

MOTORCYCLES: CRASH TRENDS, CONSPICUITY, AND INTERVENTIONS

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INTRODUCTION

Advancements in vehicle technology and upgrades to traffic safety laws have produced dramatic nationwide reductions in overall traffic crash fatalities and injuries over time. However, similar reductions have not been realized in motorcycle crashes. The Governors Highway Safety Association (GHSA) projected an approximate 9% increase in motorcyclist fatalities nationwide in 2012, representing upsurges in fatalities in 14 of the last 15 years (GHSA 2013). Data from the Fatality Analysis Reporting System (FARS) shows a steady increase in motorcycle fatalities, and the USDOT declares this upward trend to be “the Nation’s greatest highway traffic safety challenge” (2007). Similarly, North Dakota has recorded increases in motorcycle crash events across all crash types – fatal, injury, and property damage only (PDO). For this study, motorcycle crashes in North Dakota are examined using crash data from 2002 to 2012. Additional information regarding motorcycle conspicuity and rider training and education is presented as a basis for efforts to guide crash prevention.

Crash Facts and Trends in North Dakota

When considering all crash types, the number of motorcycle crashes in North Dakota largely reflects a rising trend with the 2012 total representing an 85% increase over 2002. However, the overall share of each crash type varies. The annual share of crashes by severity is illustrated in Figures 1 through 3. Fatalities show some irregular fluctuations, but have increased in the share of crash events over the years. Injury crashes declined slightly since peaking in 2003, while the share of PDO crashes with the exception of an escalation from 2003 to 2004, has remained relatively consistent. Applying a 10-year average and considering all motorcycle crash events, fatal crashes represent 4% of the aggregate crashes, and injury and PDO hold 79% and 17% shares respectively.

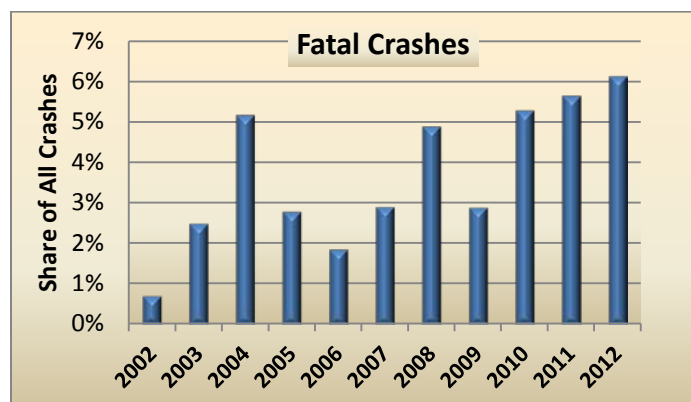


Figure 1 Fatal Crashes as Share of All Motorcycle Crashes

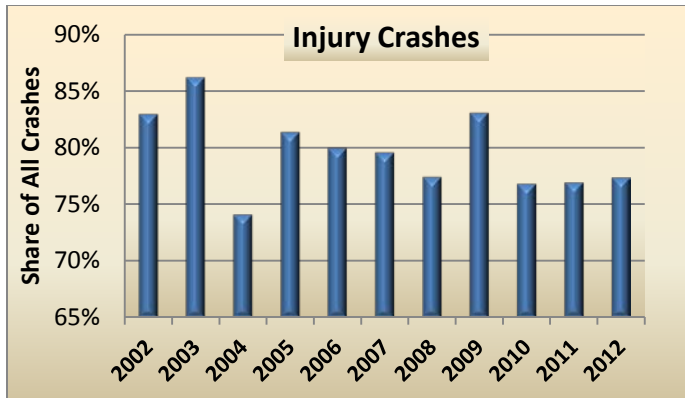


Figure 2 Injury Crashes as Share of All Motorcycle Crashes

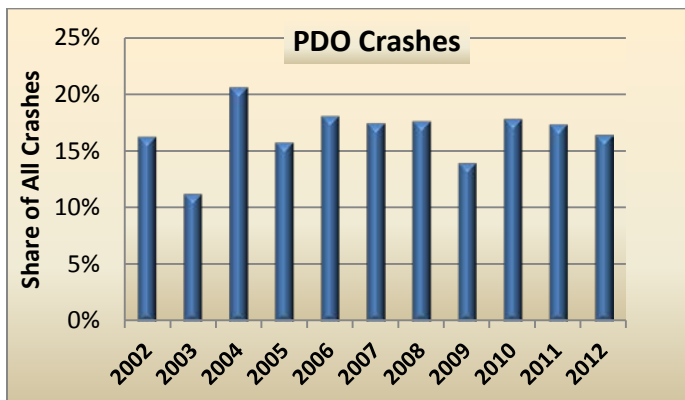


Figure 3 PDO Crashes as Share of All Motorcycle Crashes

Crashes involving motorcycles peaked in 2008 with 266 overall. Although the state saw a reduction in crashes the following year, the numbers have been on the rise again over the ensuing years, and crashes in 2012 approached the 2008 levels. An analysis of motorcycle incidents for the most recent 5 years reveals an average annual frequency of 12 fatal, 189 injury, and 41 PDO crashes. Crash frequency for 2012 outpaces these averages in all crash types. Further, evaluating driver crash severity indicates the share of fatal and disabling crashes rose from 15% in 2008 to 25% in 2011 and 2012.

Although North Dakota has seen an increase in motorcycle crash frequency, the number of licensed operators and registered motorcycles has also markedly increased. From 2002 to 2012 the number of licensed drivers increased by 50% and motorcycle registrations by 258%, with the latter approximately doubling from 2010 to 2012 alone (NDDOT). A decline in the share of fatal and injury crashes in relation to registered motorcycles is noticed in the past five years, as well as a marginal decline in these crashes corresponding to licensed operators (Figure 4).

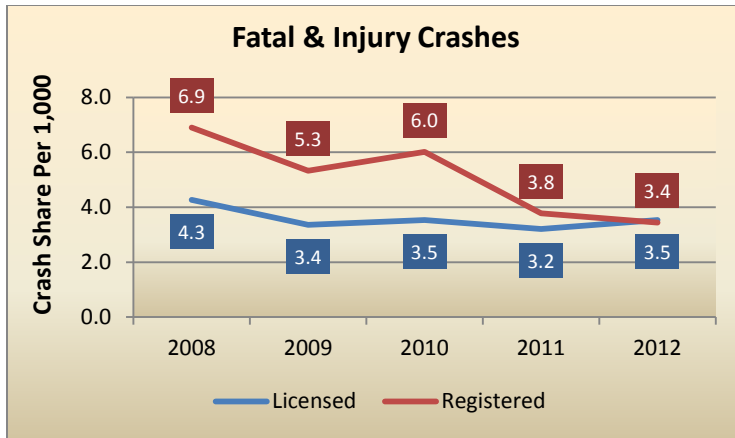


Figure 4 Crash Rates of Licensed Drivers and Registered Motorcycles

Figure 5 shows weekly crash incidents from 2002 through 2012. More than half of weekly crashes occur Friday through Sunday with Saturday comprising the largest share at 20%.

