

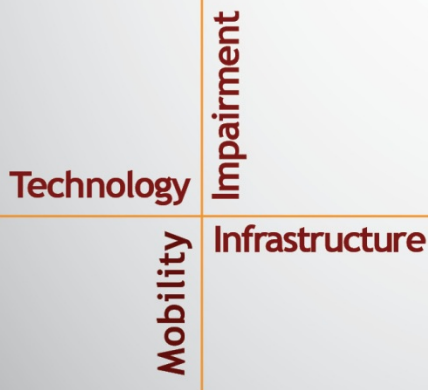
NSTSCCE

National Surface Transportation Safety Center for Excellence

Commercial Motor Vehicle Driver Risk Based on Age and Driving Experience

Naomi Dunn • Susan Soccolich • Jeffrey Hickman

Submitted: April 17, 2020



Housed at the Virginia Tech Transportation Institute
3500 Transportation Research Plaza • Blacksburg, Virginia 24061

ACKNOWLEDGMENTS

The authors of this report would like to acknowledge the support of the stakeholders of the National Surface Transportation Safety Center for Excellence (NSTSCE): Tom Dingus from the Virginia Tech Transportation Institute; John Capp from General Motors Corporation; Chris Hayes from Travelers Insurance; Terri Hallquist and Nicole Michel from the Federal Motor Carrier Safety Administration; Cathy McGhee from the Virginia Department of Transportation and the Virginia Transportation Research Council; and Jane Terry from the National Safety Council.

The NSTSCE stakeholders have jointly funded this research for the purpose of developing and disseminating advanced transportation safety techniques and innovations

ABSTRACT

The commercial motor vehicle (CMV) industry comprises a largely aging workforce, which adds to a widely held concern about a growing CMV driver shortage. As CMV drivers age and retire, there are fewer workers to step in and fill the gap. A possible solution to this problem is to recruit and hire younger drivers, although this poses a potential safety risk due to a lack of CMV driving experience among the younger driver population. However, it is largely unknown in the CMV industry what impact age has on driver risk independent of CMV driving experience, and vice versa. Thus, this study used data collected and compiled in a study sponsored by the Federal Motor Carrier Safety Administration (FMCSA), *Commercial Driver Safety Risk Factors* (Hickman et al., under Agency review), from more than 9,000 CMV drivers to determine the impact of age and CMV driving experience on crash rates, crash involvement, and moving violations. The results indicate that, while both age and CMV driving experience play a role in driver risk, CMV driving experience is more important than age when considering risk. This may be especially true for older inexperienced CMV drivers (e.g., over 55 years of age with less than 1 year of CMV driving experience), who had higher crash rates and odds of being involved in a crash than their younger, inexperienced counterparts. Generally speaking, the first year of driving a CMV is riskier in terms of crash rates, crash involvement, and moving violations, regardless of age. Thus, motor carriers may want to focus on driver training, including engaging older, experienced drivers in driver mentoring programs to share their knowledge with inexperienced CMV drivers. In addition, there are vehicle technologies that use dash cameras to help fleet managers improve driver safety, such as the Lytx DriveCam system. These cameras continually record video and provide evidence-based opportunities for driver training, which may provide additional benefits.

TABLE OF CONTENTS

LIST OF TABLES	V
LIST OF ABBREVIATIONS AND SYMBOLS	VII
CHAPTER 1. INTRODUCTION	1
CHAPTER 2. METHODS.....	3
DATA SOURCES	3
<i>Driver Demographic Data.....</i>	<i>3</i>
<i>Driver Safety Performance Data.....</i>	<i>3</i>
<i>Driver Tenure with Participating Carrier</i>	<i>3</i>
AGE AND CMV DRIVING EXPERIENCE CATEGORIES	4
ANALYSIS APPROACH	5
<i>Poisson Regression.....</i>	<i>5</i>
<i>Logistic Regression.....</i>	<i>5</i>
CHAPTER 3. RESULTS.....	7
CARRIER-RECORDED CRASHES	7
<i>All Carrier-Recorded Crash Types</i>	<i>11</i>
<i>Carrier-Recorded Preventable Crashes</i>	<i>19</i>
MCMIS CRASHES	27
<i>CMV Driving Experience Categories</i>	<i>29</i>
<i>Age Categories.....</i>	<i>30</i>
MOVING VIOLATIONS	31
<i>Moving Violations Rate.....</i>	<i>31</i>
CHAPTER 4. DISCUSSION AND CONCLUSIONS	37
LIMITATIONS	39
REFERENCES.....	41

LIST OF TABLES

Table 1. Number of participating drivers per age and CMV driving experience categories.	4
Table 2. Average driver tenure (in days) for each age and CMV driving experience category.....	7
Table 3. Carrier-recorded crashes by age category for drivers with 6 months or less of CMV driving experience.	8
Table 4. Carrier-recorded crashes by age category for drivers with 7 months to 1 year of CMV driving experience.	8
Table 5. Carrier-recorded crashes by age category for drivers with 1 to 2 years of CMV driving experience.	9
Table 6. Carrier-recorded crashes by age category for drivers with 2 to 5 years of CMV driving experience.	9
Table 7. Carrier-recorded crashes by age category for drivers with 5 to 10 years of CMV driving experience.	10
Table 8. Carrier-recorded crashes by age category for drivers with 10 to 20 years of CMV driving experience.	10
Table 9. Carrier-recorded crashes by age category for drivers with 20 to 30 years of CMV driving experience.	11
Table 10. Carrier-recorded crashes by age category for drivers with 30 years or more of CMV driving experience.	11
Table 11. Average driver carrier-recorded crash rate per 100 days for age and experience classifications.....	12
Table 12. Percentage of CMV drivers with at least one carrier-recorded crash during tenure.	13
Table 13. Poisson regression estimated RR results comparing CMV driving experience categories within each age group for carrier-recorded crashes.	14
Table 14. Logistic regression estimated OR results comparing CMV driving experience categories within each age group for carrier-recorded crashes.	16
Table 15. Poisson regression estimated RR results comparing age groups within each CMV driving experience category for carrier-recorded crashes.	18
Table 16. Logistic regression estimated OR results comparing age groups within each CMV driving experience category for carrier-recorded crashes.	19
Table 17. Average driver carrier-recorded preventable crash rate per 100 days for all age groups and CMV driving experience categories.	20
Table 18. Percentage of drivers with at least one preventable crash during tenure.	21
Table 19. Poisson regression estimated RR results comparing CMV driving experience categories within each age group for carrier-recorded preventable crashes.	22

Table 20. Logistic regression estimated OR results comparing CMV driving experience categories within each age group for carrier-recorded preventable crashes.	24
Table 21. Poisson regression estimated RR results comparing age groups within each CMV driving experience category for carrier-recorded preventable crashes.	26
Table 22. Logistic regression estimated OR results comparing age groups within each CMV driving experience category for carrier-recorded preventable crashes.	27
Table 23. Average driver MCMIS crash rate per 100 days for age and CMV driving experience categories.	28
Table 24. Percentage of drivers with at least one MCMIS crash during tenure.	29
Table 25. Poisson regression estimated RR results comparing CMV driving experience categories within each age group for MCMIS crashes.	30
Table 26. Logistic regression estimated OR results comparing CMV driving experience categories within each age group for MCMIS crashes.	30
Table 27. Poisson regression estimated RR results comparing age groups within each CMV driving experience category for MCMIS crashes.	31
Table 28. Logistic regression estimated OR results comparing age groups within each CMV driving experience category for MCMIS crashes.	31
Table 29. Average driver moving violations rate per 100 days for age and CMV driving experience categories.	32
Table 30. Poisson regression estimated RR results comparing CMV driving experience categories within each age group for moving violations.	33
Table 31. Logistic regression estimated OR results comparing CMV driving experience categories within each age group for moving violations.	34
Table 32. Poisson regression estimated RR results comparing age groups within each CMV driving experience category for moving violations.	35
Table 33. Logistic regression estimated odds ratio results comparing age groups within each CMV driving experience category for moving violations.	36

LIST OF ABBREVIATIONS AND SYMBOLS

ATA	American Trucking Associations
ATRI	American Transportation Research Institute
CDL	Commercial Driver's License
CDLIS	Commercial Driver's License Information System
CDSRF	Commercial Driver Safety Risk Factors
CMV	commercial motor vehicle
DOT	Department of Transportation
FMCSA	Federal Motor Carrier Safety Administration
MCMIS	Motor Carrier Management Information System
OR	odds ratio
RR	rate ratio

CHAPTER 1. INTRODUCTION

The American Trucking Associations (ATA) reported the highest ever commercial truck driver shortage at the end of 2018. The driver shortage hit a high of 60,800, which was an increase of nearly 20% from the previous year (Costello & Karickhoff, 2019). Additionally, the American Transportation Research Institute's annual survey of trucking industry stakeholders finds that the growing shortage of truck drivers is consistently ranked as a top concern (ATRI, 2015). One of the main factors behind the current driver shortage is the relatively high average age of the current commercial motor vehicle (CMV) driver population, with the average age of for-hire over-the-road truckload drivers being 46 years. Other sectors of the trucking industry, such as private or less-than-truckload, reportedly have an even higher average driver age (Costello & Karickhoff, 2019). Thus, the CMV driver population is an aging workforce, with the industry-wide average age for a truck driver increasing at a greater rate than that of the overall workforce, meaning that many drivers are fast approaching retirement age. Considering that 71.4% of all freight tonnage is moved on the nation's roadways by the CMV industry, the driver shortage will impact the entire supply chain (ATA, 2019). Collectively, these facts are generating a great deal of concern within the trucking industry.

A possible solution to this issue is to recruit young drivers to fill the gap and replace older drivers as they retire. However, age has been shown to be one of the strongest factors affecting crash involvement in the general population (National Highway Traffic Safety Administration, 2000). In fact, motor vehicle crashes are the leading cause of death among teens in the United States (Minino, 2010). There is also evidence related specifically to CMV drivers indicating that age is the strongest predictor of CMV driver risk (Hanowski et al., 2000). This study is limited, though, as it only considered drivers of local and short-haul trucks, not long-haul trucks. These findings also fail to take into account the contribution of driving experience, or lack thereof. Obviously, the younger a driver is, the less driving experience he or she has. However, a small number of studies have been conducted on drivers of light passenger vehicles to determine if increased crash risk is due to age or inexperience. A study on young motor vehicle drivers by Curry et al. (2015) attempted to tease apart the influence of driver age at the time of licensure and driving experience on young driver crashes and found that the two elements interacted to influence crash rates. Of significance, however, was the finding that participants with more driving experience had lower crash rates, regardless of age of licensure. This study only examined drivers between the ages of 17 and 20 years. A review paper by McCart et al. (2009) also found that length of licensure (i.e., the equivalent of driving experience) had the most powerful effect on crash risk, although age did still play a role, especially among the youngest novice driver group (i.e., 16 years of age). Young novice drivers are by definition inexperienced, but other characteristics of adolescence may also play a part in elevating crash risk. Immaturity, risk-taking, poor judgment and decision-making, and peer pressure may all contribute to young driver crash risk (Williams, 2006).

Currently, CMV drivers are required to have a valid regular driver's license, have at least one or two years of driving experience, and be at least 18 years old to drive intrastate or 21 years old to drive across state lines (e.g., long haul). These basic requirements alone may mean that some of the factors associated with elevated crash risk in young novice motor vehicle drivers (e.g., 16- and 17-year-olds) may not be relevant. For example, drivers applying for a commercial driver's license (CDL) have at least some on-road driving experience, although not in a truck, so they are

not true novices. In addition, the driving demands and driving environment are drastically different when driving a CMV versus when driving a motor vehicle. Due to the highly regulated nature of the CMV industry, particularly in regard to motor carrier safety, the focus is on safe drivers. Newly licensed CMV drivers may undergo additional training provided by their employer, driver coaching in the form of video-based driver technology, or be partnered in a mentorship program with an older, experienced CMV driver. However, despite the obvious potential for safety implications and the looming CMV driver shortage, research on the topic of age and driving experience is fairly limited in the CMV driver realm. The vast majority of the age-related driving research has focused on light-vehicle non-commercial drivers; thus, there are many unknowns when it comes to CMV drivers. In July 2019, the Federal Motor Carrier Safety Administration (FMCSA) sought public comment on a proposal for a pilot program to allow 18- to 20-year old drivers to operate CMVs in interstate commerce. This would expand on the Commercial Driver Pilot Program launched in 2018 allowing 18- to 20-year-olds to operate in interstate commerce if they had certain military training (FMCSA, 2018). Prior to lowering the age requirement for an interstate CDL, further investigation into the impact of age and driving experience on CMV crash risk is needed.

