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Exploring the Relationship Between Entry-Level Motorcycle Rider Training And Motorcycle Crashes

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16. Abstract

Research on the effect of entry-level motorcycle rider training has not overwhelmingly supported the effectiveness or ineffectiveness of training. Studies varied greatly in the methods used for comparison and the consequences of training that were investigated (the effect of training on crash rates, citation rates, and personal protective equipment usage, etc.). Much previous analysis of motorcycle operators focused on frequency and types of crashes, with special attention to motorcycle fatalities and need for universal helmet laws. The relationship between entry-level motorcycle rider training and motorcyclist safety has not been thoroughly explored. This study sought to help fill this gap by exploring the relationship between entry-level motorcyclist training and a variety of safety-related outcomes. The primary research questions for the study were: (1) Do crash characteristics (collision type, contributing factors, etc.) differ between trained and untrained motorcycle riders? (2) Is there a difference in rider behavior (contributing factors such as speed, impairment, or aggressive driving) between trained and untrained riders? (3) What types of citations are issued to trained and untrained riders while they are operating motorcycles or passenger vehicles? (4) Do crash injury outcomes (injury severity and type) differ between trained and untrained riders?

To address the research questions, an extensive analysis of public records linking motorcyclists' training to crash data, citation data, and hospital records was carried out using Maryland's Crash Outcome Data Evaluation System.

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Executive Summary

Introduction

Since its establishment in 1970 the National Highway Traffic Safety Administration has promoted motorcycle safety through a variety of initiatives, including data collection and analysis, technical assistance, State highway safety grants, and targeted safety programs. NHTSA has also recognized the role of entry-level rider training, combined with knowledge and skill testing, in preparing motorcyclists to ride safely. However, the effectiveness of training as a countermeasure to reduce motorcycle crashes is unclear. Past research on the effect of entry-level motorcycle rider training is varied and has not overwhelmingly supported the effectiveness or ineffectiveness of training.

NHTSA convened a panel of motorcycle experts to determine the feasibility of conducting a study to evaluate the effectiveness of entry-level rider training in reducing motorcycle crashes.[1] The panel recommended NHTSA study the relationship between rider training, safe-riding behavior, and rider crashes. This report explores the relationship between rider training and crashes, injuries, and citations using statewide training, license, crash, and citation databases.

Research Approach

An extensive analysis of public records linking motorcyclists' training to crash data, citation data, and hospital records was carried out using Maryland's Crash Outcome Data Evaluation System (CODES). The primary research questions for the study were:

- Do crash characteristics (collision type, contributing factors, etc.) differ between trained and untrained motorcycle riders?
- Is there a difference in rider behavior (contributing factors such as speed, impairment, or aggressive driving) between trained and untrained riders?
- What types of citations are issued to trained and untrained riders while they are operating motorcycles or passenger vehicles?
- Do crash injury outcomes (injury severity and type) differ between trained and untrained riders?

Data Sources and Analysis

The analysis for this project involved linking motorcycle training and licensing data provided by the Maryland Motor Vehicle Administration (MVA), police crash reports from the Maryland Automated Accident Reporting System provided by the Maryland State Police, emergency department and hospital inpatient records provided by the Health Services Cost Review Commission, and traffic citation data provided by the Maryland District Court. The final study population consisted of 31,714 people identified using the 2011 MVA training databased to query riders trained from 2009 to 2011 and riders who received certificates for training courses taken in another State. Both groups were matched to the MVA licensing database to identify

[1] Brock, J., Robinson, A., Robinson, B., & Percer, J. (2010, March). *Approaches to the assessment of entry-level motorcycle training: An expert panel discussion* (Traffic Safety Facts Research Note. Report No. DOT HS 811 242). National Highway Traffic Safety Administration.

riders that received a Maryland motorcycle license. The chi-square test identified significant association between four groups (trained and licensed, trained and unlicensed, untrained and licensed, and untrained and unlicensed) and variables related to crashes, citations, and injury severity. One major limitation of the study was the lack of comprehensive, accurate exposure information. As a result, the findings in the report are based on data that has not been normalized by exposure. This study also assumed riders who were not trained in Maryland are "untrained"; however, it is recognized some study subjects were likely to have been trained in another State.

Conclusions

States vary in their willingness and ability to access data on motorcycle usage, training, and crashes. The Maryland database is noteworthy in the breadth of motorcycle safety information available and its ability to link that information with crash and other data.

When crash information was compared for trained and untrained riders some differences were determined. There was a significant difference in the age distribution ($p<0.01$). Trained riders tended to be younger, regardless of subsequent licensure. Trained and unlicensed riders had the highest percentage of helmet use (97%). Untrained but licensed riders had the lowest helmet usage (77%). Approximately 29% of trained and unlicensed riders involved in crashes experienced a crash prior to their reported training, in comparison to 22% of trained and licensed riders. The trained and licensed group had the lowest incidence of impaired driving crashes, while the trained and unlicensed group had the highest incidence. The distribution of crash severity varied among the groups with a higher proportion of unlicensed rider crashes resulting in fatalities.

When citation data in passenger motor vehicles and on motorcycles were compared for trained and untrained riders, some differences were determined. A higher proportion of trained riders, both licensed and unlicensed, was arrested for driving under the influence of alcohol and/or drugs (DUI). Overall, those who were trained and licensed had the highest proportion of total citations (46%) and speeding citations (22%). When accounting for citations issued while operating motorcycles, the trained groups had the highest occurrence (2.2% among the licensed and 1.9% among the unlicensed). Without exposure data, it is not possible to determine if these are accurate conclusions.

The comparison of the four groups by injury severity and helmet use showed no differences among trained and licensed riders. The untrained and unlicensed group did not yield significant differences in helmet use by crash severity.

An important outcome of this study is that it shows the potential for States to use crash, training, citation, and injury data to evaluate entry-level motorcycle training effectiveness. Most important, it highlights the need to collect and analyze exposure data to provide more robust analysis.

1.0 Introduction

1.1 Overview

Since its establishment in 1970 NHTSA has promoted motorcycle safety through initiatives including data collection and analysis, technical assistance, State highway safety grants, safety standards, and targeted safety programs. NHTSA also has recognized the role of entry-level rider training, combined with knowledge and skill testing, in preparing motorcyclists to ride safely. However, the effectiveness of training as a countermeasure to reduce motorcycle crashes is unclear.

