Policy Focus for Reducing North Dakota Teen Driver Crash Injury

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January 2009

Abstract

For North Dakota teens, three of every four deaths are from motor vehicle crashes. Injury crash records for teen drivers were studied to gain insight regarding driver, vehicle, and road factors for public safety policy and program discussions. Results show 14-year-old drivers are three times more likely to die or be disabled in an injury crash than 17-year-old drivers, and that male drivers are 30 percent less likely to incur severe injury. As expected, seat belt use is a critical factor in severe injury avoidance. The likelihood for death or disablement is 165 percent greater for unbelted teen drivers than for those who are properly belted. In addition, rural and gravel roads pose a risk. Teens are six times more likely to be severely injured in crashes on rural roads than on urban roads. Findings suggest that an increased licensing age and seat belt emphasis may reduce teen traffic injuries in the state. In addition, more information on exposure should be attained to better understand rural and gravel road as risks.

The content of this report reflects the views of the authors, who are responsible for the facts and accuracy of the information presented. This document is disseminated under the sponsorship of the North Dakota Department of Transportation and the Federal Highway Administration.

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Introduction

Driving is a complex process requiring social, physical, and psychological skills and composure. As new drivers begin navigating the state's roadways, it is important to understand the challenges they face. New drivers know the rules of the road. They are asked to remember these as they 'rationally' process and react to signals from other drivers, traffic signals, and their own vehicles. Meanwhile they must compensate for elements of the road geography and the environment.

> Seemingly random teen crash incidence rates have been positively impacted by experience gained with graduated drivers licensing.

The ability of experienced drivers to rationally process these factors is based largely on years of behind-the-wheel experience. For novice drivers that ability is based on a limited amount of supervised driving. Therefore, it is expected that younger drivers will have higher crash rates until they gain needed experience. In a study of self-reported teen crashes, crash rate per mile was exponentially higher during the initial month of licensed driving – more than 4 times the rate in month 11 (McCartt, Shabanova, & Leaf 2003).

Many states, however, have successfully created a safer environment for teens to gain driving experience through graduated drivers licensing programs (GDL). "Graduated licensing is not designed to address deliberate risk behavior. Rather, it is aimed at the inexperience component in young drivers' crash risk" (Waller 2003). Recent research has shown that teen crash rates fell from 6 to 40 percent in states where GDL provisions have been in effect for at least 10 years (Hedlund et al. 2003, Williams et al. 2005, Dee et al 2005, Morrisey et al. 2006, Chen et al. 2006, Males 2007, Baker et al 2007). These studies show that seemingly random teen crash incidence may be positively impacted by experience gained in the lower-risk driving environment. The crash rate reduction is attributed to many factors such as GDL requirements/restrictions, enforcement, and parental support.

GDL programs are unique to each state and created through each state's enacted policies. States typically create a three-stage licensing process in which policies are designed to control for some of the higher risk factors for novice drivers. The three phases of licensing are learner's permit, intermediate license, and full license. The phases are designed to gradually introduce the novice driver to more risk in their behind-the-wheel experience. The higher risk may include things such as nighttime driving or passenger distraction. The literature on best practices for utilizing GDL as a measure in reducing traffic injuries and deaths is well-developed. It is not within the scope of this research to provide a comprehensive review of this established literature but rather to draw from it in discussing North Dakota's prospects regarding the GDL.

Many risk factors have been identified through scientific analysis of crash factors among the teen driver population. Most commonly studied risk factors include age, inexperience, classroom education, nighttime driving, seatbelt usage, passengers, and parental involvement. A rich compendium of this research is provided by Hedlund (2006). It is important to understand the relative risk associated with individual factors when discussing priorities for any young driver initiative such as the GDL program.

National Highway Safety Administration (NHTSA) reports that teens have the highest crash incidence rate among driver age groups (2006). Limited driving experience and an immaturity that often result in risk-taking behind the wheel are consistent with the fatal crash characteristics found in a relatively high proportion of teen crashes, in particular the prevalence of single vehicle and driver error crashes. Analysis of the national data traffic deaths showed that approximately 52 percent of fatal crashes involving 16-year-old drivers were single vehicle crashes in 2004, compared to 45 and 39 percent, respectively, of 17-year-old and 20- to 49-year-old drivers (Table 1). The role of experience in driver judgment is evident as driver error is reported in 78 percent of fatal crashes with 16-year-old drivers compared to 55 percent for the more experienced 20- to 49-year-old driver group. While these data provide a national-level glance at young drivers, it is important to have an understanding of young driver issues at a state level since the guiding policies are derived locally.

Table 1. Percent of National Fatal Crashes by Characteristics, 2004

Driver Age:	**16**	**17-19**	**20-49**
		Percent	
Driver error	78	69	55
Speeding	39	33	23
Single vehicle	52	45	39
3+ occupants	29	24	18
BAC .08+	13	25	44

Source: NHTSA, 2006

The Figure 1 map groups states into quartiles that rank best (green) to worst (red) in regard to teen crash incidence. The incidence is based on the crash ratio. It compares teens as a percent of drivers in fatal crashes to teens as a percent of the total driver population. For example, if teens were drivers in 5 percent of fatal crashes and were 5 percent of the driving population, the ratio would equal 1. North Dakota's young teen drivers, 14 to 17 years old, are 3.8 percent of the driver population and 10 percent of fatal crash drivers. The resulting rate of 2.6 shows a significant over-representation of teen drivers in the states' fatal crashes. The ratios range from 1.15 in Montana to more than 6 in Rhode Island and North Carolina.

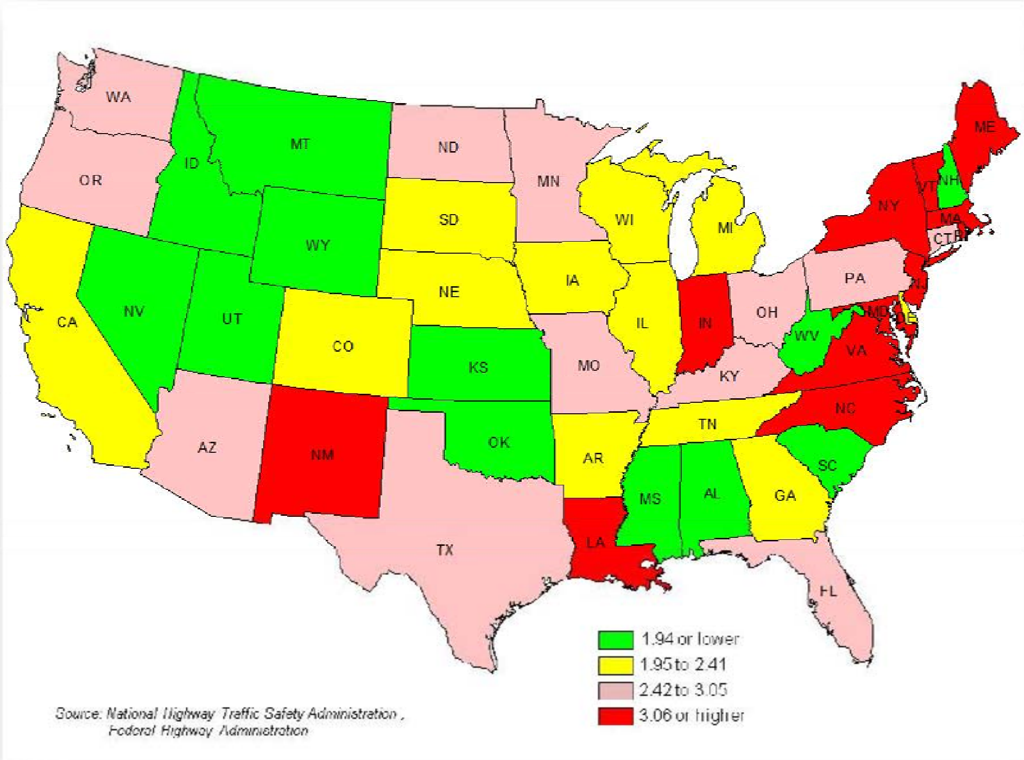

Figure 1. Teen Fatal Crashes to Drivers Ratio, 2004 to 2006

More than 7,000 teens enter North Dakota's driving population each year. In accordance with the state's licensing requirements, drivers have successfully completed a written driving assessment and a behind-the-wheel road test. The goal of this research is to provide insight into prospective benefits from graduated driver licensing for teen drivers in North Dakota. Empirical analysis is used to characterize teen driving in the state. Because individual policies or a more comprehensive GDL program may be designed from a smorgasbord of elements in the teen driving environment, it is important to have a good understanding of local teen driving. The next section is a brief overview of current licensing practices and GDL programs. Descriptive statistics for crashes involving teen drivers are presented in section four. Section five includes results from a young teen driver logistic regression model. The paper concludes with a summary of findings.

Background

Traffic crashes are the leading cause of death for North Dakotans ages 1 to 44 years (Centers for Disease Control 2008). Within the novice driver group, 14 to 17 years, three of every four unintentional deaths are from motor vehicle crashes. Traffic fatalities account for 44 percent of all deaths for this age group (Figure 2). Many states have adopted graduated driving laws as policy measures aimed at reducing death and serious injury among teens. The goal of this study is to enhance the knowledge of options to strengthen safety for North Dakota's teen drivers.