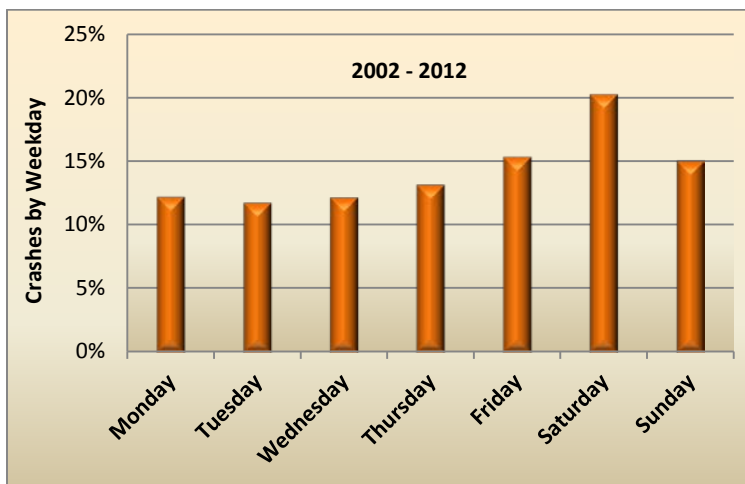


Figure 5 Motorcycle Crash Incidence by Day of Week

North Dakota's climate hinders year-round motorcycle use, and as a result, the majority of crashes (84.1%) occur between May and September (Figure 6). Research suggests that seasonal use may contribute in part to ROW (right-of-way) or angle crashes where other drivers fail to see clearly visible motorcycles. The motorcycle is in sight but does not command the driver's attention. The relationship between scanning errors and *failure to see* crashes is addressed in greater detail in the conspicuity section of this report.

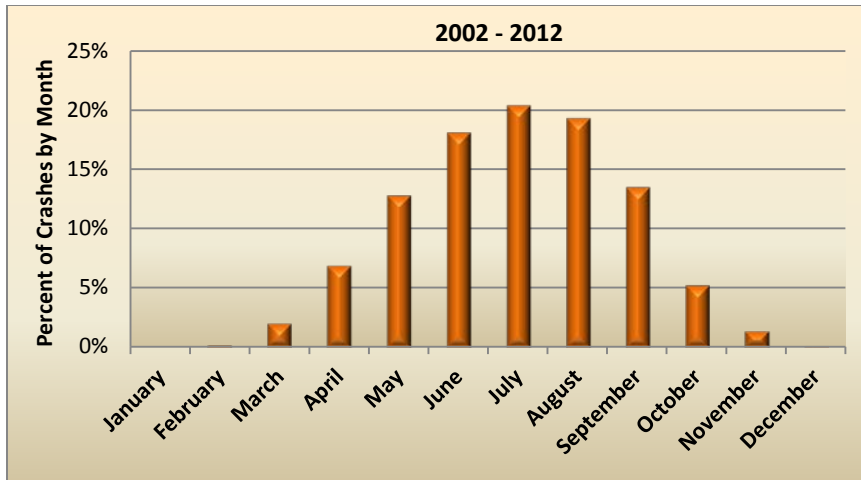


Figure 6 Motorcycle Crash Incidence by Month

Figure 7 outlines ND motorcycle crashes based on various light conditions. Approximately three-fourths of crashes occur during daylight hours with the remainder occurring under conditions where lighting may be considered less than optimum.

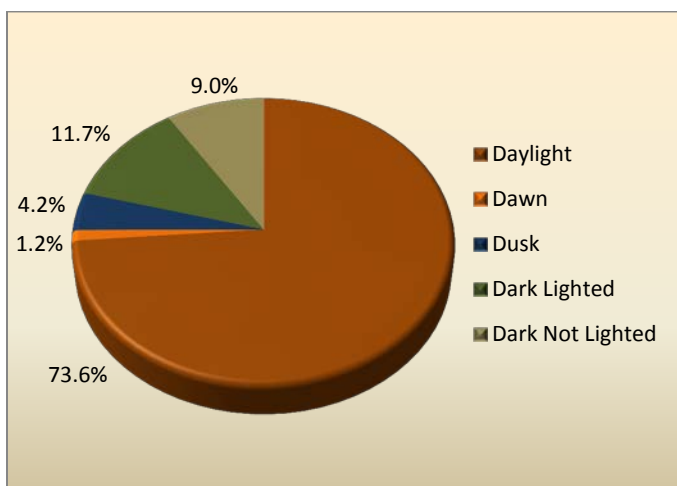


Figure 7 Crashes by Light Conditions

Categorization by rural and urban roads of all motorcycle crashes between 2002 and 2012 demonstrates overall crash frequencies of 58% on urban roads and 42% on rural roads. The tendency toward more crashes on urban roads is maintained in injury crashes (59% urban and 41% rural), as well as PDO crashes (65% urban and 35% rural). Fatal crash severity is more pronounced on rural roads, however, by an approximate 3 to 1 ratio. A detailed separation of only fatal and injury crashes within road types is represented in Figure 8. In this breakdown, crashes occur more frequently on principal arterial, minor arterial, and major collector urban roads. A noteworthy shift occurs within the local roads category where the share of crashes jumps to 90% rural and 10% urban.

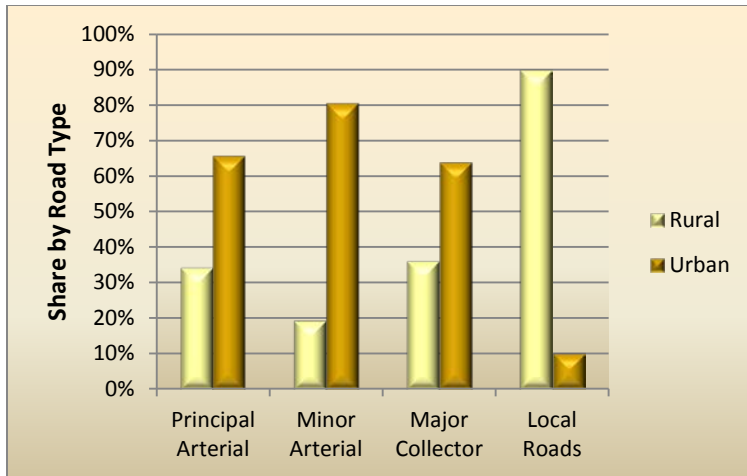


Figure 8 Fatal and Injury Crashes by Road Type

Figure 9 shows common contributing factors to motorcycle crash events as reported by the attending officer. Each crash can be attributed up to three contributing factors and these are merged in the chart. Speeding and too fast for conditions combined for the leading contributing factor to motorcycle crashes. Improper evasive action and improper handling (includes improper backing/turning, improper overtaking, improper lane change, vehicle operation erratic, and over-correcting) factored equally in crash events. The remaining contributing factors were identified in fewer than 5% of crashes.