Research on the effect of entry-level motorcycle rider training has not overwhelmingly supported the effectiveness or ineffectiveness of training. Studies varied greatly in the methods used for comparison and the consequences of training investigated (effect of training on crash rates, citation rates, and personal protective equipment usage, etc.). One U.S. study to report positive findings of entry-level training was undertaken by John Billheimer as part of the California Motorcyclist Safety Program.[2] Using matched-pair analysis, Billheimer found trained novice riders with less than 500 miles of riding experience had half as many crashes as their untrained counterparts for a period of 6 months following training. These differences in crash rates disappeared after 6 months following training, and were not evident at all among motorcyclists who had ridden more than 500 miles prior to training.

NHTSA convened a panel of motorcycle experts to determine the feasibility of conducting a study to evaluate the effectiveness of entry-level rider training in reducing motorcycle crashes.[3] The panel recommended NHTSA undertake a study of the relationship between rider training, safe-riding behavior, and rider crashes. As a result of the recommendation, NHTSA contracted with a team led by Cambridge Systematics to study these relationships. This document explores the relationship between rider training and crashes, injuries, and citations using statewide training, license, crash, and citation databases.

1.2 Research Approach

Much of the previous analysis of motorcycle operators (operator and rider are used synonymously in this report) has focused on the frequency and types of crashes in which they were involved, with special attention paid to motorcycle fatalities and the need for universal helmet laws. The relationship between entry-level motorcycle rider training and motorcyclist safety has not been thoroughly explored. This study sought to help fill this gap by exploring the relationship between entry-level motorcyclist training and a variety of safety-related outcomes.

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[2] Billheimer, J. (1998). Evaluation of California motorcyclist safety program. *Transportation Research Record*, *1640*, 100-109.

[3] Brock, J., Robinson, A., Robinson, B., & Percer, J. (2010, March). *Approaches to the assessment of entry-level motorcycle training: An expert panel discussion* (Traffic Safety Facts Research Note. Report No. DOT HS 811 242). National Highway Traffic Safety Administration.

More specifically, the primary research questions for the study were:

1. Do crash characteristics (collision type, contributing factors, etc.) differ between trained and untrained motorcycle riders?
2. Is there a difference in rider behavior contributing factors[4] such as speed, impairment, or aggressive driving between trained and untrained riders?
3. What types of citations are issued to trained and untrained riders while they are operating motorcycles or passenger vehicles?
4. Do crash injury severity and type differ between trained and untrained riders?

To address these research questions an analysis of public records linking motorcyclist training to crash data, citation data, and hospital records was carried out using Maryland's Crash Outcome Data Evaluation System.

The analysis was performed by agreement with the Charles Mathias National Study Center for Trauma and Emergency Medical Systems (NSC) of the University of Maryland School of Medicine, home of Maryland's CODES project, under whose auspices several traffic safety datasets are linked and have been analyzed for research purposes.

One major limitation of the study is the lack of comprehensive, accurate exposure information. Without incorporating the amount of travel (either in miles or minutes as the information was unavailable in the linked databases), it is difficult to associate training with rates of crash occurrence and citation issuance. The trained or licensed groups may be riding more often than the others, thus, increasing their likelihood of experiencing one of the chosen outcomes. Other factors that may influence obtaining exposure information and determining their relationships with training may include riders obtaining motorcycle operator licenses without purchasing motorcycles; the unknowns surrounding the time elapsed between training, motorcycle purchase, and frequency of motorcycle use; skills practice and membership in riding clubs; and actual miles per month and seasonal usage. As a result, the findings in the report are based on data that has not been normalized by exposure.

Another consideration is Maryland does not track motorcycle training taken in another State. For this study, it is assumed riders who were not trained in Maryland are "untrained"; however, it is recognized some study subjects were likely trained in another State.

1.3 Maryland Motorcycle Licensing and Training Procedures

The Maryland Motor Vehicle Administration (MVA) licenses vehicle operators, titles, and registers vehicles, and publicizes and enforces regulations pertaining to those activities for the State. Among the vehicle operator licenses issued by MVA are the Class M motorcycle operator licenses, and the motorcycle learner permits.

The licensure regulations require skill testing for all Class M applicants, knowledge testing for all motorcycle learners' permits, and safety training for all applicants 15 to 18 years old. Motorcyclists can satisfy these requirements through a conventional licensure process or through training, as described below.

[4] Maryland allows up to four contributing factors on the crash report.

Conventional Motorcycle Licensure

The "conventional" means of acquiring a motorcycle operator's license is a four-step process requiring:

1. Application for motorcycle operator's license and passage of a knowledge test;
2. Acquisition of motorcycle learner permit and holding it for at least 14 days but no longer than 180 days;
3. Passage of a skills test; and
4. Award of the motorcycle operator license.

About 3,000 motorcycle operators apply for licensure through the conventional system each year. On average 2,000 operators do not finish the process.

Motorcycle Safety Training Program

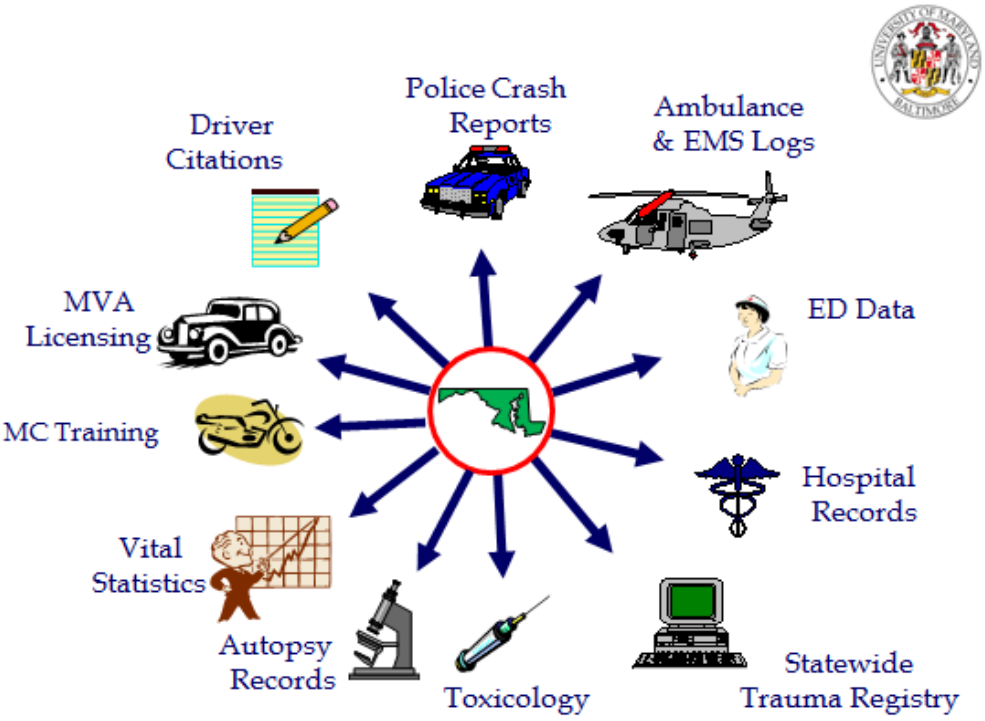
To complement the conventional approach, the MVA's Motorcycle Safety Program incorporated testing into their training program. After the successful completion of Basic Rider Course training, course graduates receive waivers to acquire Class M licenses without the need for further testing. The Motorcycle Safety Training Program has evolved from a centralized, single-source, State-provided training operation to a system where commercial providers and educational institutions such as community colleges deliver training to consumers. The 17-hour course includes classroom and riding instruction for basic street riding with training and practice on clutch-throttle control, stopping, turning, shifting, and basic crash avoidance skills. Each training operation satisfies the MVA's testing requirements pertaining to both knowledge and skills, and furthermore satisfies the MVA's training requirements for applicants under 18 years old. Through this program, training providers function as de facto licensing providers. About 7,000 students acquire training each year in Maryland, and most go on to acquire licenses through this system.