The current study provides insight into the impact of age and driving experience on crash risk and violations. Numerous data sources, including existing carrier-owned crash and driver databases, as well as national, federally managed crash and violation databases, were compiled for this study. Drivers were classified by their self-reported age and driving experience into binned age and experience categories. Using carrier-provided driver databases, driver tenure at the carrier was calculated, and crashes and violations during driving tenure were identified. The relationship between age and experience was examined for associations with carrier-reported crashes, Department of Transportation (DOT)-reportable crashes, and moving violations. Types of crashes and violations were also analyzed, when possible. Together, these different measures of safety performance were evaluated to help determine relationships between age and experience in the CMV industry.

CHAPTER 2. METHODS

DATA SOURCES

All data were originally collected as part of the FMCSA-sponsored study *Commercial Driver Safety Risk Factors* (CDSRF; Hickman et al., under Agency review). These data included driver demographic and employment information and multiple sources of driver safety data. More detailed information on these and other data sources will be available in the CDSRF technical report, which will be available online once the FMCSA review process is complete.

Driver Demographic Data

Participating drivers completed a demographic questionnaire, which included a question on driver age (in years) at the time of survey completion and a question on commercial vehicle driving experience (reported in years and months). In cases where driver age was missing or illegible, medical exam data were used to obtain the driver's date of birth and calculate age upon enrollment in the study. Medical exam data came from two sources. All drivers with a CDL are required to have a qualifying Medical Examination Report for Commercial Driver Fitness Determination (649-F). In the CDSRF study, Road Ready, Inc., collected all 649-F information for participating study drivers. As part of policy at the participating carrier, Road Ready, Inc., also conducted brief medical exams for any carrier new-hire who had a current and valid medical card within 6 months prior to the driver's hire date.

Driver Safety Performance Data

Three data sources were compiled for the current study to obtain driver safety performance metrics:

1. The Motor Carrier Management Information System (MCMIS), an FMCSA-maintained computerized system that keeps safety-performance records for all motor carriers. The system includes state-reported, DOT-recordable crashes. The MCMIS crash files comprise information on the driver involved in the crash (e.g., driver name, birth date, and CDL number), as well as crash details (e.g., crash date, crash description).
2. Carrier-recorded crash data, which were provided by the carriers and include crashes beyond DOT-recordable crashes. Similar to the MCMIS data set, the carrier-recorded crash files comprise information on the driver involved in the crash and crash details. Carrier-recorded crashes were further analyzed by preventability and resulting injury or fatality.
3. The Commercial Driver's License Information System (CDLIS), a state-maintained computer system that keeps records of commercial drivers' issued licenses, moving violation convictions, and crashes. In the current study, drivers' moving violation convictions were used as an additional driver safety performance metric.

Driver Tenure with Participating Carrier

Hire and termination dates obtained from records of employment within the carrier-recorded crash data were used to calculate driver tenure with the carrier. If a driver left the carrier and was

rehired, these employment periods were included in the data, with a record for each employment period. These records were subsequently compared to the driver safety performance data to identify MCMIS crashes and CDLIS moving violation data that occurred during the driver’s tenure with the participating carrier.

AGE AND CMV DRIVING EXPERIENCE CATEGORIES

The aim of this study was to explore how safety performance changes across different age and CMV driving experience categories. Age and CMV driving experience categories (see Table 1) were created to reflect the diverse range of values in the commercial driver population. To be included in the current analyses, at least one of the data sources had to list an age record for the driver, the driver’s self-reported years of CMV driving experience had to be available from the initial driver survey used in CDSRF data collection, and the driver had to have tenure of at least 1 day with a participating carrier.

The final data set comprised 9,136 CMV drivers with complete valid data. Of these drivers, approximately 12% reported having 6 months or less of CMV driving experience at the start of the study. An additional 12% reported having 7 months to 1 year of driving experience, and approximately 13% reported having 1 to 2 years of CMV driving experience. Most CMV drivers had between 10 and 20 years of experience (21%), while few had 30 years or more experience driving a CMV (3%). More than one-half of the CMV drivers were between the ages of 35 and 54 (56%); nearly one-quarter of CMV drivers were 25 to 34 years old (24%). There were relatively few 21- to 24-year-old CMV drivers (6%) and very few CMV drivers 65 years of age or older (1%).

Table 1. Number of participating drivers per age and CMV driving experience categories.

Age Category	CMV Driving Experience Category								Total
	6 months or less	7 months to 1 year	1 to 2 years	2 to 5 years	5 to 10 years	10 to 20 years	20 to 30 years	30 years or more	
21 to 24 years old	184	183	119	60	6	0	0	0	552
25 to 34 years old	386	384	423	530	395	99	0	0	2,217
35 to 44 years old	248	296	302	450	512	788	82	1	2,679
45 to 54 years old	193	178	210	322	387	705	404	64	2,463
55 to 64 years old	61	59	85	118	151	261	218	141	1,094
65 years or older	10	2	7	2	11	25	25	49	131
Total	1,082	1,102	1,146	1,482	1,462	1,878	729	255	9,136

ANALYSIS APPROACH

Poisson Regression

Poisson regression models were used to assess how the rate of crashes and violations changed for age and CMV driving experience category levels. The Poisson regression model was structured as

$$Y_i \sim \text{Poisson}(E_i, \lambda_i)$$

where Y_i was the number of crashes or violations for driver i , E_i was the total exposure defined as tenure time at the carrier for driver i , and λ_i was the expected crash or violation rate for driver i .

Estimated rate ratios (RRs) approximate the expected change in crash or violation rates when the independent variable (category type) changes from one level to another. The RRs were calculated in the current study using the model to compare two values of the category type (i.e., age or CMV driving experience) being modeled for significant differences in rates of crashes or violations. The method was used for each model, where a level of the age or driving experience category was held constant while testing the levels of the category variable included in the model.

Logistic Regression

Logistic regression was used to assess how the risk of a driver being a crash-involved or violation-involved driver changed across the age or CMV driving experience category. For this analysis, each CMV driver was marked as crash-involved if he or she had one or more crashes during his or her tenure period. The odds of being a crash-involved driver were then calculated using logistic regression models while holding a single level of age or driving experience category constant and comparing the category levels of the other variable.

The logistic regression model was structured as follows:

$$Y_i = \begin{cases} 1 & \text{if driver was involved in a crash during tenure} \\ 0 & \text{if driver was not involved in a crash during tenure} \end{cases}, \text{ for } i = 1, \dots, l$$

where l is the number of drivers. Y_i is assumed to follow a Bernoulli(p_i) distribution, where p_i is the probability of a driver being crash-involved during his or her driving tenure.

The regression model is then:

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

where X_i is the vector of observed covariates for driver i , and β is the vector of parameters.

Odds ratios (ORs) to compare levels of classification variables were calculated by taking the exponent of β . ORs estimate the expected change in crash-involvement odds when the independent variable changes from one level to another. Similar to the Poisson regression

models, a model and resulting ORs were built comparing all levels of one category type (i.e., age or CMV driving experience) while holding the other category type at a constant level. This method was repeated for all comparisons of age and CMV driving experience categories.

CHAPTER 3. RESULTS

The average carrier tenure recorded in the carrier data was calculated for each age category and CMV driving experience category (Table 2). For most of the age and driving experience combinations, average tenure was around 200 days. The exceptions to this were the 65 years and older group with 7 months to 1 year of driving experience, and one 35- to 44-year-old driver who had 30 years or more of self-reported driving experience with a tenure of 878 days. It is highly likely that this latter participant is an anomaly, as he/she would have needed to obtain a CDL at the age of 14 years in order to have 30 years of CMV driving experience by the age of 44. This issue with self-reported values will be addressed in the limitations section of this report.

Table 2. Average driver tenure (in days) for each age and CMV driving experience category.

Age Category	CMV Driving Experience Category							
	6 months or less	7 months to 1 year	1 to 2 years	2 to 5 years	5 to 10 years	10 to 20 years	20 to 30 years	30 years or more
21 to 24 years old	177.30	201.13	189.98	231.33	117.33	-	-	-
25 to 34 years old	179.93	207.72	211.42	212.40	221.62	231.85	-	-
35 to 44 years old	192.62	205.97	224.96	224.39	224.86	221.75	205.20	878.00
45 to 54 years old	186.64	219.37	217.57	220.58	221.89	218.77	212.02	188.66
55 to 64 years old	153.97	203.81	229.56	267.23	206.97	184.90	206.26	228.97
65 years or older	164.90	40.00	144.86	188.00	180.91	149.48	282.52	278.78

Note: '-' denotes no available data

CARRIER-RECORDED CRASHES

The carrier-recorded crash data set included information on preventable crashes, fatal crashes, and injury crashes. Total crashes includes preventable, fatal, injury, and property-damage-only crashes. Property-damage-only crashes are typically very minor (e.g., truck backs over a bush) and involve little to no risk to the CMV driver; thus, they were included in the analysis of total crashes but not investigated separately. The remaining crash types (i.e., fatal, injury, and preventable) are broken down by age within each CMV driving experience category in Table 3 through Table 10. All carrier-recorded crashes (i.e., regardless of crash type) and preventable crashes were then further analyzed for differences across age or driving experience categories. However, fatal and injury crashes were not analyzed due to low counts.

Table 3. Carrier-recorded crashes by age category for drivers with 6 months or less of CMV driving experience.

Age Categories	Total Crash Count	%	Fatal Crash Count	%	Injury Crash Count	%	Preventable Crash Count	%	Total Drivers	%
21 to 24 years	77	15.7%	0	0%	3	37.5%	54	13.7%	184	17.0%
25 to 34 years	165	33.7%	1	100%	2	25.0%	136	34.5%	386	35.7%
35 to 44 years	127	25.9%	0	0%	2	25.0%	103	26.1%	248	22.9%
45 to 54 years	86	17.6%	0	0%	1	12.5%	70	17.8%	193	17.8%
55 to 64 years	31	6.3%	0	0%	0	0%	28	7.1%	61	5.6%
65 years plus	4	0.8%	0	0%	0	0%	3	0.8%	10	0.9%
Total	490	100%	1	100%	8	100%	394	100%	1,082	100%

Table 4. Carrier-recorded crashes by age category for drivers with 7 months to 1 year of CMV driving experience.

Age Categories	Total Crash Count	%	Fatal Crash Count	%	Injury Crash Count	%	Preventable Crash Count	%	Total Drivers	%
21 to 24 years	77	13.8%	0	0%	0	0%	57	12.8%	183	16.6%
25 to 34 years	164	29.4%	0	0%	3	33.3%	131	29.3%	384	34.9%
35 to 44 years	151	27.0%	0	0%	3	33.3%	119	26.6%	296	26.9%
45 to 54 years	110	19.7%	0	0%	3	33.3%	90	20.1%	178	16.2%
55 to 64 years	54	9.7%	1	100%	0	0%	47	10.5%	59	5.4%
65 years plus	3	0.5%	0	0%	0	0%	3	0.7%	2	0.2%
Total	559	100%	1	100%	9	100%	447	100%	1,102	100%

Table 5. Carrier-recorded crashes by age category for drivers with 1 to 2 years of CMV driving experience.

