NJDOT Bureau of Research
QUARTERLY PROGRESS REPORT

Project Title:	Motorcycle Crash Analysis
RFP NUMBER: 2008-17	**NJDOT RESEARCH PROJECT MANAGER**: Edward S. Kondrath
TASK ORDER NUMBER: 12	**PRINCIPAL INVESTIGATOR:** Yusuf Mehta, Ph.D, P.E. Rowan University
Project Starting Date: 1/1/2008 **Original Project Ending Date**: 06/30/2009	**Period Starting Date**: Oct 1, 2008 **Period Ending Date**: Dec 31, 2008

Task	% of Total	% of Task this quarter	% of Task to date	% of Total Complete
1. Literature Survey	10	50	100	10
2. Survey of Best National and International Practices	10	100	100	10
3. Analysis of New Jersey Motorcycle Accident Rates	15	60	100	15
4. Needs for Enhancements to Motorcycle Training and Licensing	30	55	100	30
5. Motorcycle Compatibility with the Highway and the Roadside	15	20	3	3
6. Develop Strategic Plan and Recommendations for Improving Motorcycle Safety	10	0	0	0
7. Final Report	10	0	0	
TOTAL	100			68

ANALYSIS OF FATAL ACCIDENTS

December October 2008

Project Objectives:

The goal of this project is to develop a strategic plan for the reduction of New Jersey motorcycle accident rates in both fatal and non-fatal crashes. The specific objectives are to:

1) Determine the root causes for New Jersey both fatal and non-fatal motorcycle crashes.

2) Develop specific recommendations for reducing the NJ motorcycle rates which incorporate the unique nature of the New Jersey highway system.

1. Progress this quarter by task:

1) The research team has completed a draft white paper on our analysis of the Survey and the data from NJCRASH. A copy of the development and the results of the survey "Implementation of a State Wide Survey to Evaluate the Testing and Training Processes in the State of New Jersey" and the white paper on progress to-date and the powerpoint slides are attached for the Project Panel review and comment.
2) The research team has also conducted an extensive synthesis on the training and Licensing. The paper titled "Effectiveness of the Motorcycle testing and Licensing" and the powerpoint slides are attached.

2. Proposed activities for next quarter by task

- Collect police reports of Motorcycle Crashes
- Conduct field investigation of crash sites.
- Develop Strategic Plan and Recommendations for Improving Motorcycle Safety

3. List of deliverables provided in this quarter by task

- Paper titled: "Implementation of a State Wide Survey to Evaluate the Testing and Training Processes in the State of New Jersey" (Appendix A).
- Progress report-to-date. New Jersey Motorcycle Fatality Rates (Appendix B)
- Paper titled: ""Effectiveness of the Motorcycle testing and Licensing" (Appendix C).

4. Progress on Implementation and Training Activities

- None Scheduled

5. Problems/Proposed Solutions

- None Scheduled

Total Project Budget	199561.50
Total Project Expenditure to date	135701.82
% of Total Project Budget Expended	68

APPENDIX A

Implementation of a State Wide Survey to Evaluate the Testing and Training Processes in the State of New Jersey

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Number of words: 3,428 Number of tables: # (4 x 250 = 1000) Number of figures: # (5 x 250 = 1200) TOTAL: 3,428+1000+1200= 5,628 (**Max: 7500 words**)

Abstract

The purpose of this report is to present results of the implementation of a state wide survey aimed at understanding various factors that lead to motorcycle related crashes and fatalities, and to assist in the implementation of policy and legislation that will decrease the motorcyclist fatality rates. At a time when other motor vehicle related fatalities are decreasing, motorcycle fatalities are increasing at a rate greater than the growth rate of motorcycle ridership. There is little understanding as to why motorcycle fatality rates continue to rise at a drastic rate. A survey was developed in order to obtain information concerning the factors that lead to motorcyclist crashes and fatalities. The results of this survey data may be used as a basis for changes in state policy and legislation that will decrease the motorcyclist fatality rates.

According to the analyzed data, there are factors of motorcycling that lead to motorcyclist fatalities. The majority of these factors relate to the process of obtaining a motorcycle endorsement. This deals with the current testing and training practices within the state of New Jersey. The aspects of the endorsement process that need to be scrutinized include the lack of motorcycle engine displacement limitations, appropriate testing and training vehicle speeds, and multivehicle interaction. By incorporating these aspects into the current testing and training process, the crash and fatality rates of motorcyclist in New Jersey may be decreased.

Total words: 230
Keywords: motorcycle crash, riders,

Problem Statement

At a time when other motor vehicle related fatalities are decreasing, motorcycle fatalities are increasing at a rate greater than the growth rate of motorcycle ridership. There is little understanding as to why motorcyclist fatality rates continue to rise at a drastic rate. A survey was developed in order to obtain information concerning the factors that lead to motorcyclist crashes and fatalities. Motorcyclists themselves are a very important resource of information concerning factors that affect motorcyclist safety. They have a firsthand account and unique opinion as to what aspects of riding pose the greatest risk. It is critical to reach out to this population to extract data which will help guide researchers.

Ojective

The objective of the paper is to report on the results of a statewide series of surveys, and make suggestions concerning the implementation of policy and legislation that will decrease the motorcyclist fatality rates. The results from the surveys will provide researchers and practitioners with the perspective of the riders concerning various aspects of riding a motorcycle that lead to crashes and fatalities. Through analysis or the survey data it is possible to minimize and eliminate dangerous trends within the motorcycle community. With the knowledge of such trends, government agencies will

be better prepared to adopt policies and legislation based on increasing motorcycle safety.

Project Background

Nationally, as motorcycles become increasingly popular, motorcycle deaths have increased in the U.S. In New Jersey, motorcyclist fatalities have more than doubled since 1991 while overall highway deaths in the state have remained relatively unchanged over the same time period, see **Figure 1** below (NHTSA, 2006).

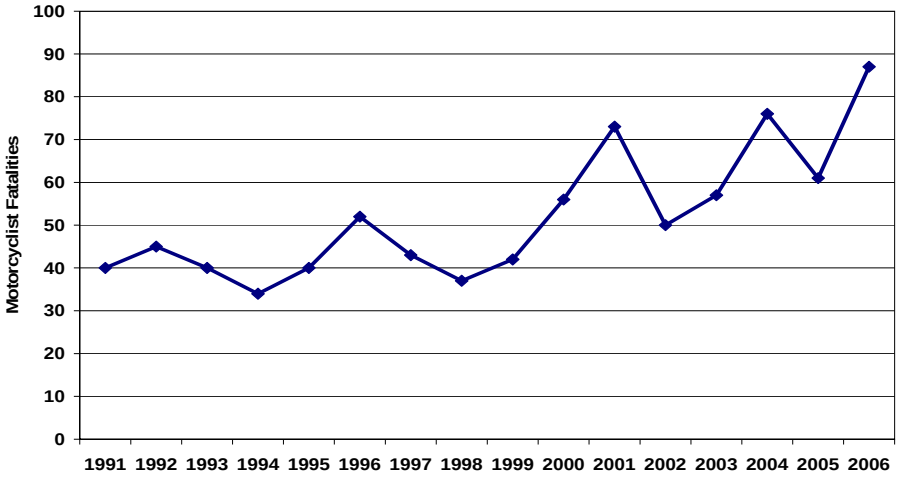

Figure 1. Annual Motorcycle Fatalities in New Jersey (1991-2006)

In the spring of 2008, Rowan University and the New Jersey Motor Vehicle Commission (NJMVC) instituted the New Jersey Motorcycle Fatality Rates project. The main goal of the project is to reduce the motorcycle rider fatality rates within the state of New Jersey. In order to accomplish this goal, the project team utilized multiple resources to determine the factors that led to motorcycle crashes and fatalities. One of the early resources involved in the project was a literature review. A summary of the literature review can be seen in TABLE 1.

The factors found through literature can be categorized into three main categories. These categories include:

- Behaviors and Trends
- Testing and Training
- Roadway Conditions

Furthermore, specific issues derived from the above areas suggested what issues should be analyzed when determining factors that increase risks for motorcyclists. These issues include, but are not limited to:

- Degree of training or experience of the rider
- Comprehensiveness of the licensing process (written test & road test)
- Legal regulations of motorcycles and their riders while traveling on the road
- Conditions of roadway surfaces

- Guardrail design

Another resource used to evaluate these factors includes the riders themselves. Currently there is no standard basis for evaluating the common practices and perceptions of the motorcyclist in the State of New Jersey. As a result the perspective of the motorcyclists is not usually recognized. In order to gather the rider's perspective and views on the aforementioned factors, a series of surveys was developed. With the information gathered from the surveys, a state may be able to take positive action to reduce the crash and fatality rates.

Table 1. Literature Research Summary

Factor Category	Author Year	Summary/Results
Behaviors and Trends	Kim et al. 1999	In the state of Hawaii, alcohol was found to significantly alter the rider's reaction time in response to a stimulus, and accidents involving alcohol occurred on weekends rather than weekdays.
Behaviors and Trends /Testing and Training	Chimba et al. 2005	Motorcycle crashes could be attributed to rider error while traversing curves, intersections, or changing lanes, rider impairment, or risk like behavior.
Roadway Conditions	Gabler 2006	Fatalities in motorcycle-guardrail collisions crashes exceed car-guardrail fatalities. 42% of fatalities in guardrail collisions are suffered by motorcyclists.
Behaviors and Trends	Kim 1999	The type of crash greatly affects the types of injuries incurred on motorcycle riders, such as broadside, head-on, sideswipe, and stationary objects.
Testing and Training	Daniello 2008	Motorcycle training has not been proven either effective or ineffective by past research. Accident and violation rates were not uniquely found to be lower for trained riders, though training tended to increase the use of personal protective equipment.
Safety	Turner et at. 2006	In the state of Texas, riders wore proper helmets for their safety benefits.

Survey Research Approach

The following steps were taken to achieve the above stated objectives:

Task 1: Development of the survey

A survey was developed to focus on 3 specific groups of motorcycle enthusiasts such as general riders, rider course instructors, and motorcycle dealers. The summary below discusses why the survey focuses on these three motorcycle populations.

- Survey for Registered Motorcyclists: This provided an overview of registered motorcyclists in New Jersey on motorcycle rider attitudes, motorcycle safety

perceptions, helmet use, experience, assessment of training opportunities, and suggestions for means to improve motorcycle safety in NJ.

- Survey for Motorcycle Safety Foundation (MSF) Training Rider Coaches (Course Instructors): Training instructors for courses, e.g. presented by the Motorcycle Safety Foundation, have unique insights into novice rider perceptions and attitudes on safety. This task will survey groups of MSF course instructors on motorcycle rider attitudes, suggestions for course improvements, and observations on changing demographics of riders.
- Survey for Motorcycle Dealers: This will survey motorcycle dealerships on novice and experienced riders' awareness of the need for a motorcycle endorsement in New Jersey. As an important stakeholder in the motorcycle safety issue, their responses will provide much insight regarding the perception of need for testing and training both for the dealer and the new rider.

Task 2: Distribution of the survey

The rider survey was distributed using the NJMVC registration renewal process already in place. The survey cards where included in the mailings that the NJMVC sends out to all registered motorcycle owners in The State of New Jersey. The Instructor and Dealer surveys were mailed directly to these individuals. The internet will serve as a primary medium for survey responses.

Task 3: Analysis of survey data

The data from the survey responses was analyzed specific to the perception of the surveyed individuals. The information from the three surveys allows for conclusions and recommendations to be formed. This will allow researchers to determine what potential steps to take to improve the effectiveness of testing and training, ultimately reducing the fatality rates among motorcycle in The State of New Jersey.

Development and Distribution of the Surveys

The surveys developed for this study focus on motorcyclists themselves and others who associate with them on a regular basis. The study developed three different surveys: Survey for Riders, Survey for Dealers, and Survey for Rider Coach/Instructor. The questions for each survey are different, but gather the same type of information.

In order to minimize costs and maximize efficiency, the surveys were designed to be online. These online surveys reduced the amount of paper consumed, and in turn made tabulating results easier. These online surveys, available at http://www.rowan.edu/mvc, were secured for privacy and no personal information is collected with the survey responses. The riders were issued a small card, as seen in **Figure 2** below. This card was distributed along with the motorcycle registration renewal forms from the NJMVC.

Figure 2 – Survey Response Card

The cards themselves had a unique identification code, which prevented multiple responses from one participant. This unique code does not link any personal information. The cards were produced in association with Rowan University's publications department, and the Web Services department produced the online survey. After review by the sponsor of the project, the cards were printed, and mailed. This printing required merging the cards with the unique ids (UID) and was done by Rowan University Duplicating.

The purpose of the UID is also to take the participant to the appropriate survey. using the UID, it was possible to use generic cards with individual codes that start with survey Identifiers. The first character of the Identifier is the survey code (I for instructors, D for dealers, R for riders), the next 2 characters being the state code (ex. NJ), and the remaining 5 digits, are the survey number. As requested by the sponsor, the last 5 digits are random and do not allow for linking to personal data in the mailer. By not linking any personal data, privacy was ensured for the participants.

Using the motorcycle registration renewal mailers sent out by the state to send the survey cards reduced incurred costs for envelopes and postage. Using the online response system also eliminates the need for return postage which would be very costly. If the return postage were required to be paid by the potential respondents, the response rate would be significantly less. Therefore the system devised increases the efficiency and response rate while reducing incurred costs to both researchers and the State of New Jersey.

Survey Results

An overview of the rider, instructor, and dealer survey statistics and demographics can be found on **Tables 2**, **3**, and **4** respectively.

TABLE 2. Rider Survey Statistics

Rider Response Statistics		Value	Percentage of Responses (%)
Approximate Number of Survey Cards Distributed		40,000	N/A
Total Responses		2,816	7.04
Male		2,562	90.98
Female		254	9.02
Age (Years Old):	18-25	37	1.31
	26-29	79	2.81
	30-39	319	11.33
	40-49	786	27.91
	50-59	972	34.52
	60-69	541	19.21
	>70	82	2.91
Risers who have taken an MSF Course		1,256	44.60
Riders who have taken the MVC Written/Road Test		2,234	79.34

TABLE 3. Instructor Survey Statistics

Instructor Response Statistics		Value	Percentage of Responses
Approximate Number of Survey Cards Distributed		200	N/A
Total Responses		71	35.50%
Male		59	83.10%
Female		12	16.90%
Instruction Time:	Less than 2 years	9	12.70%
	2 years to 5 years	24	33.80%
	5 years to 10 years	18	25.40%
	More than 10 years	20	28.17%

TABLE 4. Dealer Survey Statistics

Dealer Response Statistics	Value	Percentage of Responses
Approximate Number of Survey Cards Distributed	200	N/A
Total Responses	18	9.00%
Motorcycle Endorsement NOT Required to Purchase a Motorcycle	15	92.50%
Motorcycle Endorsement NOT Required to Ride a Motorcycle off the Lot	2	11.11%

The overall survey response was approximately 7.19%. This response was higher than expected. According to Tom Wright, typical survey response ranges from 1-2% (Tom Wright, Personal Communication, 2008, Unpublished Data). Although the response was better than a typical survey, it must be noted that the perceptions and trends of the respondents do not necessarily represent the entire population of interest. However, 84.5% of the rider response was from motorcyclists over the age of 40. On average these motorcyclists will have more experience than younger riders. The instructors who responded were also more experienced. The majority of the instructors have been actively instructing for more than five years.

Discussion

Many factors of motorcycle ridership have been explored based on the results from the surveys. Some of these factors lead to motorcycle fatalities. The main factor of concern is the process of obtaining a motorcycle endorsement. The aspects of the endorsement process that need to be scrutinized include the lack of motorcycle engine displacement limitations and appropriate testing and training vehicle speeds.

Motorcycle Engine Displacement

Currently in New Jersey there are two methods to obtain a motorcycle endorsement. The first method involves taking the NJMVC motorcycle test. This is broken into two parts, the written test and road test. The written test is designed to test general knowledge about motorcycles and vehicle safety. The road portion of the test evaluates a rider's ability to operate a motorcycle at low speeds. The second method for obtaining a license is by taking the Motorcycle Safety Foundation basic motorcycle course. This course is designed to give riders the skills necessary to safely operate a motorcycle on the roadways. The state of New Jersey has two locations at which this course is offered for free. There are also private locations where the course is offered, including Community Colleges and dealerships.

From the survey data it has been concluded that the current processes of testing and training are inadequate. Currently there are no restrictions on the size of motorcycle used to perform the testing and training. As a result motorcyclists tend to take the test and/or train on a motorcycle smaller than what they plan to use on the road. This makes the endorsement process easier for the rider, but does not accurately test the rider's ability to operate a larger motorcycle on the road. One rider reported that he purchased a 1500cc cruiser from a dealership. As part of the motorcycle purchase the dealership lent him a 50cc scooter on which he took and passed the road test. This rider's ability to properly operate his motorcycle was not tested. Likewise, the state provided motorcycles for the basic MFS course are typically smaller than 500cc. **Figure** 3 shows the distribution of motorcycle displacement sizes used to obtain a motorcycle endorsement, via testing or training. As part of this analysis, data from the Fatality Accident Reporting System (FARS) was analyzed to confirm the findings. **Figure 3** also shows the distribution of motorcycle displacement for motorcycles involved in fatal accidents.

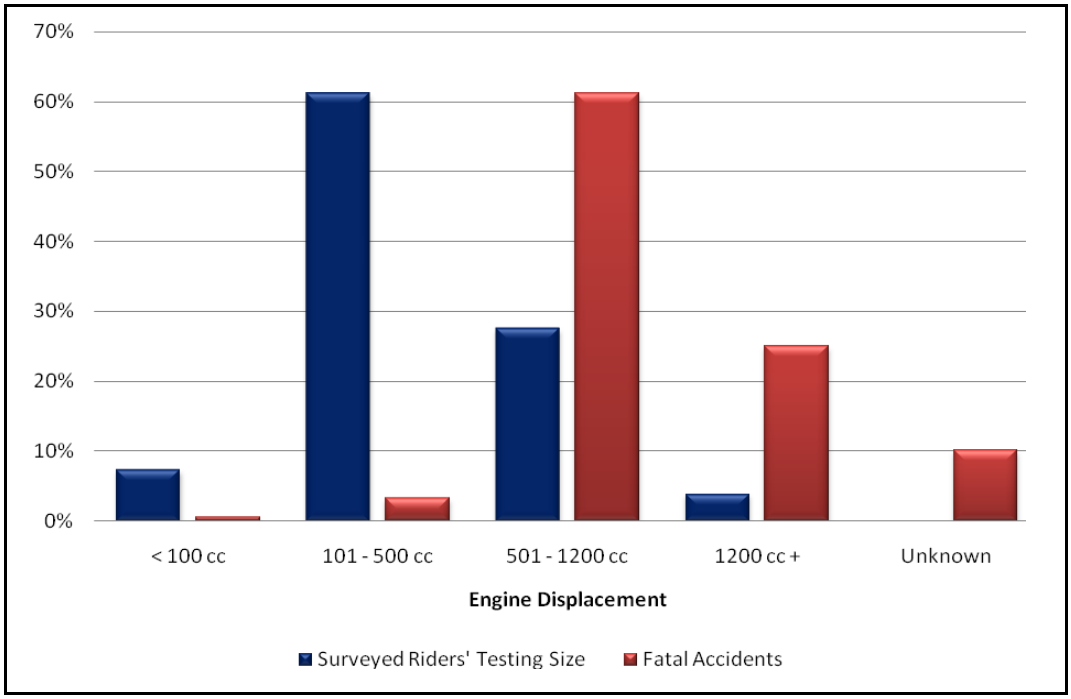

Figure 3. Motorcycle Engine Displacement Distribution for Testing/Training, and Fatalities.

According to the riders surveyed, approximately 70 percent of testing and training occurs on motorcycles with displacement smaller than 500cc. According to the FARS reports (2001-2007), 87 percent of fatalities involved motorcycles over 500cc.

Testing and Training Vehicle Speeds

Another factor that leads to motorcyclist fatalities is the testing and training vehicle speeds. The NJMVC road test and the MFS basic course are both performed in enclosed areas. The test consists of 4 various tasks, all of which are performed while traversing at low speeds. During the test riders are not exposed to higher roadway speeds. During the road test and the basic MFS course riders are not required to exceed 35mph. The testing and training at low speeds accurately test a rider's ability to operate a motorcycle at low speeds, but the rider's higher speed skills remain unevaluated. The NJCrash database was analyzed in order to confirm the importance of testing and training at higher speeds. **Figure 4** shows the results of this analysis.

