associated with that driver(s). There were four significant findings in Table 31:

- Drivers aged 34–42 who indicated English was their primary language were 71.7 percent more likely to be involved in a total carrier crash than drivers aged 34–42 with a language other than English as their primary language.
- Drivers over 52 were:
  - 39.9 percent less likely to be involved in total carrier crash than drivers over 52 with a language other than English as their primary language.
  - 55.9 percent less likely to be involved in carrier preventable crash than drivers over 52 with a language other than English as their primary language.
  - 62.9 percent less likely to be convicted of a moving violation than drivers over 52 with a language other than English as their primary language

Table 31. RR estimates and 95-percent CIs for English as a primary language.

Safety Outcome and Age Quartile	No	Yes
Total Carrier: 20–33	1.00	0.969 (0.6899,1.3608)
Total Carrier: 34–42	1.00	1.717* (1.020,2.890)
Total Carrier: 43–51	1.00	0.887 (0.604,1.303)
Total Carrier: 52+	1.00	0.601* (0.408,0.884)
Carrier Preventable: 20–33	1.00	0.891 (0.563,1.410)
Carrier Preventable: 34–42	1.00	1.791 (0.878,3.651)
Carrier Preventable: 43–51	1.00	0.804 (0.478,1.351)
Carrier Preventable: 52+	1.00	0.461* (0.284,0.749)

Safety Outcome and Age Quartile	No	Yes
National Crashes: 20–33	1.00	1.199 (0.664,2.165)
National Crashes: 34–42	1.00	1.045 (0.578,1.889)
National Crashes: 43–51	1.00	0.995 (0.562,1.763)
National Crashes: 52+	1.00	0.617 (0.373,1.021)
Violations: 20–33	1.00	0.881 (0.586,1.324)
Violations: 34–42	1.00	0.961 (0.574,1.609)
Violation: 43–51	1.00	1.127 (0.623,2.039)
Violation: 52+	1.00	0.371* (0.241,0.571)

5.2.1.4 CMV Driver Training

Table 32 shows drivers' self-reported amounts of training.

Table 32. Self-reported amount of truck driver training.

Weeks	Formal Training	Informal Training	On-the-job Training
0	3,098	7,398	1,307
<1	144	147	487
1	126	234	834
2	799	489	904
3	1,778	595	661
4	1,717	696	1,162
5	344	127	266
6	787	403	728
7	116	37	113
8+	1,484	1,118	2,430
Unknown*	100	100	864

*Training indicated, but no amount given.

Table 33 shows the RR estimates and 95-percent CIs for the amount (in weeks) of informal and formal CMV training completed by drivers. Significant RR estimates ($p < 0.05$) are denoted with an asterisk. Cells with "NA" indicate no driver was in the cell and/or no driver was in the reference cell; thus, no RR estimates could be calculated. Cells with a RR estimate of zero ("0") indicate that at least one driver was in the cell, but no crashes or violations were associated with that driver(s). There were four significant findings for informal training, three significant findings for formal training, and two significant finding for on-the-job training in Table 33:

- Drivers aged 20–33 were:

  - 0.7 percent less likely to be involved in a total carrier crash for each additional week of informal training.
  - 1.1 percent more likely to be involved in a national crash for each additional week of informal training.
- Drivers aged 34–42 were:
  - 0.8 percent more likely to be involved in a national crash and a moving violation for each additional week of informal training.
  - 1.0 percent more likely to be involved in a carrier preventable crash for each additional week of formal training.
- Drivers over 52 were:
  - 0.9 percent more likely to be involved in a national crash for each additional week of informal training.
  - 1 percent more likely to be involved in a carrier preventable crash for each additional week of formal training.
  - 0.9 percent more likely to be convicted of a moving violation for each additional week of formal training.
  - 0.8 percent more likely to be involved in a carrier preventable crash for each additional week of on-the-job training.
  - 1.2 percent less likely to be involved in a national crash for each additional week of on-the-job training.

It would be premature to conclude that extra training increases a driver's likelihood of involvement in a safety outcome. As alluded to above, it appeared drivers in the current study did not understand the question regarding truck training experience or they did not answer this question, as over 25 percent of the sample did not report any prior truck training experience.

Table 33. RR estimates and 95-percent CIs for amount of training.

Safety Outcome and Age Quartile	Informal	Formal	On the Job
Total Carrier: 20–33	0.993* (0.987,0.999)	1.00 (0.994,1.006)	1.001 (0.997,1.006)
Total Carrier: 34–42	1.001 (0.996,1.008)	1.002 (0.996,1.008)	1.003 (0.999,1.008)
Total Carrier: 43–51	0.996 (0.990,1.002)	0.998 (0.993,1.003)	1.002 (0.997,1.007)
Total Carrier: 52+	1.001 (0.995,1.008)	1.003 (0.997,1.01)	1.002 (0.996,1.007)
Carrier Preventable: 20–33	0.994 (0.985,1.003)	0.997 (0.998,1.005)	1.001 (0.994,1.007)
Carrier Preventable: 34–42	0.995 (0.986,1.004)	1.01* (1.002,1.018)	1.003 (0.997,1.009)
Carrier Preventable: 43–51	0.998 (0.990,1.007)	1.005 (0.998,1.013)	1.002 (0.995,1.008)

Safety Outcome and Age Quartile	Informal	Formal	On the Job
Carrier Preventable: 52+	1.005 (0.997,1.013)	1.01* (1.002,1.019)	1.008* (1.001,1.015)
National Crashes: 20–33	0.989* (0.979,0.999)	1.001 (0.992,1.009)	1.001 (0.994,1.008)
National Crashes: 34–42	1.009* (1.001,1.016)	0.996 (0.988,1.005)	1.00 (0.993,1.007)
National Crashes: 43–51	0.997 (0.999,1.005)	0.999 (0.991,1.006)	0.995 (0.988,1.003)
National Crashes: 52+	1.009* (1.002,1.016)	1.007 (0.999,1.015)	0.988* (0.979,0.997)
Violations: 20–33	1.001 (0.995,1.008)	1.00 (0.994,1.007)	1.001 (0.996,1.006)
Violations: 34–42	1.000 (0.992,1.008)	1.003 (0.996,1.011)	0.993 (0.986,1.000)
Violations: 43–51	0.994 (0.989,1.006)	0.997 (0.989,1.005)	0.997 (0.989,1.005)
Violations: 52+	0.994 (0.990,1.008)	1.009* (1.001,1.017)	0.998 (0.990,1.006)

5.2.1.5 CDL Endorsements

Table 34 shows the frequency and percent of drivers' self-reported CDL endorsements.

Table 34. Frequency and percent of self-reported CDL endorsements.

Endorsement	N	Percent
Hazardous Materials	3,683	32.6%
Tank Vehicle	5,324	47.1%
Passengers	1,145	10.1%
School Bus	486	4.3%
Double/Triple Trailers	3,997	35.3%
Combination HazMat/Tank	1,730	15.3%

Table 35 shows the RR estimates and 95-percent CIs for each CDL endorsement. The comparisons, which are not illustrated, were drivers who did not have the CDL endorsement (e.g., drivers with a hazardous materials endorsement were compared to drivers who did not have a hazardous materials endorsement). Significant RR estimates ($p < 0.05$) are denoted with an asterisk. Cells with "NA" indicate no driver was in the cell and/or no driver was in the reference cell; thus, no RR estimates could be calculated. Cells with a RR estimate of zero ("0") indicate that at least one driver was in the cell, but no crashes or violations were associated with that driver(s). There were four significant findings for CDL endorsements, as shown in Table 35.

- Drivers aged 43–51 with a school bus CDL endorsement were 78.1 percent less likely to be convicted of a moving violation compared to drivers aged 43–51 without a school bus CDL endorsement.

- Drivers aged 43–51 with a double/triple trailers endorsement were 39.8 percent less likely to be involved in a carrier preventable crash compared to drivers aged 43–51 without a double/triple trailers CDL endorsement.

- Drivers aged 43–51 with a double/triple trailers endorsement were 22.8 percent less likely to be involved in a total carrier crash compared to drivers aged 43–51 without a double/triple trailers CDL endorsement.

- Drivers over 52 with a hazardous materials CDL endorsement were 56.1 percent more likely to be involved in a national crash compared to drivers aged 43–51 without a hazardous materials CDL endorsement.

Table 35. RR estimates and 95-percent CIs for number of CDL endorsements.

Safety Outcome and Age Quartile	Hazardous Materials	Tank Vehicle	Passengers	School Bus	Double/ Triple Trailers	Combination Hazmat/Tank
Total Carrier: 20–33	0.995 (0.965,1.027)	1.111 (1.085,1.139)	1.205 (1.108,1.311)	1.199 (1.013,1.420)	1.114 (1.083,1.147)	0.704 (0.653,0.760)
Total Carrier: 34–42	0.881 (0.857,0.906)	0.925 (0.903,0.948)	0.759 (0.683,0.842)	0.819 (0.654,1.025)	0.917 (0.892,0.942)	1.144 (1.095,1.195)
Total Carrier: 43–51	0.9954 (0.971,1.020)	0.850 (0.831,0.870)	0.909 (0.860,0.960)	0.877 (0.757,1.015)	0.772* (0.752,0.792)	0.862 (0.822,0.903)
Total Carrier: 52+	1.148 (1.115,1.182)	1.075 (1.044,1.107)	1.089 (1.031,1.150)	1.052 (0.923,1.199)	1.007 (0.978,1.037)	1.029 (0.985,1.074)
Carrier Preventable: 20–33	0.844 (0.79,0.901)	0.959 (0.913,1.008)	1.515 (1.325,1.732)	1.355 (1.013,1.812)	0.965 (0.909,1.024)	0.677 (0.582,0.788)
Carrier Preventable: 34–42	0.777 (0.736,0.821)	0.823 (0.786,0.862)	0.873 (0.733,1.041)	0.693 (0.420,1.145)	0.711 (0.671,0.752)	1.162 (1.071,1.261)
Carrier Preventable: 43–51	0.886 (0.843,0.932)	0.753 (0.719,0.789)	0.910 (0.811,1.013)	0.748 (0.533,1.051)	0.602* (0.569,0.637)	0.840 (0.764,0.924)
Carrier Preventable: 52+	0.946 (0.893,1.001)	0.798 (0.755,0.844)	0.951 (0.849,1.066)	1.277 (1.033,1.579)	0.851 (0.804,0.901)	0.87 (0.793,0.954)
National Crashes: 20–33	1.365 (1.293,1.441)	1.170 (1.114,1.229)	0.725 (0.560,0.938)	0.517 (0.266,1.005)	1.103 (1.040,1.170)	1.203 (1.081,1.338)
National Crashes: 34–42	1.235 (1.174,1.298)	1.1594 (1.105,1.216)	1.095 (0.969,1.238)	1.362 (1.082,1.716)	1.188 (1.130,1.249)	1.013 (0.926,1.108)
National Crashes: 43–51	0.904 (0.860,0.951)	0.748 (0.714,0.783)	0.690 (0.603,0.791)	0.532 (0.355,0.797)	0.835 (0.796,0.877)	0.894 (0.820,0.974)
National Crashes: 52+	1.561* (1.484,1.642)	0.898 (0.854,0.945)	1.057 (0.966,1.158)	0.704 (0.501,0.99)	0.938 (0.891,0.988)	1.219 (1.133,1.310)
Violations: 20–33	0.902 (0.865,0.941)	0.865 (0.835,0.895)	1.134 (1.014,1.268)	0.894 (0.694,1.152)	0.930 (0.893,0.969)	0.845 (0.772,0.924)
Violations: 34–42	0.802 (0.764,0.843)	0.722 (0.691,0.754)	0.731 (0.628,0.85)	0.790 (0.564,1.107)	0.870 (0.830,0.912)	0.645 (0.578,0.720)
Violations: 43–51	0.785 (0.743,0.829)	0.791 (0.754,0.829)	0.665 (0.576,0.768)	0.219* (0.081,0.591)	1.053 (1.004,1.105)	0.881 (0.805,0.964)
Violations: 52+	0.791 (0.745,0.839)	0.852 (0.808,0.900)	0.699 (0.613,0.796)	0.653 (0.435,0.982)	0.750 (0.708,0.794)	0.798 (0.721,0.883)

5.2.1.6 Personal Vehicle Seat Belt Use

Table 36 shows drivers' self-reported seatbelt use by vehicle type (i.e., personal versus CMV).

Table 36. Drivers' self-reported seat belt use, by vehicle type.

Vehicle Type	Always	Often	Sometimes	Rarely	Never
Personal	10,144	627	297	109	75
CMV	10,888	228	93	93	14

Table 37 shows the RR estimates and 95-percent CIs for personal vehicle seat belt use. The comparison was drivers who indicated they "always" wore a seat belt while in their personal vehicle. Significant RR estimates ($p < 0.05$) are denoted with an asterisk. Cells with "NA" indicate no driver was in the cell and/or no driver was in the reference cell; thus, no RR estimates could be calculated. Cells with a RR estimate of zero ("0") indicate that at least one driver was in the cell, but no crashes or violations were associated with that driver(s). There were eight significant findings in Table 37. Seven of the eight significant findings indicated that drivers who reported wearing their seat belt less than "always" in their personal vehicles were more likely to be involved in a crash or convicted of a moving violation than drivers who always wore their seat belt in their personal vehicles. Drivers aged 43–51 who "often" wore their seat belt while driving their personal vehicles were 64.1 percent less likely to be involved in a total carrier crash than drivers aged 43–51 who always wore their seat belt while driving their personal vehicles.

Table 37. RR estimates and 95-percent CIs for personal vehicle seat belt use.

Safety Outcome and Age Quartile	Always	Often	Sometimes	Rarely	Never
Total Carrier: 20–33	1.00	1.443 (1.008,2.065)	1.377 (0.806,2.352)	0.373 (0.093,1.497)	0.361 (0.051,2.567)
Total Carrier: 34–42	1.00	1.532 (1.036,2.265)	1.348 (0.788,2.307)	1.882 (0.960,3.690)	0.690 (0.171,2.777)
Total Carrier: 43–51	1.00	0.359* (0.169,0.759)	0.741 (0.276,1.987)	0.258 (0.036,1.842)	3.35* (1.723,6.53)
Total Carrier: 52+	1.00	0.796 (0.393,1.611)	1.727 (0.815,3.659)	0 (0,Inf)	0.741 (0.104,5.286)
Carrier Preventable: 20–33	1.00	1.502 (0.924,2.443)	1.119 (0.495,2.527)	0.35 (0.049,2.502)	0 (0,Inf)
Carrier Preventable: 34–42	1.00	1.963* (1.199,3.215)	0.936 (0.384,2.285)	2.625* (1.147,6.009)	1.414 (0.349,5.726)
Carrier Preventable: 43–51	1.00	0.406 (0.150,1.096)	0.734 (0.182,2.966)	0 (0,Inf)	2.179 (0.693,6.858)
Carrier Preventable: 52+	1.00	0.752 (0.278,2.037)	0.465 (0.065,3.327)	0 (0,Inf)	1.414 (0.197,10.129)
National Crashes: 20–33	1.00	1.568 (0.972,2.529)	1.683 (0.825,3.432)	0.311 (0.044,2.227)	0.846 (0.118,6.048)
National Crashes: 34–42	1.00	0.985 (0.502,1.936)	0.939 (0.384,2.293)	2.693 (1.255,5.781)	0.709 (0.099,5.083)
National Crashes: 43–51	1.00	0.873 (0.428,1.778)	0.545 (0.135,2.204)	0.736 (0.103,5.270)	1.223 (0.303,4.935)

Safety Outcome and Age Quartile	Always	Often	Sometimes	Rarely	Never
National Crashes: 52+	1.00	1.082 (0.506,2.315)	1.531 (0.626,3.742)	2.302 (0.321,16.524)	0 (0,Inf)
Violations: 20–33	1.00	1.433 (0.968,2.121)	1.048 (0.518,2.122)	0.972 (0.400,2.360)	1.558 (0.499,4.867)
Violations: 34–42	1.00	1.890* (1.159,3.084)	0.723 (0.268,1.952)	3.073* (1.504,6.280)	2.891* (1.068,7.827)
Violations: 43–51	1.00	2.224* (1.341,3.688)	2.044 (0.900,4.639)	2.865 (0.908,9.043)	2.009 (0.640,6.31)
Violations: 52+	1.00	1.409 (0.689,2.880)	0.710 (0.175,2.871)	2.512 (0.349,18.084)	1.686 (0.236,12.064)

5.2.1.7 CMV Seat Belt Use

Table 38 shows the RR estimates and 95-percent CIs for CMV seat belt use (see Table 36 for drivers' self-reported seat belt use, by vehicle type). The comparison was drivers who indicated they "always" wore a seat belt while in a CMV. Significant RR estimates ($p < 0.05$) are denoted with an asterisk. Cells with "NA" indicate no driver was in the cell and/or no driver was in the reference cell; thus, no RR estimates could be calculated. Cells with a RR estimate of zero ("0") indicate that at least one driver was in the cell, but no crashes or violations were associated with that driver(s). There were three significant findings in Table 38. All three significant findings indicated that drivers who reported wearing their seat belt less frequently than "always" in a CMV were more likely to be involved in a crash or moving violation than drivers who always wore their seat belt in a CMV.

- Drivers aged 34–42 who "rarely" wore their seat belt while driving a CMV were 4.11 times more likely to be involved in a national crash than drivers aged 34–42 who always wore their seat belt while driving a CMV.
- Drivers aged 20–33 who "often" and "sometimes" wore their seat belt while driving a CMV were 2.61 times more likely to be convicted of a moving violation than drivers aged 20–33 who always wore their seat belt while driving a CMV.
- Drivers aged 43–51 who "often" wore their seat belt while driving a CMV were 2.81 times more likely to be convicted of a moving violation than drivers aged 43–51 who always wore their seat belt while driving a CMV.

Table 38. RR estimates and 95-percent CIs for CMV seat belt use.

Safety Outcome and Age Quartile	Always	Often	Sometimes	Rarely	Never
Total Carrier: 20–33	1.00	1.248 (0.644,2.42)	1.434 (0.592,3.470)	0 (0,Inf)	0 (0,Inf)
Total Carrier: 34–42	1.00	1.615 (0.859,3.037)	1.091 (0.350,3.403)	1.999 (0.826,4.839)	0 (0,Inf)
Total Carrier: 43–51	1.00	0.413 (0.154,1.107)	1.926 (0.858,4.3229)	0 (0,Inf)	1.337 (0.188,9.520)

Safety Outcome and Age Quartile	Always	Often	Sometimes	Rarely	Never
Total Carrier: 52+	1.00	1.110 (0.413,2.986)	1.010 (0.142,7.208)	2.797 (0.691,11.318)	NA
Carrier Preventable: 20–33	1.00	1.065 (0.395,2.872)	0.549 (0.077,3.922)	0 (0,Inf)	NA
Carrier Preventable: 34–42	1.00	2.868 (1.462,5.627)	0.710 (0.099,5.075)	0.764 (0.107,5.459)	NA
Carrier Preventable: 43–51	1.00	0.204 (0.029,1.456)	1.261 (0.312,5.088)	0 (0,Inf)	NA
Carrier Preventable: 52+	1.00	0.522 (0.073,3.739)	0 (0,Inf)	5.536 (1.355,22.628)	NA
National Crashes: 20–33	1.00	1.394 (0.571,3.401)	1.359 (0.337,5.483)	0 (0,Inf)	NA
National Crashes: 34–42	1.00	0 (0,Inf)	1.849 (0.590,5.80)	4.111* (1.523,11.096)	NA
National Crashes: 43–51	1.00	0.219 (0.031,1.564)	0.595 (0.083,4.254)	2.866 (0.401,20.474)	NA
National Crashes: 52+	1.00	1.706 (0.631,4.609)	1.018 (0.142,7.288)	0 (0,Inf)	NA
Violations: 20–33	1.00	1.796 (0.953,3.386)	2.606* (1.160,5.856)	0 (0,Inf)	NA
Violations: 34–42	1.00	1.967 (0.966,4.006)	2.865 (1.177,6.973)	0 (0,Inf)	NA
Violations: 43–51	1.00	2.805* (1.517,5.187)	0 (0,Inf)	0 (0,Inf)	NA
Violations: 52+	1.00	1.440 (0.459,4.523)	0 (0,Inf)	0 (0,Inf)	NA

5.2.1.8 Prior Crashes, Moving Violations, and OOS Violations

Table 39 shows the RR estimates and 95-percent CIs for self-reported crashes, moving violations, and OOS violations in the prior 3 years (see Table 8, Table 9, Table 10 for drivers' self-reported counts of crashes, moving violations, and OOS violations). The comparison was drivers who did not have a crash, moving violation, or OOS violation in the prior 3 years. Significant RR estimates ($p < 0.05$) are denoted with an asterisk. Cells with "NA" indicate no driver was in the cell and/or no driver was in the reference cell; thus, no RR estimates could be calculated. Cells with a RR estimate of zero ("0") indicate that at least one driver was in the cell, but no crashes or violations were associated with that driver(s). There were eight significant findings in Table 39:

- Drivers aged 34–42 with a moving violation in the last 3 years were 53.6 percent more likely to be involved in a carrier preventable crash than drivers aged 34–42 who did not have a moving violation in the prior 3 years.

- Drivers aged 20–33 with a moving violation in the last 3 years were 57.6 percent more likely to be involved in a national crash than drivers aged 20–33 who did not have a moving violation in the prior 3 years.
- Drivers aged 43–51 and over 52 with a moving violation in the last 3 years were 45.4 and 61.6 percent more likely to be convicted of a moving violation, respectively, than drivers aged 43–51 and over 52, respectively, who did not have a moving violation in the prior 3 years.
- Drivers over 52 with a crash in the last 3 years were 40.9, 58.1, and 49.7 percent more likely to be involved in a total carrier crash, carrier preventable crash, and national crash, respectively, than drivers over 52 who did not have a crash in the prior 3 years.
- Drivers aged 34–42 with an OOS violation were 87 percent more likely to be convicted of a moving violation compared to drivers aged 34–42 with no OOS violation in the last 3 years.

Table 39. RR estimates and 95-percent CIs for crashes, moving violations, and OOS violations in prior 3 years.

Safety Outcome and Age Quartile	No Moving Violation	Moving Violation	No Crash	Crash	No OOS Violation	OOS Violation
Total Carrier: 20–33	1.00	1.131 (0.901,1.421)	1.00	0.991 (0.782,1.255)	1.00	0.819 (0.521,1.285)
Total Carrier: 34–42	1.00	1.227 (0.968,1.556)	1.00	0.963 (0.743,1.249)	1.00	0.813 (0.522,1.267)
Total Carrier: 43–51	1.00	1.247 (0.986,1.577)	1.00	0.905 (0.697,1.174)	1.00	0.704 (0.432,1.147)
Total Carrier: 52+	1.00	1.185 (0.909,1.545)	1.00	1.409* (1.088,1.825)	1.00	1.086 (0.719,1.641)
Carrier Preventable: 20–33	1.00	1.217 (0.890,1.663)	1.00	0.893 (0.637,1.211)	1.00	0.956 (0.532,1.717)
Carrier Preventable: 34–42	1.00	1.536* (1.119,2.108)	1.00	0.958 (0.671,1.369)	1.00	0.971 (0.551,1.711)
Carrier Preventable: 43–51	1.00	1.314 (0.946,1.826)	1.00	0.945 (0.656,1.361)	1.00	0.747 (0.382,1.463)
Carrier Preventable: 52+	1.00	1.019 (0.697,1.489)	1.00	1.581* (1.114,2.243)	1.00	1.654 (1.018,2.686)
National Crashes: 20–33	1.00	1.576* (1.144,2.171)	1.00	1.225 (0.875,1.715)	1.00	1.684 (1.018,2.783)
National Crashes: 34–42	1.00	1.077 (0.767,1.512)	1.00	1.116 (0.774,1.620)	1.00	0.553 (0.260,1.180)
National Crashes: 43–51	1.00	0.930 (0.653,1.326)	1.00	1.054 (0.729,1.524)	1.00	0.837 (0.454,1.545)
National Crashes: 52+	1.00	1.261 (0.879,1.808)	1.00	1.497* (1.067,2.101)	1.00	0.832 (0.471,1.469)
Violations: 20–33	1.00	1.275 (0.981,1.656)	1.00	1.113 (0.847,1.463)	1.00	1.289 (0.825,2.014)
Violations: 34–42	1.00	1.131 (0.831,1.541)	1.00	0.872 (0.604,1.258)	1.00	1.870* (1.218,2.873)

Safety Outcome and Age Quartile	No Moving Violation	Moving Violation	No Crash	Crash	No OOS Violation	OOS Violation
Violations: 43–51	1.00	1.454* (1.048,2.017)	1.00	0.747 (0.494,1.129)	1.00	1.544 (0.944,2.524)
Violations: 52+	1.00	1.616* (1.136,2.299)	1.00	1.186 (0.821,1.712)	1.00	0.627 (0.319,1.232)

5.2.1.9 Self-Reported Diet

Table 40 provides drivers' self-reported diet responses.

Table 40. Drivers' self-reported diet.

Diet	N	Percent
Poor	704	6.26%
Below Average	1,977	17.57%
Average	6,817	60.57%
Above Average	1,373	12.20%
Excellent	383	3.40%
Total	**11,254**	**100%**

Table 41 shows the RR estimates and 95-percent CIs for drivers' self-reported diet. The comparison was drivers who reported an "average" diet. Significant RR estimates ($p < 0.05$) are denoted with an asterisk. Cells with "NA" indicate no driver was in the cell and/or no driver was in the reference cell; thus, no RR estimates could be calculated. Cells with a RR estimate of zero ("0") indicate that at least one driver was in the cell, but no crashes or violations were associated with that driver(s). There were four significant findings in Table 41.

- Drivers aged 43–51 with below average and above average self-reported diets were 83.3 percent and 74.8 percent, respectively, more likely to be involved in a carrier preventable crash compared to drivers aged 43–51 with average self-reported diets.

- Drivers aged 20–33 with poor self-reported diets were 55 percent and 60.7 percent less likely to be involved in a carrier preventable crash and national crash, respectively, compared to drivers aged 20–33 with self-reported average diets.

Table 41. RR estimates and 95-percent CIs for drivers' self-reported diet.

Safety Outcome and Age Quartile	Average	Poor	Below Average	Above Average	Excellent
Total Carrier: 20–33	1.00	0.630 (0.403,0.986)	1.122 (0.854,1.473)	0.849 (0.590,1.222)	1.317 (0.801,2.166)
Total Carrier: 34–42	1.00	1.431 (0.930,2.203)	1.157 (0.864,1.55)	1.289 (0.916,1.814)	1.124 (0.623,2.030)
Total Carrier: 43–51	1.00	0.928 (0.560,1.539)	1.362 (1.026,1.807)	1.248 (0.921,1.692)	1.101 (0.564,2.149)
Total Carrier: 52+	1.00	0.901 (0.370,2.197)	1.020 (0.734,1.418)	0.804 (0.561,1.153)	1.078 (0.505,2.304)

Safety Outcome and Age Quartile	Average	Poor	Below Average	Above Average	Excellent
Carrier Preventable: 20–33	1.00	0.450* (0.217,0.934)	1.384 (0.967,1.981)	1.080 (0.674,1.731)	1.446 (0.728,2.872)
Carrier Preventable: 34–42	1.00	1.299 (0.695,2.430)	1.110 (0.739,1.669)	1.33 (0.849,2.083)	0.795 (0.322,1.967)
Carrier Preventable: 43–51	1.00	0.882 (0.404,1.929)	1.833* (1.246,2.696)	1.748* (1.170,2.612)	1.370 (0.556,3.377)
Carrier Preventable: 52+	1.00	1.08 (0.340,3.417)	1.019 (0.640,1.622)	0.885 (0.543,1.441)	1.540 (0.622,3.816)
National Crashes: 20–33	1.00	0.393* (0.189,0.816)	0.736 (0.482,1.123)	0.762 (0.436,1.332)	1.241 (0.602,2.558)
National Crashes: 34–42	1.00	0.474 (0.206,1.094)	0.566 (0.350,0.915)	0.793 (0.475,1.323)	0.915 (0.399,2.097)
National Crashes: 43–51	1.00	1.419 (0.787,2.561)	1.237 (0.824,1.856)	1.380 (0.903,2.109)	1.060 (0.430,2.612)
National Crashes: 52+	1.00	0.470 (0.114,1.915)	1.134 (0.733,1.753)	0.770 (0.476,1.248)	1.198 (0.555,2.587)
Violations: 20–33	1.00	0.922 (0.598,1.423)	1.049 (0.768,1.431)	0.931 (0.614,1.411)	0.601 (0.265,1.360)
Violations: 34–42	1.00	1.291 (0.713,2.340)	1.14 (0.766,1.697)	0.913 (0.566,1.474)	2.070 (1.195,3.585)
Violations: 43–51	1.00	1.931 (1.124,3.317)	1.039 (0.665,1.624)	1.006 (0.626,1.618)	1.815 (0.913,3.605)
Violations: 52+	1.00	2.113 (0.97,4.603)	1.364 (0.882,2.109)	0.747 (0.444,1.258)	1.459 (0.705,3.017)

5.2.1.10 Caffeine Consumption

Table 42 summarizes drivers' self-reported caffeine consumption.

Table 42. Drivers' self-reported caffeine consumption.

Caffeine per day	Number	Percent
0 drinks	26	0.35%
1 drink	1,646	22.40%
2 drinks	2,433	33.11%
3 drinks	1,223	16.64%
4 drinks	668	9.09%
5 drinks	475	6.46%
6+ drinks	877	11.94%
Total	**7,348**	**100%**

Table 43 shows the RR estimates and 95-percent CIs for daily caffeine consumption. The comparison was drivers who reported no daily caffeine consumption. Significant RR estimates ($p < 0.05$) are denoted with an asterisk. Cells with "NA" indicate no driver was in the cell and/or no driver was in the reference cell; thus, no RR estimates could be calculated. Cells with a RR estimate of zero ("0") indicate that at least one driver was in the cell, but no crashes or violations

were associated with that driver. Moderate daily caffeine was defined as one to three daily caffeinated drinks and excessive daily caffeine was defined as four or more daily caffeinated drinks. There were no significant findings in Table 43.

Table 43. RR estimates and 95-percent CIs for daily caffeine consumption.

Safety Outcome and Age Quartile	No Daily Caffeine	Moderate Daily Caffeine	Excessive Daily Caffeine
Total Carrier: 20–33	1.00	0.856 (0.674,1.086)	0.868 (0.632,1.193)
Total Carrier: 34–42	1.00	0.984 (0.748,1.296)	1.181 (0.858,1.625)
Total Carrier: 43–51	1.00	0.863 (0.663,1.123)	0.960 (0.698,1.322)
Total Carrier: 52+	1.00	1.128 (0.813,1.564)	1.054 (0.712,1.561)
Carrier Preventable: 20–33	1.00	1.085 (0.778,1.515)	0.905 (0.571,1.434)
Carrier Preventable: 34–42	1.00	0.892 (0.616,1.291)	0.947 (0.604,1.484)
Carrier Preventable: 43–51	1.00	0.662 (0.458,0.956)	0.931 (0.608,1.427)
Carrier Preventable: 52+	1.00	1.314 (0.827,2.090)	0.976 (0.547,1.741)
National Crashes: 20–33	1.00	1.261 (0.891,1.784)	1.047 (0.650,1.684)
National Crashes: 34–42	1.00	0.970 (0.667,1.412)	0.970 (0.601,1.566)
National Crashes: 43–51	1.00	0.754 (0.520,1.092)	0.808 (0.501,1.302)
National Crashes: 52+	1.00	1.077 (0.723,1.602)	0.752 (0.444,1.274)
Violations: 20–33	1.00	1.033 (0.787,1.356)	0.783 (0.526,1.164)
Violations: 34–42	1.00	0.902 (0.648,1.257)	0.827 (0.532,1.285)
Violations: 43–51	1.00	0.683 (0.475,0.982)	0.757 (0.475,1.205)
Violations: 52+	1.00	0.899 (0.608,1.330)	0.712 (0.424,1.194)

5.2.1.11 Self-Reported Exercise

Table 44 shows drivers' self-reported exercise per week.

Table 44. Drivers' self-reported weekly exercise.

Exercise per week	Number	Percent
0 times	3,161	28.63%
1 time	777	7.04%
2 times	1,870	16.94%

Exercise per week	Number	Percent
3 times	2,349	21.28%
4 times	1,177	10.66%
5 times	887	8.04%
6 times	219	1.99%
7 times	305	2.76%
7+ times	294	2.66%
Total	**11,039**	**100%**

Table 45 shows the RR estimates and 95-percent CIs for self-reported exercise. The comparison was drivers who reported "no exercise." Significant RR estimates ($p < 0.05$) are denoted with an asterisk. Cells with "NA" indicate no driver was in the cell and/or no driver was in the reference cell; thus, no RR estimates could be calculated. Cells with a RR estimate of zero ("0") indicate that at least one driver was in the cell, but no crashes or violations were associated with that driver(s). Moderate exercise was defined as one to three times per week and substantial exercise was defined as four or more times per week. There were two significant findings in Table 45. Drivers over 52 with moderate and substantial exercise were 92.6 and 48.8 percent more likely, respectively, to be convicted of a moving violation than drivers over 52 with no exercise.

Table 45. RR estimates and 95-percent CIs for exercise.

Safety Outcome and Age Quartile	No	Moderate Exercise	Substantial Exercise
Total Carrier: 20–33	1.00	1.147 (0.889,1.480)	1.10 (0.826,1.464)
Total Carrier: 34–42	1.00	0.927 (0.720,1.195)	0.904 (0.669,1.220)
Total Carrier: 43–51	1.00	0.876 (0.675,1.136)	0.973 (0.727,1.302)
Total Carrier: 52+	1.00	0.986 (0.739,1.315)	1.070 (0.772,1.481)
Carrier Preventable: 20–33	1.00	1.057 (0.748,1.492)	0.907 (0.608,1.353)
Carrier Preventable: 34–42	1.00	0.927 (0.652,1.318)	0.946 (0.628,1.424)
Carrier Preventable: 43–51	1.00	0.834 (0.579,1.201)	0.970 (0.647,1.456)
Carrier Preventable: 52+	1.00	1.182 (0.775,1.802)	1.479 (0.937,2.333)
National Crashes: 20–33	1.00	1.243 (0.859,1.799)	0.990 (0.647,1.513)
National Crashes: 34–42	1.00	1.395 (0.943,2.063)	1.237 (0.792,1.932)
National Crashes: 43–51	1.00	1.187 (0.806,1.748)	1.495 (0.978,2.284)
National Crashes: 52+	1.00	1.042 (0.699,1.552)	1.306 (0.847,2.015)

Safety Outcome and Age Quartile	No	Moderate Exercise	Substantial Exercise
Violations: 20–33	1.00	0.841 (0.622,1.138)	1.280 (0.943,1.738)
Violations: 34–42	1.00	1.285 (0.902,1.830)	0.990 (0.655,1.498)
Violations: 43–51	1.00	1.154 (0.784,1.70)	1.147 (0.7351.790)
Violations: 52+	1.00	1.926* (1.227,3.02)	1.488* (0.886,2.501)

5.2.1.12 Tobacco and Alcohol Use

Table 46 shows drivers' self-reported tobacco and alcohol use.

Table 46. Drivers' self-reported tobacco and alcohol use.

Category	Number	Percent
Use Tobacco Products	**#**	**%**
Yes	7,181	63.26%
No	4,171	36.74%
Subtotal	**11,352***	**100%**
Alcoholic Drinks per Week	**#**	**%**
0 drinks	7,740	69.55%
1 drink	3,350	30.10%
2 drinks	39	0.35%
Subtotal	**11,129**	**100%**

Table 47 shows the RR estimates and 95-percent CIs for tobacco and weekly alcohol use. The comparison was drivers who reported no tobacco use or no alcohol use. Significant RR estimates ($p < 0.05$) are denoted with an asterisk. Cells with "NA" indicate no driver was in the cell and/or no driver was in the reference cell; thus, no RR estimates could be calculated. Cells with a RR estimate of zero ("0") indicate that at least one driver was in the cell, but no crashes or violations were associated with that driver(s). Moderate alcohol was defined as one alcoholic drink per week and substantial alcohol was defined as two alcoholic drinks per week. There were four significant findings in Table 47:

- Drivers over 52 who used tobacco were 32.7 percent and 30.2 percent less likely to be involved in a national crash or convicted of a moving violation, respectively, than drivers over 52 who did not use tobacco.
- Drivers aged 20–33 who consumed two alcoholic drinks per week were 43.2 percent less likely to be involved in a total carrier crash compared to drivers aged 20–33 who did not consume any alcoholic drinks.
- Drivers aged 43–51 who consumed one alcoholic drink per week were 44.1 percent less likely to be convicted of a moving violation compared to drivers aged 43–51 who did not consume any alcoholic drinks.

Table 47. RR estimates and 95-percent CIs for tobacco and alcohol use.

Safety Outcome and Age Quartile	No Tobacco	Tobacco	No Alcohol	1 Alcoholic Drink/Week	2 Alcoholic Drinks/Week
Total Carrier: 20–33	1.00	0.929 (0.749,1.154)	1.00	1.162 (0.919,1.468)	0.568* (0.370,0.872)
Total Carrier: 34–42	1.00	1.062 (0.850,1.327)	1.00	1.006 (0.771,1.313)	1.098 (0.774,1.559)
Total Carrier: 43–51	1.00	0.988 (0.787,1.240)	1.00	1.00 (0.756,1.322)	0.754 (0.516,1.102)
Total Carrier: 52+	1.00	1.102 (0.856,1.420)	1.00	1.126 (0.835,1.518)	0.802 (0.524,1.226)
Carrier Preventable: 20–33	1.00	0.773 (0.567,1.054)	1.00	1.178 (0.854,1.629)	0.714 (0.417,1.222)
Carrier Preventable: 34–42	1.00	1.134 (0.837,1.537)	1.00	1.038 (0.725,1.486)	0.879 (0.520,1.485)
Carrier Preventable: 43–51	1.00	0.899 (0.648,1.247)	1.00	1.068 (0.726,1.571)	0.756 (0.442,1.294)
Carrier Preventable: 52+	1.00	0.98 (0.686,1.40)	1.00	0.838 (0.533,1.318)	0.787 (0.442,1.402)
National Crashes: 20–33	1.00	0.791 (0.579,1.079)	1.00	1.174 (0.821,1.679)	1.333 (0.855,2.076)
National Crashes: 34–42	1.00	0.802 (0.5809,1.1083)	1.00	0.770 (0.512,1.157)	0.999 (0.608,1.643)
National Crashes: 43–51	1.00	1.084 (0.791,1.485)	1.00	1.388 (0.954,2.022)	1.186 (0.737,1.909)
National Crashes: 52+	1.00	0.673* (0.471,0.960)	1.00	1.377 (0.944,2.010)	0.926 (0.540,1.591)
Violations: 20–33	1.00	1.008 (0.794,1.280)	1.00	1.076 (0.806,1.435)	1.150 (0.796,1.662)
Violations: 34–42	1.00	0.999 (0.748,1.335)	1.00	0.751 (0.510,1.106)	1.198 (0.781,1.837)
Violations: 43–51	1.00	1.287 (0.942,1.760)	1.00	0.559* (0.337,0.927)	0.8017 (0.477,1.3473)
Violations: 52+	1.00	0.698* (0.489,0.998)	1.00	0.982 (0.634,1.521)	1.0916 (0.6531,1.8244)

5.2.1.13 Sleep Schedule

Table 48 provides drivers' self-reported sleep schedules.

Table 48. Drivers' self-reported sleep schedules.

Regular Sleep Schedule	Number	Percent
Yes	1,343	12.55%
Sometimes	5,669	52.98%
No	3,688	34.47%
Total	**11,172**	**100%**

Table 49 shows the RR estimates and 95-percent CIs for regular sleep schedule. The comparison was drivers who reported no regular sleep schedule. Significant RR estimates ($p < 0.05$) are denoted with an asterisk. Cells with "NA" indicate no driver was in the cell and/or no driver was in the reference cell; thus, no RR estimates could be calculated. Cells with a RR estimate of zero ("0") indicate that at least one driver was in the cell, but no crashes or violations were associated with that driver(s). There were no significant findings in Table 49.

Table 49. RR estimates and 95-percent CIs for regular sleep schedule.

Safety Outcome and Age Quartile	No	Yes	Sometimes
Total Carrier: 20–33	1.00	0.805 (0.578,1.122)	0.804 (0.573,1.127)
Total Carrier: 34–42	1.00	1.222 (0.837,1.786)	1.287 (0.870,1.905)
Total Carrier: 43–51	1.00	1.04 (0.734,1.486)	1.346 (0.936,1.935)
Total Carrier: 52+	1.00	0.844 (0.599,1.19)	0.785 (0.535,1.152)
Carrier Preventable: 20–33	1.00	1.023 (0.629,1.662)	0.903 (0.548,1.489)
Carrier Preventable: 34–42	1.00	1.388 (0.787,2.447)	1.710 (0.960,3.044)
Carrier Preventable: 43–51	1.00	1.105 (0.664,1.841)	1.393 (0.824,2.356)
Carrier Preventable: 52+	1.00	1.201 (0.702,2.056)	1.124 (0.626,2.018)
National Crashes: 20–33	1.00	0.884 (0.557,1.405)	0.745 (0.460,1.207)
National Crashes: 34–42	1.00	1.369 (0.777,2.413)	1.360 (0.753,2.456)
National Crashes: 43–51	1.00	0.937 (0.580,1.514)	1.097 (0.667,1.804)
National Crashes: 52+	1.00	0.839 (0.519,1.355)	1.002 (0.60,1.675)
Violations: 20–33	1.00	0.841 (0.573,1.234)	0.998 (0.681,1.462)
Violations: 34–42	1.00	1.405 (0.842,2.345)	1.130 (0.653,1.954)
Violations: 43–51	1.00	1.017 (0.618,1.674)	1.012 (0.597,1.715)
Violations: 52+	1.00	1.384 (0.788,2.429)	1.056 (0.568,1.964)

5.2.1.14 Napping During the Day

Table 50 summarizes drivers' self-reports of napping habits.