Age Category	Total Crash Count	%	Fatal Crash Count	%	Injury Crash Count	%	Preventable Crash Count	%	Total Drivers	%
21 to 24 years	35	8.2%	0	0%	1	6.7%	28	8.7%	119	10.4%
25 to 34 years	166	39.1%	0	0%	8	53.3%	120	37.4%	423	36.9%
35 to 44 years	92	21.7%	0	0%	2	13.3%	66	20.6%	302	26.4%
45 to 54 years	81	19.1%	0	0%	3	20.0%	67	20.9%	210	18.3%
55 to 64 years	49	11.5%	0	0%	1	6.7%	38	11.8%	85	7.4%
65 years plus	2	0.5%	0	0%	0	0%	2	0.6%	7	0.6%
Total	425	100%	0	0%	15	100%	321	100%	1,146	100%

Table 6. Carrier-recorded crashes by age category for drivers with 2 to 5 years of CMV driving experience.

Age Category	Total Crash Count	%	Fatal Crash Count	%	Injury Crash Count	%	Preventable Crash Count	%	Total Drivers	%
21 to 24 years	14	2.7%	0	0%	1	12.5%	8	2.2%	60	4.1%
25 to 34 years	189	36.4%	0	0%	3	37.5%	123	33.8%	530	35.8%
35 to 44 years	149	28.7%	0	0%	2	25.0%	117	32.1%	450	30.4%
45 to 54 years	117	22.5%	0	0%	2	25.0%	77	21.2%	322	21.7%
55 to 64 years	49	9.4%	0	0%	0	0%	39	10.7%	118	7.9%
65 years plus	1	0.2%	0	0%	0	0%	0	0%	2	0.1%
Total	519	100%	0	0%	8	100%	364	100%	1,482	100%

Table 7. Carrier-recorded crashes by age category for drivers with 5 to 10 years of CMV driving experience.

Age Category	Total Crash Count	%	Fatal Crash Count	%	Injury Crash Count	%	Preventable Crash Count	%	Total Drivers	%
21 to 24 years	6	1.4%	0	0%	0	0%	4	1.3%	6	0.4%
25 to 34 years	106	24.7%	0	0%	1	7.7%	71	22.4%	395	27.0%
35 to 44 years	139	32.4%	0	0%	2	15.4%	106	33.4%	512	35.0%
45 to 54 years	130	30.3%	1	100%	8	61.5%	99	31.2%	387	26.5%
55 to 64 years	46	10.7%	0	0%	2	15.4%	35	11.0%	151	10.3%
65 years plus	2	0.5%	0	0%	0	0%	2	0.6%	11	0.8%
Total	429	100%	1	100%	13	100%	317	100%	1,462	100%

Table 8. Carrier-recorded crashes by age category for drivers with 10 to 20 years of CMV driving experience.

Age Category	Total Crash Count	%	Fatal Crash Count	%	Injury Crash Count	%	Preventable Crash Count	%	Total Drivers	%
21 to 24 years	0	0%	0	0%	0	0%	0	0%	0	0%
25 to 34 years	21	4.2%	0	0%	1	10.0%	13	3.8%	99	5.3%
35 to 44 years	178	35.8%	0	0%	4	40.0%	115	33.7%	788	42.0%
45 to 54 years	213	42.9%	0	0%	4	40.0%	147	43.1%	705	37.5%
55 to 64 years	79	15.9%	0	0%	1	10.0%	62	18.2%	261	13.9%
65 years plus	6	1.2%	0	0%	0	0%	4	1.2%	25	1.3%
Total	497	100%	0	0%	10	100%	341	100%	1,878	100%

Table 9. Carrier-recorded crashes by age category for drivers with 20 to 30 years of CMV driving experience.

Age Category	Total Crash Count	%	Fatal Crash Count	%	Injury Crash Count	%	Preventable Crash Count	%	Total Drivers	%
21 to 24 years	0	0%	0	0%	0	0%	0	0%	0	0%
25 to 34 years	0	0%	0	0%	0	0%	0	0%	0	0%
35 to 44 years	10	5.3%	0	0%	1	20.0%	7	5.7%	82	11.3%
45 to 54 years	114	60.3%	0	0%	3	60.0%	73	59.4%	404	55.4%
55 to 64 years	54	28.6%	0	0%	1	20.0%	33	26.8%	218	29.9%
65 years plus	11	5.8%	0	0%	0	0%	10	8.1%	25	3.4%
Total	189	100%	0	0%	5	100%	123	100%	729	100%

Table 10. Carrier-recorded crashes by age category for drivers with 30 years or more of CMV driving experience.

Age Category	Total Crash Count	%	Fatal Crash Count	%	Injury Crash Count	%	Preventable Crash Count	%	Total Drivers	%
21 to 24 years	0	0%	0	0%	0	0%	0	0%	0	0%
25 to 34 years	0	0%	0	0%	0	0%	0	0%	0	0%
35 to 44 years	0	0%	0	0%	0	0%	0	0%	1	0.4%
45 to 54 years	13	20.6%	0	0%	0	0%	9	22.5%	63	24.6%
55 to 64 years	40	63.5%	0	0%	1	100%	23	57.5%	141	55.1%
65 years plus	10	15.9%	0	0%	0	0%	28	70.0%	49	19.1%
Total	63	100%	0	0%	1	100%	40	100%	256	100%

All Carrier-Recorded Crash Types

All carrier-recorded crashes, regardless of resulting fatality, injury, or vehicle damage, were included in the following analysis assessing crash rate and crash-involved driver counts across age and CMV driving experience categories. Table 11 shows the average driver carrier-recorded crash rate per 100 days for each age and driving experience category. The two driver groups with the highest average crash rates both had very small sample sizes (i.e., two drivers aged 65 years or older with 7 months to 1 year of experience; six drivers aged 21 to 24 years with 5 to 10 years of experience; see Table 1). Thus, these results should be interpreted with caution. Generally, the

average carrier-recorded crash rates were highest for the driver groups with less than 1 year of CMV driving experience.

Table 11. Average driver carrier-recorded crash rate per 100 days for age and experience classifications.

Age Category	CMV Driving Experience Category							
	6 months or less	7 months to 1 year	1 to 2 years	2 to 5 years	5 to 10 years	10 to 20 years	20 to 30 years	30 years or more
21 to 24 years old	0.3536	0.5751	0.3901	0.1508	1.1828	-	-	-
25 to 34 years old	0.5815	0.7229	0.3228	0.3001	0.1785	0.1096	-	-
35 to 44 years old	1.1505	0.3679	0.1642	0.2903	0.2784	0.2682	0.4487	0
45 to 54 years old	0.3697	0.4953	0.3118	0.2373	0.4153	0.1887	0.1953	0.0853
55 to 64 years old	0.6127	0.8721	0.4091	0.5065	0.2672	0.3331	0.3646	0.361
65 years or older	0.5985	5.0866	0.3655	0.1908	0.1151	0.3079	0.1505	0.1047

Note: '-' denotes no available data

Table 12 shows the percentage of drivers with at least one carrier-recorded crash during their tenure at the carrier. In almost all age categories, the driver groups with 6 months or less or 7 months to 1 year of CMV driving experience showed higher proportions of crash involvement than groups with longer CMV driving experience. Exceptions to this were the 55- to 64-year-old group, wherein the drivers with 1 to 2 years of CMV driving experience had a slightly higher percentage of crash involvement than drivers of the same age with 6 months or less of CMV driving experience. In addition, drivers who were 21 to 24 years old with 5 or more years of CMV driving experience had a higher percentage of crash involvement than all other CMV driving experience categories in the age group.

Table 12. Percentage of CMV drivers with at least one carrier-recorded crash during tenure.

Age Category	CMV Driving Experience Category							
	6 months or less	7 months to 1 year	1 to 2 years	2 to 5 years	5 to 10 years	10 to 20 years	20 to 30 years	30 years or more
21 to 24 years old	28.73%	31.69%	21.0%	20.0%	50.0%	-	-	-
25 to 34 years old	29.53%	28.39%	28.13%	25.85%	19.24%	17.17%	-	-
35 to 44 years old	32.66%	35.47%	21.85%	24.44%	21.29%	17.51%	10.98%	0.0%
45 to 54 years old	30.57%	38.76%	27.62%	25.16%	21.45%	21.56%	20.54%	15.63%
55 to 64 years old	32.79%	50.85%	34.12%	27.12%	24.50%	20.31%	20.18%	21.99%
65 years or older	30.0%	100.0%	28.57%	50.0%	9.09%	20.0%	24.0%	12.24%

Note: '-' denotes no available data

CMV Driving Experience Categories

The following results assess differences in carrier-recorded crash involvement between different CMV driving experience categories, tested within individual age categories.

Crash Rate Results

The results of the Poisson regression models with estimated RRs for CMV driving experience categories are shown in Table 13. Due to the large number of comparisons required to address the complete range of age and CMV driving experience categories, only the significant results are shown in the table ($p < 0.05$). In all age categories, no significant differences were found between CMV drivers with 6 months or less driving experience and drivers with 7 months to 1 year of driving experience. Among the youngest drivers, the drivers who self-reported 5 years or more of CMV driving experience had significantly higher crash rates than those drivers with less CMV driving experience in the same age group. This group comprised only six drivers; thus, this result should be interpreted with caution. In all other age groups, less CMV driving experience was associated with higher crash rates. However, in comparisons of longer CMV driving experience categories of 10 or more years, no significant differences were found. The model for drivers 65 years or older was not performed due to a low sample size.

Table 13. Poisson regression estimated RR results comparing CMV driving experience categories within each age group for carrier-recorded crashes.

Age Categories	Comparison CMV Driving Experience Category 1	Comparison CMV Driving Experience Category 2	RR Estimate	95% Confidence Interval Estimate
21 to 24 years old	6 months or less	1 to 2 years	1.5318	(1.0273, 2.2842)
		2 to 5 years	2.3511	(1.3303, 4.1551)
		5 to 10 years	0.2782	(0.1212, 0.6386)
	7 months to 1 year	2 to 5 years	2.0741	(1.1736, 3.6655)
		5 to 10 years	0.2455	(0.1070, 0.5633)
	1 to 2 years	5 to 10 years	0.1816	(0.0764, 0.4319)
2 to 5 years	5 to 10 years	0.1183	(0.0455, 0.3080)	
25 to 34 years old	6 months or less	1 to 2 years	1.2799	(1.0318, 1.5876)
		2 to 5 years	1.4150	(1.1484, 1.7436)
		5 to 10 years	1.9620	(1.5372, 2.5041)
		10 to 20 years	2.5967	(1.6489, 4.0891)
	7 months to 1 year	5 to 10 years	1.6980	(1.3300, 2.1678)
		10 to 20 years	2.2473	(1.4268, 3.5395)
	1 to 2 years	5 to 10 years	1.5329	(1.2014, 1.9559)
		10 to 20 years	2.0288	(1.2886, 3.1945)
2 to 5 years	5 to 10 years	1.3865	(1.0930, 1.7588)	
	10 to 20 years	1.8351	(1.1691, 2.8804)	
35 to 44 years old	6 months or less	1 to 2 years	1.9633	(1.5012, 2.5675)
		2 to 5 years	1.8017	(1.4220, 2.2829)
		5 to 10 years	2.2020	(1.7311, 2.8009)
		10 to 20 years	2.6100	(2.0786, 3.2772)
		20 to 30 years	4.4734	(2.3500, 8.5155)
	7 months to 1 year	1 to 2 years	1.8290	(1.4114, 2.3702)
		2 to 5 years	1.6785	(1.3385, 2.1048)
		5 to 10 years	2.0514	(1.6293, 2.5829)
		10 to 20 years	2.4315	(1.9575, 3.0202)
		20 to 30 years	4.1674	(2.1975, 7.9034)
	1 to 2 years	10 to 20 years	1.3294	(1.0336, 1.7098)
		20 to 30 years	2.2785	(1.1864, 4.3760)
	2 to 5 years	10 to 20 years	1.4486	(1.1653, 1.8008)
		20 to 30 years	2.4829	(1.3089, 4.7099)
5 to 10 years	20 to 30 years	2.0315	(1.0694, 3.8593)	

