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Impacts of Public Policy on Safety – Graduated Driver's License

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Impacts of Public Policy on Safety - Graduated Driver's License,

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Final Report.

by

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16. Abstract
This study evaluated the effectiveness of Missouri's GDL policy. This study found a substantial decrease in crash involvement rates among drivers aged 15-18 in Missouri while drivers aged 19 or older have a moderate decrease in the rates. This study also found Missouri teenage drivers aged 16-18 had a small but steady decrease in their fatality rates while the drivers in neighboring states with weaker GDL provisions experienced either increase or fluctuation. This study examined how teenage drivers aged 15-18 with instruction permits or intermediate licenses comply with GDL restrictions or requirements. The percent of crash-involved drivers aged 15 having a qualified front seat passenger improved substantially over the years. However, the compliance rate on the not-driving-alone restriction in early morning (1:00 a.m.- 5:00 a.m.) has been low. This study found there have been significant variations among counties in terms of crash rates among drivers aged 15-18. The teenage drivers in urban counties with major cities and higher median household income had a more pronounced decrease in crash involvement and at-fault crashes compared to rural counties with lower median household income after the implementation of GDL.

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Executive Summary:

Driving is one of the most life-threatening activities in which teenagers engage. Vehicle crash involvement is the leading cause of death among Americans aged 15-19. Graduated Driver's Licensing (GDL) policy mitigates the risks of teenage driving through a licensing structure that promotes extended supervised learning and limits teenage exposure to high risk situations. Missouri introduced its GDL policy in 2001 and is considered a state that has implemented "good" driver's licensing programs for teenage drivers by the Insurance Institute for Highway Safety (IIHS).

In Missouri, teenage drivers may obtain a learner's permit beginning at age 15 following the completion of a written exam and a vision test. Missouri's mandatory permit holding period lasts 6 months or until the driver turns 16, whichever is longer. After reaching 16 and completing the learner's stage without incident, drivers in Missouri aged 16 to 17 are eligible for an intermediate license with provisional restrictions involving nighttime driving and number of teenage passengers. The provisions expire at 17 years and 11 months if there have been no outstanding violations which might delay graduation to full licensure. Upon passing the vision and road sign tests along with having no alcohol-related offenses or traffic convictions in the last 12 months, the driver may then apply for an under-21 full driver license.

This study evaluated the effectiveness of Missouri's GDL policy using Missouri crash data for the last 10 years (1998-2007). Many results reflect the effectiveness of Missouri GDL policy. For example, there has been a substantial decrease in crash involvement rates among drivers aged 15-18 in Missouri while drivers aged 19 or older have a moderate decrease in the rates. Also, fatal crash involvement rates of Missouri's drivers aged 16-18 were compared to the rates of Arkansas, Iowa, and Kansas where GDL provisions are weaker than Missouri. This study found Missouri teenage drivers aged 16-18 had a small but steady decrease in their fatality rates while the drivers in other states experienced either increase or fluctuation.

This study also examined how teenage drivers aged 15-18 with instruction permits or intermediate licenses comply with GDL restrictions or requirements. The study found the percent of crash-involved drivers aged 15 having a qualified front seat passenger improved substantially over the years. The compliance rate of teenage drivers aged 16-17 regarding the teenage passenger limit has been consistently high. However, the compliance rate on the not-driving-alone restriction in early morning (1:00 a.m.- 5:00 a.m.) has been low even though the rate has slightly increased over the years.

Percent change in the number of crash-involved drivers aged 15-18 decreased in most of Missouri's counties. The at-fault crash rate for drivers aged 15-18 was also lower than that of drivers aged 19 or older in all but 10 counties. This study found there are significant variations among counties in terms of crash rates among drivers aged 15-18. The teenage drivers in urban counties with major cities and higher median household income had a more pronounced decrease in crash involvement and at-fault crashes compared to rural counties with lower median household incomes.

This study proposes the following recommendations to improve in Missouri's current GDL policy based on the findings of this study and recommended practices identified in traffic safety. The recommendations include: 1) expanded or new restrictions on nighttime driving as well as a focus on school commute hours, 2) prohibition of cellular phone use while driving, 3) implementation of a probationary program to more carefully monitor driving behavior under the learner's permit and intermediate license, and inclusion of violations of GDL restrictions in delaying graduation to full licensure, and 4) more efforts to improve traffic safety of teenage drivers in rural counties through inter-county communication in relation to GDL implementation.

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I. Graduated Driver's Licensing (GDL):

1. The Risks of Teenage Driving:

Learning to drive a vehicle is one of the most life-threatening activities in which teenagers engage. Vehicle crash involvement is the leading cause of death among Americans aged 15-19 (Foss & Goodwin, 2003; NCSA, 2006). Younger drivers have significantly higher fatal and police-reported crash rates compared to drivers of other ages as shown in Table 1. Driver error is common to any novice driver. However, novice teenage drivers are especially vulnerable to error resulting in injury or death. Table 2 shows driving error and speeding lead to a substantial percentage of teenagers' fatal crashes, subsiding with age. The same is true for crashes in which teenagers were carrying passengers. Table 2 also shows crashes related to blood alcohol content (BAC) are a problem associated with teenage drivers even though it increases with age.

Table 1 Fatal and police-reported crash involvement per population by driver age and gender 2005 FARS and 2005 NASS/GES.

Age	Fatal crashes per 100,000 population			Police reported crashes per 1,000 population		
	Males	Females	Total	Males	Females	Total
16	23	15	19	55	58	56
17	38	21	30	85	76	80
18	55	24	40	106	78	92
19	54	24	40	95	76	86
16-19	43	21	32	85	72	79
20-24	49	19	34	77	65	71
25-29	35	15	25	66	49	58
30-59	24	11	17	46	35	40
60-69	22	9	15	32	20	26
70+	26	9	16	27	15	20

Source: Ferguson (2007)

Table 2 Characteristics of fatal crashes by driver age (%), 2005 FARS.

	Driver age					
	16	17	18	19	20-25	26-49
Driver error	74	73	71	68	64	51
Speeding	34	32	33	33	30	19
Single vehicle	49	47	44	46	45	38
3+ passengers	29	24	23	24	19	17
Driver killed with positive BAC's	15	23	30	32	53	48

Source: Ferguson (2007)

Note: Columns sum to more than 100 percent where more than one source is attributable to the crash.

Teenage drivers have higher risks of crash due to a combination of their cognitive development and cultural factors. They have less experience making good driving judgments, overestimate their driving ability, and may seek out high risk situations. These factors are related, and the rate of teenage crashes per capita suggests these and other factors related to teenage driving need to be considered.

Risk Exposure Due to Inexperience:

Compared to other age groups, teenagers drive fewer miles than all but the oldest groups of drivers (Ferguson et al., 2007) and often have the fewest hours of experience as well. When teenagers earn their licenses and begin driving with relaxed driving restrictions and less supervision, they increase both their mileage and exposure to road hazards at a faster rate than their experience (Williams et al., 2006). In fact, obtaining a license that allows fully independent, unsupervised driving provides the greatest increase in risk exposure (Williams & Ferguson, 2002).

Novice drivers are still learning how to accurately perceive risk, manage all aspects of driving, and respond quickly and accurately to potential hazards. While they learn most basic driving skills during the supervised driving phase of licensure, more tacit skills develop with experience. A study in Canada based on analysis of police reported crashes found teenage crash rates decline from approximately 120 crashes/10,000 drivers in the first month of licensure to less than 70 crashes/10,000 drivers after the first six months of independent driving experience (Mayhew et al., 2003).

Studies of cognitive behavior and learning suggest there is great variability in ability and performance in almost any skill-dependent practice (Simons-Morton, 2007). However, the development of a memorized and automated set of knowledge and reflexes like those used when responding to road hazards comes with experience (O'Byrne et al., 1997). Such tacit skill sets cannot be taught in formal instruction. Driving is a learning-by-doing task and to fully master driving skills requires more practice than is required to obtain a license. Competency develops through extensive and frequent experience driving in a variety of conditions over a long period of time (Groeger, 2000).

Hazard Perception and Distraction:

Hazard perception requires an accurate and efficient assessment of potential risks on the roadway as well as an accurate perception of one's own driving abilities (Brown & Groeger, 1988; Ferguson, 2003). Driving acumen and reflexes are tacit driving skills, hard to teach and time-consuming to learn. Even though road hazards per mile are the same for all drivers, newer drivers face these hazards with less preparation and skill than experienced drivers and may lack the ability to accurately perceive and asses them. Experienced drivers are typically better able to quantify the degree of risk a hazard poses and respond appropriately (Ferguson, 2003). Novice drivers are often less able to assess hazards in the traffic environment as they have a different visual fixation and scanning pattern than more experienced drivers (Brown & Groeger, 1988; Mourant & Rockwell, 1972).

Inexperience in perceiving hazards is compounded by in-vehicle distractions. Using a cell phone while driving, adjusting a vehicle radio, and diverting one's attention to passengers challenge any driver. These activities can affect maintenance of lane position, appropriate traffic speed, adequate following distance, and extent of gap acceptance (Royal Society for the Prevention of Crashes, 2002). The coupling of distraction and inexperience diminishes the ability of young drivers to accurately perceive risk due to inefficient visual processing (Mourant & Rockwell, 1972; Summula, 1996). Any distraction from the road reduces the ability of most drivers to perceive and react to a potential hazard. A study by Wikman et al. (1998) showed that novice drivers exhibited greater variability in glance duration with significantly greater numbers of short and long glances directed at in-vehicle tasks compared to more experienced drivers. These glances were associated with greater lateral displacement of the vehicle, which can lead to crossing into another lane of traffic. Young drivers' misestimating of distance and speed compounds this risk.

Overconfidence and Risk Taking:

Accurate assessment of the limits of one's ability plays a critical role in evaluating the degree of risk everyday hazards pose to safety. Overconfidence can easily lead to other forms of risk taking behaviors. Young drivers consistently perceive their own risk of being in a crash to be significantly lower than that of their peers (Finn & Bragg, 1986). Furthermore, few young drivers believe they are bad drivers, rating their driving abilities as equal to older, more experienced drivers, as well as higher than their peers (Mathew & Moran, 1986). The inability to recognize the limitations of one's abilities has detrimental effects on judgment and increases crash risk. Overconfidence often augments the common adolescent behavior of risk taking.

Adolescence is a period of such rapid physical, emotional, and mental growth that in a period of several months, enormous advances may be made in self regulation, emotional control, and other issues of common sense associated with maturity (Arnette, 2007). However, since the exact timing of these advances varies, preventative measures enacted to keep teenagers safer and healthier almost always focus on delaying the age of exposure to risk. Keating (2007) suggests teenagers are just as capable of understanding and identifying risk as adults, but their intuitive responses while driving tend to be riskier. In studies examining drivers' intentional risk taking, risky behavior was often associated with disregard for legal driving rules and a belief that intentional risk would not result in legal sanctions or injury (Hirsch, 2003). This miscomprehension illustrates many teenagers' disregard of their own mortality and of the dangers some behaviors pose. A number of observational studies have found young drivers take more risks than experienced drivers (Ferguson, 2003; Bottom & Ashworth, 1978; Baxter et al., 1990; Evans & Wasielewski, 1983; Galin, 1981; Simons-Morton, 2007). For example, teenage drivers keep shorter following distances, are more inclined to disobey the posted speed-limit, and accept narrower gaps when pulling out into traffic. Some teenage drivers are more likely to engage in risky driving behavior while seeking the thrill of risk taking or showing off (Bingham et al., 2006). Some of these behaviors could be understood in the context of a novice's exploration of the vehicle's potential and their own skill level – experimenting with speed, turning radius, or other situations that would otherwise put them in a position to lose control of the vehicle (Simons-Morton, 2007).

2. GDL Policy:

Licensing systems for teenage drivers have developed with the increased understanding of the difficulty of learning to drive in modern roadway conditions. The introduction of these laws varies by state. In the U.S., most states began by introducing the learner's permit in the mid 20th century as a supplement to conventional systems that did not require the permits be held for a set period of time prior before licensure (Mayhew, 2003; Simpson, 2003). Thus, there was often little or no incentive to obtain a permit prior to licensure.

Graduated Driver's Licensing (GDL) policy intends to mitigate the risks of teenage driving through a licensing structure that promotes extended supervised learning and limits teenagers' exposure to high risk situations, such as driving late at night or with many friends that may cause distraction. Facets of these GDL laws began to be adopted in the U.S. as early as the 1970's. However, GDL as it is known today did not begin to be widely adopted until the late 1990's, beginning with the State of Florida in 1996.

The most pervasive feature of GDL is the provisional license stage, originally adopted as a part of conventional licensing systems. Provisional licensing was originally developed as a means to limit the exposure of young drivers to hazardous situations by restricting the driving privileges. Typical restrictions limit nighttime driving and the number of passengers a novice driver can have in the vehicle. In this way, the provisional license is largely the forerunner to the contemporary GDL systems we recognize today.

Early systems all grew out of a need to address teenagers' driving behaviors. The GDL systems in place today resemble these systems in their structure and are built upon similar behavioral theories. Additionally, GDL has grown in its scope to address additional risks and create increased benefits to driver safety.

GDL policies focus on the critical period in which teenagers are at greatest risk for crash involvement and injury, between 15 and 18 years old. By establishing a two-stage licensing system, GDL effectively delays the age of full licensure, increases the time period in which learning takes place, and limits teenagers' risk exposure. This begins with the instructional/learner's permit in which driving is supervised by a legal guardian or certified driving instructor and continues with the provisional license.

The learner's permit is issued prior to regular licensing and allows beginners to gain experience under the supervision of a licensed driver, usually a parent or driving instructor. This acknowledges that beginners need time to develop basic driving skills in controlled settings under the supervision of experienced drivers before graduating to a higher class of license (Simpson, 2003). In most cases, the requirements of this policy component mean that teenagers obtain independent driving privileges later, thus giving them more time to hone their driving skills under supervision and develop less risky intuitive responses to driving hazards.

The learner's permit stage is a period of low crash risk. Because a parent, driving instructor, or other adult supervises driving during this stage, exposure to risk is lowered and hazardous conditions are typically avoided (Williams & Preusser, 2003). A study by Mayhew et al. (2003) showed that crash rates are not only very low during the learning period, but do not increase over the duration of the learning period either. Those who had already held learner's permits for several months in the study did not have a higher crash rate than those in their first month of training. This suggests crash risk is low during the supervised driving period, and it does not vary over its duration. Williams et al. (1997) analyzed fatal crashes of 15-year-olds in states that license at 16 but grant permits earlier. The study found very few crashes occur among 15-year-olds holding permits while driving under supervision. However, most 15-year-olds involved in fatal crashes during the same period either did not hold permits or were not operating vehicles under the required supervision.

The age at which teenagers become eligible for a permit varies by jurisdiction. In Alaska and Arkansas, teenagers are eligible for these permits beginning at age 14 whereas Connecticut, Delaware, Massachusetts, Pennsylvania and number of other jurisdictions grant permits beginning at age 16 (IIHS, 2008a). Missouri allows drivers to apply for a permit at age 15. The length of time a novice driver must hold a permit and the amount of instruction they receive before graduating to the provisional license also varies by state. In Wyoming, a teenager must hold a driving permit for only 10 days before being eligible for a provisional license. However, in some states, teenagers are required to hold their permit for as long as 12 months. Missouri requires a 6 month holding period. Regardless of the amount of time a teenager must hold his or her permit, it is somewhat unclear as to how much instruction or experience they actually receive behind the wheel. Recently, states have begun to require parents to certify the number of hours of driving instruction teenagers receive. Though not all states have adopted this provision, those that do require somewhere between 25 and 50 hours of instruction with a portion required to be nighttime driving; Missouri requires 40 hours with a minimum of 10 hours nighttime driving. Additionally, many states offer brochures or guides for parents explaining how to teach a teenage driver in order to aid in this instructional period, such as Missouri's *Safe Driving: A Guide to Teaching the New Driver* (MoDOT, 2007).

Following the learner's permit stage is graduation to a provisional license. The provisional or intermediate licensing stage is comprised of policy provisions from both the probationary license and the provisional license stages of conventional systems (Simpson, 2003). As it has developed, this stage

discourages risky driving, like earlier provisional license policies. This provides a deterrent to reckless behavior, like in the probationary license systems, and transitions between the lower risk driving of full supervision and higher risk driving of full license. Under this license the novice driver typically has passenger limitations and is precluded from driving during certain hours at night. These provisions are similar to those of the earlier provisional license programs. However, under GDL the provisional and probationary license systems have been combined to create a hybrid system, which has perhaps been the most significant policy innovation for novice driving programs.

3. GDL Policy Structure and Implementation:

The GDL system is popular among policy makers because it is cost effective; it does not require additional public schools, leaving driver education a home schooling responsibility. It also does not require more state-paid testing, significantly more state paperwork, nor additional state employees. Each facet of the policy is reinforced by the next and each driver goes through the same licensing process. This provides a kind of system-wide uniformity in the education and testing of teenage drivers. This structure is reliant on enforcement; if drivers are not aware of, do not understand or do not believe there will be penalties for operating a vehicle outside of GDL laws, its effectiveness is diminished.

Extended Learning:

Young driver's driving skills increase with more supervised driving. However, greater amounts of supervised driving do not guarantee (but are more likely to induce) development of more tacit driving skills such as visual scanning, acumen, and reflexes; these are all crucial skills for young drivers to effectively and efficiently perceive hazards (Mayhew, 2003). With greater practice, these skills may become more automated. Supervision will also provide parents more opportunities to impart safe driving habits upon teenagers (Simons-Morton, 2007). Parents may find guides to teaching their teenagers to drive from various sources. The state of Missouri issues *Safe Driving: A Guide to Teaching the New Driver,* offering parents specific lessons to teach their young drivers, ranging from basic vehicle maintenance to hazard navigation (MoDOT, 2007). Furthermore, the more supervised training young driver's are required to have prior to licensure, the longer it takes to become fully licensed. Thus teenagers gain autonomy at older and more mature ages, a result proven to reduce their crash risk (McKnight & Peck, 2002; Simons-Morton, 2007).