Table 50. Drivers' self-reported napping.

Nap during the day	Number	Percent
Yes	8,100	72.5%
No	3,072	27.5%
Total	**11,172**	**100%**

Table 51 shows the RR estimates and 95-percent CIs for napping during the day. The comparison was drivers who reported no nap during the day. Significant RR estimates ($p < 0.05$) are denoted with an asterisk. Cells with "NA" indicate no driver was in the cell and/or no driver was in the reference cell; thus, no RR estimates could be calculated. Cells with a RR estimate of zero ("0") indicate that at least one driver was in the cell, but no crashes or violations were associated with that driver(s). There were three significant findings in Table 51:

- Drivers aged 34–42 who reported a nap during the day were 38.5 percent times more likely to be in a carrier preventable crash than drivers aged 34–42 who did not take a nap during the day.
- Drivers aged 43–51 who reported a nap during the day were 29.6 percent less likely to be in a total carrier crash than drivers aged 43–51 who did not take a nap during the day.
- Drivers over 52 who reported a nap during the day were 52.3 percent more likely to be convicted of a moving violation than drivers over 52 who did not take a nap during the day.

Table 51. RR estimates and 95-percent CIs for nap during the day.

Safety Outcome and Age Quartile	No Nap During the Day	Nap During the Day
Total Carrier: 20–33	1.00	1.069 (0.850,1.343)
Total Carrier: 34–42	1.00	1.204 (0.948,1.529)
Total Carrier: 43–51	1.00	0.704* (0.54,0.918)
Total Carrier: 52+	1.00	1.090 (0.834,1.425)
Carrier Preventable: 20–33	1.00	1.067 (0.777,1.467)
Carrier Preventable: 34–42	1.00	1.385* (1.008,1.903)
Carrier Preventable: 43–51	1.00	0.816 (0.57,1.167)
Carrier Preventable: 52+	1.00	1.167 (0.809,1.683)
National Crashes: 20–33	1.00	0.861 (0.605,1.225)
National Crashes: 34–42	1.00	1.159 (0.826,1.626)

Safety Outcome and Age Quartile	No Nap During the Day	Nap During the Day
National Crashes: 43–51	1.00	1.197 (0.863,1.66)
National Crashes: 52+	1.00	1.266 (0.901,1.780)
Violations: 20–33	1.00	1.129 (0.869,1.468)
Violations: 34–42	1.00	0.993 (0.719,1.370)
Violations: 43–51	1.00	0.809 (0.562,1.164)
Violations: 52+	1.00	1.523* (1.081,2.145)

5.2.1.15 Epworth Sleepiness Scale

Table 52 shows the results from drivers' responses to the ESS. See sections 2.3.2 and 5.1.8 of this report for more information on the ESS.

Table 52. Results from drivers' responses to the ESS.

Daytime Sleepiness	Number	Percent
Lower Normal	6,883	60%
Higher Normal	3,536	31%
Mild Excessive	536	5%
Moderate Excessive	350	3%
Severe Excessive	107	1%
Total	**11,412**	**100%**

Table 53 shows the RR estimates and 95-percent CIs for the ESS. The comparison was drivers who scored "lower normal" on the ESS. Significant RR estimates ($p < 0.05$) are denoted with an asterisk. Cells with "NA" indicate no driver was in the cell and/or no driver was in the reference cell; thus, no RR estimates could be calculated. Cells with a RR estimate of zero ("0") indicate that at least one driver was in the cell, but no crashes or violations were associated with that driver(s). There were four significant findings in Table 53:

- Drivers aged 20–33 who scored moderate excessive on the ESS were 66.9 percent less likely to be involved in a total carrier crash compared to drivers aged 20–33 that scored lower normal on the ESS.
- Drivers aged 20–33 who scored higher normal on the ESS were 51.9 percent less likely to be convicted of a moving violation compared to drivers aged 20–33 that scored lower normal on the ESS.
- Drivers aged 43–51 who scored mild excessive on the ESS were 83.7 percent more likely to be involved in a national crash compared to drivers aged 43–51 that scored lower normal on the ESS.

- Drivers over 52 who scored severe excessive on the ESS were 3.53 times more likely to be convicted of a moving violation compared to drivers over 52 that scored lower normal on the ESS.

Table 53. RR estimates and 95-percent CIs for ESS groupings.

Safety Outcome and Age Quartile	Lower Normal	Higher Normal	Mild Excessive	Moderate Excessive	Severe Excessive
Total Carrier: 20–33	1.00	1.133 (0.913,1.407)	1.203 (0.743,1.949)	0.331* (0.123,0.889)	1.452 (0.596,3.539)
Total Carrier: 34–42	1.00	0.873 (0.685,1.112)	1.455 (0.874,2.423)	1.185 (0.607,2.314)	1.222 (0.501,2.984)
Total Carrier: 43–51	1.00	0.882 (0.694,1.122)	0.894 (0.530,1.508)	1.196 (0.669,2.139)	0.873 (0.279,2.728)
Total Carrier: 52+	1.00	1.264 (0.985,1.621)	0.817 (0.431,1.548)	0.869 (0.356,2.122)	0.833 (0.206,3.365)
Carrier Preventable: 20–33	1.00	1.090 (0.801,1.483)	1.728 (0.970,3.077)	0.657 (0.242,1.783)	2.349 (0.860,6.423)
Carrier Preventable: 34–42	1.00	0.913 (0.657,1.269)	1.763 (0.920,3.376)	0.982 (0.361,2.667)	1.299 (0.409,4.121)
Carrier Preventable: 43–51	1.00	1.120 (0.805,1.556)	1.055 (0.513,2.169)	2.210 (1.153,4.236)	0.642 (0.090,4.607)
Carrier Preventable: 52+	1.00	1.251 (0.885,1.768)	0.943 (0.411,2.163)	1.009 (0.318,3.205)	0.798 (0.111,5.743)
National Crashes: 20–33	1.00	1.1023 (0.805,1.511)	0.8201 (0.360,1.87)	0.724 (0.295,1.776)	0 (0,Inf)
National Crashes: 34–42	1.00	0.974 (0.698,1.359)	0.921 (0.428,1.981)	0.440 (0.109,1.785)	0.521 (0.073,3.737)
National Crashes: 43–51	1.00	1.053 (0.756,1.466)	1.837* (1.05,3.210)	0.168 (0.024,1.205)	0 (0,Inf)
National Crashes: 52+	1.00	1.069 (0.754,1.514)	1.284 (0.648,2.545)	1.048 (0.332,3.309)	2.396 (0.974,5.895)
Violations: 20–33	1.00	0.589* (0.442,0.785)	0.507 (0.239,1.079)	0.848 (0.462,1.567)	0.983 (0.314,3.083)
Violations: 34–42	1.00	0.920 (0.672,1.261)	0.807 (0.377,1.730)	0.729 (0.269,1.975)	1.276 (0.405,4.019)
Violations: 43–51	1.00	1.242 (0.893,1.725)	1.143 (0.555,2.3538)	0.732 (0.269,1.990)	2.795 (0.885,8.826)
Violations: 52+	1.00	0.849 (0.579,1.245)	1.472 (0.766,2.829)	1.728 (0.702,4.256)	3.533* (1.637,7.626)

5.2.1.16 Berlin Questionnaire

Table 54 shows the results from drivers' responses on the BQ. See sections 2.3.3 and 5.1.9 of this report for more information about the BQ.

Table 54. Results from drivers' responses on the BQ.

BQ Score	Number	Percent
High Risk	1,948	18.6%
Low Risk	8,543	81.4%
Total	**10,491**	**100%**

Table 55 shows the RR estimates and 95-percent CIs for the BQ. The comparison was drivers who scored low risk for OSA on the BQ. Significant RR estimates ($p < 0.05$) are denoted with an asterisk. Cells with "NA" indicate no driver was in the cell and/or no driver was in the reference cell; thus, no RR estimates could be calculated. Cells with a RR estimate of zero ("0") indicate that at least one driver was in the cell, but no crashes or violations were associated with that driver(s). There were no significant findings in Table 55.

Table 55. RR estimates and 95-percent CIs for the BQ.

Safety Outcome and Age Quartile	Low Risk for OSA	High Risk for OSA
Total Carrier: 20–33	1.00	0.994 (0.747,1.325)
Total Carrier: 34–42	1.00	1.066 (0.816,1.391)
Total Carrier: 43–51	1.00	1.115 (0.863,1.443)
Total Carrier: 52+	1.00	1.236 (0.941,1.624)
Carrier Preventable: 20–33	1.00	0.985 (0.663,1.463)
Carrier Preventable: 34–42	1.00	1.028 (0.706,1.498)
Carrier Preventable: 43–51	1.00	1.106 (0.768,1.593)
Carrier Preventable: 52+	1.00	1.122 (0.764,1.650)
National Crashes: 20–33	1.00	0.901 (0.604,1.343)
National Crashes: 34–42	1.00	0.842 (0.566,1.251)
National Crashes: 43–51	1.00	0.859 (0.588,1.256)
National Crashes: 52+	1.00	1.236 (0.854,1.790)
Violations: 20–33	1.00	1.103 (0.813,1.498)
Violations: 34–42	1.00	1.001 (0.691,1.452)
Violations: 43–51	1.00	0.889 (0.599,1.320)
Violations: 52+	1.00	1.189 (0.804,1.759)

5.2.1.17 Survey of Recent Life Experiences

Table 56 shows overall mean and subscale means on the SRLE. Higher scores indicate greater stress. See sections 2.3.4 and 5.1.10 of this report for more details about the SRLE.

Table 56. Subscale results on the SRLE.

SRLE Subscales	Mean	Subscale Range
Social and Cultural	16.2	11–44
Work	11.1	7–28
Time Pressure	14.3	8–32
Finances	11.1	6–24
Social Acceptability	7.8	5–20
Social Victimization	6.9	4–16

Table 57 shows the RR estimates and 95-percent CIs for each subscale on the SRLEs. Significant RR estimates ($p < 0.05$) are denoted with an asterisk. Cells with "NA" indicate no driver was in the cell and/or no driver was in the reference cell; thus, no RR estimates could be calculated. Cells with a RR estimate of zero ("0") indicate that at least one driver was in the cell, but no crashes or violations were associated with that driver(s). There were 11 significant findings in Table 57:

- Drivers aged 43–51 were:
  - 6.4 percent less likely to be involved in a national crash for each one point on the work subscale on the SRLE.
  - 4.5 percent less likely to be involved in a national crash for each one point on the time pressure subscale on the SRLE.
  - 7.6 percent less likely to be involved in a national crash for each one point on the social victimization subscale on the SRLE.
  - 5.9 percent less likely to be involved in a national crash for each one point on the social and cultural subscale on the SRLE.
  - 9 percent less likely to be involved in a national crash for each one point on the social acceptability subscale on the SRLE.
  - 5.4 percent less likely to be involved a national crash for each one point increase on the finances subscale on the SRLE.
- Drivers over 52 were:
  - 3.9 percent more likely to be involved in a national crash for each one point increase on the time pressure subscale on the SRLE.
  - 7.1 percent more likely to be involved in a national crash for each one point increase on the social victimization subscale on the SRLE.
  - 3.8 percent more likely to be involved in a national crash for each one point increase on the social and cultural subscale on the SRLE.
- Drivers 20–33 were:

– 2.9 percent more likely to be convicted of a moving violation for each one point increase on the time pressure subscale on the SRLE.
– 4.5 percent more likely to be convicted of a moving violation for each one point increase on the social victimization subscale on the SRLE.

Table 57. RR estimates and 95-percent CIs for the SRLE.

Safety Outcome and Age Quartile	Work	Time Pressure	Social Victimization	Social and Cultural	Social Acceptability	Finances
Total Carrier: 20–33	1.012 (0.984,1.042)	1.000 (0.977,1.023)	1.00 (0.962,1.040)	1.003 (0.980,1.027)	1.020 (0.985,1.056)	1.014 (0.988,1.041)
Total Carrier: 34–42	0.996 (0.966,1.026)	0.990 (0.966,1.015)	0.997 (0.955,1.042)	1.003 (0.977,1.028)	1.016 (0.976,1.056)	1.011 (0.983,1.039)
Total Carrier: 43–51	0.99 (0.960,1.021)	1.002 (0.978,1.028)	1.013 (0.970,1.057)	0.998 (0.974,1.022)	1.004 (0.963,1.047)	1.011 (0.983,1.040)
Total Carrier: 52+	1.002 (0.971,1.035)	0.998 (0.971,1.026)	1.000 (0.953,1.050)	1.003 (0.977,1.029)	0.990 (0.945,1.037)	1.013 (0.981,1.047)
Carrier Preventable: 20–33	1.00 (0.96,1.042)	0.981 (0.950,1.013)	0.968 (0.915,1.024)	0.996 (0.965,1.029)	1.012 (0.963,1.063)	0.993 (0.957,1.031)
Carrier Preventable: 34–42	0.980 (0.939,1.022)	0.989 (0.956,1.023)	1.005 (0.947,1.066)	1.006 (0.972,1.042)	1.005 (0.951,1.062)	1.012 (0.974,1.051)
Carrier Preventable: 43–51	0.980 (0.937,1.025)	0.998 (0.963,1.034)	1.018 (0.958,1.082)	0.993 (0.958,1.029)	1.002 (0.944,1.065)	1.010 (0.970,1.052)
Carrier Preventable: 52+	0.989 (0.945,1.035)	0.994 (0.957,1.034)	1.001 (0.936,1.070)	0.988 (0.952,1.026)	0.960 (0.899,1.026)	1.00 (0.955,1.046)
National Crashes: 20–33	0.992 (0.952,1.035)	0.999 (0.967,1.032)	1.004 (0.951,1.060)	0.992 (0.960,1.025)	1.001 (0.950,1.054)	0.990 (0.953,1.027)
National Crashes: 34–42	0.987 (0.946,1.031)	1.002 (0.968,1.037)	1.036 (0.977,1.099)	0.995 (0.961,1.031)	1.038 (0.983,1.096)	1.004 (0.964,1.045)
National Crashes: 43–51	0.936* (0.894,0.979)	0.955* (0.921,0.989)	0.924* (0.867,0.985)	0.941* (0.906,0.977)	0.910* (0.853,0.971)	0.946* (0.907,0.988)
National Crashes: 52+	1.034 (0.993,1.077)	1.039* (1.003,1.076)	1.071* (1.010,1.136)	1.038* (1.007,1.071)	1.044 (0.986,1.106)	1.031 (0.989,1.075)
Violations: 20–33	0.997 (0.965,1.031)	1.029* (1.004,1.055)	1.045* (1.003,1.089)	1.021 (0.996,1.046)	1.003 (0.962,1.045)	1.019 (0.990,1.049)
Violations: 34–42	0.991 (0.953,1.030)	0.997 (0.966,1.029)	0.961 (0.906,1.019)	0.982 (0.950,1.016)	1.014 (0.961,1.069)	1.001 (0.965,1.039)
Violations: 43–51	0.992 (0.951,1.035)	0.996 (0.963,1.031)	1.002 (0.945,1.063)	1.01 (0.979,1.042)	1.001 (0.945,1.060)	0.999 (0.960,1.040)
Violations: 52+	1.005 (0.960,1.052)	1.000 (0.962,1.040)	1.011 (0.946,1.080)	1.022 (0.988,1.057)	1.012 (0.951,1.078)	1.021 (0.976,1.067)

5.2.1.18 Dula Dangerous Driving Index

Table 58 shows mean scores by gender on the DDDI. Higher scores indicate a greater tendency to drive dangerously. For more details about the DDDI, refer to sections 2.3.5 and 5.1.11 of this report.

Table 58. Mean scores by gender on the DDDI.

DDDI Scales	Males	Females
Total Score	40.66	39.05
Aggressive Driving	8.93	8.49
Negative Emotion	17.03	16.53
Risky Driving	14.70	14.03

Table 59 shows the RR estimates and 95-percent CIs for each subscale on the DDDI. Significant RR estimates ($p < 0.05$) are denoted with an asterisk. Cells with "NA" indicate no driver was in the cell and/or no driver was in the reference cell; thus, no RR estimates could be calculated. Cells with a RR estimate of zero ("0") indicate that at least one driver was in the cell, but no crashes or violations were associated with that driver(s). There were four significant findings in Table 59:

- Drivers aged 34–42 were 5.4 percent more likely to be convicted of a moving violation for each one point increase on the aggressive driving subscale on the DDDI.
- Drivers aged 34–42 were 4.6 percent more likely to be convicted of a moving violation for each one point increase on risky driving subscale on the DDDI.
- Drivers over 52 were 5.9 percent more likely to be convicted of a moving violation for each one point increase on the risky driving subscales on the DDDI.
- Drivers over 52 were 4.3 percent more likely to have a total carrier crash for each one point increase on the aggressive driving subscales on the DDDI.

Table 59. RR estimates and 95-percent CIs for the DDDI.

Safety Outcome and Age Quartile	Aggressive Driving	Risky Driving	Negative Emotion
Total Carrier: 20–33	1.014 (0.979,1.050)	1.013 (0.986,1.041)	1.002 (0.982,1.021)
Total Carrier: 34–42	1.015 (0.976,1.054)	1.020 (0.991,1.051)	1.011 (0.990,1.032)
Total Carrier: 43–51	1.007 (0.968,1.048)	0.999 (0.968,1.031)	1.011 (0.990,1.032)
Total Carrier: 52+	1.043* (1.002,1.085)	1.022 (0.984,1.062)	1.006 (0.980,1.031)
Carrier Preventable: 20–33	1.033 (0.987,1.081)	1.026 (0.990,1.063)	0.999 (0.973,1.021)
Carrier Preventable: 34–42	0.983 (0.927,1.042)	1.009 (0.968,1.052)	1.017 (0.982,1.026)
Carrier Preventable: 43–51	0.974 (0.916,1.036)	0.976 (0.928,1.026)	0.996 (0.967,1.027)
Carrier Preventable: 52+	1.030 (0.973,1.091)	1.023 (0.970,1.078)	0.997 (0.963,1.033)
National Crashes: 20–33	1.010 (0.961,1.061)	1.017 (0.981,1.053)	0.993 (0.967,1.020)

Safety Outcome and Age Quartile	Aggressive Driving	Risky Driving	Negative Emotion
National Crashes: 34–42	0.979 (0.920,1.041)	0.992 (0.946,1.041)	0.978 (0.949,1.009)
National Crashes: 43–51	0.977 (0.920,1.037)	0.956 (0.904,1.012)	0.999 (0.969,1.030)
National Crashes: 52+	1.032 (0.979,1.088)	0.993 (0.945,1.045)	1.003 (0.970,1.036)
Violations: 20–33	0.988 (0.947,1.030)	1.015 (0.987,1.044)	1.007 (0.987,1.028)
Violations: 34–42	1.054* (1.009,1.102)	1.046* (1.011,1.082)	1.012 (0.985,1.040)
Violations: 43–51	0.949 (0.888,1.015)	0.987 (0.940,1.037)	0.999 (0.969,1.031)
Violations: 52+	1.038 (0.982,1.097)	1.059* (1.028,1.091)	0.989 (0.955,1.025)

5.2.1.19 Social Desirability Scale

Table 60 provides drivers' scores on the SDS. For more information on the SDS, see sections 2.3.6 and 5.1.12 of this report.

Table 60. Drivers' scores on the SDS.

Score	Number	Percent
Low Presentation of Social Desirability	99	0.9%
High Presentation of Social Desirability	11,245	99.1%
Total	**11,344**	**100%**

Table 61 shows the RR estimates and 95-percent CIs for the SDS. Significant RR estimates ($p < 0.05$) are denoted with an asterisk. Cells with "NA" indicate no driver was in the cell and/or no driver was in the reference cell; thus, no RR estimates could be calculated. Cells with a RR estimate of zero ("0") indicate that at least one driver was in the cell, but no crashes or violations were associated with that driver(s). There were no significant findings in Table 61.

Table 61. RR estimates and 95-percent CIs for the SDS.

Safety Outcome and Age Quartile	SDS
Total Carrier: 20–33	0.989 (0.961,1.018)
Total Carrier: 34–42	0.987 (0.957,1.018)
Total Carrier: 43–51	0.985 (0.955,1.017)
Total Carrier: 52+	0.995 (0.960,1.032)
Carrier Preventable: 20–33	0.966 (0.928,1.004)

Safety Outcome and Age Quartile	SDS
Carrier Preventable: 34–42	1.003 (0.961,1.047)
Carrier Preventable: 43–51	0.983 (0.940,1.028)
Carrier Preventable: 52+	1.011 (0.960,1.064)
National Crashes: 20–33	0.999 (0.960,1.040)
National Crashes: 34–42	0.977 (0.935,1.021)
National Crashes: 43–51	1.043 (0.996,1.093)
National Crashes: 52+	0.991 (0.945,1.040)
Violations: 20–33	1.012 (0.980,1.045)
Violations: 34–42	0.984 (0.945,1.025)
Violations: 43–51	1.006 (0.961,1.053)
Violations: 52+	1.020 (0.968,1.074)

5.2.2 Stepwise Regression Model for Initial Driver Survey

The stepwise regression model results include age as a quadratic (or age^2). RR estimates and 95-percent CIs are shown for each analysis. When no additional predictor variables added anything statistically meaningful to the regression equation, the analysis stopped. The stepwise regression considers all predictor variables, unlike the individual regression model, which only evaluated the relationship of each predictor on the safety outputs. Due to small sample sizes in cells and missing values, the step-wise regression was not stratified by age, as stepwise regression is sensitive to missing data—it discards the whole driver observation if it finds one missing value.

5.2.2.1 Total Carrier Crashes

Table 62 shows the RR estimates and 95-percent CIs for the significant predictors in the stepwise regression for total carrier crashes. Significant RR estimates ($p < 0.05$) are denoted with an asterisk. The AIC value for this model was 3,069.4. AIC is a measure of the relative quality of the model; it estimates the quality of each model relative to each of the other models (when comparing models, the model with the lower AIC is better). Key findings are summarized below:

- Drivers who reported they sometimes wore their seat belt while in a CMV were 2.31 times more likely to be involved in a total carrier crash compared to drivers who always wore their seat belt while in a CMV.
- Each one point increase on the time pressure subscale in the SRLE reduced the likelihood of involvement in a total carrier crash by 2.6 percent.

- Lastly, each one point increase on the finances subscale in the SRLE increased the likelihood of involvement in a total carrier crash by 4.5 percent.

Table 62. Initial driver survey stepwise regression RR estimates and 95-percent CIs for total carrier crashes.

Predictor Variables	Risk Ratio	Lower CI	Upper CI
Age	0.956	0.909	1.006
Age^2	1.001	1.00	1.001
CMV Seal Belt Use: Always	1.00	1.00	1.00
CMV Seal Belt Use: Often	0.759	0.405	1.4228
CMV Seal Belt Use: Sometimes	2.312*	1.27	4.208
CMV Seal Belt Use: Rarely	0	0	Inf
CMV Seal Belt Use: Never	0	0	Inf
OOS Violation Prior 3 Years: No	1.00	1.00	1.00
OOS Violation Prior 3 Years: Yes	0.794	0.567	1.094
Informal CMV Training (weeks)	0.996	0.992	1.001
SRLE: Time Pressure	0.974*	0.95	0.999
SRLE: Finances	1.045*	1.017	1.075

5.2.2.2 Carrier Preventable Crashes

Table 63 shows the RR estimates and 95-percent CIs for the significant predictors in the stepwise regression for carrier preventable crashes. Significant RR estimates ($p < 0.05$) are denoted with an asterisk. The AIC value for this model was 2,025.89. Significant findings are provided below:

- Drivers who reported English as their primary language were 40.7 percent less likely to be involved in a carrier preventable crash compared to drivers who did not report English as their primary language.
- Each weekly increase in formal CMV training reduced the likelihood of involvement in a carrier preventable crash by 0.4 percent.

Table 63. Initial driver survey stepwise regression RR estimates and 95-percent CIs for carrier preventable crashes.

Predictor Variables	Risk Ratio	Lower CI	Upper CI
Marital Status: Single	1.00	1.00	1.00
Marital Status: Married	0.838	0.569	1.065
Marital Status: Divorced	0.682	0.464	1.001
Marital Status: Widowed	0.259	0.036	1.855
English as Primary Language: No	1.00	1.00	1.00
English as Primary Language: Yes	0.593*	0.405	0.866
Formal CMV Training (weeks)	1.008*	1.002	1.014
SRLE: Finances	1.028	0.999	1.058

5.2.2.3 National Crashes

Table 64 shows the RR estimates and 95-percent CIs for the significant predictors in the stepwise regression for national crashes. Significant RR estimates ($p < 0.05$) are denoted with an asterisk. The AIC value for this model was 2,033.61. Key findings are presented below:

- Each yearly increase in age reduced the likelihood of involvement in a national crash by 8.2 percent.
- Drivers who had a high school degree were 15.8 percent less likely to be involved in a national crash compared to drivers who had a GED.
- Drivers who had an associate's degree were 26.3 percent less likely to be involved in a national crash compared to drivers who had a GED.
- Drivers who had a doctorate degree were 5.87 times more likely to be involved in a national crash compared to drivers who had a GED.
- Drivers who reported a crash in the prior 3 years were 23.4 percent more likely to be involved in a national crash compared to drivers who did not report a crash in the prior 3 years.
- Drivers who reported a moving violation in the prior 3 years were 26.1 percent more likely to be involved in a national crash compared to drivers who did not report a moving violation in the prior 3 years.
- Each one point increase on the social and cultural subscale in the SRLE reduced the likelihood of involvement in a national crash by 3.2 percent.
- Each one point increase on the SDS reduced the likelihood of involvement in a national carrier crash by 2.6 percent.

Table 64. Initial driver survey stepwise regression RR estimates and 95-percent CIs for national crashes.

Predictor Variables	Risk Ratio	Lower CI	Upper CI
Age	0.918*	0.916	0.92
Age^2	1.001*	1.001	1.001
Diploma: GED	1.00	1.00	1.00
Diploma: High School	0.842*	0.807	0.879
Diploma: Associate's Degree	0.737*	0.671	0.808
Diploma: Bachelor's Degree	0.989	0.875	1.117
Diploma: Master's Degree	0.265	0.036	1.949
Diploma: Doctorate Degree	5.875*	2.92	11.822
Number of CDL Endorsements: 1	1.00	1.00	1.00
Number of CDL Endorsements: 2	0	0	Inf
Number of CDL Endorsements: 3	0	0	Inf
Number of CDL Endorsements: 4	0.66	0.34	1.282
Crash Last 3 Years: No	1.00	1.00	1.00
Crash Last 3 Years: Yes	1.234*	1.192	1.276
Moving Violation Last 3 Years: No	1.00	1.00	1.00

Predictor Variables	Risk Ratio	Lower CI	Upper CI
Moving Violation Last 3 Years: Yes	1.261*	1.224	1.3
SRLE: Social and Cultural	0.968*	0.968	0.969
SDS	0.974*	0.973	0.974

5.2.2.4 Moving Violations

Table 65 shows the RR estimates and 95-percent CIs for the significant predictors in the stepwise regression for moving violation convictions. Significant RR estimates ($p < 0.05$) are denoted with an asterisk. The AIC value for this model was 2,134.33. Key findings are presented below:

- Drivers who had four CDL endorsements were 2.80 times more likely to be convicted of a moving violation compared to drivers who had one CDL endorsement.
- Drivers who reported they "often" wore their seat belt while in their personal vehicle were 85.6 percent more likely to be convicted of a moving violation compared to drivers who always wore their seat belt while in their personal vehicle.
- Driver who reported they "rarely" wore their seat belt while in their personal vehicle were 2.34 times more likely to be convicted of a moving violation compared to drivers who always wore their seat belt while in their personal vehicle.
- Drivers who scored "higher normal" on the ESS were 31.7 percent less likely to be convicted of a moving violation compared to drivers who scored "lower normal" on the ESS.
- Drivers who scored "severe excessive" on the ESS were 2.64 times more likely to be convicted of a moving violation, respectively, compared to drivers who scored lower normal on the ESS.
- Each one point increase on the work subscale in the SRLE decreased the likelihood of conviction of a moving violation by 5.2 percent.

Table 65. Initial driver survey stepwise regression RR estimates and 95-percent CIs for moving violations.

Predictor Variables	Risk Ratio	Lower CI	Upper CI
Age	0.939	0.878	1.005
Age^2	1.001	1.00	1.001
Number of CMV Endorsements: 1	1.00	1.00	1.00
Number of CMV Endorsements: 2	1.023	0.327	3.201
Number of CMV Endorsements: 3	0	0	Inf
Number of CMV Endorsements: 4	2.803*	1.565	5.018
Personal Vehicle Seat Belt Use: Always	1.00	1.00	1.00
Personal Vehicle Seat Belt Use: Often	1.856*	1.241	2.777
Personal Vehicle Seat Belt Use: Sometimes	1.126	0.554	2.289
Personal Vehicle Seat Belt Use: Rarely	2.34*	1.089	5.031
Personal Vehicle Seat Belt Use: Never	1.939*	0.713	5.269
Moving Violation Last 3 Years: No	1.00	1.00	1.00

Predictor Variables	Risk Ratio	Lower CI	Upper CI
Moving Violation Last 3 Years: Yes	1.263*	0.995	1.603
Nap during the Day: No	1.00	1.00	1.00
Nap during the Day: Yes	1.224*	0.947	1.583
Weekly Alcohol Consumption: No	1.00	0.566	1.031
Weekly Alcohol Consumption: Moderate	0.764*	0.5	1.069
Weekly Alcohol Consumption: Substantial	0.731*	0.947	1.583
ESS: Lower Normal	1.00	1.00	1.00
ESS: Higher Normal	0.683*	0.52	0.897
ESS: Mild Excessive	0.819*	0.476	1.407
ESS: Moderate Excessive	1.095	0.587	2.043
ESS: Severe Excessive	2.641*	1.059	6.591
SRLE: Social and Cultural	1.029*	0.997	1.062
SRLE: Work	0.948*	0.91	0.988

5.3 PROSPECTIVE COHORT WITH MEDICAL

There were many prospective cohort analyses using the Medical Examination Report data from 13,724 drivers. Separate analyses were performed for each safety outcome and treatment, with results stratified by age quartiles in the individual regression model. Although many of the variables have one significant finding, it is best to look for consistent findings throughout the age quartiles and/or the different safety outcomes when interpreting the results (i.e., identify consistent findings across the age quartiles and the different safety outcomes).

5.3.1 Individual Regression Model for Medical

The individual regression model results are adjusted for age and BMI (unless otherwise noted). RR estimates and 95-percent CIs are shown for each analysis. Although analyses were performed on all medical groupings, the interpretation of medical groupings with low cell counts (≥5), even if the 95-percent CI did not contain "1.0," were not explored.

5.3.1.1 Driver BMI

Table 66 provides participating drivers' BMI categories.

Table 66. Driver demographics: BMI.

BMI Category	Number	Percent
BMI > 40 (Obese Class III)	2,008	14.73%
35 ≤ BMI < 40 (Obese Class II)	2,176	15.96%
30 ≤ BMI < 35 (Obese Class I)	3,786	27.76%
25 ≤ BMI < 30 (Overweight)	3,922	28.76%
18.5 ≤ BMI < 25 (Normal)	1,693	12.42%
BMI < 18.50 (Underweight)	51	0.37%
Total	**13,636**	**100%**

Table 67 shows the RR estimates and 95-percent CIs for drivers' BMI. Significant RR estimates ($p < 0.05$) are denoted with an asterisk. Cells with "NA" indicate no driver was in the cell and/or no driver was in the reference cell; thus, no RR estimates could be calculated. Cells with a RR estimate of zero ("0") indicate that at least one driver was in the cell, but no crashes or violations were associated with that driver(s). There were eight significant findings in Table 67:

- Drivers aged 20–33 with overweight and obese class I, II, and III BMIs were 29.5 percent, 34.7 percent, 31.2 percent, and 36.6 percent less likely to be involved in a total carrier crash compared to drivers aged 20–33 who had a normal BMI, respectively.
- Drivers aged 20–33 with overweight and obese class I, II, and III BMIs were 33.5 percent, 30 percent, 32.5 percent, and 41.5 percent less likely to be involved in a carrier preventable crash compared to drivers aged 20–33 who had a normal BMI, respectively.

Table 67. RR estimates and 95-percent CIs for BMI (not adjusted for BMI).

Safety Outcome and Age Quartile	Normal	Overweight	Obese Class I	Obese Class II	Obese Class III
Total Carrier: 20–33	1.00	0.705* (0.562,0.883)	0.653* (0.516,0.827)	0.688* (0.524,0.903)	0.634* (0.491,0.818)
Total Carrier: 34–42	1.00	0.828 (0.622,1.101)	0.801 (0.601,1.067)	0.883 (0.645,1.209)	0.832 (0.608,1.140)
Total Carrier: 43–51	1.00	1.071 (0.773,1.485)	0.922 (0.663,1.283)	1.287 (0.917,1.806)	1.248 (0.873,1.784)
Total Carrier: 52+	1.00	0.879 (0.657,1.177)	0.857 (0.635,1.155)	0.989 (0.707,1.383)	0.876 (0.588,1.304)
Carrier Preventable: 20–33	1.00	0.665* (0.486,0.911)	0.700* (0.509,0.962)	0.675* (0.463,0.982)	0.585* (0.409,0.838)
Carrier Preventable: 34–42	1.00	0.853 (0.570,1.279)	0.903 (0.605,1.348)	0.913 (0.586,1.423)	0.815 (0.520,1.278)
Carrier Preventable: 43–51	1.00	0.995 (0.648,1.529)	0.842 (0.545,1.302)	0.916 (0.575,1.461)	1.125 (0.699,1.809)
Carrier Preventable: 52+	1.00	0.841 (0.562,1.257)	0.789 (0.521,1.195)	0.833 (0.516,1.345)	0.995 (0.588,1.686)
National Crashes: 20–33	1.00	1.089 (0.781,1.517)	1.103 (0.783,1.555)	0.879 (0.588,1.314)	0.900 (0.613,1.323)
National Crashes: 34–42	1.00	1.131 (0.745,1.718)	1.246 (0.826,1.881)	0.895 (0.554,1.445)	0.935 (0.587,1.491)
National Crashes: 43–51	1.00	0.990 (0.643,1.522)	1.157 (0.760,1.764)	1.108 (0.703,1.745)	1.226 (0.771,1.949)
National Crashes: 52+	1.00	0.996 (0.693,1.431)	0.893 (0.614,1.299)	0.971 (0.642,1.469)	0.703 (0.414,1.194)
Violations: 20–33	1.00	1.077 (0.827,1.402)	0.793 (0.590,1.066)	0.751 (0.537,1.050)	0.911 (0.672,1.235)
Violations: 34–42	1.00	0.823 (0.587,1.152)	0.749 (0.532,1.053)	0.607 (0.404,0.911)	0.724 (0.496,1.059)
Violations: 43–51	1.00	0.900 (0.607,1.334)	0.850 (0.573,1.260)	0.865 (0.564,1.328)	0.701 (0.438,1.120)

Safety Outcome and Age Quartile	Normal	Overweight	Obese Class I	Obese Class II	Obese Class III
Violations: 52+	1.00	0.799 (0.561,1.137)	0.799 (0.558,1.144)	0.776 (0.516,1.168)	0.530 (0.310,0.906)

5.3.1.2 Allergies

Of the 13,724 drivers who completed the Medical Examination Report:

- 216 (1.57 percent) were diagnosed with allergies:
  - 209 were treated.
  - 4 were untreated.
  - 3 did not clearly indicate whether they were treated (categorized as "Diagnosed: Unsure" in the analysis).
- 12 (0.09 percent) had potential allergies (not formally diagnosed by a medical professional).

Table 68 shows the RR estimates and 95-percent CIs for allergies. Significant RR estimates ($p < 0.05$) are denoted with an asterisk. Cells with "NA" indicate no driver was in the cell and/or no driver was in the reference cell; thus, no RR estimates could be calculated. Cells with a RR estimate of zero ("0") indicate that at least one driver was in the cell, but no crashes or violations were associated with that driver(s). There were two significant findings in Table 68. Drivers aged 34–42 with untreated allergies were 11.63 times more likely to be involved in a total carrier crash compared to drivers aged 34–42 who did not have allergies. Drivers aged 34–42 with untreated allergies were 22.92 times more likely to be involved in a carrier preventable crash compared to drivers aged 34–42 who did not have allergies.

Table 68. RR estimates and 95-percent CIs for allergies.

Safety Outcome and Age Quartile	No Allergies	Diagnosed: Treated	Diagnosed: Untreated	Diagnosed: Unsure	Potential
Total Carrier: 20–33	1.00	1.741 (0.952,3.162)	0 (0,Inf)	0 (0,Inf)	NA
Total Carrier: 34–42	1.00	0.768 (0.364,1.622)	11.625*+ (2.880,46.926)	NA	0 (0,Inf)
Total Carrier: 43–51	1.00	1.483 (0.948,2.320)	0 (0,Inf)	0 (0,Inf)	0 (0,Inf)
Total Carrier: 52+	1.00	1.076 (0.606,1.910)	NA	NA	0 (0,6.621^{e289})
Carrier Preventable: 20–33	1.00	2.136 (1.009,4.523)	0 (0,Inf)	0 (0,Inf)	NA
Carrier Preventable: 34–42	1.00	0.642 (0.206,2.007)	22.922*+ (5.626,93.397)	NA	0 (0,Inf)
Carrier Preventable: 43–51	1.00	1.7208 (0.963,3.071)	0 (0,Inf)	0 (0,Inf)	0 (0,Inf)
Carrier Preventable: 52+	1.00	0.874 (0.360,2.123)	NA	NA	0 (0,Inf)

Safety Outcome and Age Quartile	No Allergies	Diagnosed: Treated	Diagnosed: Untreated	Diagnosed: Unsure	Potential
National Crashes: 20–33	1.00	0.578 (0.144,2.323)	0 (0,Inf)	0 (0,Inf)	0 (0,Inf)
National Crashes: 34–42	1.00	1.058 (0.394,2.841)	0 (0,Inf)	NA	0 (0,Inf)
National Crashes: 43–51	1.00	0.898 (0.401,2.015)	0 (0,Inf)	6.086 (0.853,43.439)	0 (0,Inf)
National Crashes: 52+	1.00	1.328 (0.658,2.683)	NA	NA	0 (0,Inf)
Violations: 20–33	1.00	0.991 (0.410,2.395)	0 (0,Inf)	0 (0,Inf)	0 (0,Inf)
Violations: 34–42	1.00	0.455 (0.113,1.826)	11.855 (1.653,85.029)	NA	0 (0,Inf)
Violations: 43–51	1.00	0.803 (0.332,1.944)	0 (0,Inf)	0 (0,Inf)	0(0,Inf)
Violations: 52+	1.00	0.168 (0.024,1.198)	NA	NA	0(0,Inf)

+ = One driver aged 34–42 had untreated allergies.

5.3.1.3 Abdomen or Viscera

Of the 13,724 drivers who completed the Medical Examination Report:

- 133 (0.97 percent) were diagnosed with abdomen or viscera conditions:
  - 9 were treated.
  - 51 were untreated.
  - 73 did not clearly indicate whether they were treated (categorized as "Diagnosed: Unsure" in the analysis).
- 13 (0.09 percent) had potential abdomen or viscera conditions (not formally diagnosed by a medical professional).

Table 69 shows the RR estimates and 95-percent CIs for abdomen or viscera conditions (e.g., hernia, abdominal cramps, etc.). Significant RR estimates ($p < 0.05$) are denoted with an asterisk. Cells with "NA" indicate no driver was in the cell and/or no driver was in the reference cell; thus, no RR estimates could be calculated. Cells with a RR estimate of zero ("0") indicate that at least one driver was in the cell, but no crashes or violations were associated with that driver(s). There were no significant findings in Table 69.

Table 69. RR estimates and 95-percent CIs for abdomen or viscera.