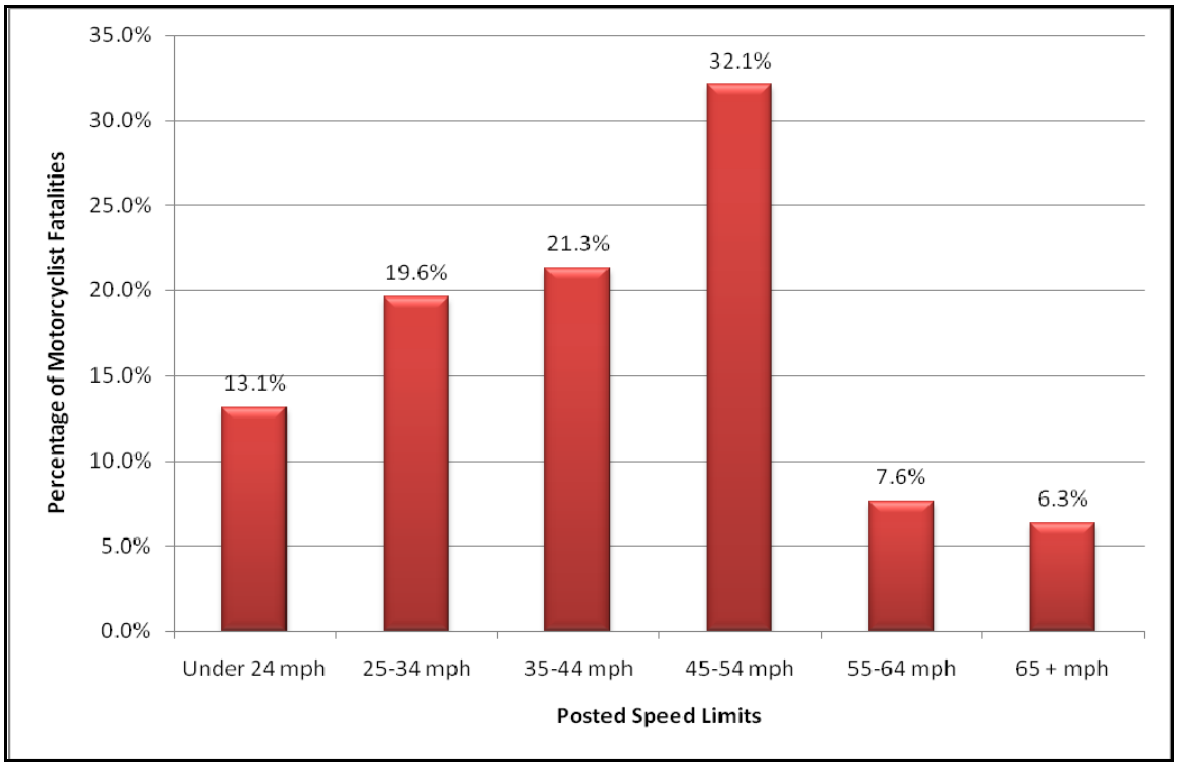

Figure 4. Motorcyclist Fatalities and the Related Posted Speed Limit According to NJCrash Data

The basic rider course and the road test do not require motorcyclists to go above 35mph, yet according to the NJCrash data, 67 percent of fatalities occur at posted speeds greater than 35mph. It is assumed that these fatalities occurred while the vehicle traversing at, or above the posted speed. There are two other factors that may affect the fatality results in relation to speed. First, higher speeds will increase the chance of fatality. Second, the majority of motorcycle travel time may be performed on roads with posted limit of 45-54mph. These factors confirm the importance of testing and training at typical roadway operation speeds.

Conclusion

By using the survey data and varies crash data sources it has been determined that the current process of motorcycle endorsement procurement in the state of New Jersey is inadequate. The NJMVC written/road test and the MFS basic rider course do not adequately test a rider's ability to operate a motorcycle on the roadway. There are methods that may be put into practice in order to better evaluate a rider's competence. These methods focus on the two major aspects of testing and training previously discussed.

Motorcycle Engine Displacement

Tiered or graduated licensing is one way to limit riders from using motorcycles that exceed the rider's skills and abilities. The common method of tiered licensing is common in Europe and other foreign countries and has even been instituted in 10 U.S. states. These licensing systems are based on various rider aspects including age and riding experience. The individuals who are in the restricted category are limited on the type of motorcycle they operate. This motorcycle limitation may be based on weight, power, type, and engine displacement of the motorcycle.

Analysis of crash data shows that tiered licensing in the state of New Jersey should be based on the rider's experience. Riders who are younger than 30 year old are responsible for approximately 40 percent of motorcycle fatalities. This is higher than any other age range; however the majority of the fatalities involve people over 30. **Figure 5** shows the age distribution for various crash data as comprised from the NJCrash database. Because of the distributed age ranges, a tiered licensing system should be based on experience and not age.

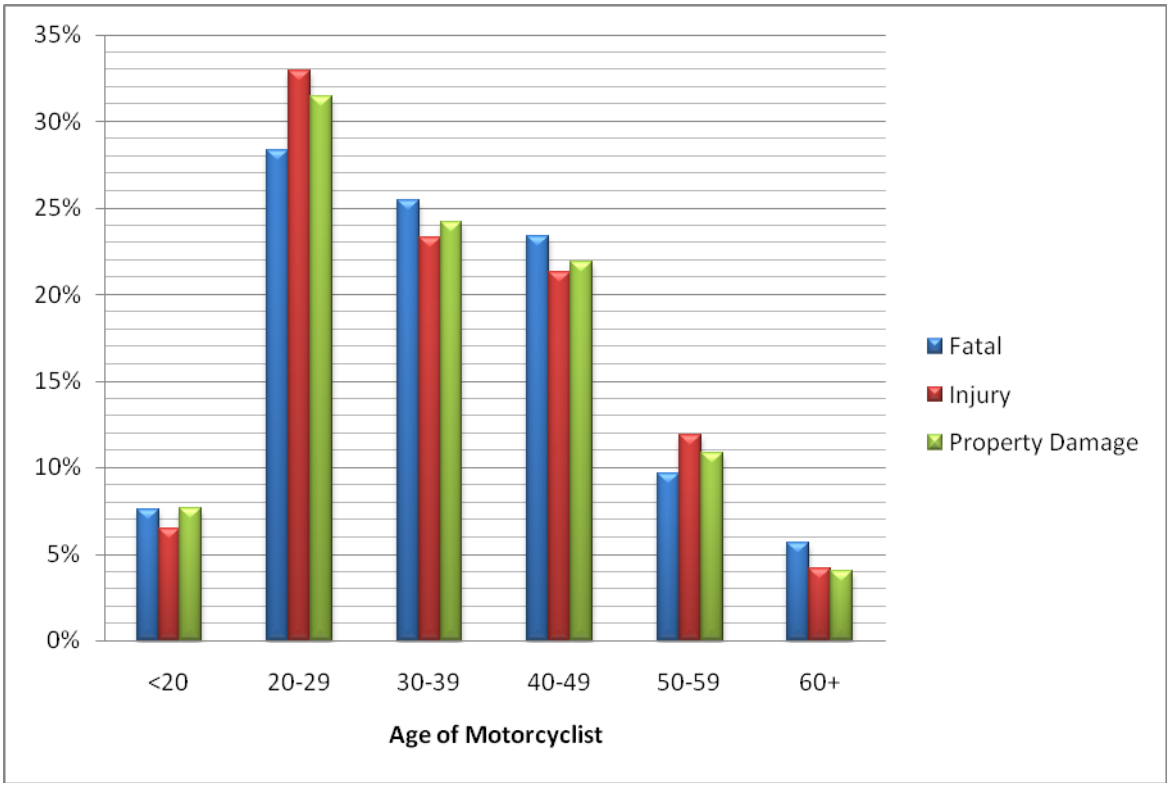

Figure 5. Motorcyle Crash Age Distribution

Another method of tiered licensing is by test staging. This would be based not on age or experience, but the ability a rider has to complete testing procedures. One method of accomplishing test staging is by limiting the motorcycle used by the rider based on the size of motorcycle used to perform the test and or training. For example, performing the test on a 500cc motorcycle would qualify the rider to operate a 500cc and lower motorcycle on the road. Only until the rider completes the test on a larger

motorcycle would he/she qualify to operate a larger motorcycle on the road. This is another way to limit the size of motorcycle based on experience and skill.

Testing and Training Vehicle Speeds

Accurate testing and training environments should mimic actual roadway conditions as best as possible. This includes the requirement to operate the vehicle at a wider range of velocities, in a wider range of situations. Currently the process of obtaining a motorcycle endorsement includes a rider's ability to make turns, weave in and out of cones, and come to a stop, all while traveling at slow velocities (NJDOT Motorcycle Manual), and passing a very basic knowledge test. Also 95 percent of the surveys instructors think the training is less than difficult. In order to better train motorcyclists for roadway operation, the current process of testing and training should be reevaluated and possibly altered. Possible alterations include, on/off ramps, intersections, lane changes, increased accident avoidance, increase speeds and other common rider situations. The testing and training would become more challenging, and as a result will have a higher failing rate. But the test and training process would better evaluate the rider's skills.

By altering the current testing and training procedures through implementation of the previously mentioned suggestions, the fatality rates within the state of New Jersey, and else ware can be decreased.

ACKNOWLEDGEMENTS

This research was funded by the New Jersey Department of Transportation, New Jersey Motor Vehicles Commission, and the Federal Highway Administration. The contents of this report reflect the views of the authors who are responsible for the facts and the accuracy of the data presented herein. The contents do not necessarily reflect the official views of the New Jersey Department of Transportation, New Jersey Motor Vehicles Commission or the Federal Highway Administration. The authors would also like to acknowledge, the Rowan University students MVC Motorcycle Research Team, Brian Donohue, Morgan Harris, Aaliyah McClinton, Nicolas Schaeffer, and Jonathan Wong.

REFERENCES

1. NHTSA, Traffic Safety Facts 2006 (2007)
2. NJDOT Motorcycle Manual, (4-6), http://www.state.nj.us/mvc/pdf/Licenses/mcm996.pdf

Appendix B

New Jersey Motorcycle Fatality Rates

Semester Report FALL .2008

Allison Daniello Aaliyah McClinton Benjamin Powell

Problem Statement

Motorcycle fatal and non-fatal accidents are increasing at an alarming 50% rate within the last ten years in New Jersey. According to the New Jersey Department of Transportation, there have been 1,166 motorcycle accidents in 2007. In 2006, 87 fatalities were the result of motorcycle crashes. The shocking rates are a result of a combination of factors ranging from poor road conditions, alcoholism, lack of protective gear, and lack of motorcycle training.

There was little understanding of why motorcycle rates have risen at a substantial amount. To proceed in trying to reduce motorcycle accidents, one must be knowledgeable about all aspects that result in the crash. These aspects involve knowing the riders' behavior, the difficulty of training courses, and the condition of the roadways. Throughout the project, all areas were approached and analyzed thoroughly to create of a criteria based on motorcycle crashes.

Objectives

The objectives of the study are to:

- Determine the root causes of motorcycle accidents.
- Develop a strategic plan for the reduction of New Jersey motorcycle accidents.
- Establish specific recommendations for reducing New Jersey motorcycle rates incorporating the New Jersey highway system.

This paper reports on the results of a statewide series of surveys, and makes suggestions concerning the implementation of policy and legislation that will decrease the motorcyclist fatality rates. The results from the surveys will provide researchers and practitioners with the perspective of the rider's concerning various aspects of riding a motorcycle that lead to crashes and fatalities. With the survey data it is possible do develop dangerous trends in the motorcycle community that can be minimized and even eliminated. With the development of such trends, government agencies will be better prepared to adopt policies and legislation based on increasing motorcycle safety.

Presently, the study is in its intermediate stages and its projected completion date is May 2009. Currently, the group has done an extensive study on compiling statistical data by distributing surveys and analyzing the results. The Junior/Senior Engineering Clinic project is a study funded by the New Jersey Department of Transportation (NJDOT) and also includes the cooperation of Virginia Polytechnic Institute and State University and New Jersey Motor Vehicle Commission.

Methods

Several different methods were used through the course of the project. The main method of data collection was a survey distributed to motorcycle riders, Motorcycle Safety Foundation course instructors, and dealers across New Jersey. A data analysis of the New Jersey Crash (NJ Crash) data and the Fatal Accident Reporting System (FARS) was also completed to supplement the findings from the survey. Site surveys were also completed to gain more insight into motorcycle-guardrail collisions.

Survey

A survey was developed to focus on 3 specific groups of motorcycle enthusiasts such as general riders, rider course instructors, and motorcycle dealers. The summary below discusses why the survey focuses on these three motorcycle populations.

- Survey for Registered Motorcyclists: This will provide an overview of registered motorcyclists in New Jersey on motorcycle rider attitudes, motorcycle safety perceptions, helmet use, experience, assessment of training opportunities, and suggestions for means to improve motorcycle safety in NJ.
- Survey for Motorcycle Safety Foundation (MSF) Training Rider Coaches (Course Instructors): Training instructors for courses, e.g. presented by the Motorcycle Safety Foundation have unique insights into novice rider perceptions and attitudes on safety. This task will survey groups of MSF course instructors on motorcycle rider attitudes, suggestions for course improvements, and observations on changing demographics of riders.
- Survey for Motorcycle Dealers: This will survey motorcycle dealerships on novice and experienced riders' awareness of the need for a motorcycle endorsement in New Jersey. As an important stakeholder in the motorcycle safety issue, their responses will provide much insight regarding the perception of need for testing and training both for the dealer and the new rider.

The rider survey was distributed using the NJMVC registration renewal process already in place. The survey cards where included in the mailings that the NJMVC sends out to all registered motorcycle owners in The State of New Jersey. The Instructor and Dealer surveys were mailed directly to these individuals. The internet will serve as a primary medium for survey responses. The riders were issued a small card, as seen in Figure 1 below. This card was distributed along with the motorcycle registration renewal forms from the NJMVC. Cards were also mailed directly to the instructors and dealers.

Figure 1. Survey response card.

The cards themselves had a unique identification code, which prevented multiple responses from one participant. This unique code does not link any personal information. The cards were produced in association with Rowan University's publications department, and the Web Services department produced the online survey. After review by the sponsor of the project, the cards were printed, and mailed. This printing required merging the cards with the unique ids (UID) and was done by Rowan University Duplicating. The purpose of the UID is also to take the participant to the appropriate survey. There are three different types of surveys, one for riders, one for course instructors, and one for Motorcycle Dealers. As requested by the sponsor, the last 5 digits of the UID are random and do not allow for linking to personal data in the mailer. By not linking any personal data, privacy was ensured for the participants.

Data Analysis

An analysis of police reports was used to supplement the survey data. The New Jersey Crash data from 2001 to 2007 were analyzed using SAS 9.2 software. Some general trends in motorcycle accidents were observed from this data set. Some of the data analyzed included the road system, surface condition, lighting, and posted speed. The FARS data were used to find the distribution of engine displacements for motorcycles involved in fatal crashes in New Jersey.

Site Surveys

Motorcycle crashes involving guardrails were found through the NJ Crash database. A few of the written police reports of these crashes were obtained from the New Jersey Department of Transportation. The reports contain information about the accidents, including the events leading up to the accident and occurrences during the accident. At the sites, this information was used to determine where the motorcyclist collided with the guardrail. Information about the guardrail, the block, the post, and the roadside environment was collected at the sites. Unfortunately due to time constraint a limited amount of site surveys were completed.

An alternative to the site surveys is procurement of additional police reports. The team is currently in the process of obtaining as many as 200 police reports that

involve motorcyclists and guardrails. These police reports contain more information than can be found on the NJ Crash database. The additional information is often a detailed explanation of the accident. This information can be more useful than the site surveys. The sites visited were determined by accidents that happened in years past. It was the case at a few sites that the roadway had been recently repaved, and the guardrails replaced. No significant data can be obtained by visiting these types of sites. Once the new police reports are retrieved, an analysis of the information therein will be performed.

Results

The survey was sent to approximately 40,000 riders and 2,816 responses were received, yielding a 7% response rate. The survey was also sent to 200 instructors and 200 dealers, with 71 instructors and 9 dealers responding. The response rates for the instructor and dealer surveys were 36% and 9% respectively. The survey was administered from March, 2008 through September 28, 2008.

NJ Crash data from 2001 to 2007 inclusive was analyzed to find trends in motorcycle accidents. There were a total of 19,636 crashes in the 7 year span, 474 (24%) of which were fatal accidents (Figure 2). The FARS data was also used to determine the engine displacement. According to the FARS data, there were 497 motorcycles involved in fatal accidents between the years 2001 and 2007, inclusive.

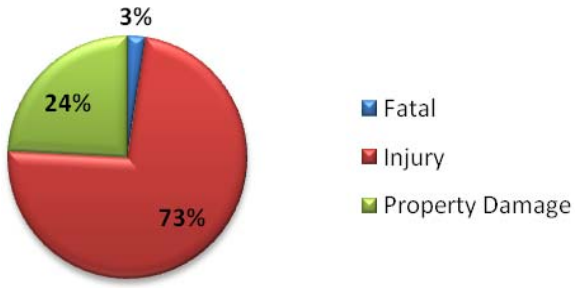

Figure 2. Distribution of accident severity in New Jersey.

The analysis of the data focuses on three main areas: motorcyclist behaviors and trends, training and testing, and road conditions and types. The survey data is compared to data from the NJ Crash database to provide insight into characteristics of crashes and the motorcyclists involved in them.

Motorcyclist Behaviors and Trends

Several of the questions in the survey aimed to understand the mentality of motorcyclists in New Jersey. These questions focused on issues such as cause of accidents, protective gear use, and drinking before riding.

One question posed to riders and dealers was what they felt was the most common cause of accidents. Both riders and dealers felt that the most common cause was inattentive drivers of other vehicles (Figure 3).

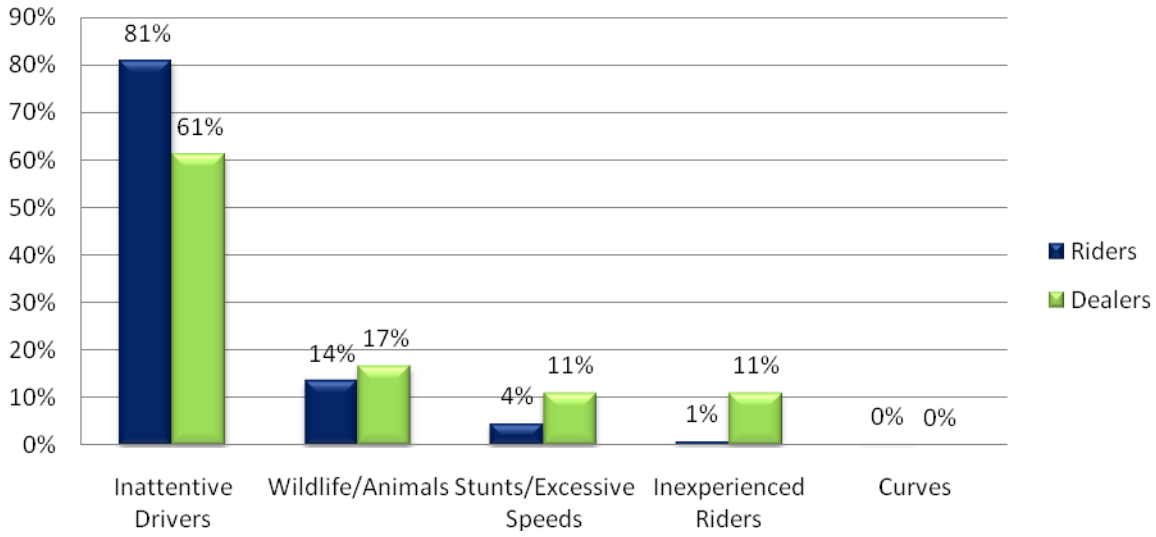

Figure 3. Perceived Accident Causes. Both riders and dealers most commonly felt that accidents were caused by inattentive drivers of other vehicles.

The NJ Crash database includes information on the first contributing factor to motorcycle accidents. An analysis of these data show that “Driver Inattention” is the second most reported cause of motorcycle accidents of all severities in New Jersey (Figure 4). It is surpassed only by “None” as the reported cause. However, these data do not specify which driver is the cause and could be interpreted as either the motorcyclist or the driver of another vehicle. The most common reported contributing factor of fatal motorcycle crashes is unsafe speed. Driver inattention is listed as the third most common cause of fatal motorcycle accidents (Figure 4).