2.0 Data Sources

2.1 Maryland's Crash Outcome Data Evaluation System

Maryland's CODES is a data set established in 1997 and hosted by the NSC. The CODES project provides a broad set of linked data with which to evaluate system and individual performance. This system includes data on rider training history, endorsements, registrations, citations, vehicle usage, crash data, and injury data. The depth of the database presented an opportunity to investigate the relationship between motorcycle training and rider performance.

Figure 1 shows the 11 statewide databases available through CODES. These databases may be used individually and in combination to assist with problem identification and program evaluation efforts for Maryland's highway safety community.



*EMS – Emergency Medical Services, ED – Emergency Department, MC – Motorcycle, MVA – Motor Vehicle Administration
Source:National Study Center.

Figure 1. Available Statewide Databases in Maryland's CODES

The analysis conducted for this project involved linking several of the databases in CODES. All of the data used in the study were made available through CODES project agreements with the data owners. The following datasets were used and are discussed in more detail below.

- Motorcycle training and licensing data provided by MVA
- Police crash reports provided by the Maryland State Police through the Maryland Automated Accident Reporting System (MAARS)
- Emergency department and hospital inpatient records provided by the Health Services Cost Review Commission (HSCRC) through the Hospital Discharge Data Set
- Traffic citation data, provided by the Maryland District Court

Figure 2 illustrates how the data files were linked and what information each linkage provided.

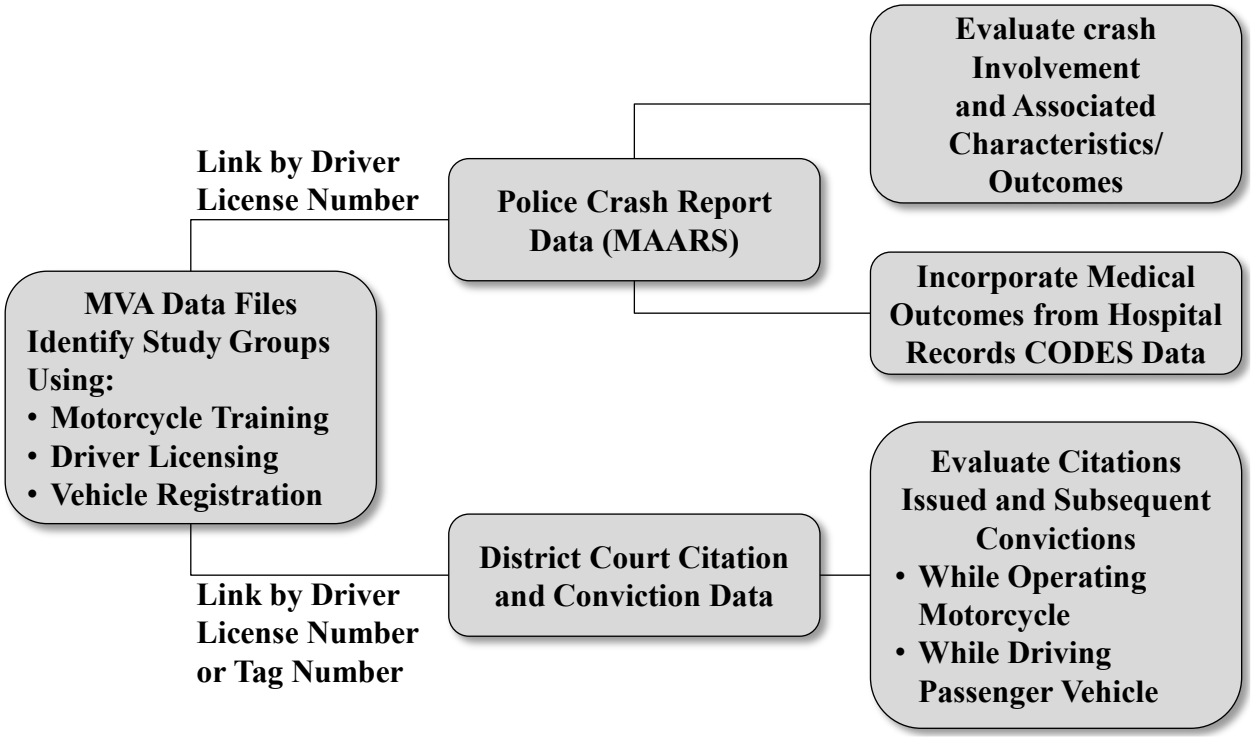


Figure 2. CODES Data Linkages

2.2 Motorcycle Training and Licensing Data

The MVA system is intended to capture and store a record of each acquisition of motorcycle safety training, associated test results, and subsequent license issuance. Furthermore, the system captures and stores all applications for motorcycle learner's permits, Class M licenses, and the knowledge and skill test results associated with those conventional license acquisitions through the MVA driver licensing system. Finally, all applicants obtaining permits and licenses through either the conventional or safety training approach, including those who immigrate with a Class M license, are asked to self-report prior motorcycle safety training by type, location, and training year, and prior riding experience by mileage and months. As noted previously, riders

were classified as "untrained" even if they immigrated with a Class M license as prior training was self-reported and not obtained in Maryland.

The information for everyone achieving motorcycle licensure in Maryland is stored in several tables in the MVA DB2 Production Database. The subject tables are never purged and the records never altered except to correct errors. The data in these tables will be maintained perpetually and synchronized with the other records of the MVA to preserve linkages with other MVA data.