Many jurisdictions, including Missouri, now require that a parent or guardian certify the number of supervised driving hours teenage drivers receive behind the wheel in order for the teenager to receive their intermediate license. Generally, this period is thought to be necessary to assure teenage drivers develop basic driving skills. To the extent this period delays licensure, the policy is effective. However, the demands of teaching and supervising driving make it unclear how effectively or equitably parents cope with this task. Teaching teenagers to drive is likely a highly stressful and demanding task, requiring parents to maintain a high priority on safety, anticipate potential hazards, alert the novice driver to unseen problems and emergencies, provide much needed guidance and navigation, and keep the internal vehicle environment free from distractions (Groeger, 2000; Simons-Morton & Ouimet, 2006). Given these demands, there is high variability in the quality and extent of instruction. Currently, no study has portrayed a clear relation between parent certified driving experience and reduced crash rates during independent driving. However, this does not mean the policy is ineffective. The literature promotes supervised driving as an important and integral provision, but advises against over reliance upon this facet of GDL policy alone. Offering formalized assistance to parent teachers in the form of information, guides, and encouragement may help standardize the quality of parent instruction.

Multi-Stage Instruction:

Multi-stage instruction provides teenagers an opportunity to first develop basic skills during the early period of supervised driving before attempting to acquire more advanced skills (McKnight & Peck, 2003). In order to move on to the second stage of instruction, drivers need to demonstrate competency of these basic skills during their driving test. Some GDL systems such as those in New Zealand and Michigan go so far as to require formal instruction even after acquiring the provisional license. However, the benefits of these interventions are mostly anecdotal. Similar programs in Europe have required instruction under adverse weather conditions. However, inquiries into the success of such programs by Katila et al. (1995) suggest that this instruction may actually lead to increased crash rates under these conditions, especially among male drivers. This is likely due to an overestimation of one's skill after instruction. Other instruction programs seek to teach defensive driving skills and crash avoidance techniques without increasing the risk exposure of young drivers and are shown to successfully reduce teenagers' crash rates in the short term. However, the most cost effective method of multi-stage instruction appears to be the application of policy provisions which allow novice drivers to gain independent driving experience behind the wheel while restricting their terms of use. This provides real and not simulated opportunities for learning while limiting exposure to potential risk.

Early Intervention:

One of the more ubiquitous GDL elements is the application of more serious driver improvement interventions at lower violation thresholds than would be the case for more experienced drivers. For instance, for some infraction or sequence of infractions for an adult, the first intervention might typically be informational or instructional. For the same infraction or sequence of infractions, the first intervention novice drivers may face is license suspension. This policy component is expected to act as a deterrent against infractions for all drivers operating under a provisional license as well as a penalty. Where applicable, this infraction would likely result in a deferral of graduation to full licensure as a part of contingent advancement policies.

The effects of early intervention programs within GDL have been significant in some states. An analysis of early versions of the provision in California showed that 16-year-olds exhibited a proportionally greater reduction in crash involvement and violation rates as they came closer to violation thresholds for intervention (Hagge & Marsh, 1988). This proportional reduction among the experimental group of 16-year-old drivers exceeded that of the control group of 19-year-old drivers who were not subject to low intervention thresholds. The program exhibited general deterrent effects on violators and also decreased recidivism after suspension. The deterrent effect of the policy seems to be more pervasive among female drivers and less so for males. The experience of actual license suspension, however, significantly reduces crash rates for either gender (McKnight & Peck, 2003), and teenage drivers may become more careful simply to avoid suspension.

Contingent Advancement:

One of the primary purposes of GDL is to ensure that the appropriate levels of acumen and skill have been developed before advancement to the next stage of licensing. Advancement contingent upon compliance ensures drivers maintain a record of compliance and safe driving during the provisional phase before restrictions are lifted (Foss & Goodwin, 2003). This incorporates an important component of human behavior into the policy's design: the provision acts as a deterrent to risk seeking behaviors but it also provides an incentive to maintain safe driving habits. The provisions of contingent advancement vary among GDL systems, but in most cases each additional violation will extend the duration of the provisional license phase.

Almost without exception, a jurisdiction's desire to see young drivers develop necessary skills for driving, is borne out of the need to improve the safety of all drivers on the roadway. All jurisdictions in the United States have laws in place that penalize young drivers who do not comply with driving restrictions, or who are involved in traffic violations or at-fault crashes (Ferguson, 2003). The application of points to a driver's license or a simple fine may not be real enough for many young drivers. A threat to their autonomy might be. Under the assumption that the goal for most young drivers is the eventual graduation to full licensure, the threat of such a penalty can be a powerful motivator if they believe it is meaningful and there is a perception it will be applied (Ferguson, 2003). Contingent advancement structurally ensures and enforces two-stage instruction and augments the deterrent effects of early intervention. It discourages risk-seeking behaviors and penalizes over estimation of driving skill where it might result in an infraction. Furthermore, it greatly improves the likelihood that young drivers will comply with restrictions on provisional licensing. However, this policy innovation is only useful where there is a belief among teenagers that the policy will be enforced and the penalties applied.

Nighttime Driving:

Although supervised nighttime driving under a learner's permit is low risk, nighttime driving under a provisional license is not. While this danger is mostly mitigated during the learner's stage, attitude and behavior can change dramatically between the parent supervised learning phase and fully independent driving. With the addition of inexperience to this dynamic, risk exposure during this phase of GDL is very high. Thus, the problem becomes one of creating and applying the appropriate provisions to limit exposure. GDL achieves this by prohibiting driving during times of high risk and in situations of compounded exposure.

Nighttime driving increases the crash risk among young drivers for numerous reasons. Driving is by nature more difficult in the dark. Novice's have less practice driving at night than during the day. Also, recreational driving, often done at night, is thought to represent considerably more risk as it often involves teenage passengers and sometimes alcohol (Williams, 2003). Darkness alters visual acuity and perception obviating driver feedback, profoundly important for all drivers (Plainis & Murray, 2002). This is especially problematic for novice drivers because they lack both the nighttime and daytime driving experience necessary to efficiently manage a vehicle (Simons-Morton, 2007). Also, fatigue may be more of an issue for teenagers at night than during the day. The notion that teenagers often do not get enough sleep is well established. Adolescents' sleep patterns shift towards later times for sleeping and waking, counter to a typical high schooler's daily schedule (National Sleep Foundation, 2000; Wolfson & Carskadon, 1998; Ferguson 2003). This could adversely affect nighttime driving patterns, though the effects of fatigue on nighttime teenage driving are not well established.

Crash rates among teenage drivers are particularly high at night. Novice drivers aged 16 and 17 years old accumulate on average only 14 percent of their miles driven between 9 p.m. and 5:59 a.m. Despite decreased exposure, more than 39 percent of teenagers' fatal crash involvements occur during this time period (Preusser & Tison, 2007; Williams & Preusser, 1997). The same study found that compared to daytime crashes, nighttime crashes also appear to more often be the result of speeding, alcohol, or driver error. Also, nighttime crashes are more likely to involve two or more passengers and only a single vehicle, as opposed to daytime crashes.

Due to the increased exposure to crash and injury during nighttime driving, GDL policy in every jurisdiction contains nighttime driving provisions. Typically, and in Missouri, provisions restrict driving on a provisional license between the hours of 1 a.m. and 5 a.m. Analyses of the effects of these provisions have found they significantly reduce teenage crash risk as a part of GDL policy. Ferguson et al. (2007) report decreases in daytime and nighttime teenage crashes between 1996 and 2005 in Tables 3

and 4. Most jurisdictions did not enact GDL policy until sometime after 1996, thus this is a good base year to compare nation-wide crash statistics independent of GDL implementation. By 2005, almost all jurisdictions had enacted some form of GDL policy. The most pronounced change in fatal crashes is among 16-year-olds at night with a 48 percent reduction in the time period. The nighttime results for police reported crashes in Table 4 are similar, with a 47 percent reduction among 16-years-olds and a 29 percent reduction among 17-year-olds.

Table 3 Daytime and nighttime fatal crashes per 100,000 population by driver age
1996 vs. 2005 FARS.

Age	1996	2005	Percent reduction
Daytime (6 a.m. to 8:59 p.m.)			
16	22	14	16
17	25	19	7
18	28	24	5
19	24	23	9
30-59	14	12	2
Nighttime (9 p.m. to 5:59 a.m.)			
16	11	6	48
17	14	10	24
18	19	16	17
19	19	17	12
30-59	6	5	11

Source: Ferguson (2007)

Table 4 Daytime and nighttime police reported crashes per 100,000 population by driver age
1996 vs. 2005 NASS/GES.

Age	1996	2005	Percent reduction
Daytime (6 a.m. to 8:59 p.m.)			
16	80	49	39
17	91	69	24
18	92	75	18
19	80	68	14
30-59	47	36	24
Nighttime (9 p.m. to 5:59 a.m.)			
16	14	7	47
17	16	11	29
18	20	17	16
19	18	17	4
30-59	7	5	30

Source: Ferguson (2007)

These tables point to the need for even greater limitation on teenage nighttime driving between the hours of 9 p.m. and 12 a.m., a period characterized by both high crash risk and high frequencies of fatal crashes among young drivers. While recreational driving at night is considered to be a high risk activity for teenagers, there are less risky types of night driving. Driving to and from school and work related activities at night do not appear to be situations of elevated risk (Williams, 2003). Unfortunately, data do not provide insight into this pattern and thus no empirical guidance to confirm this is available. GDL programs do provide exceptions for nighttime driving when it is for school and work related travel, so as not to interfere with economic or scholastic activities (Williams, 2003).

Passenger Limitations:

The second component of GDL policy limiting driving risks is the restriction on the number and nature of passengers in the car. Passengers, especially teenage passengers, represent two significant risk factors in teenage driving. First, they influence risk-seeking behaviors and may encourage inappropriate confidence. Second, they may physically distract the driver from the task of managing the vehicle, leading to poor hazard awareness (Lee, 2007). The distraction of friends socializing in a vehicle will inhibit a driver's abilities. Pressure of friends in a vehicle will encourage the driver to be more risky, drive faster, and accept smaller gaps, thus elevating the risk for crashes. Furthermore, the risk of injury extends beyond the driver to passengers as well.

Teenage passengers increase crash rates for novice drivers aged 16-17 and that rate increases with the number of passengers present (Lin & Fearn, 2003). Not only does the amount of distraction increase with each additional passenger as Lin and Fearn (2003) suggest, but the number of people at risk increases as well. Williams (2003) reports in 2000, 40 percent of crash related deaths for 16- to 19-year-olds were sustained by passengers. For 16-year-olds this split becomes closer to 50-50. Table 5 illustrates the interactions between the cause of teenage crashes and the number of passengers. Columns sum to more than 100 percent where more than one source is attributable to the crash.

Table 5 Characteristics of fatal crashes among 16-17 year-olds when driving alone or when carrying teenage passengers (%), 2005 FARS.

	Driver alone	Driver & 1 teenage passenger	Driver & 2 teenage passengers	Driver & 3 teenage passengers
Driver error	71	75	78	85
Speeding	30	34	42	46
Single vehicle	41	45	57	69
Drivers killed w/ positive BACs	12	15	12	16

Source: Ferguson (2007)

Table 6 Fatal crashes of 16-year-old drivers by passenger presence 1996 vs. 2005.

	Crashes		Percent reduction
	1996	2005	
No passengers	426	324	24
Teenage passengers only			
One	309	206	33
Two	175	93	47
Three or more	144	72	50
Total	628	371	41
Other passenger combinations	215	110	49
Total	1,269	805	37

Source: Ferguson (2007)

As seen in Table 5, as the number of passengers increases, so does rate propensity for multiple causes. Overall, from the information in Table 6, there was a 41 percent decrease in fatal crashes involving passengers between 1996 and 2005. In the limitation of risk exposure, provisions that restrict the number of passengers in the vehicle with a novice driver can be highly effective in reducing crash and fatality rates among this group of drivers.

Teenage Perceptions:

The effectiveness of GDL policy is enhanced with support from parents and teenagers. An understanding and approval of GDL provisions helps to ensure parents will help enforce and extend its provisions and teenagers will respect and abide by its restrictions. Thus, GDL is largely dependent on public perception. The literature suggests that part of maintaining a supportive context for GDL is limiting the burden of the policy on parents and drivers and providing parents and teenagers with the knowledge and tools necessary to address the risks of teenage driving with and without GDL provisions (Foss, 2007). Educating the public and introducing programs which can aide family managed teenage driving can be a cost effective way of enhancing GDL and effectively reducing crash rates.

One study conducted in Florida found that despite limiting driving privileges, teenagers had generally positive attitudes towards the policy. A study by McCartt et al. (2001) surveyed nearly 4,747 teenagers in 1996 prior to the adoption of Florida's GDL policy and another 4,760 teenagers in 1998 after the policy's introduction. The study focused on five provisions of the new policy and gauged teenagers' perceptions of each, measuring shifts in perception between pre- and post-policy adoption. Table 7 shows that prior to GDL, teenagers licensed under the old system were opposed to the new policy, despite not being affected by it. The majority of survey participants reported being either opposed or strongly opposed to several provisions. The most vehemently opposed restrictions were on nighttime driving, with 44 percent of teenagers strongly opposed to such a provision. By 1998 the new survey group which had been or expected to be licensed under the new law was less opposed to the provisions. Opposition fell drastically and approval of previously unpopular provisions such as nighttime driving improved. With time, teenagers' attitudes towards the policy became less resistant and more understanding of the policy and its benefits.

Table 7 Attitudes toward graduated license provisions, all respondents (%).

Provisions	Study sample	Strongly support	Somewhat support	Neither support/oppose	Somewhat oppose	Strongly oppose
6 months learner's permit	1996(N=4250)	31	25	16	11	18
	1998(N=4283)	39	28	16	9	9
11 p.m. - 6 a.m. driving restriction for 16-year-olds	1996(N=4250)	16	16	12	18	37
	1998(N=4283)	17	21	15	22	26
1 a.m. - 5 a.m. driving restriction for 17-year-olds	1996(N=4250)	11	15	11	19	44
	1998(N=4283)	12	18	17	22	32
Restricted license after four conviction points	1996(N=4250)	11	17	29	15	28
	1998(N=4283)	14	20	31	14	20
License suspension for BAC $\geq$ 0.02%	1996(N=4250)	43	16	14	8	19
	1998(N=4283)	49	17	15	8	11

Source: McCartt et al. (2001)

The Role of Parents:

Parental involvement has been shown to be the most supportive context for safe driving and currently shows the most promise for developing policy approaches to combat unsafe teenage driving (Keating 2007). With or without GDL, parents have been shown to possess the potential to reduce teenage driving risks by carefully managing their early driving experiences (Simons-Morton & Hartos, 2003). Furthermore, GDL systems are significantly reliant on parental endorsement and enforcement of provisions in achieving effectiveness. Parents play an important role in the management of supervised

driving experience, determination of when teenagers can test for a permit or license, and enforcement of GDL itself. Thus, their attitudes towards GDL policy and their understanding of the risks of teenage driving are critical in reducing teenagers' risk exposure.

One multi-beneficial approach to parental involvement in obtaining teenagers' compliance with GDL has been parental limit-setting. Independent of GDL policy, non-formal parental limit-setting on teenagers' driving seems to occur autonomously to some degree, and limit-setting can significantly reduce teenage crash involvement. A few early studies suggest programs to educate parents and promote a more formalized role in the licensing process have positive effects on reducing teenagers' traffic violations and increasing their safety. For example, a study by Preusser and Leaf (2003) examined parents' limit-setting in the absence of GDL policy as summarized in Table 8. The study examined the extent of limit-setting and also the nature of the provisions.

Table 8 Individual driving restrictions just after licensure, parent reported and teenager reported.

Sex	Only with adult (%)	Agree with purpose (%)	With good grades (%)	Time curfew (%)	Daylight only (%)	In town only (%)	Can be grounded (%)	Safety belts (%)	No drinking & driving (%)	Limit teenage passengers (%)
Parent-reported restrictions, when first licensed (n=758)										
Male	24.3	42.2	21.1	57.1	19.9	38.0	36.0	52.0	49.3	28.7
Female	26.0	47.7	18.6	60.9	25.4	41.1	30.9	53.4	49.7	31.1
Significance	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.
Teenage-reported parental restrictions, when first licensed (n=828)										
Male	5.1	43.0	24.5	68.6	2.7	11.8	45.4	67.9	90.2	34.8
Female	7.7	52.8	20.6	78.4	3.7	16.9	39.6	79.9	92.6	44.8
Significance	n.s.	**	n.s.	**	n.s.	*	n.s.	***	n.s.	**

Source: Preusser and Leaf (2003), Significance: *=P<.05; **=P<.01; ***=P<.001

As shown in Table 8, the most frequently teenage-reported parent-enforced driving restriction was "don't drink and drive" followed by "always wear your seatbelt." While there was no significant difference between male and female drivers for these restrictions at the 0.05 significance level for parent-reported restrictions, a safety belt requirement was significantly more cited as a parental restriction by teenage females. For both of these restrictions, parents reported them to a lesser extent than teenagers, perhaps because they felt they should already be understood. Teenagers often reported they had a time curfew, were limited in the number of teenage passengers they could transport, and that parents had to agree with the purpose of the trip. Among parents, the most cited restrictions for their teenage drivers were curfew and nighttime driving limitations, two restrictions imposed by GDL as well. Parents' restrictions may hold greater efficacy in that the threat of penalty may seem more real to teenagers; they may consider it more likely that a parent will catch them sneaking in the house late than a police officer will catch them on the street.

Many states have introduced pilot programs to engage parents and teenagers simultaneously in risk education and limit-setting. These programs encourage the joint development of parent–teenager driving agreements or contracts. The contracts "establish clear expectations, performance standards, and consequences for noncompliance" (Simons-Morton & Hartos, 2007). Combined with other incentives (such as insurance discounts), the approach effectively enhances GDL coverage and compliance without additional legislative restrictions (Keating, 2007).