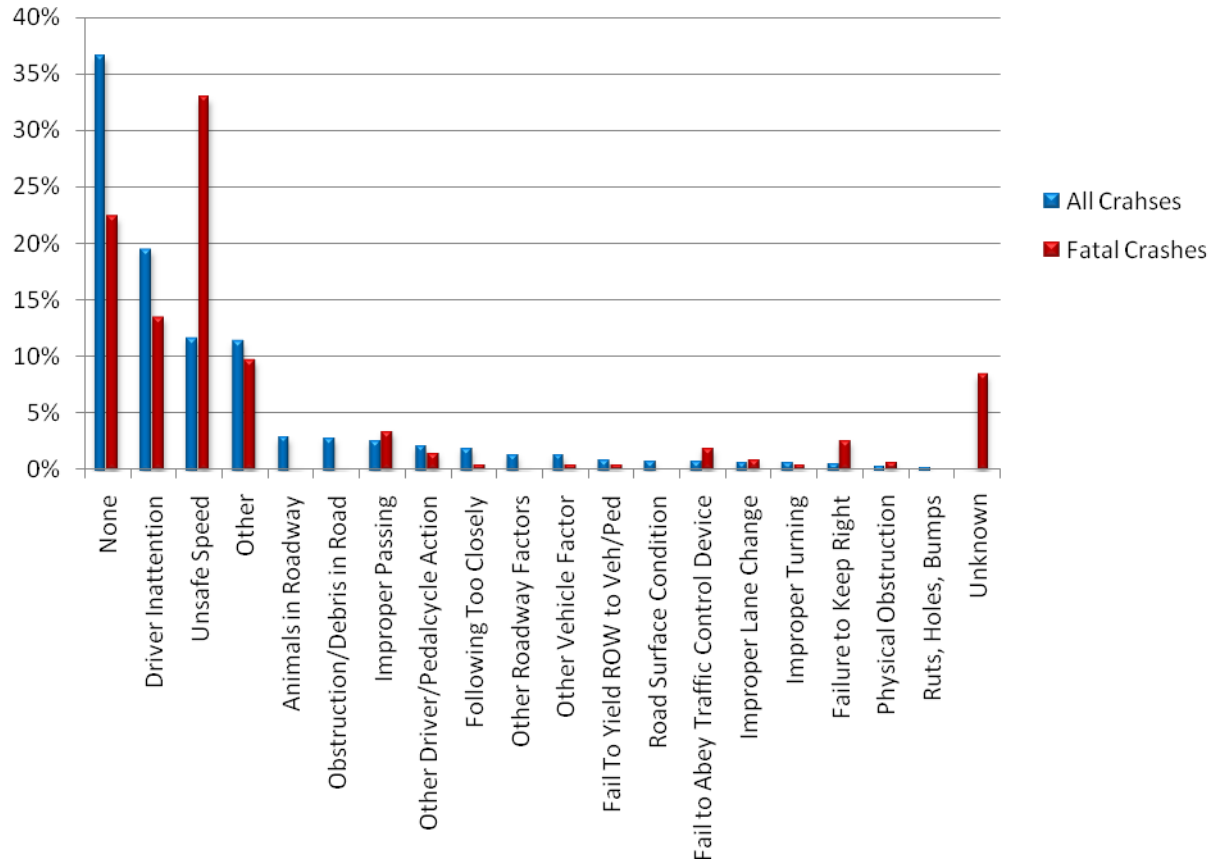

Figure 4. First contributing factor to motorcycle crashes. Driver inattention, which was thought to riders and dealers to be the most common cause of crashes, is the second highest contributing factor to all crashes and the third highest contributing factor to fatal crashes. Unsafe speed is recorded as the most common contributing factor for fatal motorcycle crashes.

The number of multi-vehicle motorcycle crashes is almost two times greater than the number of single vehicle motorcycle crashes (Figure 5). The distribution of vehicle involvement in all motorcycle crashes and fatal motorcycle crashes follows the same trend.

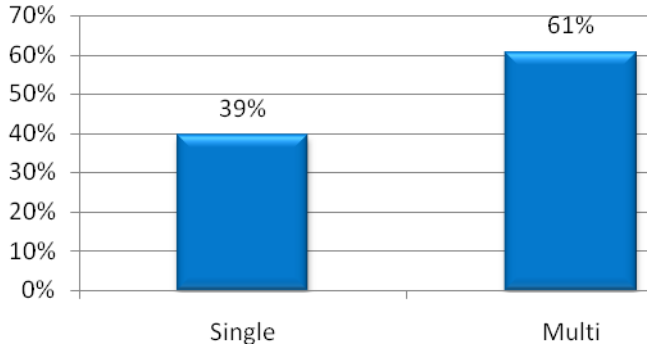

Figure 5. Single and Multi Vehicle Crashes. All motorcycle crashes and fatal motorcycle crashes follow the same trend.

Another behavior trend is alcohol involvement with accident trends. Riding while intoxicated is a high risk. In the survey, riders were asked if they had ever consumed alcohol before riding. Also, they were asked how much alcohol they consumed before riding. Seventy percent of respondents indicated that they never consumed alcohol before riding (Figure 6). Also, 24% of riders said they rode after drinking only 1-2 drinks, which may still make their BAC level below the legal limit.

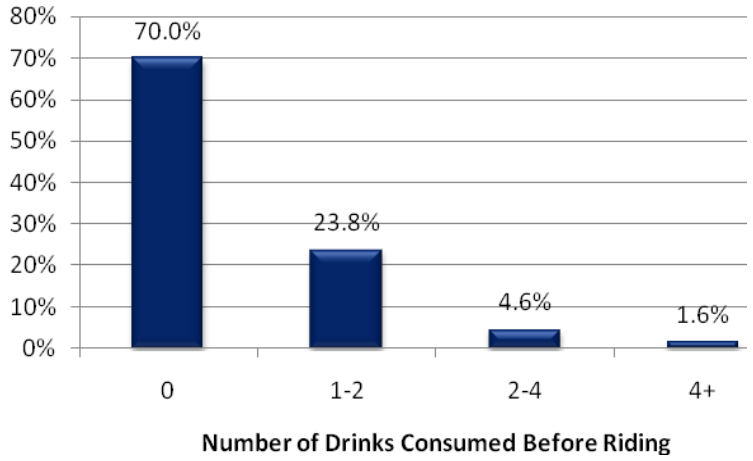

Figure 6. Number of Drinks Consumed by Riders. 70% of riders surveyed indicated that they never consumed alcohol before riding.

The NJ Crash data was also analyzed to see the influence of alcohol on motorcycle crashes. Alcohol had an influence in a higher percentage of fatal crashes than in all crashes (Figure 7). In both cases, however, the vast majority of crashes did not involve alcohol.

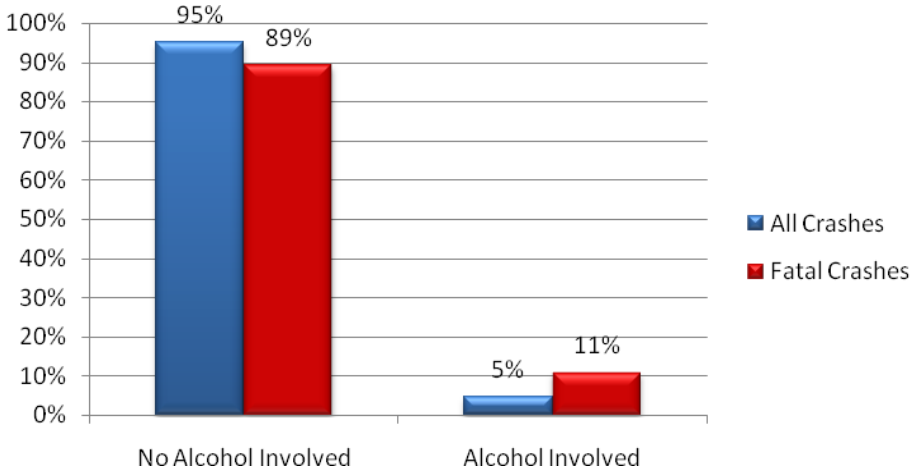

Figure 7. Alcohol Involvement in Crashes. Most motorcycle crashes do not involve alcohol, though the percentage of alcohol involved in fatal crashes is greater than the percentage of alcohol involvement for all crashes.

Training and Testing

Training is offered through the state free of charge at two locations, Sea Girt and Egg Harbor Township. Several private companies also offer training at various locations across the state. The course most frequently offered is the Motorcycle Safety Foundation Basic Rider Course (BRC). The courses involve both classroom and skills training. In the classroom, students learn about carious safety measures that motorcyclists can take to protect themselves and become more conspicuous on the road. On the range, students learn the skills needed to safely operate a motorcycle, such as cornering, braking, and swerving. Another course commonly offered is the Harley-Davidson NewRider Course, which is offered at Harley-Davidson locations. This course covers the same basic information as the BRC.

Riders who received training were asked if they felt the BRC was effective. Forty-five percent of riders surveyed had received training, and 83% of these riders classified the course as either "Very Effective" or "Extremely Effective" (Figure 8). Dealers were asked the same question as riders, and 72% of respondents felt that the BRC is extremely effective (Figure 8).

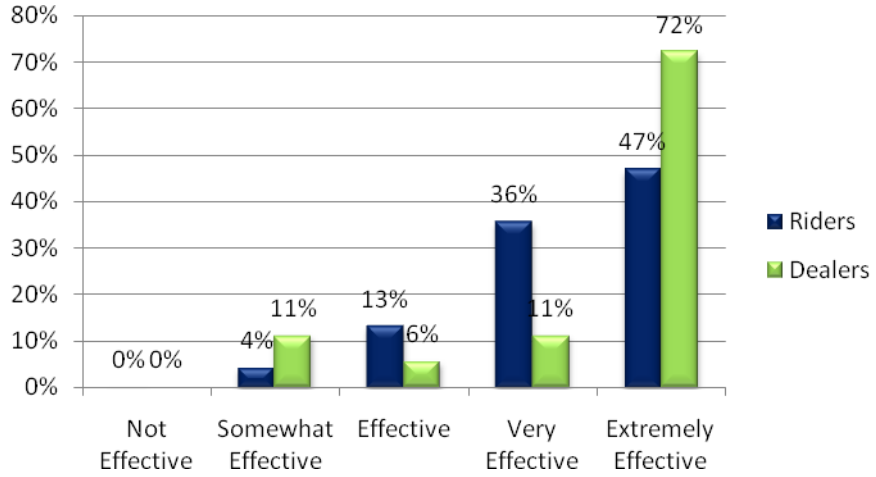

Figure 8. Perceived Effectiveness of BRC. Motorcyclist and dealers were inquired about the effectiveness of the course, and most asserted that it is either highly effective.

When asked the difficulty level of basic rider course, 94% of the instructors ranked the course of having a low difficulty level (Figure 9). The course may be too simple and does not adequately teach the basic riding skills. In a positive prospective, the course can be considered easy because the concepts are very easy to grasp.

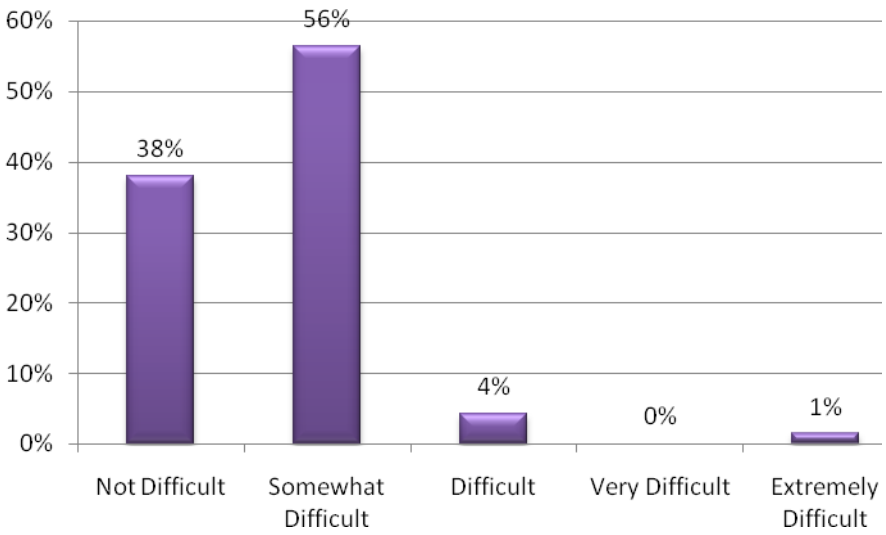

Figure 8. Difficulty of BRC as Rated by Instructors. Many of the instructors feel the course has a low level of difficulty.

Many of the trained riders and dealers rated the class as having a high level of effectiveness. Instructors do not feel the course itself is very difficult, which may mean that it is effective in providing riders with the information and basic skills they need to ride safely. However, less than half of those surveyed had received training. Those who did not receive training were asked which factors were preventing them from attending a training course. The most common response was that they did not have enough time (Figure 10). Instructors were also asked if they felt there are enough motorcycle training course locations in New Jersey. Of the instructors who responded to the survey, 62% felt there were not enough location offerings through the state.

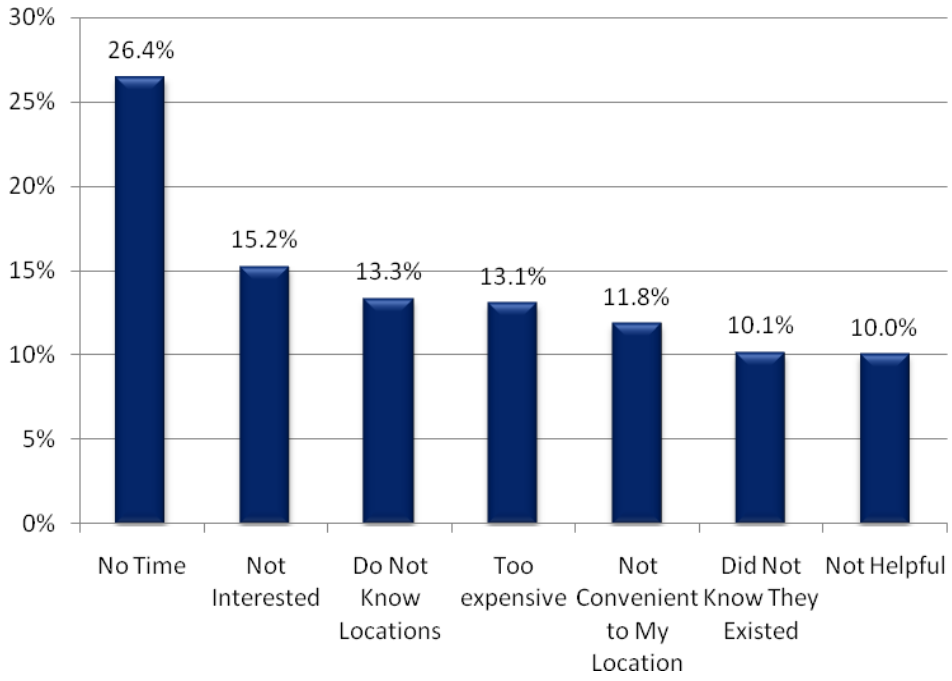

Figure 10. Factors Preventing Training as Indicated by Riders. Time is the most common limiting factor preventing riders from receiving formal motorcycle training.

New Jersey requires motorcyclists to pass both a written and skills test in order to operate a motorcycle on the roads unsupervised. The tests are offered through the Motor Vehicle Commission (MVC). The BRC also includes both tests, and in passing these tests, a motorcyclist can obtain a license with testing at the MVC. Of the 79% of riders surveyed who took the test through the MVC, 68.6% felt that the MVC road test accurately tested their ability to operate a motorcycle.

The MVC and BRC tests do not place restrictions on the engine size of the bike used to complete the tests. Most of the people surveyed used a bike with an engine displacement between 101 cc and 500 cc (Figure 11). These are relatively small engine displacements for motorcycles. The engine displacement of motorcycles involved in fatal accidents in New Jersey was found using the FARS database for the years 2001 to 2007. Most fatal accidents in New Jersey occurred on motorcycles with engine displacements between 500 cc and 1200 cc (Figure (11).

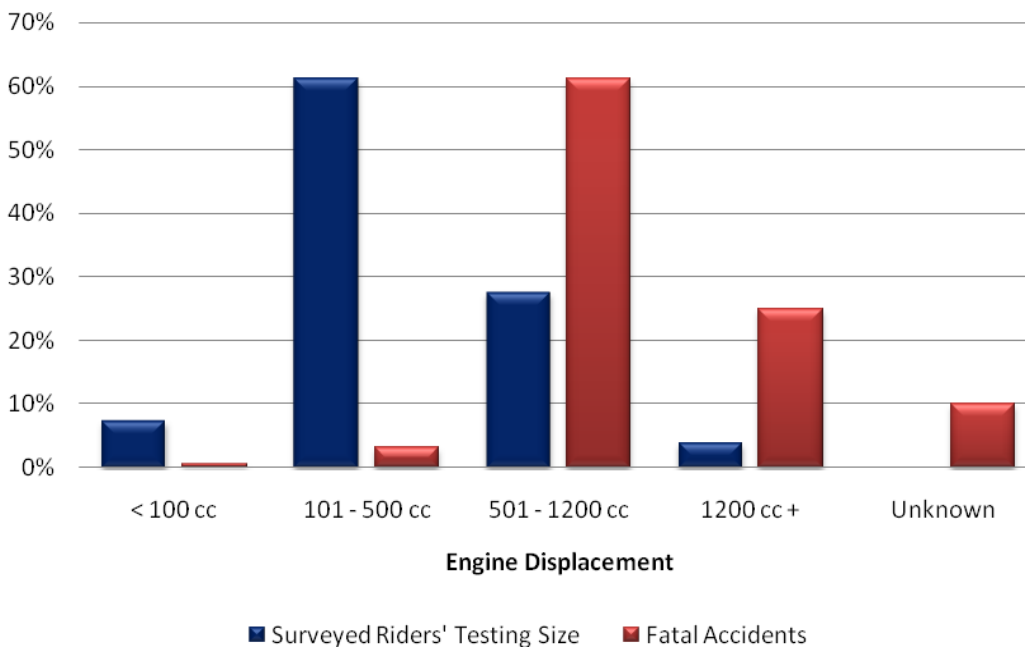

Figure 11. Engine Displacements. The surveyed riders typically used a small engine displacement (101cc – 500 cc), while fatal accidents occur mostly on motorcycle with an engine size of 501 to 1200 cc.

New Jersey does not place any restrictions on a motorcycle license. Seventy-seven percent of the instructors surveyed believed that there should be some restrictions on the license. The most common recommended suggested was having riders ride a motorcycle with a smaller engine displacement before advancing to a larger bike (Figure 12).

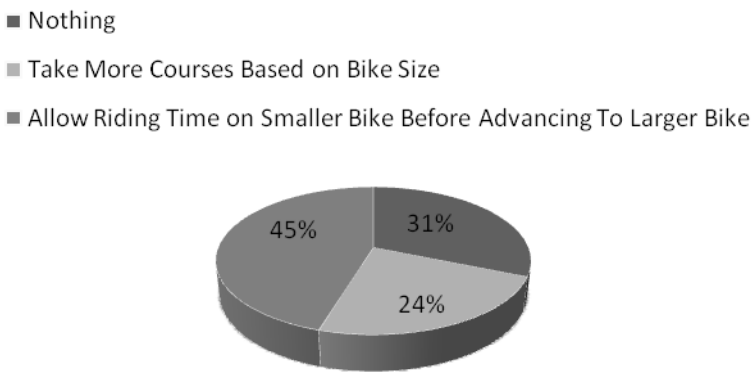

Figure 12. Suggestions Regarding Licensing Restrictions from Dealers.

Road Types and Conditions

Riders and dealers were asked what types of situations they felt proved to be the most hazardous to motorcyclists. The riders and dealers surveyed felt that the most hazardous situation is at intersections.

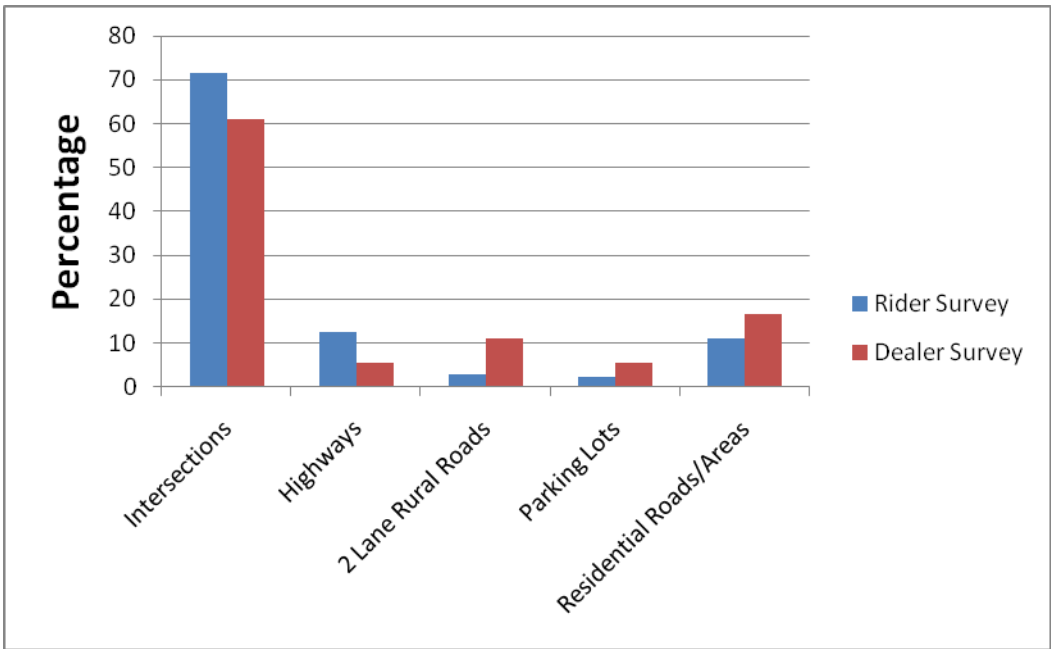

Figure 13. Perceived Hazardous Situations

According to the NJ Crash data, 72.7% of all motorcycle crashes occurred either in or near an intersection. Also, 42.6% of all fatal crashes occurred near an intersection (Figure 14).