> For ND teens between 14 to 17 years, three of every four deaths are from motor vehicle crashes (CDC, 2008).

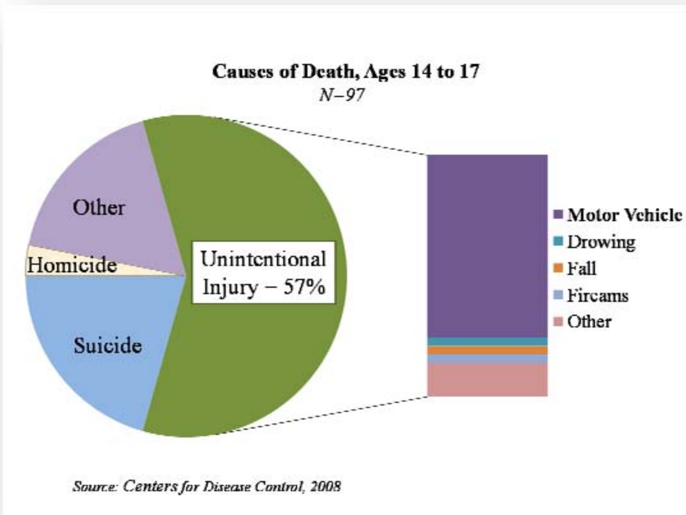

Figure 2. ND Youth Fatality Causes, 2001 to 2005

North Dakota offers driving privileges to residents age 14 years and older. Licensing under age 16 requires a minimum six hours of behind-the-wheel supervised driving instruction. Teens may also receive classroom instruction and have additional supervised driving experience depending on the requirements of individually certified programs at public schools and private driving schools. Teens can apply for a driving permit at age 14 and will be issued the permit after successfully completing the written driving examination that is administered by the North Dakota Department of Transportation (NDDOT). A permit allows the teen to operate a vehicle if a licensed driver age 18 or older is riding along in the front seat as a supervisor. Teens over age 16 are still required to complete the written examination, but are not required to complete the behind-the-wheel supervised instruction.

An initial distinction that is noted for the ND licensing process is that it begins, and can be completed, at age 14. This age is relatively young considering that 14-year-olds are permitted to drive unsupervised in only six other states. Only North Dakota and Arkansas allow 14-year-olds to become fully licensed drivers (Table 2). In fact, no other states allow teen drivers under age 16 to operate a vehicle unsupervised. Thus, little research exists regarding 14- and 15-year-old drivers at a national level. Driver maturity is often measured by age, and experience which are best measured by hours behind the wheel. Both factors are considered important contributors in drivers' ability to make rational decisions during the driving process. A distinction is made here for driver age. Unfortunately information is not available regarding actual driver behind-the-wheel experience. Age measures both experience and maturity. Special effort is made here to distinguish these differences among the 14-, 15-, and 16-year-old drivers.

Table 2. New Driver Minimum Ages

Supervised Driving	Number of States
14 years	7
15 years	33
16 years	10
Fully Licensed Driving	
14 years	2
15 years	0
16 years	16
17 years	21
18 years	11

Source: Insurance Institute for Highway Safety, 2008

Numerous studies offer guidance for designing GDL programs and assessing the benefits over subsequent time periods. The existing literature suggests that many factors contribute to risk for novice drivers, but some recent studies have attempted to provide guidance regarding priorities. A study of Connecticut teen drivers suggests there is a need to increase supervised driving requirements – given the prominence of operator error as a contributing crash cause, namely speeding, loss of control, and slippery roads (Braitman 2008). Williams (2007) finds nighttime operation and passenger restrictions are also significant in explaining risk levels. His meta analysis includes international, state, and local GDL assessments. As these studies suggest, although national and international GDL programs offer guidance for implementing policies, it is important to understand the local driving environment. For instance, the highest risk factors for 16-year-old drivers in Colorado fatal crashes between 1995 and 2001 were behavioral factors such as failing to wear safety belts and having two or more passengers (Gonzales et at 2005).

Graduated Driving License Provisions

Graduated licensing has become a popular program for addressing young driver road safety. The GDL ideals allow states to formulate policies that reduce driver risk in the initial months of driving. The risk factors are then gradually introduced as the teen gains the baseline experience needed to make dynamic driving decisions. The guidelines developed for states seeking to improve or implement graduated drivers licensing suggest a phased system that includes measures to address typical risk factors (Goodwin et al. 2007, Mayhew 2004). The GDL is designed in three phases that include the supervised permit, intermediate license, and standard license. Figure 3 illustrates a sample of provisions that may be designated in GDL system.

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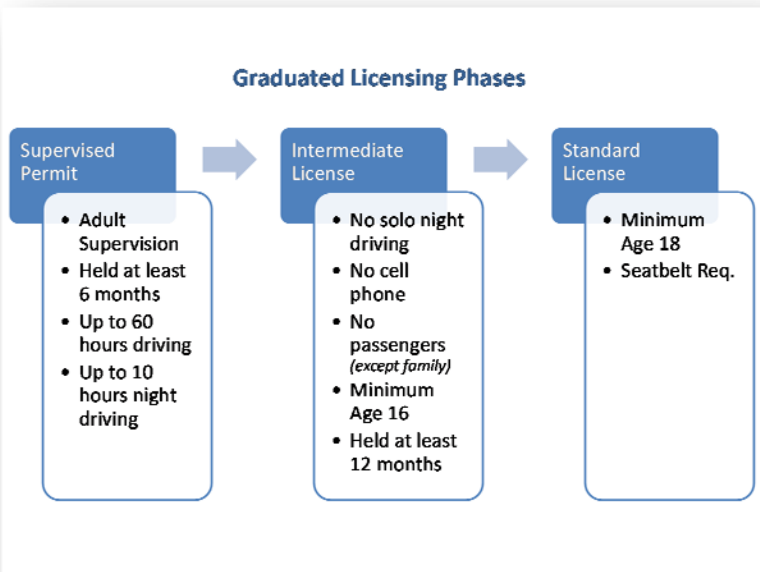

Figure 3. Graduated Licensing System

The supervised permit is the most restrictive phase. As the new driver enters the system, this phase typically provides the driver with six months of supervised driving. During this time, the new driver gains expertise by relying on a fully-licensed mentor passenger to provide guidance in behind-the-wheel driving situations. The experienced passenger may also be required to introduce the novice to less optimal driving conditions such as nighttime or inclement weather based on specified driving-hours requirement.

The intermediate license allows unsupervised driving under various restrictions. The restrictions vary widely by state, but include provisions related to risk factors such as roadway conditions, vehicle control, and driver distractions. Some common elements during this phase include no cell phone use, no passengers (except family), and no nighttime driving. The intermediate license phase may last up to one year or to a specified age. In the standard license, or final phase, the driver moves into the general driving population although certain provisions may continue, such as seatbelt requirement or passenger limitations. These provisions may remain in place until age 17 or 18. Recent research has also considered the enforcement and education activities needed to make GDL implementation successful. This success involves support from parents, law enforcement, and judicial partners (Goodwin et al. 2006).

A three-phase system has been adopted in most states. Only four states, Arkansas, Kansas, Minnesota, and North Dakota, do not have an intermediate phase in their teen licensing system (Insurance Institute for Highway Safety 2008). The provisions associated with the each phase do vary across states. Table 3 provides a licensing process summary. It includes an overview of provisions that go beyond traditional written, road, and vision exams. The information compiled for states in the region shows states share many guidelines for moving young teens into the driving population.

The license provisions in the four states do vary somewhat with the requirements for supervised driving, licensure ages, and driving restrictions (Table 3). During Phase I, Montana and Wyoming have the highest requirements for supervised driving, at 50 hours with 10 hours at night. These states also have more strict provisions regarding passengers and restraint use. Although Minnesota has a lower requirement of 30 hours, an additional 10 hours of supervised driving is required during the intermediate phase. Minnesota also restricts cell phone use and increased the minimum full-licensure age to 17 years. Legislation passed during the 2008 session will strengthen these provisions by prohibiting nighttime driving between midnight and 5 a.m. and prohibiting more than one passenger under age 20 during the first six months of licensure. The passenger age is currently 18 (Minnesota Department of Public Safety, 2008b).