Ideally, such programs would also utilize educational materials for parents and teenagers to raise awareness about the seriousness of teenage driving. These materials could potentially be used as a selling

point for program participation as well. “Checkpoints,” an early pilot program in Connecticut, operated under the premise that effective parents will establish high expectations for behavior and remain involved in monitoring and supporting their teenagers’ driving habits. Compliance and responsibility are rewarded with increased autonomy. “Checkpoints” encourages parents to complete and sign a parent-teen driving agreement to impose strict restrictions on initial driving privileges such as passenger limitations, curfews, and allowable driving purposes. These restrictions are relaxed over time. This provides an incentive to teenagers for continued skill development and compliance. Generally, the extent of parental limit-setting significantly increased in the experimental survey groups compared to the control groups over the first nine months of licensure. Teenagers in the experimental groups reported less risky driving and fewer traffic violations. Furthermore, the Checkpoints program has been shown to have significant effects on teenagers’ perception of risk and expectations of the extent of parental limits (Simons-Morton et al., 2004).

A similar program in Washington State, “Safe Drivers Wanted,” consisted of intervention sessions before and after licensure. During sessions, facilitators assisted families in improving driving related decision-making and in specifying written expectations in the form of written contracts. Parents were also encouraged to monitor compliance with expectations. Haggarty et al. (2006) reports positive effects of the development and adoption of written driving contracts between parents and teenagers in this program. This study also found students in the intervention group of the study (those subject to contracts), reported significantly fewer risky driving behaviors. This confirms that while many parents do in fact set limits independent of GDL, programs to formalize this process can significantly increase the frequency and effectiveness of parental limit-setting, reducing teenage drivers’ risk exposure.

Logistically, these programs should be attractive to many jurisdictions because they have expectedly low administrative costs and provide increased enforcement and safety benefits. “Checkpoints” was introduced to parents and teenagers at the Department of Motor Vehicles (DMV) at the teenager’s time of licensure. This provided an opportunity to educate parents about the risks of teenage driving and to manage their concerns constructively. Parents and teenagers agree upon and sign parent-teenager driving agreements at the DMV, establishing explicit expectations for the teenage driver before independent driving ever began. Providing parents continue to make the agreement and its enforcement a priority, teenagers are more likely to perceive and understand the implications of their behavior behind the wheel.

Parental Monitoring:

The introduction of formalized parental limit-setting as well as new parental awareness of driving risk has led to advancements in technology for monitoring driving behavior. Parents now have tools available to better manage teenage driving. While these tools can often be expensive, some jurisdictions have begun introducing legislation to subsidize their expense. When implemented effectively, driver-monitoring systems can complement parents’ driving restrictions and significantly reduce driver risk taking.

Currently, three types of technology address driver monitoring. The first is a cell phone Global Positioning System (GPS) device that allows parents to track the location of their teenager at any given time. This device is convenient for tracking location but offers little information about the teenager’s actual driving characteristics.

The second device is a computer chip embedded in the vehicle. This device records information about vehicle speed, mileage, acceleration, and significant lateral displacement (McCartt et al., 2007). The chip device is more useful in monitoring teenage driving patterns. However, as McGehee et al. (2007) point out, neither device offers information to parents or teenagers about the situations in which dangerous driving occurred.

Instead, their study advocated the use of a third type of technology, a video monitoring system that tracks and records incidents in which the vehicle's movement exceeds a safety threshold. This provides parents with video of what the teenager was doing and where they may have been during the incident. If a teenager was on a cell phone, had two passengers in the car, or was speeding in a residential neighborhood, the device captures this detail and shares it with parents.

Video devices were shown in McGehee's study to have effectively reduced the unsafe driving incidences of the teenagers that participated. A total of twenty-six drivers between 16 and 17 years of age were selected to participate in the study and each had a video recording device installed in their primary vehicle. The video devices provide instantaneous feedback to inform drivers they have exceeded a safety threshold and the device has begun recording. Additionally, researchers sat down with parents and teenagers to review the videotapes once every 9 weeks. The study found that over a 36-week period the frequency of safety related driving events was significantly reduced among one high risk group of seven drivers. For instance, the study tracked incidents by type and found that in one type of event, these drivers decreased their frequency of "taking turns too fast" by 81 percent. This suggests the device and interventions were highly useful in correcting driver behavior. A study by McCartt et al. (2007) was conducted in three states at DMV offices with the parents of teenage drivers to gauge perceptions of driver monitoring devices, shown in Table 9 and 10.

Table 9 Parents' responses concerning monitoring teenagers' driving after licensure (%).

	Minnesota	North Carolina	Rhode Island
Ways to plan to supervise teenagers' driving	(N=307)	(N=302)	(N=271)
Ride frequently with teenager	55	76	51
Trip permission	54	29	51
Limit number of passengers	49	38	32
Enforce curfew	43	11	51
Written contract	5	<1	1
Install monitoring device	<1	1	1
Follow them	0	3	1
Other	34	21	7
Things want to know about teenagers' driving when not in vehicle	(N=313)	(N=305)	(N=293)
Speeding	51	66	53
Distractions	52	47	34
Cell phone use	40	43	38
Number of passengers	46	32	38
Identity of passengers	27	22	53
Destination	23	10	62
Seat belt use	24	17	43
Alcohol/drug use	18	7	25
Aggressive/dangerous driving	31	10	25
Whether they obey traffic laws	8	13	1
Whether they drive defensively	5	7	1
Miles driven/how long gone	4	1	2
Following too closely	2	3	2
Near misses, sudden braking	2	1	<1
Other	7	4	3

Source: McCartt (2007),Percentages sum to more than 100 percent as multiple responses were permitted

Despite their usefulness, surveys of parents do not portray a great willingness to utilize such devices for a number of reasons. As depicted in Table 9, the study found that a majority of parents intended to monitor their teenager's driving. Asked how, most parents reported riding with their teenager and through trip permission most frequently. Less than one parent from each state intended to monitor teenage driving using an installable device. Studies such as McCartt's (2007) have found that some parents were

altogether resistant to use of devices citing that they trust their teenager and consider the device an invasion of the teen's privacy. Parents consider use of devices in cases where there is a concern with teenage safety in the absence of supervision, indicating a lack of trust.

Table 10 Parents' knowledge of devices to monitor teenage driving (%).

	Minnesota	North Carolina	Rhode Island
Heard of devices placed in teenager's vehicle to help supervise driving	(N=314)	(N=314)	(N=290)
Yes	59	54	37
No	41	46	63
Chi-squared = 33.1 (p-value = <0.0001)			
If yes, types of devices have heard about	(N=185)	(N=171)	(N=107)
Computer chip (e.g., CarChip)	39	57	32
GPS tracking on cell phone	31	25	50
Video camera (e.g., DriveCam)	32	20	39
1-800-number bumper sticker	1	1	3
Speed monitor/governor	1	3	0
OnStar	1	0	2
Other	4	0	0
Don't know/missing	10	6	3

Source: McCartt (2007), Percentages sum to more than 100 percent as multiple responses were permitted

Table 10 shows roughly half of the parents surveyed have not heard about devices to monitor their teens' driving. Taken in combination with Table 9, this table shows even the parents who have heard of the monitoring devices do not generally plan to use them. While effective, much of the technology presently available for driver monitoring may be out of the reach of some families. In the McCartt study, expense was the third most cited reason for lack of interest in device installation. Devices can be expensive to install and maintain. The New York State Legislature provided for a reduction in vehicle insurance rates for vehicles in which such devices have been installed (New York, 2005). No evidence is available to suggest whether or not the provision has been effective in encouraging use of such devices, but it at least provides a subsidy and an incentive for families to more closely monitor teenage driving.

4. GDL Effectiveness:

In the United States, each state implements its own unique GDL program. The provisions of each program vary by type, degree, and date of implementation. The Insurance Institute for Highway Safety rates programs according to point totals, which can be found on their website (IIHS, 2008a). This type of evaluation accesses programs according to the extent to which key components are likely to effectively reduce injuries. The tangible benefits of GDL implementation are perhaps the program's selling point.

Evaluations of GDL programs typically use state crash data to determine the effect of new young driver laws on crashes, comparing crash rates before and after implementation. On a national level, a comparison of crash frequencies before and after GDL implementation exhibits over a 40 percent reduction in some cases (Shope, 2007; NCIPC, 2006). However, in order to determine the real safety effect of these policies, it is necessary to consider the actual reduction in teenage crash rates and the nature of those reductions. Crash rates are determined by dividing crash counts for a given population by the number of individuals or licensed drivers in that population. For instance, to determine the crash rates for 16 year olds, one compares the number of crashes involving 16 year olds in a given time period, say a year, to the number of licensed 16 year olds in that same year. Crash rates are far more useful than straight counts in that they are normalized. Studies that fail to appropriately normalize crash counts can create spurious results.

Many states with GDL programs have conducted studies on the effectiveness of their policies. These studies have considered several factors but are typically most interested in the reduction of crash rates among young drivers. California's GDL program has received perhaps the most attention among evaluation literatures. Studies have found a wide range of results, which may be due to either the wide range of study conditions, or to actual mixed results of GDL programs. The study by Masten and Hagge (2004) considers changes in the number of fatal and injury crashes for 15 to 17 year olds on a monthly per capita basis compared to changes in the same variables among drivers aged 24 to 55 years. Their findings suggest there was no overall change in fatal or injury crash rates among teenage drivers compared to more experienced drivers following GDL revisions. Rice et al. (2004) also conducted a pre-GDL (1 year) and post-GDL (2 years) comparison analysis for California and found significant reductions in crash rates among 16 and 17 year old drivers.

Foss et al. (2007) conducted a long-term GDL impact analysis in North Carolina comparing crash rates for teenage drivers aged 16 and 17 where rates were normalized by the number of licensed drivers. For 16 year olds, results showed a 7 percent reduction in crashes per licensee following GDL implementation. Also, only a 5 percent reduction in crashes per licensee for 17 year olds was reported. Those reductions might reflect change in North Carolina's teenage populations rather than the effectiveness of its GDL policy. However, this study did find that both nighttime and passenger restrictions significantly reduced crashes, making it the first study to show positive results of passenger restrictions. A study by Hyde et al. (2005) examining GDL in Utah conducted a complex pre/post comparison from 1996 to 2001 and found a 5 percent reduction in the crash rates of 16 year old drivers with no association between GDL and crash severity. However, the GDL program in Utah imposes only basic restrictions on young drivers, which may contribute to its limited effects.

A study by Shope and Molnar (2003) analyzed the effectiveness of GDL programs in Florida, Michigan, North Carolina, California, Ohio, and Pennsylvania. The study reported that teenage drivers' crash involvement rates and their crash injury rates adjusted for populations and licensed drivers decreased after GDL implementation in general. However, the findings are still based on a short-term period. Shope and Molnar (2007) admit difficulty analyzing which specific components of GDL policy contributed to these drops in crash rate. Another study conducted in Wisconsin (Fohr et al., 2005) found a 14 percent reduction in crash rates for 16 year olds and a 6 percent reduction among 17 year olds, which they attribute more to reduced exposure to hazards than safer driving.

Several studies of GDL programs indicate that results are mixed but the programs are effective in general. They also indicate that crash rates, particularly among 16 year olds are considerably reduced under GDL programs. However, there are substantial variations in the effectiveness of GDL programs and the extent of GDL effectiveness appears to depend both on the GDL policy and on the study methodology used. It is necessary to consider the time frame and context of these studies as well. Without an appropriately long length of pre and post comparison, results can be overstated, or altogether inaccurate. Also, studies which track change over a period in which there are continual alterations to GDL structure and provisions run the risk of capturing fluctuations in crash rates and conviction rates as a result.

National comparisons are in some ways more useful for future development of GDL programs because they make the case for increased restrictions on teenage driving. Comparing the safety effects of weak programs as opposed to stronger programs illustrates the degree of effectiveness based on the extent of provisions. Generally, studies have found significant reductions in both fatal and injury crash rates, improving with the number of GDL restrictions. A study by Morrisey et al. (2006) estimated the effectiveness of state GDL policies between 1992 and 2002 as a function of the class rankings of the Insurance Institute for Highway Safety using a negative binomial model. That study found that for state GDL programs rated "good," traffic fatalities among 15-17 year olds drivers were reduced by 19 percent.

For states with “fair” programs, fatalities were down by 5 percent. For states with “marginal” programs, fatalities were down by just 1 percent.

5. The Future of GDL Policy:

The implications of GDL policy for driving after the teenage years from a developmental perspective would suggest the effects of the policy could be long lasting. To the extent that habitual patterns of responsible driving behavior are learned through this process, there is added benefit for continued policy development and application (Keating, 2007). The impressionability of adolescents due to their development makes them more capable of creating and preserving long lasting patterns of behavior and persistence in good driving habits, due at least in part to GDL policy interventions. This could lead to lower crash rates and risk taking throughout subsequent years of driving. The present and future benefits of GDL provide an incentive to review and develop new policy measures that address new research findings. The development of technology and the introduction of new knowledge about teenage driving behavior continue to open new doors for policy interventions. However, researchers have begun to shift their focus away from the introduction of new formalized provisions, instead stressing a more uniform GDL policy and the development of programs that promote supportive contexts for GDL.

Many states have increased the limitations on drivers during the provisional stage of licensure. Extensions of night driving limitations are especially significant, as are passenger restrictions. These two basic GDL policy components are key to the discussion of advancement. Limiting recreational driving at night between 9 p.m. and midnight substantially decreases crash rates of young drivers (Williams & Preusser, 1997). Interactions between nighttime driving and passengers have been proven to create extreme risk (Lin & Fearn, 2003). Thus, new or extended restrictions on these factors could prove to be valuable. Several states also updated their GDL laws in response to research on interactions between distractions inside the vehicle and the quality of driving. States have instituted more stringent passenger limitations and many have banned the use of cell phones while driving for drivers operating under the provisional license (IIHS, 2007). Currently 17 states have prohibited the use of cell phones for drivers operating under learner’s permits or intermediate licenses (some jurisdictions have prohibited the use of hand-held cell phones for all drivers). Like nighttime or passenger restrictions, this provision also limits risk exposure.

While skill evaluation is dealt with indirectly by GDL policy, some literature suggests one way to combat overestimation could include making driving tests more difficult and decreasing the pass rate. Such action would facilitate more stringent and comprehensive testing, and decrease the extent of over-confidence in driving ability. Additionally, the impression of more stringent enforcement and harsher penalties for traffic violations could curb risk taking behaviors. This can be accomplished not only through law enforcement and legislative measures, but also by greater parental involvement in constructively tracking and regulating teenage driving.

The introduction of parental involvement to licensing systems is one concept that has opened a new field of young driver policy research. Parental involvement in the education process and in setting limits for independent driving has become a key focus of research and of GDL advancement. The formalized role of parents as teachers in the learning stage is significant. Requiring a minimum amount of supervised driving behind the wheel be administered and certified by a legal guardian is step towards greater parental involvement. The real benefit of parent taught driving may be unknown, but involvement of any kind can be crucial in establishing a responsibility for education and supervision during both the learner’s and provisional stages. The addition of other cost effective limit-setting programs, like the Checkpoints program, emphasizes the role of parents and should be a focus of future interventions.

The basic concept of GDL is fairly simple: two-staged driver education and the mitigation of risk during early experience. However, the provisions vary from one jurisdiction to the next in their degree and age restrictions. GDL policy has also come to encompass other policy provisions as well. A push for these divergent policies to align more closely with one another has arisen out of this variance. The benefit of uniformity lies in the increased public understanding of GDL provisions and perhaps a greater impression among teenagers that the policies will be better enforced, particularly in border cities like Kansas City in which laws change by crossing a street.

II. Crash Data Analysis on the Effectiveness of Missouri's GDL Policy

Missouri introduced its GDL system beginning in January of 2001. License applicants between 16 and 18 years of age become licensed under the new system making their first license an intermediate one. Since 2001, Missouri's GDL policy has received several revisions that added new requirements and restrictions for intermediate licensed drivers.

In Missouri, young drivers may obtain a learner's permit in Missouri beginning at age 15 following the completion of a written exam and a vision test. The written exam tests one's ability to understand highway signs for regulating, warning, or directing traffic as well as other driving signals and laws. Missouri's mandatory permit holding period lasts 6 months or until the driver turns 16, whichever is longer. The required amount of certified driving instruction for teenagers with a permit increased to 40 hours from 20 hours in January of 2007. Legislators also added a requirement that 10 of those 40 hours of instruction be at night.

Drivers in Missouri age 16 to 17 are eligible for an intermediate license after reaching 16 and completing the learner's stage without incident. Drivers must then pass a driving test to receive the intermediate license. In Missouri, GDL policy limits nighttime driving and imposes passenger restrictions. Under the intermediate license, drivers may not drive between 1 and 5 a.m. except for school or job related purposes. Only one passenger under 19 is allowed in the first 6 months, and subsequently only three are allowed, not counting immediate family members. Additionally, the driver and all passengers must wear safety belts at all times. The provisions expire at 17 years and 11 months if there have been no outstanding violations which might delay graduation to full licensure. Upon passing the vision and road sign tests along with having no alcohol-related offenses or traffic convictions in the last 12 months, the driver may then apply for an under 21 full driver license.

Two facets of Missouri GDL policy are known as contingent advancement and early intervention. Contingent advancement reinforces policy provisions by barring graduation to full licensure if the driver violates traffic laws to some given extent. Missouri law stipulates that to gain a full license one must have no alcohol related offenses and have no traffic convictions for which points are assessed within the last 12 months. This ensures that only safe and experienced drivers graduate from the provisional licensing system. Under early intervention, drivers face more stringent penalties for driving infractions when under an intermediate license. In Missouri, if an intermediate licensee accumulates 6 or more points on his or her license in a 12-month period, then the licensee will be required to participate in and complete a driver improvement program. However, violations of GDL provisions, such as curfew, are considered statute infractions and therefore are not point accessible. This means that violations of GDL provisions will not delay a driver from receiving his or her full license.