Untrained Riders

For riders obtaining motorcycle licenses without taking MVA training, the following events are captured and stored.

- A person's application for a motorcycle learner's permit by date (one record for each application), along with self-reported prior training by type, State, and year; and self-reported riding experience by mileage/months.
- The result of a person's knowledge test (pass/fail, one record per attempt).
- The award of a motorcycle learner's permit.
- The result of the person's skill test (pass/fail, one record per attempt).
- The award of a Class M operator's license.
- The transfer into Maryland of a valid Class M license from another jurisdiction, along with self-reported prior training by type, State, and year; and self-reported riding experience by mileage/months.

Trained Riders

In connection with the training path to licensure, the following events are captured and stored.

- Registration for a specific course of a specific type on a specific date, along with self-reported prior training by course type, State, and year; and self-reported riding experience by mileage/months and reason for electing to take training (rather than gaining a Class M license by conventional licensing).
- Whether the student canceled course registration, failed to show up for class, dropped out, or completed the class.
- The student's numerical written and skill test scores including any retests in the event of test failure.
- If the student acquired a Class M license by automated means at course completion (motorcycle learner permit automatically transferred to Class M license at completion of training and test).
- If the student was not a Maryland-licensed driver, the student's full name, address, gender, date of birth, and out-of-State license number.

2.3 Police Crash Reports

The MAARS database consists of all police-reported motor vehicle traffic crashes on Maryland roadways; involve at least one motor vehicle in transport; and that result in tow-away, injury, fatality, or hit-and-run. All Maryland police jurisdictions participate with 100% compliance and all use the same crash reporting form. These forms are submitted to the Maryland State Police and the data are computerized. This information is then turned over to the State Highway Administration, which performs edits and consistency checks, further improving the quality of the data.

Crash Histories

The following crash data was compiled for trained and untrained riders.

- Total crashes
- Dates of crashes
- Injury crashes (all injury categories)
- Impaired-driving crashes
- Speed-involved crashes
- Aggressive driving crashes
- Crashes prior to training
- Crash type (single-vehicle versus multiple-vehicle)
- Collision type (head-on, side impact/angle, rear end/other)
- Crash severity (fatal, injury, and property-damage-only)

2.4 Hospital Data

All Maryland acute care hospitals are mandated to report patient discharge data to the HSCRC. There is 100-percent participation among the mandated hospitals. The HSCRC database is entirely automated once medical records personnel extract patient charts at the time of discharge. Mandatory E-coding in the HSCRC database allows for easy identification of a large portion of admissions resulting from motor vehicle crashes and more specifically motorcycle crashes.

The following hospital data were linked to motorcycle crashes.

- Injury diagnoses (up to 15 can be recorded)
- Injury severity score calculated based on data collected during the linkage process
- Injury score by body region (head, face, neck, spine, etc.)

2.5 Traffic Citation Data

All motor vehicle citations issued to drivers in Maryland are submitted to the district court system for processing. This database includes information on the violation and subsequent outcome of each citation issued.

Citation Histories

The following citation data was compiled for trained and untrained riders.

- Total citations (motor vehicle and motorcycle)
- Dates of citations
- Citations on motorcycle
- Citations prior to training
- Speeding citations
- DUI citations
- Aggressive driving citations

3.0 Data Analysis

3.1 Data Integration

Detailed training data from 2009 to 2011 were provided by the MVA. The riders included in this dataset were linked to the other data elements for data available at the time of the completion of this report. The information was collected as part of the Promising Practices effort at the MVA, which enhanced the databases to include more information related to rider training, testing, and motorcycle licensure. Figure 3 details the number of records/persons included in the Promising Practices database from 2009 to 2011 and how each person was categorized for this analysis. For this report, the term "license" refers to a motorcycle license, however, the person may also possess a license to drive motor vehicles, buses, commercial vehicles, etc.

Study Population

As shown in Figure 3, the final study population consisted of 31,714 people. The study population was identified using the 2011 MVA training database to identify riders trained from 2009 to 2011 and riders who received certificates for training courses taken in other States. Both groups were matched to the MVA licensing database to identify riders that received a Class M license to operate a motorcycle. Before final data cleaning, the four groups consisted of 18,728 people who were trained and licensed in Maryland, 907 who were trained and not licensed in Maryland; 11,346 who were licensed but not trained in Maryland; and 733 who were not trained and not licensed in Maryland. The trained and not licensed group had the codes assigned that indicate certificates were issued (SL4000, SL5000), but did not have motorcycle licenses. This could be due to data capture errors or the people not seeking the final motorcycle license after passing the examinations. Duplicate records may have existed because someone registered more than once, or older records were not purged from the file correctly; these duplicate records were removed based on driver license number.