A well-recognized national assessment of states' young driver programs is published by the Insurance Institute for Highway Safety (IIHS). The IIHS (2008) produces ratings of poor (0), marginal (1), fair (2) and good (3) based on the requirements and restrictions states have for supervised driving and driving restrictions. It is offered as a general monitoring system for tracking progress on teen driver safety initiatives. Pearson correlations show that the IIHS system is weakly reflective of differences in teen drivers' crash rates among states, considering teen driver fatal crash incidence. With teen crash rates standardized by the

Table 3. Extended Teen Licensing Requirements for States in the Region

	North Dakota	Minnesota	Montana	South Dakota	Wyoming
GDL Law Year	N.A.	1999 [d]	2006	N.A.	2005
Phase I: Learner					
Minimum Age	14 years	15 years	14½ years	14 years	15 years
Experience	• 6 hours behind the wheel from certified trainer (Age 16 without course) •Held permit 6 months	•Traffic Ed Course •Held permit 6 months •30 hours supervised driving with, •10 hours at night	•Traffic Ed Course (Age 16 without course) •Held permit 6 months •50 hours supervised driving with, •10 hours at night	•Traffic Ed Course •Held permit 90 days (180 days without Traffic Ed course)	•Traffic Ed Course •Held permit 10 days •50 hours supervised driving with, •10 hours at night
Restrictions	•Driver and passengers <18 years restrained	•Drive w/ parent or instructor •Passengers <18 years restrained •No cell or wireless phone	•Drive w/ parent or instructor •All Occupants Seatbelt req. •No traffic or alcohol citations	•Supervised driving 6 a.m. to 10 pm •Drive w/ parent 10 p.m. to 6 am	•Drive w/ parent or instructor
Duration		Minimum 6 mo.	Minimum 6 mo.	Minimum 3 mo.	
Phase II: Restricted					
Minimum Age		16 years	15 years	14 years 3 mo.	16 years
Experience		•Phase I req.	•Phase I req.	•Phase I req.	•Phase I req.
Restrictions		•10 more hours supervised driving •No cell or wireless phone •No traffic citations past 6 mo.	•All Occupants Seatbelt req. •No unsupervised driving 11 p.m. to 5 a.m.[a] •Limit 1[b] passenger <18 years (1st 6 mo.) •Limit 3[b] passengers<18 years (2nd 6 mo.)	•Parental permission for unsupervised driving 6 a.m. to 10 p.m. •Drive w/ parent 10 p.m. to 6 am •No traffic citations	•All Occupants Seatbelt req. •No unsupervised driving 11 p.m. to 5 a.m.[a] •Limit 1[b] passenger <18
Duration		1 year	1 year or until 18 years	Until 16 years	Minimum 6 mo.
Phase III: Full Privilege					
Minimum Age	14½ years	17 years[c]	16 years	16 years (Age 17 without Phase II)	16½ years (Age 17 without Phase II)
Experience		•Phase II req. •No traffic citations past year	•Phase II req.	•Phase II req.	•Phase II req.

Sources (March, 2008): E-driver, 2008; Insurance Institute for Highway Safety, 2008; Minnesota Department of Public Safety, 2008a; Montana Office of Public Instruction, 2008; North Dakota Department of Transportation, 2008; South Dakota Department of Public Safety, 2008; Wyoming Department of Transportation, 2008

[a] Limited exceptions may apply such as travel to/from church, work, etc.

[b] Family members exempt.

[c] Special farm licenses for qualified drivers ages 15 to 17 years to do work within 20 miles of certified farm operation during daylight hours.

[d] New Passenger and Nighttime Provisions for August 1, 2008 (Minnesota Department of Public Safety, 2008b).

N.A. Not Available

BTW: Behind-The-Wheel.

number of licensed teen drivers, aged 15 to 17, crash incidence rates are inversely related to the IIHS rating (Pearson's Corr.=-0.27, ρ<0.001). Given that no states are currently rated 'poor,' North Dakota and the four other states are in the lowest echelon for policies protecting young drivers.

In comparison, Nebraska received the upper tier 'good' rating. It has supervised driving of 50 hours with 10 hours between sunset and sunrise, beyond any behind the wheel requirement. Drivers in Phase II are not allowed to drive unsupervised between midnight and 6 am. These drivers cannot have passengers under 19 years in the vehicle during the first 6 months they operate under the Phase II guidelines. The state also prohibits cell phone use for drivers younger than 18 years of age in Phases I and II. As with Minnesota, a driver may become fully licensed at age 17. Nebraska offers special learners (LPE) and driving school (SCP) permits for teens between the ages of 14 years and 16 years 3 months who live more than 1.5 miles from school or attend school in smaller communities. The LPE allows the teen to legally practice driving for at least two months under parent supervision after written and vision test requirements have been met. The SCP allows the teen to drive themselves or family members unsupervised to and from school or extra circular events using the most direct and accessible route. The SCP is available after the teen successfully completes 50 hours of supervised driving or an accepted drivers safety course and test. The regional overview creates context for discussing ND decisions and peer experiences with regard to GDL.

ND Teen Drivers

Young teen drivers were involved an average 2,360 crashes annually between 2001 and 2007 in North Dakota. The crashes resulted in 70 driver deaths and 3,616 driver injuries. Teen crashes on rural roads were 25 times more likely to involve injury than those that occurred on urban roads. Sixty-five of the teen drivers killed were driving on rural roads.

The higher risk posed by young teen drivers age 14 to 17 are reflected in crash incidence rates illustrated in Figure 4. Young drivers are highly overrepresented in the crash driver population. Drivers age 14 to 17 account for about 4 percent of the ND driver population and 10 percent of the crashes. The crash ratio for the youngest age group, considering the share of licensed drivers in each group, is three times more likely to crash than drivers age 25 to 34.

Driving requires an operator to continually process signals from vehicle and roadway apparatus in conjunction with other driver actions and driving conditions. Given their lack of experience making these constant judgments, the higher crash rate is expected. The large gap in rates within the young group and compared to older drivers suggests that there is room for improving safety for these drivers. Additional information regarding these crashes offers guidance for considering the role for individual factors in creating a safer driving environment.

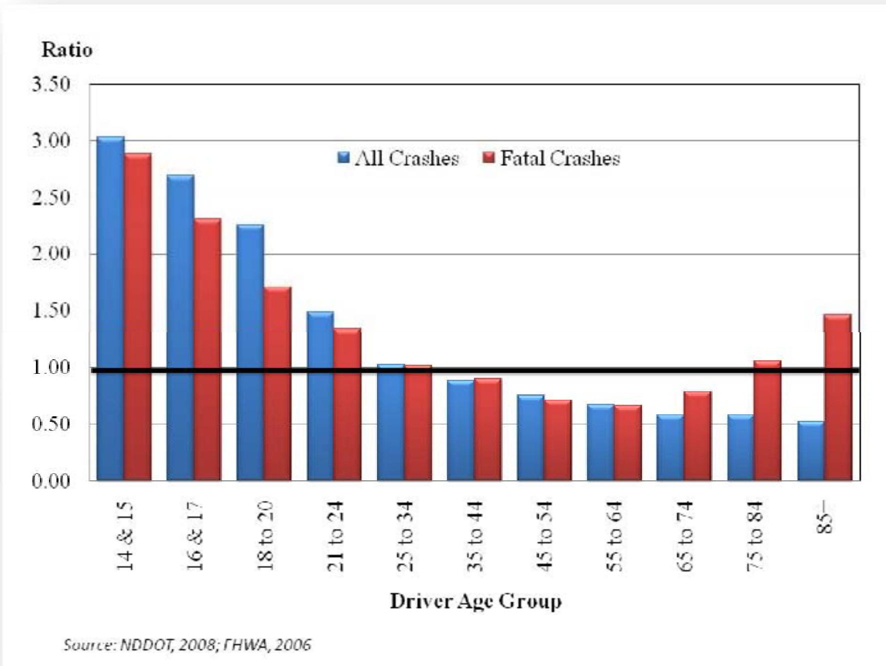

Figure 4. Crash Ratios by Driver Age Group, 2001 to 2007

Crash Types and Events

A starting point for understanding driving behavior for young ND teens is to create a comparison group representing experienced drivers. Here the experienced drivers are those age 25 to 54. Crash characteristics and statistical analysis that highlight many distinctions between the two groups are based on the crash reports between 2001 and 2007 (ND Department of Transportation, 2008). The most common accident for all age groups is the single-vehicle crash. Inexperienced drivers, however, have an increasingly greater share attributed to multi-car and other crash types. Single-car crashes account for 77.7 percent of experienced-driver crashes compared to 46 percent for 14-year-old drivers (Table 4).

Rollover crashes decrease dramatically when the experienced driver group is compared to 14 and 15 year olds. The rollover crashes are a special concern because unbelted occupants are often ejected from the vehicle. It is the most harmful event in 8.4 percent of experienced driver crashes. This compares to 27.7 and 18.7 percent of crashes involving the youngest teen drivers, respectively (Table 4). Although 16- and 17-year-old drivers also have higher share of crashes where the most harmful event is a rollover, a marked improvement is shown compared to younger drivers. These younger drivers lack judgment and operator skills, increasing the likelihood that a driver will overcorrect or take dangerous evasive action that will result in a rollover.

Table 4. ND Most Harmful Event in Crash, 2001 to 2007

Event	Young Driver Age Group				Mentor 25-54
Age=	14	15	16	17	
N=	*148*	*771*	*1,262*	*1,426*	*11,008*
	Share of Crashes				
Vehicle in Transport	46.0%	61.0%	68.0%	69.0%	77.7%
Another Vehicle in Transport	2.0%	0.4%	0.6%	0.8%	0.6%
Parked Vehicle	8.1%	4.0%	4.0%	4.0%	2.6%
Overturn/Rollover	27.7%	18.7%	11.9%	11.6%	8.4%
Ran off Roadway	2.0%	1.6%	1.7%	1.8%	1.1%
Curb	2.3%	0.8%	1.0%	1.2%	0.4%
Ditch	2.7%	2.5%	1.9%	2.2%	1.1%
Tree	1.4%	2.3%	1.7%	1.3%	0.6%
Other	7.7%	8.8%	9.3%	8.1%	7.5%

Source: ND Department of Transportation, 2008.