This study evaluated the effectiveness of Missouri's GDL policy. One of the ways to evaluate the policy is to investigate teenage drivers' crash statistics. The crash data revealed teenage drivers' crash involvement frequency and rate as well as crash involvement patterns. The data also showed if teenage drivers follow restrictions associated with GDL laws.

The Missouri Department of Transportation (MoDOT) provided crash data for the last 10 years (1998-2007). The data were compiled and processed for analyses. For the purpose of this study, only Missouri drivers were selected from the crash data and some types of crashes and drivers were excluded in data analyses. Drivers of motorcycles, mopeds, bicycles, construction or farm equipment, and leisure transport devices such as snowmobiles, golf carts, go-carts, and horses were not analyzed in this study. Also, drivers younger than 15 or older than 100 years old were not analyzed. The Missouri Department of Revenue (DOR) provided the driver's license statistics from 2000 to 2007. However, the license statistics were not generated at the same point each year, varying from January to December. Therefore, the

number of drivers was interpolated each year as of June 30. This interpolation assumes that increase or decrease in the numbers occurs incrementally at a consistent rate between two time periods. Drivers with expired licenses and drivers with only a motorcycle license were not counted in the number of drivers in this study's analyses.

Data analyses consisted of six sections. The first section analyzed crash frequencies and rates. The number of crashes involving Missouri drivers and their crash involvement rates were presented based on the number of drivers with a valid Missouri driver's license or permit along with at-fault or not-at-fault status. The at-fault status was determined by analyzing each driver's probable contributing factors to crashes such as speeding, alcohol, signal violation, failure to yield, improper vehicle maneuver, etc. The second section analyzed injury severity of teenage drivers involved in crashes. The third section analyzed teenage drivers' crash characteristics including crash type, road environment, and time. Missouri GDL laws entail several provisions to restrict teenage drivers' driving in certain conditions. The fourth section analyzed GDL compliance of teenage drivers involved in crashes. In the fifth section, teenage drivers' crashes were analyzed by county, and the sixth section offers a regional comparison between teenage driver crashes in Missouri compared to three neighboring states.

1. Teenage Drivers and Traffic Crashes in Missouri:

Table 11 shows the number of drivers involved in crashes by age between 1998 and 2007. Crash frequency increased in 2002 with a gradual return to its previous levels. This distributional pattern is found in all age groups in terms of total frequency and frequencies for drivers both at-fault and not-at-fault.

Table 11 Crash-involved Missouri drivers, 1998-2007.

Age		1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
All	Total	203553	201609	203243	201777	248954	245182	241810	234218	225976	216694
Drivers	At Fault	71978	70838	71941	71138	96285	95320	94942	91909	89048	86942
	Not At Fault	131575	130771	131302	130639	152669	149862	146868	142309	136928	129752
15	Total	304	305	282	406	500	455	488	454	366	340
	At Fault	130	139	108	196	242	218	246	226	194	173
	Not At Fault	174	166	174	210	258	237	242	228	172	167
16	Total	9523	9603	9451	8610	10117	9382	9189	8683	8231	7273
	At Fault	4936	5004	4887	4459	5715	5342	5335	5018	4772	4260
	Not At Fault	4587	4599	4564	4151	4402	4040	3854	3665	3459	3013
17	Total	9636	9633	9605	9027	11023	10064	9558	9303	8868	8323
	At Fault	4564	4462	4452	4265	5759	5260	5129	4959	4781	4502
	Not At Fault	5072	5171	5153	4762	5264	4804	4429	4344	4087	3821
18	Total	9036	9067	9198	9119	10202	10277	9510	9158	9020	8365
	At Fault	4109	4092	4229	4178	5142	5208	4947	4707	4721	4463
	Not At Fault	4927	4975	4969	4941	5060	5069	4563	4451	4299	3902
19-20	Total	13770	13758	14848	14936	17528	16724	16007	15592	15217	14250
	At Fault	5922	5767	6467	6373	8336	8146	7865	7631	7515	7180
	Not At Fault	7848	7991	8381	8563	9192	8578	8142	7961	7702	7070
21-24	Total	20159	19847	20795	21677	26982	27243	27168	25349	24234	23627
	At Fault	7591	7643	7923	8230	11552	11723	11817	11247	10613	10665
	Not At Fault	12568	12204	12872	13447	15430	15520	15351	14102	13621	12962
25-64	Total	122609	120808	121224	120161	151671	150213	149346	146034	140484	135865
	At Fault	37225	36439	36891	36365	50563	50295	50698	49505	47902	47376
	Not At Fault	85384	84369	84333	83796	101108	99918	98648	96529	92582	88489
65+	Total	18516	18588	17840	17841	20931	20824	20544	19645	19556	18651
	At Fault	7501	7292	6984	7072	8976	9128	8905	8616	8550	8323
	Not At Fault	11015	11296	10856	10769	11955	11696	11639	11029	11006	10328

Figure 1 shows the crash rate changes of Missouri drivers. Year 1998 is the base year and the rates of other years are compared to year 1998. While crash rates increased for drivers of all ages in 2002, both the sharp increase and the following decrease were most prominent for 15-year-old drivers. The reason for the crash rate increase in 2002 is unclear but is probably not related to GDL since it affects all age groups. However, the sizable decline in crash rate for 15-year-old drivers from 2002 to 2007 may be due in part to targeting teen driving habits.

Figure 1 Rate changes of crash-involved Missouri drivers, 1998-2007

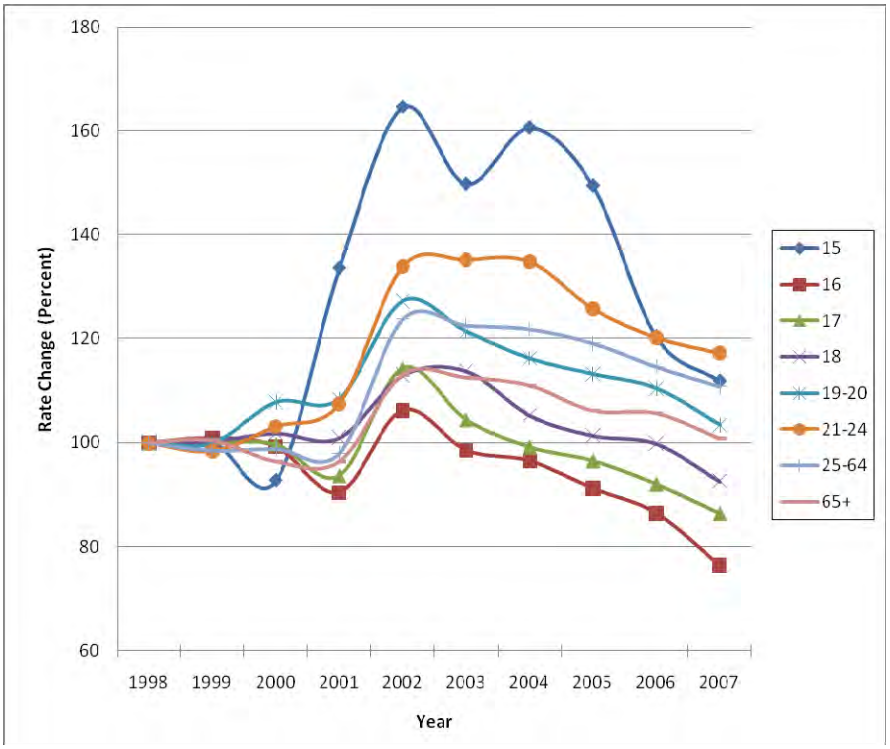


Table 12 shows percent distributions of crash-involved Missouri drivers between 1998 and 2007. The at-fault status indicates what percent of drivers in the particular age group can be classified as at-fault or not-at-fault based on crash related circumstantial factors. Table 12 reveals the proportions of teenage drivers involved in crashes have decreased over the years with the proportion of drivers aged 15 having more variation. Between 2000 and 2001 the percent of 16 and 17 year-old teenage drivers in crashes decreased while crash rate for 15 year-old and 18 year-old drivers increased. Table 12 also shows at-fault rates of drivers aged 15-24 in crashes have increased more than the rates of drivers aged 25 or older. Also, the at-fault rates of 16-year-old drivers have always been greater than 50 percent over the years and the at-fault rate of drivers aged 17-18 began to be greater than 50 percent since 2002, while the at-fault rate of drivers aged 25-65 stay around 30 percent.

Table 12 Percents of crash involvement and at-fault status among crash-involved Missouri drivers, 1998-2007.

Age		1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
15	% in Crashes	0.15	0.15	0.14	0.20	0.20	0.19	0.20	0.19	0.16	0.16
	% At Fault	42.76	45.57	38.30	48.28	48.40	47.91	50.41	49.78	53.01	50.88
	% Not At Fault	57.24	54.43	61.70	51.72	51.60	52.09	49.59	50.22	46.99	49.12
16	% in Crashes	4.68	4.76	4.65	4.27	4.06	3.83	3.80	3.71	3.64	3.36
	% At Fault	51.83	52.11	51.71	51.79	56.49	56.94	58.06	57.79	57.98	58.57
	% Not At Fault	48.17	47.89	48.29	48.21	43.51	43.06	41.94	42.21	42.02	41.43
17	% in Crashes	4.73	4.78	4.73	4.47	4.43	4.10	3.95	3.97	3.92	3.84
	% At Fault	47.36	46.32	46.35	47.25	52.25	52.27	53.66	53.31	53.91	54.09
	% Not At Fault	52.64	53.68	53.65	52.75	47.75	47.73	46.34	46.69	46.09	45.91
18	% in Crashes	4.44	4.50	4.53	4.52	4.10	4.19	3.93	3.91	3.99	3.86
	% At Fault	45.47	45.13	45.98	45.82	50.40	50.68	52.02	51.40	52.34	53.35
	% Not At Fault	54.53	54.87	54.02	54.18	49.60	49.32	47.98	48.60	47.66	46.65
19-20	% in Crashes	6.76	6.82	7.31	7.40	7.04	6.82	6.62	6.66	6.73	6.58
	% At Fault	43.01	41.92	43.55	42.67	47.56	48.71	49.13	48.94	49.39	50.39
	% Not At Fault	56.99	58.08	56.45	57.33	52.44	51.29	50.87	51.06	50.61	49.61
21-24	% in Crashes	9.90	9.84	10.23	10.74	10.84	11.11	11.24	10.82	10.72	10.90
	% At Fault	37.66	38.51	38.10	37.97	42.81	43.03	43.50	44.37	43.79	45.14
	% Not At Fault	62.34	61.49	61.90	62.03	57.19	56.97	56.50	55.63	56.21	54.86
25-64	% in Crashes	60.23	59.92	59.64	59.55	60.92	61.27	61.76	62.35	62.17	62.70
	% At Fault	30.36	30.16	30.43	30.26	33.34	33.48	33.95	33.90	34.10	34.87
	% Not At Fault	69.64	69.84	69.57	69.74	66.66	66.52	66.05	66.10	65.90	65.13
65+	% in Crashes	9.10	9.22	8.78	8.84	8.41	8.49	8.50	8.39	8.65	8.61
	% At Fault	40.51	39.23	39.15	39.64	42.88	43.83	43.35	43.86	43.72	44.62
	% Not At Fault	59.49	60.77	60.85	60.36	57.12	56.17	56.65	56.14	56.28	55.38

Figure 2 Percent of at-fault crash-involved Missouri drivers, 1998-2007

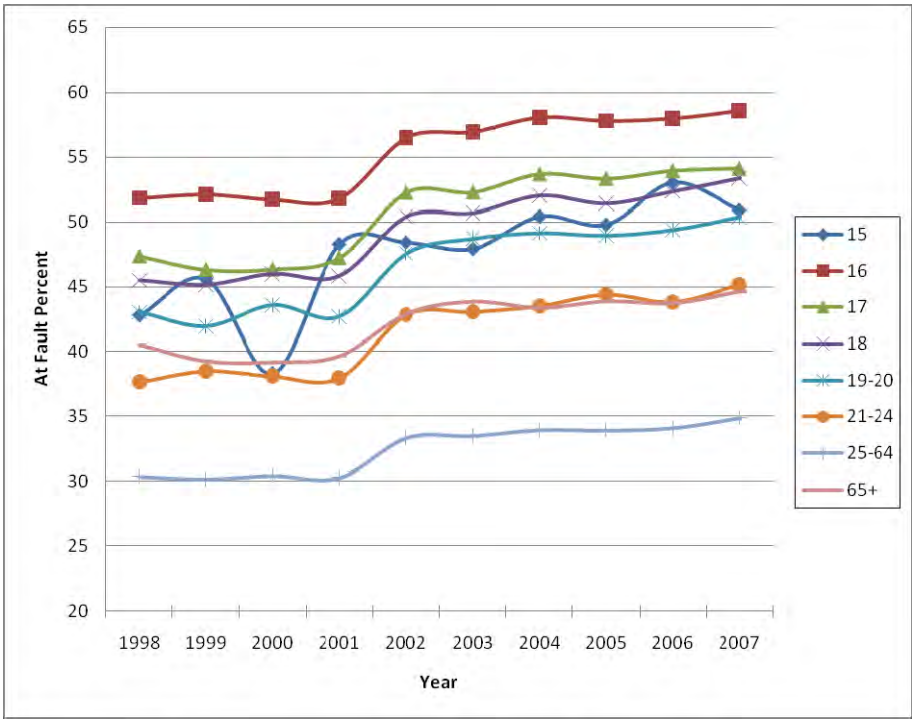


Figure 2 shows the percent of at-fault crash-involved drivers. The trend for all age-groups is one of increase, again with a more defined increase in 2002.

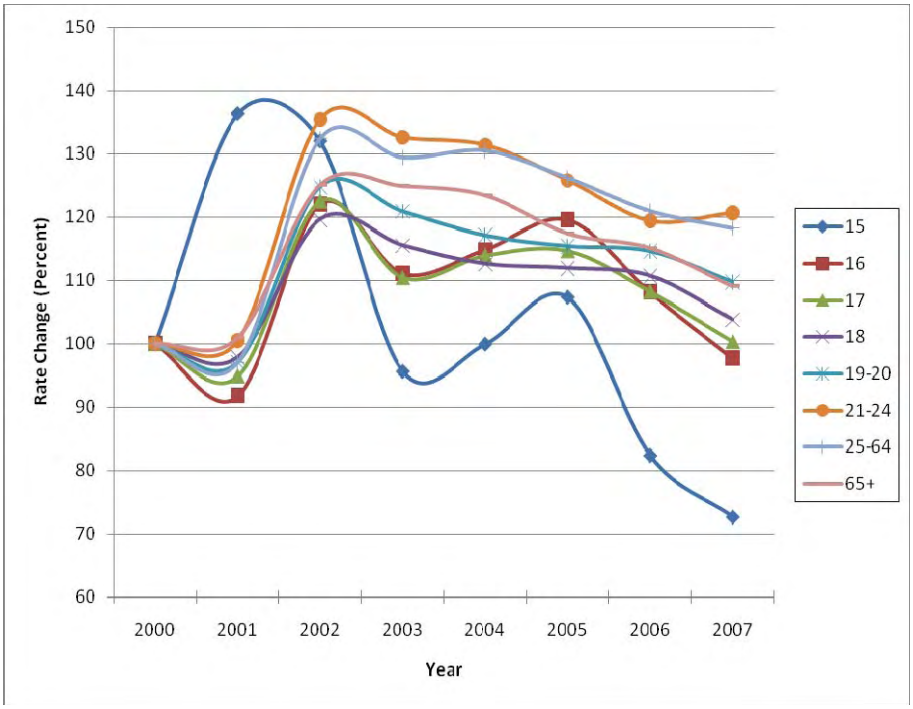
Table 13 shows the total number of crash-involved drivers and at-fault drivers in a crash per 1,000 Missouri drivers with a valid driver's license or permit between 2000 and 2007. Since the number of drivers changes over time, it was necessary to examine the rates as well as numbers of crashes reported over the years. Table 13 therefore reveals more objective measures of crash involvement of drivers over time. However, registered numbers of drivers or temporary permit holders before 2000 were not available. Therefore, crash rates here were analyzed for crashes occurring between 2000 and 2007. Total crash involvement rates of all drivers show the rates increased in 2002 and gradually declined to 2007. At-fault rates also show a similar pattern over the years. Table 13 shows 15 year-old drivers have had a noteworthy decrease in crash involvement and at-fault rates since 2001. Both crash involvement and at-fault rates decreased by approximately half between 2001 and 2007. Drivers aged 16-18 also show a defined decrease in crash involvement rates from 2002 and thereafter while drivers aged 19 or older tend to show a more moderate decrease in the rates.

Table 13 Crash involvement rate per 1,000 Missouri drivers with valid driver's license and permit, 2000-2007.

Age		2000	2001	2002	2003	2004	2005	2006	2007
All Drivers	Total	47.09	46.07	55.59	53.64	53.04	51.18	48.89	46.33
	At Fault	16.67	16.24	21.50	20.85	20.83	20.08	19.27	18.59
15	Total	17.15	18.54	17.90	13.10	13.02	14.16	10.20	9.37
	At Fault	6.57	8.95	8.67	6.28	6.56	7.05	5.41	4.77
16	Total	103.33	94.70	115.45	104.25	105.74	110.56	99.66	89.10
	At Fault	53.43	49.04	65.22	59.36	61.39	63.89	57.78	52.19
17	Total	122.50	114.03	133.22	120.01	120.60	122.21	114.02	105.34
	At Fault	56.78	53.87	69.60	62.72	64.72	65.14	61.47	56.98
18	Total	120.71	118.55	131.74	126.53	120.14	120.88	117.39	107.99
	At Fault	55.50	54.32	66.40	64.12	62.50	62.13	61.44	57.62
19-20	Total	97.69	96.83	111.68	105.59	101.43	100.38	98.78	92.69
	At Fault	42.55	41.32	53.11	51.43	49.84	49.13	48.78	46.70
21-24	Total	71.57	72.19	86.31	84.02	82.38	77.36	74.36	72.90
	At Fault	27.27	27.41	36.95	36.16	35.83	34.32	32.56	32.90
25-64	Total	41.43	40.46	50.07	48.74	48.47	46.94	44.73	42.76
	At Fault	12.61	12.24	16.69	16.32	16.45	15.91	15.25	14.91
65+	Total	26.06	25.99	29.76	29.07	29.05	27.31	26.86	24.93
	At Fault	10.20	10.30	12.76	12.74	12.59	11.98	11.75	11.12

Figure 3 shows crash involvement rate among at-fault drivers. Year 2000 is the base year and the rates of other years need to be compared to the base year's rate. This figure again depicts a sudden increase in 2002 followed by a decline. However, the rate of decline for younger drivers, particularly 15-year-old drivers, is more extreme than that of other age groups.