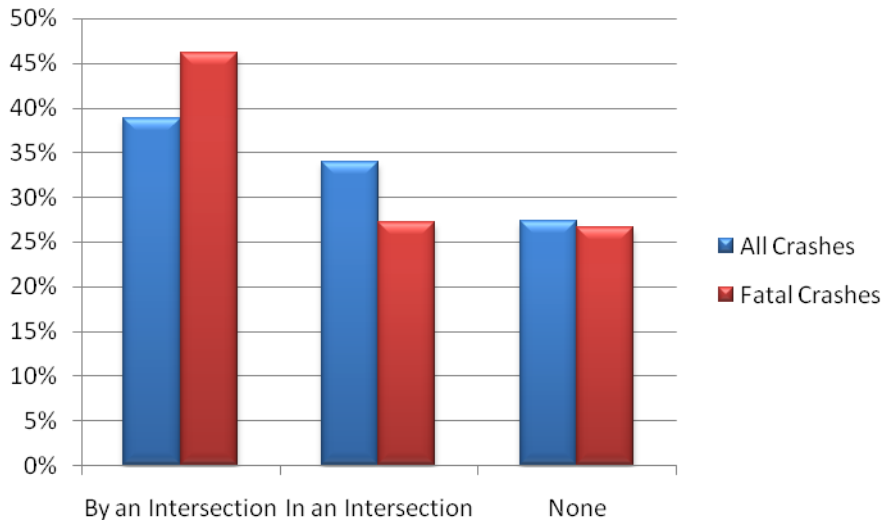

Figure 14. Distribution of Crashes with Respect to Intersections. There are a greater percentage of crashes occurring either near or by and intersection than those that are not near an intersection.

The highest percentage of all motorcycle crashes occurred on county roads (Figure 15). The same trend was seen in fatal crashes. However, the second greatest

percentage of fatal crashes occurred on highways, whereas the second most common road for motorcycle crashes of any severity are municipal roads (Figure 15).

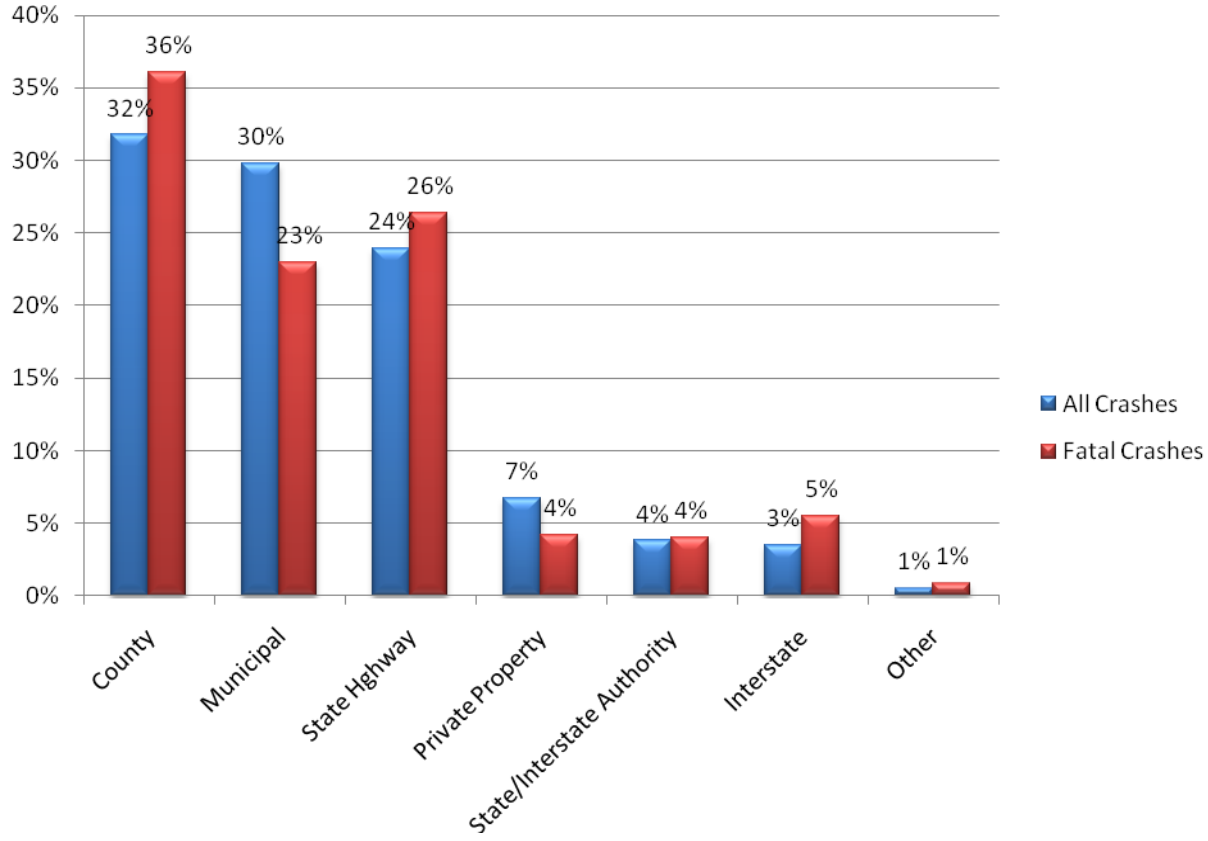

Figure 15. Distribution of road types on which motorcycle crashes occurred. The highest percentage of crashes occurred on county roads.

Also, the highest percentage of crashes occurred on roads whose posted speed limit was between 25 and 34 mph (Figure 16). However, in looking at trends of only fatal crashes, the most crashes occurred on roads whose posted speed was between 45 and 54 mph (Figure 16).

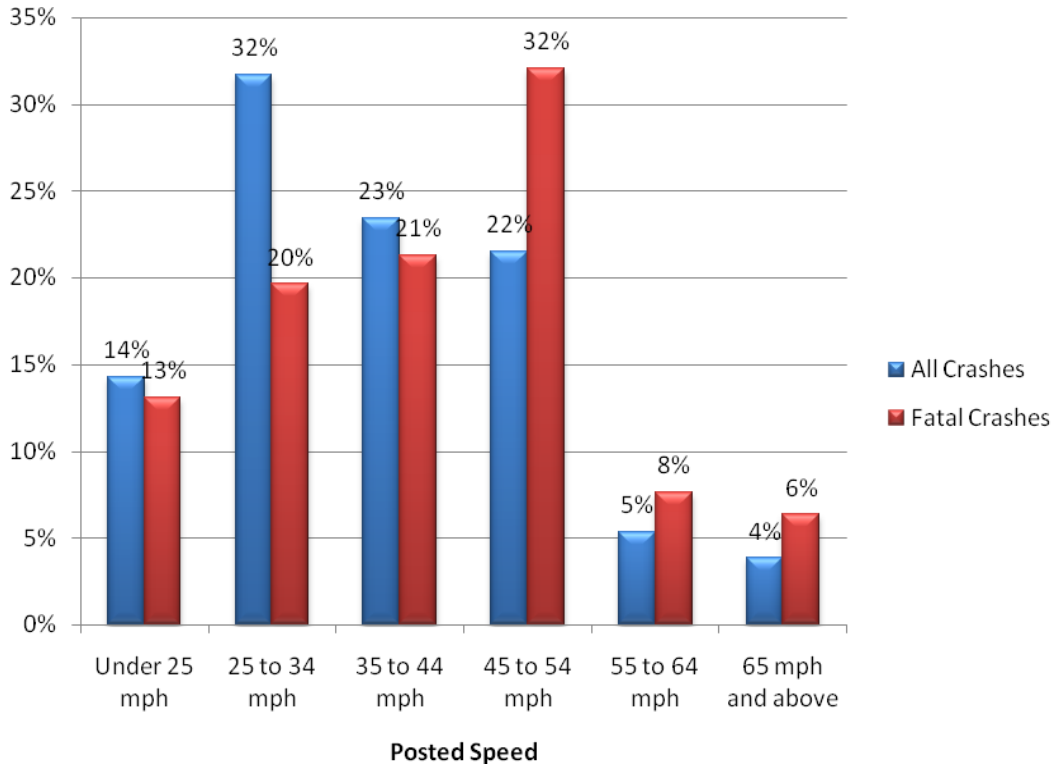

Figure 16. Posted Speed Limits of Crash Locations. The trends for all crashes and fatal crashes are not the same. The highest percentage of fatal crashes occurs on roads whose posted speed is 45 to 54 mph.

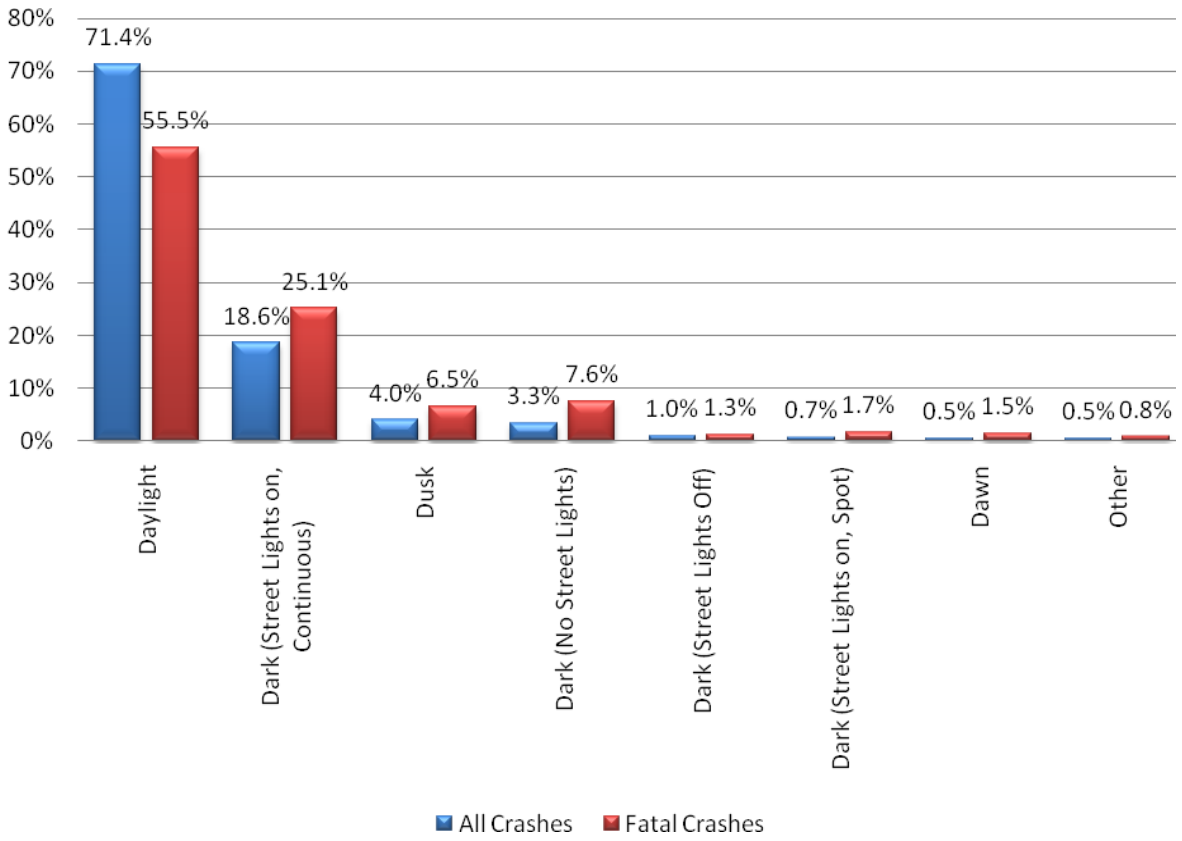

Figure 17. Lighting Conditions. Most motorcycle crashes occurred during the daylight.

However, more fatal crashes occurred in the dark than the overall occurrence. Lastly, the road surface conditions may be an influencing factor in motorcycle crashes since a motorcycle is much more sensitive to changes in the surface than other vehicles. Since a motorcycle only has two wheels, it is much harder to balance and not as stable as a vehicle with four wheels. However, it is seen that most motorcycle crashes occur when the roads are dry (Figure 18). This may be a function of motorcyclists not riding during poor weather conditions.

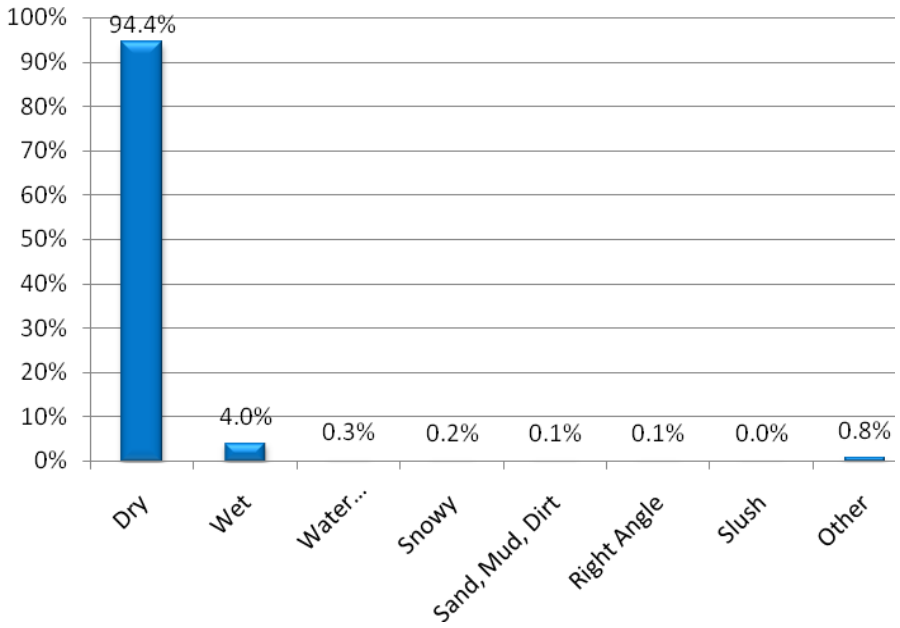

Figure 18. Road Conditions of all Motorcycle Crashes. Most crashes occur when roads are dry.

Discussion

Motorcyclist Behaviors and Trends

Driver Inattention Both motorcyclists and dealers felt the main cause of accidents is inattention by the other driver. According to New Jersey police records (NJ Crash) from 2001 to 2007, driver inattention is the second most common contributing factor to motorcycle accidents (Figure 4). However, it cannot be determined from the available data set whether the driver referred to as inattentive is the motorcyclist or the driver of another vehicle. Also, the majority of all motorcycle crashes (61%) involved two or more vehicles (Figure 5). Other drivers, as indicated by motorcyclists, may be having a large influence on motorcycle crashes. Increased awareness of the hazards of driver inattention to both drivers and riders may lead to a decrease in fatal motorcycle accidents.

Unsafe Speeds Fatal crashes followed a different contributing factor trend; travelling at unsafe speeds was the most common contributing factor to fatal motorcycle accidents (Figure 4). However, the data does not specify if the unsafe speed was being travelled by the motorcyclist or the driver of the other vehicle. From these data, the fault of the accident cannot be determined to be either drivers or motorcyclists. The distribution of single and multi-vehicle fatal crashes followed the same trend as the distribution for all motorcycle crashes (Figure 5). Increased enforcement of speed limits can lead to a decrease in fatal motorcycle accidents.

Alcohol Involvement Of the riders surveyed, 70% indicated that they never had a drink before riding, and only 1.6% indicated that they have had more than 4 drinks before riding (Figure 6). Also, 23.8% indicated that they had 1 or 2 drinks before riding, which

may still place them under the legal BAC limit of 0.08%. Through the NJ Crash data, it can be seen that few accidents involved alcohol; alcohol was only involved in 5% of all crashes (Figure 7). There was a higher percentage of alcohol involved in fatal motorcycle crashes (11%). Overall, alcohol involvement, though leading to a small percentage of crashes, does not seem to be a main contributor to motorcycle accidents.

Training and Testing

MSF Course Effectiveness Training has not been proved either effective or ineffective through past studies, though the majority of people surveyed felt the course is beneficial (Figure 8). Trainers were asked about the difficulty of the course, and many said they did not feel the course was difficult (Figure 9). Of the riders surveyed, 55% indicated they had not received training. When asked why they had not received training, the highest percentage of people indicated that they did not have time for the course. Many people indicated that they did not know the locations or the locations were not at convenient locations. One way to promote training would be to increase awareness of the courses, both public and private. Also, more training sites could be used to increase the capacity of courses. Since time seems to be a major factor in preventing training, an adjustment in the time selections of the course can be made to make times more suitable for the motorcyclist.

Speeds and Engine Displacement During Testing According to the riders surveyed, approximately 70% of testing and training occurs on motorcycles with displacement smaller than 500 cc (Figure 11). According to FARS 97% of fatalities involved motorcycles over 500 cc. The discrepancy between the size of the motorcycles involved in fatal accidents and those being used for the test expose the flaws in the testing process. Also, the NJMVC road test and the MFS basic course are both performed in enclosed areas in which the motorcyclist is not exposed to other motor vehicles or increased speeds.

Speeds experienced during the basic rider course and the road test do not exceed 35mph. The testing and training at low speeds accurately test a rider's ability to operate a motorcycle at low speeds, but the rider's higher speed skills remain unevaluated. The basic rider course and the road test do not require motorcyclist to go above 35 mph, yet according to the NJ Crash data, 67% of fatalities occur at posted speeds greater than 35 mph (Figure 16). It is assumed that these fatalities occurred while the vehicle traversing at, or above, the posted speed. There are two other factors that may affect the fatality results in relation to speed. First, higher speeds will increase the chance of fatality. Second, the majority of motorcycle travel time may be performed on road with posted limit of 45-54 mph. These two factors confirm the importance of testing and training at typical roadway operation speeds.

Road Types and Conditions

Road Types Intersections were classified as the most hazardous road situation for motorcyclists by both riders and dealers (Figure 13). The highest percentage of crashes occurred near an intersection (Figure 14). Also, 33.9% of all crashes and 27.2% of fatal crashes occurred in an intersection. Intersections are perceived to be hazardous areas

and have proven to have a high accident rate relating to them. Intersections should be approached with higher caution. This may also be related to inattention of both motorcyclists and drivers, as not being aware of other vehicles around intersections could more easily lead to an accident.

Road Conditions Most crashes occurred under normal conditions. 71.4% of all crashes occurred during under daylight (Figure 17). Also, 94.4% of crashes occurred on a dry surface (Figure 18). These conditions are most likely a function of conditions under which people are riding motorcycles.

Site Survey

Conclusions

Eighty-seven percent of fatal accidents in New Jersey occurred on motorcycles with an engine displacement greater than 500cc, though 69% of riders surveyed had completed their motorcycle road test or training on a motorcycle with an engine displacement less than 500. Motorcyclists are testing and training on motorcycles with a much smaller engine, which are easier to control. Once a license is obtained, there are currently no restrictions in New Jersey on the size of the motorcycle that can be ridden. Placing a restriction on the license relating the engine size of the testing motorcycle to the engine size of the motorcycle operated on the road would reduce the number of motorcyclists operating motorcycles they cannot control. This could lead to a reduction in accidents because more motorcyclists would be licensed to operate the appropriate vehicles.

Many riders and dealers indicated intersections as a hazardous area for motorcyclists. Driver inattention was also noted by riders and dealers to prove hazardous to motorcyclists. The police reports demonstrate that 20% of accidents are caused by driver inattention by the driver and/or motorcyclist. Intersections involve a great deal of interaction between the users on the road. The motorcycle test administered by both the NJ MVC and through the training courses takes place on a closed course where there are no interactions with other vehicles. Testing on roads where there are other vehicles would help ensure that motorcyclists can properly react in situations dealing with interactions with other drivers.

One proposed method of testing is to develop a tiered system with limits placed on the engine size based on the size of the motorcycle on which the rider tested. A permit would still need to be obtained and held for 20 days before a rider can complete any testing procedures. The first tier of licensing is for motorcycles with an engine displacement under 500cc. The testing procedure is the same as that currently in place. The test will be administered through the MVC or at the conclusion of a training course. The only restriction on this license would be the engine displacement. Riders must first attain this license and hold it for a period of time before testing for the second tier license.

The second tier of licensing would allow riders to operate motorcycles with an engine displacement above 500 cc. The testing for this license would occur on the road, such that motorcyclists are being tested on their ability to operate a larger motorcycle and interactions with other users of the road. Testing on the road would also allow a

motorcyclist to travel at higher speeds. As shown, most fatal accidents occur on roads with a posted speed of 45-54 mph and the highest percentage of all accidents occur on roads with a posted speed of 25-34 mph. The current testing procedure occurs at speeds of approximately 10-15 mph, which is not representative of speeds at which crashes are occurring. Upon completing the road test, a motorcyclist will hold an unrestricted license.