Some other harmful events, such as hitting a parked car or tree, become less likely with experience., Hitting a parked car is the most harmful event in 8.1 percent of crashes involving 14-year olds compared to 2.6 for experienced drivers. Crashes involving another moving vehicle as the most harmful event account for 2 percent of incidents for the youngest drivers. This share moderates quickly to account for less than 1 percent of the crashes for other age groups. This may be related to young drivers' inexperience in scanning for other vehicles or in anticipating/reacting to other drivers' actions (Braitman, 2008).

In addition to the most harmful event, identifying differences in the initial crash event may also be useful. The initial events in the crashes differs significantly between the experienced mentor drivers and young teen drivers (χ^2=1743.34 ρ<0.001, n=128,563). While the most common initial event is motor vehicle in transport or single car crash, which accounts for 60.3 percent in experienced driver crashes and 65.9 percent of young teen drivers, the occurrence of other events is often different. For instance, teen drivers run off the road as the initial event in 50 percent more of their crashes at 12.8 percent, compared to the mentor group. Parked vehicles are the initial incident in only 3.5 percent of experienced driver crashes, compared to 5.8 percent for the young driver group. All other initial events individually account for less than 1 percent of the total so distinctions are not made between the driver groups. The initial event, as with the most harmful event, suggests that teen drivers lack experience that reduces traffic crash incidence for older drivers.

Contributing Factors

A majority of crashes for all drivers do not involve contributing factors as identified by the law enforcement reporting agency. A significant difference does exist between the younger and experienced driver groups in contributing factor incidence (χ^2=622.94 ρ<0.00, n=128,563). Contributing factors are reported in about 22.5 percent of young driver crashes, compared to 15.5 percent of the mentor driver group. The weather is a greater contributor in experienced-driver crashes, while improper evasive action is more common among younger drivers (Table 5). Young drivers' speed is also a factor in a much greater share of crashes. Speeding is a factor in 6.1 and 4.1 percent of crashes for 14- and 17-year-old drivers, respectively, compared to 0.8 percent for experienced drivers. While speeding may be a ticketed offense associated with driving faster than the prescribed speed limit, it also may be a legal speed that is faster than the speed that would have been driven by experienced drivers in conditions such as inclement weather or icy roadways. The role inexperience plays in driving too fast for conditions is evident in the downward trend in incidents among 14- to 17-years-old age groups.

Table 5. Contributing Factors, 2001 to 2007

Factor	Driver Age				
	14	15	16	17	Mentor
	Share of Crashes				
None Reported	68.9%	69.3%	71.4%	73.1%	84.6%
Attention Distracted	3.4%	3.6%	3.9%	3.3%	1.6%
Vision Obstructed	1.4%	1.0%	1.8%	1.3%	1.1%
Speed/Too Fast for Conditions	6.1%	5.6%	5.0%	4.1%	0.8%
Failed to Yield	3.4%	3.8%	3.2%	3.3%	1.9%
Following to Close	0.7%	1.7%	2.6%	2.0%	1.2%
Weather	0.0%	1.7%	2.1%	2.4%	2.5%
Improper Evasive Action	8.8%	7.2%	5.4%	4.5%	1.6%
Share of Total	92.6%	93.9%	95.3%	93.9%	95.2%

Source: ND Department of Transportation, 2008.

Regarding this driver behavior, beginning drivers are at fault in significantly more of their crashes (χ^2=1471.80 ρ<0.001, n=128,563). Young drivers are ticketed in 43.6 percent of their crashes, compared to 28.9 percent of the experienced drivers. The most common ticket administered for all drivers is more care required, accounting for 16.3 percent of tickets in the young driver group and 7.6 percent in the experienced drivers. Care required is defined as unsafe vehicle operations that endanger life or property. Failure to yield and following too close are second and third in ticketing frequency. Young drivers were ticketed for failing to yield in about 8.4 percent of the crashes and following too close in 4.7 percent. This compares to 5.1 and 2.7 percent of experienced drivers ticketed for the yield and following violations, respectively. The composition of known citations for the driver groups is illustrated in Figure 5. These violations account for over 80 percent of the citations written for the driver groups.

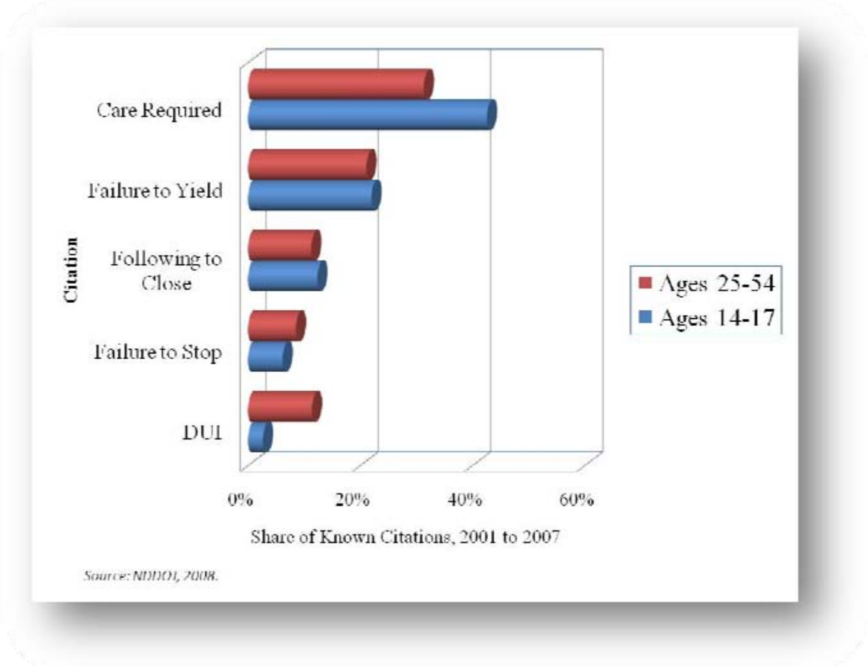

Figure 5. Citations for Driver Groups, 2001 to 2007

Driver Judgment and Skill

In addition to driver behavior and decisions, driver judgment and skill for various roadway and environmental characteristics may also be crash factors. Limited crash report data regarding climatic and roadway characteristics is used to gain some insight. The crash report provides basic information about the road surface and geometry. The road surface descriptions in the crashes are defined as concrete or brick, asphalt, and gravel or dirt. Bridge crashes are not included due to a limited number of young driver observations.

Unpaved surfaces present challenges for younger drivers with significantly more crashes occurring on gravel roads compared to mentor drivers (χ^2=502.54, ρ<0.001, n=26,604). Approximately 17 percent of crashes occur on gravel roads for the young driver group, compared to 6 percent for mentor drivers. Differences within the young drivers' crash locations, based on road surface, suggest safety does improve with age among the youngest drivers with regard to navigating gravel and dirt roadways (F=79.45, ∝=0.00, 32,043). It was found that 18.9 percent of the crashes among 14-year-olds occur on gravel roads, compared to just 7.5 percent for the more experienced 17-year-old drivers (Figure 6). It is assumed that experience and skill is a contributor to the declining share of crashes on gravel surfaces for teen drivers. The gravel surfaces create challenges in characteristics such as loose rock surface, washboard worn areas, and undefined lanes. Many teens have little instruction or behind-the-wheel experience for recognizing or dealing with these challenges.

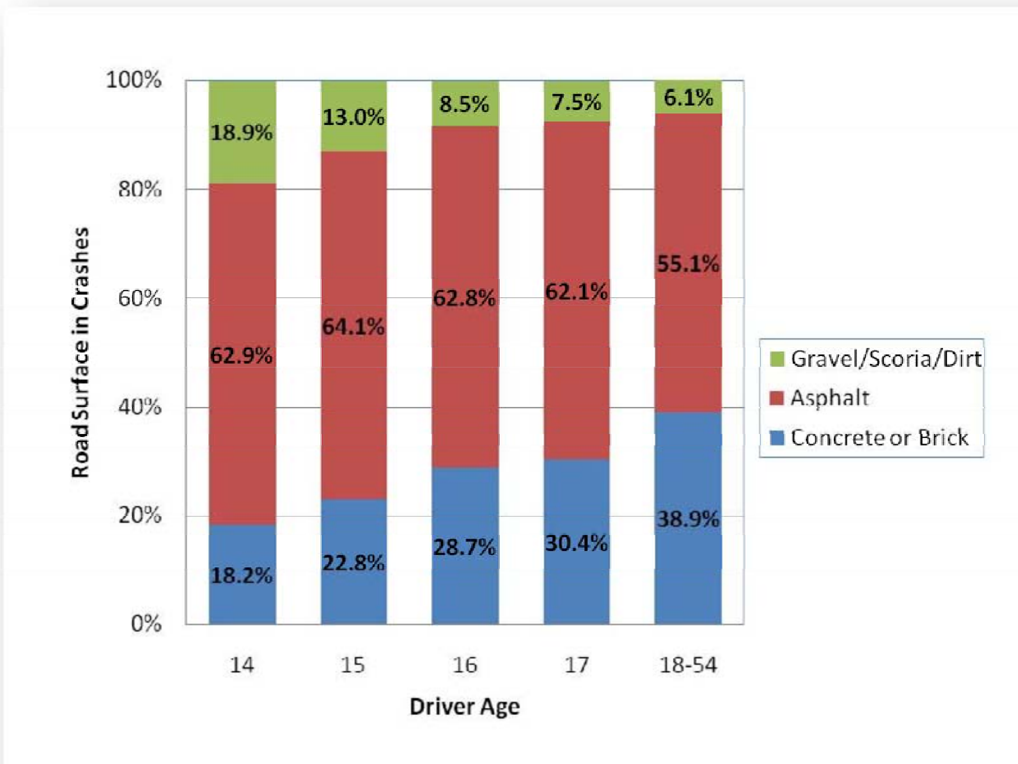

Figure 6. Rural Road Teen Driver Crashes, 2001 to 2007 by Surface

Roadway geometry is grouped into two categories, normal geometry that includes straight and curves-on-level and complex geometry includes curves-on-grade and hill crests. No difference is found between the young teen and experienced driver groups for road geometry (χ^2=1.0102 ρ=0.31, n=128,563). About 3.6 percent of crashes for both groups took place on the complex roadways geometry area.