Safety Outcome and Age Quartile	No Abdomen or Viscera Condition	Diagnosed: Treated	Diagnosed: Untreated	Diagnosed: Unsure	Potential
Total Carrier: 20–33	1.00	0.003 (0,5.871^{e239})	0.948 (0.133,6.752)	1.253 (0.176,8.918)	NA

Safety Outcome and Age Quartile	No Abdomen or Viscera Condition	Diagnosed: Treated	Diagnosed: Untreated	Diagnosed: Unsure	Potential
Total Carrier: 34–42	1.00	2.812 (0.390,20.280)	0 (0,Inf)	1.933 (0.720,5.189)	0 (0,Inf)
Total Carrier: 43–51	1.00	0 (0,Inf)	0.709 (0.177,2.851)	0.834 (0.208,3.350)	0 (0,Inf)
Total Carrier: 52+	1.00	0 (0,Inf)	0 (0,Inf)	0.727 (0.233,2.270)	0 (0,Inf)
Carrier Preventable: 20–33	1.00	3^{e-04} (0,Inf)	0 (0,Inf)	2.50 (0.350,17.803)	NA
Carrier Preventable: 34–42	1.00	0 (0,Inf)	0 (0,Inf)	2.711 (0.864,8.509)	0 (0,Inf)
Carrier Preventable: 43–51	1.00	0 (0,Inf)	0.654 (0.092,4.681)	0 ($0,1.780^{e303}$)	0 (0,Inf)
Carrier Preventable: 52+	1.00	0 (0,Inf)	0 (0,Inf)	0.456 (0.064,3.268)	0 (0,Inf)
National Crashes: 20–33	1.00	0 (0,Inf)	0 (0,Inf)	0 (0,Inf)	NA
National Crashes: 34–42	1.00	0 (0,Inf)	0 (0,Inf)	0.768 (0.108,5.477)	0 (0,Inf)
National Crashes: 43–51	1.00	0 (0,Inf)	2.808 (0.9,8.763)	1.756 (0.437,7.058)	0 (0,Inf)
National Crashes: 52+	1.00	0 (0,Inf)	0 (0,Inf)	0 (0,Inf)	1.332 (0.187,9.50)
Violations: 20–33	1.00	0 ($0,4.133^{e+77}$)	1.945 (0.273,13.848)	2.313 (0.576,9.294)	NA
Violations: 34–42	1.00	0 (0,Inf)	2.017 (0.501,8.109)	1.383 (0.344,5.559)	5.389 (0.752,38.61)
Violations: 43–51	1.00	0 (0,Inf)	0.943 (0.132,6.720)	1.889 (0.470,7.595)	0 (0,Inf)
Violations: 52+	1.00	0 (0,Inf)	0.976 (0.243,3.923)	1.358 (0.504,3.658)	1.533 (0.215,10.940)

5.3.1.4 Blood Disorder

Of the 13,724 drivers who completed the Medical Examination Report:

- 17 (0.12 percent) had a diagnosed blood disorder:
  - 13 were treated.
  - 4 were untreated.
- 1 (0.01 percent) had a potential blood disorder (not formally diagnosed by a medical professional).

Table 70 shows the RR estimates and 95-percent CIs for blood disorders. Significant RR estimates ($p < 0.05$) are denoted with an asterisk. Cells with "NA" indicate no driver was in the

cell and/or no driver was in the reference cell; thus, no RR estimates could be calculated. Cells with a RR estimate of zero ("0") indicate that at least one driver was in the cell, but no crashes or violations were associated with that driver(s). There was one significant finding related to drivers with an untreated blood disorder in Table 70. Drivers aged 34–42 with an untreated blood disorder were 19.47 times more likely to be involved in a national crash compared to drivers aged 34–42 who did not have a blood disorder.

Table 70. RRs and 95-percent CI estimates for blood disorder.

Safety Outcome and Age Quartile	No Blood Disorder	Diagnosed: Treated	Diagnosed: Untreated	Diagnosed: Unsure	Potential
Total Carrier: 20–33	1.00	0.001 (0,1.074^{e263})	NA	NA	NA
Total Carrier: 34–42	1.00	0 (0,Inf)	43.038 (0,Inf)	NA	NA
Total Carrier: 43–51	1.00	6^{e-04} (0,Inf)	5.558 (1.734,22.484)	NA	0 (0,Inf)
Total Carrier: 52+	1.00	6.446 (0.904,45.973)	NA	NA	NA
Carrier Preventable: 20–33	1.00	0.002 (0,4.892^{e259})	NA	NA	NA
Carrier Preventable: 34–42	1.00	0 (0,Inf)	43.350 (0,Inf)	NA	NA
Carrier Preventable: 43–51	1.00	4^{e-04} (0,Inf)	5.354 (0.742,38.607)	NA	0 (0,Inf)
Carrier Preventable: 52+	1.00	12.306 (1.718,88.156)	NA	NA	NA
National Crashes: 20–33	1.00	0 (0,1.024^{e277})	NA	NA	NA
National Crashes: 34–42	1.00	0 (0,Inf)	19.470*$^{+}$ (4.696,80.717)	NA	NA
National Crashes: 43–51	1.00	0 (0,Inf)	5.174 (0.720,37.155)	NA	0 (0,Inf)
National Crashes: 52+	1.00	1.943 (0.271,13.914)	NA	NA	NA
Violations: 20–33	1.00	0 (0,1.803^{e277})	NA	NA	NA
Violations: 34–42	1.00	0 (0,Inf)	0 (0,Inf)	NA	NA
Violations: 43–51	1.00	13.293 (1.847,95.663)	5.361 (0.4,38.504)	NA	0(0,Inf)
Violations: 52+	1.00	0 (0,Inf)	NA	NA	NA

+ = Two drivers aged 34–42 had an untreated blood disorder.

5.3.1.5 Cancer

Of the 13,724 drivers who completed the Medical Examination Report:

- 25 (0.18 percent) were diagnosed with cancer:
  - 16 were treated.
  - 6 were untreated.

  - 3 did not clearly indicate whether they were treated (categorized as "Diagnosed: Unsure" in the analysis).

- 18 (0.13 percent) had potential cancer (not formally diagnosed by a medical professional).

Table 71 shows the RR estimates and 95-percent CIs for cancer. Significant RR estimates ($p < 0.05$) are denoted with an asterisk. Cells with "NA" indicate no driver was in the cell and/or no driver was in the reference cell; thus, no RR estimates could be calculated. Cells with a RR estimate of zero ("0") indicate that at least one driver was in the cell, but no crashes or violations were associated with that driver(s). There were no significant findings in Table 71.

Table 71. RRs and 95-percent CI estimates for cancer.

Safety Outcome and Age Quartile	No Cancer	Diagnosed: Treated	Diagnosed: Untreated	Diagnosed: Unsure	Potential
Total Carrier: 20–33	1.00	1^{e-04} ($0,2.937^{e230}$)	NA	NA	0 (0,Inf)
Total Carrier: 34–42	1.00	NA	0 (0,Inf)	NA	0 (0,Inf)
Total Carrier: 43–51	1.00	1.305 (0.182,9.342)	6.155 (0.856,44.233)	0 (0,Inf)	0 ($0,1.045^{e234}$)
Total Carrier: 52+	1.00	0.785 (0.110,5.590)	11.202 (1.571,79.880)	18.368 (2.569,131.314)	2.763 (0.383,19.925)
Carrier Preventable: 20–33	1.00	1^{e-04} (0,Inf)	NA	NA	0 (0,Inf)
Carrier Preventable: 34–42	1.00	NA	0 (0,Inf)	NA	0 (0,Inf)
Carrier Preventable: 43–51	1.00	0 (0,Inf)	11.580 (1.593,84.148)	0 (0,Inf)	0 (0,Inf)
Carrier Preventable: 52+	1.00	0 (0,Inf)	23.437 (3.271,167.941)	0 (0,Inf)	0 (0,Inf)
National Crashes: 20–33	1.00	0 (0,Inf)	NA	NA	0 (0,Inf)
National Crashes: 34–42	1.00	NA	0 (0,Inf)	NA	0 (0,Inf)
National Crashes: 43–51	1.00	0 (0,Inf)	0 (0,Inf)	0 (0,Inf)	1.391 (0.195,9.942)
National Crashes: 52+	1.00	0.839 (0.117,6.001)	5.633 (1.397,22.723)	0 (0,Inf)	1.12 (0.157,7.995)
Violations: 20–33	1.00	0 ($0,8.483^{e275}$)	NA	NA	0 (0,Inf)
Violations: 34–42	1.00	NA	0 (0,Inf)	NA	0 (0,Inf)
Violations: 43–51	1.00	0 (0,Inf)	0 (0,Inf)	10.429 (1.424,76.376)	1.336 (0.187,9.548)
Violations: 52+	1.00	0 (0,Inf)	0 (0,Inf)	0 (0,Inf)	1.054 (0.148,7.519)

5.3.1.6 Digestive Problems

Of the 13,724 drivers who completed the Medical Examination Report:

- 479 (3.49 percent) had diagnosed digestive problems:
  - 415 were treated.
  - 23 were untreated.
  - 41 did not clearly indicate whether they were treated (categorized as "Diagnosed: Unsure" in the analysis).
- 9 (0.07 percent) had potential digestive problems (not formally diagnosed by a medical professional).

Table 72 shows the RR estimates and 95-percent CIs for digestive problems (e.g., diverticulitis, acid reflux/heartburn, etc.). Significant RR estimates ($p < 0.05$) are denoted with an asterisk. Cells with "NA" indicate no driver was in the cell and/or no driver was in the reference cell; thus, no RR estimates could be calculated. Cells with a RR estimate of zero ("0") indicate that at least one driver was in the cell, but no crashes or violations were associated with that driver(s). There was one significant finding in Table 72:

- Drivers aged 43–51 with untreated digestive problems were 6.5 times more likely to be involved in a national crash compared to drivers aged 43–51 who did not have digestive problems.

Table 72. RR estimates and 95-percent CIs for digestive problems.

Safety Outcome and Age Quartile	No Digestive Problems	Diagnosed: Treated	Diagnosed: Untreated	Diagnosed: Unsure	Potential
Total Carrier: 20–33	1.00	0.505 (0.126,2.025)	4.723 (0.658,33.915)	0 (0,Inf)	0 (0,Inf)
Total Carrier: 34–42	1.00	0.993 (0.583,1.690)	0 (0,Inf)	1.934 (0.621,6.026)	0 (0,Inf)
Total Carrier: 43–51	1.00	1.223 (0.858,1.744)	1.219 (0.170,8.735)	1.044 (0.259,4.212)	0 (0,1.323[e237])
Total Carrier: 52+	1.00	1.081 (0.698,1.676)	0.779 (0.109,5.563)	0.951 (0.236,3.831)	1.007 (0.141,7.19)
Carrier Preventable: 20–33	1.00	0.47 (0.066,3.353)	0 (0,Inf)	0 (0,Inf)	0 (0,Inf)
Carrier Preventable: 34–42	1.00	0.813 (0.362,1.829)	0 (0,Inf)	2.541 (0.630,10.242)	0 (0,Inf)
Carrier Preventable: 43–51	1.00	1.356 (0.838,2.194)	0 (0,Inf)	0.990 (0.138,7.109)	0 (0,Inf)
Carrier Preventable: 52+	1.00	1.234 (0.690,2.208)	1.555 (0.217,11.163)	0 (0,Inf)	0 (0,Inf)
National Crashes: 20–33	1.00	1.249 (0.464,3.359)	0 (0,Inf)	0 (0,Inf)	0 (0,Inf)
National Crashes: 34–42	1.00	1.162 (0.598,2.261)	0 (0,Inf)	0 (0,Inf)	0 (0,Inf)
National Crashes: 43–51	1.00	0.615 (0.317,1.193)	6.504* (2.066,20.473)	0 (0,7.832[e293])	0 (0,Inf)
National Crashes: 52+	1.00	1.460 (0.936,2.278)	0 (0,Inf)	1.958 (0.626,6.125)	2.684 (0.376,19.167)
Violations: 20–33	1.00	1.172 (0.484,2.837)	0 (0,1.078[e271])	1.932 (0.271,13.776)	4.218 (1.049,16.967)

Safety Outcome and Age Quartile	No Digestive Problems	Diagnosed: Treated	Diagnosed: Untreated	Diagnosed: Unsure	Potential
Violations: 34–42	1.00	0.897 (0.444,1.811)	0 (0,Inf)	1.192 (0.167,8.489)	0 (0,Inf)
Violations: 43–51	1.00	0.594 (0.294,1.200)	0 (0,Inf)	1.027 (0.144,7.329)	0 (0,Inf)
Violations: 52+	1.00	0.804 (0.440,1.470)	1.405 (0.196,10.071)	0.631 (0.088,4.501)	0 (0,Inf)

+ = Five drivers aged 43–51 had untreated digestive problems.

5.3.1.7 Dyslipidemia

Of the 13,724 drivers who completed the Medical Examination Report:

- 796 (5.8 percent) were diagnosed with dyslipidemia:
  - 791 were treated.
  - 3 were untreated.
  - 3 did not clearly indicate whether they were treated (categorized as "Diagnosed: Unsure" in the analysis).
- 9 (0.07 percent) had potential dyslipidemia (not formally diagnosed by a medical professional).

Table 73 shows the RR estimates and 95-percent CIs for dyslipidemia (e.g., high cholesterol). Significant RR estimates ($p < 0.05$) are denoted with an asterisk. Cells with "NA" indicate no driver was in the cell and/or no driver was in the reference cell; thus, no RR estimates could be calculated. Cells with a RR estimate of zero ("0") indicate that at least one driver was in the cell, but no crashes or violations were associated with that driver(s). There were no significant findings in Table 73.

Table 73. RR estimates and 95-percent CIs for dyslipidemia.

Safety Outcome and Age Quartile	No Dyslipidemia	Diagnosed: Treated	Diagnosed: Untreated	Diagnosed: Unsure	Potential
Total Carrier: 20–33	1.00	0.318 (0.0455,2.261)	NA	NA	NA
Total Carrier: 34–42	1.00	0.891 (0.532,1.492)	NA	NA	0 (0,Inf)
Total Carrier: 43–51	1.00	0.886 (0.643,1.221)	12.479 (3.097,50.283)	0 ($0,5.114^{e237}$)	NA
Total Carrier: 52+	1.00	1.113 (0.861,1.437)	0 (0,Inf)	0 (0,Inf)	1.735 (0.431,6.979)
Carrier Preventable: 20–33	1.00	0.612 (0.086,4.369)	NA	NA	NA
Carrier Preventable: 34–42	1.00	0.788 (0.371,1.675)	NA	NA	0 (0,Inf)
Carrier Preventable: 43–51	1.00	0.866 (0.548,1.369)	11.747 (1.638,84.266)	0 (0,Inf)	NA

Safety Outcome and Age Quartile	No Dyslipidemia	Diagnosed: Treated	Diagnosed: Untreated	Diagnosed: Unsure	Potential
Carrier Preventable: 52+	1.00	1.276 (0.902,1.807)	0 (0,Inf)	0 (0,Inf)	1.810 (0.253,12.961)
National Crashes: 20–33	1.00	1.181 (0.293,4.758)	NA	NA	NA
National Crashes: 34–42	1.00	0.913 (0.430,1.938)	NA	NA	0 (0,Inf)
National Crashes: 43–51	1.00	0.591 (0.357,0.979)	0 (0,Inf)	0 (0,Inf)	NA
National Crashes: 52+	1.00	0.847 (0.595,1.204)	0 (0,Inf)	0 (0,Inf)	3.797 (1.214,11.879)
Violations: 20–33	1.00	1.691 (0.630,4.543)	NA	NA	NA
Violations: 34–42	1.00	1.063 (0.546,2.066)	NA	NA	0 (0,Inf)
Violations: 43–51	1.00	1.10 (0.733,1.649)	4.447 (0.621,31.839)	0 (0,Inf)	NA
Violations: 52+	1.00	1.271 (0.923,1.750)	0 (0,Inf)	0 (0,Inf)	1.539 (0.216,10.981)

5.3.1.8 Diabetes/Elevated Blood Sugar

Of the 13,724 drivers who completed the Medical Examination Report:

- 1,287 (9.38 percent) were diagnosed with diabetes/elevated blood sugar:
  - 1,118 were treated.
  - 147 were untreated.
  - 22 did not clearly indicate whether they were treated (categorized as "Diagnosed: Unsure" in the analysis).
- 105 (0.77 percent) had potential diabetes/elevated blood sugar (not formally diagnosed by a medical professional).

Table 74 shows the RR estimates and 95-percent CIs for diabetes/elevated blood sugar. Significant RR estimates ($p < 0.05$) are denoted with an asterisk. Cells with "NA" indicate no driver was in the cell and/or no driver was in the reference cell; thus, no RR estimates could be calculated. Cells with a RR estimate of zero ("0") indicate that at least one driver was in the cell, but no crashes or violations were associated with that driver(s). There was one significant finding in Table 74. Drivers aged 43–51 with treated diabetes/elevated blood sugar were 50 percent less likely to be involved in a national crash compared to drivers aged 43–51 who did not have diabetes/elevated blood sugar.

Table 74. RR estimates and 95-percent CIs for diabetes/elevated blood sugar.

Safety Outcome and Age Quartile	No Diabetes/ Elevated Blood Sugar	Diagnosed: Treated	Diagnosed: Untreated	Diagnosed: Unsure	Potential
Total Carrier: 20–33	1.00	0.794 (0.329,1.92)	1.052 (0.337,3.288)	1^{e-04} ($0,2.894^{e238}$)	2.12 (0.787,5.713)
Total Carrier: 34–42	1.00	0.747 (0.482,1.160)	0.97 (0.362,2.598)	0.745 (0.105,5.309)	0 (0,Inf)
Total Carrier: 43–51	1.00	0.955 (0.728,1.254)	1.013 (0.503,2.041)	0 (0,Inf)	0.846 (0.316,2.265)
Total Carrier: 52+	1.00	0.771 (0.587,1.014)	1.026 (0.424,2.481)	0 ($0,6.113^{e274}$)	1.178 (0.438,3.165)
Carrier Preventable: 20–33	1.00	0.308 (0.043,2.201)	0.695 (0.097,4.975)	2^{e-04} (0,Inf)	2.006 (0.494,8.143)
Carrier Preventable: 34–42	1.00	0.76 (0.414,1.395)	0.466 (0.0653,3.326)	1.389 (0.194,9.930)	0 (0,Inf)
Carrier Preventable: 43–51	1.00	0.967 (0.659,1.420)	0.996 (0.370,2.681)	0 (0,Inf)	0.841 (0.209,3.386)
Carrier Preventable: 52+	1.00	0.676 (0.452,1.013)	1.233 (0.394,3.861)	0 (0,Inf)	1.696 (0.539,5.341)
National Crashes: 20–33	1.00	2.045 (0.963,4.345)	0.671 (0.094,4.795)	1^{e-04} (0,Inf)	2.874 (0.914,9.041)
National Crashes: 34–42	1.00	0.863 (0.492,1.512)	1.071 (0.343,3.343)	1.662 (0.233,11.884)	1.007 (0.250,4.056)
National Crashes: 43–51	1.00	0.50* (0.313,0.797)	0.672 (0.215,2.099)	0 (0,Inf)	1.01 (0.324,3.152)
National Crashes: 52+	1.00	0.971 (0.706,1.335)	0.571 (0.183,1.782)	0 (0,Inf)	0.712 (0.177,2.869)
Violations: 20–33	1.00	1.179 (0.525,2.647)	0 ($0,1.433^{e262}$)	0 (0,Inf)	2.065 (0.659,6.473)
Violations: 34–42	1.00	1.356 (0.883,2.084)	1.567 (0.647,3.793)	0 (0,Inf)	0 (0,Inf)
Violations: 43–51	1.00	1.268 (0.901,1.785)	1.094 (0.407,2.940)	4.054 (1.005,16.353)	1.199 (0.384,3.746)
Violations: 52+	1.00	1.128 (0.819,1.552)	1.267 (0.563,2.851)	0 (0,Inf)	1.515 (0.563,4.076)

5.3.1.9 Ear Disorder/Hearing/Balance

Of the 13,724 drivers who completed the Medical Examination Report:

- 949 (6.91 percent) were diagnosed with an ear disorder or a hearing/balance-related condition:
  - 791 were treated.
  - 3 were untreated.

  - 155 did not clearly indicate whether they were treated (categorized as "Diagnosed: Unsure" in the analysis).

- 9 (0.07 percent) had a potential ear disorder or hearing/balance-related condition (not formally diagnosed by a medical professional).

Table 75 shows the RR estimates and 95-percent CIs for ear disorder/hearing/balance (e.g., hearing loss, ocular hypertension, etc.). Significant RR estimates ($p < 0.05$) are denoted with an asterisk. Cells with "NA" indicate no driver was in the cell and/or no driver was in the reference cell; thus, no RR estimates could be calculated. Cells with a RR estimate of zero ("0") indicate that at least one driver was in the cell, but no crashes or violations were associated with that driver(s). There were no significant findings in Table 75.

Table 75. RR estimates and 95-percent CIs for ear disorder/hearing/balance.

Safety Outcome and Age Quartile	No Ear Disorder/ Hearing/ Balance	Diagnosed: Treated	Diagnosed: Untreated	Diagnosed: Unsure	Potential
Total Carrier: 20–33	1.00	0.318 (0.045,2.267)	NA	1.465 (0.607,3.537)	NA
Total Carrier: 34–42	1.00	0.890 (0.531,1.491)	NA	0.879 (0.328,2.353)	0 (0,Inf)
Total Carrier: 43–51	1.00	0.886 (0.643,1.221)	12.469 (3.094,50.245)	0.939 (0.420,2.102)	NA
Total Carrier: 52+	1.00	1.134 (0.877,1.466)	0 (0,Inf)	1.635 (1.002,2.667)	1.756 (0.436,7.066)
Carrier Preventable: 20–33	1.00	0.610 (0.085,4.358)	NA	0.572 (0.080,4.077)	NA
Carrier Preventable: 34–42	1.00	0.784 (0.369,1.667)	NA	0.424 (0.054,3.023)	0 (0,Inf)
Carrier Preventable: 43–51	1.00	0.862 (0.545,1.363)	11.672 (1.627,83.732)	0.612 (0.152,2.464)	NA
Carrier Preventable: 52+	1.00	1.313 (0.926,1.862)	0 (0,Inf)	1.963 (1.034,3.728)	1.844 (0.258,13.213)
National Crashes: 20–33	1.00	1.192 (0.296,4.804)	NA	2.213 (0.823,5.954)	NA
National Crashes: 34–42	1.00	0.912 (0.430,1.936)	NA	0.869 (0.216,3.492)	0 (0,Inf)
National Crashes: 43–51	1.00	0.594 (0.358,0.984)	0 (0,Inf)	1.458 (0.602,3.530)	NA
National Crashes: 52+	1.00	0.845 (0.594,1.203)	0 (0,Inf)	0.926 (0.412,2.082)	3.791 (1.212,11.862)
Violations: 20–33	1.00	1.694 (0.630,4.550)	NA	1.204 (0.386,3.754)	NA
Violations: 34–42	1.00	1.060 (0.545,2.062)	NA	0.719 (0.179,2.887)	0 (0,Inf)
Violations: 43–51	1.00	1.091 (0.728,1.636)	4.407 (0.615,31.556)	0.301 (0.042,2.146)	NA
Violations: 52+	1.00	1.263 (0.917,1.740)	0 (0,Inf)	0.735 (0.273,1.976)	1.530 (0.214,10.918)

5.3.1.10 Eye Disorder

Of the 13,724 drivers who completed the Medical Examination Report:

- 112 (0.82 percent) had a diagnosed eye disorder:
  - 26 were treated.
  - 16 were untreated.
  - 70 did not clearly indicate whether they were treated (categorized as "Diagnosed: Unsure" in the analysis).
- 14 (0.10 percent) had a potential eye disorder (not formally diagnosed by a medical professional).

Table 76 shows the RR estimates and 95-percent CIs for "eye disorder." Significant RR estimates ($p < 0.05$) are denoted with an asterisk. Cells with "NA" indicate no driver was in the cell and/or no driver was in the reference cell; thus, no RR estimates could be calculated. Cells with a RR estimate of zero ("0") indicate that at least one driver was in the cell, but no crashes or violations were associated with that driver(s). There was one significant finding in Table 76. Drivers aged 43–51 with a treated eye disorder were 6.53 times more likely to be involved in a total carrier crash compared to drivers aged 43–51 who did not have an eye disorder.

Table 76. RR estimates and 95-percent CIs for eye disorder.

Safety Outcome and Age Quartile	No Eye Disorder	Diagnosed: Treated	Diagnosed: Untreated	Diagnosed: Unsure	Potential
Total Carrier: 20–33	1.00	0 (0,Inf)	4.084 (0.572,29.161)	0 (0,Inf)	0 (0,Inf)
Total Carrier: 34–42	1.00	1.169 (0.164,8.349)	0 (0,Inf)	1.155 (0.288,4.634)	3^{e-04} (0,Inf)
Total Carrier: 43–51	1.00	6.532^{*+} (2.422,17.588)	0 (0,Inf)	0.315 (0.044,2.242)	0 (0,Inf)
Total Carrier: 52+	1.00	1.369 (0.439,4.268)	0 ($0,1.155^{e260}$)	1.211 (0.541,2.710)	2^{e-04} (0,Inf)
Carrier Preventable: 20–33	1.00	0 (0,Inf)	0 (0,Inf)	0 (0,Inf)	0 (0,Inf)
Carrier Preventable: 34–42	1.00	2.111 (0.294,15.148)	0 (0,Inf)	0 (0,Inf)	1^{e-04} (0,Inf)
Carrier Preventable: 43–51	1.00	9.652 (3.056,30.487)	0 (0,Inf)	0.624 (0.088,4.449)	0 (0,Inf)
Carrier Preventable: 52+	1.00	1.753 (0.435,7.071)	0 (0,Inf)	0.808 (0.201,3.253)	1^{e-04} (0,Inf)
National Crashes: 20–33	1.00	0 (0,Inf)	2.865 (0.401,20.447)	0 (0,Inf)	0 (0,Inf)
National Crashes: 34–42	1.00	2.370 (0.331,16.953)	0 (0,Inf)	0 (0,Inf)	0 (0,Inf)
National Crashes: 43–51	1.00	1.462 (0.205,10.419)	2.463 (0.345,17.586)	0 (0,Inf)	0 (0,Inf)

Safety Outcome and Age Quartile	No Eye Disorder	Diagnosed: Treated	Diagnosed: Untreated	Diagnosed: Unsure	Potential
National Crashes: 52+	1.00	0 (0,Inf)	0 (0,Inf)	1.431 (0.533,3.847)	0 (0,Inf)
Violations: 20–33	1.00	0 (0,Inf)	0 (0,Inf)	0 (0,Inf)	0 (0,Inf)
Violations: 34–42	1.00	0 (0,Inf)	0 (0,Inf)	0.649 (0.091,4.621)	0 (0,Inf)
Violations: 43–51	1.00	1.568 (0.220,11.183)	0 (0,Inf)	2.019 (0.647,6.301)	1.927 (0.269,13.778)
Violations: 52+	1.00	0 (0,Inf)	0 (0,Inf)	0 (0,Inf)	0 (0,Inf)

+ = Seven drivers aged 43–51 had treated eye disorder.

5.3.1.11 Genitourinary

Of the 13,724 drivers who completed the Medical Examination Report:

- 286 (2.08 percent) had a diagnosed genitourinary condition:
  - 114 were treated.
  - 117 were untreated.
  - 55 did not clearly indicate whether they were treated (categorized as "Diagnosed: Unsure" in the analysis).
- 77 (0.56 percent) had a potential genitourinary condition (not formally diagnosed by a medical professional).

Table 77 shows the RR estimates and 95-percent CIs for "genitourinary" condition (hematuria, enlarged prostate, etc.). Significant RR estimates ($p < 0.05$) are denoted with an asterisk. Cells with "NA" indicate no driver was in the cell and/or no driver was in the reference cell; thus, no RR estimates could be calculated. Cells with a RR estimate of zero ("0") indicate that at least one driver was in the cell, but no crashes or violations were associated with that driver(s). There were no significant findings in Table 77.

Table 77. RR estimates and 95-percent CIs for genitourinary.

Safety Outcome and Age Quartile	No Genitourinary	Diagnosed: Treated	Diagnosed: Untreated	Diagnosed: Unsure	Potential
Total Carrier: 20–33	1.00	0 (0,Inf)	2.023 (0.834,4.905)	0 (0,Inf)	0.990 (0.139,7.059)
Total Carrier: 34–42	1.00	0 (0,Inf)	1.523 (0.630,3.680)	0 (0,Inf)	0.651 (0.162,2.611)
Total Carrier: 43–51	1.00	1.933 (0.864,4.324)	1.139 (0.426,3.048)	0 ($0,2.254^{e266}$)	1.238 (0.397,3.857)
Total Carrier: 52+	1.00	0.768 (0.393,1.50)	0.269 (0.038,1.914)	0 ($0,6.744^{e258}$)	0.838 (0.269,2.608)
Carrier Preventable: 20–33	1.00	0 (0,Inf)	2.427 (0.772,7.634)	0 (0,Inf)	0 (0,Inf)

Safety Outcome and Age Quartile	No Genitourinary	Diagnosed: Treated	Diagnosed: Untreated	Diagnosed: Unsure	Potential
Carrier Preventable: 34–42	1.00	0 (0,Inf)	1.178 (0.293,4.743)	0 (0,Inf)	0.631 (0.089,4.506)
Carrier Preventable: 43–51	1.00	0.636 (0.089,4.534)	2.178 (0.811,5.852)	0 (0,Inf)	1.714 (0.425,6.907)
Carrier Preventable: 52+	1.00	0.657 (0.242,1.788)	0 (0,Inf)	0 (0,Inf)	1.103 (0.274,4.442)
National Crashes: 20–33	1.00	0 (0,Inf)	0.589 (0.083,4.201)	0 (0,Inf)	3.730 (0.924,15.059)
National Crashes: 34–42	1.00	0 (0,Inf)	0.328 (0.046,2.338)	0.981 (0.138,6.991)	0 (0,Inf)
National Crashes: 43–51	1.00	0 (0,Inf)	1.259 (0.470,3.376)	2.854 (1.064,7.654)	1.001 (0.249,4.024)
National Crashes: 52+	1.00	0.991 (0.489,2.009)	0.301 (0.042,2.144)	0.466 (0.065,3.326)	1.673 (0.5364,5.2185)
Violations: 20–33	1.00	1.616 (0.226,11.558)	1.161 (0.372,3.622)	0 (0,Inf)	2.458 (0.611,9.890)
Violations: 34–42	1.00	3.080 (0.763,12.430)	1.155 (0.431,3.098)	1.688 (0.420,6.783)	0.864 (0.121,6.154)
Violations: 43–51	1.00	0.60 (0.084,4.2743)	0.655 (0.163,2.630)	1.460 (0.363,5.867)	2.121 (0.790,5.697)
Violations: 52+	1.00	1.084 (0.510,2.303)	1.930 (0.858,4.342)	1.461 (0.467,4.569)	0 (0,Inf)

5.3.1.12 Heart/Cardiovascular Disease

Of the 13,724 drivers who completed the Medical Examination Report:

- 330 (2.4 percent) were diagnosed with heart/cardiovascular disease:
  - 224 were treated.
  - 47 were untreated.
  - 59 did not clearly indicate whether they were treated (categorized as "Diagnosed: Unsure" in the analysis).
- 90 (0.66 percent) had potential heart/cardiovascular disease (not formally diagnosed by a medical professional).

Table 78 shows the RR estimates and 95-percent CIs for heart/cardiovascular disease (e.g., coronary artery disease, heart murmur, etc.). Significant RR estimates ($p < 0.05$) are denoted with an asterisk. Cells with "NA" indicate no driver was in the cell and/or no driver was in the reference cell; thus, no RR estimates could be calculated. Cells with a RR estimate of zero ("0") indicate that at least one driver was in the cell, but no crashes or violations were associated with that driver(s). There were no significant findings in Table 78.

Table 78. RR estimates and 95-percent CIs for heart/cardiovascular disease.

Safety Outcome and Age Quartile	No Heart/ Cardiovascular Disease	Diagnosed: Treated	Diagnosed: Untreated	Diagnosed: Unsure	Potential
Total Carrier: 20–33	1.00	1.014 (0.142,7.250)	0 (0,1.747^{e230})	2.401 (0.877,6.569)	0.641 (0.090,4.563)
Total Carrier: 34–42	1.00	0.965 (0.310,3.004)	2.596 (0.644,10.467)	0.404 (0.057,2.887)	0.597 (0.084,4.249)
Total Carrier: 43–51	1.00	0.709 (0.352,1.428)	0 (0,Inf)	0 (0,Inf)	1.097 (0.352,3.414)
Total Carrier: 52+	1.00	0.952 (0.60,1.51)	2.320 (0.577,9.328)	0.865 (0.277,2.696)	0.484 (0.121,1.939)
Carrier Preventable: 20–33	1.00	0 (0,Inf)	0 (0,Inf)	0 (0,Inf)	1.243 (0.174,8.858)
Carrier Preventable: 34–42	1.00	0 (0,Inf)	2.354 (0.328,16.899)	0.817 (0.114,5.880)	0 (0,Inf)
Carrier Preventable: 43–51	1.00	0.533 (0.171,1.67)	0 (0,Inf)	0 (0,Inf)	0.695 (0.098,4.954)
Carrier Preventable: 52+	1.00	0.898 (0.460,1.753)	2.323 (0.325,16.624)	0.576 (0.081,4.116)	0.489 (0.068,3.492)
National Crashes: 20–33	1.00	0 (0,Inf)	0 (0,Inf)	3.303 (0.814,13.404)	0 (0,Inf)
National Crashes: 34–42	1.00	0.633 (0.089,4.515)	0 (0,Inf)	0 (0,Inf)	0 (0,Inf)
National Crashes: 43–51	1.00	0.392 (0.097,1.573)	0 (0,Inf)	0.888 (0.125,6.325)	1.932 (0.719,5.195)
National Crashes: 52+	1.00	0.713 (0.378,1.346)	0 (0,Inf)	1.839 (0.759,4.455)	0.599 (0.149,2.408)
Violations: 20–33	1.00	0 (0,Inf)	0.803 (0.113,5.733)	0 (0,Inf)	0 (0,Inf)
Violations: 34–42	1.00	0 (0,Inf)	0 (0,Inf)	0.855 (0.120,6.090)	2.033 (0.652,6.339)
Violations: 43–51	1.00	0.843 (0.314,2.262)	1.173 (0.292,4.715)	1.895 (0.472,7.618)	0 (0,Inf)
Violations: 52+	1.00	1.038 (0.579,1.860)	0 (0,Inf)	0.825 (0.205,3.317)	0.696 (0.173,2.801)

5.3.1.13 High Blood Pressure

Of the 13,724 drivers who completed the Medical Examination Report:

- 3,347 (24.39 percent) were diagnosed with high blood pressure:
  - 3,105 were treated.
  - 178 were untreated.
  - 64 did not clearly indicate whether they were treated (categorized as "Diagnosed: Unsure" in the analysis).

- 559 (4.07 percent) had potential high blood pressure (not formally diagnosed by a medical professional).

Table 79 shows the RR estimates and 95-percent CIs for high blood pressure. Significant RR estimates ($p < 0.05$) are denoted with an asterisk. Cells with "NA" indicate no driver was in the cell and/or no driver was in the reference cell; thus, no RR estimates could be calculated. Cells with a RR estimate of zero ("0") indicate that at least one driver was in the cell, but no crashes or violations were associated with that driver(s). There were four significant findings in Table 79:

- Drivers aged 34–42 with potential high blood pressure were 69.7 percent more likely to be involved in a total carrier crash compared to drivers aged 34–42 who did not have high blood pressure.
- Drivers aged 34–42 with treated high blood pressure were 40 percent less likely to be convicted of a moving violation compared to drivers aged 34–42 who did not have high blood pressure.
- Drivers aged 34–42 with untreated high blood pressure and potential high blood pressure were 2.19 and 2.96 times more likely to be convicted of a moving violation, respectively, compared to drivers aged 34–42 who did not have high blood pressure.

Table 79. RR estimates and 95-percent CIs for high blood pressure.

Safety Outcome and Age Quartile	No High Blood Pressure	Diagnosed: Treated	Diagnosed: Untreated	Diagnosed: Unsure	Potential
Total Carrier: 20–33	1.00	1.167 (0.812,1.678)	2.135 (0.796,5.726)	0 ($0,7.205^{e238}$)	1.153 (0.741,1.792)
Total Carrier: 34–42	1.00	0.816 (0.622,1.071)	1.254 (0.592,2.654)	0.813 (0.202,3.263)	1.697* (1.226,2.350)
Total Carrier: 43–51	1.00	0.905 (0.743,1.102)	1.202 (0.619,2.334)	0.792 (0.296,2.123)	1.366 (0.964,1.934)
Total Carrier: 52+	1.00	0.965 (0.796,1.170)	1.075 (0.571,2.024)	0.604 (0.150,2.43)	1.519 (1.027,2.246)
Carrier Preventable: 20–33	1.00	1.261 (0.770,2.064)	2.058 (0.51,8.303)	0 (0,Inf)	1.056 (0.558,1.999)
Carrier Preventable: 34–42	1.00	0.872 (0.606,1.256)	1.380 (0.511,3.726)	0 (0,Inf)	1.128 (0.656,1.938)
Carrier Preventable: 43–51	1.00	1.111 (0.85,1.4535)	1.446 (0.593,3.527)	1.241 (0.396,3.89)	1.405 (0.854,2.314)
Carrier Preventable: 52+	1.00	0.912 (0.695,1.196)	1.444 (0.674,3.093)	0.563 (0.078,4.037)	1.147 (0.619,2.126)
National Crashes: 20–33	1.00	0.694 (0.366,1.315)	0 (0,Inf)	0 (0,Inf)	0.987 (0.522,1.865)
National Crashes: 34–42	1.00	1.032 (0.734,1.451)	0.717 (0.178,2.891)	1.740 (0.243,12.442)	1.521 (0.950,2.433)
National Crashes: 43–51	1.00	0.701 (0.536,0.917)	0.764 (0.315,1.854)	0.854 (0.212,3.436)	1.033 (0.639,1.670)

Safety Outcome and Age Quartile	No High Blood Pressure	Diagnosed: Treated	Diagnosed: Untreated	Diagnosed: Unsure	Potential
National Crashes: 52+	1.00	0.977 (0.769,1.240)	1.163 (0.514,2.631)	0.815 (0.202,3.295)	0.647 (0.317,1.317)
Violations: 20–33	1.00	0.527 (0.288,0.965)	1.663 (0.619,4.468)	0 ($0,5.087^{e230}$)	0.827 (0.464,1.475)
Violations: 34–42	1.00	0.600* (0.403,0.894)	2.193* (1.032,4.660)	0 (0,Inf)	2.960* (2.139,4.095)
Violations: 43–51	1.00	0.851 (0.649,1.115)	1.586 (0.813,3.093)	1.007 (0.25,4.056)	1.295 (0.817,2.050)
Violations: 52+	1.00	1.010 (0.788,1.294)	2.084 (1.097,3.961)	1.396 (0.444,4.387)	0.941 (0.509,1.739)

5.3.1.14 Head/Brain Injury

Of the 13,724 drivers who completed the Medical Examination Report:

- 128 (0.93 percent) had a diagnosed head or brain injury:
  - 38 were treated.
  - 2 were untreated.
  - 88 did not clearly indicate whether they were treated (categorized as "Diagnosed: Unsure" in the analysis).
- 3 (0.02 percent) had a potential head or brain injury (not formally diagnosed by a medical professional).

Table 80 shows the RR estimates and 95-percent CIs for head/brain injury (e.g., migraine, head/brain injury). Significant RR estimates ($p < 0.05$) are denoted with an asterisk. Cells with "NA" indicate no driver was in the cell and/or no driver was in the reference cell; thus, no RR estimates could be calculated. Cells with a RR estimate of zero ("0") indicate that at least one driver was in the cell, but no crashes or violations were associated with that driver(s). There were no significant findings in Table 80.

Table 80. RR estimates and 95-percent CIs for head/brain injury.

Safety Outcome and Age Quartile	No Head/Brain Injury	Diagnosed: Treated	Diagnosed: Untreated	Diagnosed: Unsure	Potential
Total Carrier: 20–33	1.00	2.732 (1.020,7.318)	NA	0.979 (0.314,3.053)	8^{e-04} ($0,1.534^{e239}$)
Total Carrier: 34–42	1.00	1.112 (0.276,4.472)	NA	0.951 (0.355,2.546)	NA
Total Carrier: 43–51	1.00	0.482 (0.068,3.441)	0 ($0,8.419^{e237}$)	1.309 (0.42,4.080)	NA
Total Carrier: 52+	1.00	1.175 (0.165,8.378)	1^{e-04} (0,Inf)	1.759 (0.786,3.936)	0.003 (0,Inf)
Carrier Preventable: 20–33	1.00	2.527 (0.627,10.177)	NA	0 (0,Inf)	0 (0,Inf)

Safety Outcome and Age Quartile	No Head/Brain Injury	Diagnosed: Treated	Diagnosed: Untreated	Diagnosed: Unsure	Potential
Carrier Preventable: 34–42	1.00	1.006 (0.141,7.199)	NA	0 (0,Inf)	NA
Carrier Preventable: 43–51	1.00	0.928 (0.130,6.652)	0 (0,Inf)	1.709 (0.424,6.892)	NA
Carrier Preventable: 52+	1.00	0 (0,Inf)	0 (0,Inf)	1.747 (0.559,5.459)	1e-04 (0,Inf)
National Crashes: 20–33	1.00	0.784 (0.11,5.593)	NA	0.793 (0.111,5.677)	0 (0,Inf)
National Crashes: 34–42	1.00	0 (0,Inf)	NA	0 (0,Inf)	0 (0,Inf)
National Crashes: 43–51	1.00	1.088 (0.153,7.764)	0 (0,Inf)	0.411 (0.058,2.925)	NA
National Crashes: 52+	1.00	1.197 (0.168,8.540)	0 (0,Inf)	0 (0,Inf)	0 (0,Inf)
Violations: 20–33	1.00	0 (0,Inf)	NA	0.551 (0.077,3.930)	0 (0,Inf)
Violations: 34–42	1.00	1.908 (0.474,7.677)	NA	0.461 (0.065,3.280)	0 (0,Inf)
Violations: 43–51	1.00	0 (0,Inf)	0 (0,Inf)	2.095 (0.865,5.072)	NA
Violations: 52+	1.00	1.119 (0.157,7.977)	0 (0,Inf)	0 (0,Inf)	0 (0,Inf)

5.3.1.15 Hormone Dysfunction

Of the 13,724 drivers who completed the Medical Examination Report:

- 34 (0.25 percent) were diagnosed with a hormone dysfunction; all 34 of these drivers were treated.
- 3 (0.02 percent) had a potential hormone dysfunction (not formally diagnosed by a medical professional).