However, in order to implement the described licensing system, a new testing method for the unrestricted license would need to be developed. An alternative to testing a second time would be to increase the period between attaining a restricted and unrestricted and remove the second testing procedure. It is anticipated that riders' skills improve over time and practice. Allowing riders to operate motorcycles that are easier to control when they first start riding would allow them to develop their skills under somewhat safer conditions.

APPENDIX C

THE EFFECTIVENESS OF MOTORCYCLE TRAINING AND LICENSING

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ABSTRACT
Motorcycle-crash fatalities in the United States have been increasing since 1997, when the total number of fatalities reached a record low. Motorcycle training programs were enacted before this rise and many studies have aimed to show their effectiveness. The objective of this paper is to review and synthesize the results of existing research on the effectiveness of motorcycle education courses and different licensing procedures. The effectiveness of programs is examined through the effect training has on accident rates, violation rates, and personal protective equipment usage found through past research. Research to date has not consistently supported the notion that training is either effective or ineffective. Some studies have demonstrated that accident and traffic violation rates are lower for trained riders than untrained riders, while others demonstrated that they are higher for trained riders. Training increases the use of personal protective equipment amongst motorcyclists. Motorcycle licensing procedures have been shown to have different effects on accident rates. Lower accident rates have been observed in areas with stricter regulations for obtaining a license. The studies varied greatly in both the methods used for comparison and the rigor of their evaluation methodology. No standards for evaluation exist. The findings of these previous studies may be more a reflection of the methods used to evaluate motorcycle training rather the effectiveness of training itself.

INTRODUCTION

Motorcycle-crash fatalities in the United States have been increasing since 1997, when the total number of fatalities reached a record low (*1*). Motorcycle training programs were put in place long before this rise, but motorcycle training has taken on renewed prominence as a method to improve motorcycle safety by producing safer, more skilled motorcycle riders. Training may be popular with policymakers however because of what Mayhew (*2*) refers to as "strong face validity". However, Mayhew found that there is little evidence that driver training is effective at improving safety. Motorcycle and car driving skills are of course very different. The question is how effective are motorcycle training programs at improving rider safety.

The training courses developed by the Motorcycle Safety Foundation (MSF) are the most frequently used curricula in the United States (*3*). The two novice courses taught are the *Motorcycle RiderCourse: Rider and Street Skills* (MRC:RSS) and the *Basic RiderCourse* (BRC). The BRC is a more recent program that some states have adapted as their main curriculum, though many still use the MRC:RSS (*4*). Both courses involve training in a classroom and on a motorcycle. The classroom training incorporates information about how to safely operate the motorcycle on the road. Moreover, classroom training focuses on safety measures that motorcyclists can take to protect themselves and become more conspicuous to other drivers. The skills training includes the basic skills needed to safely operate a motorcycle, such as shifting, braking, and swerving. These are considered some of the more difficult maneuvers and are not easily mastered. The MSF courses are all taught by certified *RiderCoaches*, who undergo extensive training to become prepared to teach the courses (*5*).

Another novice course frequently offered is Harley-Davidson's *Rider's Edge* New Rider course, which is based on the courses developed by the MSF. The course is offered at Harley-Davidson dealers and, upon completion of the course, the graduate is awarded a card stating they have passed the MSF RiderCourse. This course also incorporates both knowledge and skill training (*6*). Moreover, some states, such as Oregon and Maine, have developed their own curriculum for training motorcyclists. These courses are generally based on the same curriculum as the MSF courses, but are modified as the states see fit (*7*). The Motorcycle Training Program in Canada offered in 1980, which was studied by Jonah et al., consisted of classroom, off-street, and on-street training (*8*).

Licensing is intertwined with rider education. Licensing procedures often encourage motorcyclists to seek formal training. Motorcycle training is mandatory for licensing in nineteen states. In 16 states, training is only mandatory for riders through a certain age (either 18 or 21) and, in three states training is required for new riders at any age (*9*). Different licensing procedures may also have an effect on motorcyclist safety. Graduated driver licensing for car drivers has been widely studied and accepted as an effective method of improving driver safety in cars. Much less is known about whether a graduated licensing system would be as effective for motorcyclists.

OBJECTIVE

This literature review aims to look at the effectiveness of motorcycle education courses, especially amongst the various training programs. The effectiveness of programs is examined through the effect that training had on accident rates, violation rates, and the personal protective equipment usage found through past research. Moreover, this study aims to review different motorcycle licensure systems and their effectiveness.

METHODS

The methods, findings, and conclusions of seven independent studies were compared to evaluate the effectiveness of motorcycle training. The studies examined several different outcome events that may be affected through training. These include the effect of training on accident rates, violation rates, and personal protective equipment usage. Studies were selected that compared trained and untrained riders based on accidents or violations. Engineering Village search engine was used to search the Compendex, Ei Backfile, Inspec, Inspec Archive, and NTIS databases. TRIS, Science Direct and Medline were also used to search for relevant articles. Keywords included motorcycl*, training, effectiv*, and accident. A critical comparison was made between the findings of the different studies. Moreover, two other studies were examined to review the effects of different motorcycle licensing programs. The studies were analyzed in terms of the reported effects different licensing systems had on accident rates.

RESULTS

Effectiveness of Training Programs

The effectiveness of motorcycle training classes has been evaluated by several different studies. An overview of the studies is given in Table 1. No standard methods for evaluation exist. The studies vary greatly in the comparisons that are made and the effects that are examined. These previous studies have usually used small sample groups, opening the possibility that the data does not accurately represent the population (*10*). Haworth et al. found that the evaluation of training courses is typically based on the number of accidents occurring in years following the training, rather than on the curriculum itself (*10*).

TABLE 1 Overview of Studies on Training Effectiveness

Author(s)	Year	Course Evaluated	Method of Collection	Sample Size[1]	Method of Normalization	Metric of Effectiveness
Billheimer, J. H.	1999	California Motorcyclist Safety Program (CMSP) [2]	Accident Trends, Interviews	T: 1139 U: 1139	Rider-reported miles ridden	*Accidents *Violations

Davis, C.F.	1997	Connecticut Rider Education Program (CONREP)	Accident Reports	T:9320 U:41680	Rider Population	*Accidents *Accident Severity *Accident Responsibility
Jonah, B. A. Dawson, N. E. Bragg, B. W. E.	1982	Motorcycle Training Program (MTP)	Telephone Interviews, Driving Records	T: 811 U: 1080	Rider-reported miles ridden	* Accidents * Traffic violations
McDavid, J. C. Lohrmann, B. A. Lohrmann, G.	1989	British Columbia's motorcycle safety program	Driving Records	T: 139 U: 139	N/A	* Motorcycle Accidents * Motor Vehicle Accidents
Mortimer, R. G.	1984	MRC:RSS	Survey	T: 213 U: 303	Rider-reported miles ridden	* Moving violation * Accidents * Cost of damage to motorcycle
Mortimer, R. G.	1988	MRC:RSS	Survey	T: 913 U: 500	Rider Population, Rider-reported miles ridden	* Protective equipment usage * Accidents * Violations * Cost of damage and injury
Savolainen, P. Mannering, F.	2007	BRC	Survey	1327	N/A	* Accident involvement

[1]T = Trained, U = Untrained

[2]In California, training was mandatory for people under age 18 from 1988-1991. In 1991, training became mandatory for anyone seeking their motorcycle license and was under the age of 21.

Effect of Rider Training on Accidents

All of the studies evaluated accident counts or accident rates as a metric of effectiveness of motorcycle training (Table 2). It should be noted that accident rates are a common, but not necessarily ideal, measure of training effectiveness. Accidents are infrequent, and may have many causes besides training or rider skill. Nonetheless, several studies have shown that training produces a decline in accident rates. Billheimer analyzed California accident trends to see the effects of the introduction of a safety program in

1987 (*11*). The California Motorcyclist Safety Program (CMSP) was mandatory for all people under the age of eighteen seeking a motorcycle license at the time of its introduction, though this age was increased to twenty-one in 1991. In the nine years following the introduction of the program, the number of fatal motorcycle accidents dropped 69% (*11*). However, Billheimer suggests several other factors besides the introduction of a mandatory training program may have influenced this decline. He notes that a mandatory helmet law was introduced in 1992. Also, the number of motorcycles sold during this time period declined (*11*). Also, U.S. motorcycle fatalities were declining nationally during the time period of this study (*1*). Therefore, the decrease cannot be solely attributed to the introduction of the CMSP.

Billheimer also completed a matched-pair study to examine the effects of motorcycle training by the CMSP. Trained and untrained riders were paired based on age, sex, and riding experience to make a more accurate comparison between the two groups. It was found that there were fewer accidents per kilometers for trained riders with little experience before training as opposed to their untrained counterparts. Accident rates were calculated based on distance travelled as reported by riders in the survey. However, both one and two years after the training period, there was no significant difference found in accident rates between trained and untrained riders. Moreover, no significant difference in accident rates was seen between the trained riders with prior experience and their untrained equivalents (*11*). Billheimer concluded that those who had little to no experience prior to taking the course benefited most from it (*11*).

The British Columbia Safety Council's motorcycle safety training program was evaluated by McDavid, Lohrmann, and Lohrmann through a matched-pair study (*12*). Using an entirely male sample, they paired trained and untrained riders based on age, month licensed, and number of automobile accidents involved in before licensing. All data was gathered from police reported accidents and fault was not considered in the analysis. According to McDavid et al., a statistical analysis which takes into account different factors, as done in many other studies, is not accurate enough due to the variability in driving behavior between the people in the two groups. Pairing based on number of accidents before attaining a motorcycle license controls for this variable (*12*). The untrained group was found to have 32% more motor vehicle accidents than the trained group and 64% more motorcycle accidents during the first five years after licensing. Though the higher percentage of motor vehicle accidents was found to be statistically significant, the difference in percentage of motorcycle accidents was not. The number of accidents both on motor vehicles and motorcycles decreased as the number of years ridden increased. Moreover, the accidents that trained riders were involved in were less severe. From these findings it appears that training produces desirable outcomes; however, due to the small sample size, no definite conclusions could be drawn (*12*).

The Connecticut Rider Education Program (CONREP) was evaluated by Davis, and he found that the number of accidents per rider were significantly lower for those who completed CONREP (*13*). The accident records for Connecticut were examined and the operators of the motorcycles involved in crashes were cross referenced with a list of

people who had completed CONREP. The accident rates of CONREP graduates and those who did not receive training were 0.0042 and 0.0196 respectively (*13*). It was also found that the accidents involving people who completed CONREP were significantly less severe than those involving non-graduates. However, it was not concluded that graduates were responsible for fewer accidents than non-graduates (*13*).

Some studies have shown that existing training courses may not be effective or may even have negative effects. An evaluation by Jonah et al. of the Motorcycle Training Program, a course offered throughout Canada, demonstrated that, after controlling for confounding factors such as age, sex, time licensed, education, distance traveled, and alcohol usage, there was no difference in accident rates between trained and untrained riders (*8*). Through a study conducted in Indiana, Savolainen and Mannering found that those who completed the BRC were 44% more likely to be involved in an accident (*14*). Moreover, those who took the course more than once were 180% more likely to be involved in an accident than untrained riders (*14*). Savolainen and Mannering offered several different possible explanations for this observation. First, the course may give riders the feeling of improved skill, increasing risk taking behaviors because they are operating at the same perceived risk level. Alternatively, the course may be attracting a group of riders who are less skilled. Thus, the course may not be the cause of more people being in accidents, it is the inherent skill level of the people themselves. The last possibility is that the course itself may be ineffective (*14*).

Mortimer reviewed the effectiveness of the MRC:RSS and found that 22.1% of those surveyed who had taken the motorcycle rider course reported being in a motorcycle accident during the twelve months prior to the study, whereas 16.2% of the untrained survey group reported being in an accident (*15*). The participants who were trained had taken the MRC:RSS less than three years prior to the survey and remained active motorcyclists. The control group was composed of people who were active motorcycle riders in the year prior to the survey. When the accident rates are calculated using distance ridden as reported by the riders in the survey, the accident rate for those who completed the training course was more than twice as great as the rate for the control group. For the trained group the rate was 103.5 accidents per million miles, as opposed to 43.8 accidents per million miles for the control group (*15*). Moreover, for those who held a license for less than two years, there was no significant difference in accidents between the trained and untrained groups. This is significant because it is anticipated that the training will affect drivers most within the first two years of receiving a license (*15*). Four years later, Mortimer repeated the same experiment with more than twice the sample size. The accident rates per million miles ridden for trained and untrained riders were 86.7 and 37.7 respectively (*16*). Though the rates for each group were less than those found in 1984, the trained riders still maintained a higher accident rate than untrained riders. After the rates were controlled for both age and number of years licensed, the trained group still had a higher accident rate than the untrained group. Lastly, it was again found that within the first two years of holding a license those who were trained did not have lower accident rates than those who were untrained (*16*).

TABLE 2 Findings of Studies Examining the Effect of Training on Accident Rates

Author(s)	Year	Method of Control	Findings
Billheimer, J. H.	1999	Matched-pair	* Fewer accidents per kilometer 6 mo. after training for trained riders with <805 km of prior experience * Similar number of accidents per kilometer 6 mo. after training for trained riders with >805 km of prior experience * No difference in number of accident per kilometer 1 and 2 years after training
Davis, C.F.	1997	N/A	*Fewer accidents per operator for CONREP graduates *Accidents involving CONREP graduates were not as severe *Accident responsibility was equally distributed between graduates and non-graduates
Jonah, B. A. Dawson, N. E. Bragg, B. W. E.	1982	Statistical	* Fewer reported accidents by MTP graduates * No effect on accidents seen between MTP and IT groups when controlled for sex, age, time licensed, distance traveled, education, and drinking
McDavid, J. C. Lohrmann, B. A. Lohrmann, G.	1989	Matched-pair	* Trained riders had fewer motor vehicle accidents * Trained riders tended to be in fewer and less severe motorcycle accidents
Mortimer, R. G.	1984	Statistical	* Accidents per mile for trained were not lower after age and years licensed had been controlled for
Mortimer, R. G.	1988	Statistical	* Trained did not have fewer accidents per mile
Savolainen, P. Mannering, F.	2007	Statistical	* Increased number of accidents for those who were trained * Increased number of accidents for those who were trained more than once

Effect of Rider Training on Violation Rates

Another means of evaluating the effectiveness of training programs is comparing the rates of traffic violations between trained and untrained motorcyclists. Violations are more frequent than accidents, and can provide further insight into driving behaviors. It is expected that there would be lower violation rates among trained riders because they should have a better understanding of, as well as more respect for, the laws of the road (*8*). However, as with accident rates, the reported effects of training on traffic violation rates also varies across several studies (Table 3).

Billheimer states that those who were novice riders and completed the CMSP "tended" to have lower violation rates than their untrained counterparts, though the differences were not found to be statistically significant (*11*). After controlling for factors that may cause variability in driving attitudes, Jonah et al. found that those who completed the Motorcycle Training Program were also less likely to be involved in traffic violations (*8*). In contrast, Mortimer found, in both of his studies, that there was no statistically significant difference between violation rates of trained and untrained riders (*15, 16*). Moreover, Billheimer found that more experienced riders – those with more than 805 km of riding experience – tended to have higher violation rates, which may be an indicator that some experienced riders are more willing to take risks. This conclusion was not, however, found to be statistically significant (*11*).

TABLE 3 Findings of Studies Examining the Effect of Training on Violation Rates

Author(s)	Year	Method of Control	Findings
Billheimer, J. H.	1999	Matched-pair	* Lower violations per kilometer 6 mo. after training for trained riders with <805 km of prior experience * Higher violations per mile 6 mo. after training for trained riders with >805 km of prior experience
Jonah, B. A. Dawson, N. E. Bragg, B. W. E.	1982	Statistical	* Lower traffic violations seen amongst MTP graduates
Mortimer, R. G.	1984	Statistical	* No difference in violations per mile between trained and untrained riders
Mortimer, R. G.	1988	Statistical	* No difference in frequency of violations * No difference in violations per mile

Effect of Rider Training on Personal Protection Equipment Usage

Riders who received training were found to be more likely to use personal protective equipment while riding (Table 4). Mortimer observed that people who received training wore protective equipment while riding more often than those who did not. However, Mortimer also noted that riders who received training were more likely to wear their seatbelt while driving a car (*15, 16*). Thus, this observation may be a reflection of the nature of those who seek training (*15*). In a study completed in Indiana, Savolainen and Mannering found that only 5% of those who received training never wore their helmet, as opposed to the 14% of untrained riders who did not wear a helmet (*14*). It should be noted that over 55% of the people included in this study were members of the ABATE of Indiana (*14*). The ABATE organization opposes mandatory helmet laws (*17*), but it is unknown whether those individual members who were surveyed share this position.

TABLE 4 Findings of Studies Examining the Effect of Training on Usage of Personal Protective Equipment

Author(s)	Year	Method of Control	Findings
Mortimer, R. G.	1984	Statistical	* Trained riders used personal protective equipment more * Trained riders used seatbelt more often in a motor vehicle than untrained riders
Mortimer, R. G.	1988	Statistical	* Trained riders used personal protective equipment more * Trained riders used seatbelt more often in a motor vehicle than untrained riders
Savolainen, P. Mannering, F.	2007	Statistical	* Trained riders used helmets more frequently, though it should be noted that about 55% of those surveyed were ABATE members

Limitations of Studies

Comparison of the findings of the studies is not straightforward as the methodology, outcome metric, and even the curricula vary from study to study. There is no standard method for evaluating training effectiveness. The following section examines the limitations of the methodologies used in the studies reviewed above.

Differences in Curricula According to Haworth et al., one common flaw in studying the effectiveness of motorcycle training has been the failure to directly examine the teaching methods used. Instead, many studies focus on the outcome events that may be influenced by training, such as accident and injury rates (*10*). These studies do not take into account the inherent differences in curricula, training sites, and instructors (*18*).

Forty-seven states offer government-sponsored motorcycle training programs (*4*). Most states offer one of the two MSF courses: either the MRC:RSS or the BRC. Some states offer a curriculum that is unique to the state; however, it is generally based on the same basic curriculum as the MSF courses (*7*). Baldi et al. evaluated the government sponsored training programs in each state based on three main categories: administration, education, and licensing. Each category contained subcategories upon which each state's program was evaluated, and states were scored based on these criteria. The categories and effective practices were based on suggestions made in the National Agenda for Motorcycle Safety (NAMS). The administration and licensing categories evaluated the organization of the course and integration of licensing into the course. The education category assessed the quality of the course itself. This category was broken down into subcategories of sound curricula, effective training and delivery, outreach and information efforts, incentives for training, regular program assessments and quality control, and instructor education and teaching (*18*). The scores of the states ranged and this variance represent variations in the effectiveness of each state's program. The same curricula, when presented at different training sites, can differ in effectiveness.

Bias of Self-Selection Most motorcycle training programs are not mandatory. The set of riders who choose to take motorcycle training may not be representative of the entire population of riders. Several studies (*8, 13, 15, 16*) have concluded that riders who choose training tend to be more conscious of safety than those who do not seek formal training. Mortimer questioned participants about how frequently they use a seatbelt while operating a motor vehicle. In both studies, the percentage of trained riders that reported consistent use of a seat belt was higher than both the percentage of untrained riders and the average percentage of people in the state that expressed consistent use of a seat belt (*15, 16*). The effects of this bias should be in favor of the training program. Since those enrolled in the course are more conscious of safety, there should be lower accident rates amongst the trained group (*8*).

It is also possible that those who seek training are inherently not as good at motorcycling as those who do not seek training (*14*). Also, Savolainen and Mannering noted that those who expressed no need to take a training course were 51% less likely to be involved in an accident (*14*). Seeking training may then be a result of a lesser skill level, favoring the notion that those who are trained are more likely to be involved in an accident.

One method used in an attempt to eliminate this bias is matching trained and untrained riders based on significant similarities such as age, sex, and years riding or licensed (*11, 12*). McDavid et al. also paired riders based on the number of accidents they were involved in before receiving a motorcycle license (*12*). It was assumed that having a similar driving record implied a similar level of safety while driving. The notion is that this approach should equalize the levels of risk taking and safety consciousness of riders in the experimental and control groups. The matched pair approach suffers from two drawbacks. First, the method makes the assumption that the researcher knows a priori what factors to control for. Other factors, for example, years of education, weekly alcohol consumption, or vision acuity, may or may not be more important. Second, because subjects are picked manually by the researcher, rather than through random selection, these choices are subject to the unintentional prejudices of the researcher.