Lighting and weather are considered as environmental conditions that may affect driver's visibility. Several lighting conditions are used to describe illumination during the crash.

Approximately 25 percent of the young driver crashes occur during the dark, compared to 21 percent for the experienced drivers. A significant difference is found between the driver groups (χ^2=134.19, ρ<0.001, n=129,349), but not within the young drivers (χ^2=16.72, ρ=0.16, n=15,574). The share of accidents just before and after dark is similar for the groups (Table 6). Due to the low number of crashes in several categories, the lighting conditions are condensed to dark and partial or full light for the young driver regression analysis presented in the next section.

Table 6. Crash Lighting Conditions, 2001-2007

Weather	14-17 years	25-54 years
n=	*15,574*	*113,775*
Daylight	70.4	74.4
Dawn	1.7	1.8
Dusk	2.9	2.7
Dark (Lighted)	16.7	13.8
Dark (Not Lighted)	8.2	7.3

Source: ND Department of Transportation, 2008.

Eight weather categories are used in the crash reports. Approximately 87 and 85 percent of crashes among younger and older drivers occur on clear and cloudy days (Table 7) respectively. Snowy and rainy weather are next among weather conditions for the crashes, with each accounting for 4 to 5 percent of the crashes in each driver group. Overall, the climatic conditions seem similar for the group and are likely representative of the weather cycle in the region. A significant difference is indicated for the two groups so it will be given consideration in the model for factors in young driver crashes (χ^2=130.60, ρ<0.001, n=129,349).

Table 7. Crash Weather Conditions, 2001-2007

Weather	14-17 years	25-54 years
n=	*15,574*	*113,775*
Clear	64.6	61.5
Cloudy	23.0	23.6
Rain	4.3	4.4
Snow	4.3	5.1
Blowing Soil/Snow	2.1	3.5
Sleet/Hail/Freezing Rain	0.9	1.1
Fog/Smoke/Dust	0.6	0.6
Severe Wind	0.2	0.2

Source: ND Department of Transportation, 2008.

The weather may also affect road surface, and this factor is noted in the crash record as a road surface condition. Approximately 70 percent of the crashes among both the young and experienced drivers occur during normal weather (Table 8). Although the two driver groups seem to have a similar distribution for crashes across the conditions, a statistically significant variation is found (χ^2=67.81 ρ<0.001, n=129,349). A statistically valid difference in weather conditions is not found within the young driver group. These factors will be considered for control in the young driver model, but with limited expectation for influence.

Table 8. Crash Road Surface Conditions, 2001-2007

Surface		14-17 years	25-54 years
	n=	*15,574*	*113,775*
Dry		63.4	61.0
Wet		9.5	10.1
Muddy		0.3	0.2
Snow		3.2	3.9
Slush		0.8	1.2
Ice/Compacted Snow		22.0	22.5
Frost		0.9	1.1

Source: ND Department of Transportation, 2008.

Crash Time

Restrictions for young drivers based on the time of day are popular as a measure for controlling risk for young drivers. Risk associated with driving times throughout the day may be related to exposure, such as time around school start/end, other drivers, and the environment. Crash distribution among the teen drivers shows a similar risk pattern, with highest crash risk – shaded darker – between 3:00 p.m. and 5:59 p.m. (Table 9). The concentration of young drivers traveling to and from school would largely account for the increased crash incidence during this period, along with the 7:00 a.m. to 8:59 a.m. period – which is identified as above average for risk. These values suggest that the common restrictions on young driver operating hours may be related to risk behavior, lighting, and other drivers. An interesting delineation, however, is found by examining where the crashes occur.

Table 9. Time of Teen Driver Crashes from 2001 to 2007, by Hour and Driver Age

Hour Beginning		14 year	15 years	16 years	17 years
	N=	*692*	*3530*	*6081*	*6535*
12:00 a.m.		1.45%	1.44%	2.12%	2.43%
1:00 a.m.		0.72%	1.27%	1.41%	2.39%
2:00 a.m.		0.43%	0.20%	0.76%	0.90%
3:00 a.m.		0.43%	0.25%	0.49%	0.44%
4:00 a.m.		0.43%	0.14%	0.31%	0.44%
5:00 a.m.		0.58%	0.37%	0.43%	0.60%

6:00 a.m.	0.58%	0.42%	0.72%	0.57%
7:00 a.m.	2.75%	5.89%	6.36%	5.77%
8:00 a.m.	5.78%	4.99%	5.77%	5.97%
9:00 a.m.	1.73%	1.84%	1.86%	1.70%
10:00 a.m.	1.45%	2.12%	1.76%	2.02%
11:00 a.m.	4.91%	2.63%	3.86%	3.60%
12:00 p.m.	4.77%	6.12%	5.69%	6.35%
1:00 p.m.	4.19%	4.42%	4.19%	4.39%
2:00 p.m.	5.20%	5.41%	5.89%	6.43%
3:00 p.m.	13.73%	14.59%	13.71%	11.63%
4:00 p.m.	8.82%	8.73%	8.90%	7.91%
5:00 p.m.	9.54%	7.76%	7.94%	7.04%
6:00 p.m.	9.68%	6.06%	5.46%	5.59%
7:00 p.m.	5.64%	6.46%	5.44%	4.85%
8:00 p.m.	5.35%	5.47%	4.92%	4.96%
9:00 p.m.	4.48%	5.61%	5.31%	5.83%
10:00 p.m.	3.32%	4.70%	4.00%	5.07%
11:00 p.m.	4.05%	3.09%	2.68%	3.14%

Above average share for hour.
Much above average share for hour.

Source: ND Department of Transportation, 2008.

The composition of teen driver crashes on rural and urban roadways shows that rural roads pose a much higher relative risk between the hours of 8 p.m. and 3:59 a.m. (Figure 7). The share of crashes occurring on rural roadways during the evening, between 8 p.m. and 12:59 a.m. is 76 percent higher than that for urban roads. While the shares are smaller, this discrepancy is even larger for the 1 a.m. to 3:59 a.m., with the share of teen driver injury crashes on rural road crashes attributed to this time are 168 percent higher than for teens on urban roads. The differences may be explained to some degree by exposure in travel on rural roads for sports and work, but certainly other factors – such as a less controlled rural driving environment including signing, access, and lighting – contribute to the differences in crash times for teen drivers on rural and urban roads.

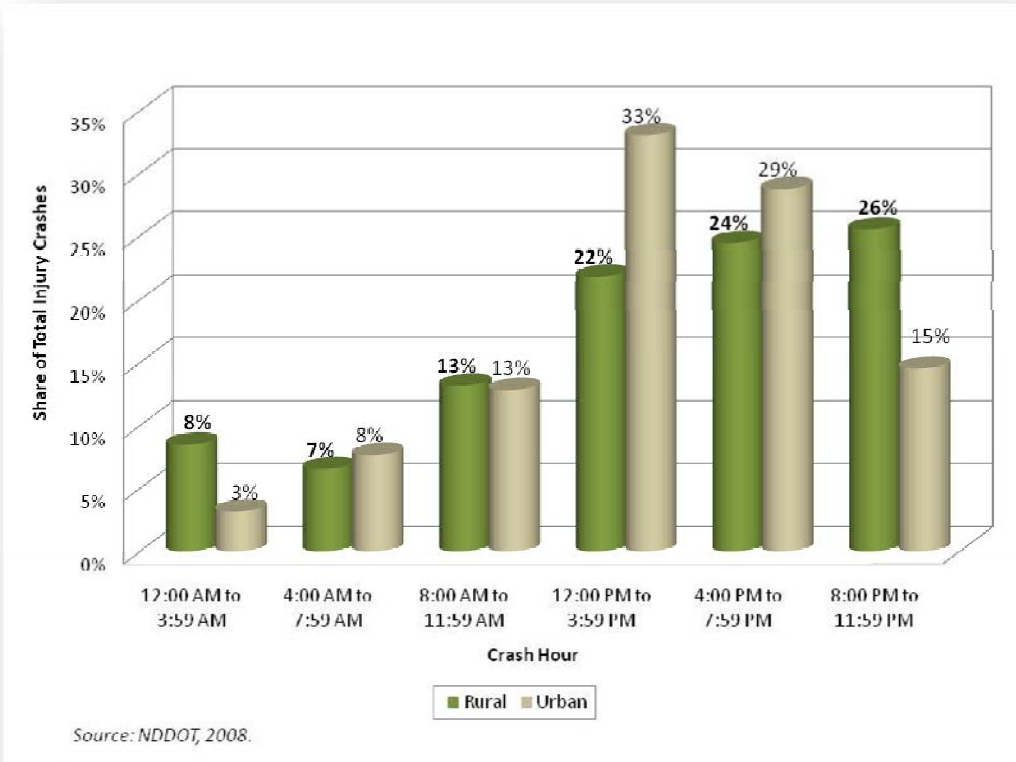

Figure 7. Time of Teen Driver Injury Crashes from 2001 to 2007, for Rural and Urban Roads