Table 82 shows the RR estimates and 95-percent CIs for hormone dysfunction. Significant RR estimates ($p < 0.05$) are denoted with an asterisk. Cells with "NA" indicate no driver was in the cell and/or no driver was in the reference cell; thus, no RR estimates could be calculated. Cells with a RR estimate of zero ("0") indicate that at least one driver was in the cell, but no crashes or violations were associated with that driver(s). There was one significant finding in Table 82. Drivers over 52 with potential hormone dysfunction were 9.21 times more likely to be involved in a carrier preventable crash compared to drivers over 52 without hormone dysfunction.

Table 81. RR estimates and 95-percent CIs for hormone dysfunction.

Safety Outcome and Age Quartile	No Hormone Dysfunction	Diagnosed: Treated	Diagnosed: Untreated	Diagnosed: Unsure	Potential
Total Carrier: 20–33	1.00	3^{e-04} ($0,5.062^{e238}$)	NA	NA	NA
Total Carrier: 34–42	1.00	0 (0,Inf)	NA	NA	NA

Safety Outcome and Age Quartile	No Hormone Dysfunction	Diagnosed: Treated	Diagnosed: Untreated	Diagnosed: Unsure	Potential
Total Carrier: 43–51	1.00	1.169 (0.291,4.688)	NA	NA	NA
Total Carrier: 52+	1.00	1.02 (0.254,4.098)	NA	NA	4.382 (1.084,17.717)
Carrier Preventable: 20–33	1.00	2^{e-04} (0,Inf)	NA	NA	NA
Carrier Preventable: 34–42	1.00	0 (0,Inf)	NA	NA	NA
Carrier Preventable: 43–51	1.00	2.336 (0.581,9.400)	NA	NA	NA
Carrier Preventable: 52+	1.00	0 (0,Inf)	NA	NA	9.213^{*+} (2.25,37.692)
National Crashes: 20–33	1.00	0 (0,Inf)	NA	NA	NA
National Crashes: 34–42	1.00	1.127 (0.158,8.040)	NA	NA	NA
National Crashes: 43–51	1.00	1.524 (0.379,6.129)	NA	NA	NA
National Crashes: 52+	1.00	1.910 (0.474,7.695)	NA	NA	0 (0,Inf)
Violations: 20–33	1.00	0 ($0,7.527^{e237}$)	NA	NA	NA
Violations: 34–42	1.00	0.990 (0.139,7.061)	NA	NA	NA
Violations: 43–51	1.00	0 ($0,7.558^{e288}$)	NA	NA	NA
Violations: 52+	1.00	0 (0,Inf)	NA	NA	0 (0,Inf)

+ = Three drivers over 52 had potential hormone dysfunction.

5.3.1.16 Hormone Therapy

Of the 13,724 drivers who completed the Medical Examination Report:

- 11 (0.08 percent) were receiving hormone therapy (all treated).
- 1 (0.01 percent) was potentially receiving hormone therapy (not formally confirmed by a medical professional).

Table 82 shows the RR estimates and 95-percent CIs for hormone therapy (e.g., hormone therapy, transgender therapy, etc.). Significant RR estimates ($p < 0.05$) are denoted with an asterisk. Cells with "NA" indicate no driver was in the cell and/or no driver was in the reference cell; thus, no RR estimates could be calculated. Cells with a RR estimate of zero ("0") indicate that at least one driver was in the cell, but no crashes or violations were associated with that driver(s). There were no significant findings in Table 82.

Table 82. RR estimates and 95-percent CIs for hormone therapy.

Safety Outcome and Age Quartile	No Hormone Therapy	Diagnosed: Treated	Diagnosed: Untreated	Diagnosed: Unsure	Potential
Total Carrier: 20–33	1.00	0 (0,Inf)	NA	NA	NA
Total Carrier: 34–42	1.00	5.017 (1.242,20.261)	NA	NA	NA
Total Carrier: 43–51	1.00	1.643 (0.405,6.661)	NA	NA	NA
Total Carrier: 52+	1.00	NA	NA	NA	0 (0,Inf)
Carrier Preventable: 20–33	1.00	0 (0,Inf)	NA	NA	NA
Carrier Preventable: 34–42	1.00	4.873 (0.677,35.074)	NA	NA	NA
Carrier Preventable: 43–51	1.00	1.415 (0.196,10.233)	NA	NA	NA
Carrier Preventable: 52+	1.00	NA	NA	NA	0 (0,Inf)
National Crashes: 20–33	1.00	0 (0,Inf)	NA	NA	NA
National Crashes: 34–42	1.00	0 (0,Inf)	NA	NA	NA
National Crashes: 43–51	1.00	1.803 (0.252,12.899)	NA	NA	NA
National Crashes: 52+	1.00	NA	NA	NA	0 (0,Inf)
Violations: 20–33	1.00	0 ($0,3.059^{e221}$)	NA	NA	NA
Violations: 34–42	1.00	0 (0,Inf)	NA	NA	NA
Violations: 43–51	1.00	0 (0,Inf)	NA	NA	NA
Violations: 52+	1.00	NA	NA	NA	0 (0,Inf)

5.3.1.17 Inflammatory Disease

Of the 13,724 drivers who completed the Medical Examination Report:

- 7 (0.05 percent) were diagnosed with inflammatory disease:
  - 3 were treated.
  - 3 were untreated.
  - 1 did not clearly indicate whether they were treated (categorized as "Diagnosed: Unsure" in the analysis).
- None (0) had potential inflammatory disease.

Table 83 shows the RR estimates and 95-percent CIs for inflammatory disease (e.g., lupus, sarcoidosis, etc.). Significant RR estimates ($p < 0.05$) are denoted with an asterisk. Cells with "NA" indicate no driver was in the cell and/or no driver was in the reference cell; thus, no RR estimates could be calculated. Cells with a RR estimate of zero ("0") indicate that at least one

driver was in the cell, but no crashes or violations were associated with that driver(s). There were no significant findings in Table 83.

Table 83. RR estimates and 95-percent CIs for inflammatory disease.

Safety Outcome and Age Quartile	No Inflammatory Disease	Diagnosed: Treated	Diagnosed: Untreated	Diagnosed: Unsure	Potential
Total Carrier: 20–33	1.00	NA	0 (0,1.405^{e237})	NA	NA
Total Carrier: 34–42	1.00	NA	NA	NA	NA
Total Carrier: 43–51	1.00	NA	NA	NA	NA
Total Carrier: 52+	1.00	NA	NA	NA	NA
Carrier Preventable: 20–33	1.00	NA	0 (0,Inf)	NA	NA
Carrier Preventable: 34–42	1.00	NA	NA	NA	NA
Carrier Preventable: 43–51	1.00	NA	NA	NA	NA
Carrier Preventable: 52+	1.00	NA	NA	NA	NA
National Crashes: 20–33	1.00	NA	0 (0,1.799^{e277})	NA	NA
National Crashes: 34–42	1.00	7.342 (1.024,52.670)	NA	NA	NA
National Crashes: 43–51	1.00	NA	0 (0,Inf)	NA	NA
National Crashes: 52+	1.00	0 (0,Inf)	NA	0(0,Inf)	NA
Violations: 20–33	1.00	NA	0 (0,3.383^{e275})	NA	NA
Violations: 34–42	1.00	0 (0,Inf)	NA	NA	NA
Violations: 43–51	1.00	NA	8.470 (1.180,60.827)	NA	NA
Violations: 52+	1.00	0 (0,Inf)	NA	0 (0,Inf)	NA

5.3.1.18 Loss/Altered Consciousness

Of the 13,724 drivers who completed the Medical Examination Report:

- 13 (0.09 percent) were diagnosed with loss/altered consciousness; none of these clearly indicated whether they were treated (categorized as "Diagnosed: Unsure" in the analysis).
- 1 (0.01 percent) had potential loss/altered consciousness (not formally diagnosed by a medical professional).

Table 84 shows the RR estimates and 95-percent CIs for loss/altered consciousness. Significant RR estimates ($p < 0.05$) are denoted with an asterisk. Cells with "NA" indicate no driver was in the cell and/or no driver was in the reference cell; thus, no RR estimates could be calculated. Cells with a RR estimate of zero ("0") indicate that at least one driver was in the cell, but no crashes or violations were associated with that driver(s). There were no significant findings in Table 84.

Table 84. RR estimates and 95-percent CIs for loss/altered consciousness.

Safety Outcome and Age Quartile	No Loss/Altered Consciousness	Diagnosed: Treated	Diagnosed: Untreated	Diagnosed: Unsure	Potential
Total Carrier: 20–33	1.00	NA	NA	1^{e-04} ($0,2.391^{e238}$)	NA
Total Carrier: 34–42	1.00	NA	NA	0.383 (0.054,2.725)	3^{e-04} (0,Inf)
Total Carrier: 43–51	1.00	NA	NA	0.001 ($0,2.727^{e239}$)	NA
Total Carrier: 52+	1.00	NA	NA	0 (0,Inf)	NA
Carrier Preventable: 20–33	1.00	NA	NA	1^{e-04} (0,Inf)	NA
Carrier Preventable: 34–42	1.00	NA	NA	0 (0,Inf)	2^{e-04} (0,Inf)
Carrier Preventable: 43–51	1.00	NA	NA	4^{e-04} (0,Inf)	NA
Carrier Preventable: 52+	1.00	NA	NA	0 (0,Inf)	NA
National Crashes: 20–33	1.00	NA	NA	0 ($0,9.111^{e275}$)	NA
National Crashes: 34–42	1.00	NA	NA	1.724 (0.241,12.316)	0 (0,Inf)
National Crashes: 43–51	1.00	NA	NA	0 (0,Inf)	NA
National Crashes: 52+	1.00	NA	NA	0 (0,Inf)	NA
Violations: 20–33	1.00	NA	NA	0 ($0,1.606^{e275}$)	NA
Violations: 34–42	1.00	NA	NA	0 (0,Inf)	0 (0,Inf)
Violations: 43–51	1.00	NA	NA	0 (0,Inf)	NA
Violations: 52+	1.00	NA	NA	0 (0,Inf)	NA

5.3.1.19 Kidney Disease/Disorder

Of the 13,724 drivers who completed the Medical Examination Report:

- 131 (0.95 percent) had a diagnosed kidney disease or disorder:
  - 14 were treated.
  - 95 were untreated.
  - 22 did not clearly indicate whether they were treated (categorized as "Diagnosed: Unsure" in the analysis).
- 218 (1.59 percent) had potential kidney disease or a kidney disorder (not formally diagnosed by a medical professional).

Table 85 shows the RR estimates and 95-percent CIs for kidney disease or disorder (e.g., proteinuria, renal functional impairment, etc.). Significant RR estimates ($p < 0.05$) are denoted

with an asterisk. Cells with "NA" indicate no driver was in the cell and/or no driver was in the reference cell; thus, no RR estimates could be calculated. Cells with a RR estimate of zero ("0") indicate that at least one driver was in the cell, but no crashes or violations were associated with that driver(s). There were no significant findings in Table 85.

Table 85. RR estimates and 95-percent CIs for kidney disease/disorder.

Safety Outcome and Age Quartile	No Loss of Consciousness	Diagnosed: Treated	Diagnosed: Untreated	Diagnosed: Unsure	Potential
Total Carrier: 20–33	1.00	2.208 (0.310,15.735)	1.685 (0.539,5.262)	0 (0,Inf)	0.853 (0.425,1.715)
Total Carrier: 34–42	1.00	0 (0,Inf)	0.859 (0.214,3.447)	0 (0,Inf)	0.510 (0.191,1.364)
Total Carrier: 43–51	1.00	0 (0,Inf)	1.577 (0.747,3.330)	0 (0,Inf)	0.819 (0.366,1.835)
Total Carrier: 52+	1.00	1.291 (0.181,9.203)	0.975 (0.436,2.182)	1.288 (0.321,5.171)	1.221 (0.670,2.225)
Carrier Preventable: 20–33	1.00	4.332 (0.606,30.976)	1.143 (0.160,8.186)	0 (0,Inf)	1.438 (0.679,3.044)
Carrier Preventable: 34–42	1.00	0 (0,Inf)	0.815 (0.114,5.812)	0 (0,Inf)	0.494 (0.123,1.988)
Carrier Preventable: 43–51	1.00	0 (0,Inf)	2.328 (0.959,5.653)	0 (0,Inf)	0.257 (0.036,1.831)
Carrier Preventable: 52+	1.00	0 (0,Inf)	1.298 (0.483,3.491)	1.267 (0.178,9.048)	1.283 (0.568,2.895)
National Crashes: 20–33	1.00	0 (0,Inf)	1.051 (0.147,7.517)	0 (0,Inf)	1.056 (0.436,2.560)
National Crashes: 34–42	1.00	0 (0,Inf)	0.620 (0.087,4.415)	0 (0,Inf)	1.190 (0.443,3.193)
National Crashes: 43–51	1.00	0 (0,Inf)	1.607 (0.664,3.890)	0 (0,Inf)	1.015 (0.419,2.456)
National Crashes: 52+	1.00	2.688 (0.373,19.207)	0.278 (0.039,1.982)	1.091 (0.153,7.784)	1.950 (1.094,3.478)
Violations: 20–33	1.00	0 (0,Inf)	0.692 (0.097,4.938)	0 (0,Inf)	0.993 (0.470,2.098)
Violations: 34–42	1.00	0 (0,Inf)	0.550 (0.077,3.9207)	0 (0,Inf)	1.487 (0.663,3.334)
Violations: 43–51	1.00	0 (0,6.496^{e291})	1.348 (0.502,3.616)	3.420 (0.478,24.454)	2.037 (1.049,3.956)
Violations: 52+	1.00	2.631 (0.367,18.864)	1.566 (0.645,3.801)	1.374 (0.192,9.815)	2.085 (1.169,3.720)

5.3.1.20 Lung and Chest

Of the 13,724 drivers who completed the Medical Examination Report:

- 367 (2.67 percent) had a diagnosed lung and chest condition:
  - 274 were treated.
  - 28 were untreated.
  - 65 did not clearly indicate whether they were treated (categorized as "Diagnosed: Unsure" in the analysis).

- 13 (0.09 percent) had a potential lung and chest condition (not formally diagnosed by a medical professional).

Table 86 shows the RR estimates and 95-percent CIs for lung and chest conditions (e.g., chronic obstructive pulmonary disease, asthma, etc.). Significant RR estimates ($p < 0.05$) are denoted with an asterisk. Cells with "NA" indicate no driver was in the cell and/or no driver was in the reference cell; thus, no RR estimates could be calculated. Cells with a RR estimate of zero ("0") indicate that at least one driver was in the cell, but no crashes or violations were associated with that driver(s). There were four significant findings in Table 86:

- Drivers over 52 with an untreated lung and chest condition were 3.72 times more likely to be involved in a total carrier crash compared to drivers over 52 who did not have a lung and chest condition.
- Drivers over 52 with a potential lung and chest condition were 4.11 times more likely to be involved in a total carrier crash compared to drivers over 52 who did not have a lung and chest condition.
- Drivers over 52 with an untreated lung and chest condition were 4.72 times more likely to be involved in a carrier preventable crash compared to drivers over 52 who did not have a lung and chest condition.
- Drivers over 52 with a potential lung and chest condition were 8.67 times more likely to be involved in a carrier preventable crash compared to drivers over 52 who did not have a lung and chest condition.

Table 86. RR estimates and 95-percent CIs for lung and chest.

Safety Outcome and Age Quartile	No Lung and Chest Condition	Diagnosed: Treated	Diagnosed: Untreated	Diagnosed: Unsure	Potential
Total Carrier: 20–33	1.00	1.40 (0.837,2.341)	0 (0,1.905[e269])	0.251 (0.035,1.785)	0 (0,Inf)
Total Carrier: 34–42	1.00	0.691 (0.343,1.391)	0 (0,Inf)	1.189 (0.381,3.706)	0 (0,Inf)
Total Carrier: 43–51	1.00	1.24 (0.772,1.993)	2.015 (0.502,8.096)	1.874 (0.700,5.014)	0 (0,2.777[e247])
Total Carrier: 52+	1.00	0.895 (0.467,1.717)	3.724*+ (1.535,9.035)	0 (0,Inf)	4.110*+ (1.017,16.602)
Carrier Preventable: 20–33	1.00	1.625 (0.836,3.160)	0 (0,Inf)	0 (0,Inf)	0 (0,Inf)
Carrier Preventable: 34–42	1.00	0.496 (0.159,1.550)	0 (0,Inf)	0.759 (0.106,5.417)	0 (0,Inf)
Carrier Preventable: 43–51	1.00	1.325 (0.700,2.508)	0 (0,Inf)	3.707 (1.380,9.956)	0 (0,Inf)
Carrier Preventable: 52+	1.00	0.810 (0.301,2.178)	4.72*+ (1.501,14.89)	0 (0,Inf)	8.671*+ (2.124,35.403)
National Crashes: 20–33	1.00	0.614 (0.229,1.648)	1.396 (0.195,10.021)	0.595 (0.083,4.247)	12.706 (1.743,92.650)

Safety Outcome and Age Quartile	No Lung and Chest Condition	Diagnosed: Treated	Diagnosed: Untreated	Diagnosed: Unsure	Potential
National Crashes: 34–42	1.00	0 (0,Inf)	0 (0,Inf)	1.714 (0.426,6.892)	0 (0,Inf)
National Crashes: 43–51	1.00	0.648 (0.268,1.569)	2.247 (0.315,16.024)	0 (0,Inf)	0 (0,Inf)
National Crashes: 52+	1.00	1.027 (0.457,2.310)	4.318 (1.608,11.597)	0.748 (0.105,5.335)	0 (0,Inf)
Violations: 20–33	1.00	0.721 (0.341,1.522)	0 (0,1.072^{e240})	0.395 (0.055,2.812)	8.466 (1.172,61.171)
Violations: 34–42	1.00	0.484 (0.155,1.510)	0 (0,Inf)	0.690 (0.097,4.914)	5.073 (1.260,20.434)
Violations: 43–51	1.00	0.730 (0.301,1.767)	0 (0,Inf)	0.657 (0.092,4.678)	4.613 (0.645,32.979)
Violations: 52+	1.00	1.135 (0.505,2.551)	1.050 (0.147,7.487)	0 (0,Inf)	0 (0,Inf)

+ = 10 drivers over the age of 52 had an untreated lung and chest condition and 6 drivers over the age of 52 had a potential lung and chest condition.

5.3.1.21 Missing/Impaired Limb

Of the 13,724 drivers who completed the Medical Examination Report:

- 117 were diagnosed with a missing/impaired limb:
  - 4 were treated.
  - 5 were untreated.
  - 108 did not clearly indicate whether they were treated (categorized as "Diagnosed: Unsure" in the analysis).
- None (0) had a potential missing/impaired limb.

Table 87 shows the RR estimates and 95-percent CIs for missing/impaired limb (e.g., missing extremity, amputation). Significant RR estimates ($p < 0.05$) are denoted with an asterisk. Cells with "NA" indicate no driver was in the cell and/or no driver was in the reference cell; thus, no RR estimates could be calculated. Cells with a RR estimate of zero ("0") indicate that at least one driver was in the cell, but no crashes or violations were associated with that driver(s). There were three significant findings in Table 87:

- Drivers aged 20–33 with a treated missing limb were 37.04 times more likely to be involved in a national crash compared to drivers aged 20–33 who did not have a missing limb.
- Drivers over 52 with a treated missing/impaired limb were 14.71 times more likely to be involved in a national crash compared to drivers 52 and older who did not have a missing/impaired limb.
- Drivers over 52 with a treated missing limb were 17.51 times more likely to be convicted of a moving violation compared to drivers over 52 who did not have a missing limb.

Table 87. RR estimates and 95-percent CIs for missing/impaired limb.

Safety Outcome and Age Quartile	No Missing/ Impaired Limb	Diagnosed: Treated	Diagnosed: Untreated	Diagnosed: Unsure	Potential
Total Carrier: 20–33	1.00	12.949 (1.343,124.863)	2.438 (0.341,17.422)	1.403 (0.349,5.637)	NA
Total Carrier: 34–42	1.00	NA	NA	1.134 (0.424,3.037)	NA
Total Carrier: 43–51	1.00	NA	NA	1.828 (0.812,4.117)	NA
Total Carrier: 52+	1.00	2.358 (0.329,16.888)	0 (0,Inf)	0.411 (0.132,1.280)	NA
Carrier Preventable: 20–33	1.00	1^{e-04} (0,Inf)	4.889 (0.679,35.181)	2.683 (0.665,10.824)	NA
Carrier Preventable: 34–42	1.00	NA	NA	0.543 (0.076,3.871)	NA
Carrier Preventable: 43–51	1.00	NA	NA	1.111 (0.274,4.499)	NA
Carrier Preventable: 52+	1.00	4.706 (0.651,34.011)	0 (0,Inf)	0.551 (0.137,2.217)	NA
National Crashes: 20–33	1.00	37.035*+ (3.338,410.886)	3.977 (0.553,28.585)	0 ($0,6.970^{e260}$)	NA
National Crashes: 34–42	1.00	NA	NA	0.512 (0.072,3.649)	NA
National Crashes: 43–51	1.00	NA	NA	0.428 (0.060,3.051)	NA
National Crashes: 52+	1.00	14.712*+ (3.623,59.735)	0 (0,Inf)	1.533 (0.724,3.245)	NA
Violations: 20–33	1.00	13.066 (1.565,109.062)	0 ($0,9.245^{e224}$)	0.456 (0.064,3.245)	NA
Violations: 34–42	1.00	NA	NA	0.882 (0.219,3.544)	NA
Violations: 43–51	1.00	NA	NA	0.911 (0.227,3.660)	NA
Violations: 52+	1.00	17.506*+ (4.308,71.175)	0 (0,Inf)	0.696 (0.223,2.170)	NA

+ = There was one driver aged 20–33 with a treated missing/impaired limb and three drivers aged 52 or older with a treated missing/impaired limb.

5.3.1.22 Mouth and Throat

Of the 13,724 drivers who completed the Medical Examination Report:

- 16 (0.12 percent) had a mouth and throat condition:
  - 4 were treated.
  - 12 did not clearly indicate whether they were treated (categorized as "Diagnosed: Unsure" in the analysis).

- None (0) had a potential mouth and throat condition.

Table 88 shows the RR estimates and 95-percent CIs for mouth and throat conditions (e.g., thrush, dental infections, etc.). Significant RR estimates ($p < 0.05$) are denoted with an asterisk. Cells with "NA" indicate no driver was in the cell and/or no driver was in the reference cell; thus, no RR estimates could be calculated. Cells with a RR estimate of zero ("0") indicate that at least one driver was in the cell, but no crashes or violations were associated with that driver(s). There were no significant findings in Table 88.

Table 88. RR estimates and 95-percent CIs for mouth and throat.

Safety Outcome and Age Quartile	No Mouth and Throat	Diagnosed: Treated	Diagnosed: Untreated	Diagnosed: Unsure	Potential
Total Carrier: 20–33	1.00	0 (0,7.872^{e237})	NA	NA	NA
Total Carrier: 34–42	1.00	NA	NA	NA	NA
Total Carrier: 43–51	1.00	NA	NA	NA	NA
Total Carrier: 52+	1.00	NA	NA	NA	NA
Carrier Preventable: 20–33	1.00	0 (0,Inf)	NA	NA	NA
Carrier Preventable: 34–42	1.00	NA	NA	NA	NA
Carrier Preventable: 43–51	1.00	NA	NA	NA	NA
Carrier Preventable: 52+	1.00	NA	NA	NA	NA
National Crashes: 20–33	1.00	0 (0,Inf)	NA	NA	NA
National Crashes: 34–42	1.00	NA	NA	NA	NA
National Crashes: 43–51	1.00	NA	NA	NA	NA
National Crashes: 52+	1.00	NA	NA	NA	NA
Violations: 20–33	1.00	0 (0,6.031^{e237})	NA	NA	NA
Violations: 34–42	1.00	NA	NA	NA	NA
Violations: 43–51	1.00	NA	NA	NA	NA
Violations: 52+	1.00	NA	NA	NA	NA

5.3.1.23 Muscular Disease

Of the 13,724 drivers who completed the Medical Examination Report:

- 151 (1.10 percent) had diagnosed muscular disease:
  - 61 were treated.
  - 14 were untreated.
  - 76 did not clearly indicate whether they were treated (categorized as "Diagnosed: Unsure" in the analysis).
- 14 (0.10 percent) had potential muscular disease (not formally diagnosed by a medical professional).

Table 89 shows the RR estimates and 95-percent CIs for muscular disease (e.g., chronic musculoskeletal pain, chronic low back pain, etc.). Significant RR estimates ($p < 0.05$) are denoted with an asterisk. Cells with "NA" indicate no driver was in the cell and/or no driver was in the reference cell; thus, no RR estimates could be calculated. Cells with a RR estimate of zero ("0") indicate that at least one driver was in the cell, but no crashes or violations were associated with that driver(s). There were two significant findings in Table 89:

- Drivers aged 20–33 with treated muscular disease were 5.76 times more likely to be involved in a carrier preventable crash compared to drivers aged 20–33 who did not have muscular disease.
- Drivers aged 20–33 with untreated muscular disease were 7.92 times more likely to be involved in a carrier preventable crash compared to drivers aged 20–33 who did not have muscular disease.

Table 89. RR estimates and 95-percent CIs for muscular disease.

Safety Outcome and Age Quartile	No Muscular Disease	Diagnosed: Treated	Diagnosed: Untreated	Diagnosed: Unsure	Potential
Total Carrier: 20–33	1.00	3.092 (0.987,9.687)	6.323 (2.025,19.743)	0.548 (0.077,3.895)	1.812 (0.254,12.919)
Total Carrier: 34–42	1.00	2.374 (0.886,6.361)	0 (0,Inf)	0 (0,Inf)	0 (0,Inf)
Total Carrier: 43–51	1.00	0.616 (0.088,4.392)	1.656 (0.531,5.169)	2.440 (1.002,5.942)	0 (0,1.856[e305])
Total Carrier: 52+	1.00	1.358 (0.507,3.638)	0 (0,Inf)	1.005 (0.414,2.444)	1.59 (0.223,11.331)
Carrier Preventable: 20–33	1.00	5.756[*+] (1.820,18.203)	7.916[*+] (1.958,31.995)	0 (0,8.088[e251])	3.397 (0.475,24.322)
Carrier Preventable: 34–42	1.00	1.148 (0.161,8.198)	0 (0,Inf)	0 (0,Inf)	0 (0,Inf)
Carrier Preventable: 43–51	1.00	0 (0,Inf)	1.069 (0.149,7.644)	0.919 (0.128,6.601)	0 (0,Inf)
Carrier Preventable: 52+	1.00	1.395 (0.346,5.624)	0 (0,Inf)	0.843 (0.209,3.403)	0 (0,Inf)
National Crashes: 20–33	1.00	3.179 (1.014,9.96)	0 (0,Inf)	0.596 (0.084,4.242)	0 (0,Inf)
National Crashes: 34–42	1.00	1.442 (0.358,5.798)	0 (0,Inf)	0.700 (0.098,4.988)	0 (0,Inf)
National Crashes: 43–51	1.00	0.766 (0.107,5.458)	1.244 (0.174,8.870)	0.884 (0.124,6.293)	0 (0,Inf)
National Crashes: 52+	1.00	0.589 (0.083,4.202)	0 (0,Inf)	0.951 (0.237,3.823)	2.499 (0.350,17.866)
Violations: 20–33	1.00	0.763 (0.107,5.439)	0 (0,Inf)	0 (0,4.266[e249])	0 (0,Inf)
Violations: 34–42	1.00	1.886 (0.605,5.885)	0 (0,Inf)	1.208 (0.301,4.850)	0 (0,Inf)
Violations: 43–51	1.00	0 (0,1.688[e292])	3.833 (1.226,11.984)	0.887 (0.125,6.321)	0 (0,Inf)

Safety Outcome and Age Quartile	No Muscular Disease	Diagnosed: Treated	Diagnosed: Untreated	Diagnosed: Unsure	Potential
Violations: 52+	1.00	1.188 (0.295,4.784)	0 (0,Inf)	1.003 (0.249,4.031)	0 (0,Inf)

+ = 11 drivers aged 20–33 had treated muscular disease and 3 drivers aged 20–33 had untreated muscular disease.

5.3.1.24 Nervous/Psychiatric Disorder

Of the 13,724 drivers who completed the Medical Examination Report:

- 401 (2.92 percent) had a diagnosed nervous/psychiatric disorder:
  - 325 were treated.
  - 34 were untreated.
  - 42 did not clearly indicate whether they were treated (categorized as "Diagnosed: Unsure" in the analysis).
- 18 (0.13 percent) had a potential nervous/psychiatric disorder (not formally diagnosed by a medical professional).

Table 90 shows the RR estimates and 95-percent CIs for nervous/psychiatric disorder (e.g., depression, anxiety, etc.). Significant RR estimates ($p < 0.05$) are denoted with an asterisk. Cells with "NA" indicate no driver was in the cell and/or no driver was in the reference cell; thus, no RR estimates could be calculated. Cells with a RR estimate of zero ("0") indicate that at least one driver was in the cell, but no crashes or violations were associated with that driver(s). There were three significant findings in Table 90:

- Drivers aged 43–51 with a treated nervous/psychiatric disorder were 84.8 percent and 2.42 times more likely to be involved in a total carrier crash and carrier preventable crash, respectively, compared to drivers aged 43–51 who did not have a nervous/psychiatric disorder.
- Drivers over 52 with an untreated nervous/psychiatric disorder were 11.43 times more likely to be involved in a national crash compared to drivers over 52 without a nervous/psychiatric condition.

Table 90. RR estimates and 95-percent CIs for nervous/psychiatric disorder.

Safety Outcome and Age Quartile	No Nervous/ Psychiatric Disorder	Diagnosed: Treated	Diagnosed: Untreated	Diagnosed: Unsure	Potential
Total Carrier: 20–33	1.00	1.327 (0.592,2.976)	1.164 (0.289,4.693)	0.530 (0.074,3.770)	7^{e-04} $(0,1.300^{e221})$
Total Carrier: 34–42	1.00	1.462 (0.873,2.446)	1.844 (0.459,7.416)	0.724 (0.101,5.173)	2.430 (0.604,9.773)
Total Carrier: 43–51	1.00	1.848* (1.234,2.766)	0.611 (0.086,4.355)	1.834 (0.586,5.739)	0 $(0,1.245^{e221})$
Total Carrier: 52+	1.00	1.512 (0.954,2.396)	0 (0,Inf)	1.488 (0.370,5.989)	0 (0,Inf)

Safety Outcome and Age Quartile	No Nervous/ Psychiatric Disorder	Diagnosed: Treated	Diagnosed: Untreated	Diagnosed: Unsure	Potential
Carrier Preventable: 20–33	1.00	0.838 (0.208,3.380)	0 (0,Inf)	0 (0,Inf)	1^{e-04} (0,Inf)
Carrier Preventable: 34–42	1.00	1.520 (0.751,3.077)	3.687 (0.912,14.910)	0 (0,Inf)	2.322 (0.325,16.620)
Carrier Preventable: 43–51	1.00	2.418* (1.455,4.019)	0 (0,Inf)	1.137 (0.159,8.151)	0 (0,Inf)
Carrier Preventable: 52+	1.00	1.613 (0.855,3.043)	0 (0,Inf)	0 (0,Inf)	0 (0,Inf)
National Crashes: 20–33	1.00	1.218 (0.453,3.281)	0 (0,Inf)	0 (0,Inf)	0 (0,Inf)
National Crashes: 34–42	1.00	0.848 (0.377,1.905)	0(0,Inf)	0 (0,Inf)	8.391 (2.079,33.866)
National Crashes: 43–51	1.00	1.051 (0.559,1.974)	1.450 (0.203,10.352)	3.060 (0.981,9.550)	1.288 (0.181,9.182)
National Crashes: 52+	1.00	1.662 (0.987,2.797)	11.429*+ (2.819,46.328)	0 (0,Inf)	0 (0,Inf)
Violations: 20–33	1.00	0.213 (0.030,1.517)	0.511 (0.072,3.639)	1.633 (0.406,6.563)	2.599 (0.363,18.602)
Violations: 34–42	1.00	0.972 (0.482,1.961)	0 (0,Inf)	1.734 (0.242,12.431)	0 (0,Inf)
Violations: 43–51	1.00	1.678 (0.998,2.822)	1.326 (0.186,9.463)	0 ($0,3.795^{e286}$)	1.402 (0.197,9.995)
Violations: 52+	1.00	0.908 (0.449,1.836)	0 (0,Inf)	0 (0,Inf)	0 (0,Inf)

+ = Three drivers over 52 had untreated nervous/psychiatric disorder.

5.3.1.25 Neurological

Of the 13,724 drivers who completed the Medical Examination Report:

- 93 (0.68 percent) had a diagnosed neurological condition:
  - 17 were treated.
  - 17 were untreated.
  - 59 did not clearly indicate whether they were treated (categorized as "Diagnosed: Unsure" in the analysis).
- 9 (0.07 percent) had a potential neurological condition (not formally diagnosed by a medical professional).

Table 91 shows the RR estimates and 95-percent CIs for neurological conditions (e.g., carpal tunnel, Parkinson's Disease, etc.). Significant RR estimates ($p < 0.05$) are denoted with an asterisk. Cells with "NA" indicate no driver was in the cell and/or no driver was in the reference cell; thus, no RR estimates could be calculated. Cells with a RR estimate of zero ("0") indicate that at least one driver was in the cell, but no crashes or violations were associated with that driver(s). There were no significant findings in Table 91.

Table 91. RR estimates and 95-percent CIs for neurological.

Safety Outcome and Age Quartile	No Neurological Condition	Diagnosed: Treated	Diagnosed: Untreated	Diagnosed: Unsure	Potential
Total Carrier: 20–33	1.00	NA	0 (0,Inf)	2.013 (0.282,14.369)	NA
Total Carrier: 34–42	1.00	NA	3.133 (0.439,22.373)	1.486 (0.208,10.610)	0 (0,Inf)
Total Carrier: 43–51	1.00	0 (0,Inf)	0 (0,Inf)	0 (0,Inf)	0 (0,Inf)
Total Carrier: 52+	1.00	0 (0,Inf)	2.355 (0.330,16.80)	0 (0,Inf)	2.204 (0.308,15.779)
Carrier Preventable: 20–33	1.00	NA	0 (0,Inf)	0 (0,Inf)	NA
Carrier Preventable: 34–42	1.00	NA	5.791 (0.806,41.596)	2.843 (0.396,20.403)	0 (0,Inf)
Carrier Preventable: 43–51	1.00	0 (0,Inf)	0 (0,Inf)	0 (0,Inf)	0 (0,Inf)
Carrier Preventable: 52+	1.00	0 (0,Inf)	4.686 (0.654,33.595)	0 (0,Inf)	4.550 (0.630,32.870)
National Crashes: 20–33	1.00	NA	0 (0,Inf)	0 (0,Inf)	NA
National Crashes: 34–42	1.00	NA	0 (0,Inf)	1.506 (0.211,10.744)	0 (0,Inf)
National Crashes: 43–51	1.00	0 (0,Inf)	0 (0,Inf)	0 (0,Inf)	0 (0,Inf)
National Crashes: 52+	1.00	0.909 (0.128,6.482)	2.047 (0.286,14.652)	0.597 (0.083,4.267)	5.615 (0.780,40.395)
Violations: 20–33	1.00	NA	0 ($0,1.051^{e220}$)	1.894 (0.266,13.485)	NA
Violations: 34–42	1.00	NA	1.507 (0.211,10.767)	2.587 (0.643,10.402)	0 (0,Inf)
Violations: 43–51	1.00	3.567 (0.886,14.358)	0 (0,Inf)	0 (0,Inf)	0 (0,Inf)
Violations: 52+	1.00	1.057 (0.148,7.543)	0 (0,Inf)	0 (0,Inf)	4.705 (0.655,33.813)

5.3.1.26 OSA

Of the 13,724 drivers who completed the Medical Examination Report:

- 981 (7.15 percent) had diagnosed OSA:
  - 724 were treated.
  - 139 were untreated.
  - 118 did not clearly indicate whether they were treated (categorized as "Diagnosed: Unsure" in the analysis).
- 879 (6.40 percent) had potential OSA (not formally diagnosed by a medical professional).

Table 92 shows the RR estimates and 95-percent CIs for OSA. Significant RR estimates ($p < 0.05$) are denoted with an asterisk. Cells with "NA" indicate no driver was in the cell and/or no driver was in the reference cell; thus, no RR estimates could be calculated. Cells with a RR

estimate of zero ("0") indicate that at least one driver was in the cell, but no crashes or violations were associated with that driver(s). There were four significant findings in Table 92:

- Drivers aged 34–42 with treated OSA were 95.9 percent less likely to be involved in a carrier preventable crash compared to drivers aged 34–42 who did not have OSA.
- Drivers aged 34–42 with potential OSA were 66.2 percent more likely to be convicted of a moving violation compared to drivers aged 34–42 who did not have OSA.
- Drivers aged 43–51 with potential OSA were 78.3 percent more likely to be involved in a carrier preventable crash compared to drivers aged 43–51 who did not have OSA.
- Drivers aged 34–42 with untreated OSA were 78.6 percent more likely to be convicted of a moving violation compared to drivers aged 34–42 who did not have OSA.

Table 92. RR estimates and 95-percent CIs for OSA.

Safety Outcome and Age Quartile	No OSA	Diagnosed: Treated	Diagnosed: Untreated	Diagnosed: Unsure	Potential
Total Carrier: 20–33	1.00	0.971 (0.600,1.573)	1.088 (0.401,2.95)	0 (0,Inf)	0.938 (0.652,1.350)
Total Carrier: 34–42	1.00	0.629 (0.384,1.030)	0.708 (0.288,1.742)	0.618 (0.153,2.498)	1.411* (1.025,1.942)
Total Carrier: 43–51	1.00	0.700 (0.454,1.077)	1.320 (0.673,2.591)	1.631 (0.766,3.474)	1.314 (0.959,1.801)
Total Carrier: 52+	1.00	0.724 (0.462,1.134)	1.091 (0.513,2.318)	0.461 (0.146,1.453)	0.647 (0.372,1.124)
Carrier Preventable: 20–33	1.00	0.424 (0.169,1.062)	0.968 (0.237,3.961)	0 (0,Inf)	0.719 (0.420,1.229)
Carrier Preventable: 34–42	1.00	0.061* (0.008,0.439)	0.782 (0.244,2.509)	0.573 (0.080,4.12)	1.421 (0.920,2.195)
Carrier Preventable: 43–51	1.00	0.626 (0.319,1.230)	2.011 (0.870,4.649)	2.377 (0.965,5.854)	1.783* (1.154,2.754)
Carrier Preventable: 52+	1.00	0.502 (0.250,1.010)	0.89 (0.283,2.813)	0.274 (0.038,1.988)	0.694 (0.337,1.426)
National Crashes: 20–33	1.00	0.583 (0.232,1.466)	1.885 (0.677,5.246)	2.240 (0.548,9.150)	1.104 (0.675,1.806)
National Crashes: 34–42	1.00	0.527 (0.238,1.166)	1.030 (0.322,3.292)	0 (0,Inf)	1.551 (0.989,2.433)
National Crashes: 43–51	1.00	0.572 (0.320,1.021)	1.418 (0.652,3.084)	0.383 (0.053,2.753)	0.923 (0.595,1.432)
National Crashes: 52+	1.00	1.310 (0.809,2.114)	0.782 (0.193,3.176)	0.697 (0.220,2.212)	0.872 (0.470,1.616)
Violations: 20–33	1.00	0.450 (0.195,1.037)	0.607 (0.149,2.479)	0.749 (0.104,5.378)	1.247 (0.849,1.831)
Violations: 34–42	1.00	0.952 (0.528,1.716)	1.786 (0.773,4.128)	0 (0,Inf)	1.662* (1.094,2.523)
Violations: 43–51	1.00	0.565 (0.296,1.077)	0.761 (0.239,2.425)	0.947 (0.233,3.858)	0.997 (0.622,1.598)

Safety Outcome and Age Quartile	No OSA	Diagnosed: Treated	Diagnosed: Untreated	Diagnosed: Unsure	Potential
Violations: 52+	1.00	0.661 (0.346,1.263)	2.356 (1.029,5.396)	1.021 (0.372,2.799)	1.097 (0.618,1.947)

5.3.1.27 Organ Failure

Of the 13,724 drivers who completed the Medical Examination Report:

- 3 (0.02 percent) had diagnosed organ failure:
  - 2 were treated.
  - 1 did not clearly indicate whether they were treated (categorized as "Diagnosed: Unsure" in the analysis).
- None (0) had potential organ failure.

Table 93 shows the RR estimates and 95-percent CIs for organ failure. Significant RR estimates ($p < 0.05$) are denoted with an asterisk. Cells with "NA" indicate no driver was in the cell and/or no driver was in the reference cell; thus, no RR estimates could be calculated. Cells with a RR estimate of zero ("0") indicate that at least one driver was in the cell, but no crashes or violations were associated with that driver(s). There were no significant findings in Table 93.

Table 93. RR estimates and 95-percent CIs for organ failure.