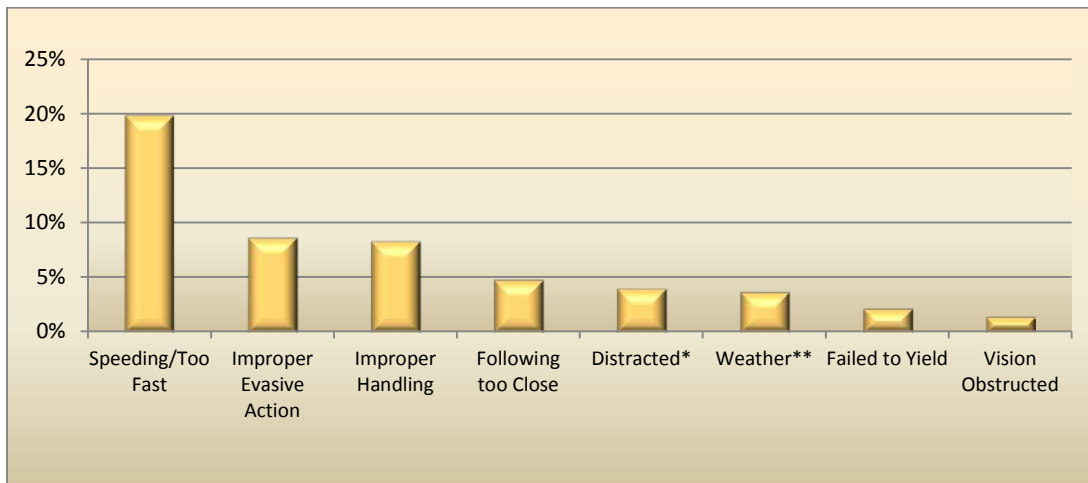


Figure 9 Contributing Crash Factors

The three categories of crashes shown in Figure 10 account for roughly 75% of crashes from 2002-2012. One third of crashes occurred at intersections, and 21% and 18% of crashes were run-off-the road and lane departure respectively. Additional research to realize improvement in these areas may be essential to ongoing reductions in the number and severity of motorcycle crashes.

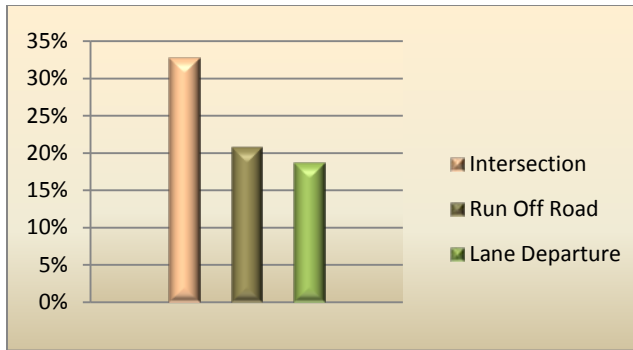


Figure 10 Share of Motorcycle Crashes by Crash Type

An examination of citations also provides insight for safety focus areas. Motor vehicle crash attenuation often includes recommendations for reducing impaired driving. An analysis of alcohol-involved motorcycle crashes in North Dakota from 2008-2012 shows an average of 12% of crashes annually involved some measure of motorcyclist alcohol impairment as reported by the attending officer (Figure 11). Supplemental analyses of citations issued during the same timeframe reveals motorcyclists hold a disproportionate share of *DUI* citations when limiting citations to angle crashes (4:1 ratio motorcyclist to other drivers), as well as multi-vehicle crashes 70% to 30% (motorcyclists and other drivers respectively).

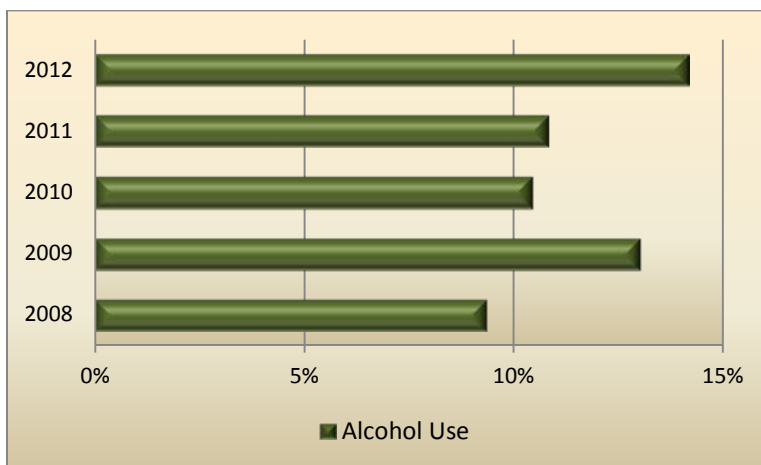


Figure 11 Motorcycle Crashes Involving Alcohol

Figure 12 further identifies the type and share of citations based only on crashes where citations were issued to motorcyclists. In this analysis, frequency of *care required* citations exceeded *DUI* citations, 25% compared to 22%. Motorcyclists were cited for *driver' license* and *insurance* violations in about 15% of crashes, while *following too close* and *careless driving* citations combined for another 10%.

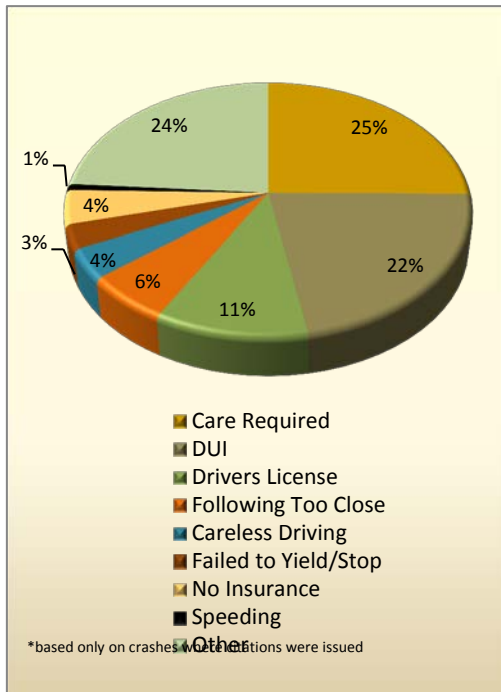


Figure 12 Citations Issued to Motorcycle Drivers

A breakdown of citations encompassing only multi-vehicle crashes is shown in Figure 13. Citations issued for *care required* were slightly more frequent for motorcyclists; however, there was a near equal share of this violation with other drivers, 51.9% and 48.1% respectively. As with all crashes, multi-vehicle crashes reflect sizeable differences in citation classifications.

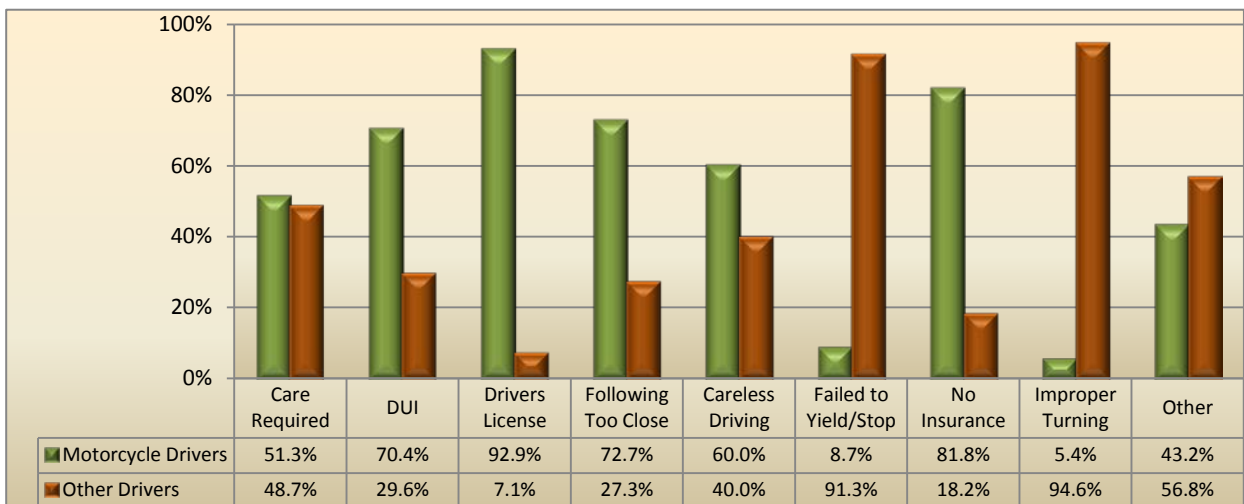


Figure 13 Citations Issued in Multi-Vehicle Crashes

Helmet Use by Motorcyclists

Helmet use is commonly believed to mitigate crash severity. The GHSA reports that “helmets are by far the single most effective method to prevent motorcyclist fatalities and serious injuries” (GHSA 2013). The report goes on to state that helmets are 37% effective in preventing fatalities in operators and 41% effective for passengers. Helmet use in states with universal laws is 84% while only 50% in states without said laws (GHSA 2013). There are 19 states with mandated universal helmet laws with several states having repealed laws. After laws were repealed, GHSA affirms helmet use dropped and states saw increases in fatalities anywhere from 21% to 108%.