Figure 3 At-fault crash involvement rate of Missouri drivers, 2000-2007



Overall crash frequency for Missouri drivers is consistent between teenage drivers and those of other ages. However, since 2001 when GDL was introduced, crash involvement rates have decreased more significantly for teenage drivers (drivers aged 15 in particular) than adult drivers, and this reflects the effectiveness of Missouri's GDL policy.

2. Teenage Drivers and Injury Severity:

The number of injured drivers in crashes between 1998 and 2007 were analyzed. Table 14 presents the numbers of total injuries and fatal and non-fatal injuries, which increase in 2002 followed by a steady decrease. Total and fatal injuries of 15 year-old drivers were fewer than other teenage drivers.

Table 14 Number of injured Missouri drivers in crashes, 1998-2007.

Age		1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
All Drivers	All Injury	36098	35530	34688	34396	41024	39330	38458	37644	35401	33435
	Fatal Injury	451	426	398	443	626	644	597	645	555	482
15	All Injury	50	52	30	64	87	69	80	57	53	49
	Fatal Injury	0	0	1	0	3	2	0	1	2	1
16	All Injury	1661	1655	1632	1466	1741	1517	1509	1430	1316	1108
	Fatal Injury	14	13	13	14	17	17	19	20	14	12
17	All Injury	1658	1715	1701	1552	1814	1597	1599	1512	1430	1288
	Fatal Injury	15	23	12	16	19	23	19	15	20	11
18	All Injury	1643	1639	1634	1588	1837	1803	1580	1544	1483	1331
	Fatal Injury	15	14	16	13	22	24	23	19	21	17
19-20	All Injury	2695	2614	2722	2700	3133	2881	2774	2635	2642	2298
	Fatal Injury	24	27	29	36	54	40	42	48	41	29
21-24	All Injury	3868	3604	3707	3925	4634	4714	4532	4333	3997	3784
	Fatal Injury	40	36	45	40	69	66	79	82	62	53
25-64	All Injury	21348	21101	20263	20255	24417	23466	23247	23045	21432	20678
	Fatal Injury	248	220	215	248	351	356	327	353	313	273
65+	All Injury	3175	3150	2999	2846	3361	3283	3137	3088	3048	2899
	Fatal Injury	95	93	67	76	91	116	88	107	82	86

As seen in Table 14, the frequency of driver injury decreased significantly in all age groups between 2002 and 2007:

- 43.7 percent for age 15
- 36.4 percent for age 16
- 29.0 percent for age 17
- 27.5 percent for age 18
- 26.7 percent for age 19-20
- 18.3 percent for age 21-24
- 15.3 percent for age 25-64
- 13.7 percent for age 65 or older.

This indicates that while all age groups' injury rates have been decreasing, young drivers' injury rates are decreasing more quickly.

Table 15 shows distributions of the number of injured drivers per 1,000 drivers who were involved in crashes between 1998 and 2007. In 1998, about 177 drivers were injured in total per 1,000 drivers in crashes. However, the total injury rates decreased over the years even though the total fatality rates fluctuated. The rates by age group indicate a decrease in injury rates among crash involved drivers of every age group. Both all injury and fatal injury rates of 16-18 year-old drivers were not substantially different from rates of all drivers. Drivers aged 19-24 and 65 or older tend to have higher injury rates compared to other age groups.

Table 15 Injury rates per 1,000 crash-involved Missouri drivers, 1998-2007.

Age		1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
All Drivers	All Injury	177.34	176.23	170.67	170.47	164.79	160.41	159.04	160.72	156.66	154.30
	Fatal Injury	2.22	2.11	1.96	2.20	2.51	2.63	2.47	2.75	2.46	2.22
15	All Injury	164.47	170.49	106.38	157.64	174.00	151.65	163.93	125.55	144.81	144.12
	Fatal Injury	0.00	0.00	3.55	0.00	6.00	4.40	0.00	2.20	5.46	2.94
16	All Injury	174.42	172.34	172.68	170.27	172.09	161.69	164.22	164.69	159.88	152.34
	Fatal Injury	1.47	1.35	1.38	1.63	1.68	1.81	2.07	2.30	1.70	1.65
17	All Injury	172.06	178.03	177.10	171.93	164.57	158.68	167.29	162.53	161.25	154.75
	Fatal Injury	1.56	2.39	1.25	1.77	1.72	2.29	1.99	1.61	2.26	1.32
18	All Injury	181.83	180.77	177.65	174.14	180.06	175.44	166.14	168.60	164.41	159.12
	Fatal Injury	1.66	1.54	1.74	1.43	2.16	2.34	2.42	2.07	2.33	2.03
19-20	All Injury	195.72	190.00	183.32	180.77	178.74	172.27	173.30	169.00	173.62	161.26
	Fatal Injury	1.74	1.96	1.95	2.41	3.08	2.39	2.62	3.08	2.69	2.04
21-24	All Injury	191.87	181.59	178.26	181.07	171.74	173.04	166.81	170.93	164.93	160.16
	Fatal Injury	1.98	1.81	2.16	1.85	2.56	2.42	2.91	3.23	2.56	2.24
25-64	All Injury	174.11	174.67	167.15	168.57	160.99	156.22	155.66	157.81	152.56	152.20
	Fatal Injury	2.02	1.82	1.77	2.06	2.31	2.37	2.19	2.42	2.23	2.01
65+	All Injury	171.47	169.46	168.11	159.52	160.58	157.65	152.70	157.19	155.86	155.43
	Fatal Injury	5.13	5.00	3.76	4.26	4.35	5.57	4.28	5.45	4.19	4.61

The number of drivers with a valid driver's license or permit varies by year. Therefore, it is necessary to analyze injury rates based on the number of eligible drivers.

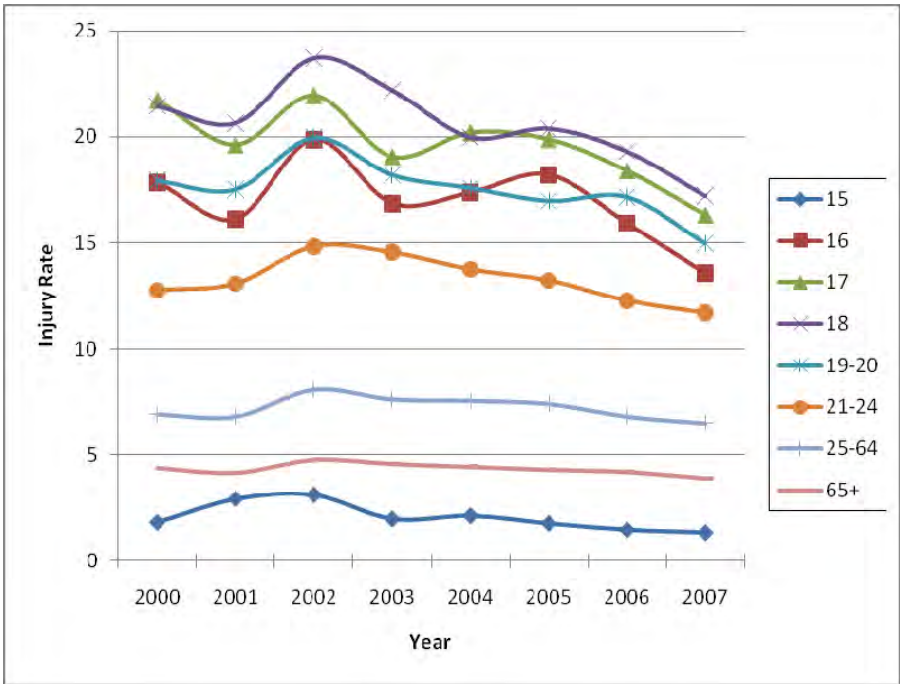
Table 16 Driver injury rate in crashes per 1,000 Missouri drivers with valid driver's license and permit, 2000-2007.

Age		2000	2001	2002	2003	2004	2005	2006	2007
All Drivers	All Injury	8.04	7.85	9.16	8.60	8.44	8.23	7.66	7.15
	Fatal Injury	0.09	0.10	0.14	0.14	0.13	0.14	0.12	0.10
15	All Injury	1.82	2.92	3.12	1.99	2.13	1.78	1.48	1.35
	Fatal Injury	0.06	0.00	0.11	0.06	0.00	0.03	0.06	0.03
16	All Injury	17.84	16.12	19.87	16.86	17.36	18.21	15.93	13.57
	Fatal Injury	0.14	0.15	0.19	0.19	0.22	0.25	0.17	0.15
17	All Injury	21.69	19.60	21.92	19.04	20.18	19.86	18.39	16.30
	Fatal Injury	0.15	0.20	0.23	0.27	0.24	0.20	0.26	0.14
18	All Injury	21.44	20.64	23.72	22.20	19.96	20.38	19.30	17.18
	Fatal Injury	0.21	0.17	0.28	0.30	0.29	0.25	0.27	0.22
19-20	All Injury	17.91	17.50	19.96	18.19	17.58	16.96	17.15	14.95
	Fatal Injury	0.19	0.23	0.34	0.25	0.27	0.31	0.27	0.19
21-24	All Injury	12.76	13.07	14.82	14.54	13.74	13.22	12.26	11.67
	Fatal Injury	0.15	0.13	0.22	0.20	0.24	0.25	0.19	0.16
25-64	All Injury	6.92	6.82	8.06	7.61	7.54	7.41	6.82	6.51
	Fatal Injury	0.07	0.08	0.12	0.12	0.11	0.11	0.10	0.09
65+	All Injury	4.38	4.15	4.78	4.58	4.44	4.29	4.19	3.87
	Fatal Injury	0.10	0.11	0.13	0.16	0.12	0.15	0.11	0.11

Table 16 indicates drivers aged 15 have lower all injury and fatal injury rates than the rates of all drivers. However, the rates of young drivers aged 16-24 are significantly higher than the rates of all drivers. In particular, the rates of 17 and 18 year-old drivers are highest. However, the rates of drivers aged 15-18 show substantial decreases in both all injury and fatal injury rates since 2002 while drivers of other ages' rate decreases have been relatively small.

Figure 4 depicts the rates of all injuries of Missouri drivers per 1,000. The general trend from 2000-2007 for all injuries is one of decrease for all ages after a small increase in 2002. However, teenage drivers have higher injury rates than other age groups. Teenage drivers tend to have the highest fatal injury rates. However, while teenagers in general have the highest rate, 15-year-olds have the lowest injury rate of any age group.

Figure 4 All injury rate per 1,000 Missouri drivers, 2000-2007



Because overall teenage injury rates are higher than other populations, special attention should be paid to reducing these injuries. Since 2002, their injury rates have for the most part been declining and the magnitudes of the declines among driver aged 16-18 have been greater than those of other drivers. These results could be attributed by the introduction of GDL.

3. Analysis of Crash Types and Environmental Factors:

In this section, comparisons were drawn between drivers aged 15-18 and drivers aged 19 or older. The values depict the percents of each crash type in total crashes between 1998 and 2007. Table 17 shows 15-18 year-old drivers consistently had higher rates of involvement in collisions with fixed objects as well as overturning while they had lower rates of collision with moving vehicles compared to drivers aged 19 or older. Collisions with fixed objects include tree, utility pole, fence, wall, building, median barrier, fire hydrant, utility boxes, etc. Many of these fixed object collisions may be due to younger drivers learning to maneuver their vehicles off the main roads without emphasis on staying in control in tight areas.

Table 17 Crash types of Missouri drivers by age, 1998-2007.

	Age	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Animal	15-18	0.04	0.04	0.07	0.04	0.05	0.06	0.03	0.03	0.04	0.04
	19+	0.07	0.05	0.04	0.06	0.05	0.06	0.06	0.06	0.05	0.05
Pedacycle	15-18	0.08	0.10	0.09	0.09	0.05	0.11	0.12	0.09	0.08	0.08
	19+	0.14	0.11	0.10	0.10	0.13	0.13	0.12	0.12	0.13	0.14
Fixed Object	15-18	19.22	17.35	18.74	18.28	20.78	21.47	21.82	21.62	21.71	23.08
	19+	13.43	12.87	14.12	13.83	16.13	16.64	16.81	17.24	16.73	19.47
Other Object	15-18	0.12	0.25	0.12	0.16	0.25	0.22	0.30	0.31	0.33	0.19
	19+	0.19	0.28	0.25	0.28	0.27	0.31	0.31	0.29	0.28	0.28
Pedestrian	15-18	0.25	0.23	0.13	0.16	0.18	0.23	0.19	0.11	0.15	0.17
	19+	0.28	0.26	0.21	0.21	0.26	0.24	0.27	0.24	0.29	0.29
Train	15-18	0.01	0.05	0.01	0.00	0.02	0.02	0.04	0.01	0.02	0.02
	19+	0.03	0.03	0.03	0.02	0.04	0.04	0.03	0.04	0.03	0.02
Moving Vehicle	15-18	74.79	75.93	74.73	75.92	72.67	72.17	71.84	72.07	71.50	70.64
	19+	80.63	80.97	79.79	80.12	76.62	76.25	76.14	75.95	76.23	73.21
Vehicle on Other Roadway	15-18	0.27	0.23	0.11	0.27	0.21	0.15	0.14	0.13	0.15	0.14
	19+	0.34	0.28	0.25	0.32	0.21	0.24	0.20	0.16	0.18	0.15
Parked Vehicle	15-18	2.69	2.77	3.25	2.69	3.18	3.07	2.89	3.27	3.15	3.03
	19+	3.11	3.06	3.16	3.25	3.93	3.95	3.90	3.87	4.07	4.22
Overturning	15-18	2.16	2.70	2.35	2.13	2.36	2.27	2.39	2.15	2.63	2.40
	19+	1.46	1.76	1.70	1.49	2.09	1.89	1.89	1.79	1.80	1.92
Other Non-Collision	15-18	0.36	0.35	0.40	0.26	0.25	0.21	0.24	0.21	0.23	0.21
	19+	0.32	0.34	0.35	0.34	0.27	0.26	0.27	0.26	0.21	0.27

Table 18 shows factors contributing to crashes. Comparisons between drivers aged 15-18 and drivers aged 19 or older were made to show the percents of crashes involved with the factors. In 1998, for example, 1.11 percent of 15-18 year-old drivers in crashes had vehicle defects compared to 0.67 percent of 19+ year-old drivers. These rates are consistently higher than those of drivers aged 19 or older, reflecting the fact that younger drivers often drive older vehicles more prone to crash-causing breakdowns.

Table 18 also shows 15-18 year-old drivers involved in crashes had higher rates of speed (both in exceeding the speed limit and driving too fast for conditions), followed too close, and were inattentive compared to 19+ year-old drivers. The sudden decrease in inattention in 2002 for both groups is due to a change in police crash-report systems. Higher rates of the younger drivers' engagement in aggressive driving (such as following too closely) and inattention along with their limited driving experiences may contribute to the results in Table 18. The rate of speeding (exceed limit) tends to decrease for all drivers

since 2001. However, alcohol involvement has been a consistent crash factor for about 3 percent of younger drivers who were involved in crashes over the years even though their rates have been much lower than those of other drivers. Improper use of signaling, not abiding by street signs, and improper lane changing are shown to be a factors contributing to collisions for non-teenage drivers more than for teenage drivers.

Table 18 Factors contributed to crashes of Missouri drivers by age, 1998-2007.