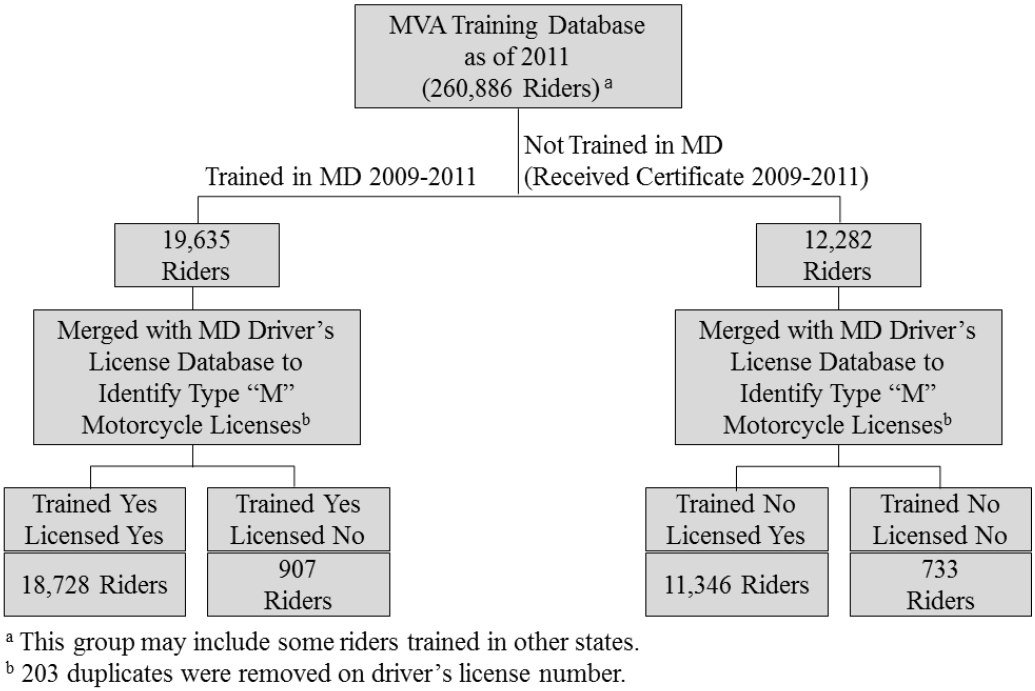


Figure 3. Inclusion and Categorization of the Study Population

Table 1 shows the age and gender characteristics of the study population by training and licensing status. About 59% (18,728) of the study population were trained and licensed; 3% (907) were trained but had not obtained motorcycle licenses; 36% (11,346) were licensed but had no training record in Maryland; and 2% (733) were not trained or licensed. The majority of trained and licensed riders and trained and not licensed riders were 20 to 29 years old. The largest age group of untrained and licensed riders were 40 to 49. Male riders made up the majority of all four training and licensing status groups, though the trained groups contained a larger percentage of women than the untrained groups.

Table 1. Characteristics of the Rider Study Population Percentage

	Trained YES Licensed YES	Trained YES Licensed NO	Trained NO[a] Licensed YES	Trained NO[a] Licensed NO
	N=18,728	N=907	N=11,346	N=733
Age				
<20	5.9	5.3	0.2	0.4
20-29	35.7	45.1	20.5	23.5
30-39	22.4	21.0	27.2	26.5
40-49	21.5	14.1	27.8	25.0
50-59	11.6	7.0	18.4	16.0
60+	2.9	2.3	6.0	6.4
Unknown	0.0	5.3	0.0	2.3
Gender				
Male	77.6	71.6	86.4	84.0
Female	22.4	22.7	13.6	13.6
Unknown	0.0	5.7	0.0	2.3

[a] This group may include some riders trained in other States.

Study Population and Crash Database Linkage

Figure 4 shows the sequential process for integrating the study population from Figure 3 and the MAARS statewide crash report database.

The information contained in Figure 4 relates each step of the process undertaken to quantify motorcycle crash involvement of the study population during the study period. The study group consists of people trained and/or licensed from 2009 to 2011. Crash data records were linked to include any crashes riders in the study population were involved in from 2009 to 2012. Only a crash where the person was riding on a motorcycle as an operator or passenger was included; those crashes where people were riding in motor vehicles were excluded due to the focus of this study. A total of 824 riders in the study population were involved in crashes from 2009 to 2012, with 134 in 2009, 204 in 2010, then 288 in 2011, and 225 in 2012. The number or linked events is significantly lower than the number of crashes in the study population as the events represent rider crash cases with complete data. Of those 824 riders, 27 were each involved in two crashes during that time for a total of 851 crash events. It is possible some riders were involved in motorcycle crashes before being trained as crashes may have occurred before the study period of interest. These crashes are included in the analysis if they occurred from 2009 and 2012 in Maryland. (Of note is the magnitude of crashes among the study population with more than 8,000 crashes over the 4 years.)

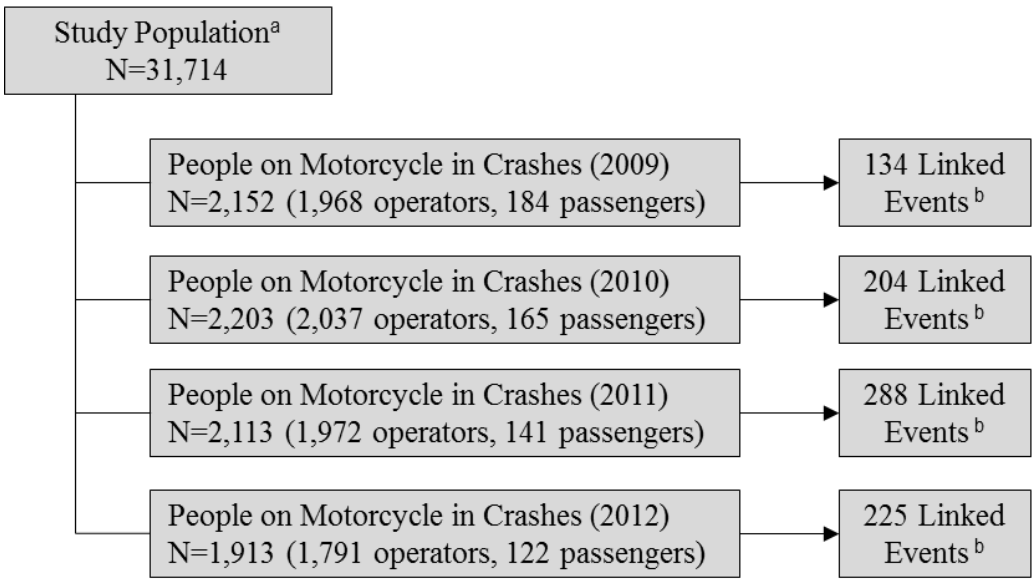
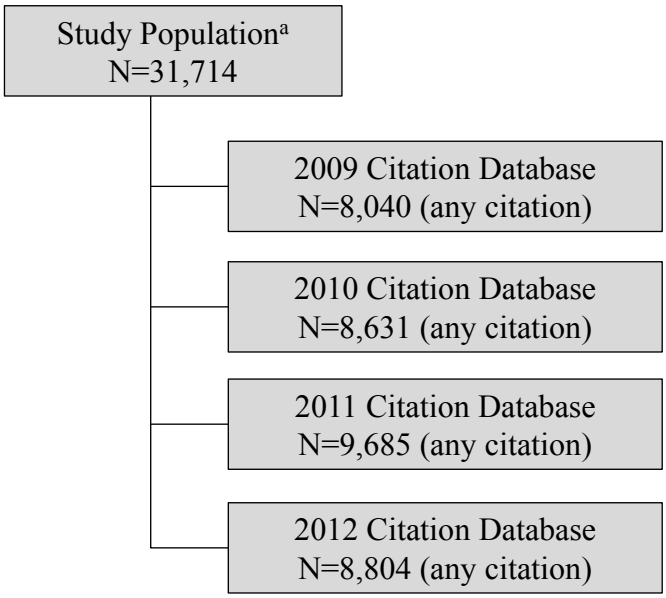


Figure 4. Study Population and Crash Database Linkage

Study Population and Citation Database Linkage

Figure 5 shows the sequential process for integrating the study population from Figure 3 and the statewide citation database, provided by Maryland District Court. The citation database includes all violations of the Maryland Transportation Article issued on Maryland roads, which include moving and administrative (suspended license, etc.) citations.



a Study Population = trained in MD + not trained in MD – duplicates.