Teen Passengers

Teen driving research shows a safety benefit, in terms of crash reduction, where states have prohibited young teen drivers with respect to teen passengers. Overall, 24 percent of the teen drivers involved in injury crashes between 2001 and 2007 did have teen passengers. As expected, this share varies substantially from the experienced driver group, which has teen passengers in only about 6 percent of crashes. An interesting finding is that

Table 10. Teen Passengers in All Injury Crashes, 2001 to 2007

Passengers	Driver Age			
	14	15	16	17
N=	*150*	*789*	*1298*	*1461*
None	69%	69%	73%	78%
One or More	31%	31%	27%	22%

Source: ND Department of Transportation, 2008.

within the teen driver the passenger rate decreases with age (χ^2=28.69 ρ<0.001, n=3,714). The 14-year-old drivers have teen passengers in 31 percent of the injury crashes compared to only 22 percent of the 17-year-old drivers (Table 10). The lower shares may be related to increasing travel related to work or sports relative to leisure. A significant difference in teen passenger presence is not found among the teen age groups for the serious crashes.

In addition to the driver judgment and skill factors discussed here, special attention is given to seatbelt use because it is a primary vehicle safety device. Unlike the above factors, seatbelt use is not seen as an experience factor, but rather a driver behavior factor in deaths and injuries. North Dakota statute does require seatbelt use by all vehicle occupants under age 18. While citation for this primary enforcement offense is a $25 fine and one point on the driver's license, it appears many ND teens are not convinced of the need to buckle-up.

Safety Restraint Decisions

Vehicle safety equipment is an important factor in understanding crash injuries among ND teen drivers. Of the 11 teen drivers killed on ND roads in 2007, 5 were not wearing seatbelts. The younger drivers consistently exhibit less propensity to use safety equipment despite the obvious higher risks associated with novice driving (Figure 9). Because limited observational data is available with regard to statewide seatbelt usage by drivers, the seatbelt use in injury and fatal accidents is used as a proxy for population performance. Driver seatbelt use in fatal crashes is found to be strongly correlated with observational seatbelt surveys (NHTSA 2001 and 2004) done in the 48 states (Pearson Corr.=-0.615, $\rho<0.001$; n=48). Figure 8 illustrates usage rates among teen drivers, from 14 and 17 years old, in fatal crashes between 2004 and 2006. The highest usage rate is in Oregon, where over 80 percent of teen drivers were reported to be buckled in these crashes. The lowest usage rate was in Wyoming where only 15 percent of the teen drivers in fatal crashes had chosen to buckle up. North Dakota is 46th among the 48 contiguous states in teen seatbelt usage based on fatal crash data, with a measly rate of 20 percent.

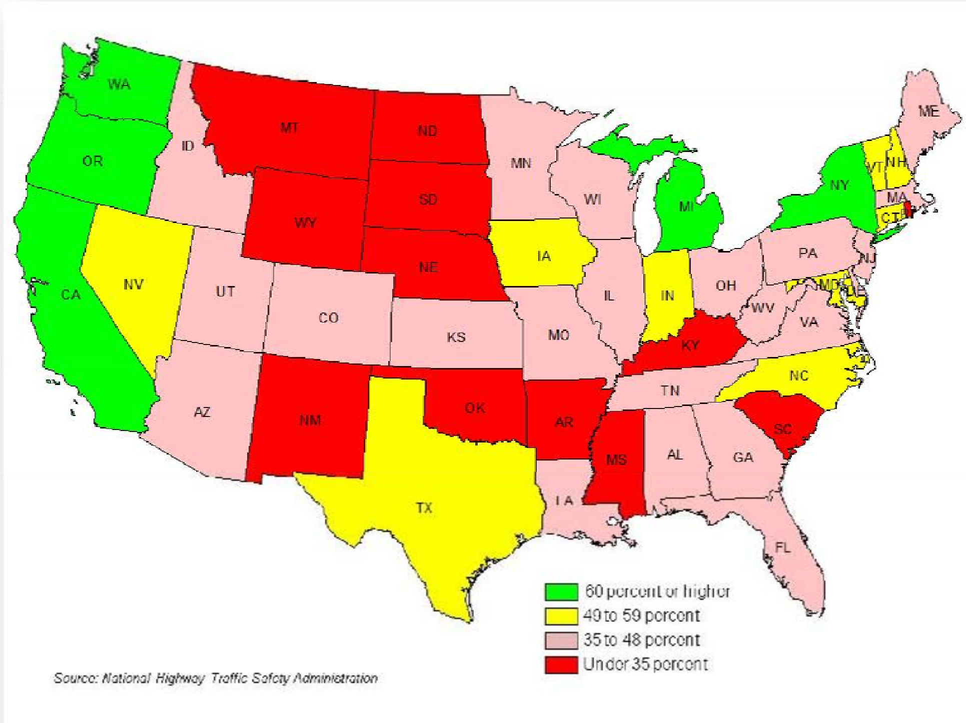

Figure 8. Seatbelt Usage Rates for Teen Drivers in Fatal Crashes, 2004 to 2006

Discussion with ND Highway Patrol suggest the correlation can be extended to all injury crashes because in these cases the seatbelt information is often collected by medical personnel and not as a part of the law enforcement activity (Gerhart, 2008). Therefore, drivers are likely to provide accurate seatbelt information to ensure proper medical care. The ND injury crash data between 2001 and 2007 are used here.

Approximately 78.1 of experienced drivers in injury crashes are wearing seatbelts compared to 75.8 of the young teen drivers. The difference is significant at the 99^{th} percentile (χ^2=72.65, $\rho<0.001$, n=156,918). Although information on seat belt use in all crashes is not available, NHTSA does provide information for drivers in fatal crashes in its FARS database. Nationally, a positive correlation is found between a state primary seatbelt law and teen driver seatbelt usage, in analyzing the FARS crash data between 2001 and 2006 (Pearson Corr.=0.498, $\propto$=.000, n=48). While North Dakota does have a primary seatbelt law for vehicle occupants under age 18, law enforcement indicates that the law is not easy to enforce because officers have to determine an occupant is under 18 by observation. This is a weakness in the law with respect to targeting this driver group.

In North Dakota, a significant difference is also found with regard to genders adhering to the seatbelt law. It was found that 73.9 percent of young males and 77.7 percent of the female drivers are reportedly wearing seatbelts in serious injury crashes – those which are coded as fatal or disabling (χ^2=32.96 ρ<0.001, n=16,540). A significant difference is not found among age groups within the young teen drivers (χ^2=5.11 ρ=0.16 n=16,545). The annual trends in usage by individual driver age groups show an increasing tendency by teens to buckle up when driving. Teen seatbelt usage remains below levels for all drivers, 16 and 17 year olds appear to have a slight positive trend in usage (Figure 9). Usage rates among 14 and 15 year olds also show some evidence toward higher usage, but trends were not found to be significant with the crash data to date.