	Age	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Vehicle Defects	15-18	1.11	0.95	0.88	0.75	1.00	0.94	0.88	0.87	0.94	0.98
	19+	0.67	0.68	0.59	0.59	0.70	0.60	0.61	0.61	0.75	0.72
Traffic Control Inoperable	15-18	0.69	0.50	0.50	0.53	0.07	0.07	0.05	0.03	0.06	0.03
or Missing	19+	0.95	0.87	0.81	0.61	0.10	0.06	0.07	0.06	0.10	0.06
Speed - Exceed Limit	15-18	5.62	5.40	5.60	5.99	5.66	5.14	5.03	4.91	5.30	4.92
	19+	2.61	2.79	2.75	2.95	2.86	2.81	2.58	2.77	2.86	2.78
Too fast for conditions	15-18	29.20	27.22	28.83	25.75	29.01	29.68	29.10	27.95	27.49	29.57
	19+	19.66	18.00	19.77	16.96	20.89	21.05	20.77	19.90	17.81	21.76
Improper Passing	15-18	1.85	1.86	1.63	1.79	1.79	1.88	1.77	1.69	1.57	1.46
	19+	2.05	1.90	1.91	1.94	2.24	2.17	2.08	2.13	2.11	1.87
Violation Signal/Sign	15-18	5.97	5.83	5.85	5.52	5.20	5.02	4.98	5.16	4.65	5.16
	19+	7.24	7.47	7.39	6.94	6.35	6.39	6.46	6.29	6.10	5.91
Wrong Side (not passing)	15-18	3.76	3.64	3.80	3.47	3.75	3.65	3.42	3.16	3.52	3.03
	19+	2.67	2.68	2.63	2.80	3.09	2.83	2.88	2.83	2.75	2.67
Following Too Close	15-18	19.49	20.12	20.05	21.00	22.96	23.37	23.81	24.13	24.04	23.82
	19+	17.24	18.01	17.61	18.39	21.03	21.41	21.86	22.67	23.34	21.98
Improper Signal	15-18	0.28	0.44	0.37	0.43	0.25	0.26	0.25	0.28	0.36	0.19
	19+	0.43	0.43	0.45	0.41	0.37	0.36	0.34	0.34	0.30	0.29
Improper Backing	15-18	2.39	2.37	2.25	2.41	2.50	2.74	2.59	2.72	2.64	2.92
	19+	2.93	2.85	2.79	3.04	4.47	4.27	4.52	4.36	4.64	4.44
Improper Turn	15-18	4.21	4.38	4.12	4.31	4.38	4.27	4.28	4.03	4.05	3.98
	19+	5.02	5.03	4.82	4.80	5.25	5.07	4.82	4.91	5.06	4.71
Improper Lane Usage/Change	15-18	6.21	6.44	6.26	6.83	8.19	9.11	9.41	9.89	10.36	10.65
	19+	7.38	7.77	7.91	8.78	10.06	10.38	10.91	11.48	12.23	12.59
Wrong Way (One-Way)	15-18	0.19	0.12	0.15	0.18	0.10	0.11	0.12	0.16	0.22	0.14
	19+	0.28	0.27	0.24	0.30	0.22	0.22	0.19	0.20	0.24	0.19
Improper Start From Park	15-18	0.52	0.39	0.39	0.45	0.49	0.51	0.39	0.35	0.42	0.28
	19+	0.47	0.40	0.35	0.41	0.52	0.48	0.42	0.44	0.38	0.32
Improperly Parked	15-18	0.17	0.20	0.14	0.17	0.10	0.12	0.09	0.12	0.05	0.07
	19+	0.29	0.29	0.28	0.23	0.20	0.15	0.16	0.15	0.15	0.15
Failed to Yield	15-18	27.65	28.36	26.81	27.80	26.79	25.70	26.04	25.49	26.15	24.76
	19+	28.49	28.08	27.30	27.93	27.15	27.17	26.67	25.78	26.32	24.67
Alcohol	15-18	2.66	2.80	2.52	2.67	2.82	2.91	2.98	2.90	2.99	2.86
	19+	7.18	7.19	7.11	7.21	7.84	7.53	7.73	7.59	7.83	7.62
Drugs	15-18	0.28	0.34	0.34	0.25	0.31	0.44	0.34	0.38	0.52	0.43
	19+	0.53	0.51	0.71	0.73	0.75	0.80	0.88	0.84	0.94	1.07
Physical Impairment	15-18	1.38	1.47	1.52	1.47	1.62	1.76	1.82	1.60	1.81	1.56
	19+	2.64	2.90	2.70	2.90	3.00	2.99	2.92	3.18	3.09	3.11
Inattention	15-18	49.57	51.89	52.47	51.09	17.12	15.94	16.37	16.56	16.20	15.89
	19+	44.35	46.27	46.69	45.34	14.73	14.40	14.64	13.83	14.57	13.76

Table 19 shows drivers aged 15-18 were less involved in crashes on interstate highways and city streets and were slightly more involved in crashes on state highways compared to drivers aged 19 or older. Younger drivers had higher crash rates on county roads. The rates by road class show substantial fluctuations over the years.

Table 19 Road class and crashes of Missouri drivers by age, 1998-2007.

	Age	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Interstate Hwy	15-18	7.05	6.56	6.08	6.00	4.68	5.20	5.12	5.27	5.70	6.11
	19+	13.43	14.13	12.65	12.47	9.56	10.13	9.74	10.25	10.80	11.58
US/State Hwy/ Road	15-18	40.22	41.76	36.93	38.33	40.23	39.75	40.13	39.98	39.05	38.68
	19+	39.33	39.34	35.35	35.43	39.28	38.22	39.05	38.34	37.28	37.30
County Road	15-18	15.27	14.48	15.37	14.00	14.18	14.69	14.47	13.63	13.91	13.64
	19+	9.63	9.05	9.95	9.68	9.33	9.68	8.96	8.63	8.40	8.35
City Street	15-18	34.48	34.29	38.94	39.26	38.39	37.62	37.02	37.88	38.50	38.82
	19+	34.84	34.90	39.57	40.25	38.66	38.92	38.74	39.47	40.33	39.86
Other	15-18	3.07	2.94	2.67	2.39	2.20	2.30	2.71	2.45	2.53	2.50
	19+	2.78	2.58	2.48	2.17	3.18	3.04	3.51	3.31	3.18	2.90

Table 20 shows lighting conditions when crashes occurred. Drivers aged 15-18 had higher percentages of crash involvement when it was dark with either streetlights on or no streetlights. Interestingly, they had lower percentages of crash involvement in the daylight compared to those aged 19+. The percentages have not changed substantially over the years.

Table 20 Light conditions and crashes of Missouri drivers by age, 1998-2007.

	Age	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Daylight	15-18	70.37	72.06	72.07	70.90	71.17	71.63	72.20	71.74	72.43	72.73
	19+	77.09	77.89	76.95	76.18	76.07	76.27	76.36	76.29	76.16	75.88
Dark-Streetlights On	15-18	17.95	16.69	16.99	17.75	16.32	16.14	15.53	16.73	15.86	15.67
	19+	13.94	13.71	14.17	14.75	13.70	13.93	13.89	14.19	14.55	14.09
Dark-Streetlights Off	15-18	0.66	0.62	0.67	0.56	0.50	0.66	0.50	0.49	0.52	0.50
	19+	0.61	0.56	0.60	0.62	0.44	0.50	0.46	0.42	0.48	0.44
Dark-No Streetlights	15-18	11.02	10.63	10.27	10.79	12.01	11.57	11.76	11.05	11.19	11.10
	19+	8.36	7.84	8.28	8.45	9.79	9.29	9.29	9.09	8.82	9.59

Crash involvement percentages along with weather and road conditions are presented in Table 21. Drivers aged 15-18 had slightly higher percents of crash involvement on rainy days and lower percents of crash involvement on snowy days compared to other drivers. In 2006, snow related crashes decreased in both age groups, which may be due to fluctuations in the yearly snowfall. In terms of road conditions, younger drivers also had higher percents of crash involvement in wet conditions and lower percents of crash involvement in icy, snowy, and slushy road conditions. This may indicate that on snowy days, younger drivers were discouraged to drive due to safety concerns. However, on rainy days, considered as less serious inclement weather conditions, younger drivers were more involved in crashes. Overall, since 2002, younger driver's crash rates in rainy weather conditions decreased while they increased in snowy conditions. However, wet road conditions did not cause a clear increase or decrease in crash rates. Younger drivers' association with speeding and aggressive driving behaviors may further increase their

crash risk on rainy days. In both dry weather and road conditions, the non-teenage group had slightly higher crash rates.

Table 21 Weather and road conditions of Missouri drivers by age, 1998-2007.

	Age	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Weather Conditions											
Clear	15-18	51.63	58.19	54.31	56.84	59.04	57.89	56.86	59.51	62.90	58.70
	19+	51.93	59.45	55.94	59.10	60.55	59.23	57.87	61.49	63.92	60.07
Cloudy	15-18	28.59	26.34	28.69	27.33	26.20	28.46	30.53	28.52	27.16	27.94
	19+	28.60	25.92	27.54	26.33	25.06	26.92	29.15	26.91	26.65	26.91
Rain	15-18	15.77	12.29	12.22	13.11	10.16	9.51	10.11	8.56	8.17	8.64
	19+	14.73	10.75	10.59	11.37	8.86	8.57	9.59	7.33	7.15	7.38
Snow	15-18	1.63	1.35	3.14	1.23	2.78	2.65	1.21	2.15	0.79	3.04
	19+	1.97	1.90	4.05	1.42	3.74	3.73	1.83	2.90	1.10	3.70
Sleet	15-18	0.38	0.35	0.39	0.42	0.23	0.24	0.17	0.20	0.24	0.54
	19+	0.51	0.50	0.47	0.42	0.37	0.32	0.36	0.21	0.37	0.71
Freezing	15-18	0.58	0.66	0.54	0.27	0.67	0.41	0.45	0.29	0.26	0.60
(temp.)	19+	0.98	0.74	0.81	0.46	0.67	0.42	0.56	0.50	0.30	0.71
Fog or Mist	15-18	1.42	0.82	0.71	0.80	0.92	0.83	0.68	0.77	0.49	0.54
	19+	1.29	0.74	0.60	0.89	0.75	0.81	0.64	0.68	0.51	0.52
Road Conditions											
Dry	15-18	69.88	74.14	72.30	74.22	73.83	72.44	72.33	74.61	77.82	71.25
	19+	70.59	75.88	74.10	76.72	75.39	74.16	73.23	76.62	80.14	73.55
Wet	15-18	26.66	22.07	21.81	22.63	21.44	22.37	24.37	21.58	20.08	22.86
	19+	24.80	19.13	18.76	19.69	18.38	19.51	22.13	18.68	17.20	19.14
Snow	15-18	1.33	1.44	3.24	1.20	2.76	3.39	1.72	2.65	0.91	3.82
	19+	1.72	1.95	3.92	1.32	3.73	4.32	2.44	3.26	1.30	4.53
Ice	15-18	1.84	1.98	2.39	1.70	1.47	1.28	1.08	0.83	0.84	1.66
	19+	2.45	2.65	2.92	1.99	1.94	1.50	1.73	0.97	0.94	2.15
Slush	15-18	0.05	0.07	0.03	0.06	0.25	0.24	0.19	0.16	0.07	0.22
	19+	0.04	0.02	0.02	0.05	0.34	0.29	0.22	0.22	0.19	0.39
Other	15-18	0.24	0.30	0.23	0.18	0.25	0.28	0.32	0.17	0.28	0.19
	19+	0.40	0.36	0.28	0.23	0.22	0.21	0.26	0.25	0.23	0.24

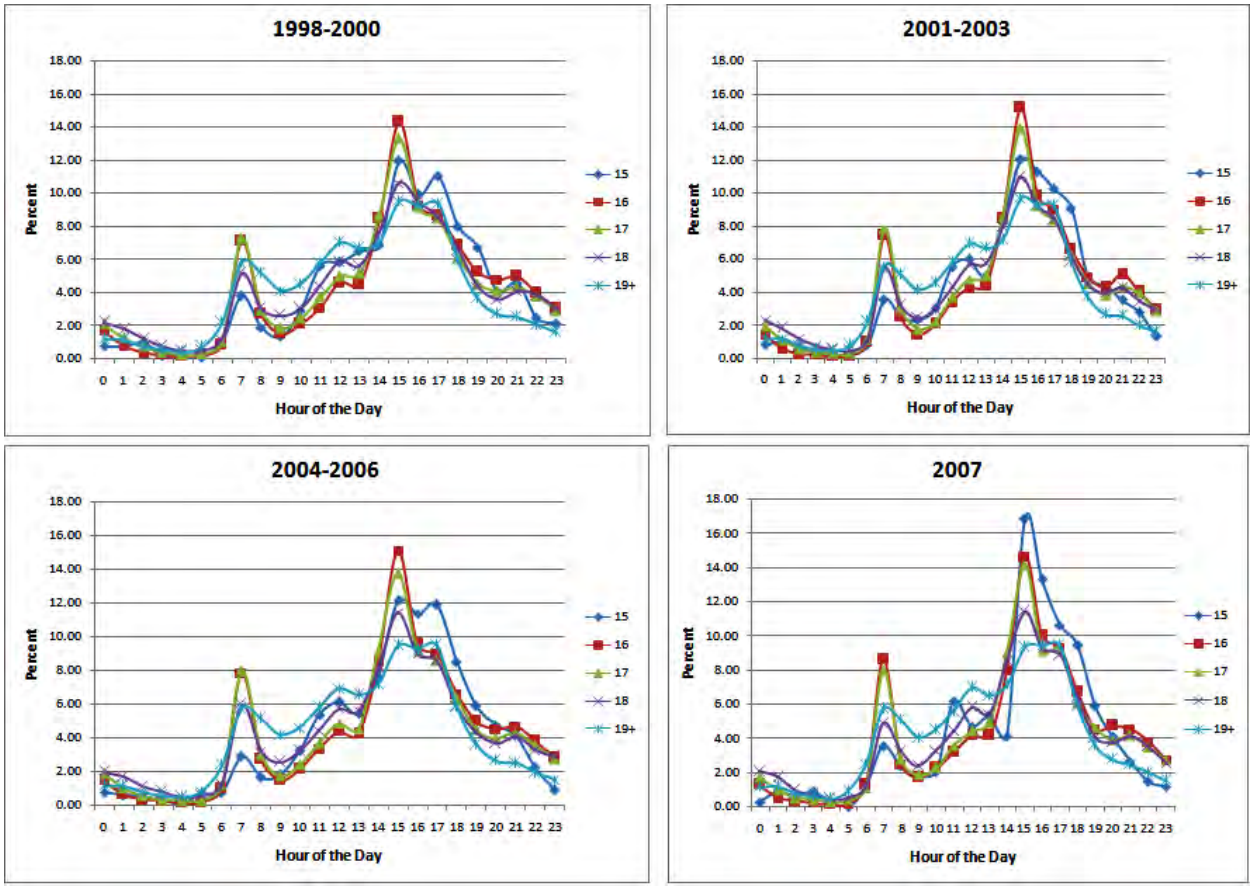
Table 22 shows the percentage of drivers involved in crashes on each day of the week, which was not statistically significant as an indicator of crash factors. From 1998-2000, crash rates were relatively equal across all ages on all days of the week, excepting a high crash rate for 15 year-olds on Sundays. Crash rates were similarly comparable from 2001-2003 and 2004-2006. In 2007, the crash rates of 15 year-olds become much more sporadic than in previous years, dramatically decreasing on Sundays and dramatically increasing on Wednesdays compared to both previous years and other age groups.

Table 22 Percent distributions of crash-involved drivers by day of the week.

Year	Age	Sun	Mon	Tue	Wed	Thu	Fri	Sat
1998-2000	15	16.09	14.62	13.30	12.78	14.77	14.70	13.74
	16	14.12	14.09	15.20	14.28	14.20	13.95	14.15
	17	14.25	14.17	14.44	13.85	14.64	14.23	14.41
	18	14.15	14.39	14.86	14.59	13.78	14.25	13.97
	19+	13.74	13.99	14.67	14.08	14.51	14.33	14.68
2001-2003	15	14.12	14.09	15.20	14.28	14.20	13.95	14.15
	16	14.25	14.17	14.44	13.85	14.64	14.23	14.41
	17	14.15	14.39	14.86	14.59	13.78	14.25	13.97
	18	13.74	13.99	14.67	14.08	14.51	14.33	14.68
	19+	13.70	15.05	14.90	14.05	13.59	14.67	14.03
2004-2006	15	14.25	14.17	14.44	13.85	14.64	14.23	14.41
	16	14.15	14.39	14.86	14.59	13.78	14.25	13.97
	17	13.74	13.99	14.67	14.08	14.51	14.33	14.68
	18	13.70	15.05	14.90	14.05	13.59	14.67	14.03
	19+	14.58	14.29	14.61	14.33	14.19	14.09	13.91
2007	15	11.47	13.82	13.53	18.24	14.41	12.65	15.88
	16	14.00	13.85	15.07	13.39	14.40	14.57	14.73
	17	13.87	13.55	15.16	13.50	14.29	14.96	14.67
	18	14.73	13.16	15.88	13.11	13.94	14.21	14.97
	19+	13.63	14.07	15.00	13.97	14.23	14.61	14.49

Figure 5 shows the overall trend of crash distribution by hour of day. Note that the figure for 2007 only contains one year of data. Teenagers' crash distributions have similar patterns with other drivers across the years and tend to be concentrated in school commuting times in the morning and the afternoon. Also, teenage drivers' crash distributions have more defined peaks compared to other drivers.

Figure 5 Crash distributions by hour of the day.



It is notable that the proportions of drivers aged 15-18 involved in crashes from 9 p.m. as well as before and after school (around 7:00 a.m. and 3:00 p.m.) are higher than drivers aged 19 or older over the years. This indicates that school commute driving as well as nighttime driving pose a substantial crash risk among Missouri's teenage drivers and nighttime driving requirements, and restrictions need to be strengthened in GDL.

4. GDL Compliance Assessment from Missouri Crash Data:

Missouri GDL laws have specific provisions to restrict driving in certain conditions. The restrictions include:

For drivers who have instruction permits:

- Under age 16, drive only when accompanied in the front seat by a parent, legal guardian, grandparent, or qualified driving instructor.
  At age 16 or older, drive when accompanied in the front seat by a person who is at least 21 years old and has a valid driver license.

For drivers who have intermediate driver's licenses:

- During the first 6 months, drivers may not operate a motor vehicle with more than one passenger who is under 19 years old and who is not a member of their immediate family.
  After the first 6 months, drivers may not operate a motor vehicle with more than three passengers who are under 19 years old and who are not members of their immediate family.
  Drivers may not drive between 1:00 a.m. - 5:00 a.m. except to and from a school activity, job, or for an emergency, unless accompanied by a licensed driver 21 years old or older.

For drivers who have instruction permits or intermediate driver's licenses:

- Seat belts must be worn by the driver and all passengers.

Police crash data have certain limitations to examine how young drivers with instruction permits or intermediate licenses comply with those GDL restrictions or requirements. However, some aspects of compliance can be examined. Table 23 shows a probable compliance rate of young drivers with instruction permits. It is assumed that qualified persons (parents, grandparents, driving instructors) should be at least 21 years old. Thus, the percent of drivers aged 15 involved in crashes who had a qualified passenger in the front seat was examined. Table 23 shows about 17. 3 percent of drivers who were involved in crashes from 2001 and 2007 had a qualified front seat passenger. A notable finding is that the percent began to increase substantially in 2006, and it reached 63.3 percent in 2007. While this dramatic increase is encouraging and may need further investigation, 36.7 percent of the drivers still did not comply with their restrictions.

Table 23 GDL compliance of crash-involved 15 year-old drivers with instruction permit.