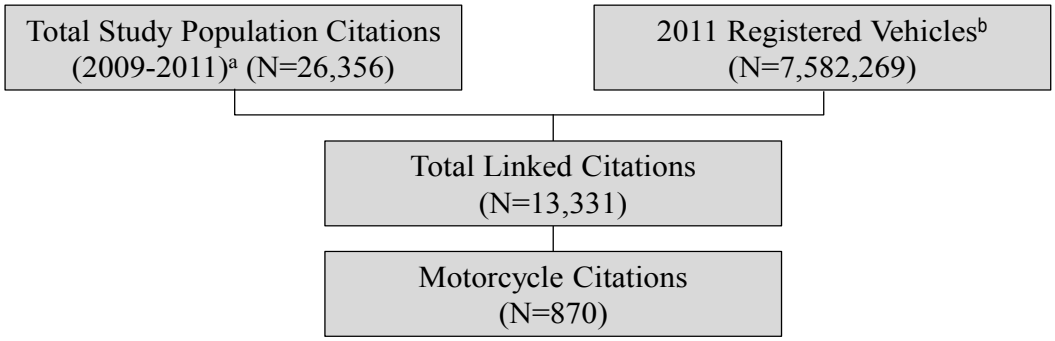
Figure 5. Study Population and Citation Database Linkage

All citations were included in this integration process, including those received by people while operating vehicles other than motorcycles. There were a total of 35,160 citations issued to 11,906 people from 2009 to 2012.

Study Population and Motorcycle Citation Linkage

Figure 6 shows the process for integrating the study population who received some type of citation (Figure 5) with a vehicle registration file. This narrowed the citations to those issued while the subjects were operating motorcycles. Vehicle body type is not captured on the citation report, so a link to the registration file (using license plate data) was necessary for this stage. The citations issued in 2012 were not included in this part of the analysis because the updated linkage to the vehicle registration file was not available at the time of this study.

The linkage shown in Figure 6 produced 870 motorcycle-specific citations for the study population from 2009 to 2011. Approximately 50% of the citations were linked to a vehicle registration file. This could be due to several reasons, including poor data accuracy in the citation file (the vehicle license tag number was not captured correctly), or the citation was issued while the person was operating a motorcycle registered in a State other than Maryland. Although the final dataset is small, with only 870 citations issued when the subjects were operating motorcycles, it did produce an additional data source for analysis.



[a] The citations issued in 2012 have not been included in this part of the analysis because the updated linkage to the vehicle registration file was not complete.

[b] The registration files are historical so any motorcycle registered in the state of Maryland, even if it was currently unregistered, was included.

Figure 6. Identifying Motorcycle Citations Among Study Population

3.2 Crash Characteristics by Training/License Group

One objective of this study was to explore if crash characteristics for trained and untrained motorcycle operators differ. To explore this question, the MVA training file was linked to the crash databases through the use of the driver license (Soundex) number to identify crashes from 2009 to 2012 involving motorcyclists. Based on the linked cases of riders involved in crashes from 2009 to 2012, only 4 riders were classified as untrained and unlicensed. This group was excluded from this crash analysis due to the small sample size. All results discussed here reflect only the other three study groups (trained and licensed, trained and unlicensed, not trained and licensed).

Table 2 contains crash characteristics for motorcycle operators, stratified by their training and licensure status (if they were trained by the Maryland Motorcycle Safety Program from 2009 to 2011). This report will discuss "trained" and "untrained" riders; again, those "untrained" riders may have received safety training outside of Maryland, but any information on their training status is not available for this analysis. Note the p-value listed in the table; a $p < 0.05$ signifies a significant association between training and the variable of interest using a chi-square test for association.

Table 2. Crash Characteristics for Operators Trained in Maryland, 2009 to 2012 Percentage

	Trained YES Licensed YES	Trained YES Licensed NO	Trained NO[a] Licensed YES	
	N=698	N=35	N=114	p-value*
Crash Information – 847 Crash Events				
Age				
<20	8.4	5.7	2.6	
20-29	43.8	62.9	30.7	
30-39	19.6	17.1	21.9	
40-49	17.8	8.6	29.0	
50-59	7.7	5.7	14.9	
60+	2.6	0.0	0.9	<0.01
Gender				
Male	90.1	94.3	94.7	
Female	9.7	5.7	5.3	*ns*
Crash Type				
Single-Vehicle	50.7	45.7	42.1	
Multi-Vehicle	49.3	54.3	57.9	*ns*
Collision Type				
Head-On	8.9	14.3	8.8	
Side Impact/Angle	21.6	25.7	23.7	
Rear-End/Other	18.8	14.3	25.4	
Single-Vehicle	50.7	45.7	42.1	*ns*
Helmet Use				
Yes	83.8	97.1	77.2	
No	16.2	2.9	22.8	0.04
Crash Prior to Training (2009-2011)				
Yes	22.4	28.6	–	
No	77.6	71.4	–	<0.01
Speed-Involved Crash				
Yes	23.6	40.0	20.0	
No	76.4	60.0	79.8	*ns*
Impaired Crash				
Yes	3.9	17.1	6.1	
No	96.1	82.9	93.9	<0.01
Aggressive Driving Crash				
Yes	34.5	48.6	32.5	
No	65.5	51.4	67.5	*ns*
Crash Severity				
No Injuries	14.8	5.7	15.8	
Injuries	84.5	51.4	81.6	
Fatalities	0.7	42.9	2.6	<0.01

[a] This group may include some riders trained in other States.

*$p < 0.05$ signifies a significant association between training and the variable of interest using a chi-square test for association.

ns = not significant

Note: Speed, impaired-, and aggressive-driving crashes were identified using the crash characteristics relating to the study subjects (not those of other motor vehicle operators involved in the crashes).

Age and Gender

Of the motorcyclists trained and/or licensed in Maryland from 2009 to 2011 and involved in crashes while riding motorcycles during those years, there was a significant difference in the age distribution ($p<0.01$). Trained riders tended to be younger regardless of subsequent licensure. Although not statistically significant regarding training, many more males were represented in all groups of this study population.