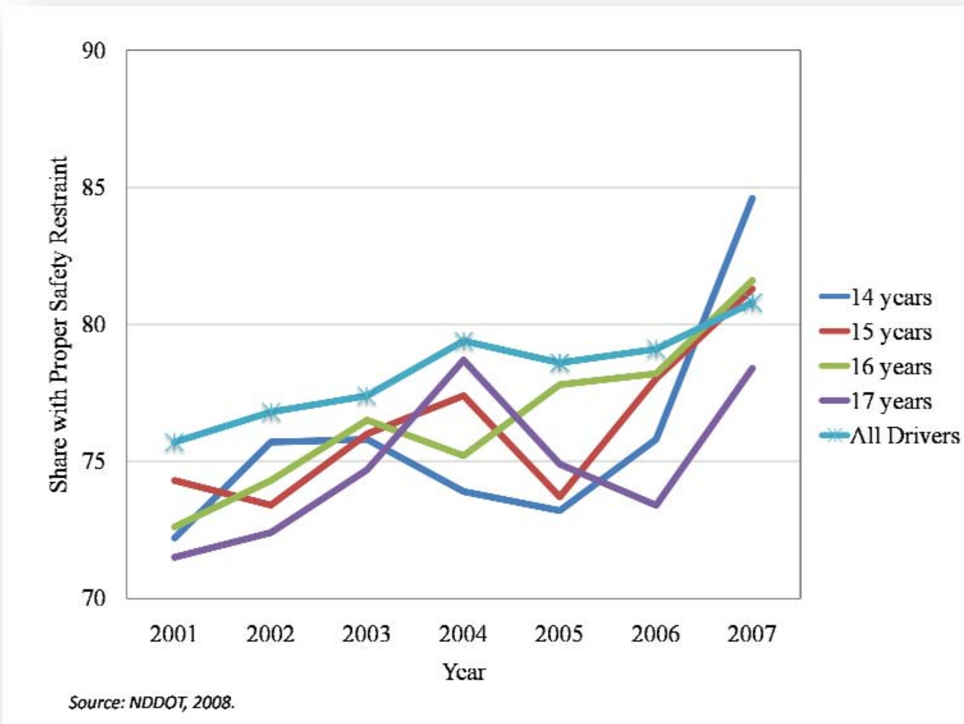

Figure 9. Driver Seatbelt Usage Rates for All Crashes, by Age

An important aspect of this seatbelt usage seems to be attributed to road type. The NDDOT classifies roadways based on the National Highway Systems definition. Within this population-density based definition, a vast majority of road lane miles in the state are rural including interstates and state highway. The urban roadways are found in cities and near the edges of major population centers. In 2007, seatbelts were used in 79.9 percent of urban roadway crashes compared to just 64.9 of rural roadway crashes. The gap in usage on rural and urban roadways is evident in the injury and crash data. Seatbelt usage rates are 15 to 18 percent lower on rural roads than urban roads. The rate for teen drivers on rural roads was 56.9 over the seven years. The trend in road type seatbelt usage rates between teen drivers and other drivers is not found to be statistically different, so only the rates for all drivers are shown in the Figure 10 illustration of the usage gap and trends.

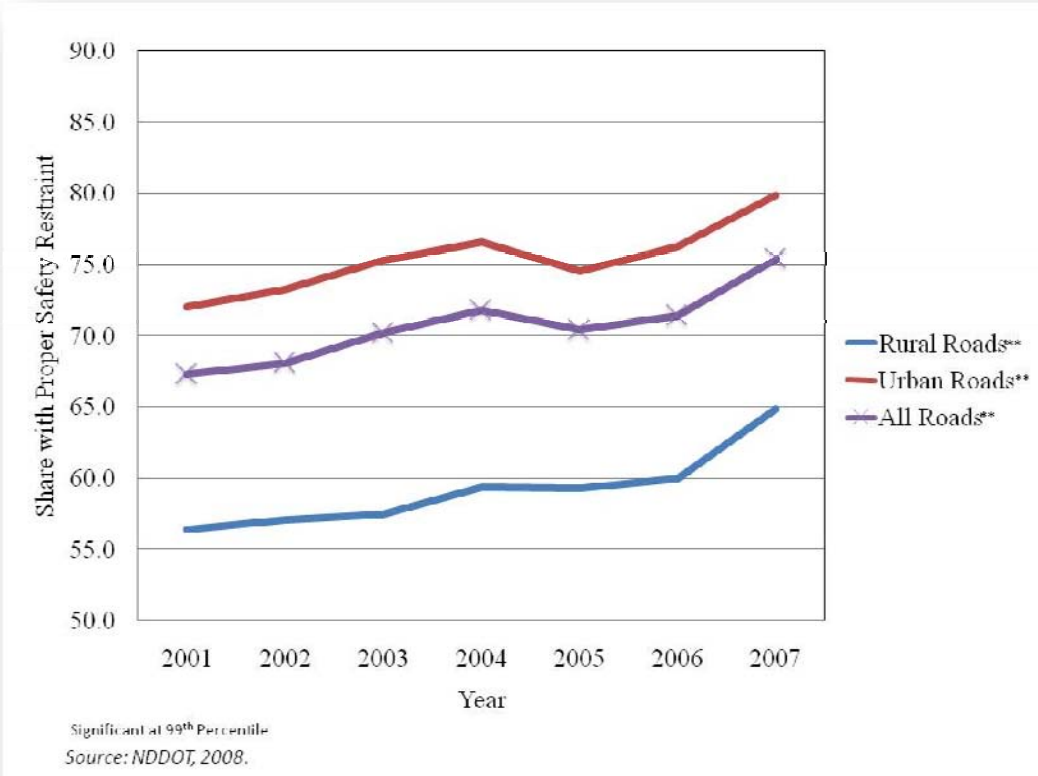

Figure 10. Safety Restraint Usage rates on Rural and Urban Roads

The characteristics and trends discussed in this section form the ND teen driver crash typology. The statistical relationships offer some means for prioritizing breadth of crash factors that may be addressed in GDL provisions. This section, however, did not offer a holistic means for weighting or prioritizing individual factors. As a next step in this research, the need for a multifactor approach is addressed. The information presented in the previous sections creates the context needed for empirical analysis of North Dakota teen crash factors. A logit model has been selected as the regression technique to consider multiple factors that may be priorities in advancing safe driving for the state's young driver population.

Empirical Analysis

Data

All reported North Dakota teen driver fatal and injury crashes are included in the analysis. Light passenger vehicle crashes from 2001 to 2007 ND crash files are used as a panel data source for this analysis (NDDOT). Given the short time line and similar safety policy and engineering environment across these years, temporal effects are not included. The crash records were queried to select observations where driver injury was categorized as fatal or disabling. These driver records are then limited to the group of interest here, drivers age 14 to 17. These drivers would fall into the age group typically covered by novice or graduated driver licensing provisions.

Method

Logistic regression analysis is used to model the young driver risk factors injury crashes. The fatal and disabling crashes are considered serious crashes in this analysis of ND crash data. This model form provides measures for the independent variables while recognizing effects of interactions among terms in relation to the dependent variable. Due to the low-density of traffic and episodic nature of rural roadways crashes in the state, a geographic distinction is limited to the rural and urban roadways as reported in the crash record. The model cannot be used to explain factors that lead to the crash, but does produce log-odds ratios that provide an understanding of behaviors and other factors that lead to death and serious injuries for teen drivers. This methodology has been applied in other systematic traffic safety assessments and provides valuable quantitative information that may be used in prioritizing activities and designing policies to improve public safety (Chandraratna et al. 2006, Gonzales et al. 2005, Ghamdi 2002, Kim et al. 1995).

The relative likelihood of serious injury in a crash, which is a crash resulting in driver death or disabling injury, is the dependant factor. The dependent variable in the model characterizes driver injury as serious. A dichotomous indicator for fatal or disabling injury differentiates crashes as severe compared to those that result in a lesser, non-disabling injury. The observed values of this response variable are compared to the predicted variable obtained in the models with and without the variable in question based on a log likelihood function. The model is generally defined as follows:

$$P_n = \frac{e^{g(x)}}{1+e^{g(x)}}, \text{ so} \qquad \textbf{Equation 1}$$

$$P_s = 1 - P_n = 1 - \pi(x) = \frac{1}{1+e^{g(x)}} \qquad \textbf{Equation 2}$$

P_n = probability of non-severe driver injury in crash, and

P_s = probability of severe or fatal driver injury in crash,

where g(x) includes a set of independent variables related to driver, vehicle, road, and environment in

$$g(x) = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \ldots + \beta_n x_n \qquad \text{Equation 3}$$

Maximum-likelihood technique is used to determine the coefficients that make the observed set of outcomes (several or non-severe) most likely. The independent variables included in the model control for road, vehicle, and environmental conditions, while estimating the effects of driver behavior in crash severity.

Variables

As mentioned in the previous sections, these crash records include information about the driver, passengers, incident, vehicle, and roadway. Driver age and gender, driver behavior, and passenger information are considered in model. Other parameters that control for environment, vehicle, and roadway characteristics and may be influential were also included in the model.

Crash severity is the dependent variable. The injury severity is modeled as crashes resulting in fatal and disabling injury to driver versus a non-disabling injury to the driver. Based on the review of young driver and other crash studies, independent variables included in the initial model were:

Variable Name	Definition
Driver Age	14, 15, or 16 *(17 omitted as comparison age)*
Gender	Male (=1) or Female (=0)
Adult Occupant	Occupant 18 year or Older (=1) or no occupants 18 years or older (=0)
Teen Occupant	Teen Passengers in Vehicle (=1) or not Teen Passengers (=0)
No Safety Restraint	Yes (0) or No/Not Used or Improperly Used (1)
Late Night	11:00 p.m. to 6:00 a.m. (=1) or Other time (=0)
Speeding	Yes (=1) or No (=0)
Alcohol Use	Yes (=1) or No (=0)
Alcohol or Drug Use	Yes (=1) or No or Unknown(=0)
Antilock Brakes	Yes (=1) or No (=0)
Airbag	Yes (=1) or No (=0)
Rural or Urban Road	Rural (=1) or Urban or Urban Interstate (=0)
Gravel	Gravel (=1) or Other Roadway Surface Types (=0)
Road Geometry	Curve on Grade or Hill Crest (=1) or Straight, on Level/Grade, or Curve on Level (=0)
Intersection	Yes (=0) or No (=1)
Surface Condition	Dry, Wet, Muddy (=0) or Snow, Slush, Ice/Compacted Snow, Frost (=1)
Divided Highway	Divided Highway or One-way Traffic (=1) or Two-Way Traffic (=0)
Weather Conditions	Clear or Cloudy (=0) or Rain, Sleet, Hail, Freezing Rain, Snow Fog, or Smoke (=1)

Daylight	Daylight (=1) or Other including dawn, dusk, and dark (=0)

The final model, presented in the following section, provides the subsequent parsimonious model. Initial variables have been removed or modified slightly based on results from several iterations of the theoretical model. The resulting model includes the variables and definitions that best explained likelihood for ND teen driver injury severity.