Age Categories	Comparison CMV Driving Experience Category 1	Comparison CMV Driving Experience Category 2	RR Estimate	95% Confidence Interval Estimate
45 to 54 years old	6 months or less	2 to 5 years	1.4493	(1.0971, 1.9146)
		5 to 10 years	1.5770	(1.2009, 2.0709)
		10 to 20 years	1.7288	(1.3458, 2.2207)
		20 to 30 years	1.7939	(1.3559, 2.3734)
		30 years or more	2.2174	(1.2375, 3.9731)
	7 months to 1 year	1 to 2 years	1.5890	(1.1926, 2.1172)
		2 to 5 years	1.7101	(1.3182, 2.2186)
		5 to 10 years	1.8608	(1.4435, 2.3987)
		10 to 20 years	2.0398	(1.6205, 2.5677)
		20 to 30 years	2.1167	(1.6289, 2.7506)
	30 years or more	2.6164	(1.4725, 4.6488)	
1 to 2 years	20 to 30 years	1.3321	(1.0019, 1.7710)	
55 to 64 years old	6 months or less	2 to 5 years	2.1241	(1.3547, 3.3306)
		5 to 10 years	2.2425	(1.4221, 3.5361)
		10 to 20 years	2.0163	(1.3309, 3.0546)
		20 to 30 years	2.7484	(1.7671, 4.2745)
		30 years or more	2.6641	(1.6667, 4.2582)
	7 months to 1 year	1 to 2 years	1.7883	(1.2148, 2.6326)
		2 to 5 years	2.8899	(1.9631, 4.2542)
		5 to 10 years	3.0509	(2.0589, 4.5208)
		10 to 20 years	2.7432	(1.9407, 3.8775)
		20 to 30 years	3.7392	(2.5643, 5.4525)
	30 years or more	3.6245	(2.4081, 5.4553)	
	1 to 2 years	2 to 5 years	1.6160	(1.0876, 2.4011)
		5 to 10 years	1.7061	(1.1409, 2.5512)
		10 to 20 years	1.5340	(1.0741, 2.1908)
		20 to 30 years	2.0909	(1.4204, 3.0781)
30 years or more		2.0268	(1.3348, 3.0775)	

Crash-Involved Driver Results

The results of the logistic regression models for CMV driving experience categories are listed in Table 14, with estimated ORs and 95% confidence intervals. As above, due to the large number of comparisons required to address the complete range of age and CMV driving experience categories, only the significant results are shown in the table ($p < 0.05$). For nearly all age categories, less CMV driving experience was associated with greater odds of being a crash-involved CMV driver. The exception to this was the 55- to 64-year-old age group, which showed a significant difference between 6 months or less and 7 months to 1 year of CMV driving experience, with lower odds for the less-experienced group. For all age categories, the odds of being a crash-involved CMV driver were not significantly different for drivers with more than 10 years of CMV driving experience. The model for CMV drivers 65 years or older was not performed due to a low sample size.

Table 14. Logistic regression estimated OR results comparing CMV driving experience categories within each age group for carrier-recorded crashes.

Age Category	Comparison CMV Driving Experience Category 1	Comparison CMV Driving Experience Category 2	OR Estimate	95% Confidence Interval Estimate
21 to 24 years old	7 months to 1 year	1 to 2 years	1.745	(1.017, 2.994)
25 to 34 years old	6 months or less	5 to 10 years	1.759	(1.262, 2.453)
		10 to 20 years	2.022	(1.148, 3.561)
	7 months to 1 year	5 to 10 years	1.664	(1.191, 2.324)
		10 to 20 years	1.912	(1.084, 3.372)
	1 to 2 years	5 to 10 years	1.643	(1.184, 2.281)
		10 to 20 years	1.888	(1.075, 3.318)
2 to 5 years	5 to 10 years	1.463	(1.066, 2.009)	
35 to 44 years old	6 months or less	1 to 2 years	1.734	(1.185, 2.538)
		2 to 5 years	1.499	(1.065, 2.110)
		5 to 10 years	1.793	(1.277, 2.518)
		10 to 20 years	2.285	(1.654, 3.155)
		20 to 30 years	3.934	(1.874, 8.258)
	7 months to 1 year	1 to 2 years	1.966	(1.368, 2.824)
		2 to 5 years	1.699	(1.233, 2.342)
		5 to 10 years	2.033	(1.478, 2.795)
		10 to 20 years	2.589	(1.917, 3.498)
		20 to 30 years	4.459	(2.144, 9.273)
	1 to 2 years	20 to 30 years	2.268	(1.078, 4.775)
	2 to 5 years	10 to 20 years	1.524	(1.149, 2.022)
		20 to 30 years	2.624	(1.271, 5.418)
	5 to 10 years	20 to 30 years	2.194	(1.064, 4.525)
45 to 54 years old	6 months or less	5 to 10 years	1.613	(1.091, 2.384)
		10 to 20 years	1.602	(1.123, 2.284)
		20 to 30 years	1.703	(1.153, 2.515)
		30 years or more	2.378	(1.133, 4.988)
	7 months to 1 year	1 to 2 years	1.659	(1.082, 2.543)
		2 to 5 years	1.883	(1.272, 2.790)
		5 to 10 years	2.319	(1.574, 3.415)
		10 to 20 years	2.303	(1.621, 3.271)
		20 to 30 years	2.448	(1.664, 3.602)
		30 years or more	3.418	(1.632, 7.158)
	1 to 2 years	20 to 30 years	1.476	(1.002, 2.173)

Age Category	Comparison CMV Driving Experience Category 1	Comparison CMV Driving Experience Category 2	OR Estimate	95% Confidence Interval Estimate
55 to 64 years old	6 months or less	7 months to 1 year	0.472	(0.225, 0.987)
		10 to 20 years	1.914	(1.036, 3.537)
		20 to 30 years	1.929	(1.029, 3.617)
	7 months to 1 year	1 to 2 years	1.998	(1.013, 3.941)
		2 to 5 years	2.780	(1.448, 5.337)
		5 to 10 years	3.187	(1.696, 5.990)
		10 to 20 years	4.060	(2.244, 7.345)
		20 to 30 years	4.091	(2.227, 7.515)
		30 years or more	3.671	(1.921, 7.014)
	1 to 2 years	10 to 20 years	2.032	(1.184, 3.489)
		20 to 30 years	2.048	(1.173, 3.575)
		30 years or more	1.838	(1.009, 3.348)

Age Categories

The following results assess differences in carrier-recorded crash involvement between different age categories, tested within individual levels of CMV driving experience.

Crash Rate Results

The results of the Poisson regression models with estimated RRs for age categories are shown in Table 15. Due to the large number of comparisons required to address the complete range of age and CMV driving experience categories, only the significant results are shown in the table ($p < 0.05$). No significant differences were found between age categories for drivers with 6 months or less of CMV driving experience. Generally, the RR was lower for CMV drivers younger than 55 years of age compared to CMV drivers 55 years or older. This finding was strong for CMV drivers with 7 months to 1 year of CMV driving experience. However, the exception to this finding was for drivers with 5 to 10 years of experience driving a CMV, wherein the youngest age group showed significantly higher crash rates than all other age groups.

Table 15. Poisson regression estimated RR results comparing age groups within each CMV driving experience category for carrier-recorded crashes.

CMV Driving Experience Category	Comparison Age Category 1	Comparison Age Category 2	RR Estimate	95% Confidence Interval Estimate
7 months to 1 year	21 to 24 years old	45 to 54 years old	0.7426	(0.5550, 0.9937)
		55 to 64 years old	0.4659	(0.3290, 0.6597)
		65 years or older	0.0558	(0.0176, 0.1768)
	25 to 34 years old	45 to 54 years old	0.7299	(0.5732, 0.9293)
		55 to 64 years old	0.4579	(0.3367, 0.6227)
		65 years or older	0.0548	(0.0175, 0.1718)
	35 to 44 years old	55 to 64 years old	0.5515	(0.4042, 0.7526)
		65 years or older	0.0660	(0.0211, 0.2071)
	45 to 54 years old	55 to 64 years old	0.6273	(0.4529, 0.8688)
		65 years or older	0.0751	(0.0239, 0.2365)
55 to 64 years old	65 years or older	0.1198	(0.0374, 0.3830)	
1 to 2 years	21 to 24 years old	55 to 64 years old	0.6165	(0.3995, 0.9513)
	25 to 34 years old	35 to 44 years old	1.3707	(1.0625, 1.7684)
	35 to 44 years old	55 to 64 years old	0.5393	(0.3813, 0.7627)
5 to 10 years	21 to 24 years old	25 to 34 years old	7.0384	(3.0922, 16.0205)
		35 to 44 years old	7.0589	(3.1176, 15.9830)
		45 to 54 years old	5.6297	(2.4835, 12.7620)
		55 to 64 years old	5.7903	(2.4730, 13.5572)
		65 years or older	8.4801	(1.7116, 42.0150)
10 to 20 years	25 to 34 years old	55 to 64 years old	0.5589	(0.3454, 0.9043)
	35 to 44 years old	45 to 54 years old	0.7376	(0.6045, 0.9001)
		55 to 64 years old	0.6223	(0.4774, 0.8111)
20 to 30 years	35 to 44 years old	45 to 54 years old	0.4466	(0.2340, 0.8523)
		55 to 64 years old	0.4949	(0.2520, 0.9717)
		65 years or older	0.3816	(0.1621, 0.8985)

Crash-Involved Driver Results

The results of the logistic regression models for age categories are shown in Table 16 with estimated ORs and 95% confidence intervals. As above, due to the large number of comparisons required to address the complete range of age and CMV driving experience categories, only the significant results are shown in the table ($p < 0.05$). For drivers with CMV driving experience of 2 years or more, no significant differences were found for any age category in the odds of being a crash-involved driver.

Table 16. Logistic regression estimated OR results comparing age groups within each CMV driving experience category for carrier-recorded crashes.

CMV Driving Experience Category	Comparison Age Category 1	Comparison Age Category 2	OR Estimate	95% Confidence Interval Estimate
7 months to 1 year	21 to 24 years old	55 to 64 years old	0.449	(0.247, 0.816)
	25 to 34 years old	35 to 44 years old	0.721	(0.521, 0.998)
		45 to 54 years old	0.626	(0.431, 0.910)
		55 to 64 years old	0.383	(0.220, 0.668)
	35 to 44 years old	55 to 64 years old	0.531	(0.303, 0.933)
1 to 2 years	21 to 24 years old	55 to 64 years old	0.514	(0.274, 0.963)
	35 to 44 years old	55 to 64 years old	0.540	(0.319, 0.913)

Carrier-Recorded Preventable Crashes

The following section investigates the relationship between age and CMV driving experience on involvement in preventable carrier-recorded crashes. Table 17 lists the average driver carrier-recorded preventable crash rate for all age groups and CMV driving experience categories. Two drivers who were 65 years and older with only 7 months to 1 year of CMV driving experience (see Table 1) had the highest average preventable crash rate at 3.39 preventable crashes per 100 days. This rate is much higher than all other results in the analysis. Drivers aged 35 to 44 years old with 6 months or less CMV driving experience had the second highest average preventable crash rate.

Table 17. Average driver carrier-recorded preventable crash rate per 100 days for all age groups and CMV driving experience categories.

Age Category	CMV Driving Experience Categories							
	6 months or less	7 months to 1 year	1 to 2 years	2 to 5 years	5 to 10 years	10 to 20 years	20 to 30 years	30 years or more
21 to 24 years old	0.2401	0.4884	0.3417	0.0622	0.1728	-	-	-
25 to 34 years old	0.4294	0.4604	0.2183	0.2378	0.1118	0.0922	-	-
35 to 44 years old	0.8471	0.2817	0.1130	0.2535	0.2353	0.2272	0.4268	0.0000
45 to 54 years old	0.2981	0.4018	0.2712	0.1721	0.3567	0.1288	0.1495	0.0620
55 to 64 years old	0.5169	0.6299	0.3197	0.4586	0.1643	0.2843	0.1687	0.1176
65 years or older	0.4909	3.3911	0.0366	0.0000	0.1055	0.2865	0.1136	0.0799

Note: '-' denotes no available data

Table 18 lists the percentage of drivers with at least one carrier-recorded preventable crash during their tenure with the carrier. Similar to the results observed for all carrier-recorded crashes, in nearly all age categories, the driver groups with 6 months or less and 7 months to 1 year of CMV driving experience showed higher proportions of crash involvement than driver groups with more experience driving a CMV.