Safety Outcome and Age Quartile	No Organ Failure	Diagnosed: Treated	Diagnosed: Untreated	Diagnosed: Unsure	Potential
Total Carrier: 20–33	1.00	NA	NA	NA	NA
Total Carrier: 34–42	1.00	NA	NA	NA	NA
Total Carrier: 43–51	1.00	NA	NA	NA	NA
Total Carrier: 52+	1.00	NA	NA	NA	NA
Carrier Preventable: 20–33	1.00	NA	NA	NA	NA
Carrier Preventable: 34–42	1.00	NA	NA	NA	NA
Carrier Preventable: 43–51	1.00	NA	NA	NA	NA
Carrier Preventable: 52+	1.00	NA	NA	NA	NA
National Crashes: 20–33	1.00	NA	NA	NA	NA
National Crashes: 34–42	1.00	NA	NA	NA	NA
National Crashes: 43–51	1.00	NA	NA	NA	NA
National Crashes: 52+	1.00	NA	NA	NA	NA
Violations: 20–33	1.00	NA	NA	NA	NA
Violations: 34–42	1.00	NA	NA	NA	NA
Violations: 43–51	1.00	NA	NA	NA	NA
Violations: 52+	1.00	NA	NA	NA	NA

5.3.1.28 Other Sleep Disorders

Of the 13,724 drivers who completed the Medical Examination Report:

- 42 (0.31 percent) had a diagnosed other sleep disorder:
  - 36 were treated.
  - 4 were untreated.
  - 2 did not clearly indicate whether they were treated (categorized as "Diagnosed: Unsure" in the analysis).
- None (0) had potential other sleep disorders.

Table 94 shows the RR estimates and 95-percent CIs for other sleep disorders (e.g., restless leg syndrome, insomnia, etc.). Significant RR estimates ($p < 0.05$) are denoted with an asterisk. Cells with "NA" indicate no driver was in the cell and/or no driver was in the reference cell; thus, no RR estimates could be calculated. Cells with a RR estimate of zero ("0") indicate that at least one driver was in the cell, but no crashes or violations were associated with that driver(s). There was one significant finding in Table 94: drivers aged 34–42 with a treated other sleep disorder were 6.23 times more likely to be convicted of a moving violation compared to drivers aged 34–42 who did not have any other sleep disorders.

Table 94. RR estimates and 95-percent CIs for other sleep disorders.

Safety Outcome and Age Quartile	No Other Sleep Disorders	Diagnosed: Treated	Diagnosed: Untreated	Diagnosed: Unsure	Potential
Total Carrier: 20–33	1.00	0 (0,5.061^{e266})	NA	NA	NA
Total Carrier: 34–42	1.00	4.718 (0.661,33.652)	0 (0,Inf)	NA	NA
Total Carrier: 43–51	1.00	1.590 (0.223,11.331)	0 (0,1.002^{e301})	NA	NA
Total Carrier: 52+	1.00	1.085 (0.270,4.358)	NA	0.003 (0,Inf)	NA
Carrier Preventable: 20–33	1.00	0 (0,1.230^{e265})	NA	NA	NA
Carrier Preventable: 34–42	1.00	9.291 (1.297,66.574)	0 (0,Inf)	NA	NA
Carrier Preventable: 43–51	1.00	3.473 (0.485,24.852)	0 (0,Inf)	NA	NA
Carrier Preventable: 52+	1.00	0 (0,Inf)	NA	1^{e-04} (0,Inf)	NA
National Crashes: 20–33	1.00	5.445 (0.760,39.017)	NA	NA	NA
National Crashes: 34–42	1.00	0 (0,Inf)	0 (0,Inf)	NA	NA
National Crashes: 43–51	1.00	0 (0,Inf)	0 (0,Inf)	NA	NA
National Crashes: 52+	1.00	0 (0,Inf)	NA	0 (0,Inf)	NA
Violations: 20–33	1.00	0 (0,4.074^{e277})	NA	NA	NA

Safety Outcome and Age Quartile	No Other Sleep Disorders	Diagnosed: Treated	Diagnosed: Untreated	Diagnosed: Unsure	Potential
Violations: 34–42	1.00	6.233*+ (1.988,19.541)	0 (0,Inf)	NA	NA
Violations: 43–51	1.00	2.272 (0.727,7.103)	0 (0,Inf)	NA	NA
Violations: 52+	1.00	1.618 (0.402,6.505)	NA	0 (0,Inf)	NA

+ = Five drivers aged 34–42 had treated other sleep disorders.

5.3.1.29 Seizures/Epilepsy

Of the 13,724 drivers who completed the Medical Examination Report:

- 5 (0.04 percent) had diagnosed seizures/epilepsy:
  - 1 was treated.
  - 4 did not clearly indicate whether they were treated (categorized as "Diagnosed: Unsure" in the analysis).
- None (0) had potential seizures/epilepsy.

Table 95 shows the RR estimates and 95-percent CIs for seizures/epilepsy. Significant RR estimates ($p < 0.05$) are denoted with an asterisk. Cells with "NA" indicate no driver was in the cell and/or no driver was in the reference cell; thus, no RR estimates could be calculated. Cells with a RR estimate of zero ("0") indicate that at least one driver was in the cell, but no crashes or violations were associated with that driver(s). There were no significant findings in Table 95.

Table 95. RR estimates and 95-percent CIs for seizures/epilepsy.

Safety Outcome and Age Quartile	No Seizures/ Epilepsy	Diagnosed: Treated	Diagnosed: Untreated	Diagnosed: Unsure	Potential
Total Carrier: 20–33	1.00	NA	NA	NA	NA
Total Carrier: 34–42	1.00	NA	NA	NA	NA
Total Carrier: 43–51	1.00	NA	NA	NA	NA
Total Carrier: 52+	1.00	NA	NA	NA	NA
Carrier Preventable: 20–33	1.00	NA	NA	NA	NA
Carrier Preventable: 34–42	1.00	NA	NA	NA	NA
Carrier Preventable: 43–51	1.00	NA	NA	NA	NA
Carrier Preventable: 52+	1.00	NA	NA	NA	NA
National Crashes: 20–33	1.00	NA	NA	1^{e-04} (0,Inf)	NA
National Crashes: 34–42	1.00	NA	NA	0 (0,Inf)	NA
National Crashes: 43–51	1.00	0 (0,Inf)	NA	0 (0,Inf)	NA
National Crashes: 52+	1.00	NA	NA	NA	NA

Safety Outcome and Age Quartile	No Seizures/ Epilepsy	Diagnosed: Treated	Diagnosed: Untreated	Diagnosed: Unsure	Potential
Violations: 20–33	1.00	NA	NA	1^{e-04} ($0,2.854^{e238}$)	NA
Violations: 34–42	1.00	NA	NA	0 (0,Inf)	NA
Violations: 43–51	1.00	0 (0,Inf)	NA	0 (0,Inf)	NA
Violations: 52+	1.00	NA	NA	NA	NA

5.3.1.30 Skin Disease/Disorder

Of the 13,724 drivers who completed the Medical Examination Report:

- 66 (0.48 percent) had a diagnosed skin disease or disorder:
  - 38 were treated.
  - 14 were untreated.
  - 14 did not clearly indicate whether they were treated (categorized as "Diagnosed: Unsure" in the analysis).
- 6 had a potential skin disease or disorder (not formally diagnosed by a medical professional).

Table 96 shows the RR estimates and 95-percent CIs for skin disease/disorder. Significant RR estimates ($p < 0.05$) are denoted with an asterisk. Cells with "NA" indicate no driver was in the cell and/or no driver was in the reference cell; thus, no RR estimates could be calculated. Cells with a RR estimate of zero ("0") indicate that at least one driver was in the cell, but no crashes or violations were associated with that driver(s). There were no significant findings in Table 96.

Table 96. RR estimates and 95-percent CIs for skin disease/disorder.

Safety Outcome and Age Quartile	No Skin Disease/ Disorder	Diagnosed: Treated	Diagnosed: Untreated	Diagnosed: Unsure	Potential
Total Carrier: 20–33	1.00	NA	0 ($0,4.463^{e284}$)	0 (0,Inf)	NA
Total Carrier: 34–42	1.00	2.483 (0.617,9.998)	0 (0,Inf)	0.891 (0.125,6.346)	0 (0,Inf)
Total Carrier: 43–51	1.00	1.306 (0.326,5.241)	0 (0,Inf)	2.353 (0.327,16.955)	0 ($0,2.513^{e284}$)
Total Carrier: 52+	1.00	1.358 (0.436,4.233)	1.440 (0.356,5.828)	3^{e-04} ($0,3.412^{e301}$)	0 (0,Inf)
Carrier Preventable: 20–33	1.00	NA	0 ($0,2.469^{e283}$)	0 (0,Inf)	NA
Carrier Preventable: 34–42	1.00	4.875 (1.203,19.760)	0 (0,Inf)	1.756 (0.246,12.552)	0 (0,Inf)
Carrier Preventable: 43–51	1.00	1.246 (0.175,8.887)	0 (0,Inf)	4.334 (0.594,31.632)	0 (0,Inf)
Carrier Preventable: 52+	1.00	0.907 (0.127,6.477)	1.457 (0.202,10.522)	0 (0,Inf)	0 (0,Inf)

Safety Outcome and Age Quartile	No Skin Disease/ Disorder	Diagnosed: Treated	Diagnosed: Untreated	Diagnosed: Unsure	Potential
National Crashes: 20–33	1.00	0 (0,Inf)	2.357 (0.33,16.835)	0 (0,Inf)	NA
National Crashes: 34–42	1.00	2.810 (0.697,11.329)	0 (0,Inf)	2.355 (0.329,16.843)	0 (0,Inf)
National Crashes: 43–51	1.00	0.843 (0.118,6.006)	0 (0,Inf)	3.206 (0.447,23.001)	0 (0,Inf)
National Crashes: 52+	1.00	0 (0,Inf)	2.230 (0.309,16.065)	0 (0,Inf)	0 (0,Inf)
Violations: 20–33	1.00	0 (0,Inf)	1.523 (0.214,10.855)	0 (0,2.598^{e276})	NA
Violations: 34–42	1.00	0 (0,Inf)	0 (0,Inf)	0 (0,Inf)	0 (0,Inf)
Violations: 43–51	1.00	2.660 (0.852,8.303)	0 (0,Inf)	0 (0,Inf)	0 (0,Inf)
Violations: 52+	1.00	0.746 (0.105,5.320)	2.805 (0.389,20.228)	0 (0,Inf)	0 (0,Inf)

5.3.1.31 Spine/Other Musculoskeletal

Of the 13,724 drivers who completed the Medical Examination Report:

- 488 (3.56 percent) had a diagnosed spine or other musculoskeletal condition:
  - 232 were treated.
  - 54 were untreated.
  - 202 did not clearly indicate whether they were treated (categorized as "Diagnosed: Unsure" in the analysis).
- 15 (0.11 percent) had a potential spine or other musculoskeletal condition (not formally diagnosed by a medical professional).

Table 97 shows the RR estimates and 95-percent CIs for "spine/other musculoskeletal." Significant RR estimates ($p < 0.05$) are denoted with an asterisk. Cells with "NA" indicate no driver was in the cell and/or no driver was in the reference cell; thus, no RR estimates could be calculated. Cells with a RR estimate of zero ("0") indicate that at least one driver was in the cell, but no crashes or violations were associated with that driver(s). There were no significant findings in Table 97.

Table 97. RR estimates and 95-percent CIs for spine/other musculoskeletal.

Safety Outcome and Age Quartile	No Spine/Other Musculoskeletal Condition	Diagnosed: Treated	Diagnosed: Untreated	Diagnosed: Unsure	Potential
Total Carrier: 20–33	1.00	0 (0,Inf)	0 (0,Inf)	0.176 (0.025,1.254)	NA
Total Carrier: 34–42	1.00	1.386 (0.689,2.788)	3.072 (0.979,9.640)	0.584 (0.218,1.565)	0 (0,Inf)

Safety Outcome and Age Quartile	No Spine/Other Musculoskeletal Condition	Diagnosed: Treated	Diagnosed: Untreated	Diagnosed: Unsure	Potential
Total Carrier: 43–51	1.00	0.937 (0.50,1.756)	1.577 (0.747,3.332)	1.70 (0.980,2.948	0 (0,6.196^{e237})
Total Carrier: 52+	1.00	0.853 (0.517,1.407)	1.241 (0.513,3.002)	0.912 (0.501,1.660)	0.719 (0.100,5.150)
Carrier Preventable: 20–33	1.00	0 (0,Inf)	0 (0,Inf)	0 (0,Inf)	NA
Carrier Preventable: 34–42	1.00	0.986 (0.316,3.080)	1.988 (0.276,14.308)	0.284 (0.040,2.029)	0 (0,Inf)
Carrier Preventable: 43–51	1.00	1.521 (0.749,3.088)	1.727 (0.642,4.648)	1.528 (0.680,3.435)	0 (0,Inf)
Carrier Preventable: 52+	1.00	0.632 (0.280,1.426)	0.975 (0.242,3.933)	0.991 (0.440,2.23)	1.524 (0.211,11.028)
National Crashes: 20–33	1.00	1.643 (0.229,11.792)	1.431 (0.199,10.315)	1.317 (0.421,4.113)	NA
National Crashes: 34–42	1.00	2.008 (0.893,4.515)	0 (0,Inf)	0.256 (0.036,1.823)	6.846 (0.938,49.980)
National Crashes: 43–51	1.00	0.721 (0.298,1.748)	1.726 (0.554,5.384)	0 (0,Inf)	0 (0,Inf)
National Crashes: 52+	1.00	0.899 (0.477,1.693)	2.683 (1.105,6.518)	1.018 (0.481,2.156)	2.951 (0.939,9.272)
Violations: 20–33	1.00	0 (0,2.586^{e237})	0.880 (0.122,6.335)	0.965 (0.309,3.007)	NA
Violations: 34–42	1.00	0.578 (0.144,2.323)	2.805 (0.698,11.276)	1.557 (0.736,3.294)	0 (0,Inf)
Violations: 43–51	1.00	1.155 (0.545,2.450)	0.638 (0.090,4.546)	1.519 (0.752,3.068)	0 (0,Inf)
Violations: 52+	1.00	0.875 (0.449,1.705)	1.835 (0.587,5.738)	0.888 (0.396,1.995)	0 (0,Inf)

5.3.1.32 Stroke/Paralysis

Of the 13,724 drivers who completed the Medical Examination Report:

- 20 (0.15 percent) had diagnosed stroke or paralysis:
  - 1 was treated.
  - 19 did not clearly indicate whether they were treated (categorized as "Diagnosed: Unsure" in the analysis).
- None (0) had potential stroke or paralysis.

Table 98 shows the RR estimates and 95-percent CIs for stroke/paralysis. Significant RR estimates ($p < 0.05$) are denoted with an asterisk. Cells with "NA" indicate no driver was in the cell and/or no driver was in the reference cell; thus, no RR estimates could be calculated. Cells with a RR estimate of zero ("0") indicate that at least one driver was in the cell, but no crashes or violations were associated with that driver(s). There were no significant findings in Table 98.

Table 98. RR estimates and 95-percent CIs for stroke/paralysis.

Safety Outcome and Age Quartile	No Stroke/ Paralysis	Diagnosed: Treated	Diagnosed: Untreated	Diagnosed: Unsure	Potential
Total Carrier: 20–33	1.00	NA	NA	NA	NA
Total Carrier: 34–42	1.00	NA	NA	NA	NA
Total Carrier: 43–51	1.00	NA	NA	NA	NA
Total Carrier: 52+	1.00	NA	NA	NA	NA
Carrier Preventable: 20–33	1.00	NA	NA	NA	NA
Carrier Preventable: 34–42	1.00	NA	NA	NA	NA
Carrier Preventable: 43–51	1.00	NA	NA	NA	NA
Carrier Preventable: 52+	1.00	NA	NA	NA	NA
National Crashes: 20–33	1.00	NA	NA	NA	NA
National Crashes: 34–42	1.00	NA	NA	NA	NA
National Crashes: 43–51	1.00	NA	NA	NA	NA
National Crashes: 52+	1.00	NA	NA	NA	NA
Violations: 20–33	1.00	NA	NA	NA	NA
Violations: 34–42	1.00	NA	NA	NA	NA
Violations: 43–51	1.00	NA	NA	NA	NA
Violations: 52+	1.00	NA	NA	NA	NA

5.3.1.33 Thyroid Disorder

Of the 13,724 drivers who completed the Medical Examination Report:

- 164 (1.19 percent) had a diagnosed thyroid disorder:
  - 162 were treated.
  - 1 was untreated.
  - 1 did not clearly indicated whether they were treated (categorized as "Diagnosed: Unsure" in the analysis).
- 2 (0.01 percent) had a potential thyroid disorder (not formally diagnosed by a medical professional).

Table 99 shows the RR estimates and 95-percent CIs for "thyroid disorder." Significant RR estimates ($p < 0.05$) are denoted with an asterisk. Cells with "NA" indicate no driver was in the cell and/or no driver was in the reference cell; thus, no RR estimates could be calculated. Cells with a RR estimate of zero "0" indicate that a driver(s) was in the cell, but no crashes or violations were associated with that driver(s). There was one significant finding in Table 99: Drivers aged 20–33 with a treated thyroid disorder were 4.19 times more likely to have a moving violation compared to drivers aged 20–33 who did not have a thyroid disorder.

Table 99. RR estimates and 95-percent CIs for thyroid disorder.

Safety Outcome and Age Quartile	No Thyroid Disorder	Diagnosed: Treated	Diagnosed: Untreated	Diagnosed: Unsure	Potential
Total Carrier: 20–33	1.00	1.438 (0.202,10.244)	NA	NA	NA
Total Carrier: 34–42	1.00	0.261 (0.037,1.854)	NA	NA	3.951 (0.551,28.342)
Total Carrier: 43–51	1.00	1.018 (0.526,1.968)	2^{e-04} (0,Inf)	1^{e-04} (0,Inf)	NA
Total Carrier: 52+	1.00	0.743 (0.408,1.352)	NA	NA	0 (0,Inf)
Carrier Preventable: 20–33	1.00	0 ($0,3.130^{e295}$)	NA	NA	NA
Carrier Preventable: 34–42	1.00	0.510 (0.072,3.638)	NA	NA	0 (0,Inf)
Carrier Preventable: 43–51	1.00	0.650 (0.208,2.029)	2^{e-04} (0,Inf)	0 (0,Inf)	NA
Carrier Preventable: 52+	1.00	0.956 (0.450,2.032)	NA	NA	0 (0,Inf)
National Crashes: 20–33	1.00	2.940 (0.941,9.183)	NA	NA	NA
National Crashes: 34–42	1.00	0.985 (0.245,3.960)	NA	NA	0 (0,Inf)
National Crashes: 43–51	1.00	0.643 (0.206,2.006)	0 (0,Inf)	0 (0,Inf)	NA
National Crashes: 52+	1.00	0.697 (0.288,1.688)	NA	NA	0 (0,Inf)
Violations: 20–33	1.00	4.187* (1.868,9.389)	NA	NA	NA
Violations: 34–42	1.00	0.839 (0.209,3.368)	NA	NA	0 (0,Inf)
Violations: 43–51	1.00	0.929 (0.346,2.493)	0 (0,Inf)	0 (0,Inf)	NA
Violations: 52+	1.00	1.018 (0.481,2.16)	NA	NA	0 (0,Inf)

5.3.1.34 Tobacco Use

Of the 13,724 drivers who completed the Medical Examination Report:

- 664 (4.84 percent) had confirmed tobacco use:
  - 17 were receiving treatment for tobacco use.
  - 639 were not treated.
  - 8 did not clearly indicate whether they were receiving treatment (categorized as "Diagnosed: Unsure" in the analysis).
- 7 were potential tobacco users (not confirmed by a medical professional).

Table 100 shows the RR estimates and 95-percent CIs for tobacco use. Significant RR estimates ($p < 0.05$) are denoted with an asterisk. Cells with "NA" indicate no driver was in the cell and/or no driver was in the reference cell; thus, no RR estimates could be calculated. Cells with a RR estimate of zero ("0") indicate that at least one driver was in the cell, but no crashes or violations were associated with that driver(s). There were no significant findings in Table 100.

Table 100. RR estimates and 95-percent CIs for tobacco use.

Safety Outcome and Age Quartile	No Tobacco Use	Diagnosed: Treated	Diagnosed: Untreated	Diagnosed: Unsure	Potential
Total Carrier: 20–33	1.00	3.164 (1.010,9.904)	1.002 (0.665,1.508)	2.569 (0.638,10.342)	NA
Total Carrier: 34–42	1.00	0 (0,Inf)	0.921 (0.589,1.439)	2.531 (0.354,18.109)	0 (0,Inf)
Total Carrier: 43–51	1.00	0 (0,Inf)	0.915 (0.585,1.432)	0 (0,Inf)	3.452 (0.483,24.67)
Total Carrier: 52+	1.00	2.352 (0.329,16.812)	1.479 (1.010,2.165)	0 (0,Inf)	2.891 (0.401,20.864)
Carrier Preventable: 20–33	1.00	0 (0,Inf)	0.782 (0.416,1.469)	5.107 (1.260,20.702)	NA
Carrier Preventable: 34–42	1.00	0 (0,Inf)	1.265 (0.739,2.165)	0 (0,Inf)	0 (0,Inf)
Carrier Preventable: 43–51	1.00	0 (0,Inf)	0.792 (0.407,1.540)	0 (0,Inf)	0 (0,Inf)
Carrier Preventable: 52+	1.00	0 (0,Inf)	0.986 (0.520,1.877)	0 (0,Inf)	0 (0,Inf)
National Crashes: 20–33	1.00	3.227 (0.451,23.10)	0.573 (0.295,1.112)	3.168 (0.443,22.669)	NA
National Crashes: 34–42	1.00	1.828 (0.256,13.061)	0.839 (0.481,1.463)	0 (0,Inf)	0 (0,Inf)
National Crashes: 43–51	1.00	0 (0,Inf)	1.012 (0.603,1.70)	0 (0,Inf)	0 (0,Inf)
National Crashes: 52+	1.00	4.026 (1.00,16.224)	0.764 (0.417,1.40)	0 (0,Inf)	12.115 (1.664,88.233)
Violations: 20–33	1.00	0 (0,Inf)	0.809 (0.505,1.298)	0 (0,Inf)	NA
Violations: 34–42	1.00	1.450 (0.203,10.351)	0.530 (0.282,0.993)	0 (0,Inf)	0 (0,Inf)
Violations: 43–51	1.00	0 (0,Inf)	0.758 (0.415,1.383)	4.900 (0.682,35.203)	0 (0,Inf)
Violations: 52+	1.00	0 (0,Inf)	0.449 (0.212,0.952)	0 (0,Inf)	0 (0,Inf)

5.3.1.35 Vascular

Of the 13,724 drivers who completed the Medical Examination Report:

- 89 (0.65 percent) had a diagnosed vascular condition:
  - 66 were treated.
  - 13 were untreated.
  - 10 did not clearly indicate whether they were treated (categorized as "Diagnosed: Unsure" in the analysis).

- 9 (0.07 percent) had a potential vascular condition (not formally diagnosed by a medical professional).

Table 101 shows the RR estimates and 95-percent CIs for vascular conditions (e.g., edema, blood clots, etc.). Significant RR estimates ($p < 0.05$) are denoted with an asterisk. Cells with "NA" indicate no driver was in the cell and/or no driver was in the reference cell; thus, no RR estimates could be calculated. Cells with a RR estimate of zero ("0") indicate that at least one driver was in the cell, but no crashes or violations were associated with that driver(s). There were no significant findings in Table 101.

Table 101. RR estimates and 95-percent CIs for vascular conditions.

Safety Outcome and Age Quartile	No Vascular Condition	Diagnosed: Treated	Diagnosed: Untreated	Diagnosed: Unsure	Potential
Total Carrier: 20–33	1.00	1^{e-04} ($0,2.437^{e238}$)	NA	NA	NA
Total Carrier: 34–42	1.00	0 (0,Inf)	0 (0,Inf)	$1e^{-04}$ (0,Inf)	NA
Total Carrier: 43–51	1.00	0 (0,Inf)	NA	0 (0,Inf)	0 (0,Inf)
Total Carrier: 52+	1.00	0.569 (0.182,1.777)	1.129 (0.156,8.142)	0.748 (0.104,5.377)	0 ($0,3.924^{e289}$)
Carrier Preventable: 20–33	1.00	1^{e-04} (0,Inf)	NA	NA	NA
Carrier Preventable: 34–42	1.00	0 (0,Inf)	0 (0,Inf)	3^{e-04} (0,Inf)	NA
Carrier Preventable: 43–51	1.00	0 (0,Inf)	NA	0 (0,Inf)	0 (0,Inf)
Carrier Preventable: 52+	1.00	0.777 (0.192,3.14)	1.947 (0.267,14.220)	0 (0,Inf)	0 (0,Inf)
National Crashes: 20–33	1.00	0 ($0,3.357^{e277}$)	NA	NA	NA
National Crashes: 34–42	1.00	4.380 (0.610,31.453)	0 (0,Inf)	0 (0,Inf)	NA
National Crashes: 43–51	1.00	2.400 (0.987,5.837)	NA	4.930 (0.685,35.483)	0 (0,Inf)
National Crashes: 52+	1.00	1.285 (0.529,3.124)	0 (0,Inf)	0 (0,Inf)	0 (0,Inf)
Violations: 20–33	1.00	0 ($0,1.137^{e277}$)	NA	NA	NA
Violations: 34–42	1.00	0 (0,Inf)	2.797 (0.386,20.275)	0 (0,Inf)	NA
Violations: 43–51	1.00	0 (0,Inf)	NA	0 (0,Inf)	1.873 (0.259,13.542)
Violations: 52+	1.00	1.570 (0.646,3.818)	0 (0,Inf)	0 (0,Inf)	0 (0,Inf)

5.3.1.36 Vitamin Deficiency/Excess

Of the 13,724 drivers who completed the Medical Examination Report:

- 10 (0.07 percent) had diagnosed vitamin deficiency or excess:
  - 9 were treated.
  - 1 did not clearly indicate whether they were treated (categorized as "Diagnosed: Unsure" in the analysis).
- 1 (0.01 percent) had potential vitamin deficiency/excess (not formally diagnosed by a medical professional).

Table 102 shows the RR estimates and 95-percent CIs for vitamin deficiency/excess. Significant RR estimates ($p < 0.05$) are denoted with an asterisk. Cells with "NA" indicate no driver was in the cell and/or no driver was in the reference cell; thus, no RR estimates could be calculated. Cells with a RR estimate of zero ("0") indicate that at least one driver was in the cell, but no crashes or violations were associated with that driver(s). There were no significant findings in Table 102.

Table 102. RR estimates and 95-percent CIs for vitamin deficiency/excess.

Safety Outcome and Age Quartile	No Vitamin Deficiency/ Excess	Diagnosed: Treated	Diagnosed: Untreated	Diagnosed: Unsure	Potential
Total Carrier: 20–33	1.00	NA	NA	NA	NA
Total Carrier: 34–42	1.00	NA	NA	NA	NA
Total Carrier: 43–51	1.00	NA	NA	NA	NA
Total Carrier: 52+	1.00	NA	NA	NA	NA
Carrier Preventable: 20–33	1.00	NA	NA	NA	NA
Carrier Preventable: 34–42	1.00	NA	NA	NA	NA
Carrier Preventable: 43–51	1.00	NA	NA	NA	NA
Carrier Preventable: 52+	1.00	NA	NA	NA	NA
National Crashes: 20–33	1.00	NA	NA	NA	NA
National Crashes: 34–42	1.00	NA	NA	NA	NA
National Crashes: 43–51	1.00	NA	NA	NA	NA
National Crashes: 52+	1.00	NA	NA	NA	NA
Violations: 20–33	1.00	NA	NA	NA	NA
Violations: 34–42	1.00	NA	NA	NA	NA
Violations: 43–51	1.00	NA	NA	NA	NA
Violations: 52+	1.00	NA	NA	NA	NA

5.3.1.37 Viral Infection

Of the 13,724 drivers who completed the Medical Examination Report:

- 25 (0.18 percent) had a diagnosed viral infection:
  - 20 were treated.

  - 3 were untreated.
  - 2 did not clearly indicate whether they were treated (categorized as "Diagnosed: Unsure" in the analysis).
- 2 (0.01 percent) had a potential viral infection.

Table 103 shows the RR estimates and 95-percent CIs for viral infection (e.g., hepatitis C). Significant RR estimates ($p < 0.05$) are denoted with an asterisk. Cells with "NA" indicate no driver was in the cell and/or no driver was in the reference cell; thus, no RR estimates could be calculated. Cells with a RR estimate of zero ("0") indicate that at least one driver was in the cell, but no crashes or violations were associated with that driver(s). There was one significant finding in Table 103: drivers aged 20–33 with a treated viral infection were 6.63 times more likely to be involved in a total carrier crash compared to drivers aged 20–33 with no viral infection.

Table 103. RR estimates and 95-percent CIs for viral infection.

Safety Outcome and Age Quartile	No Vitamin Deficiency	Diagnosed: Treated	Diagnosed: Untreated	Diagnosed: Unsure	Potential
Total Carrier: 20–33	1.00	6.632* (1.637,26.862)	NA	NA	NA
Total Carrier: 34–42	1.00	0 (0,Inf)	NA	NA	NA
Total Carrier: 43–51	1.00	0 (0,Inf)	NA	0 (0,Inf)	NA
Total Carrier: 52+	1.00	1.169 (0.164,8.337)	0 (0,Inf)	NA	1.868 (0.261,13.359)
Carrier Preventable: 20–33	1.00	6.88 (0.952,49.787)	NA	NA	NA
Carrier Preventable: 34–42	1.00	0 (0,Inf)	NA	NA	NA
Carrier Preventable: 43–51	1.00	0 (0,Inf)	NA	0 (0,Inf)	NA
Carrier Preventable: 52+	1.00	2.326 (0.325,16.665)	0 (0,Inf)	NA	3.792 (0.526,27.339)
National Crashes: 20–33	1.00	0 (0,Inf)	NA	NA	NA
National Crashes: 34–42	1.00	0 (0,Inf)	NA	NA	NA
National Crashes: 43–51	1.00	1.615 (0.227,11.513)	NA	0 (0,Inf)	NA
National Crashes: 52+	1.00	0 (0,Inf)	0 (0,Inf)	0 (0,Inf)	0 (0,Inf)
Violations: 20–33	1.00	0 ($0,2.465^{e223}$)	NA	NA	NA
Violations: 34–42	1.00	0 (0,Inf)	NA	NA	NA
Violations: 43–51	1.00	0 (0,Inf)	NA	0 (0,Inf)	NA
Violations: 52+	1.00	6.402 (2.383,17.20)	0 (0,Inf)	0 (0,Inf)	0 (0,Inf)

+ = Three drivers aged 20–33 had a treated viral infection.

5.3.1.38 Weight Control

Of the 13,724 drivers who completed the Medical Examination Report:

- 8 had diagnosed weight control:
  - 7 were treated.
  - 1 was untreated.
- 26 had potential weight control.

Table 104 shows the RR estimates and 95-percent CIs for weight control. Significant RR estimates ($p < 0.05$) are denoted with an asterisk. Cells with "NA" indicate no driver was in the cell and/or no driver was in the reference cell; thus, no RR estimates could be calculated. Cells with a RR estimate of zero ("0") indicate that at least one driver was in the cell, but no crashes or violations were associated with that driver(s). There were no significant findings in Table 104.

Table 104. RR estimates and 95-percent CIs for weight control.

Safety Outcome and Age Quartile	No Weight Control	Diagnosed: Treated	Diagnosed: Untreated	Diagnosed: Unsure	Potential
Total Carrier: 20–33	1.00	NA	NA	NA	0 (0,2.778^{e222})
Total Carrier: 34–42	1.00	0 (0,Inf)	NA	0 (0,Inf)	0 (0,Inf)
Total Carrier: 43–51	1.00	1^{e-04} (0,Inf)	NA	NA	0 (0,Inf)
Total Carrier: 52+	1.00	0 (0,Inf)	0 (0,Inf)	NA	0 (0,Inf)
Carrier Preventable: 20–33	1.00	NA	NA	NA	0 (0,Inf)
Carrier Preventable: 34–42	1.00	0 (0,Inf)	NA	0 (0,Inf)	0 (0,Inf)
Carrier Preventable: 43–51	1.00	2^{e-04} (0,Inf)	NA	NA	0 (0,Inf)
Carrier Preventable: 52+	1.00	0 (0,Inf)	0 (0,Inf)	NA	0 (0,Inf)
National Crashes: 20–33	1.00	NA	NA	NA	0 (0,7.318^{e242})
National Crashes: 34–42	1.00	0 (0,Inf)	NA	0 (0,Inf)	0 (0,Inf)
National Crashes: 43–51	1.00	0 (0,Inf)	NA	NA	0 (0,Inf)
National Crashes: 52+	1.00	0 (0,Inf)	0 (0,Inf)	NA	0 (0,Inf)
Violations: 20–33	1.00	NA	NA	NA	0 (0,2.093^{e242})
Violations: 34–42	1.00	0 (0,Inf)	NA	0 (0,Inf)	0 (0,Inf)
Violations: 43–51	1.00	0 (0,Inf)	NA	NA	0 (0,Inf)
Violations: 52+	1.00	0 (0,Inf)	0 (0,Inf)	NA	0 (0,Inf)

5.3.1.39 Alcohol Use

Of the 13,724 drivers who completed the Medical Examination Report:

- 48 (0.35 percent) had diagnosed alcohol use.
  - 1 was treated.
  - 47 did not indicate whether they were treated (categorized as "Diagnosed: Unsure" in the analysis).
- None (0) had potential alcohol use.

Table 105 shows the RR estimates and 95-percent CIs for alcohol use. Significant RR estimates ($p < 0.05$) are denoted with an asterisk. Cells with "NA" indicate no driver was in the cell and/or no driver was in the reference cell; thus, no RR estimates could be calculated. Cells with a RR estimate of zero ("0") indicate that at least one driver was in the cell, but no crashes or violations were associated with that driver(s). There was one significant finding in Table 105: drivers aged 20–33 with "unsure if treated" alcohol use were 3.1 times more likely to be involved in a total carrier crash compared to drivers aged 20–33 who did not have alcohol use.

Table 105. RR estimates and 95-percent CIs for alcohol use.

Safety Outcome and Age Quartile	No Alcohol Use	Diagnosed: Treated	Diagnosed: Untreated	Diagnosed: Unsure	Potential
Total Carrier: 20–33	1.00	NA	NA	3.096* (1.28,7.487)	NA
Total Carrier: 34–42	1.00	NA	NA	0.765 (0.191,3.068)	NA
Total Carrier: 43–51	1.00	NA	NA	0.715 (0.178,2.871)	NA
Total Carrier: 52+	1.00	NA	NA	0.576 (0.081,4.103)	NA
Carrier Preventable: 20–33	1.00	NA	NA	1.200 (0.168,8.569)	NA
Carrier Preventable: 34–42	1.00	NA	NA	0.745 (0.104,5.314)	NA
Carrier Preventable: 43–51	1.00	NA	NA	1.326 (0.329,5.339)	NA
Carrier Preventable: 52+	1.00	NA	NA	1.136 (0.159,8.116)	NA
National Crashes: 20–33	1.00	NA	NA	2.420 (0.338,17.330)	NA
National Crashes: 34–42	1.00	NA	NA	0 (0,Inf)	NA
National Crashes: 43–51	1.00	NA	NA	0.609 (0.085,4.335)	NA
National Crashes: 52+	1.00	0 (0,Inf)	NA	0 (0,Inf)	NA
Violations: 20–33	1.00	NA	NA	1.802 (0.252,12.871)	NA

Safety Outcome and Age Quartile	No Alcohol Use	Diagnosed: Treated	Diagnosed: Untreated	Diagnosed: Unsure	Potential
Violations: 34–42	1.00	NA	NA	1.683 (0.419,6.757)	NA
Violations: 43–51	1.00	NA	NA	0.628 (0.088,4.474)	NA
Violations: 52+	1.00	21.60 (3.012,154.89)	NA	2.287 (0.566,9.235)	NA

+ = Five drivers aged 20–33 had "unsure if treated" alcohol use.

5.3.2 Stepwise Regression Model for Medical

The stepwise regression model results include age as a quadratic (or age^2). RR estimates and 95-percent CIs are shown for each analysis. When no additional predictor variables added anything statistically meaningful to the regression equation, the analysis stopped. The stepwise regression considers all predictor variables, unlike the individual regression model, which only evaluated the relationship of each predictor on the safety outputs. Due to small sample sizes in cells and missing values, the step-wise regression was not stratified by age, as stepwise regression is sensitive to missing data (it discards the whole driver observation if it finds one missing value). Although analyses were performed on all medical groupings, the interpretation of medical groupings with low cell counts (≥5), even if the 95-percent CI did not contain "1.0," were not explored.

5.3.2.1 Total Carrier Crashes

Table 106 shows the RR estimates and 95-percent CIs for the significant predictors in the stepwise regression for total carrier crashes. Significant RR estimates ($p < 0.05$) are denoted with an asterisk. The AIC value for this model was 10,834.97. Key findings are as follows:

- Each yearly increase in age reduced the likelihood of involvement in a total carrier crash by 5 percent.
- Drivers who obtained a temporary disqualified medical certification were 40.9 percent less likely to be involved in a total carrier crash compared to drivers who obtained a full 2-year medical certification.
- Drivers who reported an injury or illness in the last 5 years were 11 percent less likely to be involved in a total carrier crash compared to drivers who reported no injury or illness in the last 5 years.
- Drivers with potential high blood pressure were 46.2 percent more likely to be involved in a total carrier crash compared to drivers who did not have high blood pressure.
- Drivers with a treated nervous/psychiatric disorder were 74.7 percent times more likely to be involved in a total carrier crash compared to drivers who did not have a nervous/psychiatric disorder.

Table 106. Medical stepwise regression RR estimates and 95-percent CIs for total carrier crashes.

Predictor Variables	Risk Ratio	Lower CI	Upper CI
Age	0.95*	0.926	0.975
Age^2	1.001	1.00	1.001
Certification: 2 Year	1.00	1.00	1.00
Certification: Periodic	0.966	0.86	1.086
Certification: Temp Disqualified	0.591*	0.377	0.926
Certification: Failed	0.453	0.202	1.014
No Injury or Illness Last 5 Years	1.00	1.00	1.00
Illness or Injury Last 5 Years	0.89*	0.805	0.983
No Genitourinary	1.00	1.00	1.00
Genitourinary: Diagnosed Treated	0.923	0.55	1.547
Genitourinary: Diagnosed Untreated	1.115	0.67	1.854
Genitourinary: Diagnosed Unsure	0	0	1.55^{e180}
Genitourinary: Potential	0.899	0.466	1.733
No High Blood Pressure	1.00	1.00	1.00
High Blood Pressure: Diagnosed Treated	0.957	0.831	1.101
High Blood Pressure: Diagnosed Untreated	1.311	0.903	1.902
High Blood Pressure: Diagnosed Unsure	0.734	0.364	1.481
High Blood Pressure: Potential	1.462*	1.197	1.787
No Nervous/Psychiatric Disorder	1.00	1.00	1.00
Nervous/Psychiatric Disorder: Diagnosed Treated	1.747*	1.357	2.25
Nervous/Psychiatric Disorder: Diagnosed Untreated	1.102	0.458	2.653
Nervous/Psychiatric Disorder: Diagnosed Unsure	1.286	0.611	2.707
Nervous/Psychiatric Disorder: Potential	1.316	0.328	5.271
Fail Hearing Test	1.00	1.00	1.00
Pass Hearing Test	0.633	0.379	1.055

5.3.2.2 Carrier Preventable Crashes

Table 107 shows the RR estimates and 95-percent CIs for the significant predictors in the stepwise regression for carrier preventable crashes. Significant RR estimates ($p < 0.05$) are denoted with an asterisk. The AIC value for this model was 7,352.23. Key findings are summarized below:

- Each yearly increase in age reduced the likelihood of involvement carrier preventable crash by 5.6 percent.
- Drivers who reported an injury or illness in the last 5 years were 28.8 percent less likely to be involved in a carrier preventable crash compared to drivers who reported no injury or illness in the last 5 years.
- Drivers with untreated allergies were 17.51 times more likely to be involved in a carrier preventable crash compared to drivers who did not have allergies.

- Drivers with untreated cancer were 11.27 times more likely to be involved in a carrier preventable crash compared to drivers who did not have cancer.
- Drivers with a treated eye disorder were 3.02 times more likely to be involved in a carrier preventable crash compared to drivers who did not have an eye disorder.
- Drivers with a potential hormone dysfunction were 6.92 times more likely to be involved in a carrier preventable crash compared to drivers who did not have a hormone dysfunction.
- Drivers with a treated nervous/psychiatric disorder were 2.03 times more likely to be involved in a carrier preventable crash compared to drivers who did not have a nervous disorder.
- Drivers with treated OSA were 48 percent less likely to be involved in a carrier preventable crash compared to drivers who did not have OSA.

Table 107. Medical stepwise regression RR estimates and 95-percent CIs for carrier preventable crashes.