Year	Qualified Front Seat Passenger		No Qualified Front Seat Passenger	
	Frequency	Percent	Frequency	Percent
2001	40	10.58	338	89.42
2002	38	8.17	427	91.83
2003	45	10.87	369	89.13
2004	49	10.82	404	89.18
2005	40	9.85	366	90.15
2006	67	19.76	272	80.24
2007	200	63.29	116	36.71
Total	479	17.29	2292	82.71

Table 24 GDL Compliance of Crash-Involved 16-17 Year-Old Drivers with Intermediate Driver's License on the Teenage Passenger Limit.

Year	No More than 3 Teenage Passengers	More than 3 Teenage Passengers

	Frequency	Percent	Frequency	Percent
2001	579	100.00	0	0.00
2002	20235	99.92	17	0.08
2003	18689	99.93	13	0.07
2004	18095	99.93	13	0.07
2005	17330	99.89	19	0.11
2006	16444	99.85	24	0.15
2007	14905	99.37	94	0.63
Total	106277	99.83	180	0.17

Table 24 examines the compliance of crash-involved 16-17 year olds regarding the teenage passenger limit. From 2001-2007, about 99.8 percent of these drivers complied with passenger restrictions. However, in 2001, this age group had 100 percent compliance, but compliance dropped to about 99.4 percent in 2007.

Table 25 examines crash-involved 16-17 year-olds' compliance of the early morning requirement for a qualified passenger. From 2001-2007, a qualified front seat passenger was only present about 3.3 percent of the time. Compliance has increased from 5.6 percent in 2001 to 9.5 percent in 2007, but about 90.5 percent of crash-involved drivers from this age group still did not have a qualified passenger in 2007.

Table 25 GDL compliance of crash-involved 16-17 year-old drivers with intermediate driver's license on the not-driving-alone restriction on early morning (1:00 a.m. – 5:00 a.m.).

Year	Qualified Front Seat Passenger		No Qualified Front Seat Passenger	
	Frequency	Percent	Frequency	Percent
2001	1	5.56	17	94.44
2002	5	1.37	361	98.63
2003	4	1.31	301	98.69
2004	8	2.47	316	97.53
2005	7	2.46	277	97.54
2006	11	3.82	277	96.18
2007	24	9.52	228	90.48
Total	60	3.27	1777	96.73

In summary, the compliance of crash-involved 16-17 year olds regarding the teenage passenger limit has been very high. Two other GDL compliance measures have been improved over the years. In particular, the percent of crash-involved drivers aged 15 having a qualified front seat passenger improved dramatically and this result is very encouraging. However, still 36.7 percent of the drivers did not comply with their restrictions in 2007. Also, the compliance rate on the not-driving-alone restriction on early morning (1:00 a.m.-5:00 a.m.) among crash-involved 16-17 year-old drivers with intermediate driver's license has been very low and the rate was merely 9.5 percent in 2007. These findings warrant more attention and strict enforcement on these two restrictions in GDL. Also, further studies to identify factors associated with these low compliance rates are necessary.

5. Teenage Drivers' Crashes by County:

Missouri drivers' crash involvement by county was analyzed to examine spatial variations depicting the effectiveness of GDL policy in Missouri. Table 26 shows the numbers of crash involved drivers by county over the three time periods and the percent changes of crash-involved 15-18 year old drivers and those age 19 or over between 1998-2000 and 2004-2006.

Table 26 Number of crash-involved drivers by county.

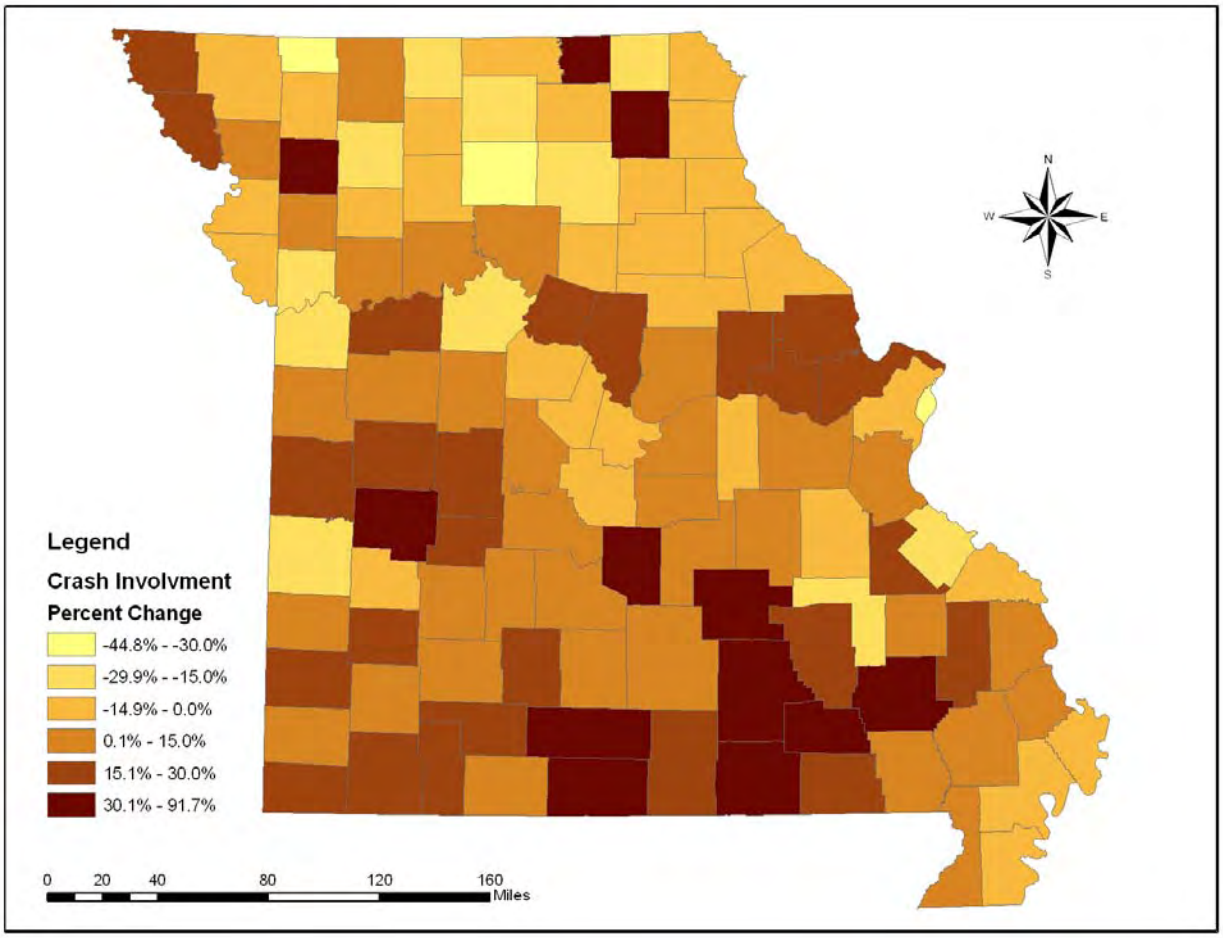
County	Age 15-18			Age 19+		
	1998-2000	2004-06	% Change	1998-2000	2004-2006	% Change
Adair	287	280	-2.4	1615	1740	7.7
Andrew	156	162	3.8	700	789	12.7
Atchison	34	41	20.6	124	193	55.6
Audrain	349	344	-1.4	1489	1859	24.8
Barry	402	473	17.7	1689	2521	49.3
Barton	126	128	1.6	542	703	29.7
Bates	119	140	17.6	605	853	41.0
Benton	173	216	24.9	882	1280	45.1
Bollinger	97	112	15.5	377	660	75.1
Boone	1864	2260	21.2	12106	19012	57.0
Buchanan	1801	1584	-12.0	8499	10269	20.8
Butler	753	856	13.7	4097	5847	42.7
Caldwell	88	79	-10.2	305	384	25.9
Callaway	479	543	13.4	2471	3136	26.9
Camden	624	682	9.3	3065	4504	46.9
Cape Girardeau	1664	1842	10.7	8568	10919	27.4
Carroll	74	75	1.4	366	345	-5.7
Carter	34	59	73.5	248	396	59.7
Cass	1308	1348	3.1	4744	6887	45.2
Cedar	157	141	-10.2	549	624	13.7
Chariton	89	102	14.6	268	366	36.6
Christian	669	830	24.1	2482	4440	78.9
Clark	75	68	-9.3	279	330	18.3
Clay	3224	2616	-18.9	18709	21655	15.7
Clinton	242	246	1.7	717	1059	47.7
Cole	1554	1353	-12.9	7946	7972	0.3
Cooper	254	242	-4.7	1045	1565	49.8
Crawford	307	350	14.0	1276	2118	66.0
Dade	43	54	25.6	229	300	31.0
Dallas	201	203	1.0	735	1092	48.6
Daviess	78	66	-15.4	387	389	0.5
DeKalb	98	131	33.7	502	752	49.8
Dent	155	219	41.3	783	1072	36.9
Douglas	106	167	57.5	386	673	74.4
Dunklin	371	416	12.1	1824	2657	45.7
Franklin	1863	1955	4.9	7835	11048	41.0
Gasconade	250	242	-3.2	777	1017	30.9
Gentry	61	58	-4.9	247	316	27.9
Greene	3845	4260	10.8	22598	35594	57.5
Grundy	153	143	-6.5	660	728	10.3
Harrison	90	94	4.4	342	605	76.9
Henry	275	318	15.6	1370	1804	31.7
Hickory	53	62	17.0	234	323	38.0
Holt	37	48	29.7	198	253	27.8
Howard	93	107	15.1	332	438	31.9
Howell	533	632	18.6	2186	3342	52.9
Iron	107	85	-20.6	429	610	42.2
Jackson	10749	7684	-28.5	88887	85513	-3.8
Jasper	1739	2059	18.4	8799	13052	48.3
Jefferson	3503	3827	9.2	15269	21607	41.5
Johnson	661	672	1.7	3130	4165	33.1
Knox	25	33	32.0	120	141	17.5
Laclede	696	708	1.7	2702	3853	42.6

Table 26 Number of crash-involved drivers by county (Continued).

County	Age 15-18			Age 19+		
	1998-2000	2004-06	% Change	1998-2000	2004-2006	% Change
Lafayette	408	496	21.6	1897	2379	25.4
Lawrence	437	493	12.8	1843	2349	27.5
Lewis	94	80	-14.9	315	394	25.1
Lincoln	536	690	28.7	1779	3437	93.2
Linn	206	144	-30.1	653	778	19.1
Livingston	290	258	-11.0	1020	1244	22.0
McDonald	159	184	15.7	714	1095	53.4
Macon	206	158	-23.3	796	1142	43.5
Madison	131	140	6.9	580	840	44.8
Maries	89	90	1.1	438	598	36.5
Marion	591	528	-10.7	2720	2954	8.6
Mercer	33	26	-21.2	110	146	32.7
Miller	385	375	-2.6	1676	1960	16.9
Mississippi	127	113	-11.0	728	706	-3.0
Moniteau	252	229	-9.1	742	995	34.1
Monroe	118	114	-3.4	310	466	50.3
Montgomery	144	170	18.1	896	968	8.0
Morgan	218	220	0.9	922	1445	56.7
New Madrid	214	195	-8.9	1253	1550	23.7
Newton	652	702	7.7	3019	4161	37.8
Nodaway	285	245	-14.0	1104	1511	36.9
Oregon	48	92	91.7	248	441	77.8
Osage	130	144	10.8	615	765	24.4
Ozark	64	95	48.4	217	408	88.0
Pemiscot	191	190	-0.5	1216	1502	23.5
Perry	380	337	-11.3	1163	1425	22.5
Pettis	839	928	10.6	3778	5062	34.0
Phelps	718	824	14.8	3792	5616	48.1
Pike	167	151	-9.6	607	1064	75.3
Platte	882	827	-6.2	5311	6731	26.7
Polk	352	393	11.6	1538	2205	43.4
Pulaski	422	583	38.2	1882	2987	58.7
Putnam	45	45	0.0	175	230	31.4
Ralls	109	104	-4.6	390	559	43.3
Randolph	497	426	-14.3	2192	2649	20.8
Ray	284	326	14.8	1051	1329	26.5
Reynolds	42	50	19.0	215	399	85.6
Ripley	110	136	23.6	486	904	86.0
St. Charles	4906	6226	26.9	20460	33778	65.1
St. Clair	60	86	43.3	305	624	104.6
Ste. Genevieve	242	181	-25.2	831	952	14.6
St. Francois	810	1011	24.8	3862	6506	68.5
St. Louis	17483	15287	-12.6	118978	128497	8.0
St. Louis (City of)	4287	2788	-35.0	63904	53048	-17.0
Saline	362	296	-18.2	1529	1769	15.7
Schuyler	22	32	45.5	99	130	31.3
Scotland	84	67	-20.2	257	247	-3.9
Scott	616	661	7.3	3020	3602	19.3
Shannon	32	57	78.1	216	333	54.2
Shelby	57	57	0.0	176	203	15.3
Stoddard	322	344	6.8	1449	2273	56.9
Stone	296	344	16.2	1403	1810	29.0
Sullivan	67	55	-17.9	290	338	16.6
Taney	641	727	13.4	3335	5358	60.7
Texas	208	237	13.9	822	1280	55.7
Vernon	334	282	-15.6	1273	1554	22.1
Warren	365	453	24.1	1790	2497	39.5
Washington	246	228	-7.3	1213	1646	35.7
Wayne	118	195	65.3	572	907	58.6
Webster	251	318	26.7	1195	1630	36.4
Worth	29	16	-44.8	50	89	78.0
Wright	162	164	1.2	618	937	51.6

Figure 6 shows the percent change of crash-involved teenage drivers by county. The percent change of crash-involved teenagers ranges from -44.8 percent to 91.7 percent. Figure 7 reveals an increase in crash involvement is most prevalent in southern counties. Urban counties, such as Jackson and St. Louis, as well as the City of St. Louis are among those displaying a decreased percent change in crash-involved teenage drivers.

Figure 6 Changes in crash-involved teenage drivers (age 15-18) between 1998-2000 and 2004-2006.



At-fault crash involvement of Missouri teenagers was also analyzed by county. The number of teenage at-fault drivers involved in crashes was compared to older at-fault drivers in Table 27. Again, teenage crashes decreased or remained constant in 42 counties, while crash rate only decreased in 4 counties for older drivers. The at-fault crash rate for the younger group was also lower than that of the older group in all but 10 counties (less than 9 percent), indicating probable successes in current GDL policy. Cities that initially had large numbers of crashes within a large population, such as Jackson and St. Louis, plus the City of St. Louis display percent decreases for drivers ages 15-18 and modest increases in older drivers.

Table 27 Number of at-fault drivers in crashes by county.

County	Age 15-18			Age 19+		
	1998-2000	2004-2006	% Change	1998-2000	2004-2006	% Change
Adair	154	144	-6.5	611	681	11.5
Andrew	89	105	18.0	285	407	42.8
Atchison	18	27	50.0	58	95	63.8
Audrain	159	180	13.2	574	694	20.9
Barry	206	290	40.8	672	1189	76.9
Barton	88	80	-9.1	224	289	29.0
Bates	55	78	41.8	209	340	62.7
Benton	88	134	52.3	330	589	78.5
Bollinger	46	69	50.0	156	315	101.9
Boone	917	1067	16.4	4384	6361	45.1
Buchanan	933	935	0.2	3327	4415	32.7
Butler	420	512	21.9	1678	2724	62.3
Caldwell	50	56	12.0	122	219	79.5
Callaway	300	347	15.7	1161	1503	29.5
Camden	335	382	14.0	1144	1847	61.5
Cape Girardeau	942	1089	15.6	3657	4835	32.2
Carroll	38	45	18.4	129	153	18.6
Carter	13	38	192.3	85	208	144.7
Cass	642	825	28.5	1685	2974	76.5
Cedar	71	80	12.7	223	285	27.8
Chariton	35	62	77.1	89	174	95.5
Christian	375	484	29.1	958	1779	85.7
Clark	35	35	0.0	103	143	38.8
Clay	1497	1494	-0.2	5966	7907	32.5
Clinton	127	161	26.8	320	550	71.9
Cole	821	844	2.8	3047	3504	15.0
Cooper	108	125	15.7	357	669	87.4
Crawford	131	175	33.6	505	866	71.5
Dade	27	24	-11.1	90	124	37.8
Dallas	113	134	18.6	308	497	61.4
Daviess	47	48	2.1	169	230	36.1
DeKalb	62	89	43.5	213	396	85.9
Dent	72	136	88.9	275	559	103.3
Douglas	45	107	137.8	127	314	147.2
Dunklin	112	177	58.0	522	901	72.6
Franklin	905	1134	25.3	2843	4562	60.5
Gasconade	119	137	15.1	283	400	41.3
Gentry	22	39	77.3	96	119	24.0
Greene	2118	2236	5.6	9061	12960	43.0
Grundy	79	90	13.9	290	363	25.2
Harrison	45	54	20.0	131	266	103.1
Henry	160	207	29.4	609	843	38.4
Hickory	30	46	53.3	105	181	72.4
Holt	13	31	138.5	85	138	62.4
Howard	35	63	80.0	137	227	65.7
Howell	230	321	39.6	746	1307	75.2
Iron	56	51	-8.9	158	297	88.0
Jackson	5079	4235	-16.6	26626	29164	9.5
Jasper	897	1163	29.7	3596	5621	56.3
Jefferson	1717	1955	13.9	5607	7903	40.9
Johnson	338	344	1.8	1151	1737	50.9
Knox	18	16	-11.1	53	70	32.1
Laclede	347	420	21.0	1074	1578	46.9
Lafayette	195	292	49.7	682	1103	61.7
Lawrence	185	249	34.6	637	838	31.6
Lewis	29	40	37.9	101	169	67.3
Lincoln	239	362	51.5	587	1210	106.1
Linn	94	91	-3.2	269	412	53.2
Livingston	174	112	-35.6	442	452	2.3

Table 27 Number of at-fault drivers in crashes by county (Continued).