Table 18. Percentage of drivers with at least one preventable crash during tenure.

Age Category	CMV Driving Experience Categories							
	6 months or less	7 months to 1 year	1 to 2 years	2 to 5 years	5 to 10 years	10 to 20 years	20 to 30 years	30 years or more
21 to 24 years old	27.98%	29.69%	21.88%	13.11%	50.0%	-	-	-
25 to 34 years old	32.54%	31.12%	26.61%	22.12%	17.32%	13.0%	-	-
35 to 44 years old	36.65%	36.17%	20.95%	24.38%	19.85%	14.25%	8.43%	0.0%
45 to 54 years old	33.18%	43.69%	29.65%	22.78%	23.68%	19.95%	17.30%	13.64%
55 to 64 years old	40.0%	60.26%	38.78%	30.71%	22.01%	22.30%	14.86%	15.86%
65 years or older	27.27%	100.0%	28.57%	0.0%	16.67%	16.0%	34.48%	15.38%

Note: '-' denotes no available data

CMV Driving Experience Categories

The following section includes results assessing differences in carrier-recorded preventable crash involvement between different CMV driving experience categories, tested within each individual age group.

Crash Rate Results

The results of the Poisson regression models with estimated RRs for CMV driving experience categories are shown in Table 19. Due to the large number of comparisons required to address the complete range of age and CMV driving experience categories, only the significant results are shown in the table ($p < 0.05$). For preventable crashes, no significant differences were found in crash rates for drivers with 1 year or less CMV driving experience. In nearly all age categories, the preventable crash rate was significantly higher for drivers with less CMV driving experience compared to those with more driving experience. There were no significant differences between CMV driving experience categories in the 65 years and older age category; thus, those results are not included in Table 19.

Table 19. Poisson regression estimated RR results comparing CMV driving experience categories within each age group for carrier-recorded preventable crashes.

Age Category	Comparison CMV Driving Experience Category 1	Comparison CMV Driving Experience Category 2	RR Estimate	95% Confidence Interval Estimate
21 to 24 years old	6 months or less	2 to 5 years	2.6160	(1.2450, 5.4967)
	7 months to 1 year	2 to 5 years	2.5107	(1.1979, 5.2623)
	2 to 5 years	5 to 10 years	0.1877	(0.0565, 0.6234)
25 to 34 years old	6 months or less	1 to 2 years	1.4428	(1.1288, 1.8442)
		2 to 5 years	1.7157	(1.3444, 2.1895)
		5 to 10 years	2.6281	(1.7023, 3.0220)
		10 to 20 years	3.1619	(1.7900, 5.5855)
	7 months to 1 year	2 to 5 years	1.3958	(1.0913, 1.7853)
		5 to 10 years	1.8452	(1.3823, 2.4632)
		10 to 20 years	2.5724	(1.4549, 3.5485)
	1 to 2 years	5 to 10 years	1.5720	(1.1722, 2.1081)
		10 to 20 years	2.1915	(1.2365, 3.8840)
	2 to 5 years	10 to 20 years	1.8430	(1.0406, 3.2641)
35 to 44 years old	6 months or less	1 to 2 years	1.8911	(1.3884, 2.5759)
		2 to 5 years	1.6486	(1.2650, 2.1484)
		5 to 10 years	2.0516	(1.5643, 2.6907)
		10 to 20 years	2.7318	(2.0940, 3.5639)
		20 to 30 years	4.2689	(1.9854, 9.1789)
	7 months to 1 year	1 to 2 years	1.7817	(1.3189, 2.4070)
		2 to 5 years	1.5532	(1.2034, 2.0047)
		5 to 10 years	1.9330	(1.4878, 2.5113)
		10 to 20 years	2.5738	(1.9919, 3.3256)
		20 to 30 years	4.0219	(1.8767, 8.6196)
	1 to 2 years	10 to 20 years	1.4445	(1.0673, 1.9551)
		20 to 30 years	2.2574	(1.0357, 4.9199)
	2 to 5 years	10 to 20 years	1.6571	(1.2811, 2.1434)
		20 to 30 years	2.5894	(1.2078, 5.5516)
	5 to 10 years	10 to 20 years	1.3315	(1.0227, 1.7336)

Age Category	Comparison CMV Driving Experience Category 1	Comparison CMV Driving Experience Category 2	RR Estimate	95% Confidence Interval Estimate	
45 to 54 years old	6 months or less	2 to 5 years	1.7321	(1.2532, 2.3942)	
		5 to 10 years	1.8016	(1.3265, 2.4467)	
		10 to 20 years	1.9498	(1.4668, 2.5917)	
		20 to 30 years	2.1801	(1.5707, 3.0261)	
		30 years or more	2.4312	(1.2145, 4.8668)	
	7 months to 1 year	2 to 5 years	1.7631	(1.3006, 2.3901)	
		5 to 10 years	1.8338	(1.3784, 2.4396)	
		10 to 20 years	1.9846	(1.5267, 2.5799)	
		20 to 30 years	2.2191	(1.6297, 3.0217)	
		30 years or more	2.4747	(1.2472, 4.9102)	
	1 to 2 years	5 to 10 years	1.3762	(1.0093, 1.8764)	
		10 to 20 years	1.4894	(1.1157, 1.9883)	
		20 to 30 years	1.6654	(1.1954, 2.3202)	
	55 to 64 years old	6 months or less	1 to 2 years	1.7451	(1.0711, 2.8432)
			2 to 5 years	2.3902	(1.4709, 3.8840)
5 to 10 years			2.6576	(1.6168, 4.3682)	
10 to 20 years			2.3432	(1.4997, 3.6612)	
20 to 30 years			3.8319	(2.3158, 6.3405)	
30 years or more			4.0199	(2.3157, 6.9784)	
7 months to 1 year		1 to 2 years	1.8273	(1.1916, 2.8022)	
		2 to 5 years	2.5028	(1.6370, 3.8266)	
		5 to 10 years	2.7828	(1.7966, 4.3105)	
		10 to 20 years	2.4536	(1.6795, 3.5845)	
		20 to 30 years	4.0125	(2.5710, 6.2622)	
		30 years or more	4.2094	(2.5563, 6.9314)	
1 to 2 years		20 to 30 years	2.1958	(1.3774, 3.5006)	
		30 years or more	2.3036	(1.3726, 3.8662)	
2 to 5 years		20 to 30 years	1.6032	(1.0084, 2.5486)	
		30 years or more	1.6818	(1.0046, 2.8156)	
10 to 20 years		20 to 30 years	1.6353	(1.0720, 2.4947)	
		30 years or more	1.7156	(1.0631, 2.7684)	

Crash-Involved Driver Results

Table 20 shows the results of logistic regression models for CMV driving experience categories, with estimated ORs and 95% confidence intervals. Due to the large number of comparisons required to address the complete range of age and CMV driving experience categories, only the significant results are shown in the table ($p < 0.05$). The results are similar to the preventable crash rate results above; in nearly all age categories, the odds of being a preventable-crash-involved driver were greater among the lower CMV driving experience categories compared to

the higher CMV driving experience categories. As mentioned previously, there were no significant differences between CMV driving experience categories in the 65 years and older age group; thus, those results are not included in Table 20.

Table 20. Logistic regression estimated OR results comparing CMV driving experience categories within each age group for carrier-recorded preventable crashes.

Age Category	Comparison CMV Driving Experience Category 1	Comparison CMV Driving Experience Category 2	OR Estimate	95% Confidence Interval Estimate
21 to 24 years old	6 months or less	2 to 5 years	2.519	(1.124, 5.645)
	7 months to 1 year	2 to 5 years	2.797	(1.250, 6.258)
	2 to 5 years	5 to 10 years	0.151	(0.031, 0.728)
25 to 34 years old	6 months or less	2 to 5 years	1.698	(1.275, 2.261)
		5 to 10 years	2.303	(1.659, 3.195)
		10 to 20 years	3.227	(1.740, 5.985)
	7 months to 1 year	2 to 5 years	1.590	(1.193, 2.120)
		5 to 10 years	2.157	(1.553, 2.996)
		10 to 20 years	3.023	(1.629, 5.610)
	1 to 2 years	5 to 10 years	1.731	(1.244, 2.408)
		10 to 20 years	2.426	(1.306, 4.506)
	2 to 5 years	10 to 20 years	1.901	(1.026, 3.521)
35 to 44 years old	6 months or less	1 to 2 years	2.183	(1.517, 3.142)
		2 to 5 years	1.795	(1.304, 2.472)
		5 to 10 years	2.336	(1.692, 3.226)
		10 to 20 years	3.482	(2.547, 4.761)
		20 to 30 years	6.283	(2.791, 14.141)
	7 months to 1 year	1 to 2 years	2.138	(1.503, 3.041)
		2 to 5 years	1.758	(1.294, 2.389)
		5 to 10 years	2.288	(1.679, 3.118)
		10 to 20 years	3.410	(2.528, 4.599)
		20 to 30 years	6.152	(2.747, 13.777)
	1 to 2 years	10 to 20 years	1.595	(1.140, 2.231)
		20 to 30 years	2.878	(1.267, 6.536)
	2 to 5 years	10 to 20 years	1.939	(1.456, 2.584)
		20 to 30 years	3.499	(1.570, 7.801)
	5 to 10 years	10 to 20 years	1.490	(1.115, 1.992)
		20 to 30 years	2.689	(1.205, 6.001)

Age Category	Comparison CMV Driving Experience Category 1	Comparison CMV Driving Experience Category 2	OR Estimate	95% Confidence Interval Estimate
45 to 54 years old	6 months or less	7 months to 1 year	0.640	(0.430, 0.952)
		2 to 5 years	1.683	(1.147, 2.468)
		5 to 10 years	1.600	(1.111, 2.304)
		10 to 20 years	1.993	(1.420, 2.796)
		20 to 30 years	2.373	(1.620, 3.477)
		30 years or more	3.144	(1.472, 6.718)
	7 months to 1 year	1 to 2 years	1.841	(1.238, 2.737)
		2 to 5 years	2.630	(1.808, 3.825)
		5 to 10 years	2.500	(1.751, 3.569)
		10 to 20 years	3.114	(2.240, 4.328)
		20 to 30 years	3.709	(2.553, 5.388)
		30 years or more	4.914	(2.310, 10.454)
	1 to 2 years	10 to 20 years	1.691	(1.206, 2.371)
		20 to 30 years	2.015	(1.376, 2.949)
30 years or more		2.669	(1.250, 5.699)	
5 to 10 years	20 to 30 years	1.484	(1.058, 2.081)	
55 to 64 years old	6 months or less	7 months to 1 year	0.440	(0.227, 0.850)
		5 to 10 years	2.362	(1.286, 4.337)
		10 to 20 years	2.323	(1.333, 4.047)
		20 to 30 years	3.818	(2.086, 6.988)
		30 years or more	3.536	(1.839, 6.798)
	7 months to 1 year	1 to 2 years	2.394	(1.302, 4.401)
		2 to 5 years	3.421	(1.897, 6.170)
		5 to 10 years	5.371	(2.982, 9.676)
		10 to 20 years	5.282	(3.096, 9.011)
		20 to 30 years	8.683	(4.837, 15.588)
		30 years or more	8.042	(4.259, 15.186)
	1 to 2 years	5 to 10 years	2.244	(1.291, 3.901)
		10 to 20 years	2.206	(1.345, 3.619)
		20 to 30 years	3.627	(2.094, 6.283)
		30 years or more	3.359	(1.838, 6.140)
	2 to 5 years	20 to 30 years	2.538	(1.497, 4.304)
		30 years or more	2.351	(1.311, 4.214)
10 to 20 years	20 to 30 years	1.644	(1.032, 2.618)	

Age Categories

The following results assess differences in carrier-recorded preventable crash involvement between different age groups, tested within individual CMV driving experience categories.