North Dakota does not have a primary helmet use law. Currently, use is only required for any operator or rider younger than 18 years of age, along with a passenger requirement (regardless of age) if use is stipulated for the operator (NDDOT). Fatal and injury crashes represent an 83% share of overall motorcycle crash events in ND. Helmet use in fatal and disabling injury crashes in North Dakota from 2008 to 2012 is shown in Figure 14. Helmet use in fatal crashes has risen since 2009, but remains below 30%, whereas, after rising from 2009 to 2010, use in disabling crashes has been declining and was 23% in 2012.

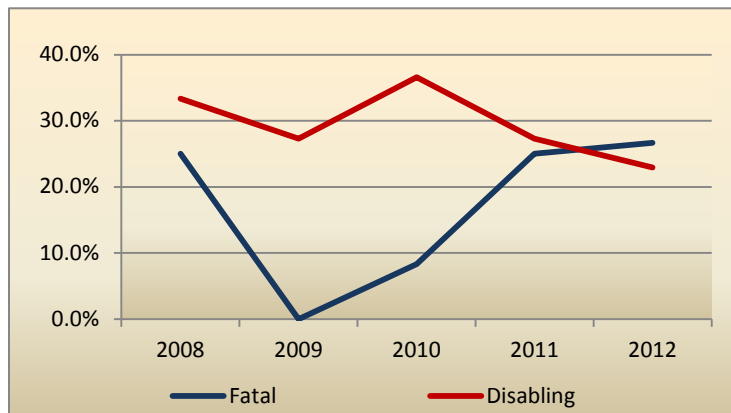


Figure 14 Helmet Use in Fatal and Disabling Crashes

In all crashes between 2008 and 2012, overall helmet use in ND was 33%. In three of the previous five years, helmet use by gender was similar (Figure 15). Female helmet use of 55% in 2008 was followed by a drop in subsequent years. The average use for females over five years is 39%. Male helmet use shows a low in 2011 of 28% with the overall five year average at 33%.

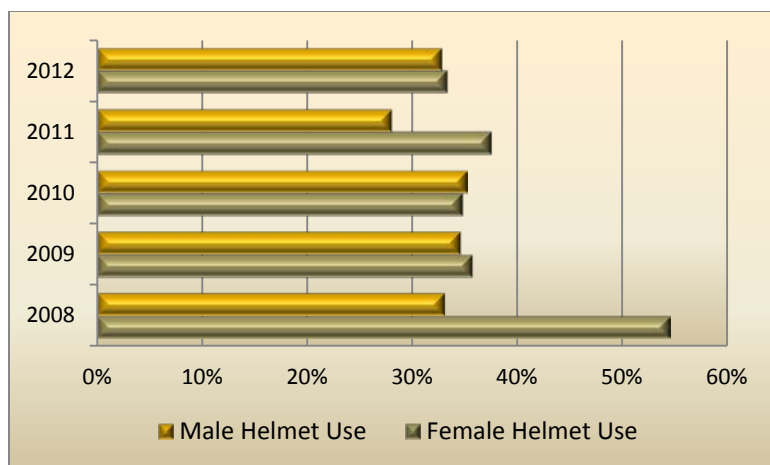


Figure 15 Helmet Use in Crashes by Gender

Supplementary data on motorcyclist helmet use was obtained for 2010 through 2012 in conjunction with the statewide observational surveys of seat belt use, following the same protocols and methodology for collection (Vachal et al. 2012). The number of observations is relatively low (N=711, 3 year total), so caution is used when comparing these rates to national levels or considering them to be fully representative. However the measurement of helmet use can be used as an indicator to help direct educational focus and determine economic impact.

Data from these observational surveys indicate that approximately one-half of motorcyclists overall were using helmets during the timeframe studied (Figure 16). Passengers had higher observed rates of helmet use than drivers in 2010 and 2011, but this tendency did not carry through to 2012 when passenger helmet use fell to 40%. Driver helmet use ranged from a high of 54% to a low of 47% over the time period. When helmet use was evaluated by gender, females used helmets with greater frequency regardless of occupant position (Table 1).

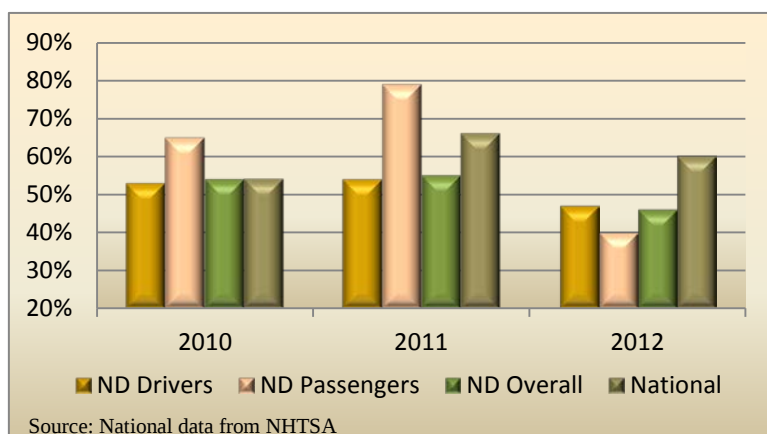


Figure 16 Observed Helmet Use by Occupant

Table 1 Observed Helmet Use by Gender

	2010	2011	2012
Female	78.6%	70.0%	47.6%
Male	50.5%	54.3%	46.0%

Similar assessments of helmet use were also obtained in strictly rural settings through the survey of seat belt use on rural roads (Vachal and Benson, 2012). Considering limited data, helmets were observed to be worn by motorcyclists on rural highways at a rate of 44% in 2011 and 62% in 2012. No observations were obtained in rural towns in 2011; however, the 2012 survey provided usage rates of 32% in this classification.

One final measure of rider helmet use in North Dakota is from the annual self-reported survey as evaluated in the *North Dakota Statewide Traffic Safety Survey, 2012, Traffic Safety Performance Measures for State and Federal Agencies* (Vachal et al. 2012). If survey participants indicated they rode a motorcycle, they were asked to specify protective gear used. Self-reported behavior for helmet use was decidedly lower than the overall observational rates for the two years surveyed. In 2011, self-reported helmet use was 41%, and in 2012, 27%, compared to observed use that was 14 to 19 percentage points higher for those same years. Overarching data on helmet use in North Dakota is meager, whether self-reported or observed, and may provide only limited application to the broader motorcycling population.