Non-representative Samples Many of the studies acquired information through surveys and interviews. Not all riders will take the time to complete a survey or participate in an interview. These studies rely on that subgroup of riders who self-select to participate. This selection is evident in the response rates reported in the studies. Mortimer mailed surveys to people who completed the BRC to compile his experimental group and interviewed riders at motorcycle stores to compile the control group (*15, 16*). The study was conducted in both 1984 and 1988 and the response rates for the surveys were 59.2% and 56% respectively (*15, 16*). The response rate for the control group was over 90% in both studies. Jonah et al. conducted telephone interviews to gather data for both the trained and untrained groups and the response rates were 57% and 71% respectively (*8*). Savolainen and Mannering mailed surveys to members of the American Bikers Aimed Towards Education (ABATE) of Indiana and a control group. The response rate for ABATE members was 14%, with 181 additional surveys gathered from the ABATE of Indiana newsletter. It is anticipated that the low response rate is due to

mailings to outdated addresses. The response rate for the control group, however, was 14.7% (*14*). These are just a sample of some of the response rates from the surveys. Because a large fraction of those surveyed did not respond, there is potentially a non-response bias in the results of these studies. The non-respondents may be a very different group with very different riding and accident experiences than the respondent group.

Licensure

Licensing is intertwined with rider education; motorcycle licensing procedures often encourage motorcyclists to seek formal training. Many aspects of licensing are facilitated through the completion of a motorcycle training course. Some states waive testing procedures for those who have completed an approved course (*4*). As demonstrated above, this incentive motivates people to seek training.

Even though a motorcycle license is required in all 50 states and the District of Columbia (*19*) as well as in New Zealand, Australia, and other countries (*10, 20*), motorcyclists without a motorcycle endorsement account for a large portion of people who are involved in motorcycle accidents. In Maryland, 17% of motorcycle owners do not possess a motorcycle license; however, 27% of motorcyclists involved in accidents were unlicensed (*21*). In a study conducted in southern California in the 1970's, Hurt et al found that unlicensed motorcyclists accounted for 25% of the riders but 50% of all motorcycle crashes (*22*). In 2005, 8% of New South Wales riders involved in accidents were not licensed to ride a motorcycle, though they were involved in 32% of fatal accidents (*23*). Licensing procedures vary between the different states as well as amongst different countries. Most states in the United States do not have a graduated licensing system established for motorcycle riders; however, this is more widely used in other countries such as New Zealand and Australia.

Licensing Systems

Each state has different requirements to obtain a motorcycle license. In 2004, 46 states and the District of Columbia require operators to hold a permit before they can acquire a motorcycle license. However, restrictions placed on permits vary by state. According to McGwin, Jr. et al., the three restrictions most frequently placed on permit holders amongst the states are no passengers or night riding and a helmet must be in use at all times (*19*). Fifteen states have a graduated licensing system similar to those currently in place for automobile drivers. Tiered motorcycle licensing programs are in place in nine states (*24*). Tiered licensing places operating restrictions on motorcycle operation based upon engine displacement (*3*).

The procedure to obtain a motorcycle license in Victoria, Australia has three steps. First, a learner permit is held for at least three months. Then a skills test is taken to obtain a restricted license, which is held for a year. The restricted license can be upgraded to an unrestricted license without any further testing. Restrictions on the learner's permit and restricted license include a maximum engine size of 260 cubic centimeters and a zero BAC level. In order to obtain a restricted license, the seeker must complete a licensing training course (*10*). The motorcycle licensing process is

similar in New South Wales, Australia. However, as of 1990, training is required before receiving both the learner's license and the provisional license, where the provisional license is the equivalent of the restricted license in Victoria. The duration of holding each license is slightly different, requiring the learner's permit to be held for three months and the provisional license to be held for one year (*23*). A similar graduated system was enacted in New Zealand in 1987 (*20*).

Effect of Different Licensing Systems on Accident Rates

Accident rates and the licensing system in place in a locality are correlated (Table 5). In the United States, McGwin Jr et al found that states requiring a training course for licensing tended to have lower fatality rates based on the estimated VMT. Moreover, the number of fatal accidents per miles travelled was significantly lower in states where a system with a restricted permit was implemented as opposed to states with an unrestricted permit. Also, states that require a skills test to attain a permit, mandate a longer duration of time between receiving a permit and obtaining a license, or place three or more restrictions on permit holders have a lower motorcyclist fatality rate than other states when comparing the number of accidents per miles traveled (*19*).

It should be noted that the VMT estimated by the Federal Highway Administration (FHWA) for motorcycles may be underestimated. In North Carolina, it was found that the VMT as reported by the FHWA differed from the VMT reported by the state starting in 1998 and increasing in the following years (*25*). Also, a telephone survey was completed to verify the estimated VMT, and the reported VMT was more than two times greater than the estimated VMT (*25*). The underestimated VMT would make the accident rates calculated using these data artificially high. However, the rates for other types of vehicles, such as automobiles, are more accurate. The inaccuracy in the estimated VMT proves a problem when comparing motorcycle accident rates to accident rates for other motor vehicles. It is anticipated that the inaccuracy should not greatly affect a comparison between accident rates of trained and untrained motorcyclists in the same area and time frame since they are both calculated using the same data.

The effects of the New Zealand graduated licensing system the accident rates were studied to determine the impact of the system. Data from 1978 to 1994 were examined in the study. It was found that the number of riders between the age of 15 and 19 who were involved in a crash decreased between 1984 and 1993. Moreover, there was an observed 22% decrease in hospitalization for people in this age group after the graduated licensing system was enacted. As anticipated, accidents and hospitalizations decreased the most for the 15 to 19 year old age group, as compared to the 20-24 year old and the 25 year old and above groups. However, during this same period, there was also a decline in the number of people aged 15-19 years old who owned motorcycles (*20*), making this study inconclusive.

TABLE 5 Findings of Studies Examining the Effect of Licensing on Accident Rates

Author(s)	Year	Location	Licensing System	Metric of Effectiveness	Findings
McGwin, Jr., G. Whatley, J. Metzger, J. Valent, F. Barbone, F. Rue III, L. W.	2004	United States	Various	Mortality rate based on VMT	When comparing miles ridden, lower mortality rate in states that * Required a skill test to obtain a permit * Placed three or more restrictions on the permit * Required a longer permit holding period When comparing number of riders, lower mortality rate in states that * Required training for licensure
Reeder, A. I. Alsop, J. C. Langley, J. D. Wagenaar, A. C.	1999	New Zealand	Graduated	Hospitalization due to motorcycle accidents	* 22% decrease for 15-19 year old hospitalizations * Decrease in the number of licensed 15-19 year olds * General trends before implementation of GDLS were down and no great effect seen by the start of the GDLS

DISCUSSION

The divided support for motorcycle training between the studies may seem surprising. Like drivers education, there is a common assumption that training should produce safer riders. However, in a review of driver education, Mayhew found no clear evidence that driver education is effective (*2*). The "DeKalb" study, published in 1983, is the largest and most thorough review of driver education (*2*). The study demonstrated that the effects of driver education were minor and not lasting (*26* cited in *2*). Though driver education and motorcycle training cannot be directly compared, many of the studies reviewed in this paper have also questioned the value of motorcyclist training. Previous research has addressed several of the assumptions regarding motorcycle training effectiveness.

One common assumption is that trained motorcyclists have fewer accidents. A review of the literature shows that there is no consensus for the validity of this assumption. McDavid et al. found that trained riders tended to have fewer and less severe motorcycle accidents (*12*). Davis found that motorcyclists with training had fewer accidents per person than untrained riders (*13*). Billheimer demonstrated that, in the first six months following training, riders with little experience before training tended to

have fewer accidents than untrained riders with a similar amount of experience. However, after this time period, there was little difference in the accident rates (*11*). For riders with more experience before completing training, no significant differences were observed in accident rates at any time (*11*). After statistically controlling for factors that may influence accidents, Jonah et al. found there to be no difference in accident rates between trained and untrained riders (*8*). Likewise, Mortimer came to the same conclusion in both his studies (*15, 16*). Savolainen and Mannering reported that trained riders had an increased accident rate (*14*). Based on the current findings, the assumption that training decreases accident involvement cannot be wholly accepted as true.

Another common assumption about motorcycle training is there will be a decrease in traffic violation rates. Again, the literature provides a mixed review on the validity of this assumption. McDavid et al. demonstrated that trained riders had fewer violations (*12*). Likewise, Billheimer found that those with little experience prior to training tended to have lower violation rates. However, he also found that those with greater prior experience exhibited higher violation rates (*11*). Similarly, Mortimer found no difference in violation rates between trained and untrained riders (*15, 16*).

An increased use of personal protective equipment is another supposition made about training. Both of the Mortimer studies concluded that trained riders used personal protective equipment more often than untrained riders *(15, 16*). Savolainen and Mannering also found that trained riders used helmets more frequently (*14*). Thus, the literature supports this benefit of training.

Lastly, a common assumption about licensing is that graduated licensing systems are effective in reducing accidents and their severity. In the United States, many states do not have graduated licensing for motorcyclists. However, McGwin, Jr. et al. found that there were fewer motorcyclist fatalities in states with longer permit holding periods (*19*). This supports the notion that those who are allotted more time to practice before receiving an unrestricted license, as is the case with a graduated licensing system, are less likely to be involved in a severe accident. A study conducted by Reeder et al. on the effectiveness of a graduated licensing system in New Zealand was inconclusive (*20*).

Limitations of Studies

The evaluation of training and licensing effectiveness is not a straightforward exercise. Many of the studies examined in this review had shortcomings. Following is a summary of the limitations of the studies reviewed here, and recommendations for improvements for future effectiveness studies:

- Random Samples vs. Biased Samples. Ideally, studies should be conducted based upon random sampling. Only in this manner can a sample be assured to capture all the variation in the motorcycling population. Riders who choose to respond to a survey may not be representative of the population of all riders. They may respond for example because they are motivated by having suffered an accident. Equally suspect are samples of convenience in which a group of riders is selected for survey not because the sample is representative of all riders, but because it is convenient to

survey. A sample of convenience would include riders surveyed because they are in a class, or because their names are on an organization's readily obtainable mailing list. Riders who voluntarily choose training may have self-selected to be in the class for reasons ranging from being less skilled to simply being more safety consciousness than the general population of motorcycle riders.

- Surveys vs. Interviews. Surveys with low response rates are suspect to non-response bias. Non-respondents may have had very different riding experiences than respondents. A much improved method of collecting personal data would be through on-site interviews because the response rate would be much higher.

- Researcher Bias. A match-pair sample is questionable because pairing people assumes that the researcher knows what factors essentially make people "equal" enough to be directly compared. The factors chosen to match the riders are subject to the conscious and unconscious biases of the individual researcher. One possible way of eliminating a sample bias would be to include all possible subjects, and look at the sample over a period of time, including time both before and after training.

- Outcome Metrics. The ideal study would consider another means of evaluation other than accidents. Accidents are relatively rare, and may not be based on the skill of the rider. The use of violations counts or rates, while still not representative of the entire skill set of the motorcyclist, would provide more insight into motorcycle trends since there are more violations than accidents. Also, the denominator for rates needs to be carefully chosen and computed. As discussed above, current VMT data is faulty, making rates artificially high, so a different measure for comparison should be chosen.

- All Training Courses are not Equivalent. Lastly, not all training is equal because not all trainers and training sites are equally proficient in teaching the material of the course.

An ideal study would use a random sample, base conclusions on factors other than accident rates, and choose an appropriate method for calculating rates. These ideal conditions would be challenging to attain, but would lead to a more conclusive assessment of training and licensing effectiveness.

CONCLUSION

Research to date has not consistently supported the notion that training is either effective or ineffective. No standard methods for evaluation exist, and studies vary greatly in the comparisons that are made and the effects of training that are investigated. Many studies evaluated the effectiveness of training programs through a comparison of the accident rates between trained and untrained riders. Some studies have demonstrated that motorcycle training is effective (*7, 18, 11-13*), while other studies have demonstrated that it is ineffective (*8, 14-16*). However, not all training

offered is equal; different curricula and different motivators for receiving training exist. Motorcycle education has proven to be effective in increasing the usage of personal protective equipment. Trained riders were found to make use of personal protective equipment more often than untrained riders (*14, 15*).

Licensing systems were also found to have an effect on motorcycle accidents. Licensing systems, which increase the amount of supervised practice time motorcyclists must complete before receiving an unrestricted license, were shown to result in lower accident rates.

The conclusions of this paper are based upon the review of a limited number of studies. There exists a great variability between different studies due to the methods used and consequences of training that are examined. One of the major findings of this review is that many of the studies suffered from methodological shortcomings which cast varying degrees of doubt on their findings. This paper has identified a number of limitations in these previous studies, and recommended elements which should be incorporated into future effectiveness studies. The results of these previous studies may be more a reflection of the methods used to evaluate motorcycle training rather than the effectiveness of training itself.

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New Jersey Motor Vehicle Commission, Virginia Tech, Rowan University:

New Jersey Motorcycle Fatality Rates

Allison Daniello
Aaliyah McClinton
Benjamin Powell

Project Background

- **Problem Statement:**

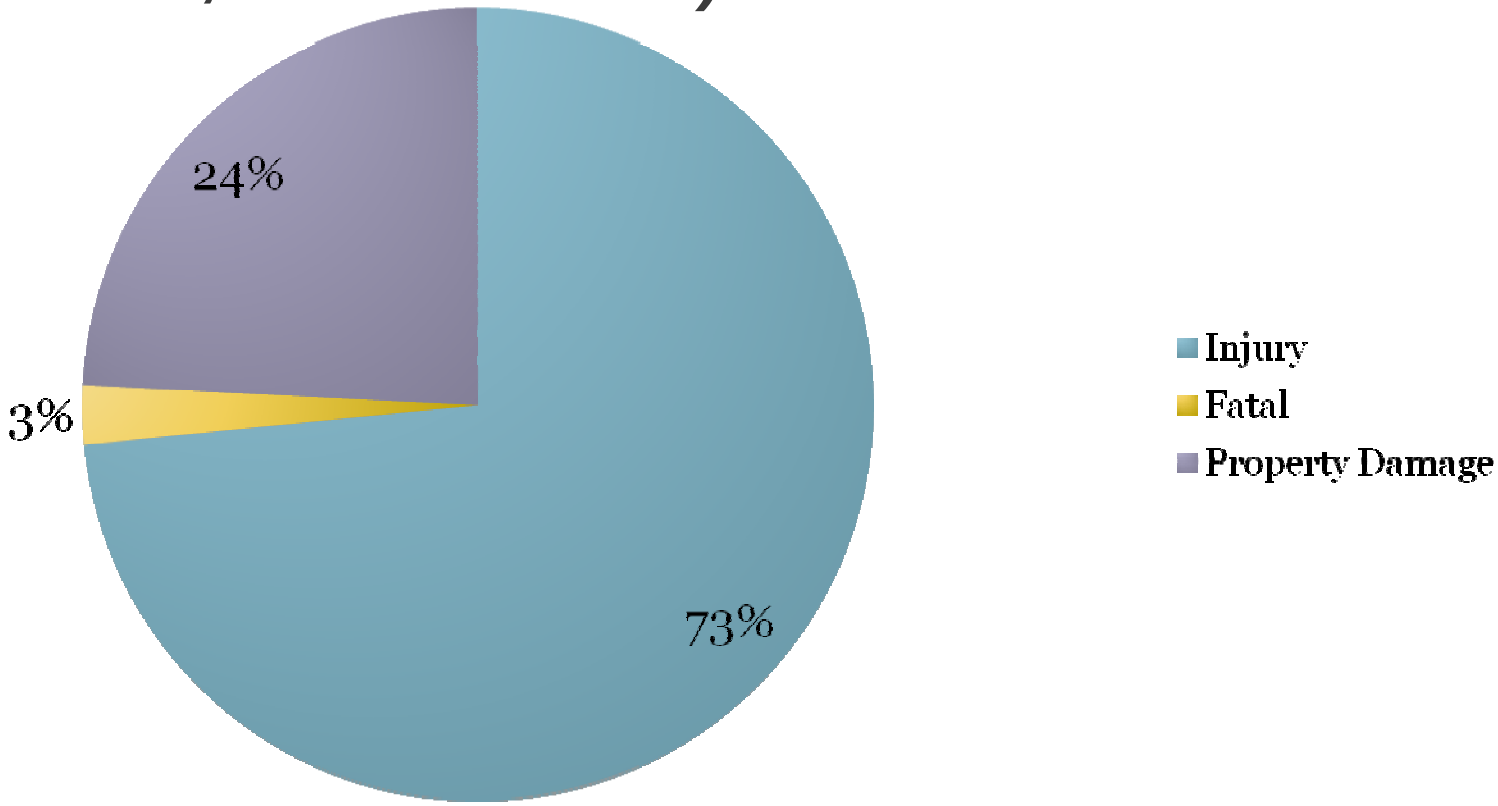
While vehicular transportation related fatalities are decreasing, motorcycle fatalities are increasing at a rate GREATER than the growth rate of motorcycle ridership.

- **Project Objectives:**
  - Gather data concerning motorcycle accidents in NJ.
  - Determine the root causes of NJ motorcycle accidents.
  - Develop a strategic plan for the reduction of NJ motorcycle accidents.

Overview

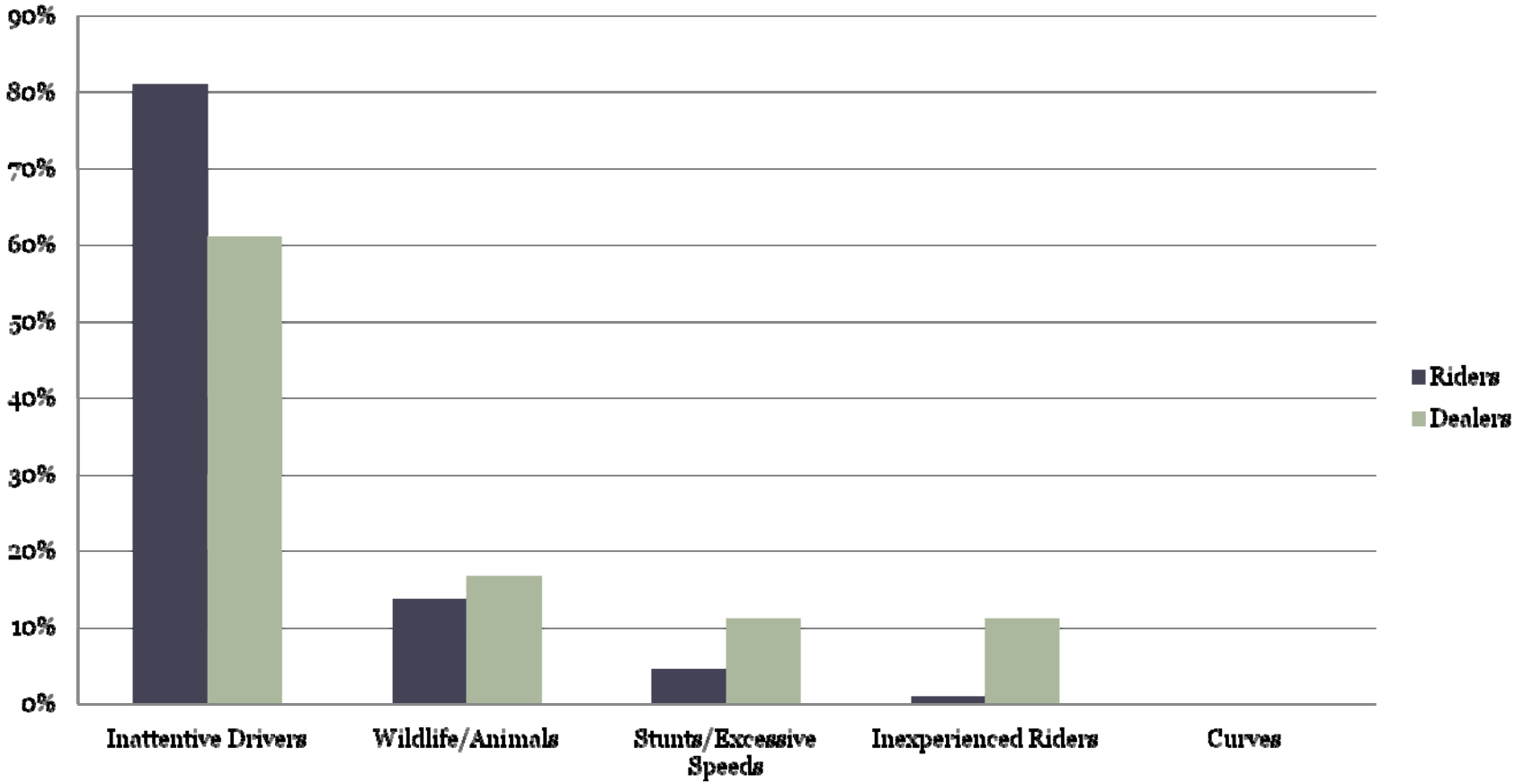
- Behavior and Trend Analysis
- Crash Data Analysis
- Conclusions & Suggestions

Motorcycle Accidents by Severity (NJCrash, 2001-2007)