Crash and Collision Type

There were no significant differences in the three groups when compared by crash type (single versus multiple vehicles) or collision type -- head-on (77 riders), side impact/angle (187 riders), rear-end/other (165 riders), etc. While 418 riders were involved in single-vehicle crashes, more trained and licensed riders were involved in single-vehicle crashes as compared to untrained and licensed riders (51% versus 42%). When comparing all crash types, trends are similar across all three groups. One exception, although not statistically significant, is that a higher percentage of trained and unlicensed riders were involved in head-on collisions ($p = 0.28$).

Helmet Use

Overall, reported helmet use in crashes was high, although it was only 84% among the trained and licensed operators. Trained and unlicensed riders had the highest percentage of helmet use (97%). Untrained, but licensed riders had the lowest helmet usage at only 77%.

Crash History Prior to Training

Crash history varied statistically across the groups. Approximately 29% of trained and unlicensed riders involved in crashes experienced a crash prior to their reported training compared to 22% of trained and licensed riders.

Crash Factors

When analyzing crash factors, fewer licensed riders were involved in speeding-related crashes. This pattern was evident among the trained and untrained riders; only the unlicensed had a higher frequency of speeding crashes (40%). Note the unlicensed group only contained 35 people.

Significant differences in incidences of impaired riding crashes were noticed. The trained and licensed group had the lowest incidence of impaired riding crashes, but the trained and not licensed group had the highest incidence of impaired riding crashes, higher than the untrained and licensed group.

There was no significant difference in aggressive driving crashes between the three groups.

Finally, the distribution of crash severity varied among the groups, with a higher proportion of unlicensed driver crashes resulting in fatalities. As noted previously, this group only contained 35 people.

Additional Analyses

Additional tests were performed to identify any differences in crash occurrence based on training and license status, age, and gender. The analyses estimated a series of binary logistic regression models that regressed occurrence of crashes over a set of independent variables: training and licensing status of the rider (trained and licensed in Maryland [TL]; trained but not licensed in Maryland [TNL]; untrained in Maryland and licensed in Maryland [UL]); age group (younger than 30, 30 to 49, 50 and older); and gender (male, female). Four models were estimated where the following crash scenarios were tested: all crashes, crashes in which speeding was reported as a contributing factor, crashes in which aggressive riding was reported as a contributing factor, and crashes in which impairment was reported as a contributing factor.

All models used female TL riders who were 50 years or older as the base. All models were statistically significant at the 99% confidence level, and none of the interaction terms with rider status was found as significant. The parameter estimates were evaluated at the 95% confidence level.

The logistic regression model estimation provided a counterintuitive finding that untrained riders generally had less severe crash histories than trained riders. The riders who were not licensed had higher rates of involvement in speeding-related and impaired-riding crashes. All demographic variables showed effects as expected.

Due to unavailability of exposure data, a statistical control could not be imposed on the effect of miles ridden. In the absence of reliable exposure data, the logistic regression model results should be considered as inconclusive. Moreover, since reliable information on the date of acquiring licenses were not available, a hazard duration model could not be estimated, which could help analyze the elapsed time to the first crash by different rider groups.

3.3 Citation Characteristics by Training/License Group

One objective of this study was to determine what types of citations are issued to trained and untrained riders while they are operating motorcycles or passenger vehicles. The study population and citation databases from 2009 to 2011 were linked using driver license numbers. This analysis included all four study groups and examined citations issued while the people operated any type of motor vehicles and the occurrence of citations while operating motorcycles. It should be noted citation for more than one violation may be issued at each traffic stop, and some people did not receive any citations during the study period.

Table 3 contains citation information for the study population, stratified by their training and licensure status (if they were trained by the Maryland Motorcycle Safety Program in 2009 to 2011).

Table 3. Citation Characteristics for Motorcycle Operators in Maryland, 2009 to 2011
Percentage

	Trained YES Licensed YES	Trained YES Licensed NO	Trained NO[a] Licensed YES	Trained NO[a] Licensed NO	
	N=18,728	N=907	N=11,346	N=733	p-value*
Citation Information – 10,146 riders received citations					
Citation in Any Vehicle (Including Motorcycles)					
Total Citations	46.2	42.6	24.3	13.6	<0.01
Speeding Citations	29.8	24.6	11.8	6.3	<0.01
Driving Under the Influence	2.8	3.5	1.3	0.6	<0.01
Aggressive Driving	0.3	0.6	0.0	0.0	<0.01
Other	32.3	33.2	17.5	9.1	<0.01
Citation Prior to Training (2009-2011)					
Yes	27.5	27.7	–	–	
No	72.5	72.3	–	–	ns
Citation on Motorcycle (2009-2011) N = 870 linked citations					
Yes	2.2	1.9	0.6	0.3	
No	97.8	98.1	99.4	99.7	<0.01

[a] This group may include some riders trained in other States.

*$p < 0.05$ signifies a significant association between training and the variable of interest using a chi-square test for association.

ns = not significant

A higher proportion of trained riders, both licensed and unlicensed, were arrested for DUI (driving under the influence of alcohol and/or drugs). Those arrests may have occurred in any driving situation, whether on a motorcycle or in another type of vehicle. Overall, those who were trained and licensed had the highest proportion of total citations (46%) and speeding citations (30%). Also, those trained and unlicensed had the highest proportions (although only slightly higher than the other groups) of impaired (3.5%), aggressive (0.6%), and other types of citations (33.2%).

When accounting for citations issued while operating a motorcycle from 2009 to 2011, the trained groups had the highest occurrence, with 2.2% among the licensed, and 1.9% among the unlicensed groups. Without exposure data, it is not possible to determine if this is an accurate conclusion, or if the trained riders simply logged more miles and therefore were likely to receive more citations.

Again, one major limitation of this study is the lack of comprehensive, accurate exposure information. Without incorporating the amount of travel (either in miles or minutes), it is

difficult to associate training or licensure with rates of crash occurrence or citation issuance. The trained or licensed groups may have been riding more often than the others, thus, increasing their likelihood of experiencing a crash or receiving one or more citations.

3.4 Injury Severity of Motorcycle Operators Involved in Crashes, 2009 to 2012

To further understand the severity and outcomes of motorcycle crashes, one objective of this study was to determine the level of severity of crashes involving trained and untrained riders. Table 4 contains information about motorcyclists involved in crashes from 2009 to 2012. Of those 851 riders, 687 (81%) were reported to be injured in the crashes, and an additional 25 were killed.

The comparison of the four groups by injury severity and helmet use showed no difference among trained and licensed riders. Over 75% of the "not injured" group (n=117) were wearing helmets, compared to 85% of the "injured" group (n=576). Five of the 698 trained and licensed riders were killed in the crashes, and all were wearing helmets.