Conspicuity

Improving motorcycle safety requires a multifaceted approach. Safety standards for vehicle performance (e.g. anti-lock brakes), infrastructure upgrades (e.g. lighting, road markings, signage), communication and behavioral safety measures (e.g. improved helmet use, educational materials, novice and experienced rider training) are all part of this approach (USDOT 2007). While these areas are all vital to reducing motorcycle crash incidence, this section focuses on motorcycle conspicuity with particular attention to angle/ROW crashes.

Analysis of multi-vehicle crashes reveals that vehicles encroaching on motorcyclists ROW to be the most “typical and catastrophic” crash type (Pai 2010). Whereas the majority of motorcycle crashes in North Dakota do not involve a collision with another vehicle, when the crash is multi-vehicle, angle crashes comprise 54% of the total (Figure 17). Furthermore, crash severity is greater in angle crashes (Figure 18) over all other types including rear-end, head-on, sideswipe and rear-to-rear.

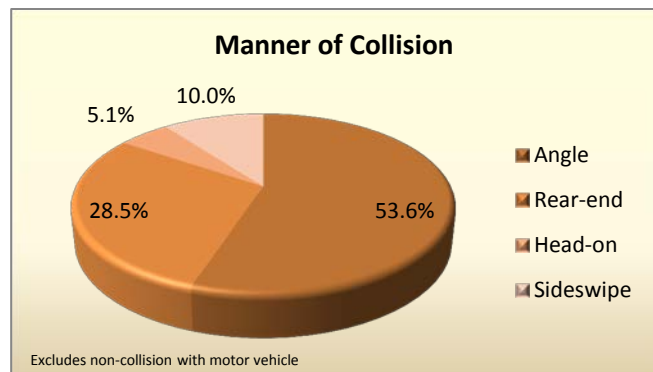


Figure 17 Share by Crash Type

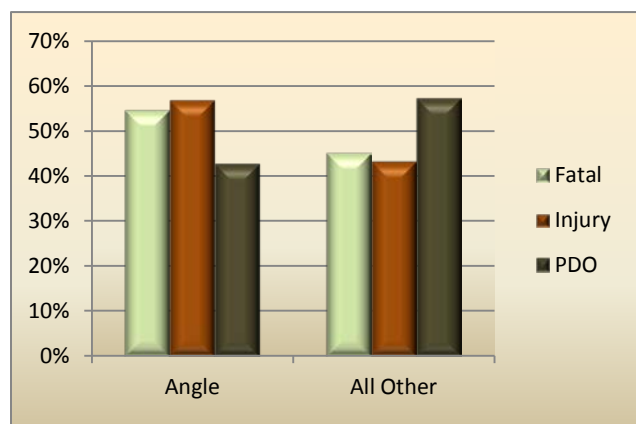


Figure 18 Crash Severity: Angle Crashes versus Other Crashes

Two factors are frequently involved in angle crashes: 1) failure to detect the motorcycle, and where detection occurs, 2) an inability to accurately judge the distance (gap) and speed of the motorcycle (Pai 2010). Explanations for *failure to see* crashes include “target prevalence” and “inattentional blindness”. Both terms relate to the expectancy of encountering motorcycles (Wolfe et al. 2007, Underwood et al. 2011, Clarke et al. 2006). The likelihood that a target will be missed is greater if target prevalence is low and if the “direction of the gaze is disconnected from attention” (Underwood et al. 2011). Due to the paucity of motorcycles on roadways relative to other year-round vehicles, the driver’s search criterion

may shift. Attention may be directed to more customary vehicles, and consequently, drivers *fail to see* the motorcycle as a hazard. In motorcycle crashes involving a second vehicle, ND crash data from the last five years show that citations for failure to yield/stop in angle crashes are more frequently issued to drivers of the second vehicle than the motorcyclist, 87.5% compared to 12.5%. These figures may support the conclusion that drivers of other vehicles are not “seeing” the motorcycles, but could also infer decision-making errors in gap and speed judgments.

Clarke et al. (2006) found that in more than 30% of ROW crashes where other drivers were at fault, motorcyclists were also using daytime running lights and/or reflective clothing. Although augmented conspicuity measures are believed to elevate motorcycle detection, it is not a comprehensive solution, as conspicuity alone does not nullify *failure to see* crashes. Nevertheless, lapses in driver scanning and judgment are valid reasons to enhance motorcycle conspicuity. Influences that should be considered are visibility at various times of the day and travel environment such as cluttered/urban versus uncluttered/rural settings. A summary of research examining two elements of motorcycle conspicuity, daytime running lights and reflective clothing, is outlined in the next section. In large part, the studies examine characteristics of the motorcycle and motorcyclist that can be manipulated for enhanced detection.

Daytime Running Lights (DRLs)

Several studies explore the benefits of using daytime running lights (DRLs) on motorcycles to determine whether tangible benefits exist with DRL use, and/or whether there are adverse effects on conspicuity with other vehicles increasingly equipped with DRLs. Research has demonstrated that DRLs can improve conspicuity, but the benefit is dependent on the background, as well as light intensity and color (Pai 2010).

Smither and Torrez determined that overall a motorcycle with DRLs was detected faster than one without (2010). Although conspicuity was not necessarily enhanced by DRLs if the motorcycle was traveling in an uncluttered environment, when the road became more visually cluttered (e.g. additional vehicles), DRLs provided more conspicuity. Smithers and Torrez concluded there was a direct positive effect for motorcycle DRLs to augment visibility relative to the motorcycle’s surroundings. These results support the conclusions of Hole et al. 1996 whereby DRLs offered negligible conspicuity benefit in an uncluttered background but positively influenced reaction times when the background was more cluttered (as cited in Pai 2010). Mitsopoulos-Rubens and Lenné (2012) reported that low-beam headlights conferred some benefit in gap acceptance of short gaps, but not for medium or long gaps. Finally, Wells et al. established that the use of daytime DRLs correlated to a 27% lower risk of crash related injury (2004). Whereas DRLs on motorcycles have been shown to have a positive effect on conspicuity in certain conditions, there is also a suggestion that increasingly wide-spread use of DRLs on other vehicles has an adverse effect. Cavallo and Pinto investigated whether the conspicuity advantage of motorcycle DRLs is lost in a traffic setting where car DRLs are in use (2011). It was concluded there was a significant decline in motorcycle detection at longer distances in this type of traffic environment, but there was little or no bearing on conspicuity at shorter distances.

Because crash severity in North Dakota is significant on rural roads where uncluttered backgrounds are more characteristic over urban crash environments (73% of fatal crashes), DRLs may have limited benefit with regard to these crash types. Results from the above-mentioned studies and ND crash records suggest the solution to enhanced conspicuity through the use of motorcycle DRLs is a complex issue requiring allowances for a variety of environmental and operator factors.

Reflective Clothing

As with DRLs, reflective clothing offered some improved conspicuity depending on conditions (Gershon 2010, Wulf et al. 1989, Wells 2004). Wulf et al. reported added benefit from the use of fluorescent clothing at dusk (1989). Additional research establishes that the brightness of the motorcyclist is less a determinant of conspicuity in daylight than contrast between the motorcyclist and surroundings (Pai 2010). Experiments conducted by Gershon et al. (2010) also suggested that in an urban environment where the background was more complex or cluttered, reflective clothing increased conspicuity for a motorcycle that was more distant, while white clothing improved detection at a medium distance. In an inter-urban setting (defined as a background that was only bright blue sky), the black clothing provided greater conspicuity for the motorcyclist because of the contrasting properties. An analysis of crash records in New Zealand found the use of reflective/fluorescent clothing represented a 37% lower risk of crash-related injury and this association increased slightly as light levels diminished (Wells et al. 2004).