Crash Rate Results

Significant results from the Poisson regression models for carrier-recorded preventable crashes are shown in Table 21. Due to the large number of comparisons required to address the complete range of age and CMV driving experience categories, only the significant results are shown in the table ($p < 0.05$). For drivers with 6 months or less of CMV driving experience, the 55- to 64-year age group was associated with higher crash rate estimates than the younger age categories. This pattern was also significant for drivers with 7 months to 1 year of CMV driving experience.

Table 21. Poisson regression estimated RR results comparing age groups within each CMV driving experience category for carrier-recorded preventable crashes.

CMV Driving Experience Category	Comparison Age Category 1	Comparison Age Category 2	RR Estimate	95% Confidence Interval Estimate
6 months or less	21 to 24 years old	55 to 64 years old	0.5490	(0.3478, 0.8665)
	25 to 34 years old	55 to 64 years old	0.6370	(0.4241, 0.9567)
	35 to 44 years old	55 to 64 years old	0.6375	(0.4198, 0.9680)
	45 to 54 years old	55 to 64 years old	0.6306	(0.4069, 0.9775)
7 months to 1 year	21 to 24 years old	55 to 64 years old	0.5032	(0.3420, 0.7403)
		65 years or older	0.0693	(0.0217, 0.2213)
	25 to 34 years old	55 to 64 years old	0.4949	(0.3546, 0.6906)
		65 years or older	0.0682	(0.0217, 0.2141)
	35 to 44 years old	55 to 64 years old	0.5736	(0.4092, 0.8040)
		65 years or older	0.0790	(0.0251, 0.2484)
45 to 54 years old	55 to 64 years old	0.6130	(0.4308, 0.8723)	
	65 years or older	0.0844	(0.0267, 0.2667)	
1 to 2 years	35 to 44 years old	45 to 54 years old	0.6998	(0.4981, 0.9831)
		55 to 64 years old	0.5883	(0.3947, 0.8768)
5 to 10 years	21 to 24 years old	25 to 34 years old	3.9806	(1.4539, 10.8988)
		35 to 44 years old	3.5978	(1.3258, 9.7632)
		45 to 54 years old	3.1937	(1.1754, 8.6776)
		55 to 64 years old	2.9710	(1.0559, 8.3592)
10 to 20 years	25 to 34 years old	55 to 64 years old	0.4720	(0.2596, 0.8583)
	35 to 44 years old	45 to 54 years old	0.7215	(0.5653, 0.9209)
		55 to 64 years old	0.5468	(0.4015, 0.7447)
20 to 30 years	35 to 44 years old	65 years or older	0.3522	(0.1341, 0.9253)

Crash-Involved Driver Results

Significant results (i.e., $p < 0.05$) from logistic regression models for carrier-recorded preventable crashes are shown in Table 22. The odds of being a CMV driver involved in a preventable crash were not significantly different for drivers 21 to 24 years of age and drivers 25 to 34 years of age, except in one CMV driving experience category (i.e., for 5 years or more of CMV driving experience, the younger drivers had significantly higher odds of crash involvement). For CMV drivers with 7 months to 1 year of CMV driving experience, younger drivers were less likely to be involved in a preventable crash. This finding also held true for CMV drivers with 1 to 2 years of experience driving a CMV.

Table 22. Logistic regression estimated OR results comparing age groups within each CMV driving experience category for carrier-recorded preventable crashes.

CMV Driving Experience Category	Comparison Age Category 1	Comparison Age Category 2	OR Estimate	95% Confidence Interval Estimate
6 months or less	21 to 24 years old	35 to 44 years old	0.657	(0.442, 0.977)
7 months to 1 year	21 to 24 years old	45 to 54 years old	0.544	(0.360, 0.824)
		55 to 64 years old	0.278	(0.161, 0.482)
	25 to 34 years old	45 to 54 years old	0.582	(0.413, 0.821)
		55 to 64 years old	0.298	(0.181, 0.490)
	35 to 44 years old	55 to 64 years old	0.374	(0.225, 0.620)
45 to 54 years old	55 to 64 years old	0.512	(0.301, 0.870)	
1 to 2 years	21 to 24 years old	55 to 64 years old	0.442	(0.247, 0.793)
	25 to 34 years old	55 to 64 years old	0.572	(0.362, 0.904)
	35 to 44 years old	45 to 54 years old	0.629	(0.424, 0.933)
		55 to 64 years old	0.419	(0.257, 0.682)
2 to 5 years	21 to 24 years old	55 to 64 years old	0.341	(0.148, 0.784)
	25 to 34 years old	55 to 64 years old	0.641	(0.418, 0.982)
5 to 10 years	21 to 24 years old	25 to 34 years old	4.775	(1.166, 19.543)
	25 to 34 years old	45 to 54 years old	0.675	(0.480, 0.949)
10 to 20 years	25 to 34 years old	55 to 64 years old	0.521	(0.273, 0.995)
	35 to 44 years old	45 to 54 years old	0.667	(0.510, 0.872)
		55 to 64 years old	0.579	(0.410, 0.817)
20 to 30 years	35 to 44 years old	45 to 54 years old	0.440	(0.195, 0.994)
		65 years or older	0.175	(0.059, 0.502)
	45 to 54 years old	65 years or older	0.397	(0.177, 0.890)
	55 to 64 years old	65 years or older	0.332	(0.142, 0.776)

MCMIS CRASHES

The average driver MCMIS crash rate per 100 days is shown in Table 23. The crash types included in MCMIS are more limited and occur less frequently than the crash types included in carrier-recorded crash data. CMV drivers who were 55 to 64 years of age with 20 to 30 years of CMV driving experience had the highest average driver MCMIS crash rate (i.e., average of 0.316

crashes per 100 days, which is approximately one crash per year). This same age group with 30 or more years of CMV driving experience had the second highest average rate at 0.195 crashes per 100 days.

Table 23. Average driver MCMIS crash rate per 100 days for age and CMV driving experience categories.

Age Category	CMV Driving Experience Category							
	6 months or less	7 months to 1 year	1 to 2 years	2 to 5 years	5 to 10 years	10 to 20 years	20 to 30 years	30 years or more
21 to 24 years old	0.0034	0.0893	0.0055	0.0030	0.0054	-	-	-
25 to 34 years old	0.0988	0.0135	0.0279	0.0182	0.0710	0.0011	-	-
35 to 44 years old	0.0114	0.0475	0.0297	0.0553	0.0194	0.0112	0.0027	0.0000
45 to 54 years old	0.0331	0.0202	0.0095	0.0188	0.0044	0.0222	0.0128	0.0037
55 to 64 years old	0.0000	0.0069	0.0131	0.0000	0.0094	0.0072	0.3162	0.1955
65 years or older	0.0585	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

Note: '-' denotes no available data

Table 24 shows the percentage of drivers with at least one MCMIS crash during their tenure with the carrier for each age and CMV driving experience category. Interestingly, the most experienced CMV drivers (i.e., 30 years or more) in the 55- to 64-year age group had the highest percentage of drivers involved in at least one MCMIS crash. This was followed by less-experienced drivers (i.e., 7 months to 2 years CMV driving experience) in the same age group.

Table 24. Percentage of drivers with at least one MCMIS crash during tenure.

Age Category	CMV Driving Experience Category							
	6 months or less	7 months to 1 year	1 to 2 years	2 to 5 years	5 to 10 years	10 to 20 years	20 to 30 years	30 years or more
21 to 24 years old	1.10%	3.28%	2.52%	1.67%	16.67%	-	-	-
25 to 34 years old	2.33%	2.34%	2.60%	1.70%	2.03%	1.01%	-	-
35 to 44 years old	2.02%	3.72%	3.31%	1.56%	1.56%	1.78%	1.22%	0.00%
45 to 54 years old	1.55%	2.25%	1.90%	4.04%	1.03%	1.84%	1.98%	1.56%
55 to 64 years old	0.00%	3.39%	3.53%	0.00%	2.65%	1.92%	2.75%	4.26%
65 years or older	10.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%

Note: '-' denotes no available data

CMV Driving Experience Categories

Crash Rate Results

Significant results from Poisson regression models for MCMIS crashes by CMV driving experience categories are shown in Table 25. Due to the large number of comparisons between age and CMV driving experience categories, only significant results ($p < 0.05$) are shown in the table. For MCMIS crashes, CMV driving experience categories of 6 months or less and 7 months to 1 year showed no significant differences in any age groups. Other results were less consistent. For younger drivers aged 21 to 24 years, less CMV driving experience was associated with lower crash rates when compared to the 5- to 10-year CMV driving experience group. CMV drivers who were 35 to 44 years old generally saw significant increases in crash risk for less-experienced drivers compared to those with 5 or more years of CMV driving experience. CMV drivers who were 45 to 54 years old showed an inconsistent pattern for the impact of CMV driving experience on crash rates. No significant differences were observed in CMV driving experience categories for drivers who were 25 to 34 years old and 55 to 64 years old. The model for CMV drivers 65 years and older did not perform well due to low sample size.

Table 25. Poisson regression estimated RR results comparing CMV driving experience categories within each age group for MCMIS crashes.

Age Category	Comparison CMV Driving Experience Category 1	Comparison CMV Driving Experience Category 2	RR Estimate	95% Confidence Interval Estimate
21 to 24 years old	6 months or less	5 to 10 years	0.0434	(0.0039, 0.4782)
	1 to 2 years	5 to 10 years	0.0934	(0.0097, 0.8981)
	2 to 5 years	5 to 10 years	0.0507	(0.0032, 0.8109)
35 to 44 years old	7 months to 1 year	10 to 20 years	2.5079	(1.2241, 5.1384)
	1 to 2 years	2 to 5 years	2.2294	(1.0739, 4.6282)
		5 to 10 years	2.1787	(1.0836, 4.3806)
		10 to 20 years	2.8936	(1.4756, 5.6742)
45 to 54 years old	6 months or less	5 to 10 years	3.5758	(1.0091, 12.6712)
	7 months to 1 year	5 to 10 years	5.4978	(1.7243, 17.5293)
	2 to 5 years	5 to 10 years	5.1382	(1.7290, 15.2700)
	5 to 10 years	10 to 20 years	0.3124	(0.1080, 0.9032)
		20 to 30 years	0.2494	(0.0834, 0.7459)

Crash-Involved Driver Results

The model estimating driver crash involvement showed few significant results, which are shown in Table 26. CMV drivers who were 45 to 54 years old with 2 to 5 years of CMV driving experience had significantly higher odds of being involved in a crash than drivers with 5 to 20 years of CMV driving experience. All other CMV driving experience categories showed no significant differences within any age groups.

Table 26. Logistic regression estimated OR results comparing CMV driving experience categories within each age group for MCMIS crashes.

Age Category	Comparison CMV Driving Experience Category 1	Comparison CMV Driving Experience Category 2	OR Estimate	95% Confidence Interval Estimate
21 to 24 years old	6 months or less	5 to 10 years	0.055	(0.004, 0.710)
45 to 54 years old	2 to 5 years	5 to 10 years	4.028	(1.300, 12.478)
		10 to 20 years	2.239	(1.026, 4.887)

Age Categories

Crash Rate Results

Table 27 shows significant results ($p < 0.05$) from the Poisson regression for MCMIS crash rate models. In comparing age categories for differences in crash rates, the largest significant differences were in CMV drivers aged 21 to 24 years old who self-reported 5 to 10 years of CMV driving experience (i.e., high number of years of driving experience given their age) compared to CMV drivers in all other age categories. For CMV drivers with 1 to 2 years of driving experience, higher crash rates were observed for drivers who were 35 to 44 years old

compared to those who were 45 to 54 years old. No other age group comparisons showed significant differences for any CMV driving experience categories.

Table 27. Poisson regression estimated RR results comparing age groups within each CMV driving experience category for MCMIS crashes.