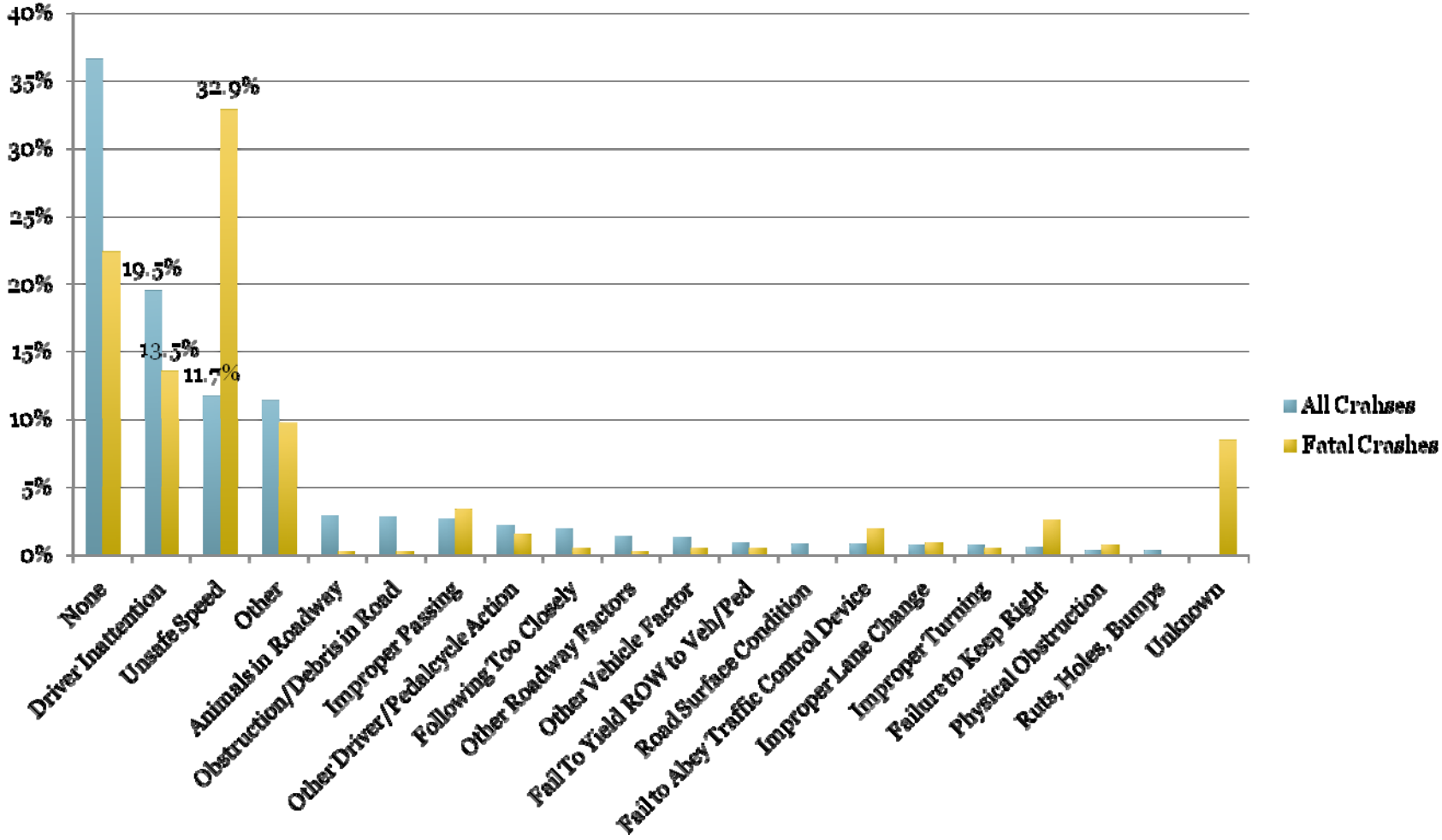


Motorcyclist Behavior & Trend Analysis

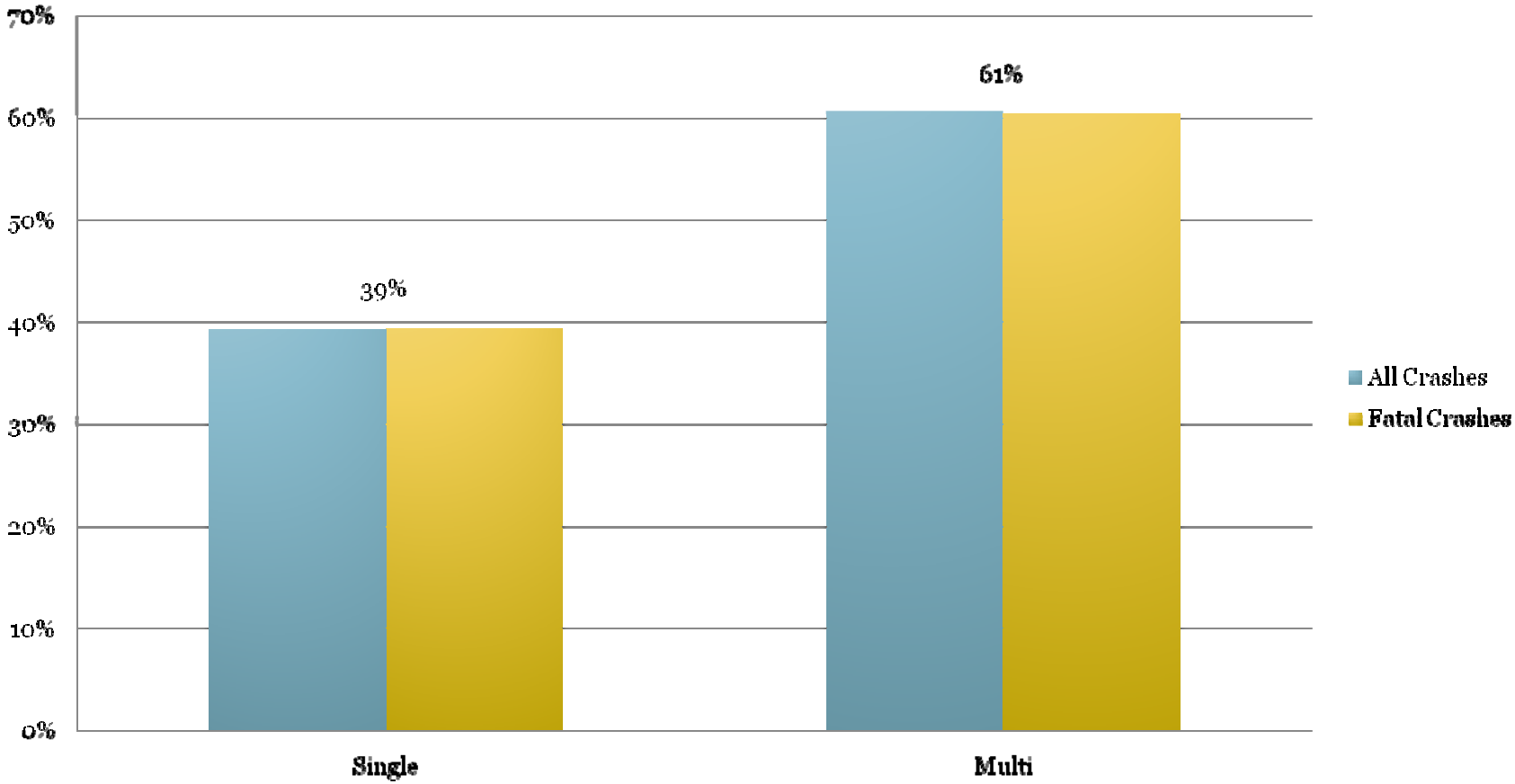
Perceived Accident Causes



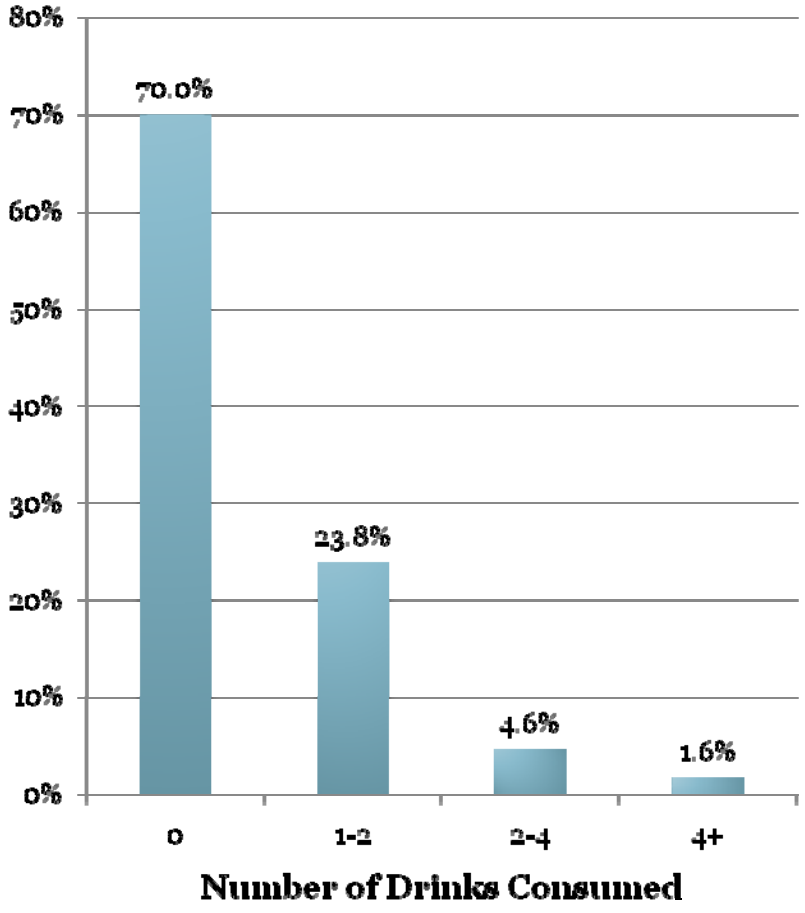
First Contributing Factor to Motorcycle Crashes