Predictor Variables	Risk Ratio	Lower CI	Upper CI
Age	0.944*	0.911	0.978
Age^2	1.001	1.00	1.001
Certification: 2 Year	1.00	1.00	1.00
Certification: Periodic	1.423	1.084	1.868
Certification: Temp Disqualified	0.562	0.299	1.057
Certification: Failed	0.856	0.381	1.926
No Injury or Illness Last 5 Years	1.00	1.00	1.00
Illness or Injury Last 5 Years	0.812*	0.704	0.936
No Allergies	1.00	1.00	1.00
Allergies: Diagnosed Treated	1.249	0.839	1.86
Allergies: Diagnosed Untreated	17.509*+	4.194	73.093
Allergies: Diagnosed Unsure	0.00	0	Inf
Allergies: Potential	0.00	0	Inf
No Cancer	1.00	1.00	1.00
Cancer: Diagnosed Treated	0.00	0	Inf
Cancer: Diagnosed Untreated	11.271*+	2.798	45.399
Cancer: Diagnosed Unsure	0.00	0	Inf
Cancer: Potential	0.00	0	Inf
No Eye Disorder	1.00	1.00	1.00
Eye Disorder: Diagnosed Treated	3.017*	1.347	6.756
Eye Disorder: Diagnosed Untreated	0.00	0	Inf
Eye Disorder: Diagnosed Unsure	0.424	0.132	1.363
Eye Disorder: Potential	0.00	0	7.39^{e204}
No Hormone Dysfunction	1.00	1.00	1.00
Hormone Dysfunction: Diagnosed Treated	0.691	0.172	2.771
Hormone Dysfunction: Potential	6.919*+	1.633	29.318

Predictor Variables	Risk Ratio	Lower CI	Upper CI
No Nervous/Psychiatric Disorder	1.00	1.00	1.00
Nervous/Psychiatric Disorder: Diagnosed Treated	2.032*	1.443	2.86
Nervous/Psychiatric Disorder: Diagnosed Untreated	0.979	0.244	3.927
Nervous/Psychiatric Disorder: Diagnosed Unsure	0.367	0.052	2.61
Nervous/Psychiatric Disorder: Potential	1.295	0.182	9.225
No OSA	1.00	1.00	1.00
OSA: Diagnosed Treated	0.52*	0.368	0.734
OSA: Diagnosed Untreated	1.288	0.787	2.106
OSA: Diagnosed Unsure	0.956	0.449	2.035
OSA: Potential	0.764	0.556	1.049

+ = Four drivers had untreated allergies, three drivers had potential hormone dysfunction, and six drivers had untreated cancer.

5.3.2.3 National Crashes

Table 108 shows the RR estimates and 95-percent CIs for the significant predictors in the stepwise regression for national crashes. Significant RR estimates ($p < 0.05$) are denoted with an asterisk. The AIC value for this model was 8,462.89. Key findings are summarized below:

- Each yearly increase in age reduced the likelihood of involvement in a national crash by 4.0 percent.
- Drivers with an untreated blood disorder were 7.43 times more likely to be involved in a national crash compared to drivers without a blood disorder.
- Drivers with an untreated lung and chest condition were 2.47 times more likely to be involved in a national crash compared to drivers without a lung and chest condition.
- Drivers with a treated missing/impaired limb were 15.71 times more likely to be involved in a national crash compared to drivers without a missing/impaired limb.
- Drivers with a potential spine/other musculoskeletal condition were 2.84 times more likely to be involved in a national crash compared to drivers without a spine/other musculoskeletal condition.

Table 108. Medical stepwise regression RR estimates and 95-percent CIs for national crashes.

Predictor Variables	Risk Ratio	Lower CI	Upper CI
Age	0.96*	0.929	0.992
Age^2	1.00	1.00	1.001
No Blood Disorder	1.00	1.00	1.00
Blood Disorder: Diagnosed Treated	0.867	0.122	6.173
Blood Disorder: Diagnosed Untreated	7.428*+	2.371	23.269
Blood Disorder: Potential	0.00	0	Inf
No Heart Condition	1.00	1.00	1.00

Predictor Variables	Risk Ratio	Lower CI	Upper CI
Heart/Cardiovascular Disease: Diagnosed Treated	0.637	0.366	1.108
Heart/Cardiovascular Disease: Diagnosed Untreated	0.00	0	1.66e151
Heart/Cardiovascular Disease: Diagnosed Unsure	1.468	0.728	2.962
Heart/Cardiovascular Disease: Potential	0.685	0.306	1.531
No Lung and Chest	1.00	1.00	1.00
Lung and Chest: Diagnosed Treated	0.605	0.364	1.008
Lung and Chest: Diagnosed Untreated	2.472*	1.107	5.524
Lung and Chest: Diagnosed Unsure	0.708	0.264	1.898
Lung and Chest: Potential	0.865	0.121	6.168
No Missing Limb	1.00	1.00	1.00
Missing/Impaired Limb: Diagnosed Treated	15.707*+	5.042	48.935
Missing Impaired Limb: Diagnosed Untreated	2.458	0.343	17.616
Missing Impaired Limb: Diagnosed Unsure	0.886	0.459	1.71
No OSA	1.00	1.00	1.00
OSA: Diagnosed Treated	0.759	0.574	1.004
OSA: Diagnosed Untreated	1.491	0.958	2.322
OSA: Diagnosed Unsure	0.595	0.266	1.331
OSA: Potential	0.879	0.696	1.11
No Spine Condition	1.00	1.00	1.00
Spine/Other Musculoskeletal: Diagnosed Treated	1.029	0.67	1.578
Spine/Other Musculoskeletal: Diagnosed Untreated	1.934	1.002	3.733
Spine/Other Musculoskeletal: Diagnosed Unsure	0.599	0.33	1.087
Spine/Other Musculoskeletal: Potential	2.84*	1.057	7.633
Fail Hearing Test	1.00	1.00	1.00
Pass Hearing Test	0.584	0.328	1.042
Fail Vision Test	1.00	1.00	1.00
Pass Vision Test	1.696	0.807	3.566

+ = Four drivers had an untreated blood disorder and four drivers had a treated missing/impaired limb.

5.3.2.4 Moving Violations

Table 109 shows the RR estimates and 95-percent CIs for the significant predictors in the stepwise regression for moving violations. Significant RR estimates ($p < 0.05$) are denoted with an asterisk. The AIC value for this model was 9,360.94. Key findings are summarized below:

- Each yearly increase in age reduced the likelihood of a moving violation conviction by 6.0 percent.
- Each unit increase in BMI reduced the likelihood of a moving violation conviction by 1.2 percent.
- Drivers who obtained a periodic medical certification were 45.1 percent more likely to be convicted of a moving violation compared to drivers who obtained a full 2-year medical certification.

- Drivers who reported an injury or illness in the last 5 years were 26.9 percent less likely to be convicted of a moving violation compared to drivers who reported no injury or illness in the last 5 years.
- Drivers with treated alcohol use were 34.78 times more likely to be convicted of a moving violation compared to drivers who did not have alcohol use.
- Drivers with treated diabetes/elevated blood sugar were 38.7 percent more likely to be convicted of a moving violation compared to drivers who did not have diabetes/elevated blood sugar.
- Drivers with treated high blood pressure were 18.7 percent less likely to be convicted of a moving violation compared to drivers who did not have high blood pressure.
- Drivers with untreated high blood pressure were 65.2 percent more likely to be convicted of a moving violation compared to drivers who did not have high blood pressure.
- Drivers with potential high blood pressure were 34 percent more likely to be convicted of a moving violation compared to drivers who did not have high blood pressure.
- Drivers with a potential lung and chest condition were 3.95 times more likely to be convicted of a moving violation compared to drivers who did not have a lung and chest condition.
- Drivers with a treated missing/impaired limb were 15.96 times more likely to be convicted of a moving violation compared to drivers without a missing/impaired limb.
- Drivers with treated OSA were 36.6 percent less likely to have a moving violation conviction compared to drivers who did not have OSA.
- Drivers with a treated other sleep disorder were 3.05 times more likely to be convicted of a moving violation compared to drivers who did not have a sleep disorder.
- Drivers with untreated tobacco use were 33.1 percent less likely to be convicted of a moving violation compared to drivers with no tobacco use.

Table 109. Medical stepwise regression RR estimates and 95-percent CIs for moving violations.

Predictor Variables	Risk Ratio	Lower CI	Upper CI
Female	1.00	1.00	1.00
Male	1.335	0.977	1.825
Age	0.94*	0.911	0.97
Age^2	1.001	1.00	1.001
BMI	0.988*	0.979	0.997
Medical Certification: 2 Year	1.00	1.00	1.00
Medical Certification: Periodic	1.451*	1.114	1.891
Medical Certification: Temp Disqualified	1.248	0.924	1.684
Medical Certification: Failed	0.802	0.549	1.172
No Injury or Illness Last 5 Years	1.00	1.00	1.00
Illness or Injury Last 5 Years	0.731*	0.639	0.836

Predictor Variables	Risk Ratio	Lower CI	Upper CI
No Alcohol Use	1.00	1.00	1.00
Alcohol Use: Diagnosed Treated	34.773*+	4.747	254.698
Alcohol Use: Diagnosed Unsure	1.568	0.702	3.503
No Diabetes/Elevated Blood Sugar	1.00	1.00	1.00
Diabetes/Elevated Blood Sugar: Diagnosed Treated	1.387*	1.122	1.713
Diabetes/Elevated Blood Sugar: Diagnosed Untreated	1.056	0.63	1.771
Diabetes/Elevated Blood Sugar: Diagnosed Unsure	1.206	0.296	4.918
Diabetes/Elevated Blood Sugar: Potential	1.143	0.608	2.151
No High Blood Pressure	1.00	1.00	1.00
High Blood Pressure: Diagnosed Treated	0.813*	0.675	0.979
High Blood Pressure: Diagnosed Untreated	1.652*	1.124	2.428
High Blood Pressure: Diagnosed Unsure	0.906	0.37	2.22
High Blood Pressure: Potential	1.34*	1.04	1.726
No Lung and Chest	1.00	1.00	1.00
Lung and Chest: Diagnosed Treated	0.809	0.525	1.248
Lung and Chest: Diagnosed Untreated	0.392	0.055	2.788
Lung and Chest: Diagnosed Unsure	0.481	0.155	1.497
Lung and Chest: Potential	3.952*	1.476	10.58
No Missing Limb	1.00	1.00	1.00
Missing/Impaired Limb: Diagnosed Treated	15.964*+	5.121	49.765
Missing/Impaired Limb: Diagnosed Untreated	0.00	0	3.85e267
Missing/Impaired Limb: Diagnosed Unsure	0.798	0.398	1.602
No OSA	1.00	1.00	1.00
OSA: Diagnosed Treated	0.634*	0.455	0.882
OSA: Diagnosed Untreated	1.386	0.864	2.224
OSA: Diagnosed Unsure	0.703	0.331	1.494
OSA: Potential	1.084	0.827	1.422
No Other Sleep Disorders	1.00	1.00	1.00
Other Sleep Disorders: Diagnosed Treated	3.05*	1.513	6.15
Other Sleep Disorders: Diagnosed Untreated	0.00	0	7.63e304
Other Sleep Disorders: Diagnosed Unsure	0.00	0	Inf
No Tobacco use	1.00	1.00	1.00
Tobacco Use: Diagnosed Treated	0.405	0.057	2.89
Tobacco Use: Diagnosed Untreated	0.669*	0.498	0.898
Tobacco Use: Diagnosed Unsure	0.968	0.136	6.889
Tobacco Use: Potential	0.00	0	5.70e237
No Vitamin Deficiency	1.00	1.00	1.00
Vitamin Deficiency: Diagnosed Treated	1.133	0.159	8.077
Vitamin Deficiency: Diagnosed Unsure	11.463*+	2.73	48.131
Vitamin Deficiency Potential	0.00	0	Inf

+ = One driver had treated alcohol use, four drivers had a diagnosed/treated missing/impaired limb, and one driver had "unsure if treated" vitamin deficiency.

5.4 NESTED CASE-CONTROL ANALYSIS WITH FOLLOW-UP QUESTIONNAIRE

The Follow-up Questionnaire included the JIG, ESS, BQ, and SRLE. The analyses presented in this section are limited to those specific questionnaires. As indicated above, the response rate was poor for this questionnaire and the research team only contacted those case drivers who signed an ICF; thus, the sample included 300 case drivers and 1,045 control drivers. Table 110 shows the OR estimates and 95-percent CIs for each specific questionnaire in the Follow-up Questionnaire. Significant OR estimates ($p < 0.05$) are denoted with an asterisk. There were two significant findings in Table 110. Drivers who scored "mild excessive" and "moderate excessive" on the ESS were 66 percent and 2.27 times more likely to be involved in a case event, respectively, compared to drivers who scored "lower normal" on the ESS.

Table 110. OR estimates and 95-percent CIs for follow-up questionnaire.

Follow-up Questionnaires	Odds Ratio Estimate	Lower CI	Upper CI
JIG	1.001	0.991	1.011
SRLE: Work	1.022	0.992	1.054
SRLE: Time Pressure	1.022	0.996	1.050
SRLE: Social Victimization	1.037	0.992	1.085
SRLE: Social and Cultural	1.011	0.979	1.045
SRLE: SA	1.020	0.977	1.065
SRLE: Finances	1.015	0.981	1.050
SRLE: Work	1.022	0.992	1.054
ESS: Lower Normal	1.00	1.00	1.00
ESS: Higher Normal	1.065	0.792	1.432
ESS: Mild Excessive	1.662*	1.001	2.762
ESS: Moderate Excessive	2.267*	1.355	3.792
ESS: Severe Excessive	0.657	0.222	1.948
BQ: Low Risk	1.00	1.00	1.00
BQ: High Risk	0.929	0.608	1.419

5.5 OSA PREDICTIVE ANALYSIS

Table 111 and Table 112 display the frequency and percent of diagnosed OSA drivers by age quartiles and BMI categories, respectively. As shown in these tables, the frequency and percent of drivers diagnosed with OSA increases as age and BMI increase.

Table 111. Frequency and percent of diagnosed OSA by age quartiles.

Measure	20–33	34–42	43–51	52+
Frequency	145	245	290	301
Percent	4.77%	7.84%	8.37%	9.36%

Table 112. Frequency and percent of diagnosed OSA by BMI categories.

Measure	Underweight	Normal weight	Overweight	Obese Class I	Obese Class II	Obese Class III
Frequency	0	10	35	104	261	568
Percent	0%	0.59%	0.89%	2.78%	13.88%	38.51%

Table 113 shows the OR estimates and 95-percent CIs for the OSA prediction logistic regression for drivers diagnosed with OSA (per the Medical Examination Report). Significant OR estimates ($p < 0.05$) are denoted with an asterisk. Key findings are summarized below:

- Drivers over 52 were 2.08 times more likely to be diagnosed with OSA compared to drivers aged 20–33.
- Drivers with an obese class II BMI were 22.13 times more likely to be diagnosed with OSA compared to drivers with a normal BMI.
- Drivers with an obese class III BMI were 103.34 times more likely to be diagnosed with OSA compared to drivers with a normal BMI.
- Male drivers were 5.5 times more likely to be diagnosed with OSA compared to female drivers.
- Drivers with diagnosed high blood pressure were 2.30 times more likely to be diagnosed with OSA compared to drivers without high blood pressure.
- Drivers who scored high risk on the BQ were 3.57 times more likely to be diagnosed with OSA compared to drivers who scored low risk on the BQ.

Table 113. OR estimates and 95-percent CIs for OSA prediction logistic regression.

Predictor Variables	Odds Ratio Estimate	CI Lower	CI Upper
Age: 20–33	1.00	1.00	1.00
Age: 34–42	1.163	0.796	1.699
Age: 43–51	1.39	0.948	2.04
Age: 52+	2.08*	1.373	3.152
BMI: Underweight	N/A	N/A	N/A
BMI: Normal	1.00	1.00	1.00
BMI: Overweight	2.377	0.536	10.54
BMI: Obese Class I	4.172	0.992	17.542
BMI: Obese Class II	22.131*	5.379	91.056
BMI: Obese Class III	103.341*	25.282	422.404
Gender: Female	1.00	1.00	1.00
Gender: Male	5.504*	2.469	12.267
No High Blood Pressure	1.00	1.00	1.00
High Blood Pressure	2.3*	1.738	3.043
No Diabetes/Elevated Blood Sugar	1.00	1.00	1.00
Diabetes/Elevated Blood Sugar	1.412	0.986	2.022

Predictor Variables	Odds Ratio Estimate	CI Lower	CI Upper
ESS	0.944	0.909	0.981
BQ: Low Risk	1.00	1.00	1.00
BQ: High Risk	3.573*	2.748	4.647

Although the logistic regression results presented in in Table 113 report the odds that a driver with each predictor variable was diagnosed with OSA, it does not tell us the relative importance of each predictor. The classification tree shown in Figure 19 shows the relative importance of the predicator variables in identifying diagnosed OSA drivers (BMI and age were treated as continuous variables in the trees classification rather than ordinal variables). As shown in Figure 19, the classification tree shows the following splits:

- Split 1: For drivers with a BMI less than or equal to 35.03, the odds of being diagnosed with OSA were 1.6:100 (or 152/9,358).
- Split 2: For the drivers with a BMI greater than 39.19 (a near match with obese classes I, II, and III), the odds of being diagnosed with OSA were 56:100 (or 619/1,055).
- Split 3: For those drivers with a BMI between 35.04 and 39.19 and diagnosed high blood pressure, the odds of being diagnosed with OSA were 27:100 (or 119/439).
- Split 4: For those drivers (aged 33.5 or younger) who had a BMI between 35.04 and 39.19 and no diagnosed high blood pressure, the odds of being diagnosed with OSA were 3.6:100 (or 12/335).
- Split 5: Drivers (older than 33.5) who had a BMI between 35.04 and 39.19, no diagnosed high blood pressure, and who scored high risk (left split in Figure 19) or low risk (right split in Figure 19) on the BQ.
- Split 6: For those drivers (older than 33.5) who had a BMI between 35.04 and 39.19, no diagnosed high blood pressure, and who scored high risk for OSA on the BQ, the odds of being diagnosed with OSA were 11.0:100 (or 36/326). For those drivers (older than 33.5) with a BMI between 35.04 and 36.25, no diagnosed high blood pressure, and who scored high risk for OSA, the odds of being diagnosed with OSA were 4.8:100 (or 10/208).
- Split 7: For those drivers (older than 36.5) with no diagnosed high blood pressure, who scored low risk for OSA on the BQ, and who had a BMI between 35.04 and 39.19, the odds of being diagnosed with OSA were 19.7:100 (or 23/117). For those drivers between the ages of 33.6 and 36.5, who had a BMI between 35.04 and 39.19, with no diagnosed high blood pressure, and who scored low risk for OSA, the odds of being diagnosed with OSA were 0:100 (or 0/26).

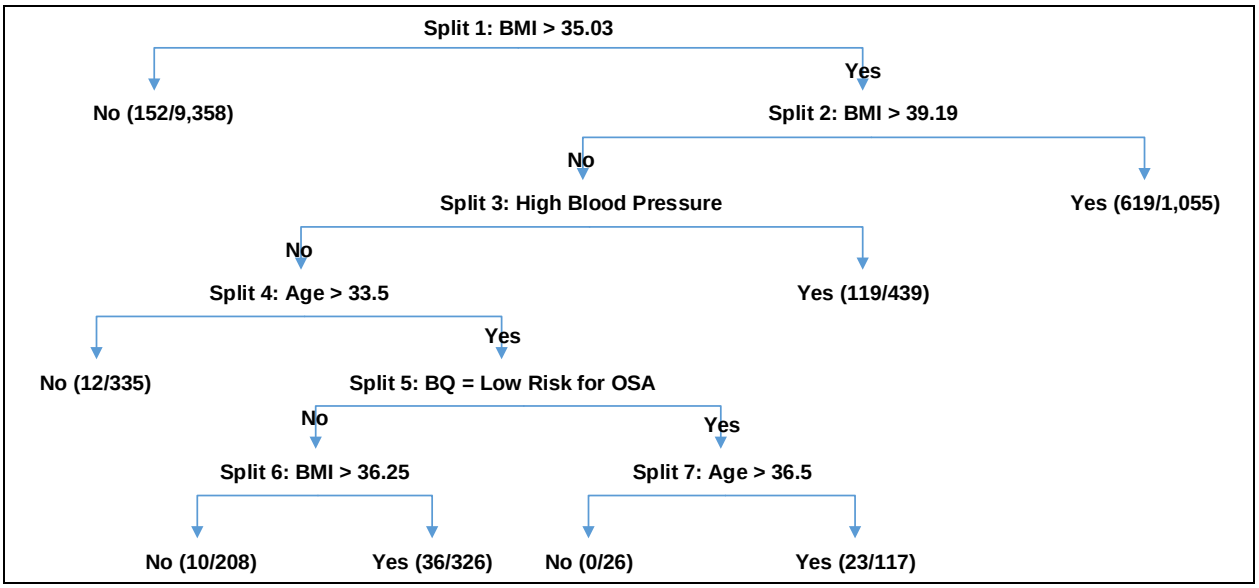

Figure 19. Tree classification of OSA predictors.

The research team decided to stop growing the classification tree at the seventh split, as the cross-validation error increased afterwards (see Table 114).

Table 114. Number of splits and associated cross validation error.

N Split	Error
0	1.04356
1	0.38072
4	0.37178
6	0.36912
7	0.36120
13	0.36328
15	0.36157
16	0.3616
20	0.36187

Lastly, Table 115 provides the OSA classification counts, which can be used to calculate the rates in the classification tree. The tree model labels 21.4 percent of the drivers with OSA. Among these drivers, 82.2 percent (807/981) of drivers with diagnosed OSA were successfully detected. Thus, if we only gave an OSA test (i.e., polysomnography) to drivers labeled with OSA by our tree model, we would detect over 80 percent of the OSA diagnoses. However, if the remainder of the 10,101 drivers were tested, only 1.7 percent (174/10,101) would be diagnosed with OSA. The overall misclassification rate was 16.4 percent (15.1 percent were not diagnosed with OSA, but were classified as having OSA by the tree, and 1.4 percent were not diagnosed but classified as having OSA by the tree).

Table 115. OSA classification counts and percent.

Tree Prediction	No OSA Per Medical Examination Report	OSA Per Medical Examination Report	Total
Tree Predicted No OSA	9,927 (77.3%)	174 (1.4%)	10,101 (78.7%)
Tree Predicted OSA	1,937 (15.1%)	807 (6.3%)	2,744 (21.4%)
Total	**11,864 (92.3%)**	**981 (7.7%)**	**12,845 (100%)**

6. DISCUSSION

This study was one of the first to prospectively assess how various factors affect the crash and moving violation risk in truck drivers. These factors included the following: demographics, medical history, sleep history, driver training, job satisfaction, prior safety record (including prior crashes, moving violations, and OOS violations), daytime sleepiness, propensity for dangerous driving, risk for OSA, social desirability, recent life experiences, and driver behaviors. One of the more striking findings was the profound effect of age and driving experience on future crash risk. Younger and less experienced truck drivers age 20 to 33 were far more likely to be involved in safety outcomes compared to older and more experienced truck drivers age 52 and older. The distribution of the crash rate by age for truck drivers in the current study was similar to the distribution of the U.S. crash rate by age.[110] Moreover, older drivers in the current study were more likely than their younger counterparts to have the presence of one or more medical conditions. To address this issue, many of the analyses were stratified by age quartiles; drivers in each age quartile were compared to other drivers in the same age quartile.

Another interesting finding was the degree to which drivers responded on the Initial Driver Survey in a socially desirable way (i.e., trying to present themselves in a good light). Almost all drivers who completed the Initial Driver Survey scored high on the SDS (99.1 percent), and the mean scores on the DDDI and SRLE were well below the norms for those questionnaires, making normative comparisons on these questionnaires inappropriate. This also reduced the variance in driver responses, making it more challenging to find significant relationships with the safety outcomes.

Before we discuss some of the notable trends identified in the results, it is appropriate to discuss the representativeness of our sample to the general truck driver population. Although we recruited truck drivers from across the United States, most of the participants were recruited from one large for-hire truck fleet. Moreover, those who completed the Initial Driver Survey can be considered a convenience sample. According to the Bureau of Labor Statistics (BLS), in 2017, the average age of a truck driver was 46.4, and 6 percent of drivers were female.[111,112] An analysis by Short[113] using BLS data in the Truck Transportation Category found that 20.5 percent of truck drivers in the United States were between the ages of 20 and 34, with 53.3 percent between the ages of 35 and 54. A nationally representative sample of long-haul truck drivers performed by the National Institute of Occupational Safety and Health (called the Long-Haul Truck Driver Survey or LHTDS) found the average age of truck drivers in their sample was 48; 6.5 percent were female; and 35 percent were independent contractors.[114] This study also reported that 22 percent of their sample were between the ages of 20 and 39, with 62.1 between the ages of 40 to 59. The percent of owner-operators in the LHTDS appears to be high, as according to statistics from the Owner-Operator Independent Drivers Association (OOIDA)[115] and the BLS,[116] only about 19.5 percent of large truck drivers are owner-operators. In the current study, 11 percent were independent contractors, 4 percent were female, and 25.4 percent and 50.59 percent were between the ages of 20 and 33 and 34 and 51, respectively. Note there was 1 driver that was age 20 out of over 21,000 drivers in the study. Thus, compared to these other studies, the current sample was slightly younger and contained fewer females and owner-operators. The latter was expected given that, as noted, the majority of our sample was recruited from a for-hire carrier.

The remainder of this section describes the noteworthy trends. There were many analyses performed that produced a number of statistically significant findings. Here, we focus on the consistent trends across these analyses (i.e., consistent trends across age bins, safety outcomes, and/or the independent regression and stepwise regression). We also considered the number of drivers for each medical grouping and treatment when selecting which results to discuss in more detail. Those medical groupings with few drivers are not discussed in detail. These other significant results are meaningful, and we chose to focus on the consistent trends, as we believed these findings were the most relevant from a regulatory and CMV safety management perspective.

6.1 DRIVER DEMOGRAHICS

Most of the drivers (47.7 percent) in the current study were married at the time they completed the Initial Driver Survey (the remainder were single, divorced, or widowed). This was similar to the results reported in the LHTDS, where 53.4 percent of the drivers were married.[117] The LHTDS also found that 54.2 percent and 46.3 percent of truck drivers had a high school level or below education or a college level and above education, respectively. However, the drivers in the current study reported a greater proportion of higher education, with 24.4 percent having a high school or less education and 75.6 percent having a college or greater education. At least for drivers in the oldest age quartile (52 and above), higher levels of education were associated with a significantly lower likelihood of a national crash. Drivers with a high school diploma, associate's degree, and bachelor's degree were about 30 percent less likely to be involved in a national crash compared to drivers with a GED (the stepwise regression supported these findings for a high school and associate's degree). The literature is mixed on this topic. A study with Danish drivers found no relationship between level of education and crash risk;[118] however, a review of U.S. death rates found decreased mortality rates by motor vehicle crashes with increasing levels of education.[119] Both studies focused largely on passenger car drivers and the latter study assessed mortality rather than crash risk.

The LHTDS found the following percentage of truck drivers in each BMI category: 0.4 percent were underweight, 7.9 percent were normal weight, 22.8 percent were overweight, and 64.4 percent were obese. Using a dataset similar to that used in the current study (including data from 2005 to 2012), Thiese et al.[120] found the following percent of drivers in each BMI category: 0.48 percent were underweight, 10.4 percent were normal weight, 24.7 percent were overweight, and 53.2 percent were obese. These numbers were very similar to those found in the current study, where 0.37 percent of CMV drivers were underweight, 12.4 percent were normal weight, 28.8 percent were overweight, and 58.4 percent were obese. These studies confirm that obesity (BMI > 30) is almost twice as prevalent in CMV drivers compared to the national prevalence of obesity in the working population (30.5 percent).[121]

Several studies have found a relationship between obesity and increased risk of a fatal or severe injury crash;[122,123,124] however, this increased risk in death or injury may be related to physiological factors rather than driver performance factors (e.g., fatigue susceptibility). Other studies have found a relationship between obesity and increased crash risk. For example, Wiegand et al.[125] found that obese CMV drivers had a higher risk of involvement in a safety-critical event when evaluating naturalistic truck driving data, and Anderson et al.[126] found that

newly recruited obese CMV drivers were more likely to have a future crash compared to newly recruited normal weight CMV drivers. These studies did not assess individual health conditions, but concluded that the increase in crash risk was likely due to comorbid health conditions that adversely affect driver performance (such as OSA). Obesity predisposes one to a variety of negative health conditions, including high blood pressure, diabetes, heart disease, and OSA.[127,128] The current study only found a significant trend between obesity and the safety outcomes for drivers aged 20–33 in the individual regression analyses. Drivers with a BMI that classified them as overweight or above were significantly less likely to be involved in a total carrier crash and a carrier preventable crash compared to normal weight drivers. This was an interesting finding, as this group of drivers had fewer medical conditions compared to the other age quartiles. It appears obesity itself does not increase crash risk, but rather crash risk is increased by the comorbid health conditions associated with obesity (the current study found several of these conditions significantly increase risk if not treated).

6.2 DRIVER EXPERIENCE, TENURE, TRAINING

The mean amount of total experience driving a CMV in the current study was 102 months and the median amount was 60 months. The mean weighted amount of CMV driving experience in the LHTDS was 192 months.[129] OOIDA reported that their drivers have, on average, 312 months of CMV driving experience.[130] At least for those drivers who completed the Initial Driver Survey, the sample in the current study had less CMV driving experience (17.5 years to 7.5 years or less of CMV driving experience). CMV driving experience was highly correlated with age and was thus not included in the modeling approach. Moreover, CMV driving experience was available only for those drivers who completed the Initial Driver Survey, whereas age was available for every driver in the current study.

Turnover, or driver churn, is problematic in the trucking industry, especially in the for-hire truckload industry. High turnover is usually a reflection of high demand for drivers. Most of the driver churn in the trucking industry is accounted for by voluntary turnover (drivers going from one carrier to another carrier) rather than involuntary turnover (driver is laid off or fired).[131] In the past, turnover rates have exceeded 100 percent; however, more recent turnover rates have decreased to 5-year lows at 74 percent for large truckload carriers and 66 percent for small truckload carriers.[132] This doesn't mean that 74 percent of the drivers who started at the carrier at the beginning of the year did not make it to the end of the year; it means that 74 percent of a carrier's total driver workforce was replaced throughout the year. The data in the current study seem to support this, as the median and mean number of days at the participating carrier were 114 days and 213 days, respectively. However, these numbers are somewhat misleading for two reasons. First, they include driver tenure from drivers who were employed at the participating carrier multiple times over the course of data collection (this would increase driver tenure). Second, they include a cutoff date of May 30, 2016, and many drivers likely remained at the participating carrier beyond this date (this would decrease driver tenure).

As alluded to above, it appeared drivers in the current study did not understand the question regarding truck training experience or they did not answer this question, as over 25 percent of the sample did not report any prior truck training experience. Although the participating carrier required at least 6 months of CMV driving experience prior to hire, only 35 percent of drivers

reported any prior on-the-job training. This suggests that smaller carriers, which are more likely to hire drivers with no prior driving experience, may not provide adequate on-the-job training or drivers simply did not understand the question. Based on the average age and amount of driving experience for drivers in the current study, we can conclude that most of the drivers were not entry-level drivers. Interestingly, 38 percent of the drivers in the LHTDS reported they did not have adequate training at the beginning of their career to safely drive a truck under all road and weather conditions.[133]

In the individual regression model, there was some evidence that more formal and informal training were related to a significantly higher risk of involvement in a carrier preventable crash and a national crash (though the RR was small, at only ~1 percent increase per additional week). However, the step-wise regression showed the opposite relationship, with a significantly lower risk of involvement in a total carrier crash or a carrier preventable crash with more informal and formal training, respectively (again, the RR was small, at only ~1 percent reduction per additional week). A review of CMV driver training in 2007 could not find a scientific study that evaluated the effectiveness of different training methods and/or the amount of training on future safety outcomes.[134] Morgan et al. evaluated the effectiveness of using truck driving simulators in entry-level training. One of the findings suggested that drivers who obtained their CDLs via a short, CDL-test focused approach were more likely to fail an independent Department of Motor Vehicles road and range test compared to entry-level drivers who completed a certified 8-week training approach.[135] ATRI (2008) examined the relationship between driver training and driver safety performance using data from participating carriers that provided information on the training programs and safety data. Results showed that variation among driver safety performance was not explained by the duration of training.[136] There are currently Federal standards for testing and issuing Class A CDLs; however, there were no Federal requirements for training CMV drivers at the time of data collection. This has changed, as FMCSA published a final rule on entry-level driver training on December 8, 2016. This rule, which became effective on February 6, 2017 (with a compliance date of February 6, 2020), specifies requirements for knowledge and behind-the-wheel instruction for entry-level drivers, but does not require a specific number of instruction or behind-the-wheel training hours.[137]

6.3 DRIVER BEHAVIORS IN THE INITIAL DRIVER SURVEY

Over 80 percent of the drivers in the current study who completed the Initial Driver Survey reported their diet as average or worse. However, the forced-choice responses for this question were not defined, and thus the responses were largely based on each individual driver's perception of what an average diet entails (e.g., eating a diet that contains a lot of fast food might be perceived as an average diet). In order to maximize driving time, drivers may snack throughout the day to keep their energy up and consume one large meal at the end of their shift. They also are restricted to eating at restaurants that accommodate their large vehicles (mostly truck stop diners and fast food restaurants). Limited cab space inside the truck makes it difficult to store and prepare healthier meals on the road. One study of long-haul drivers indicated that half of the drivers reported consuming one or fewer servings of fruit and vegetables daily,[138] far fewer than the recommended five daily servings.[139]

The most frequently reported amount of weekly exercise was no exercise (28.6 percent); however, 47.5 percent of the drivers reported exercising at least three times a week. Similar to the forced choices on diet, these responses were largely based on each individual driver's perception of what consisted of exercise and no information was collected on the length of the exercise session. The LHTDS found that 24.7 percent of men and 12 percent of women, respectively, reported zero days with 30 minutes of physical activity in the last week. The results for men in the LHTDS are similar to what was found in the current study. Long hours spent driving can limit motivation and opportunities for exercise. Bigert et al.[140] reported that 46–56 percent of truck drivers self-reported no physical activity during leisure time. Excess calorie consumption and limited exercise are likely the reason behind the large proportion of obese trucks drivers.

Prior studies have found that cigarette smoking rates in this population remain significantly elevated compared to working adults in the United States (51 percent versus 19 percent).[141,142] The current study also found elevated rates of current tobacco use, with 63.3 percent of drivers who completed the Initial Driver Survey reporting use of tobacco. Although tobacco use wasn't associated with any of the safety outcomes, it is associated with a myriad of adverse health complications, including cancer, cardiovascular disease, and respiratory diseases.[143] Much like the adverse health conditions associated with poor diet and lack of physical exercise, tobacco use is one of the most significant causes of preventable diseases and premature mortality in the United States.[144]

Caffeine consumption is ubiquitous in the United States, with almost 95 percent of the U.S. population over 18 years old consuming at least one caffeinated beverage each day.[145] CMV drivers are no different; however, the results in the current study suggest they may consume more compared to the general U.S. population. Almost all drivers in the current study (99.6 percent) reported drinking at least one caffeinated drink per day, and most drivers (77.2 percent) reported consuming two or more drinks per day. Prior studies have found that caffeine can serve as a short-term countermeasure for fatigue; however, these studies were able to isolate the time of caffeine intake in relation to the safety event (see references 146, 147, 148, and 149). The current study assessed an average of daily caffeine consumption without identifying when caffeine intake occurred in relation to a safety outcome; thus, we did not find any relationship between caffeine and any of the safety outcomes.

In the current study, 69.6 percent of drivers who completed the Initial Driver Survey reported no alcohol use and 30 reported one alcoholic drink each week. The percent of CMV drivers in the current study reporting no alcohol use was far lower than reported in the LHTDS and the U.S. working population (38.9 percent and 10.9 percent, respectively). A meta-analysis performed by Girotto et al.[150] found the presence of alcohol in 3.6 percent of the biological samples from truck drivers. Fatal crashes where the driver had a blood alcohol content above 0.08 are very low for truck drivers compared to passenger car drivers (2 percent versus 22 percent, respectively).[151] This is likely because truck drivers are subject to random drug and alcohol tests and Federal laws have zero tolerance for driving under the influence (i.e., drivers are not allowed to have a detectable amount of alcohol in their system).

Although only 12.6 percent of drivers in the current study who completed the Initial Driver Survey reported a regular sleep schedule, 72.9 percent of the drivers reported 7 or more hours of

sleep each night. This is at the recommended 7-hour threshold for daily sleep to promote health.[152] However, several naturalistic truck driving studies that objectively monitored sleep via actigraphy found that truck drivers averaged about 6–6.5 hours of sleep on duty days.[153,154,155] The LHTDS also found that truck drivers self-reported more sleep than these naturalistic driving studies, with 22.1 percent reporting more than 8 hours of sleep in the last 24 hours and 51.4 percent reporting 6–8 hours of sleep in the last 24 hours. The proportion of truck drivers reporting more than 8 hours of sleep in the last 24 hours was over four times greater than that of the U.S. working population (5 percent),[156] indicating that drivers may be self-reporting a picture of their sleep that is rosier than the reality. Truck drivers work extended hours and shifts that can start at various times of the day and night and the conditions in the truck cab are not conducive to good quality sleep (due to noise, comfortability, and temperature). All of these factors can adversely affect the amount and quality of sleep. Adequate sleep is important, as fatigue has been shown to be the principal cause in 13–31 percent of truck crashes.[157,158]

FMCSA requires CMV drivers to use seat belts while driving. Prior observational surveys in the early 2000s estimated overall safety belt usage of 48 percent for CMV drivers in the United States. Large national fleets averaged a usage rate of 54 percent, and independent and local fleets were estimated to be at 44 percent usage. These usage rates compared poorly with the national seat belt usage rate for passenger car drivers of about 79 percent.[159] Due to these poor rates of seat belt use by CMV drivers, FMCSA established the CMV Safety Belt Partnership, and the current national rate of seat belt use among CMV drivers is now at 86.1 percent.[160] Over 95 percent of drivers in the current study reported “always” wearing their seat belt while driving a CMV. Several of the analyses showed that drivers who wore their seat belt less than always were significantly more likely to be convicted of a moving violation (45–234 percent more likely). Only 5 percent of the moving violation convictions in the current study were related to lack of restraint use, indicating that most drivers were convicted of other moving violations. However, the relationship between lack of seat belt use and performing other risky driving behaviors (e.g., speeding, following too closely, etc.) has been well documented in the behavioral literature.[161,162,163]

Drivers in the current study who reported a prior moving violation were significantly more likely to be involved in a carrier preventable crash (54 percent more likely) and a national crash (58 percent more likely) or convicted of a moving violation (45–62 percent more likely) in the individual regression analyses. They were also 26 percent more likely to be involved in a national crash or convicted of a moving violation in the stepwise regression analyses. Associations between risky driving behaviors and crash involvement are strongly supported in the literature. Murray et al.[164] evaluated the relationship between moving violations and future crash involvement. Having past convictions and violations, especially serious violations, increased a driver’s likelihood of a future crash. For example, reckless driving increased the likelihood of a future crash by 3.25 times; improper turn violations increased future crash likelihood by 105 percent; and improper or erratic lane change, failure to yield, improper turn, or failure to maintain proper lane increased the likelihood of a future crash by 91–100 percent. A 2011 update to this methodology found similar results; however, some violation behaviors demonstrated different trends.[165] Moreover, drivers over the age of 52 who reported prior crashes were significantly more likely to be involved in total carrier crashes, carrier preventable crashes, and national crashes.

6.4 QUESTIONNAIRES IN THE INITIAL DRIVER SURVEY

The results from the ESS produced inconsistent results. Most of the individual regression results showed that drivers who scored "mild excessive" or above were significantly more likely to be involved in a national crash or convicted of a moving violation, but there were exceptions. The nested-case control analysis with the Follow-up Questionnaire found similar results. The stepwise regression also provided inconsistent results, with drivers scoring "higher normal" and "mild excessive" on the ESS being significantly more likely to be convicted of a moving violation compared to drivers who scored "lower normal." Drivers who scored "severe excessive" on the ESS were significantly more likely to be convicted of a moving violation compared to drivers who scored "lower normal." Although the ESS did not show a consistent relationship with the safety outcomes, it is likely it reflects daytime sleepiness in relation to a medical condition associated with sleep difficulties (such as OSA). We were unable to test this hypothesis, as we were unable to combine the Initial Driver Survey with the medical data from the Medical Examination Report. Still, the results suggest the ESS was a somewhat effective measure in predicting future safety outcomes.

The SRLE was included in the Initial Driver Survey with the thinking that it could assess stress in various personal domains. Stress is typically viewed as a temporary physiological and emotional response to an external aversive event; however, when stressful events are seen as long-lasting or recurrent, then stress can be considered an individual trait. Although prior studies do not establish a causal relationship between stress and crash involvement, they do suggest that a relationship exists (see references 166, 167, 168, and 169). It may be the case that individuals who are experiencing significant stress are preoccupied, and are thus less attentive than they would otherwise be, leading to increased crash risk.[170] Much like the ESS, the results on the SRLE were inconsistent. The individual regression results found that drivers aged 43–51 were significantly less likely to be involved in a national crash, as their scores on the work, time pressure, social victimization, social and cultural, social acceptability, and finances subscales increased. The opposite trend was found for drivers over 52 on the time pressure, social victimization, social and cultural subscales. Higher scores on the finances scale of the SRLE in the stepwise regression were associated with a significantly higher likelihood of involvement in a total carrier crash (4.5 percent increase for each one-point increase on the subscale); however, higher scores on the time pressure and social and cultural scales were associated with significantly lower likelihood of involvement in a total carrier crash and national crash, respectively (2.6 percent and 3.2 percent increase for each one-point increase on the subscale). The most notable finding, as indicated above, was the low mean scores across each subscale on the SRLE in relation to the mean normative scores. This suggests drivers who completed the Initial Driver Survey may have been responding in a more positive light than the normative group of respondents.

Truck crashes are largely the result of human error, most of which are associated with drivers performing risky driving behaviors.[171,172,173] These risky driving behaviors can reflect one's general driving style or they can reflect emotional aspects, such as impulsivity and risk taking (both of which have been shown to be correlated with risky driving behaviors and crash risk).[174] The DDDI assesses one's aggressive driving style, impulsivity, and emotional driving; however, it did not reliably predict any of the safety outcomes. Again, the mean scores for drivers in the current study on each of the subscales in the DDDI were far below the mean normative scores on

the subscale. It is worth noting that the normative scores were based on a sample of mostly college-aged passenger car drivers, so it is not surprising that truck drivers scored well below this group.