Conspicuity at a sensory level is related to the above-mentioned factors. However, the phenomenon referred to as “looked-but-failed-to-see” (Smither and Torrez 2010) is not universally accepted as the primary cause of detection failures. Hole (2007) as cited in Smither and Torrez (2010) counters the idea that failure to detect is mainly because of motorcycle size and conspicuity, and suggests instead that other cognitive factors are more likely causes than “perceptual limitations.” It becomes apparent that enhanced detection cannot be advanced with any one solution. Appropriate clothing worn by the motorcyclist based on time of day and background may be helpful, as well as DRLs under certain conditions. These efforts, coupled with driver awareness, may positively impact crash rates.

Training and Education

There are risks to motorcycle use that cannot be manipulated or lessened because of vehicle design. Therefore, emphasis paid to basic motorcycle tenets could mitigate the risks.

Approximately one-third of the ND motorcycle crashes during the most recent five years can be attributed to operator error, mishandling, and distraction. Contributing factors that excluded mechanical failure, weather, or obstructions, and concentrated only on improper operation of the motorcycles, totaled 28%. Distraction represented an additional 4%. Motorcyclists demonstrated no evasive action in more than a third of the crashes. These figures suggest additional training and education on proper handling and risk evaluation may have potential impacts in crash reduction where operator control is correlated to the crash.

Finally, detection failure and gap error focus on other vehicle operators. Efforts can also be directed toward motorcycle operators to improve and increase rider training. Rider education and licensing can factor into crash susceptibility and severity as expressed by Baldi et al. (2004): “Trained riders tend to have fewer crashes, less severe crashes, and overall lower cost of damage resulting from crashes”. Baldi et al. reviewed best practices using the model shown in Figure 19 to identify what constitutes effective education and licensing. Three program components consisting of rider education, licensing, and program administration were examined. States were rated and placed into best practices categories: low (scores of 3 to 9), medium (scores of 11 to 18) and high (scores of 19 to 24) with a total of 36 possible points. North Dakota placed in the top end of “medium” best practices with a composite score of 18, consisting of the following: program administration = 1 (mean 1.4), rider education = 12 (mean 9.3) and licensing = 5 (mean 3.9). While North Dakota measured fairly well among the states reviewed, further initiatives could be considered in striving to implement all elements of the best practices model.

PROGRAM ADMINISTRATION

- 1) Integration between rider education and licensing
- 2) An adequate, dedicated funding source
- 3) Collection of rider training, licensing, and crash data

LICENSING

- 1) Graduated licensing system
- 2) Comprehensive and sound testing
- 3) Comprehensive and sound procedures for obtaining and renewing a license
- 4) Incentives for licensing

RIDER EDUCATION

- 1) Sound curricula
- 2) Effective training and delivery
- 3) Outreach and information efforts
- 4) Incentives for training
- 5) Regular program assessments and quality control
- 6) Instructor education and training

Source: Journal of Safety Research 36 (2005) 19-32; Identifying best practices states in motorcycle rider education and licensing, Baldi, Stephane et al.

Figure 19 Training and Education Best Practices Model

It is commonly believed that education and training benefit rider safety. Zegeer et al. proposed a benefit to updating training at regular intervals such as that required of other specialized operators, e.g. pilots and commercial motor vehicle drivers. Additionally, insurance companies could offer incentive discounts to encourage periodic training. Zegeer et al. also suggested possible improvements to overall rider training and education in the form of graduated licensing to regulate motorcycle type and size and sanctions for citations or crashes during the graduated period that prompt training reviews (2010).

Rider safety and education classes are offered to novice and experienced riders in North Dakota through the North Dakota Motorcycle Safety Program (NDMSP) sponsored by American Bikers Aiming Toward Education (ABATE). Course content is detailed in Table 2.

Table 2 Descriptions of Rider Courses

		Duration	Course Content
Basic Rider Course	Permit/License Not Required	3-4 hours in class, 8 hours range	Straight-line riding, turning, shifting and stopping; gradually progress to cornering, swerving and emergency braking; learn about the different types of motorcycles, their controls, and how they operate; advice on what to wear for comfort and protection; how alcohol and other drugs affect your ability to ride safely; how to create your own strategy for riding in traffic, and dealing with critical situations. The course concludes with a knowledge test and skill evaluation.
Experienced Rider Course	License and Proof of Insurance Required	4-6 hours riding	Discuss with peers how to balance the mental and physical aspects of safe riding, manage risk, increase visibility and optimize your lane position; also covers protective gear, rider responsibility, motorcycle inspection and care, the effects of alcohol and other drugs on riding, and includes an optional skill evaluation and knowledge test.

Source: NDMSP

The following section is a review of rider training in North Dakota that examines whether a correlation can be established between NDMSP rider participation and crash involvement.

Assessing the NDDOT Motorcycle Safety Program (NDMSP)

Motorcyclists have an opportunity to participate in basic and advanced safety training at several locations in the state. The program is offered by ABATE, which is a nonprofit group that involves volunteers in motorcycle training and public awareness. The NDDOT collected information from ABATE about participants in the NDMSP program between 2010 and 2011. Probabilistic matching was used to merge NDMSP participant marker fields with motorcycle driver records based on residence city, date of birth, and gender. Among about 587,000 driver records there were 59,300, or about 10% of drivers, authorized as motorcycle operators with the licenses bearing a class M endorsement. The most common endorsement among drivers was for the motorcycle along with the light vehicle, Class D, endorsement (Figure 20). Matching the registered motorcycle driver population and the NDMSP participant list resulted in an intervention group including 1,778 drivers – or 44% of drivers that took part in the NDMSP.

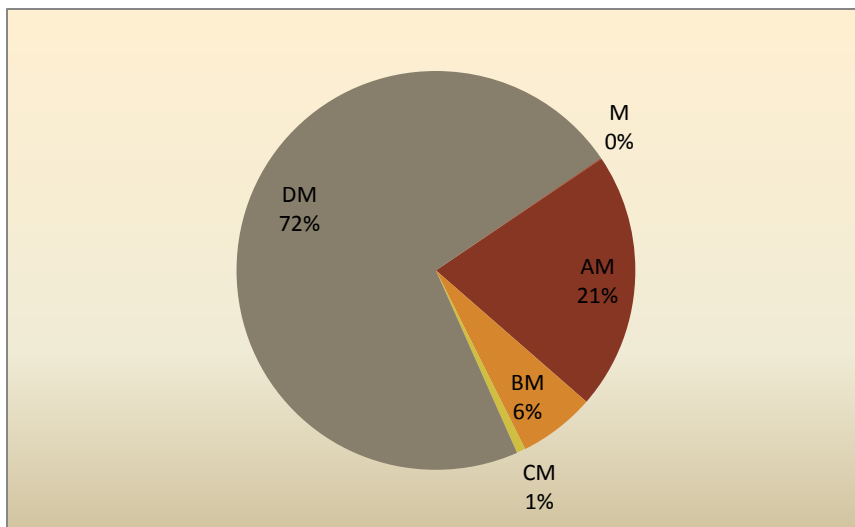


Figure 20 ND Motorcycle Driver Licenses

North Dakota Driver License Classes		
Class	Operator	Endorsement
A:	Any combination of vehicles with a gross combination weight rating of 26,001 pounds or more, provided the GVWR of the vehicle(s) being towed is in excess of 10,000 pounds.	
B:	Any single vehicle with gross vehicle weight rating of 26,001 pounds or more and any such vehicle towing a vehicle not in excess of 10,000 pounds.	
C:	Any single vehicle with a gross vehicle weight rating of 26,000 pounds or less, any such vehicle towing a vehicle with a gross weight rating not in excess of 10,000 pounds comprising: vehicles designed to transport 16 or more passengers, including the driver; and Vehicles used in the transportation of hazardous materials under 49 CFR Part 172 (placarded material) and 42 CFR part 73.	
D:	Any single vehicle less than 26,001 pounds GVWR; may tow vehicles not in excess of 10,000 pounds.	
M:	Any two or three wheeled motorcycle.	