CMV Driving Experience Category	Comparison Age Category 1	Comparison Age Category 2	RR Estimate	95% Confidence Interval Estimate
1 to 2 years	35 to 44 years old	45 to 54 years old	3.0264	(1.0242, 8.9421)
5 to 10 years	21 to 24 years old	25 to 34 years old	12.4345	(1.5918, 97.1352)
		35 to 44 years old	11.6808	(1.5360, 88.8280)
		45 to 54 years old	30.4943	(3.4084, 272.8294)
		55 to 64 years old	11.0980	(1.2404, 99.2927)

Crash-Involved Driver Results

Significant logistic regression results for MCMIS crash-involved drivers are shown in Table 28. The analysis of MCMIS crash-involved drivers echoes earlier findings. For drivers with less than 2 years of experience driving a CMV, there were no significant differences in odds of crash involvement for any age categories. For drivers with 10 or more years of CMV driving experience, there were also no significant differences in odds of crash involvement for any age categories. CMV drivers aged 21 to 24 years old with 5 to 10 years of driving experience showed significantly higher odds of being involved in a crash compared to older drivers with the same reported years of CMV driving experience. For CMV drivers with 2 to 5 years of driving experience, the 25- to 34-year age group and 35- to 44-year age group had lower odds of being involved in a crash than drivers who were in the 45- to 54-year age group.

Table 28. Logistic regression estimated OR results comparing age groups within each CMV driving experience category for MCMIS crashes.

CMV Driving Experience Category	Comparison Age Category 1	Comparison Age Category 2	OR Estimate	95% Confidence Interval Estimate
2 to 5 years	25 to 34 years old	45 to 54 years old	0.411	(0.173, 0.972)
	35 to 44 years old	45 to 54 years old	0.376	(0.148, 0.952)
5 to 10 years	21 to 24 years old	25 to 34 years old	9.675	(1.011, 92.558)
		35 to 44 years old	12.600	(1.318, 120.479)
		45 to 54 years old	19.150	(1.804, 203.270)

MOVING VIOLATIONS

Several different types of moving violations were included in the current analysis, ranging from alcohol or drug-related violations to speed violations to defects in vehicle equipment. The following section presents the results from all moving violations grouped together.

Moving Violations Rate

Table 29 lists the average moving violations rate per 100 days for each age and CMV driving experience category. CMV drivers aged 25 to 34 years old with 6 months of driving experience

or less showed the highest average moving violations rate at 0.3888 per 100 days (i.e., more than one moving violation per year). Drivers aged 65 years or older showed no moving violations in three of the CMV driving experience categories (i.e., 6 months or less, 7 months to 1 year, and 2 to 5 years).

Table 29. Average driver moving violations rate per 100 days for age and CMV driving experience categories.

Age Category	CMV Driving Experience Category							
	6 months or less	7 months to 1 year	1 to 2 years	2 to 5 years	5 to 10 years	10 to 20 years	20 to 30 years	30 years or more
21 to 24 years old	0.1290	0.1655	0.1063	0.0722	0.0000	-	-	-
25 to 34 years old	0.3888	0.1202	0.0692	0.0632	0.1020	0.0759	-	-
35 to 44 years old	0.1608	0.0671	0.0272	0.1052	0.1336	0.0549	0.0093	0.0000
45 to 54 years old	0.0965	0.0933	0.0980	0.0645	0.2099	0.1697	0.0542	0.0964
55 to 64 years old	0.1249	0.0430	0.0616	0.0276	0.0887	0.0260	0.0062	0.0144
65 years or older	0.0000	0.0000	0.2677	0.0000	0.1299	0.0652	0.0058	0.0214

Note: '-' denotes no available data

CMV Driving Experience Category

Moving Violation Rate Results

Significant results from the Poisson regression model for moving violation rates are shown in Table 30. Due to the large number of comparisons between age and CMV driving experience categories, only significant results ($p < 0.05$) are shown in the table. No significant differences were found for CMV drivers with 6 months or less driving experience and CMV drivers with 7 months to 1 year of driving experience, regardless of age. For drivers who were 35 to 44 years old, those with 7 months to 1 year of CMV driving experience had higher moving violation rates than drivers with 1 year or more of driving experience. For CMV drivers who were 45 to 54 years old, the results were inconsistent across age and CMV driving experience categories. Overall, regardless of age, drivers with more than 5 years of CMV driving experience had significantly lower moving violation rates or no difference in rates when compared to CMV drivers with less driving experience. No significant differences were observed in any CMV driving experience categories for drivers in the 25- to 34-year age group or the 55- to 64-year age group.

Table 30. Poisson regression estimated RR results comparing CMV driving experience categories within each age group for moving violations.

Age Category	Comparison CMV Driving Experience Category 1	Comparison CMV Driving Experience Category 2	RR Estimate	95% Confidence Interval Estimate
21 to 24 years old	6 months or less	1 to 2 years	0.5432	(0.3129, 0.9431)
35 to 44 years old	7 months to 1 year	1 to 2 years	1.6234	(1.0149, 2.5969)
		2 to 5 years	1.5610	(1.0350, 2.3544)
		5 to 10 years	1.7218	(1.1442, 2.5910)
		10 to 20 years	1.6115	(1.1120, 2.3352)
45 to 54 years old	6 months or less	1 to 2 years	0.2685	(0.1307, 0.5516)
		2 to 5 years	0.3728	(0.1825, 0.7616)
	7 months to 1 year	1 to 2 years	0.5668	(0.3433, 0.9360)
	1 to 2 years	5 to 10 years	1.9410	(1.2718, 2.9625)
		10 to 20 years	1.9606	(1.3374, 2.8743)
		20 to 30 years	2.5403	(1.5900, 4.0585)
	2 to 5 years	20 to 30 years	1.8297	(1.1551, 2.8982)

Drivers Involved in Moving Violations

The results of logistic regression models modeling the likelihood of a driver being involved in one or more moving violations are included in Table 31. Due to the large number of comparisons between age and CMV driving experience categories, only significant results ($p < 0.05$) are shown in the table. For CMV drivers who were 45 to 54 years old, the odds of being involved in a moving violation were lower for drivers with 6 months or less of CMV driving experience, compared to those with 1 to 20 years of CMV driving experience. For CMV drivers who were 35 to 44 years old, those with 7 months to 1 year of CMV driving experience had higher odds of being involved in a moving violation than CMV drivers of the same age with 5 to 10 years or 20 to 30 years of CMV driving experience. For drivers aged 55 to 64 years old, less CMV driving experience generally resulted in higher odds of being involved in a moving violation compared to drivers with more CMV driving experience. No significant differences in CMV driving experience categories were observed for drivers in the 21- to 34-year age group.

Table 31. Logistic regression estimated OR results comparing CMV driving experience categories within each age group for moving violations.

Age Category	Comparison CMV Driving Experience Category 1	Comparison CMV Driving Experience Category 2	OR Estimate	95% Confidence Interval Estimate
35 to 44 years old	7 months to 1 year	5 to 10 years	1.693	(1.023, 2.800)
		20 to 30 years	4.515	(1.061, 19.216)
45 to 54 years old	6 months or less	7 months to 1 year	0.245	(0.097, 0.617)
		1 to 2 years	0.235	(0.095, 0.586)
		2 to 5 years	0.324	(0.132, 0.796)
		5 to 10 years	0.331	(0.137, 0.800)
		10 to 20 years	0.349	(0.148, 0.821)
	7 months to 1 year	20 to 30 years	2.174	(1.174, 4.026)
	1 to 2 years	20 to 30 years	2.261	(1.244, 4.110)
55 to 64 years old	6 months or less	1 to 2 years	0.311	(0.099, 0.974)
	7 months to 1 year	20 to 30 years	6.082	(1.483, 24.939)
	1 to 2 years	5 to 10 years	2.390	(1.079, 5.297)
		10 to 20 years	2.996	(1.449, 6.194)
		20 to 30 years	14.240	(4.044, 50.144)
		30 years or more	4.520	(1.701, 12.010)
	2 to 5 years	20 to 30 years	7.615	(2.107, 27.527)
	5 to 10 years	20 to 30 years	5.958	(1.653, 21.474)
10 to 20 years	20 to 30 years	4.754	(1.375, 16.432)	

CMV Driver Age Categories

Moving Violation Rate Results

Significant results from the Poisson regression models ($p < 0.05$) for moving violation rates are shown in Table 32. For drivers with 6 months or less of CMV driving experience, the 21- to 24-year age group had significantly higher rates than the 45- to 54-year age group; the 25- to 34-year age group had significantly higher rates than both the 35- to 44-year age group and the 45- to 54-year age group. For drivers with 5 to 10 years of CMV driving experience, those who were between 25 and 64 years of age had significantly lower moving violation rates than CMV drivers who were 65 years and older. For drivers with 10 years or more of CMV driving experience, younger drivers (25- to 34-year age group) had significantly higher moving violation rates than older drivers between 35 and 64 years of age.

Table 32. Poisson regression estimated RR results comparing age groups within each CMV driving experience category for moving violations.

CMV Driving Experience Category	Comparison Age Category 1	Comparison Age Category 2	RR Estimate	95% Confidence Interval Estimate
6 months or less	21 to 24 years old	45 to 54 years old	2.8837	(1.3344, 6.2320)
	25 to 34 years old	35 to 44 years old	1.9262	(1.1763, 3.1542)
		45 to 54 years old	3.2348	(1.6002, 6.5394)
7 months to 1 year	21 to 24 years old	25 to 34 years old	1.7644	(1.1513, 2.7038)
		45 to 54 years old	1.9980	(1.1953, 3.3395)
1 to 2 years	21 to 24 years old	25 to 34 years old	1.9828	(1.2646, 3.1090)
		35 to 44 years old	3.0095	(1.7825, 5.0814)
	35 to 44 years old	45 to 54 years old	0.4736	(0.2936, 0.7640)
		65 years or older	0.1960	(0.0467, 0.8225)
2 to 5 years	21 to 24 years old	35 to 44 years old	2.2927	(1.2369, 4.2498)
		55 to 64 years old	2.2705	(1.0673, 4.8303)
	25 to 34 years old	35 to 44 years old	1.5018	(1.0368, 2.1753)
5 to 10 years	25 to 34 years old	35 to 44 years old	1.6134	(1.0906, 2.3868)
		65 years or older	0.3157	(0.1144, 0.8712)
	35 to 44 years old	65 years or older	0.1957	(0.0704, 0.5436)
	45 to 54 years old	65 years or older	0.2258	(0.0811, 0.6283)
	55 to 64 years old	65 years or older	0.2184	(0.0719, 0.6636)
10 to 20 years	25 to 34 years old	35 to 44 years old	1.8284	(1.0771, 3.1040)
		45 to 54 years old	1.7104	(1.0068, 2.9057)
		55 to 64 years old	1.9136	(1.0024, 3.6530)
20 to 30 years	45 to 54 years old	55 to 64 years old	5.0107	(1.5292, 16.4181)

Drivers Involved in Moving Violations

Table 33 shows the significant findings for CMV drivers involved in moving violations, with very few comparisons showing significant differences ($p < 0.05$). For drivers with 6 months or less of CMV driving experience, those aged 21 to 34 years old had significantly higher odds of being involved in a moving violation compared to drivers who were 45 to 54 years old. For drivers with 20 to 30 years of CMV driving experience, those who were 45 to 54 years old had higher odds of being involved in a moving violation than drivers who were 55 to 64 years old. Overall, significant differences were rare, but when they occurred, younger drivers typically had higher odds of being involved in a moving violation than older drivers with the same levels of CMV driving experience.

Table 33. Logistic regression estimated odds ratio results comparing age groups within each CMV driving experience category for moving violations.