Results

A population of 3,607 teen drivers sustained crash injuries between 2001 and 2007. Crashes resulted in 43 deaths and 151 disabling injuries for teen drivers. The model identifies several significant factors in likelihood that a teen crash will result in driver death or disablement. The independent variables result in 80.6 percent concordance of predicted and observed dependent values. Most important among factors, in terms of log-ratio values, are rural road, age, seat belts, and alcohol.

The role and interaction of these factors is evident. About 36 percent of the teen driver injury crashes occurred on rural roads. A large share, 80 percent, of the teen driver death and serious injury crashes occurred on rural roads. Teen drivers failed to use legally required seat belt restraint in 68 percent of all crashes. Use on urban roads was 75.4 percent. This level is much higher than the 59.9 percent use rate found in rural road teen driver injury crashes. Illegal alcohol consumption was reported in 5.9 percent of the teen driver crashes. The incidence rate for rural crashes was 13.1 percent, about 5 times greater than the 2.7 percent rate on urban roadways. Model results can be interpreted to further understand the role of individual factors (Table 11).

Teens are nearly six times more likely to die or be disabled in rural roads crashes than in urban roadway crashes (OR=5.818, 95% CI=4.010, 8.440). About 36 percent of the teen driver injury crashes occurred on rural roads, while 80 percent of teen driver deaths and disabling injuries occurred on these roads. The rural roads account for 74 percent of annual vehicle-miles in the state (Federal Highway Administration 2007). This value, however, is a poor proxy to typify individual driver activity since it includes a large volume of non-resident traffic that travels through the state on its two rural interstates. Additional information on teen driving regarding exposure to distance or time spent on rural and urban roadways is needed to better understand this factor in teen driver risk.

The collective benefit of increasing age and experience in reducing crash risk is consistent with other research (Shope and Bingham 2008, Ballesteros and Dischinger 2002, Waller et al. 2001). Fourteen-year-old drivers are 3.1 times more likely than 17-year-old drivers to be killed or severely injured. The 16-year-old drivers have a 1.5 time greater chance for death or disablement than drivers just one year older. The greater risk in the 16-year-old group may be associated with those new drivers entering the population without completing the behind-the-wheel instruction that is required for licensure for those under age 16. The 15-year-old drivers' crash likelihood does not vary significantly from that of 17 year olds. Although it is not statistically significant in the reduced model, the 15-year-old group variable is retained to avoid omitted-variable bias. The distinction between influences from a higher licensing age and expanded driving experience requirements remain blurred. While a higher crash risk for teens compared to older drivers, especially beyond age 25, is common, findings for differences among teens by either age or experience – such as supervised driving or permit time length – is not well established (McKnight and McKnight 2003, McCartt et al. 2008).

Table 11. Model Results and Log Odds Ratios

Parameter	Estimate	S.E.	P-Value	Sig.	Log Odds	95% CI
Gender	-0.3397	0.1616	0.0355	*	0.712	0.519 to 0.977
14 Years	1.1317	0.3005	0.0002	**	3.101	1.721 to 5.588
15 Years	0.1912	0.2232	0.3916		1.211	0.782 to 1.875
16 Years	0.3719	0.1897	0.0499	*	1.451	1.000 to 2.104
Teen Passenger	-0.4678	0.1917	0.0147	*	0.626	0.430 to 0.912
No Seatbelt	0.9751	0.1677	<.0001	**	2.651	1.909 to 3.683
Alcohol Involved	1.1818	0.2569	<.0001	**	3.26	1.970 to 5.394
Antilock Brakes	-0.3524	0.1680	0.0360	*	0.703	0.506 to 0.977
Late Night	-0.1604	0.2504	0.5217		0.852	0.521 to 1.391
Rural Road	1.7609	0.1898	<.0001	**	5.818	4.010 to 8.440
Road Geometry	0.6079	0.2716	0.0252		1.837	1.079 to 3.127

**significance at ρ=0.01
*significance at ρ=0.05
N=3,607

Seat belt use, which is legally required under age 18, is a large contributor for risk of death or disabling injury among teen drivers. ND teen drivers who fail to buckle up are 165 percent more likely to die or suffer disabling injuries in crashes (OR=2.65, C.I. 1.909, 3.683). Seat belts are a proven safety measure for traffic safety, and indicated again in findings here. The seat belt requirement is not distinguished in the discussions of phased licensing since it is already a primary law in many states. While North Dakota does have a primary seat belt law for vehicle occupants under age 18, the effectiveness is a huge concern. This finding is consistent with a study of Colorado teens where seat belts were used by fewer than half of the drivers (Gonzales et at. 2005). North Dakota ranks 45th among 48 states ranked from top to bottom in belt use by drivers aged 14 to 17 in teen driver fatalities (National Highway Traffic Safety Administration 2008b). This teen risk factor certainly seems a likely target for education and enforcement. It appears thus far, however, that teen behavior does not consistently reflect state legal requirements.

The presence of teen passengers in the vehicle has been identified as a risk factor for the teen drivers (Lee and Abdel-Aty 2008, Williams 2007). Contradictory results here show teen passengers actually reduce likelihood for driver death or disabling injury in the teen injury crashes. Teens driving with peers – between the ages of 13 and 17 – are 37 percent less likely to be severely hurt in an injury crash than teen drivers without peers. Some possible explanations for this unexpected result may be that the teen passengers are relatives rather than friends, the passenger factor increases teens' sense of responsibility, or that they are less likely to fall asleep or be distracted by things like visiting on cell phones or texting. Although some research has shown passenger associated risk-behavior may be a precursor to a crash (Simons-Morton et al. 2005), it should also be reiterated that the results of the present study are based only on injury crashes.

Alcohol or drug use, while a factor in only about 6 percent of teen crashes, contributes greatly to risk of an injury crash resulting in severe injury. Where alcohol or drug use is reported as a factor, teen drivers are 3.3 times more likely to incur severe injury. The risk may be associated with engaging in riskier behavior due to reduced inhibitions. Public awareness of this issue is evident in media campaigns surrounding prom- and graduation-type events and with activist groups such as Students Against Drunk Driving and Mothers Against Drunk Driving.

The rural roads, seat belt use, and drinking offer some potential targets for reducing teen traffic deaths. Additional focus may be identified through the control parameters introduced in the model. Factors such as gender, antilock brakes, and road geometry may also offer means for creating a safer driving environment for these young teen drivers.

After controlling factors such as seat belt and alcohol or drug use, young female drivers generally have a higher risk for severe injury than their male counterparts. Male teen drivers are 29 percent less likely to be severely injured in these crashes than their female counterparts. These findings are consistent with studies of injury severity in the general crash population where females have greater likelihood of serious injury controlling for other crash factors (Evans 2001, Ulfarsson and Mannering 2004). While it is unlikely that policy would be a means for addressing gender-specific risk, it does provide justification for directing education and enforcement resources toward this driver group. It may also present opportunities for targeting messages to parents, siblings and peers of these drivers.

Wisdom in the advice to 'put your teen in your most safety-equipped vehicle' is supported by the significance of antilock brakes. Teens driving cars with antilock brakes were 30 percent less likely to be involved in fatal or disabling crashes. The newest vehicle safety requirement – stability control systems – is not yet known, but these results suggest this type of vehicle safety equipment is beneficial in reducing injuries among young drivers.

This model has taken into account a breadth of parameters available for teen driver injury severity in crashes. The role of the collective age-experience factor and seat belts in teen driver crash injuries are very important. In addition, risk is significantly higher in navigating rural, gravel, and complex roadways but more information is needed about exposure. These results provide local information regarding teen drivers that can be useful in licensing guidelines and programs initiatives aimed at reducing teen crash deaths.

Conclusion

North Dakota's teens are highly over-represented as drivers in the state's injury crashes. A logit model of North Dakota teen driver injury crashes offers insight for creating a safer driving environment for the state's novice drivers. Most findings here are consistent with the large literature published on teen drivers. The danger attached to lower collective age-experience values, lack of seat belt use, and impaired driving are evident. The benefit of vehicle safety engineering – considering antilock brakes – is also significant in reducing injury severity for the teen drivers. Some factors, however, differ from findings elsewhere. For instance, more experience driving on rural roads may benefit North Dakota's novice drivers. About 36 percent of the teen driver injury crashes occurred on rural roads. A much larger share, 80 percent, of the teen driver fatal and disabling injury crashes happen on rural roads. Gender is also found to be a factor in teen driver injury severity, with females at higher risk. With both these factors, however, more information is needed on driver exposure. Literature on best practices and experiences elsewhere offer a plethora of ideas for increasing teen driver safety through licensing and interventions. Findings here provide a local perspective for potentially reducing teen traffic deaths by understanding crash factors.

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