Source: NDDOT

Data was queried to compile descriptive statistics about motorcycle drivers, comparing those who participated in the NDMSP program during the two-year timeframe to other licensed motorcycle drivers. The original intent for the method was to limit analysis to drivers that had received their license during 2010 and 2011, but information in the driver record could not be used to parse the data as planned. The common starting point would have created some basis for means testing between the groups based on their exposure to the NDMSP program as “new” motorcycle drivers, with some type of control to account for driving experience that may have been obtained under other licenses. The larger driver set is very diverse in terms of age, experience, and exposure – in terms of time or miles. The brief summary provided here is strictly for informational purposes as no extrapolation to the larger motorcycle driver population can be made based on the information available in the datasets.

The profile for the NDMSP motorcycle-driver participants does vary significantly from the rest of the motorcycle driver population, considering both age (Chi-Sq.=2702.41, df=2, p=<0.0001) and gender (Chi-Sq.=604.50.41, df=1, p=<0.0001). The NDMSP driver group is skewed toward the younger and female driver groups. With regard to age, only 22% of the matched participants in the NDMSP were 45 years or older compared to 56% of the other motorcycle drivers (Figure 21). The female share in the NDMSP matched participant group of 29% was more than twice as large as the female representation in the other driver population of 12% (Figure 22). The dissimilarity between the groups’ characteristics

supports the earlier note that information presented should not be used to draw general conclusions about the motorcycle driver population and the effects of the NDMSP on safety outcomes such as crash and citation events.

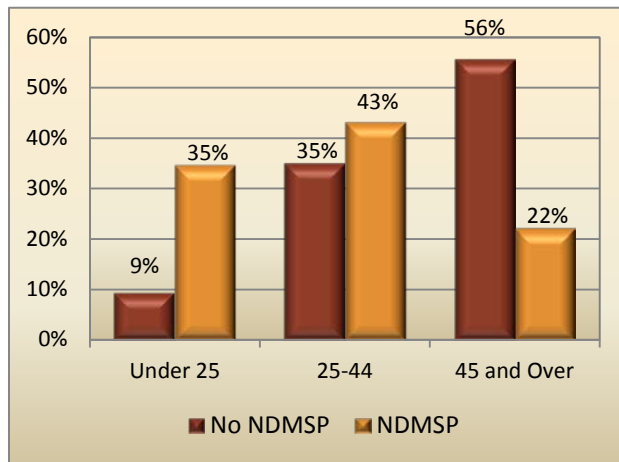


Figure 21 Motorcycle Driver Ages

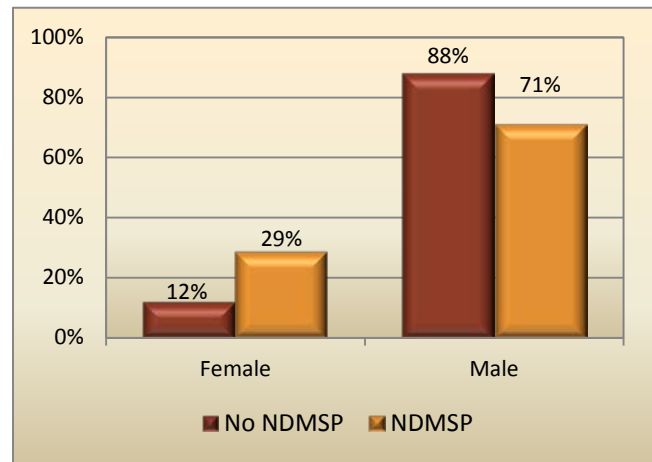


Figure 22 Motorcycle Driver Gender

The crash and citation events for motorcycle drivers were collected for 2012 to assess safety outcomes for the motorcycle drivers, considering the NDMSP participation (Figure 23). Overall, 78% of the drivers who participated in the safety program had no citations in 2012 compared to 85% of the other drivers. The effects did show more variation between the younger driver groups. For drivers under age 25, 70% of the NDMSP participants had no citations during 2012 compared to 75% for cohort drivers without the safety training. The groups performed at a closer rate for the older age groups. For drivers ages 25 to 44 with the NDMSP training, 80% had no citations compared to 81% for those without the training. Among older drivers, 86% with the training had no citations in 2012 compared to 88% for drivers who did not participate in the training. It should again be noted that exposure is a key in making these comparisons but the available data does not provide a means to standardize the figures by driving time or distance.

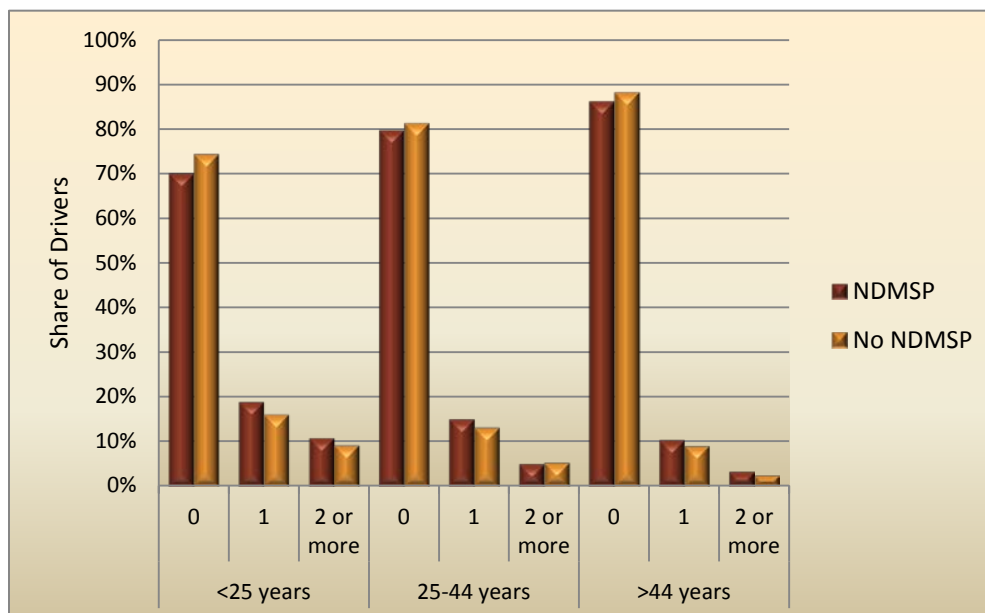


Figure 23 Number of Citations in 2012 by Driver Age Group

Analysis of 2012 crashes involving motorcycles, based on the NDMSP participation, shows that 96% of non-NDMSP drivers were involved in crashes compared to no crashes for 95% of drivers that had participated in the training (Figure 24). The results do show potentially positive influences of NDMSP participation for the older age group cohorts. These results however, as previously noted, could be influenced by driver exposure differences between the two groups in terms of driving time and driving distance.