CMV Driving Experience Category	Comparison Age Category 1	Comparison Age Category 2	OR Estimate	95% Confidence Interval Estimate
6 months or less	21 to 24 years old	45 to 54 years old	4.100	(1.619, 10.386)
	25 to 34 years old	45 to 54 years old	3.516	(1.464, 8.444)
1 to 2 years	21 to 24 years old	35 to 44 years old	2.040	(1.044, 3.984)
	35 to 44 years old	55 to 64 years old	0.385	(0.193, 0.766)
5 to 10 years	25 to 34 years old	35 to 44 years old	1.733	(1.077, 2.787)
	35 to 44 years old	65 years or older	0.198	(0.051, 0.765)
20 to 30 years	45 to 54 years old	55 to 64 years old	4.015	(1.188, 13.565)

CHAPTER 4. DISCUSSION AND CONCLUSIONS

The goal of this study was to explore the impact of age and CMV driving experience— independent of each other—on safety performance and driver risk in the CMV driver population. The multiple data sources and safety performance measures compiled from the FMCSA-sponsored CDSRF study provided a large data pool of more than 9,000 CMV drivers ranging from 21 years old to more than 65 years old ($n = 8,453$) and with CMV driving experience of anywhere from 6 months or less up to 30 years ($n = 8,152$). CMV drivers 65 years and older, as well as CMV drivers with more than 20 years of driving experience, yielded smaller sample sizes, which is logical when considering a typical retirement age of 65. Additionally, CMV drivers in the 21- to 24-year age category had a smaller sample size. This is not surprising as the CMV industry has struggled for many years to attract younger truck drivers. Thus, the CMV driver shortage issue becomes even more critical due to the lack of young drivers available to replace the older drivers when they reach retirement age (Costello & Suarez, 2015).

Carrier-recorded crash rates and crash involvement were assessed for all carrier crash types combined, as well as for fatal crashes, injury crashes, and preventable crashes. Fatal crashes and injury crashes had very low frequencies in all age and CMV driving experience categories and, therefore, were not tested in the current study for significant differences. For all crash types combined, the average carrier-recorded crash rates were highest for drivers with less than 1 year of CMV driving experience, regardless of age. Interestingly, for drivers with 7 months to 1 year of CMV driving experience, crash rates were higher for drivers aged 55 years and older compared to their younger counterparts. Similarly, for all crash types combined, CMV drivers with less experience driving a CMV (i.e., less than 1 year) had higher proportions of crash involvement than drivers with longer CMV driving experience, regardless of age.

Preventable crashes showed the same pattern of results, with less-experienced CMV drivers having higher proportions of crash involvement across the majority of age groups. These results seem to indicate that CMV driving experience has a greater impact than age on crash rates and crash involvement in the carrier-recorded crash data. The results of all crashes combined also indicate that CMV driving experience may be more important for drivers over the age of 55. Older CMV drivers with less than 1 year of CMV driving experience had up to 3.7 times higher crash rates and 4 times the odds of being involved in a crash than more-experienced drivers in the same age category. The same pattern held true for carrier-recorded preventable crashes, with crash rates and odds of being involved in a preventable crash being greater for CMV drivers with less driving experience, particularly 1 year or less, than for CMV drivers who were more experienced. This was especially true for inexperienced older CMV drivers (i.e., 55 years and older with 1 year or less of CMV driving experience), who had higher preventable crash rate estimates and greater odds of being involved in a preventable crash than all other age and CMV driving experience categories. This may suggest two possibilities: (1) older inexperienced CMV drivers (i.e., over the age of 55) have more difficulty learning to safely drive a CMV than their younger counterparts; or (2) older inexperienced CMV drivers may be overconfident in their abilities to drive a CMV safely since they presumably have greater on-road driving experience from their years driving a light vehicle compared to their younger counterparts.

For MCMIS crashes, the results were less consistent than for the carrier-recorded crash data. Crashes that qualify for entry into MCMIS are more limited and occur less frequently than those

found in the carrier-recorded crash data, as they tend to be more serious. To be included in MCMIS, a CMV crash must be DOT-reportable, meaning the crash resulted in a fatality, an injury, or one or more vehicles required a tow-away from the scene. The carrier-recorded crash data included these types of crashes plus more minor property-damage-only crashes. Thus, the carrier-recorded crash data set was much larger than the MCMIS data set. Surprisingly, it was the older, more-experienced CMV drivers (i.e., 55 to 64 years of age with 20 to 30 years of experience driving a CMV) who had the highest MCMIS crash rates. This is contrary to what was found in the carrier-recorded crash data, where it was the less-experienced CMV drivers who had the highest crash rates, regardless of age. This may be an indication that inexperience with driving a CMV may contribute to more minor crashes that may be due to such factors as carelessness or judgement errors (e.g., underestimating stopping distance, taking a turn too wide). However, when looking at the percentage of CMV drivers with at least one MCMIS crash, this percentage tended to be higher for CMV drivers with less experience driving a CMV, regardless of age. Thus, there was a greater proportion of inexperienced CMV drivers who were involved in at least one MCMIS crash during their tenure with the carrier compared to experienced CMV drivers.

A CMV moving violation refers to a traffic law that is violated by a vehicle in motion. For example, speeding, running a red light, or driving under the influence of alcohol or drugs. The results of this study indicate that the least amount of CMV driving experience (i.e., 6 months or less) was associated with higher average moving violation rates, particularly for the 21- to 24-year age group, who had more than one moving violation per year. Overall, regardless of age, CMV drivers with more than 5 years of experience driving a CMV had lower moving violation rates than drivers with less experience driving a CMV. Interestingly, in regard to the odds of a CMV driver receiving a moving violation, the least experienced CMV drivers (i.e., 6 months or less) who were 45 to 54 years of age had significantly lower odds of receiving a moving violation, compared to drivers with anywhere from 7 months to 20 years of CMV driving experience. CMV drivers in this older age group may be more cognizant of their lack of experience so they are more careful when they first obtain their CDL, although this difference does not last long. Generally speaking, CMV drivers with less driving experience (i.e., 2 years or less) had much higher odds of receiving a moving violation compared to the most experienced CMV drivers (i.e., 20 years or more). CMV drivers with 20 to 30 years of experience driving a CMV had significantly lower odds of receiving a moving violation than all other CMV driving experience categories, regardless of age, indicating the importance of CMV driving experience to safe driving behavior. These results may also serve as an indication of a self-selection process that occurs in the CMV industry, whereby the penalties associated with violations serve to “weed out” the unsafe drivers over time; thus, the CMV drivers who remain in the industry for 20 plus years are inherently safer drivers.

Overall, the findings were fairly consistent across all safety performance measures, indicating that CMV driving experience has a greater impact on crash rates, crash involvement, and moving violations than driver age. This was especially evident in the crash data for older drivers with less CMV driving experience whose crash rates and involvement were higher than their more-experienced counterparts. These results indicate that age may be a mediating factor, as the older, less-experienced group of CMV drivers performed worse than their younger, inexperienced counterparts. Overall, though, while both age and CMV driving experience play a role in determining driver risk, CMV driving experience has a greater impact than age. It would be

beneficial for fleet managers to focus on retaining older, more-experienced drivers and engage them in driver mentoring programs before they retire so inexperienced drivers can benefit from their knowledge. Technology-based options for driver training may also be beneficial, including video-based technologies, such as the Lytx DriveCam system (<https://www.lytx.com/en-us/fleet-management/drivecam>). These systems use dash cameras to continually record driving behavior, which can then be reviewed and used for driver training purposes. Video-based technology systems have been shown to be associated with a reduction in crashes and risky driving behavior, such as cell phone use while driving, late braking, and following too closely (Lytx, 2019). Collectively, these training methods will be helpful for inexperienced CMV drivers as they are learning to safely negotiate the roadways.

LIMITATIONS

CMV driver data for this study were based on driver tenure at a carrier. Thus, it is not possible to determine if, and for how long, CMV drivers continued their driving career after leaving that carrier. Many CMV drivers terminated their tenure with a carrier during the 3 years of data collection for the CDSRF study. If these drivers had a DOT-reportable crash after leaving the carrier, that crash should show up in the MCMIS crash data. However, for any CMV driver who terminated his or her tenure, it would not be possible to calculate an accurate crash rate without knowing the driver's tenure with other carriers. Similarly, if a CMV driver who terminated his or her tenure did not have a MCMIS crash, there is no way to determine from these data if that CMV driver continued driving without being involved in any crashes or if he or she stopped driving altogether. Limiting the crash and violation data to those that occurred during CMV driver tenure with the carrier unfortunately lowered the amount of crash and violation data available for use.

Additionally, the CMV driving experience variable was based on self-reports made by the drivers, which may have resulted in some inaccuracies. For instance, one CMV driver in the 35- to 44-year age group self-reported having 30 years or more of CMV driving experience (see Table 1). Similarly, six CMV drivers in the 21- to 24-year age group reported having 5 to 10 years of CMV driving experience. A driver must be at least 18 years of age to obtain an intrastate CDL, thus it is likely that these self-reported CMV driving experience values were overestimated. The driver may be including driving experience he or she gained prior to obtaining an official CDL.

One limitation of the analysis approach was the decision to leave alpha at 0.05 for CI calculations, which raises the risk of a type 1 error. Due to the exploratory nature of this project, which examined all possible combinations of driver age and CMV driving experience, the number of statistical comparisons was very large. Therefore, controlling for type 1 errors would have resulted in an alpha value reduced drastically from 0.05. For this study, alpha remained at 0.05 and tables with average rates across driver age and CMV driving experience categories were included to illustrate any practical differences. Additionally, tables listing the RR and full 95% CI values (as opposed to just marking significant comparisons) were included to be transparent in how distant the CI bounds were from the value of 1. Given the broad range of driver age and CMV driving experience categories investigated in this study, future studies may narrow the scope and focus on certain age and experience categories, which would allow for greater control of type 1 error risks.

REFERENCES

- American Transportation Research Institute. (2015). *Critical issues in the trucking industry – 2015*. Arlington, VA: American Transportation Research Institute.
- American Trucking Associations. (2019). *U.S. freight transportation forecast: 2019 to 2030*. Arlington, VA: American Trucking Associations.
- Costello, B., & Karickhoff, A. (2019). *Truck driver shortage analysis 2019*. Arlington, VA: American Trucking Associations.
- Costello, B., & Suarez, R. (2015). *Truck driver shortage analysis 2015*. Arlington, VA: American Trucking Associations.
- Curry, A. E., Pfeiffer, M. R., Durbin, D. R., & Elliott, M. R. (2015). Young driver crash rates by licensing age, driving experience, and license phase. *Accident Analysis and Prevention, 80*, 243-250.
- FMCSA. (2018). *New USDOT pilot program provides boost to military recruitment*. <https://www.fmcsa.dot.gov/newsroom/new-usdot-pilot-program-provides-boost-military-recruitment>
- Hanowski, R. J., Wierwille, W. W., Garness, S. A., & Dingus, T. A. (2000). *Impact of local/short haul operations on driver fatigue* (DOT-MC-00-203). Washington, DC: Federal Motor Carriers Safety Administration.
- Hickman, J. S., Mabry, J. E., Glenn, L., Guo, F., Mao, H., Hanowski, R. J., Whiteman, J., & Herbert, W. (under Agency review). *Commercial Driver Safety Risk Factors (CDSRF)*. Washington, DC: Federal Motor Carrier Safety Administration.
- Lytix. (2019). *Case Study: Murphy-Hoffman Company sees 79% reduction in roadway collisions with Lytx*. <https://www.lytx.com/en-us/our-clients/success-stories/murphy-hoffman-company>
- McCartt, A. T., Mayhew, D. R., Braitman, K. A., Ferguson, S. A., & Simpson, H. M. (2009). Effects of age and experience on young driver crashes: Review of the recent literature. *Traffic Injury Prevention, 10*(3), 209-219.
- Minino, A. M. (2010). *Mortality among teenagers aged 12–19 years: United States, 1999-2006*. Washington, DC: Center for Disease Control and Prevention.
- National Highway Traffic Safety Administration. (2000). *Traffic safety facts – Older population* (DOT HS 809 328). Washington, DC: NHTSA.
- Williams, A. F. (2006). Young driver risk factors: Successful and unsuccessful approaches for dealing with them and an agenda for the future. *Injury Prevention, 12* (Suppl 1), i4-i8.