6.5 MEDICAL CONDITIONS

It is important to remember the Medical Examination Report is not an exhaustive medical examination. It is largely based on drivers' self-reports, with a physical examination and several objective tests. The results obtained in this study are not reflective of the general prevalence rates in the CMV driver population, as there is likely underreporting and under diagnosis of medical conditions. For example, the likelihood of moderate-to-severe OSA in people with a BMI greater than 35 is 80 percent.[175] Thus, approximately 3,300 drivers (~24 percent) in the current study should have had moderate-to-severe OSA; however, only 7.2 percent (over a threefold difference) were diagnosed with OSA on the Medical Examination Report. This underreporting is largely due to the likelihood of drivers receiving a temporary certification or a disqualification due to a medical condition, thereby minimizing their ability to maintain their livelihood. It could also be that drivers may not want deal with the treatment option, such as being on PAP if they have OSA.[176]

FMCSA provides guidance for certification length, but certification length is still largely at the medical examiner's discretion.[177] Table 22, Table 23, and Table 24 illustrate that medical examiners were largely following this guidance, as drivers with a BMI greater than 35, sleep disorder, diabetes, high blood pressure, nervous/psychiatric disorder, and lung abnormalities were all significantly more likely to receive a temporary medical certification or be medically disqualified compared to drivers who did not have these medical conditions. These results are very similar to what Thiese et al.[178] reported using a similar dataset from calendar years 2005 to 2012, and suggest the National Registry for Certified Medical Examiners has been effective in reducing the variability between different medical examiners.

Even with underreporting and under diagnosis, many of the prevalence rates for several of the medical conditions were similar to or above the U.S. average. The prevalence of diabetes (9.4 percent versus 6.8 percent), hypertension (24.4 percent versus 24 percent), and obstructive sleep apnea (7.2 percent versus 4 percent) were above those in the general population and other occupational cohorts, whereas heart disease was lower (2.4 percent versus 6.7 percent).[179] These rates were also similar to the 2012 data from Thiese et al.[180], where 8 percent of drivers had a sleep disorder, 10.2 percent had diabetes, and 25.3 percent had high blood pressure. The LHTDS found that drivers self-reported higher rates of diabetes (14.1 percent), heart disease (4.4 percent), and high blood pressure (26.3 percent) compared to the current study.[181]

Most studies that assess the crash risk of a medical condition only consider the presence of the medical condition and disregard whether the medical condition is being treated. The current study found protective effects for several medical conditions when those medical conditions were being treated, but largely found that diagnosed drivers who received treatment were no different than drivers without the medical condition. When there was an increased risk in one of the safety outcomes, it meant the driver was not treating the medical condition or the driver

potentially had the medical condition (but wasn't being treated, as the medical condition was undiagnosed at this stage).

Another important consideration is the interpretation of the results for diagnosed drivers with untreated medical conditions. These results largely showed that diagnosed drivers with untreated medical conditions were no different than undiagnosed drivers. This may be true; however, it is premature to conclude that interpretation in the current study. First, this group of drivers had small cell counts for each medical grouping (i.e., made up a small proportion of diagnosed drivers) thus lowering statistical power. Second, the frequency of crashes in this group may be biased as a medical examiner may elect to disqualify a driver if he/she is not treated for certain medical conditions. This would lower the frequency of crashes in this group as these drivers would not be on the road.

The one medical condition where treatment adversely affected the likelihood of involvement in a safety outcome—nervous/psychiatric disorder—encompassed a variety of psychological disorders. Drivers who were diagnosed with a nervous/psychiatric disorder, regardless of treatment, were more likely to be involved in a total carrier crash, preventable carrier crash, and national crash. Norris et al.[182] found individuals who reported high levels of anxiety were more likely to be involved in a previous crash than individuals reporting low anxiety ($p < 0.05$). Another study found significant adjusted OR estimates for individuals reporting anxiety (OR estimate = 3.15), indicating these individuals were more likely than non-crash-involved drivers to experience a crash.[183] The increase in crash risk may be a result of the disorder causing the driver to divert attention from the driving task to their worries and ruminations.[184] Regardless of these studies, more research is needed to determine why the individuals in the current study who were being treated for a nervous/psychiatric disorder still exhibited an increased likelihood of involvement in a crash.

In certain age groups, drivers receiving treatment for OSA, high blood pressure, and diabetes/elevated blood sugar were less risky than drivers who did not have the condition. Drivers aged 34–42 with OSA who were currently being treated were significantly less likely to be involved in a carrier preventable crash compared to drivers without OSA (95.9 percent reduction), whereas drivers aged 34–42 who had OSA and weren't being treated were significantly more likely to be convicted of a moving violation (66.2 percent increase). Drivers with potential OSA (thus untreated) were more likely to be involved in a carrier preventable crash and moving violations. Burks et al.[185] evaluated data from the first large-scale, employer-mandated OSA program for CMV drivers to quantify the safety benefits of the program on the risk of involvement in a preventable DOT-reportable crash. CMV drivers diagnosed with OSA who were not adherent to treatment had a crash rate nearly 500 percent greater than matched controls without or unlikely to have OSA. However, CMV drivers with OSA who were fully or partially adherent to treatment had crash rates similar to controls, demonstrating the effectiveness of PAP treatment in terms of safety.

High blood pressure showed a consistent trend across the analyses. Drivers aged 34–42 who had high blood pressure and received treatment were less likely to be convicted of a moving violation (40 percent reduction). However, drivers aged 34–42 with high blood pressure who weren't being treated were significantly more likely to be convicted of a moving violation (twofold increase), and drivers who potentially had high blood pressure were significantly more likely to

be involved in a total carrier crash (70 percent increase) or be convicted of a moving violation (almost threefold increase). Several studies have found that hypertension causes cognitive impairment;[186] however, a study assessing the relationship between hypertension and crash risk in truck drivers was inconclusive.[187] The same authors conducted a follow-up study with bus drivers and found those with hypertension were involved in more severe crashes in comparison to healthy bus drivers.[188] Thus, the CDSRF study is the first study to find a relationship between hypertension and crashes among truck drivers.

Drivers aged 43–51 with treated diabetes/elevated blood sugar were 50 percent less likely to be involved in a national crash compared to drivers aged 43–51 who did not have diabetes/elevated blood sugar. Drivers with treated diabetes/elevated blood sugar were 38.7 percent more likely to have a moving violation compared to drivers who did not have diabetes/elevated blood sugar.

Post-hoc analyses were completed for these three medical conditions (i.e., OSA, high blood pressure, and diabetes/elevated blood sugar) comparing treated and untreated drivers. As shown in Table 116, in certain age groups, drivers receiving treatment for high blood pressure and OSA were less risky than untreated, diagnosed drivers. See Appendix H for the individual regression analyses comparing treated and untreated drivers with diabetes/elevated blood sugar, high blood pressure, and OSA.

Table 116. Post-hoc analysis: safety outcomes (adjusted for age and BMI) of drivers treated for diabetes/elevated blood sugar, OSA, or high blood pressure compared to drivers with the condition who were not receiving treatment.

Crash/Moving Violation Category	Treated Drivers versus Untreated Drivers
Carrier-Defined Preventable Crashes	**Treated OSA:** • Drivers aged 34–42 with treated OSA were **92.2% less likely** to be involved in a carrier preventable crash than untreated drivers with OSA. • Drivers aged 43–51 with treated OSA were **68.9% less likely** to be involved in a carrier preventable crash than untreated drivers with OSA. In all other age groups, there were no statistically significant differences in this safety outcome between drivers with treated OSA and drivers with untreated OSA. **Treated Diabetes/Elevated Blood Sugar and Treated High Blood Pressure:** There were no statistically significant findings in this category for these conditions.
National Crashes as Reported to MCMIS	**Treated OSA:** • Drivers aged 43–51 with treated OSA were **59.7% less likely** to be involved in a MCMIS-reportable* crash compared to untreated drivers with OSA. In all other age groups, there were no statistically significant differences in this safety outcome between drivers with treated OSA and drivers with untreated OSA. **Treated Diabetes/Elevated Blood Sugar and Treated High Blood Pressure:** There were no statistically significant findings in this category for these conditions.

Crash/Moving Violation Category	Treated Drivers versus Untreated Drivers
Moving Violation Convictions found in CDLIS	**Treated High Blood Pressure:** • Drivers aged 20–33 with treated high blood pressure were **69.3% less likely** to be convicted of a moving violation compared to untreated drivers with high blood pressure. • Drivers aged 34–42 with treated high blood pressure were **72.6% less likely** to be convicted of a moving violation compared to untreated drivers with high blood pressure. • Drivers aged 52 or older with treated high blood pressure were **51.5% less likely** to be convicted of a moving violation compared to untreated drivers with high blood pressure. In the 43–51 age group, there were no statistically significant differences in this safety outcome between drivers with treated high blood pressure and drivers with untreated high blood pressure. **Treated OSA:** • Drivers aged 52 or older with treated OSA were **71.9% less likely** to be convicted of a moving violation compared to untreated drivers with OSA. In all other age groups, there were no statistically significant differences in this safety outcome between drivers with treated OSA and drivers with untreated OSA. **Treated Diabetes/Elevated Blood Sugar:** There were no statistically significant findings in this category for these conditions.

* A crash is MCMIS-reportable if it involves a vehicle meeting certain thresholds (i.e., a CMV) and results in a minimum grade of damage or injury, or in a fatality.

6.6 OSA PREDICTION

Obesity is the primary risk factor for OSA; more than 80 percent of individuals with OSA are also obese.[189] A 10 percent increase in body weight increases the risk for OSA six fold.[190] Other risk factors include increasing age, being male, smoking, and alcohol use. OSA is also related to several comorbid health outcomes, such as hypertension, cardiovascular disease, and metabolic syndrome.[191] The only mandated screening for OSA and other sleep disorders is a single question on the Medical Examination Report, answered by the driver, about whether they have "sleep disorders, pauses in breathing while asleep, daytime sleepiness, loud snoring." Parks et al. found that 85 percent of drivers with likely OSA answered this question negatively.[192] Bergoffen et al.[193] provide a review of different OSA screening measures, and suggest that OSA screening should rely on objective measures, as subjective measures have been largely unreliable with truck drivers. The current study found similar results, with the ESS and BQ predicting little variance in diagnosed OSA. However, many drivers in the current study who were diagnosed with OSA were being treated; this treatment may have eliminated or alleviated some of the symptoms being assessed in these questionnaires. The STOP-Bang, which is a screening tool that combines subjective and objective criteria, including snoring, tiredness, observed apneas,

hypertension, BMI, age, neck circumference and gender, demonstrated high sensitivity, and negative predictive value among European bus drivers.[194] However, it has yet to be evaluated with truck drivers. The data in the current study support this criterion, as BMI was the best predictor of those diagnosed with OSA, with the first split at a BMI of 35 or greater. Some have argued this cutoff will impose a significant financial hardship on CMV carriers and drivers, given that 25 percent of CMV drivers will meet this criterion. The current study also found that high blood pressure was predictive of those diagnosed with OSA; this could possibly be added to the screening criteria to reduce the number of false positives.

6.7 CONCLUSIONS

One of the more important findings with respect to future research in this domain was the effect of age on safety outcomes and the relationship of age with BMI and medical conditions. Older drivers age 52 and older who had more CMV driving experience were safer drivers (as they exhibited lower rates of safety outcomes). These older, safer, and more experienced drivers were more likely to have a higher BMI and be diagnosed with one or more medical conditions compared to their younger (age 20-33), less safe, and inexperienced counterparts. Note there was 1 driver that was age 20 out of over 21,000 drivers in the study. Thus, controlling for age and BMI as a covariate was not enough to overcome this safety selection. Most of the significant effects for the medical conditions were present in the age quartiles above age 33, as most of the drivers in the youngest quartile (20–33) did not have a lot of diagnosed medical conditions (see Appendix F). We did not evaluate the effect of various treatments (e.g., treatment for elevated blood sugar with diet versus medication versus insulin) or compliance with treatment. There are likely differences with respect to type of treatment and compliance with treatment.

The results suggest the requirements for CMV drivers being medically certified to drive are working with respect to safety outcomes. As noted, those receiving treatment for a medical condition were no riskier than drivers without the medial condition, and, in several cases, were less risky than those without a diagnosis of the medical condition. When there was an increase in risk in one or more of the safety outcomes, it was usually associated with the driver not receiving treatment or the driver not being officially diagnosed with the medical condition (thus, not receiving treatment). Nervous/psychiatric disorder—comprised of a variety of anxiety-related psychological conditions (e.g., post-traumatic stress disorder)—was the only medical condition that consistently showed a trend for a significant increase in risk for those being treated. It could be that one of the specific conditions within this grouping was responsible for this effect; thus, more research should be conducted to understand this finding. The results from the OSA prediction analysis support the proposed cutoff of a BMI 35 or greater for mandatory OSA testing.

Considering that one of the more robust findings in the current study was that drivers being treated for a medical condition were no riskier than drivers without that same medical condition, and, in several cases, were less risky than those who did not have the medical condition, the benefits of attending to drivers' health become even clearer. Given the high rates of obesity and tobacco use, which are both associated with a variety of adverse health outcomes, fleets should focus their efforts on identifying solutions to address these two issues. The results also highlight the importance of successfully recruiting, selecting, and retaining qualified safe drivers, as prior

convictions for moving violations were also predictive of future safety outcomes. Thus, effective pre-employment screening practices should go beyond crash history and include prior moving violations, as this study and other studies[195,196] have found moving violations are predictive of future crashes.

6.8 FUTURE RESEARCH

Further research is needed to evaluate the impact of specific working conditions and lifestyle implications on a range of health outcomes, including research evaluating the impacts of altering working conditions. No previous studies have assessed the prevalence of mental disorders among truck drivers, which is essential for developing assessment techniques, educational programs, and mental health services. Data are also lacking on the onset and progression of excess body weight for entry-level truck drivers. Research is needed on the economic costs of chronic diseases and other health conditions to workers, employers, productivity, and the health care system. There is a need to improve access to health care, screening, and treatment for chronic diseases and other medical conditions. Research is needed on the cost-effectiveness of screening and treatment for OSA. To increase the use of health interventions, research is needed that evaluates their effectiveness, acceptance, and return-on-investment. Efforts are needed to translate and disseminate prevention and treatment strategies. Lastly, given the poor health outcomes and job conditions, truck drivers might be at-risk for diminished life expectancy; however, no research has assessed this hypothesis. It may be possible to answer some of these questions using the data collected in this study. To facilitate further research, the dataset used in this study will be made public in FMCSA's data repository.

6.9 LIMITATIONS

Below are some limitations readers should consider when interpreting the results of this study:

- Exposure was measured in calendar days and not vehicle miles traveled or hours driving. The latter two are preferable measurements, as they are more closely related with increased opportunities for safety outcomes.
- Although the study team recruited truck drivers from across the United States, 20,745 participants were recruited from one large for-hire truck fleet. Moreover, those who completed the Initial Driver Survey can be considered a convenience sample. As such, the results are not generalizable to the national truck driver population.
- Although fleet personnel did not view any of the drivers' responses on the Initial Driver Survey, distribution occurred during the orientation meeting at the participating carrier. Thus, drivers may have responded less openly than if the distribution of the Initial Driver Survey occurred at a neutral location.
- The research team only used on-road crashes and excluded off-road crashes and claim incidents. These latter safety outcomes, although not as severe as the on-road crashes, still reflect safety incidents within CMV operations.

- As indicated above, due to likely underreporting and under diagnosis, it is also likely that many drivers were incorrectly classified as not having a medical condition, thereby impacting the results.
- "Treatment" for medical conditions did not consider the specific type of treatment or the efficacy of the specific treatment. Different types of treatment are likely associated with different efficacy and impact on the safety outcomes.
- Once drivers left the participating carrier, we had no way of knowing whether that driver continued to be employed as a CMV driver. Thus, the analyses using national crash and violations may be biased (e.g., drivers with poor safety records, who are unable to find employment, would have zero crash risk).

APPENDIX A: INITIAL DRIVER SURVEY

Fleet Name: _____

Orientation Location: _____

First 5 characters of Driver License #_____

Date: _____

In order to ensure that we can properly link you with your data while still protecting your identity, please enter you're the information requested in the space provided below.

The first two letters of your first name _____

The first six letters of your last name _____ (If you last name is shorter than 6 letters, write your entire last name)

Questionnaire #1

Please respond to the following questions by either placing an "X" in the appropriate box or writing a clear answer in the space provided. There are no "correct" responses, please just be honest. **REMEMBER, you are only able to participate if you are currently completing driver orientation with your current fleet. You will not be compensated for your participation if this is not true for you.**

1. What is your age? _____ (yrs)
2. Please mark your marital status (please check).

   ☐Single ☐Married ☐Divorced ☐Widowed

   i. If **married**, how long have you been married in years? _____
3. Do you have any children [include step-children] (please check). ☐Yes ☐No

   i. If **yes**, how many children live at home with you?_____

4. What is the highest academic degree you have earned (please check one)?

   ☐ GED
   ☐ High School Diploma
   ☐ Associate's Degree
   ☐ Bachelor's Degree
   ☐ Master's Degree
   ☐ Doctorate
   ☐ MD
   ☐ None of the above

5. Is English your primary language (please check)? ☐Yes ☐ No

   i. If **no**, please indicate your primary language here_____

6. What is your ***height*** in feet _____ (ft) and inches _____ (in)

7. What is your ***weight*** in pounds _____ (lbs)

8. How long have you been driving commercial vehicles? _____years _____months

9. Please give the type of trucking license(s) you currently hold _____

10. Type of truck endorsements held (please check all that apply):

    ☐ Hazardous Materials
    ☐ Tanker Vehicle
    ☐ Bus Passenger
    ☐ School Bus
    ☐ Double/Triple Trailers
    ☐ Combination HazMat/Trailer
    ☐ Other _____

11. Are you an owner operator? ☐Yes ☐ No

12. When driving your **personal vehicle**, how often do you wear a seat belt (please check)?
    ☐ Always ☐ Often ☐ Sometimes ☐ Rarely ☐ Never

13. When driving a **commercial vehicle**, how often do you wear a seat belt (please check)?
    ☐ Always ☐ Often ☐ Sometimes ☐ Rarely ☐ Never

14. Over the past three years, have you had any crashes in any vehicle, either personal or commercial [also include any crash reported to police, insurance company, and/or carrier] (please check)? ☐ Yes ☐ No (if **no**, skip to question 15)

    i. If **yes**, check the **type of vehicle, fault status,** and **crash type/role code** (using the below codes 1-13) for each crash over the past three years. Each row is a different crash: thus, if you had two crashes you would complete two rows, one for each crash:

Crash Type/Role Codes

(1) Roadside Departure
(2) Rear-end
(3) Side-swipe
(4) Hit Fixed Object
(5) Hit Moving Object
(6) Backing
(7) Parking Lot
(8) Roll-over
(9) Jacknife
(10) T-bone
(11) Head-on
(12) Pedestrian
(13) Other

	Commercial Vehicle	Personal Vehicle	At-Fault	Not At-Fault	Crash Type/Role (Code)
1.	☐	☐	☐	☐	
2.	☐	☐	☐	☐	
3.	☐	☐	☐	☐	
4.	☐	☐	☐	☐	
5.	☐	☐	☐	☐	
6.	☐	☐	☐	☐	
7.	☐	☐	☐	☐	

15. Over the past three years, have you had any moving violations in any vehicle, either personal or commercial (please check)? ☐ Yes ☐ No (If **no**, skip to question 16)

    i. If **yes**, check the **type of vehicle** and **violation type** (e.g., speeding, tailgating, signal violation), for each crash over the past three years. Each row is a different violation: thus, if you had two violations you would complete two rows, one for each violation:

	Commercial Vehicle	Personal Vehicle	Violation Type
1.	☐	☐	
2.	☐	☐	
3.	☐	☐	
4.	☐	☐	
5.	☐	☐	
6.	☐	☐	
7.	☐	☐	

16. Over the past three years, have you been put out-of-service in any roadside inspection(s) (please check)?

☐ Yes (list the vehicle and driver violations below) ☐ No (If **no**, skip to question 17)

i. If **yes**, list the vehicle (e.g., brakes, tires, etc.) and/or driver (e.g., hours-of-service, log violation, etc.) out-of-service violation. Each row is a different violation: thus, if you had two violations you would complete two rows, one for each violation:

	Vehicle Violation
1.	
2.	
3.	
4.	
5.	
6.	
7.	

	Driver Violation
1.	
2.	
3.	
4.	
5.	
6.	
7.	

17. Have you attended a formal truck driver training school prior to your current training (please check)? ☐Yes ☐No

i. If **yes**, how long was the training you received, in weeks/days (please check)?

Weeks	**Days**
☐ 0	☐ 0
☐ 1	☐ 1
☐ 2	☐ 2
☐ 3	☐ 3
☐ 4	☐ 4
☐ 5	☐ 5
☐ 6	☐ 6
☐ 7	
☐ 8	

18. Prior to your first commercial driving job, did you receive any other commercial driver training? This includes informal training such as a friend or relative teaching you how to drive a truck (please check).

☐Yes ☐No

i. If **yes**, how long was the training? Please indicate length in hours, days, or weeks, whatever is appropriate.

How many weeks? _____
How many days if less than a week? _____
How many hours if less than a day? _____

19. How much on-the-job training have you received? Please indicate whether it was hours, days or weeks in your answer. _____

20. Do you usually nap during the day (or between major sleep periods)? [Note: Naps may be of any duration] (please check). ☐Yes ☐No

21. Do you drink coffee or other caffeinated beverages or energy supplements (e.g., tea, Coke, Pepsi, Mountain Dew, Red Bull, No Doz, etc.) (please check)? ☐Yes ☐No

i. If **yes**, please list how many cups/glasses/pills per day (e.g., 2 cups of coffee). _____

22. Do you drink alcohol (please check)? ☐Yes ☐ No

i. If **yes**, how many days a week (please check)?

☐1
☐2
☐3
☐4
☐5
☐6
☐7

ii. If **yes**, how many alcoholic drinks do you average in a week? _____ drinks per week

23. Do you currently smoke cigarettes or use other tobacco products (please check)?
☐Yes ☐No

24. When you are not working, do you find time to exercise (please check)? ☐Yes ☐ No

i. If **yes**, how many times per week do you engage in at least moderate intensity exercise (such as brisk walking) for a minimum of 30 minutes (please check)?

☐1
☐2
☐3
☐4
☐5
☐6
☐7
☐ More than 7

25. How would you describe your diet (please check)?
☐ Poor ☐ Below Average ☐ Average ☐ Above Average ☐ Excellent

26. In general, do you keep a regular sleep schedule? ☐Yes ☐ Sometimes ☐No

27. Overall, about how many **hours of actual sleep** do you usually get in a 24-hour period (please check)?

☐1	☐7	☐13
☐2	☐8	☐14
☐3	☐9	☐15
☐4	☐10	☐16
☐5	☐11	☐17
☐6	☐12	☐18

The following scale is used to determine the level of daytime sleepiness. How likely are you to doze or fall asleep in the following situations? This refers to your usual way of life in recent times. Even if you have not done some of these things recently, try to work out how they would have affected you. Use the following scale for questions 28-35 to choose the most appropriate number for each situation:

0 = would **never** doze
1 = **slight** chance of dozing
2 = **moderate** chance of dozing
3 = **high** chance of dozing

It is important that you answer each question as best you can.

Situation	Chance of Dozing (0-3)
28. Sitting and reading	____
29. Watching TV	____
30. Sitting, inactive in a public place (e.g. a theatre or a meeting)	____
31. As a passenger in a motor vehicle for an hour without a break	____
32. Lying down to rest in the afternoon when circumstances permit	____
33. Sitting and talking to someone	____
34. Sitting quietly after lunch (no alcohol)	____
35. In a motor vehicle, while stopped for a few minutes in traffic	____

Please choose your response to each following question.

36. Do you snore? ☐Yes ☐No ☐Don't Know

If you answered NO, please skip to question 40.

If you snore:

37. Your snoring is:
- ☐ Slightly louder than breathing
- ☐ As loud as talking
- ☐ Louder than talking
- ☐ Very loud – can be heard in adjacent rooms

38. How often do you snore?
- ☐ Nearly every day
- ☐ 3-4 times a week
- ☐ 1-2 times a week
- ☐ 1-2 times a month
- ☐ Never or nearly never

39. Has your snoring ever bothered other people?
☐Yes ☐No ☐Don't Know

40. Has anyone noticed that you quit breathing during your sleep?
- ☐ Nearly every day
- ☐ 3-4 times a week
- ☐ 1-2 times a week
- ☐ 1-2 times a month
- ☐ Never or nearly never

41. How often do you feel tired or fatigued after your sleep?
- ☐ Nearly every day
- ☐3-4 times a week
- ☐ 1-2 times a week
- ☐ 1-2 times a month
- ☐ Never or nearly never

42. During your waking time, do you feel tired, fatigued or not up to par?
- ☐ Nearly every day
- ☐ 3-4 times a week
- ☐ 1-2 times a week
- ☐ 1-2 times a month
- ☐ Never or nearly never

43. Have you ever nodded off or fallen asleep while driving a vehicle?
☐Yes ☐No

If you answered "Yes" in question 43, proceed to question 44. Otherwise, proceed to question 45.

44. How often does this occur?
- ☐ Nearly every day
- ☐ 3-4 times a week
- ☐ 1-2 times a week
- ☐ 1-2 times a month
- ☐ Never or nearly never

45. Do you have high blood pressure? ☐Yes ☐No ☐Don't Know

Questionnaire #2

Below are 41 life experiences you may have experienced recently. For each of the following experiences, indicate to what degree it has been a part of your life **OVER THE PAST MONTH** by marking an "X" in the column under your response. There are no "correct" responses, please answer honestly.

1. Disliking your daily activities.

☐ *Not at all part of my life* ☐ *Only slightly part of my life* ☐ *Distinctly part of my life* ☐ *Very much part of my life*

2. Disliking your work

☐ *Not at all part of my life* ☐ *Only slightly part of my life* ☐ *Distinctly part of my life* ☐ *Very much part of my life*

3. Ethnic or racial conflict

☐ *Not at all part of my life* ☐ *Only slightly part of my life* ☐ *Distinctly part of my life* ☐ *Very much part of my life*

4. Conflicts with in-laws or boyfriend's/girlfriend's family

☐ *Not at all part of my life* ☐ *Only slightly part of my life* ☐ *Distinctly part of my life* ☐ *Very much part of my life*

5. Being let down or disappointed by friends

☐ *Not at all part of my life* ☐ *Only slightly part of my life* ☐ *Distinctly part of my life* ☐ *Very much part of my life*

6. Conflict with supervisor(s) at work

☐ *Not at all part of my life* ☐ *Only slightly part of my life* ☐ *Distinctly part of my life* ☐ *Very much part of my life*

7. Social rejection

☐ *Not at all part of my life* ☐ *Only slightly part of my life* ☐ *Distinctly part of my life* ☐ *Very much part of my life*

8. Too many things to do at once

☐ *Not at all part of my life* ☐ *Only slightly part of my life* ☐ *Distinctly part of my life* ☐ *Very much part of my life*

9. Being taken for granted

☐ *Not at all part of my life* ☐ *Only slightly part of my life* ☐ *Distinctly part of my life* ☐ *Very much part of my life*

10. Financial conflicts with family members

☐ *Not at all part of my life* ☐ *Only slightly part of my life* ☐ *Distinctly part of my life* ☐ *Very much part of my life*

11. Having your trust betrayed by a friend

☐ *Not at all part of my life* ☐ *Only slightly part of my life* ☐ *Distinctly part of my life* ☐ *Very much part of my life*

12. Having your contributions overlooked

☐ *Not at all part of my life* ☐ *Only slightly part of my life* ☐ *Distinctly part of my life* ☐ *Very much part of my life*

13. Struggling to meet your own standards of performance or accomplishment

☐ *Not at all part of my life* ☐ *Only slightly part of my life* ☐ *Distinctly part of my life* ☐ *Very much part of my life*

14. Being taken advantage of

☐ *Not at all part of my life* ☐ *Only slightly part of my life* ☐ *Distinctly part of my life* ☐ *Very much part of my life*

15. Not enough leisure time

☐ *Not at all part of my life* ☐ *Only slightly part of my life* ☐ *Distinctly part of my life* ☐ *Very much part of my life*

16. Cash-flow difficulties

☐ *Not at all part of my life* ☐ *Only slightly part of my life* ☐ *Distinctly part of my life* ☐ *Very much part of my life*

17. A lot of responsibilities

☐ *Not at all part of my life* ☐ *Only slightly part of my life* ☐ *Distinctly part of my life* ☐ *Very much part of my life*

18. Dissatisfaction with work

☐ *Not at all part of my life* ☐ *Only slightly part of my life* ☐ *Distinctly part of my life* ☐ *Very much part of my life*

19. Decisions about intimate relationship(s)

☐ *Not at all part of my life* ☐ *Only slightly part of my life* ☐ *Distinctly part of my life* ☐ *Very much part of my life*

20. Not enough time to meet your obligations

☐ *Not at all part of my life* ☐ *Only slightly part of my life* ☐ *Distinctly part of my life* ☐ *Very much part of my life*

21. Financial burdens

☐ *Not at all part of my life* ☐ *Only slightly part of my life* ☐ *Distinctly part of my life* ☐ *Very much part of my life*

22. Lower evaluation of your work than you think you deserve

☐ *Not at all part of my life* ☐ *Only slightly part of my life* ☐ *Distinctly part of my life* ☐ *Very much part of my life*

23. Experiencing high levels of noise

☐ *Not at all part of my life* ☐ *Only slightly part of my life* ☐ *Distinctly part of my life* ☐ *Very much part of my life*

24. Lower evaluation of your work than you hoped for

☐ *Not at all part of my life* ☐ *Only slightly part of my life* ☐ *Distinctly part of my life* ☐ *Very much part of my life*

25. Conflicts with family member(s)

☐ *Not at all part of my life* ☐ *Only slightly part of my life* ☐ *Distinctly part of my life* ☐ *Very much part of my life*

26. Finding your work too demanding

☐ *Not at all part of my life* ☐ *Only slightly part of my life* ☐ *Distinctly part of my life* ☐ *Very much part of my life*

27. Conflicts with friends

☐ *Not at all part of my life* ☐ *Only slightly part of my life* ☐ *Distinctly part of my life* ☐ *Very much part of my life*

28. Trying to secure loans

☐ *Not at all part of my life* ☐ *Only slightly part of my life* ☐ *Distinctly part of my life* ☐ *Very much part of my life*

29. Getting “ripped off” or cheated in the purchase of goods

☐ *Not at all part of my life* ☐ *Only slightly part of my life* ☐ *Distinctly part of my life* ☐ *Very much part of my life*

30. Unwanted interruptions of your work

☐ *Not at all part of my life* ☐ *Only slightly part of my life* ☐ *Distinctly part of my life* ☐ *Very much part of my life*

31. Social isolation

☐ *Not at all part of my life* ☐ *Only slightly part of my life* ☐ *Distinctly part of my life* ☐ *Very much part of my life*

32. Being ignored

☐ *Not at all part of my life* ☐ *Only slightly part of my life* ☐ *Distinctly part of my life* ☐ *Very much part of my life*

33. Dissatisfaction with your physical appearance

☐ *Not at all part of my life* ☐ *Only slightly part of my life* ☐ *Distinctly part of my life* ☐ *Very much part of my life*

34. Unsatisfactory housing conditions

☐ *Not at all part of my life* ☐ *Only slightly part of my life* ☐ *Distinctly part of my life* ☐ *Very much part of my life*

35. Finding work uninteresting

☐ *Not at all part of my life* ☐ *Only slightly part of my life* ☐ *Distinctly part of my life* ☐ *Very much part of my life*

36. Failing to get money you expected

☐ *Not at all part of my life* ☐ *Only slightly part of my life* ☐ *Distinctly part of my life* ☐ *Very much part of my life*

37. Gossip about someone you care about

☐ *Not at all part of my life* ☐ *Only slightly part of my life* ☐ *Distinctly part of my life* ☐ *Very much part of my life*

38. Dissatisfaction with your physical fitness

☐ *Not at all part of my life* ☐ *Only slightly part of my life* ☐ *Distinctly part of my life* ☐ *Very much part of my life*

39. Gossip about yourself

☐ *Not at all part of my life* ☐ *Only slightly part of my life* ☐ *Distinctly part of my life* ☐ *Very much part of my life*

40. Difficulty dealing with modern technology

☐ *Not at all part of my life* ☐ *Only slightly part of my life* ☐ *Distinctly part of my life* ☐ *Very much part of my life*

41. Hard work to look after and maintain home

☐ *Not at all part of my life* ☐ *Only slightly part of my life* ☐ *Distinctly part of my life* ☐ *Very much part of my life*

Questionnaire #3

Below are 38 questions about your driving. Please note the rating scale has changed from the previous section. Read each item and choose your response by marking an "X" in the column under your response. There are no "correct" responses. Please answer honestly.

1. I drive when I am angry or upset.
   ☐Never ☐Rarely ☐Sometimes ☐Often ☐ Always
2. I lose my temper when driving.
   ☐Never ☐Rarely ☐Sometimes ☐Often ☐ Always
3. I consider the actions of other drivers to be inappropriate or "stupid."
   ☐Never ☐Rarely ☐Sometimes ☐Often ☐ Always
4. I flash my headlights when I am annoyed by another driver.
   ☐Never ☐Rarely ☐Sometimes ☐Often ☐ Always
5. I make rude gestures (for example, giving the "finger" or yelling curse words) toward drivers who annoy me.
   ☐Never ☐Rarely ☐Sometimes ☐Often ☐ Always
6. I sometimes feel resentful when I don't get my own way.
   ☐Never ☐Rarely ☐Sometimes ☐Often ☐ Always
7. I verbally insult drivers who annoy me.
   ☐Never ☐Rarely ☐Sometimes ☐Often ☐ Always
8. I deliberately use my car/truck to block drivers who tailgate me.
   ☐Never ☐Rarely ☐Sometimes ☐Often ☐ Always
9. If another driver <u>seriously</u> threatens my safety, I would defend myself.
   ☐Never ☐Rarely ☐Sometimes ☐Often ☐ Always
10. I would tailgate a driver who annoys me.
    ☐Never ☐Rarely ☐Sometimes ☐Often ☐ Always
11. I sometimes try to get even rather than forgive and forget.
    ☐Never ☐Rarely ☐Sometimes ☐Often ☐ Always
12. I "drag race" other drivers at stop lights to get out front.
    ☐Never ☐Rarely ☐Sometimes ☐Often ☐ Always

13. I will illegally pass a car/truck that is going too slowly.

☐Never ☐Rarely ☐Sometimes ☐Often ☐ Always

14. I am always willing to admit when I've made a mistake.

☐Never ☐Rarely ☐Sometimes ☐Often ☐ Always

15. I feel it is my right to strike back in some way, if I feel another driver has been aggressive toward me.

☐Never ☐Rarely ☐Sometimes ☐Often ☐ Always

16. When I get stuck in a traffic jam I get very irritated.

☐Never ☐Rarely ☐Sometimes ☐Often ☐ Always

17. I will race a slow moving train to a railroad crossing.

☐Never ☐Rarely ☐Sometimes ☐Often ☐ Always

18. I have sometimes taken unfair advantage of another person.

☐Never ☐Rarely ☐Sometimes ☐Often ☐ Always

19. I will weave in and out of slower traffic.

☐Never ☐Rarely ☐Sometimes ☐Often ☐ Always

20. I will drive if I am only mildly intoxicated or buzzed.

☐Never ☐Rarely ☐Sometimes ☐Often ☐ Always

21. I am always courteous, even to people who are disagreeable.

☐Never ☐Rarely ☐Sometimes ☐Often ☐ Always

22. When someone cuts me off, I feel I should punish him/her.

☐Never ☐Rarely ☐Sometimes ☐Often ☐ Always

23. I am always a good listener, no matter who I'm talking to.

☐Never ☐Rarely ☐Sometimes ☐Often ☐ Always

24. I get impatient and/or upset when I fall behind schedule when I am driving.

☐Never ☐Rarely ☐Sometimes ☐Often ☐ Always

25. Passengers in my car/truck tell me to calm down.

☐Never ☐Rarely ☐Sometimes ☐Often ☐ Always

26. I get irritated when a car/truck in front of me slows down for no reason.

☐Never ☐Rarely ☐Sometimes ☐Often ☐ Always

27. I will cross double yellow lines to see if I can pass a slow moving car/truck.

☐Never ☐Rarely ☐Sometimes ☐Often ☐ Always

28. I feel it is my right to get where I need to go as quickly as possible.

☐Never ☐Rarely ☐Sometimes ☐Often ☐ Always

29. I am an aggressive driver.

☐Never ☐Rarely ☐Sometimes ☐Often ☐ Always

30. I feel that passive drivers should learn how to drive or stay home.

☐Never ☐Rarely ☐Sometimes ☐Often ☐ Always

31. There have been occasions when I have taken advantage of someone.

☐Never ☐Rarely ☐Sometimes ☐Often ☐ Always

32. I keep some type of weapon in my car/truck.

☐Never ☐Rarely ☐Sometimes ☐Often ☐ Always

33. I will drive in the shoulder lane or median to get around a traffic jam.

☐Never ☐Rarely ☐Sometimes ☐Often ☐ Always

34. When passing a car/truck on a 2-lane road, I will barely miss on-coming cars.

☐Never ☐Rarely ☐Sometimes ☐Often ☐ Always

35. I will drive when I am drunk.

☐Never ☐Rarely ☐Sometimes ☐Often ☐ Always

36. I feel that I may lose my temper if I have to confront another driver.

☐Never ☐Rarely ☐Sometimes ☐Often ☐ Always

37. I consider myself to be a risk-taker.

☐Never ☐Rarely ☐Sometimes ☐Often ☐ Always

38. I feel that most traffic “laws” could be considered as suggestions.

☐Never ☐Rarely ☐Sometimes ☐Often ☐ Always

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APPENDIX B: ITEMS ON THE FOLLOW-UP SURVEY

Participant Code: _____

Fleet Name: _____

First 5 characters of Driver License #_____

Date: _____

In order to ensure that we can properly link you with your data while still protecting your identity, please enter the information requested in the space provided below.

The first two letters of your first name _____

The first six letters of your last name _____ (If you last name is shorter than 6 letters, write your entire last name)

1. How are you compensated by your fleet? Please check all that apply.
   - ☐ Per mile
   - ☐ Per trip
   - ☐ Per load
   - ☐ Per hour
   - ☐ Other (please write in)_____

2. How much do you get paid (only respond to those relevant to you)
   - Per mile? $_____
   - Per trip? $_____
   - Per load? $_____
   - Per hour? $_____
   - Per "other" $_____

Questionnaire #1

Below are 41 life experiences you may have experienced recently. For each of the following experiences, indicate to what degree it was a part of your life **LAST WINTER (JANUARY/FEBRUARY 2016)** by marking an "X" in the column under your response. There are no "correct" responses, please answer honestly.