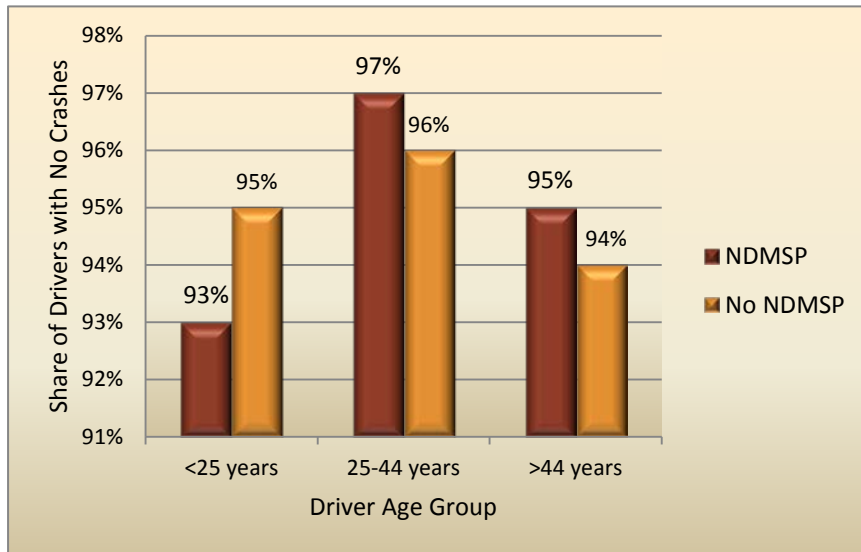


Figure 24 Crashes by Driver Age Group Based on NDMSP Participation

SUMMARY

Motorcycle use brings increased risk to the operator simply by the nature of the vehicle. When a crash occurs, the threat of injury or death is magnified by physical exposure compared to that of other vehicle occupants. Detection and gap/speed judgments by other motorists present additional hazards to the users.

Motorcycle crashes in North Dakota largely reflect what is occurring at the national level. Fatal, injury and PDO crashes have been on an upward trajectory since 2002. At the same time, the numbers of motorcycle registrations and licensed drivers have risen to their highest levels. Analyses reveal the largest share of fatal and injury crashes occurred on local rural roads. *Speeding/Too fast for conditions*, *improper evasive action*, and *improper handling* were the principal contributing factors to crashes. *Care required* and *DUI* were the lead categories where citations were issued to motorcyclists. Additional examination shows that half of crashes in collisions with another motor vehicle were angle crashes, and that drivers of other vehicles were more frequently cited for failure to yield or stop. Crash severity was also higher in angle crashes than all other crashes combined. Finally, one-third of riders in crashes were wearing helmets. Supplemental data on helmet use was obtained through observational surveys which recorded helmet use of approximately 50%.

Continued efforts to improve motorcycle conspicuity would seem prudent. A number of studies conclude DRLs and reflective clothing are beneficial in motorcycle detection and gap/speed assessment within certain environmental parameters. Rider education and training to ensure proper operation, reduced risk-taking, and sustained crash avoidance skills is also considered essential.

REFERENCES

- ABATE – North Dakota, <http://www.abatend.com>, accessed April 2013.
- Baldi, Stephane, Justin D. Baer, Andrea L. Cook. “Identifying best practices states in motorcycle rider education and licensing.” *Journal of Safety Research*. 36 (2005): 19-32.
- Cavallo, Viola and Maria Pinto. “Are car daytime running lights detrimental to motorcycle conspicuity?” *Accident Analysis and Prevention*. Vol. 49(2012): 78-85.
- Clarke, David D., Patrick Ward, Craig Bartle, Wendy Truman. “The role of motorcyclist and other driver behavior in two types of serious accident in the UK.” *Accident analysis and Prevention*. 39 (2007): 974-981.
- Gershon, Pnina, Noam Ben-Asher, David Shinar. “Attention and search conspicuity of motorcycles as a function of their visual context.” *Accident Analysis and Prevention* 44 (2012): 97-103.
- Mitsopoulos-Rubens, Eve and Michael G. Lenné. “Issues in motorcycle sensory and cognitive conspicuity: The impact of motorcycle low-beam headlights and riding experience on drivers’ decisions to turn across the path of a motorcycle.” *Accident Analysis and Prevention*. 49 (2012): 86-95.
- Motorcycle Safety Information and Resources. The Hurt Study. Accessed March 2011.
- National Highway Transportation Safety Association. Traffic Safety Facts. “Motorcycle helmet use laws”. Accessed April 2011.
- National Highway Transportation Safety Association. Traffic Safety Facts. “Approaches to the assessment of entry-level motorcycle training: an expert panel discussion”. March 2010.
- National Highway Transportation Safety Association. Model National Standards for Entry-Level Motorcycle Rider Training. August 2011.
- North Dakota Department of Transportation. North Dakota Crash Summary 2011. Accessed December 2012.
- North Dakota Motorcycle Safety Program (NDMSP). <http://www.ndmsp.com/>, accessed April 2013.
- Pai, Chih-Wei. “Motorcycle right-of-way accidents – A literature review.” *Accident Analysis and Prevention*. 43(2011): 971-982.
- Smither, Al-Awar Janan, Lorenzo I. Torrez. “Motorcycle conspicuity: effects of age and daytime running lights.” *Human Factors: The Journal of the Human Factors and Ergonomics Society*. 52(2010): 355-369.
- Underwood, Geoffrey, Katherine Humphrey, Editha van Loon. “Decisions about objects in real-world scenes are influenced by visual saliency before and during their inspection.” *Vision Research*. 51 (2011): 2031-2038.
- U.S. Department of Transportation. U.S. Department of Transportation Action Plan to Reduce Motorcycle Fatalities. 2007.

- Vachal, Kimberly and Laurel Benson. Seat Belt Use on North Dakota Rural Roads. Upper Great Plains Transportation Institute, North Dakota State University, Fargo. September 2012.
- Vachal, Kimberly, Laurel Benson, and Andrew Kubas. North Dakota Statewide Traffic Safety Survey, 2012 -- Traffic Safety Performance Measures for State and Federal Agencies. Upper Great Plains Transportation Institute, North Dakota State University, Fargo. September 2012.
- Wells, Susan, Bernadette Mullin, Robyn Norton, John Langley, Jennie Connor, Roy Lay-Yee, Rod Jackson. "Motorcycle rider conspicuity and crash related injury: case-control study." *British Medical Journal*. BMJ, doi:10.1136/bmj.37984.574757.EE. Accessed December 2011.
- Wolfe, Jeremy M. and Todd S. Horowitz. "Low target prevalence is a stubborn source of errors in visual search tasks." *Journal of Experimental Psychology: General*. 136 (2007): No. 4: 623-638.
- Wulf, G., P.A. Hancock, M. Rahimi. "Motorcycle conspicuity: an evaluation and synthesis of influential factors." *Journal of Safety Research*. 20 (1989): 153 – 176.
- Zegeer, Charlie, William Hunter, Loren Staplin, Fran Bents, Richard Huey, Janet Barlow. "Safer vulnerable road users: pedestrians, bicyclists, motorcyclists, and older users." *White Papers for: "Toward Zero Deaths: A national Strategy on Highway Safety"*. 2010.