Table 4. Motorcyclist-Involved Crashes by Training and Licensure Status, Year, and Helmet Usage Percentage

	Trained and Licensed (n=698)	Trained and Not Licensed (n=35)	Not Trained[a] and Licensed (n=114)	Not Trained[a] and Not Licensed (n=4)
Crash Year				
2009	15.2	25.7	15.8	25.0
2010	23.6	34.3	21.9	50.0
2011	34.4	34.3	31.6	0.0
2012	26.8	5.7	30.7	25.0
Helmet Used				
Yes	83.8	97.1	77.2	75.0
No	16.2	2.9	22.8	25.0

[a] This group may include some riders trained in other States.

Table 5. Injury Severity of Motorcycle Operators Involved in Crashes by Training and Licensure Status and Helmet Usage, 2009 to 2012
Percentage

	Not Injured	Injured	Killed	p-value
Injury Severity	(n=139)	(n=687)	(n=25)	
Helmet Used				
Yes	77.0	84.3	96.0	
No	23.0	15.7	4.0	0.05
Among Trained and Licensed (n=698)	n=117	n=576	n=5	
Helmet Used				
Yes	76.9	85.1	100.0	
No	23.1	15.0	0.0	ns
Among Trained and NOT Licensed (n=35)	n=2	n=18	n=15	
Helmet Used				
Yes	50.0	100.0	100.0	
No	50.0	0.0	0.0	<0.01
Among Not Trained[a] and Licensed (n=114)	n=20	n=92	n=2	
Helmet Used				
Yes	80.0	76.1	100.0	
No	20.0	23.9	0.0	<0.01

[a] This group may include some riders trained in other States.

*p < 0.05 signifies a significant association between training/licensing and the variable of interest using a chi-square test for association.

ns = not significant

Significant differences (p-value <0.01) were identified in the trained and not licensed group (n=35). While this group was much smaller than the trained and licensed group (n=698), the differences were similar. Initial inspection might suggest helmets are associated with greater likelihood of injury/death, but helmet usage for this group was 97%, so no definitive conclusion can be made without controlling for other variables such as impairment or speed.

The untrained and licensed group did not yield significant differences in injury severity by helmet use. The limitations in the dataset may be the root of this. A number of riders in the group may have received training in States other than Maryland.

4.0 Conclusions

Most past evaluations of training effectiveness have attempted to answer the question, "What is the effect of training on motorcycle crashes and injuries?" Comprehensive approaches to answering this question depend on access to public records of crashes and injuries, as well as training activities and riding histories. The willingness of States to cooperate in providing this information is a key concern in any study of training effectiveness.

States vary in their willingness and ability to access data on motorcycle usage, training, and crashes. However, the MVA has developed and deployed a database noteworthy in the breadth of motorcycle safety information available, and in its ability to link information with crash and other data. This system includes rider training history, endorsements, registrations, citations, vehicle usage, exposure (more recently added), and crash and injury data. The depth of this database presented an opportunity for investigating the relationship between motorcycle training and rider performance. Specifically, the current study explored the relationship between entry-level motorcyclist training and safety-related outcomes including crash characteristics and rider behavior, types of citations issued, and crash injury outcomes.

While the Maryland CODES database provides a wealth of data and opportunities to link data, data limitations should be noted. One major limitation of this study is the lack of comprehensive, accurate exposure information. A second limitation of the data is the untrained groups likely include some riders trained in States other than Maryland, or trained in Maryland before training records were kept. For this reason, some results may be skewed by the "trained outside of Maryland" or "trained before records were established" riders. A third data limitation involves the helmet data available in the MVA database. Helmet information is limited to two categories on the crash reports – helmet or not helmeted. No information about helmet type or compliance with Federal Motor Vehicle Safety Standards is available.

4.1 Differences Between Trained and Untrained Groups

The following sections summarize the identified differences in the trained and untrained groups analyzed for this study. (As noted previously, the untrained riders group may include some riders trained in other States.)

Crashes

- There was a significant difference in the age distribution ($p<0.01$). Trained riders tended to be younger, regardless of subsequent licensure.
- Trained and unlicensed riders had the highest percentage of helmet use (97%). Un-trained, but licensed riders had the lowest helmet usage at only 77%.
- Approximately 29% of trained riders and unlicensed riders involved in crashes experienced a crash prior to their reported training, in comparison to 22% of trained and licensed riders.

- The trained and licensed group had the lowest proportion of impaired driving crashes, but the trained and not licensed group had the highest (higher than the untrained and licensed group).
- The distribution of crash severity varied among the groups, with a higher proportion of unlicensed driver crashes resulting in fatalities.

Citations

- A higher proportion of trained riders, both licensed and unlicensed, were arrested for DUI (driving in any type of vehicle under the influence of alcohol and/or drugs).
- Overall, trained and licensed riders had the highest proportion of total citations (46%) and speeding citations (30%) while driving any vehicle.
- Trained and unlicensed riders had the highest proportions (although only slightly higher than the other groups) of impaired (4%), aggressive (1%), and other types of citations (33%) while driving any vehicles.
- When accounting for citations issued while operating motorcycles from 2009 to 2011, the trained groups had the highest occurrence (2.2% among the licensed and 1.9% among the unlicensed).

Injury Severity

- The comparison of the four groups by injury severity and helmet use shows no significant difference among trained and licensed riders. Seventy-seven percent of the "not injured" group (n=117) were wearing a helmet. The "injured" group (n=576) was the largest and showed 85% of riders were wearing a helmet. Five of the 698 trained and licensed riders were killed in the crashes, and each were wearing a helmet.
- The trained and licensed group did not yield significant differences in helmet use by severity. The limitations in the dataset may explain this.

4.2 Feasibility of Future Analyses

An important outcome of this study is that it shows the potential for States to use crash, training, citation, and injury data to evaluate entry-level motorcycle training effectiveness. It emphasizes the need to collect and analyze exposure data to provide more robust analysis. As States improve data collection, quality, and linkage methods, there will be greater opportunities to evaluate the effectiveness of various countermeasures and strategies to improve motorcycle safety.

This study highlights the need for data to include exposure data and linkages to injury, citation, training, and crash data. While this study explored the relationships between entry-level training and licensing, without such linked exposure data, the effectiveness of motorcycle training as a countermeasure to reduce motorcycle crashes will continue to be unclear. After a linkable training database is developed, there will be a period of time before crash, citation, and injury data can be analyzed. Unless a training database is retroactively populated, data subsets linked to crash, citation, and injury data will be small. States that train a large number of entry-level riders annually will be able to more quickly build an adequate dataset, which provides sufficient quantities to conduct meaningful analysis.

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