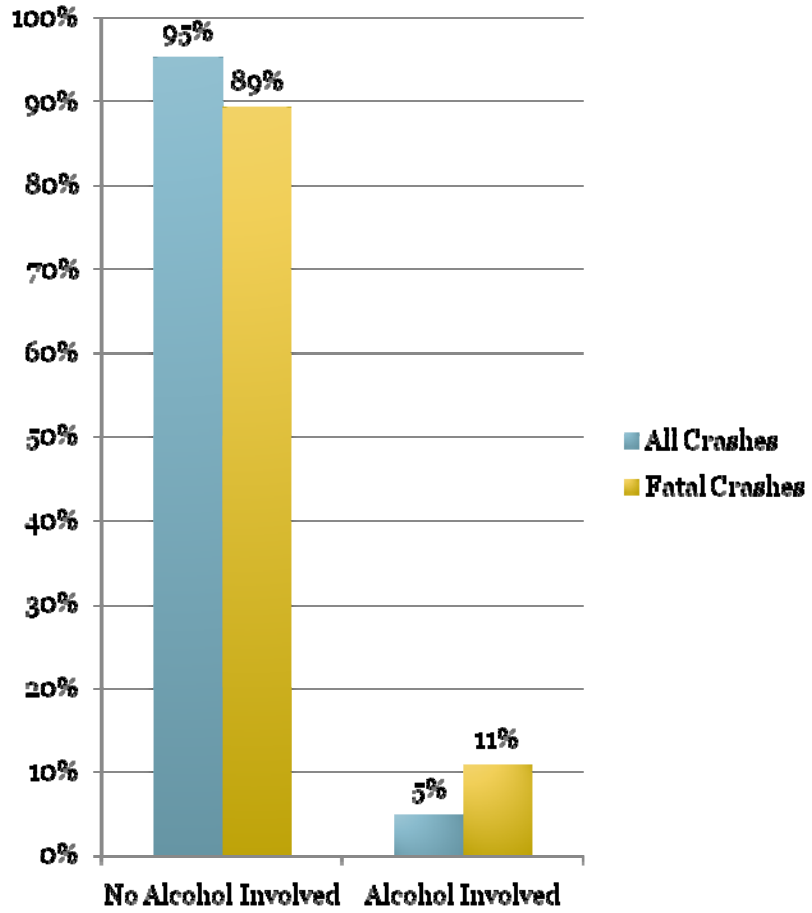


Single And Multi Vehicle Crashes



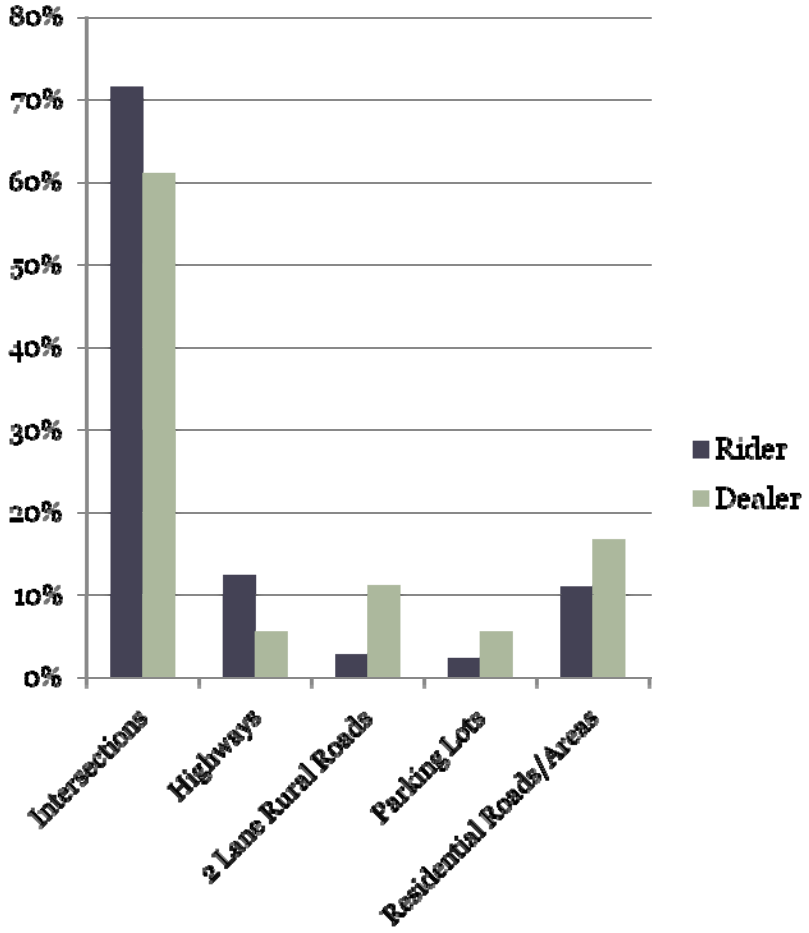
Alcohol Involvement In Crashes

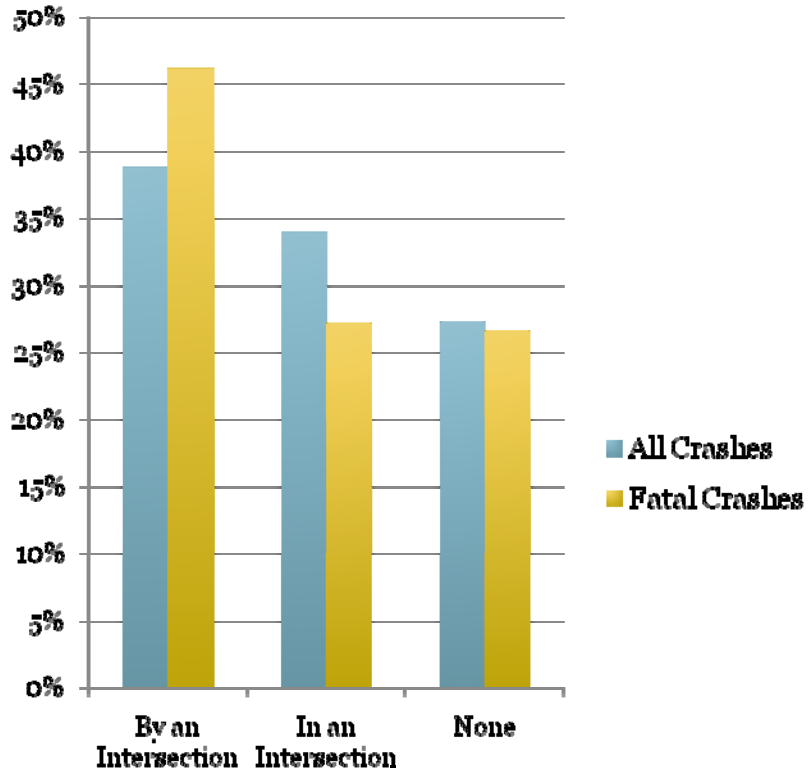




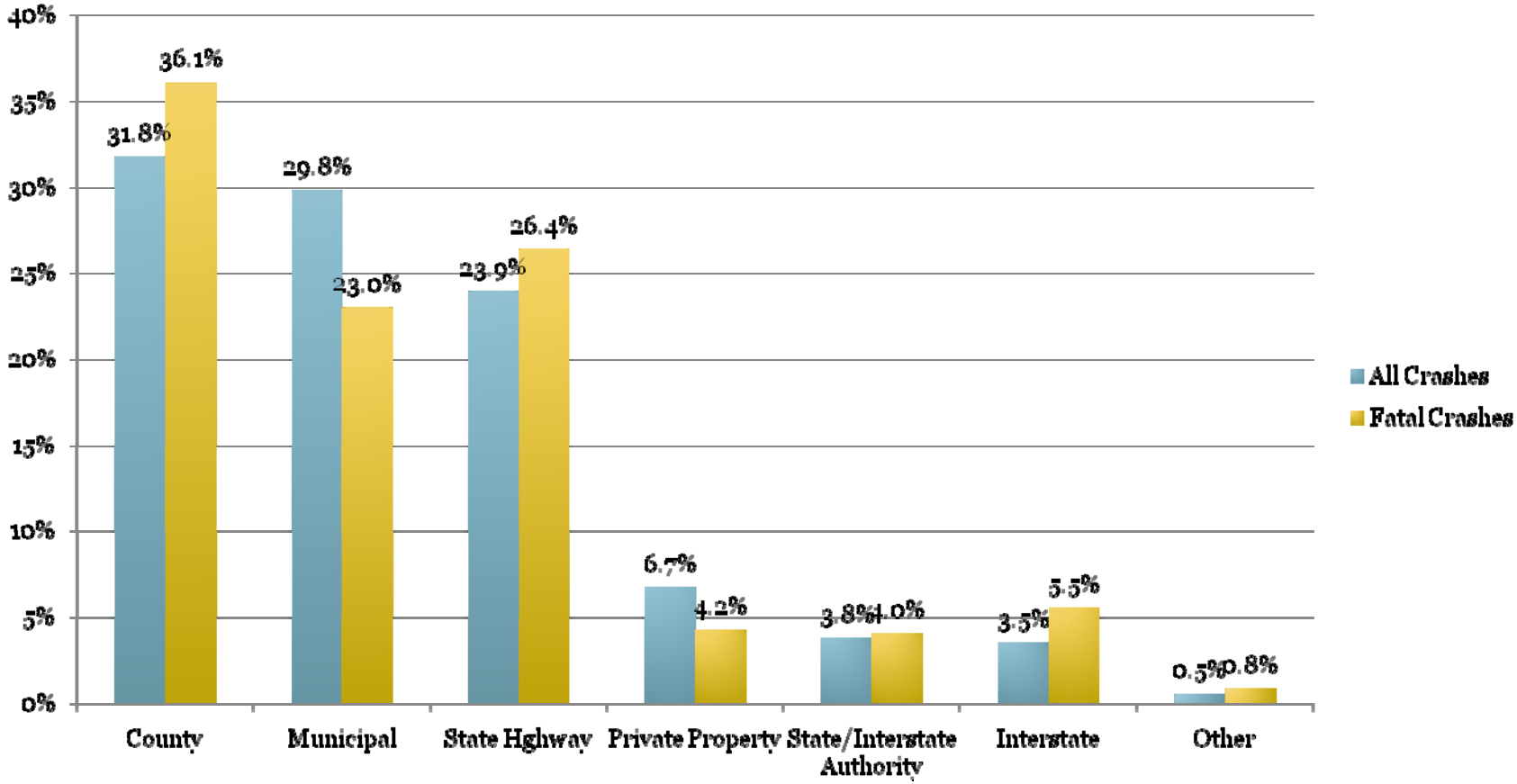
NJCrash Data Analysis

Hazardous Areas



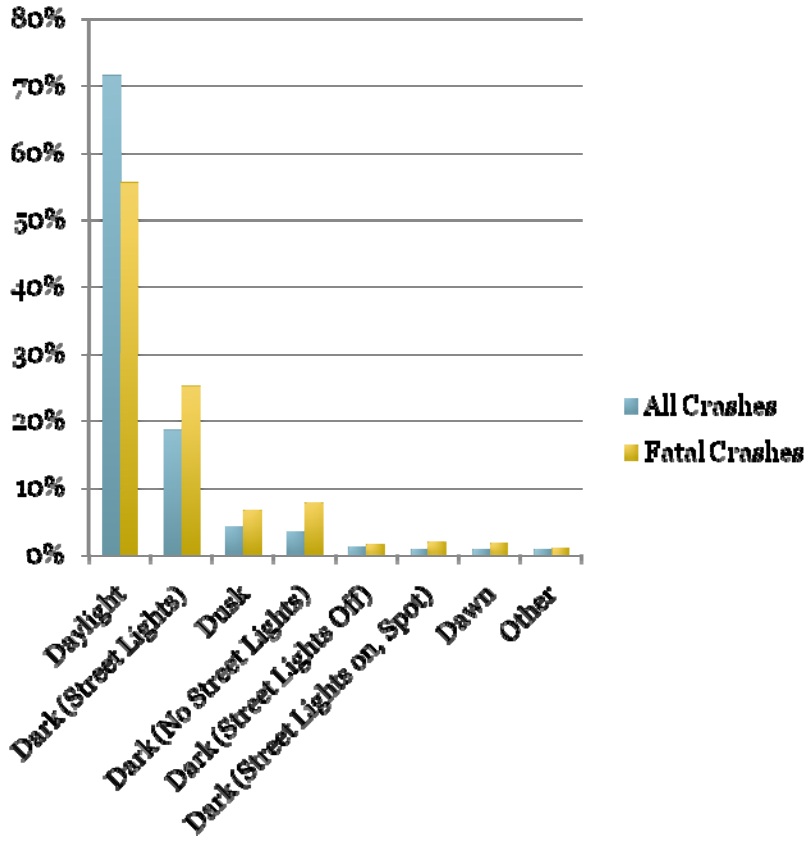


Road types where Motorcycle Accidents Occurred

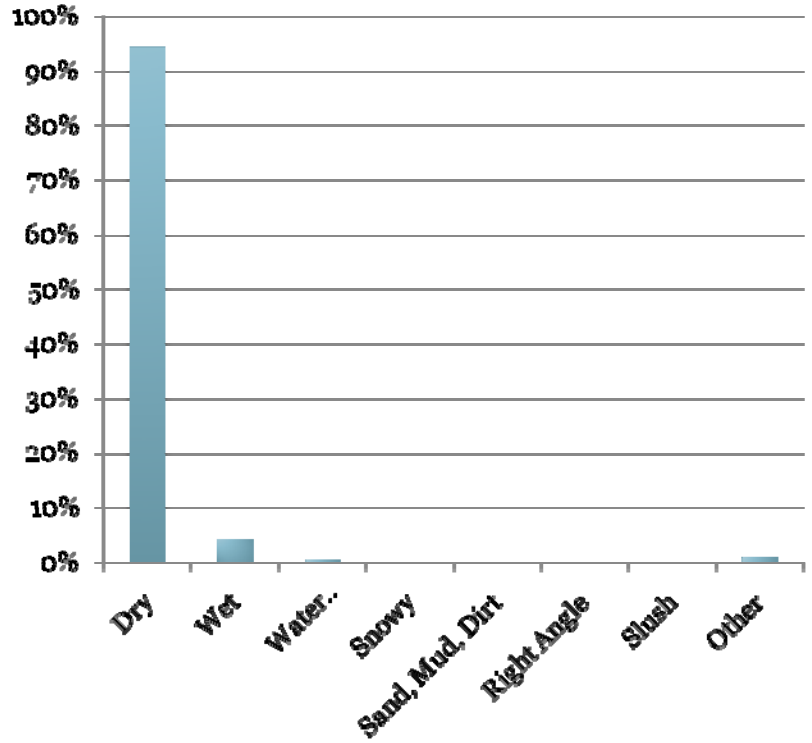


Road Conditions

Lighting condition



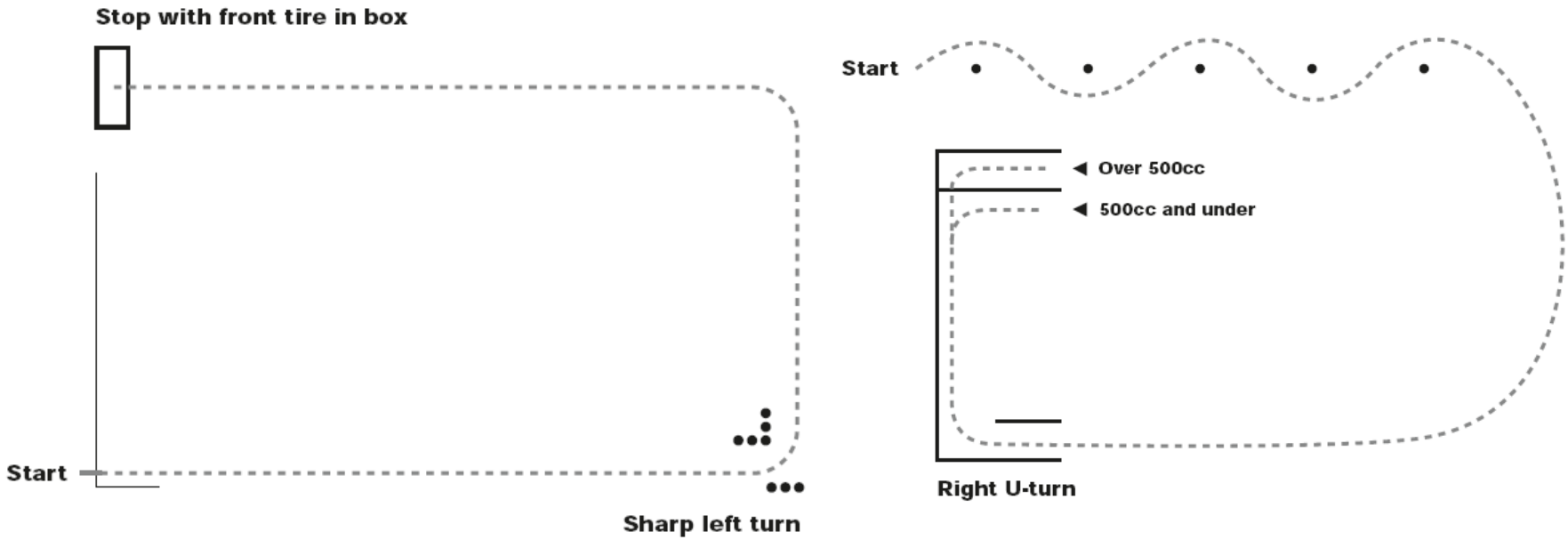
Road Surface Condition



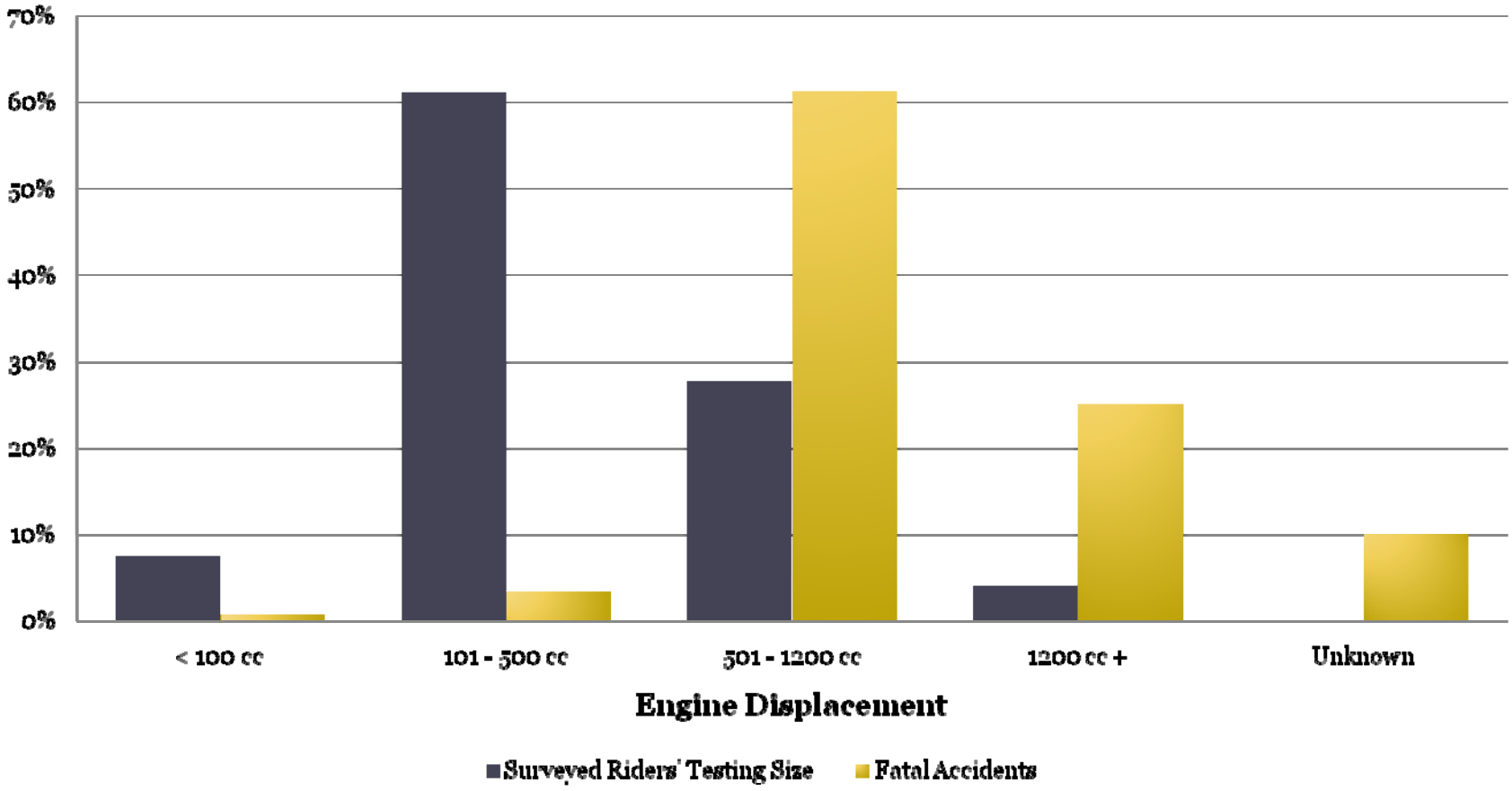
Conclusions & Suggestions

Conclusions and Suggestions

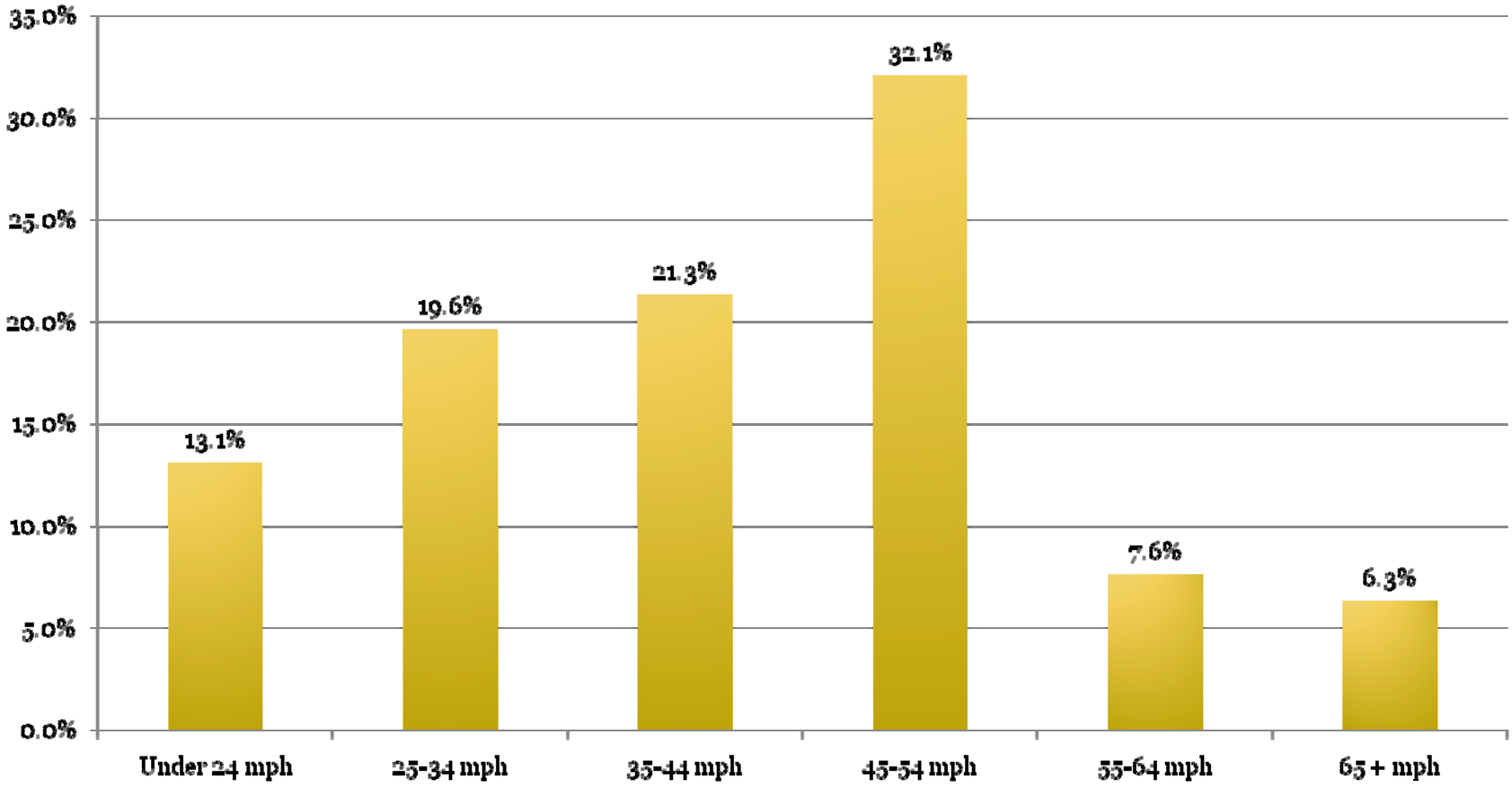
- Focus on process of motorcycle endorsement procurement
- NJMVC Road Test, MSF Basic Rider Course
  - No engine displacement requirements
  - No vehicle speed requirements



Conclusions: Engine Displacement



Conclusions: Posted Speed



Suggestions

- **Tiered/Graduated Licensing**
  - Based on individual rider experience
  - Limited by motorcycle engine displacement

- **Reevaluation of endorsement processes**
  - Multiple tests based on skill level
  - Use same testing process, limit on motorcycle used
  - Include speed requirements
  - Change process to better imitate roadway situations

Questions?

The Effectiveness of Motorcycle Training and Licensing

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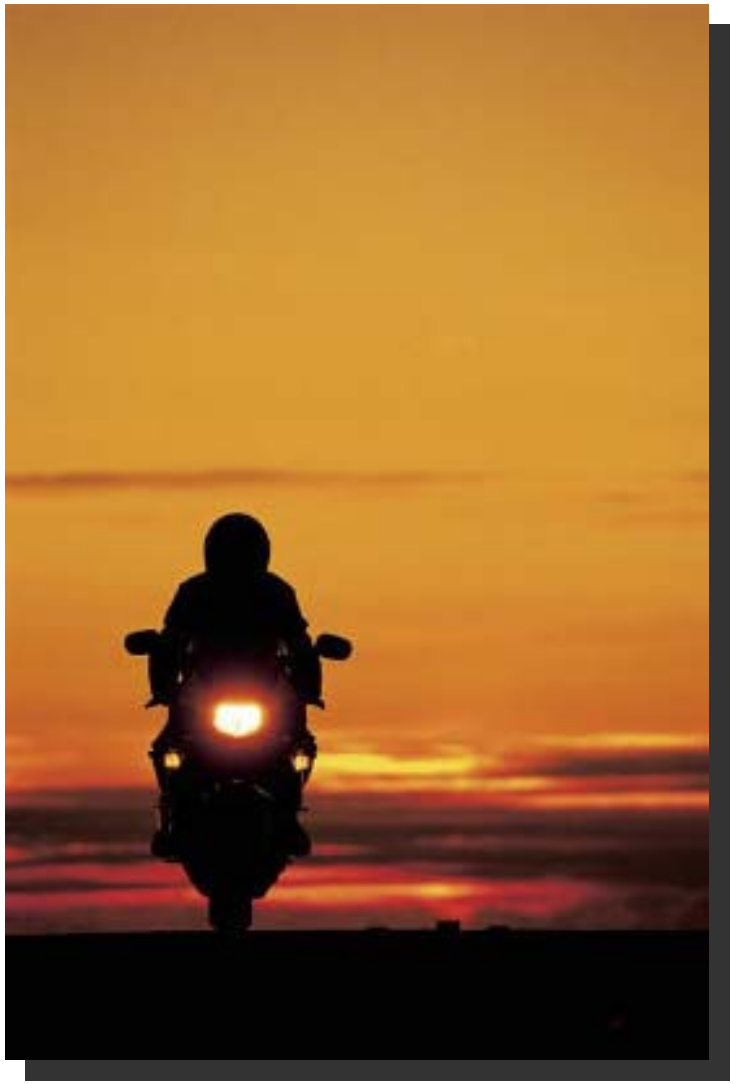
Rowan University

STATE OF NEW JERSEY
MOTOR VEHICLE COMMISSION

Overview

- Rider Training Programs
- Licensure
- Limitations of Studies



Source: Robert Houser, www.art.com

Rider Training Programs

- Overview of Rider Training Courses
- Effect on Accidents
- Effect on Violation Rates
- Effect on Personal Protective Equipment

Rider Training Courses

- MSF Courses
  - Motorcycle RiderCourse: Rider and Street Skills (MRC:RSS)
  - Basic RiderCourse (BRC)
- Other Courses
  - Harley Davidson Rider's Edge New Rider Course
  - Courses developed by individual states
- Classroom Training
- Skills Training

Source: www.michigan.gov/sos

Effect on Accident Rates
Matched-Pair Control

- Paired trained and untrained riders based on characteristics that determine riding style
- Trained riders had fewer motorcycle accidents (McDavid et al., 1989)
- Trained riders with little prior experience had fewer accidents (Billheimer, 1999)
- Trained riders with prior experience did not have lower accident rates (Billheimer, 1999)

Effect on Accident Rates Statistical control

Source: www.nj.com

- Used statistical methods to control for confounding factors
- Trained riders did not have lower accident per mile (Mortimer 1984, 1988; Jonah et al, 1982)
- Increased number of accidents for those who were trained (Savolainen and Mannering, 2007)
- Fewer accidents per operator for trained riders (Davis, 1997)

Effect on Violation Rates

- Trained had lower violation rates
  - Billheimer, 1999; Jonah et al, 1982
- No difference in violation rates between trained and untrained riders
  - Mortimer 1984, 1988
- More experienced riders tended to have higher violation rates
  - Billheimer, 1999

Effect on Personal Protection Equipment Usage

Source: www.harley-davidson.com

- Trained riders were more likely to use personal protective equipment
- Mortimer noted that trained riders were more likely to wear a seatbelt
  - Reflection on nature of those trained

Licensure

- Licensure Methods
- Effect on Accident Rates

Licensure Methods

- Tiered licensing (US)
  - Restriction on engine displacement
- Graduated licensing (Australia, NZ)
  - Permit, provisional license, unrestricted license

Source: Michael Lichter, www.art.com

Effect on Accident Rates

- United States (McGwin Jr. et al, 2004)
  - States that required training for licensing had lower mortality rate
  - States with more restrictions on permit had lower mortality rate
- New Zealand (Reeder et al, 1999)
  - Decrease in hospitalizations for 15-19 year olds after graduate licensing introduced
  - Also decrease in number of licensed riders

Limitations of Studies

- Differences in Curricula
- Sample collection
- Outcome Metrics

Differences in Curricula

- Studies usually focus on accidents, not the curricula itself
- Differences curricula, training sites, and instructors not taken into account
- Varying effectiveness of US state-sponsored programs based on an evaluation administration, education and licensing

Source: www.rockymountainmotorcylcetraining.com

Sample Collection Self Selection Bias

Source: www.floridasafety.org

- Riders who seek training tend to be more safety conscious
  - Tend to lower accident rates
- Riders seeking training may be inherently not as good at motorcycling
  - Tend to raise accident rates
- Matched-pair research method used to eliminate
  - Assumes researcher knows everything that affects accidents

Sample Collection
Non-Representative Samples

- Ideally, studies should be based on random samples
- Surveys rely on people selecting themselves to participate
- Samples of convenience may exclude are not representative
- Non-respondents may be a vastly different group
- Interviews yielded a higher response rate

Outcome Metrics

- Relatively few accidents and may not be a result of rider skill
- Violation rates provide more insight
- Careful choice of denominator for computing rates

Ideal Study

- Random Sample
- Base conclusions on factors other than accident rates
- Choose an appropriate method for calculating rates

Conclusions

- Training has not been proven either effective or ineffective through past literature
- Licensing systems with some restrictions have shown to reduce accidents
- Variability in studies due to methods and consequences examined
- Some methodological shortcomings cast varying degrees of doubt on finidings

Questions?