1. Disliking your daily activities

☐ *Not at all part of my life* ☐ *Only slightly part of my life* ☐ *Distinctly part of my life* ☐ *Very much part of my life*

2. Disliking your work

☐ *Not at all part of my life* ☐ *Only slightly part of my life* ☐ *Distinctly part of my life* ☐ *Very much part of my life*

3. Ethnic or racial conflict

☐ *Not at all part of my life* ☐ *Only slightly part of my life* ☐ *Distinctly part of my life* ☐ *Very much part of my life*

4. Conflicts with in-laws or boyfriend's/girlfriend's family

☐ *Not at all part of my life* ☐ *Only slightly part of my life* ☐ *Distinctly part of my life* ☐ *Very much part of my life*

5. Being let down or disappointed by friends

☐ *Not at all part of my life* ☐ *Only slightly part of my life* ☐ *Distinctly part of my life* ☐ *Very much part of my life*

6. Conflict with supervisor(s) at work

☐ *Not at all part of my life* ☐ *Only slightly part of my life* ☐ *Distinctly part of my life* ☐ *Very much part of my life*

7. Social rejection

☐ *Not at all part of my life* ☐ *Only slightly part of my life* ☐ *Distinctly part of my life* ☐ *Very much part of my life*

8. Too many things to do at once

☐ *Not at all part of my life* ☐ *Only slightly part of my life* ☐ *Distinctly part of my life* ☐ *Very much part of my life*

9. Being taken for granted

☐ *Not at all part of my life* ☐ *Only slightly part of my life* ☐ *Distinctly part of my life* ☐ *Very much part of my life*

10. Financial conflicts with family members

☐ *Not at all part of my life* ☐ *Only slightly part of my life* ☐ *Distinctly part of my life* ☐ *Very much part of my life*

11. Having your trust betrayed by a friend

☐ *Not at all part of my life* ☐ *Only slightly part of my life* ☐ *Distinctly part of my life* ☐ *Very much part of my life*

12. Having your contributions overlooked

☐ *Not at all part of my life* ☐ *Only slightly part of my life* ☐ *Distinctly part of my life* ☐ *Very much part of my life*

13. Struggling to meet your own standards of performance or accomplishment

☐ *Not at all part of my life* ☐ *Only slightly part of my life* ☐ *Distinctly part of my life* ☐ *Very much part of my life*

14. Being taken advantage of

☐ *Not at all part of my life* ☐ *Only slightly part of my life* ☐ *Distinctly part of my life* ☐ *Very much part of my life*

15. Not enough leisure time

☐ *Not at all part of my life* ☐ *Only slightly part of my life* ☐ *Distinctly part of my life* ☐ *Very much part of my life*

16. Cash-flow difficulties

☐ *Not at all part of my life* ☐ *Only slightly part of my life* ☐ *Distinctly part of my life* ☐ *Very much part of my life*

17. A lot of responsibilities

☐ *Not at all part of my life* ☐ *Only slightly part of my life* ☐ *Distinctly part of my life* ☐ *Very much part of my life*

18. Dissatisfaction with work

☐ *Not at all part of my life* ☐ *Only slightly part of my life* ☐ *Distinctly part of my life* ☐ *Very much part of my life*

19. Decisions about intimate relationship(s)

☐ *Not at all part of my life* ☐ *Only slightly part of my life* ☐ *Distinctly part of my life* ☐ *Very much part of my life*

20. Not enough time to meet your obligations

☐ *Not at all part of my life* ☐ *Only slightly part of my life* ☐ *Distinctly part of my life* ☐ *Very much part of my life*

21. Financial burdens

☐ *Not at all part of my life* ☐ *Only slightly part of my life* ☐ *Distinctly part of my life* ☐ *Very much part of my life*

22. Lower evaluation of your work than you think you deserve

☐ *Not at all part of my life* ☐ *Only slightly part of my life* ☐ *Distinctly part of my life* ☐ *Very much part of my life*

23. Experiencing high levels of noise

☐ *Not at all part of my life* ☐ *Only slightly part of my life* ☐ *Distinctly part of my life* ☐ *Very much part of my life*

24. Lower evaluation of your work than you hoped for

☐ *Not at all part of my life* ☐ *Only slightly part of my life* ☐ *Distinctly part of my life* ☐ *Very much part of my life*

25. Conflicts with family member(s)

☐ *Not at all part of my life* ☐ *Only slightly part of my life* ☐ *Distinctly part of my life* ☐ *Very much part of my life*

26. Finding your work too demanding

☐ *Not at all part of my life* ☐ *Only slightly part of my life* ☐ *Distinctly part of my life* ☐ *Very much part of my life*

27. Conflicts with friends

☐ *Not at all part of my life* ☐ *Only slightly part of my life* ☐ *Distinctly part of my life* ☐ *Very much part of my life*

28. Trying to secure loans

☐ *Not at all part of my life* ☐ *Only slightly part of my life* ☐ *Distinctly part of my life* ☐ *Very much part of my life*

29. Getting “ripped off” or cheated in the purchase of goods

☐ *Not at all part of my life* ☐ *Only slightly part of my life* ☐ *Distinctly part of my life* ☐ *Very much part of my life*

30. Unwanted interruptions of your work

☐ *Not at all part of my life* ☐ *Only slightly part of my life* ☐ *Distinctly part of my life* ☐ *Very much part of my life*

31. Social isolation

☐ *Not at all part of my life* ☐ *Only slightly part of my life* ☐ *Distinctly part of my life* ☐ *Very much part of my life*

32. Being ignored

☐ *Not at all part of my life* ☐ *Only slightly part of my life* ☐ *Distinctly part of my life* ☐ *Very much part of my life*

33. Dissatisfaction with your physical appearance

☐ *Not at all part of my life* ☐ *Only slightly part of my life* ☐ *Distinctly part of my life* ☐ *Very much part of my life*

34. Unsatisfactory housing conditions

☐ *Not at all part of my life* ☐ *Only slightly part of my life* ☐ *Distinctly part of my life* ☐ *Very much part of my life*

35. Finding work uninteresting

☐ *Not at all part of my life* ☐ *Only slightly part of my life* ☐ *Distinctly part of my life* ☐ *Very much part of my life*

36. Failing to get money you expected

☐ *Not at all part of my life* ☐ *Only slightly part of my life* ☐ *Distinctly part of my life* ☐ *Very much part of my life*

37. Gossip about someone you care about

☐ *Not at all part of my life* ☐ *Only slightly part of my life* ☐ *Distinctly part of my life* ☐ *Very much part of my life*

38. Dissatisfaction with your physical fitness

☐ *Not at all part of my life* ☐ *Only slightly part of my life* ☐ *Distinctly part of my life* ☐ *Very much part of my life*

39. Gossip about yourself

☐ *Not at all part of my life* ☐ *Only slightly part of my life* ☐ *Distinctly part of my life* ☐ *Very much part of my life*

40. Difficulty dealing with modern technology

☐ *Not at all part of my life* ☐ *Only slightly part of my life* ☐ *Distinctly part of my life* ☐ *Very much part of my life*

41. Hard work to look after and maintain home

☐ *Not at all part of my life* ☐ *Only slightly part of my life* ☐ *Distinctly part of my life* ☐ *Very much part of my life*

Questionnaire #2

The following scale is used to determine the level of daytime sleepiness. *How likely are you to doze or fall asleep in the following situations?* This refers to your usual way of life in recent times. Even if you have not done some of these things recently, try to work out how they would have affected you. Use the following scale for questions 1-8 to choose the most appropriate number for each situation:

0 = would ***never*** doze
1 = ***slight*** chance of dozing
2 = ***moderate*** chance of dozing
3 = ***high*** chance of dozing

It is important that you answer each question as best you can.

Situation	Chance of Dozing (0-3)
• Sitting and reading	____
• Watching TV	____
• Sitting, inactive in a public place (e.g. a theatre or a meeting)	____
• As a passenger in a motor vehicle for an hour without a break	____
• Lying down to rest in the afternoon when circumstances permit	____
• Sitting and talking to someone	____
• Sitting quietly after lunch (no alcohol)	____
• In a motor vehicle, while stopped for a few minutes in traffic	____

Questionnaire #3

Please choose your response to each following question.

1. Do you snore? ☐Yes ☐No ☐Don't Know

If you answered NO, please skip to question 5.

If you snore:

2. Your snoring is:
☐ Slightly louder than breathing
☐ As loud as talking
☐. Louder than talking
☐. Very loud – can be heard in adjacent rooms

3. How often do you snore?
☐ Nearly every day
☐ 3-4 times a week
☐ 1-2 times a week
☐ 1-2 times a month
☐ Never or nearly never

4. Has your snoring ever bothered other people?
☐Yes ☐No ☐Don't Know

5. Has anyone noticed that you quit breathing during your sleep?
☐ Nearly every day
☐ 3-4 times a week
☐ 1-2 times a week
☐ 1-2 times a month
☐ Never or nearly never

6. How often do you feel tired or fatigued after your sleep?
☐ Nearly every day
☐3-4 times a week
☐ 1-2 times a week
☐ 1-2 times a month
☐ Never or nearly never

7. During your waking time, do you feel tired, fatigued or not up to par?
☐ Nearly every day
☐ 3-4 times a week
☐ 1-2 times a week
☐ 1-2 times a month
☐ Never or nearly never

8. Have you ever nodded off or fallen asleep while driving a vehicle?
☐Yes ☐No

If you answered "Yes" in question 8, proceed to question 9. Otherwise, proceed to question 10.

9. How often does this occur?
☐ Nearly every day
☐ 3-4 times a week
☐ 1-2 times a week
☐ 1-2 times a month
☐ Never or nearly never

10. Do you have high blood pressure or are you on blood pressure controlling medications??
☐Yes ☐No ☐Don't Know

11. Have you taken a sleep disorders test, i.e. home monitoring or laboratory test?
☐Yes ☐No ☐Don't Know

12. Have you been diagnosed with sleep apnea? ☐Yes ☐No ☐Don't Know

13. Have you been diagnosed with another sleep disorder? ☐Yes ☐No ☐Don't Know

14. Are you currently receiving positive airway pressure (PAP) treatment for your sleep apnea? ☐Yes ☐No ☐Don't Know

Should you have any questions about these questionnaires or the research, you may contact:

- Jeff Hickman, *Principal Investigator*, (540) 231-1542, jhickman@vtti.vt.edu
- Erin Mabry, *Co-PI,* (540) 231-1055, emabry@vtti.vt.edu
- Laurel Marburg, *Co-PI,* (540) 231-1543, lmarburg@vtti.vt.edu

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APPENDIX C: INFORMED CONSENT FORM

VIRGINIA POLYTECHNIC INSTITUTE AND STATE UNIVERSITY

Informed Consent for Participants of Investigative Projects

Title of Project: Case Control Commercial Driver Individual Differences Study

Investigators: Dr. Jeffrey Hickman (Virginia Tech Transportation Institute) and Joel Whiteman (Road Ready)

I. PARTICIPANT ELIGIBILITY

You are eligible to participate in this study if you are currently completing driver orientation with your current fleet. Please understand that you will only be compensated for your participation if this is true.

II. THE PURPOSE OF THIS RESEARCH PROJECT

The Case-Control Commercial Driver Safety Risk Factors (CDSRF) study will look at how often various driver and situational factors occur. The study will also look at whether these factors are related to crashes and/or violations. The goal of the CDSRF study is to look at differences in commercial drivers with respect to risk factors by linking driver characteristics with their driving records during the study.

III. PROCEDURES

After reviewing and indicating your consent to voluntarily participate in the CDSRF study by printing and signing your name at the end of this Informed Consent Form, you will begin the study. You will fill out the questionnaires included in this Driver Survey. These questionnaires should take approximately 30-45 minutes to complete, but you may take as much time as needed. The questionnaires will ask you to record basic personal information, such as marital status and driving history, recent life experiences, and your driving behavior. Once you indicate your consent and complete the Driver Survey, you will return materials either to clinic staff on-site at the trucking terminal who are administering the physicals and medical exams, or to front desk personnel (depending on which option is available at your terminal). Upon receipt, the clinic or front desk staff will mail study materials to the VTTI research team. Note that your study materials will be sealed in the tamper-proof envelope and although clinic or front desk staff will handle the envelopes, the questionnaires are only allowed to be accessed by the VTTI research team. You may also seal your study materials (signed Informed Consent Form and completed Driver Survey) in the tamper-proof envelope provided and mail your study materials directly to VTTI using the pre-paid, addressed envelope provided by the front desk staff upon request. Note that your participation, or lack of participation, will have no influence on your job status.

Your carrier will permit the research team to access your most recent Medical Examination Report for Commercial Driver Fitness Determination, if applicable. Your fleet may also provide researchers with individual driver crash files from the entire fleet (i.e., all drivers), which may be

followed for up to 3 years. Please note that the safety records received by the research team will include all company drivers, not just those participating in this research. The research team may also have access to your Commercial Driver's License Information System (CDLIS) records and/or Motor Carrier Management Information System (MCMIS) records to gain additional information on your driving record.

You may be contacted in the future by the research team (within the next three years) to voluntarily participate in some additional data collection and analyses. If the contact information received by the research team changes or becomes invalid during this time, the research team may use a third-party software database, Accurint, in an attempt to gain current contact information (e.g., phone number and mailing address). You may be invited to complete additional questionnaires which will take approximately 20 minutes to complete. You will not be obligated to participate in additional data collection. Note that your participation or lack of participation, in these additional analyses will have no influence on your job status.

IV. RISKS

There is minimal risk involved in this study, including possible minor discomfort due to disclosing personal information, feelings, and emotions. You have been given a tamper-proof envelope in which to return completed surveys to the VTTI to provide confidentiality. Though the envelopes are tamper proof and the VTTI research team will be alerted if a questionnaire is received that someone has possibly opened and viewed, study materials may be accessed by those who handle them.

You may withdraw from this study at any time if you feel uncomfortable for any reason. Your participation, or lack thereof, will have no impact on your job status.

V. BENEFITS

No promise or guarantee of benefits will be made to encourage your participation. This landmark study promises to provide a better understanding of CMV driver individual differences and crash/violation risk factors. The study results may improve truck driver health and safety, thereby making our Nation's roadways safer for all drivers.

VI. EXTENT OF ANONYMITY AND CONFIDENTIALITY

The data gathered in this experiment will be treated with confidentiality. Coding (for example, Driver #0001) will be used so participant names will not be linked with any data collected. Please include your **Driver's License *code*** and your ***personal name code*** on your Driver Survey. The Driver's License code is the first 5 characters of your Driver's License number. Your personal name code is the first two letters of your first name followed by the first six letters of your last name). All data that is reported will be in summary form so that your participation will remain confidential. For example, reports may indicate that 20,000 drivers participated in this study (18,000 males, 2,000 females; average age was 45 years old).
The research team will have access to your name and phone number from Road Ready so that you may be contacted for recruitment for follow-up data collection, though you are not obligated to participate and participation is voluntary.

The data from this study will be stored at the Virginia Tech Transportation Institute within a secure, password protected, and limited access data folder on a VTTI secure server. Once collected data has been entered electronically into the secure, password protected database at the VTTI, all collected data will be stripped of identifying information. It is possible that the Institutional Review Board (IRB) may view this study's collected data for auditing purposes. The IRB is responsible for the oversight of the protection of human subjects involved in research. Access to the data will be under the supervision of Dr. Jeffrey Hickman. All original data sources collected in this study will be saved until the completion of the study and then will be destroyed or deleted. All data collected and stored in the master database at the VTTI will be saved for 5 years following the completion of the study (anticipated September 2020) and then will be destroyed or deleted.

VII. COMPENSATION

You will be compensated with a $20 check by mail once the VTTI research team receives your study materials in the mail. If you choose to return study materials to on-site clinic staff or front desk staff at the trucking terminal (if this is an option at your terminal), you will immediately be compensated with a $20 debit or gift card, cash or check. Should you decline to return the Driver Survey to the VTTI research team, you will not be compensated. If you are asked to complete a Follow-up Survey by VTTI in the future and voluntarily participate, once VTTI receives your completed survey you will receive a $10 check in the mail.

VIII. FREEDOM TO WITHDRAW

As a voluntary participant in this study, you are free to withdraw at any time for any reason. Further, if you withdraw it will not adversely impact your employment status with the company.

IX. APPROVAL OF RESEARCH

This research project has been approved, as required, by the Institutional Review Board for Research Involving Human Subjects at Virginia Polytechnic Institute and State University. This approval is good for the period of time listed at the bottom of this page.

X. PARTICIPANT RESPONSIBILITIES

If you voluntarily agree to participate in this study, you will have the following responsibilities:

1. Have a valid, Class-A CDL
2. Be willing to express your honest opinions and responses requested on the surveys.

XI. PARTICIPANT'S PERMISSION

By printing my name and signing below, I indicate that I understand the requirements, procedures, and conditions of this project. I have had all of my questions answered. I hereby acknowledge the above and give my voluntary consent for participation in this project. If I

participate in this study, I understand that I may withdraw at any time without penalty. I agree to abide by the rules of this project.

- I understand that participation in this study involves reading and signing this Informed Consent Form and spending approximately 30-45 minutes filling out questionnaires and then returning both to VTTI

- I understand that Road Ready will send VTTI my Medical Examination Report for Commercial Driver Fitness Determination (Form 649-F), if applicable, which contains health information from my CDL medical exam

- I understand that VTTI may obtain information about my driving record from my fleet, including incident type and severity, date, time, damage, etc.

- I understand that if I participate, VTTI may obtain information about my driving record from the CDLIS and/or MCMIS database.

- I understand that if I participate, VTTI may contact at me at a later date and ask me if I am willing to fill out an additional questionnaire.

You may begin the survey after signing below. **Please be sure to print your name very clearly as this is how we will identify you for payment purposes.**

_____

Participant's name (Print) Signature Date

Should I have any questions about this research or its conduct, I may contact:

Jeff Hickman, *Principal Investigator* (540) 231-1542, jhickman@vtti.vt.edu

If I should have any questions about the protection of human research participants regarding this study, I may contact:

Dr. David Moore,
Chair Virginia Tech Institutional Review Board for the Protection of Human Subjects
Telephone: (540) 231-4991; Email: moored@vt.edu

Participants must be given a complete copy (or duplicate original) of the signed Informed Consent.

APPENDIX D: FLEET PERSONNEL RECRUITMENT SCRIPT

During driver orientation, please introduce the CDSRF study to drivers by following the below script as it is written, then play the CDSRF Study Recruitment Video/DVD. Distribute study packets to drivers. Please do not attempt to answer driver's questions that you are unsure of; please direct drivers to contact Jeff Hickman with all questions.

Fleet staff: [carrier name]*is participating in a research project with Virginia Tech that we are excited about and would appreciate your help. If you choose to participate in this study you will receive this $20 compensation [hold up cash or pilot card]. Please watch the following video that will give you more detail on the study and how you may participate to receive your $20.*

Play video

Fleet staff: *Thanks for your attention.*

If on-site clinic staff is available for collecting surveys and distributing payments, please say the following: *Clinic staff [say names here] that are administering the physicals and medical exams will be here the following days and times to collect surveys and give you your $20 compensation for completed surveys.* List days/times clinic staff will be on-site.

If front-desk fleet staff is available for collecting surveys and distributing payments, please say the following: *The front desk staff, [say names here] will be available this week to collect surveys and give you your $20 compensation for completed surveys.*

If you choose to mail the study materials yourself to the VTTI, you may ask the clinic staff for an addressed envelope and return in via mail at your leisure. You will receive a $20 check in the mail if you choose to do this.

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APPENDIX E: VIDEO RECRUITMENT SCRIPT

Hi, I'm Laurel Marburg, and I'm Erin Mabry, and we are researchers at the Virginia Tech Transportation Institute, or VTTI for short.

We are conducting a study titled, Case-Control Commercial Driver Individual Differences Study. The goal of the study is to look at how fleet and driver characteristics are associated with future crash involvement. We would like to invite you to participate in this study, along with 20,000 other commercial drivers, like yourselves.

Your participation will require you to complete three questionnaires, which will take about 30 minutes or less to complete. You will receive immediate compensation via $20 in cash or gift card depending on your terminal, or a check for completing and returning these questionnaires to the VTTI.

Study packets will be given to everyone but you are not obligated to take one, nor are you obligated to complete the packet you are given. The packets will include basic information about the study for you to review.

If you decide to participate in the study you will need to read the enclosed Consent Form, print your name clearly and sign your name on the consent form, and complete the questionnaires included in the packet. These questionnaires should take approximately 30 minutes or less to complete and you will be compensated for completing and returning these questionnaires. The questionnaires will ask you basic personal information, such as marital status and driving history, recent life experiences, and your driving behavior. After you complete the questionnaires you can return study materials on-site at the trucking terminal if this is an option at your terminal. To do so, return materials to either front desk personnel or clinic staff who are administering the physicals and medical exams, depending on which option is available at your terminal.

The staff will seal your questionnaire in the tamper proof envelope, check that you signed the consent form, and give you either $20 in cash or as agift card upon receipt. In addition, you may also complete all study materials, including the consent form and questionnaires, and seal them in a pre-paid and self-addressed envelope and mail directly to the VTTI yourself. A pre-paid and self-addressed envelope will be provided to you by fleet staff upon request. If you choose to submit your study materials this way, you will receive a $20 check in the mail in 4-6 weeks. Please read more about the study in the study packet you are receiving and decide if you would like to participate in the study and complete the questionnaires for $20 compensation. This study is completely voluntary and your participation, or lack thereof, will have no influence on your job status with your fleet.

Your name will not be linked with your questionnaire responses. Instead, you will be identified by a name code and a driver's license code. The only document that requires your name is the consent form that requires your signature. Once researchers receive your questionnaires and enter your responses into the secure, password protected database at the VTTI, your name code and driver's license code will be removed from all data and a participant code (for example,

Participant #0001) will replace the former codes so there is no personal link to the data and to ensure that all information is treated with strict confidence.

If you choose to participate in this study, your fleet will provide the VTTI research team with Medical Examination Reports and crash files from all fleet drivers, which may be followed for up to 3 years.

If you have any questions about this study please feel free to contact us. Contact information for researchers at the VTTI is available in the study packet. Please read more about the study to see if you are interested in participating and please remember that you may submit only one survey per person.

Just to recap, if you decide to participate, please read the Consent Form and print and sign your name on it. Also, please complete the questionnaires provided in the study packet. Turn in study materials to either front desk personnel at your terminal or on-site clinic staff who are administering the physicals and medical exams, depending on which option is available at your terminal to receive your $20 cash or gift card immediately. Or, you may mail the completed consent form and questionnaires back to the VTTI using the prepaid envelope provided by fleet staff upon request to receive your $20 check in the mail within 4-6 weeks of mailing your study packet to the VTTI.

The tamper-proof sealed envelope and individual ID codes provide confidentially and no carrier staff will have access to your data, only VTTI staff. Also remember that your participation or lack thereof is voluntary and will not affect your job with your fleet in any way.
We hope you'll consider participating in this exciting research with us! Thank you for your attention and have a great day!

APPENDIX F: MEDICAL CATEGORY GROUPINGS

Table 117. Medical category groupings.

Medical Group	Specific Medical Condition
ABDOMEN AND VISCERA	Abdomen Ventral Wall Weakness
ABDOMEN AND VISCERA	Abdominal Cramps
ABDOMEN AND VISCERA	Diastasis Recti
ABDOMEN AND VISCERA	Fistula
ABDOMEN AND VISCERA	Hernia
ABDOMEN AND VISCERA	Hiatal Hernia
ABDOMEN AND VISCERA	Lipoma
ABDOMEN AND VISCERA	Staunched Hernia
ALCOHOL USE	Alcohol Abuse
ALLERGIES	Allergies
ALLERGIES	Chronic Rhinitis
BLOOD DISORDER	Anemia
BLOOD DISORDER	Hypereosinophilic Syndrome
BLOOD DISORDER	Hypovolemia
BLOOD DISORDER	Sickle Cell
BLOOD DISORDER	Thrombocytopenia
CANCER	Axilla Cancer
CANCER	Bladder Cancer
CANCER	Breast Cancer
CANCER	Cancerous Growth
CANCER	Cervical Cancer
CANCER	Colon Cancer
CANCER	Esophageal Cancer
CANCER	Leukemia
CANCER	Lung Cancer
CANCER	Lymphoma/Hodgkin’s Lymphoma
CANCER	Prostate Cancer
CANCER	Testicular Cancer
CANCER	Thyroid Cancer
DIABETES/ELEVATED BLOOD SUGAR	Diabetes Mellitus
DIABETES/ELEVATED BLOOD SUGAR	Glycosuria
DIABETES/ELEVATED BLOOD SUGAR	Hypoglycemia
DIABETES/ELEVATED BLOOD SUGAR	Prediabetes
DIGESTIVE PROBLEMS	Barrett’s Esophagus
DIGESTIVE PROBLEMS	Chronic Diarrhea
DIGESTIVE PROBLEMS	Coccidioidomycosis
DIGESTIVE PROBLEMS	Constipation
DIGESTIVE PROBLEMS	Crohn's disease
DIGESTIVE PROBLEMS	Cyclic Vomiting
DIGESTIVE PROBLEMS	Diverticulitis

Medical Group	Specific Medical Condition
DIGESTIVE PROBLEMS	Diverticulosis
DIGESTIVE PROBLEMS	Esophageal Varices
DIGESTIVE PROBLEMS	Gastric/Stomach Ulcer
DIGESTIVE PROBLEMS	Gastritis
DIGESTIVE PROBLEMS	Gastroesophageal Reflux Disease/Acid Reflux/heartburn
DIGESTIVE PROBLEMS	Irritable Bowel Disease (IBD)
DIGESTIVE PROBLEMS	Inflammatory Bowel Syndrome (IBS)
DYSLIPIDEMIA	Dyslipidemia/Hypercholesterolemia
DYSLIPIDEMIA	High Cholesterol
DYSLIPIDEMIA	Hyperlipidemia
DYSLIPIDEMIA	Triglyceridemia
DYSLIPDEMIA	Hypertriglyceridemia
EAR DISORDER/HEARING/BALANCE	Hearing Loss/Difficulty
EAR DISORDER/HEARING/BALANCE	Tinnitus
EAR DISORDER/HEARING/BALANCE	Vertigo
EAR DISORDER/HEARING/BALANCE	Cataracts
EAR DISORDER/HEARING/BALANCE	Glaucoma/Ocular Hypertension
EAR DISORDER/HEARING/BALANCE	Macular Degeneration
EAR DISORDER/HEARING/BALANCE	Myopia
EAR DISORDER/HEARING/BALANCE	Nystagmus
EAR DISORDER/HEARING/BALANCE	Strabismus
EAR DISORDER/HEARING/BALANCE	Subconjunctival Hemorrhage
EAR DISORDER/HEARING/BALANCE	Vision Loss/Problems
GENITOURINARY	Abnormal urine
GENITOURINARY	Benign Prostatic Hyperplasia
GENITOURINARY	Endometriosis
GENITOURINARY	Enlarged prostate
GENITOURINARY	Epididymitis
GENITOURINARY	Erectile dysfunction
GENITOURINARY	Hematuria
GENITOURINARY	Hydrocele
GENITOURINARY	Incontinence/bladder spasms
GENITOURINARY	Low Testosterone
GENITOURINARY	Prostate Condition
GENITOURINARY	Prostatitis
GENITOURINARY	Pyuria
GENITOURINARY	Urinary Condition
GENITOURINARY	Urinary Frequency
GENITOURINARY	Urinary Outflow Obstruction
GENITOURINARY	Uterine Fibroids/Abdominal Mass
HEAD/BRAIN INJURIES	Migraines
HEAD/BRAIN INJURIES	Head/Brain Injuries
HEART/CARDIOVASCULAR DISEASE	Aortic Stenosis

Medical Group	Specific Medical Condition
HEART/CARDIOVASCULAR DISEASE	Arrhythmia
HEART/CARDIOVASCULAR DISEASE	Atrial fibrillation
HEART/CARDIOVASCULAR DISEASE	Atrial flutter
HEART/CARDIOVASCULAR DISEASE	Blocked artery
HEART/CARDIOVASCULAR DISEASE	Bradycardia
HEART/CARDIOVASCULAR DISEASE	Cardiac/Heart Condition
HEART/CARDIOVASCULAR DISEASE	Cardiomyopathy
HEART/CARDIOVASCULAR DISEASE	Cardiovascular Disease
HEART/CARDIOVASCULAR DISEASE	Chest Pain
HEART/CARDIOVASCULAR DISEASE	Congestive Heart Failure
HEART/CARDIOVASCULAR DISEASE	Coronary Artery Disease
HEART/CARDIOVASCULAR DISEASE	Enlarged Heart
HEART/CARDIOVASCULAR DISEASE	Heart Disease
HEART/CARDIOVASCULAR DISEASE	Heart Murmur
HEART/CARDIOVASCULAR DISEASE	Irregular Heart Rate
HEART/CARDIOVASCULAR DISEASE	Mitral Valve issue
HEART/CARDIOVASCULAR DISEASE	Mitral Valve Prolapse
HEART/CARDIOVASCULAR DISEASE	Myocardial Infarction/Heart Attack
HEART/CARDIOVASCULAR DISEASE	Myocarditis
HEART/CARDIOVASCULAR DISEASE	Premature Ventricular Contraction
HEART/CARDIOVASCULAR DISEASE	Pulmonary Embolism
HEART/CARDIOVASCULAR DISEASE	Syncope
HEART/CARDIOVASCULAR DISEASE	Tachycardia
HEART/CARDIOVASCULAR DISEASE	Transient Ischemic Attack
HIGH BLOOD PRESSURE	Hypertension
HORMONE DYSFUNCTION	Hormone Imbalance
HORMONE DYSFUNCTION	Low Testosterone
HORMONE DYSFUNCTION	Hypogonadism
HORMONE DYSFUNCTION	Polycystic Ovary Syndrome
HORMONE DYSFUNCTION	Klinefelter's Syndrome
HORMONE DYSFUNCTION	Congenital Adrenal Hyperplasia
HORMONE THERAPY	Gender Identity Disorder/Hormone Therapy
HORMONE THERAPY	Transgender Therapy
INFLAMMATORY DISEASE	Lupus
INFLAMMATORY DISEASE	Rheumatic Fever
INFLAMMATORY DISEASE	Sarcoidosis
KIDNEY DISEASE/DISORDER	Hemodialysis Shunt
KIDNEY DISEASE/DISORDER	Kidney Condition
KIDNEY DISEASE/DISORDER	Kidney Disease
KIDNEY DISEASE/DISORDER	Polycystic Kidney Disease
KIDNEY DISEASE/DISORDER	Proteinuria
KIDNEY DISEASE/DISORDER	Renal Functional Impairment Disease
KIDNEY DISEASE/DISORDER	Renal Tubular Acidosis

Medical Group	Specific Medical Condition
LOSS/ALTERED CONSCIOUSNESS	Loss of Consciousness
LOSS/ALTERED CONSCIOUSNESS	Altered Consciousness
LUNG AND CHEST	Asthma
LUNG AND CHEST	Bronchiectasis
LUNG AND CHEST	Bronchitis
LUNG AND CHEST	Bronchospasm
LUNG AND CHEST	Common Cold
LUNG AND CHEST	Chronic Obstructive Pulmonary Disease
LUNG AND CHEST	Emphysema
LUNG AND CHEST	Histoplasmosis
LUNG AND CHEST	Sinus Congestion
LUNG AND CHEST	Tuberculosis
MISSING/IMPAIRED LIMB	Amputation
MISSING/IMPAIRED LIMB	Missing Extremities
MOUTH AND THROAT	Dental Infections/Gum Infections
MOUTH AND THROAT	Swallowing/Throat Issues
MOUTH AND THROAT	Thrush
MUSCULAR DISEASE	Chronic Musculoskeletal Pain
MUSCULAR DISEASE	Chronic Low Back Pain
MUSCULAR DISEASE	Multiple Sclerosis
MUSCULAR DISEASE	Muscle Spasms
MUSCULAR DISEASE	Myasthenia Gravis
NERVOUS/PSYCHIATRIC DISORDER	Attention-deficit Disorder
NERVOUS/PSYCHIATRIC DISORDER	Attention-deficit/Hyperactivity Disorder
NERVOUS/PSYCHIATRIC DISORDER	Anger Disorder
NERVOUS/PSYCHIATRIC DISORDER	Anxiety
NERVOUS/PSYCHIATRIC DISORDER	Bipolar
NERVOUS/PSYCHIATRIC DISORDER	Depression
NERVOUS/PSYCHIATRIC DISORDER	Dissociative Disorder
NERVOUS/PSYCHIATRIC DISORDER	Dysthymia/Long-term Depression
NERVOUS/PSYCHIATRIC DISORDER	Mood Swings
NERVOUS/PSYCHIATRIC DISORDER	Obsessive-Compulsive Disorder
NERVOUS/PSYCHIATRIC DISORDER	Panic Disorder
NERVOUS/PSYCHIATRIC DISORDER	Psychological Condition
NERVOUS/PSYCHIATRIC DISORDER	Post-Traumatic Stress Disorder
NERVOUS/PSYCHIATRIC DISORDER	Schizoaffective Disorder
NERVOUS/PSYCHIATRIC DISORDER	White Coat Syndrome
NEUROLOGICAL	Bell’s Palsy
NEUROLOGICAL	Carpal Tunnel
NEUROLOGICAL	Difficulty Balancing (when walking; unspecified neurological or inner ear issue)
NEUROLOGICAL	Erb's Palsy

Medical Group	Specific Medical Condition
NEUROLOGICAL	Essential Tremors
NEUROLOGICAL	Fluid Collection, Skull
NEUROLOGICAL	Guillain-Barre Syndrome
NEUROLOGICAL	Neurological condition
NEUROLOGICAL	Numbness
NEUROLOGICAL	Paresthesia
NEUROLOGICAL	Parkinson's disease
NEUROLOGICAL	Spinal Meningitis
NEUROLOGICAL	Tourette Syndrome
NEUROLOGICAL	Tremor
NEUROLOGICAL	Trigeminal Neuralgia
NEUROLOGICAL	Von Recklinghausen's disease (NF1) Neurofibromatosis Type 1
ORGAN FAILURE	Organ Failure
OBSTRUCTIVE SLEEP APNEA	Obstructive Sleep Apnea
SEIZURES/EPILEPSY	Seizures
SEIZURES/EPILEPSY	Epilepsy
SKIN DISEASE/DISORDER	Alopecia
SKIN DISEASE/DISORDER	Cellulitis
SKIN DISEASE/DISORDER	Chronic Skin Changes
SKIN DISEASE/DISORDER	Dermatitis/Eczema
SKIN DISEASE/DISORDER	Dermatomyositis
SKIN DISEASE/DISORDER	Fungal Infection
SKIN DISEASE/DISORDER	Furuncle
SKIN DISEASE/DISORDER	Hidradenitis
SKIN DISEASE/DISORDER	Hidradenitis Suppurativa
SKIN DISEASE/DISORDER	Mole
SKIN DISEASE/DISORDER	Psoriasis
SKIN DISEASE/DISORDER	Rash
SKIN DISEASE/DISORDER	Rosacea
SKIN DISEASE/DISORDER	Severe Skin Irritation
SKIN DISEASE/DISORDER	Shingles
SKIN DISEASE/DISORDER	Tinea Infection
SKIN DISEASE/DISORDER	Tinea Unguium
SKIN DISEASE/DISORDER	Urticaria
SKIN DISEASE/DISORDER	Vitiligo
SKIN DISEASE/DISORDER	Xerosis
OTHER SLEEP DISORDERS	Daytime Drowsiness
OTHER SLEEP DISORDERS	Insomnia
OTHER SLEEP DISORDERS	Narcolepsy
OTHER SLEEP DISORDERS	Restless Leg Syndrome
OTHER SLEEP DISORDERS	Shift sleep/work disorder
SPINE/OTHER MUSCULOSKELETAL	Bursitis
SPINE/OTHER MUSCULOSKELETAL	Degenerative Disc Disease
SPINE/OTHER MUSCULOSKELETAL	Dupuytren’s Contracture

Medical Group	Specific Medical Condition
SPINE/OTHER MUSCULOSKELETAL	Fibromyalgia
SPINE/OTHER MUSCULOSKELETAL	Fibrous Dysplasia
SPINE/OTHER MUSCULOSKELETAL	Gout
SPINE/OTHER MUSCULOSKELETAL	Herniated Nucleus Pulposus
SPINE/OTHER MUSCULOSKELETAL	Joint Injury
SPINE/OTHER MUSCULOSKELETAL	Knee Sprain/Pain
SPINE/OTHER MUSCULOSKELETAL	Lumbar Stenosis
SPINE/OTHER MUSCULOSKELETAL	Orthopedic Condition
SPINE/OTHER MUSCULOSKELETAL	Osteoarthritis
SPINE/OTHER MUSCULOSKELETAL	Osteoporosis
SPINE/OTHER MUSCULOSKELETAL	Pectus Excavatum
SPINE/OTHER MUSCULOSKELETAL	Pinched Nerve/Herniated Disc
SPINE/OTHER MUSCULOSKELETAL	Psoriatic Arthritis
SPINE/OTHER MUSCULOSKELETAL	Rhabdomyolysis
SPINE/OTHER MUSCULOSKELETAL	Rheumatoid Arthritis
SPINE/OTHER MUSCULOSKELETAL	Rickets
SPINE/OTHER MUSCULOSKELETAL	ROM issue
SPINE/OTHER MUSCULOSKELETAL	Sacroiliitis
SPINE/OTHER MUSCULOSKELETAL	Sciatica
SPINE/OTHER MUSCULOSKELETAL	Spondylosis
SPINE/OTHER MUSCULOSKELETAL	Tendonitis
STROKE OR PARALYSIS	Stroke
STROKE OR PARALYSIS	Stroke Paralysis
THYROID DISORDER	Goiter/Enlarged Thyroid
THYROID DISORDER	Graves
THYROID DISORDER	Hyperthyroid
THYROID DISORDER	Hypothyroid
THYROID DISORDER	Thyroid Condition
TOBACCOS USE	Tobacco Use
VASCULAR	Blood Clots/Thrombus/Thrombosis
VASCULAR	Compartment Syndrome
VASCULAR	Diabetic Neuropathy
VASCULAR	Edema
VASCULAR	Lymphedema
VASCULAR	Neuropathy
VASCULAR	Peripheral Neuropathy
VASCULAR	Poor Circulation
VASCULAR	Thrombophlebitis
VASCULAR	Varicosities
VASCULAR	Vascular disease
VIRAL INFECTION	Hepatitis B
VIRAL INFECTION	Hepatitis C
VIRAL INFECTION	Herpes
VIRAL INFECTION	Human Immunodeficiency Virus (HIV)

Medical Group	Specific Medical Condition
VIRAL INFECTION	Viral Infection
VITAMIN DEFICIENCY/EXCESS	Favism
VITAMIN DEFICIENCY/EXCESS	Hemochromatosis
VITAMIN DEFICIENCY/EXCESS	Low Potassium
VITAMIN DEFICIENCY/EXCESS	Vitamin D Deficiency
WEIGHT CONTROL	Weight Control

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APPENDIX G: LIST OF MOVING VIOLATIONS

- DUI, drugs and/or alcohol, impaired driving, administrative per se DUI
- Refused test for alcohol
- Possession open container
- Violation ignition interlock or immobilization device
- Transporting controlled substance
- Underage drinking
- Hit and Run, Behaviors after accidents
- Driving after Withdrawal
- Driver License/Vehicle Reg. & Title, Miscellaneous Duties
- Misrepresentations
- Miscellaneous Duty Failure
- Operating without, failure to use, or improper use of Equipment Required
- Protective equipment not used (safety belt, helmet, etc.)
- Obstructing or impeding traffic with motor vehicle
- Failure to obey (driving/on road)
- Following improperly
- Improper lane or location
- Ran off road
- Improper passing
- Reckless, careless, negligent driving
- Texting, handheld phone while driving
- Failure to yield
- Failure to signal or wrong signal
- Improper turn
- Wrong way driving
- Miscellaneous maneuvers
- Speeding
- Vehicle use in prohibited actions
- Violation resulting in fatal accident

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APPENDIX H: REGRESSION OUTPUTS FOR TREATED VERSUS UNTREATED DRIVERS

Table 118 shows the RR estimates and 95-percent CIs for treated versus untreated drivers with diagnosed diabetes/elevated blood sugar, high blood pressure, and OSA. Significant RR estimates ($p < 0.05$) are denoted with an asterisk. Cells with a RR estimate of zero ("0") indicate that at least one driver was in the cell, but no crashes or violations were associated with that driver(s). There were seven significant findings in Table 118.

- Drivers with treated high blood pressure were 68.3 percent, 72.6 percent, and 51.5 percent less likely to be convicted of a moving violation compared to drivers with untreated high blood pressure aged 20–33, 43–51, and over 52, respectively.
- Drivers aged 43–51 with treated OSA were 68.9 percent and 59.7 percent less likely to be involved in a carrier preventable crash and national crash, respectively, compared to drivers aged 43–51 with untreated OSA.
- Drivers aged 34–42 with treated OSA were 92.2 percent less likely to be involved in a carrier preventable crash compared to drivers aged 34–42 with untreated OSA.
- Drivers over 52 with treated OSA were 71.9 percent less likely to be convicted of a moving violation compared to drivers over 52 with untreated OSA.

Table 118. RR estimates and 95-percent CIs for treated versus untreated drivers with diagnosed diabetes/elevated blood sugar, high blood pressure, and OSA.

Safety Outcome and Age Quartile	Treated Diabetes/ Elevated Blood Sugar	Untreated Diabetes/ Elevated Blood Sugar	Untreated High Blood Pressure	Treated High Blood Pressure	Untreated OSA	Treated OSA
Total Carrier: 20–33	1.00	0.755 (0.180,3.169)	1.00	0.547 (0.193,1.546)	1.00	0.893 (0.304,2.622)
Total Carrier: 34–42	1.00	0.770 (0.264,2.252)	1.00	0.651 (0.298,1.424)	1.00	0.888 (0.331,2.38)
Total Carrier: 43–51	1.00	0.943 (0.451,1.974)	1.00	0.753 (0.384,1.476)	1.00	0.530 (0.247,1.136)
Total Carrier: 52+	1.00	0.752 (0.302,1.873)	1.00	0.898 (0.475,1.697)	1.00	0.664 (0.284,1.552)
Carrier Preventable: 20–33	1.00	0.444 (0.028,7.121)	1.00	0.613 (0.142,2.647)	1.00	0.438 (0.085,2.270)
Carrier Preventable: 34–42	1.00	1.63 (0.210,12.666)	1.00	0.632 (0.224,1.782)	1.00	0.078* (0.008,0.746)
Carrier Preventable: 43–51	1.00	0.971 (0.342,2.759)	1.00	0.768 (0.311,1.895)	1.00	0.311* (0.113,0.858)
Carrier Preventable: 52+	1.00	0.549 (0.166,1.811)	1.00	0.631 (0.292,1.363)	1.00	0.563 (0.153,2.080)
National Crashes: 20–33	1.00	3.050 (0.375,24.820)	1.00	657,688.121 (0,Inf)	1.00	0.309 (0.083,1.152)
National Crashes: 34–42	1.00	0.806 (0.229,2.831)	1.00	1.439 (0.348,5.947)	1.00	0.511 (0.132,1.981)

Safety Outcome and Age Quartile	Treated Diabetes/ Elevated Blood Sugar	Untreated Diabetes/ Elevated Blood Sugar	Untreated High Blood Pressure	Treated High Blood Pressure	Untreated OSA	Treated OSA
National Crashes: 43–51	1.00	0.743 (0.220,2.512)	1.00	0.917 (0.371,2.270)	1.00	0.403* (0.163,1.0)
National Crashes: 52+	1.00	1.702 (0.529,5.475)	1.00	0.840 (0.370,1.905)	1.00	1.67 (0.393,7.108)
Violations: 20–33	1.00	731,859.626 (0,6.511^{e273})	1.00	0.317* (0.101,0.995)	1.00	0.741 (0.150,3.67)
Violations: 34–42	1.00	0.865 (0.328,2.280)	1.00	0.274* (0.120,0.627)	1.00	0.533 (0.204,1.390)
Violations: 43–51	1.00	1.160 (0.414,3.247)	1.00	0.537 (0.269,1.072)	1.00	0.741 (0.207,2.658)
Violations: 52+	1.00	0.89 (0.380,2.085)	1.00	0.485* (0.254,0.925)	1.00	0.281* (0.103,0.762)

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