County	Age 15-18			Age 19+		
	1998-2000	2004-2006	% Change	1998-2000	2004-2006	%Change
McDonald	89	105	18.0	306	499	63.1
Macon	121	85	-29.8	315	483	53.3
Madison	59	83	40.7	205	399	94.6
Maries	36	54	50.0	179	265	48.0
Marion	288	335	16.3	1075	1410	31.2
Mercer	15	17	13.3	39	81	107.7
Miller	187	213	13.9	616	856	39.0
Mississippi	46	52	13.0	238	284	19.3
Moniteau	102	115	12.7	244	405	66.0
Monroe	46	49	6.5	107	183	71.0
Montgomery	88	115	30.7	460	530	15.2
Morgan	105	131	24.8	316	669	111.7
New Madrid	84	110	31.0	497	700	40.8
Newton	376	420	11.7	1349	1943	44.0
Nodaway	138	140	1.4	418	681	62.9
Oregon	24	57	137.5	89	179	101.1
Osage	82	89	8.5	279	336	20.4
Ozark	32	61	90.6	78	208	166.7
Pemiscot	75	106	41.3	422	673	59.5
Perry	153	181	18.3	414	651	57.2
Pettis	459	536	16.8	1482	2276	53.6
Phelps	381	474	24.4	1423	2504	76.0
Pike	72	76	5.6	204	423	107.4
Platte	370	467	26.2	1615	2238	38.6
Polk	196	257	31.1	646	1030	59.4
Pulaski	172	301	75.0	596	1131	89.8
Putnam	27	25	-7.4	75	115	53.3
Ralls	58	68	17.2	156	303	94.2
Randolph	273	263	-3.7	926	1227	32.5
Ray	149	209	40.3	388	658	69.6
Reynolds	26	36	38.5	74	225	204.1
Ripley	45	78	73.3	154	423	174.7
St. Charles	2469	3205	29.8	7504	12229	63.0
St. Clair	32	54	68.8	107	263	145.8
Ste. Genevieve	112	119	6.3	272	445	63.6
St. Francois	322	520	61.5	1112	2469	122.0
St. Louis	8250	7995	-3.1	41063	46087	12.2
St. Louis (City of)	1105	947	-14.3	11595	12744	9.9
Saline	183	186	1.6	599	868	44.9
Schuyler	11	21	90.9	40	64	60.0
Scotland	34	38	11.8	59	88	49.2
Scott	321	373	16.2	1220	1593	30.6
Shannon	12	38	216.7	87	183	110.3
Shelby	28	28	0.0	73	94	28.8
Stoddard	148	197	33.1	522	929	78.0
Stone	181	217	19.9	601	787	30.9
Sullivan	32	34	6.3	136	184	35.3
Taney	347	426	22.8	1317	2595	97.0
Texas	114	141	23.7	314	637	102.9
Vernon	176	190	8.0	559	731	30.8
Warren	153	239	56.2	632	1010	59.8
Washington	120	114	-5.0	446	636	42.6
Wayne	65	105	61.5	189	444	134.9
Webster	153	180	17.6	476	711	49.4
Worth	16	7	-56.3	23	40	73.9
Wright	59	87	47.5	182	387	112.6

Figure 7 shows the percent change of at-fault crash-involved teenage drivers by county. The percent change of at-fault crash-involved teenage drivers ranges from -56.3 percent to 216.7 percent, a much broader range of change than all crash-involved teenage drivers. Figure 8 reveals an even more pronounced increase in percent change in southern counties, even though the number of counties with a decreased percent change remained comparable between crash-involved teenagers and at-fault crash involved teenagers. Urban counties, such as Jackson and St. Louis, plus the City of St. Louis still display a decreased percent change. This decreased percent change in major cities may be associated with socio-economic factors as found in Figure 9, which shows median household income in Missouri.

Figure 7 Changes in at-fault teenage drivers (age 15-18) in crashes between 1998-2000 and 2004-2006.

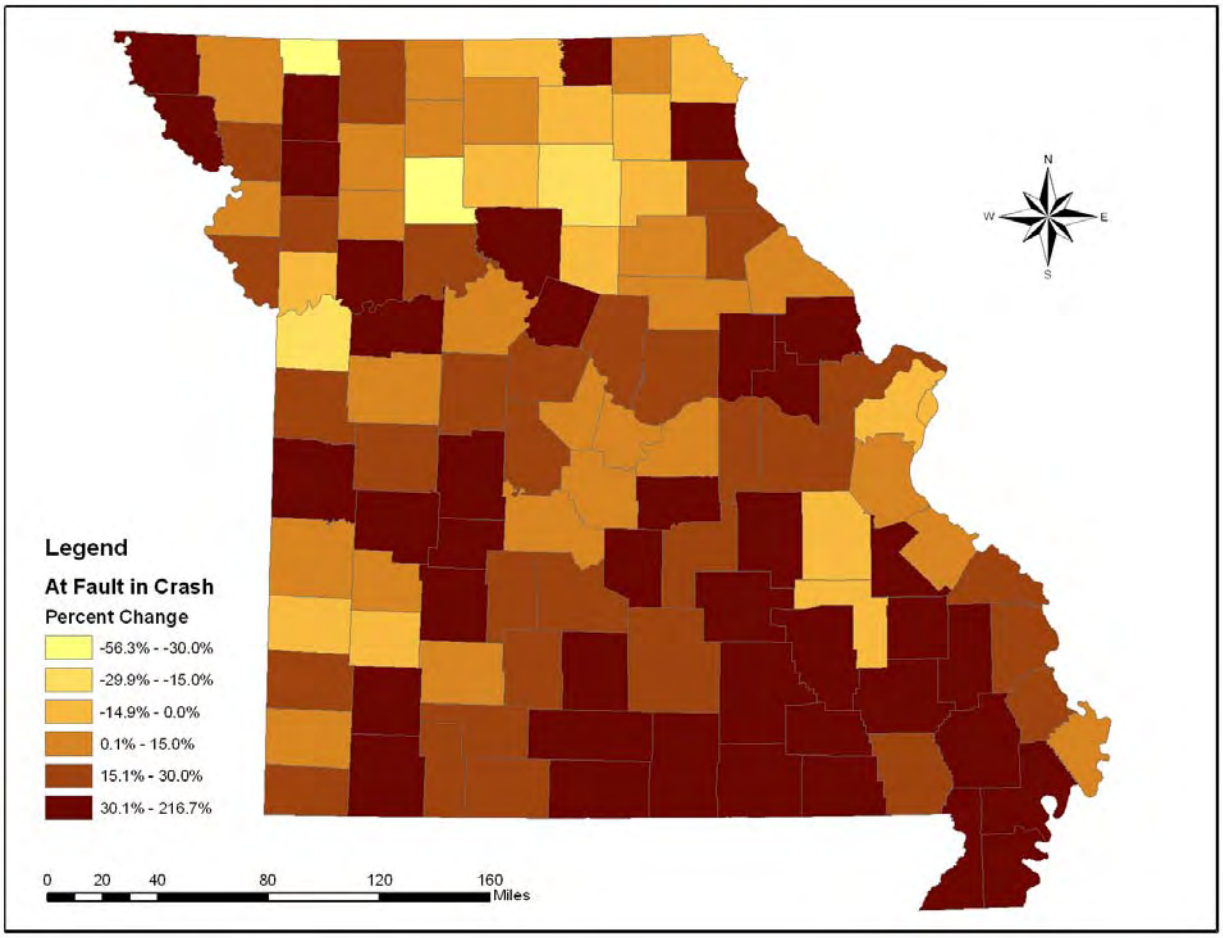
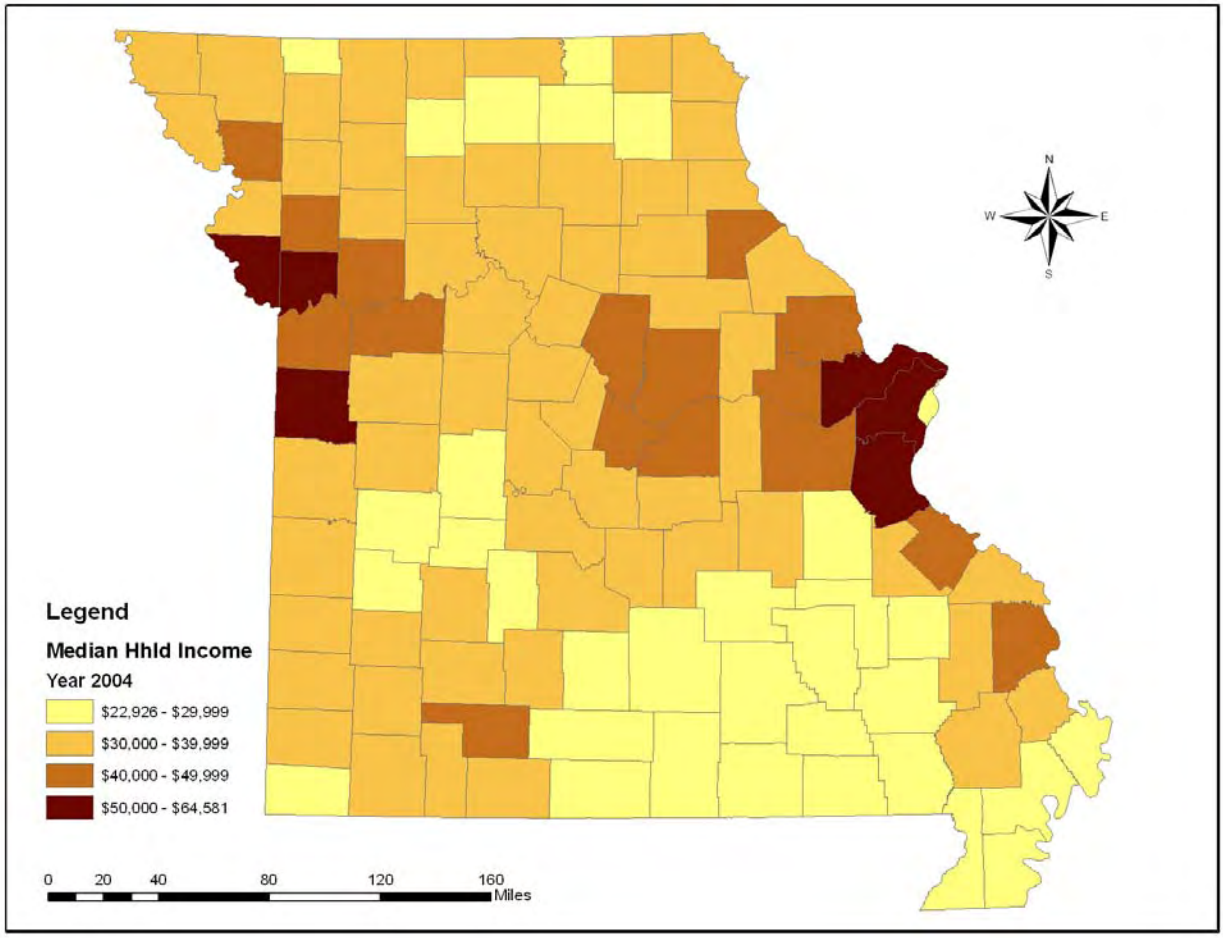


Figure 8 shows that counties in southern Missouri tend to have the lowest median household incomes. These counties often coincide with those showing the highest increase of crash-involved and at-fault crash involved drivers ages 15-18 in Figures 6 and 7. Also, areas with higher household incomes such as Kansas City and St. Louis County tend to also have decreasing rates of crash-involved and at-fault crash-involved teenage drivers. This may indicate that implementation of current GDL laws by way of educational programs and enforcement might get more attention in urban counties than rural counties with lower median household incomes.

Figure 8 Median household income by county.



Figures 9 and 10 compare median household income to teenage crash involvement rate and at-fault rate. The downward slope of Figure 9 shows the higher teenage drivers' crash involvement rate of a county, the lower the median household income of the county. While many counties clustered around the percent change axis, those with a more pronounced increase in crash involvement clearly display lower median household incomes. The slope in Figure 10 is even more pronounced, showing increases in teenage drivers' at-fault rate are associated with even lower median household incomes in the county. The county with the highest increase in at-fault teenage crashes also had the lowest median household income. Higher income counties generally have moderate success, while low income counties seem to have mixed results

Figure 9 Scatter plots of teenage drivers' crash involvement rate change and 2004 median household income by county in Missouri.

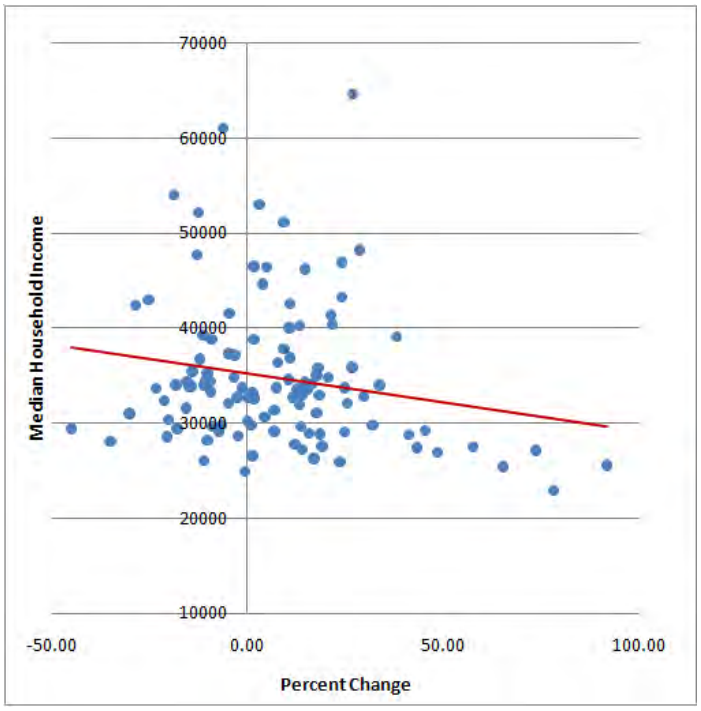
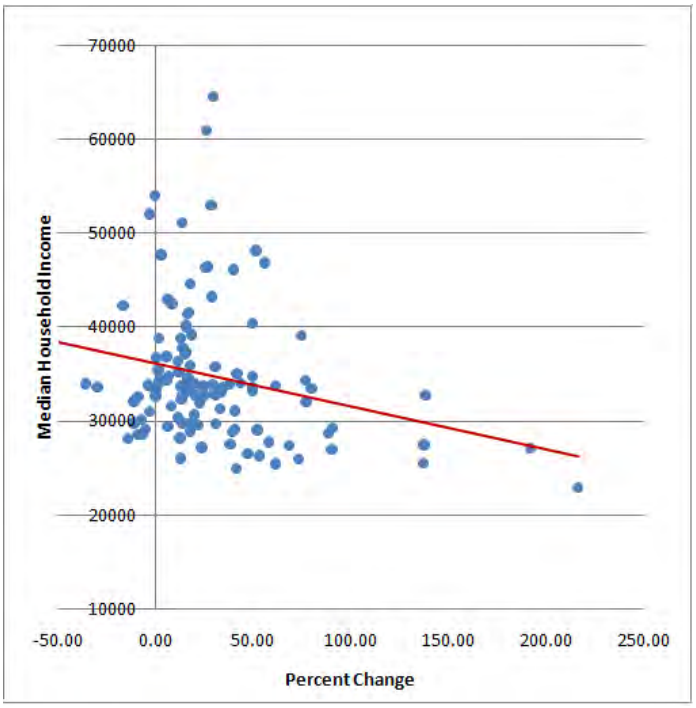


Figure 10 Scatter plots of teenage drivers' at-fault rate change and 2004 median household income by county in Missouri.



These results imply that rural counties with low income might not concentrate their efforts on teenage driver education or provision enforcement as much as high income urban counties. Rural counties need more attention in future efforts to improve traffic safety of teenage drivers through GDL. Increased communication between counties could also help to improve the overall success of GDL as they would learn from each others' successes and failures.

6. Multi-State Comparison of Teenage Drivers' Crashes:

In order to examine the effectiveness of Missouri's GDL policy, a multi-state comparison was conducted. Some changes in teenage drivers' crash involvement may be attributed to unobserved regional trends or effects including changes in teenage drivers' travel behavior. Thus, the crash rates of fatally injured teenage drivers aged 16-18 in Missouri were compared to the rates of three neighboring states (Arkansas, Iowa, and Kansas) where GDL policy is implemented differently. This intends to assess if any changes in crash rates in Missouri were influenced by historical or regional effects or GDL itself. Both the pre-GDL crash period (1998-2000) and two post-GDL crash periods (2001-2003 and 2004-2006) were compared between Missouri and the three other states in terms of average fatal injury rates among drivers.

According to the Insurance Institute for Highway Safety (IIHS), Missouri has implemented a "good" driver's licensing programs for teenage drivers (IIHS, 2008a). However, the GDL provisions for Arkansas and Kansas are considered "marginal," and Iowa has a "fair" level of licensing provisions for those young drivers. Arkansas and Kansas are two of only three states in the U.S. lacking intermediate stage licensing for new drivers. Both Arkansas and Kansas have a 6 month mandatory holding period in the learner stage. However, Arkansas does not have any minimum amount of supervised driving. The learner's permit can be issued to those who are 14 or older, and 16 is the minimum license age for a full driver's license. Kansas has a 25 hour minimum for supervised driving in the learner stage with an additional 25 hours before age 16 along with 10 supervised nighttime driving hours out of the 50 total hours. The minimum age for a driver's license is 16. Iowa also has a 6 month mandatory hold period in the learner stage. It requires a minimum of 20 hours supervised driving in the learner stage and 2 hours of supervised nighttime driving out of the 20 hours. In Iowa, those who are 16 years old have a prohibition of unsupervised driving from 12:30-5:00 a.m. However, this restriction is lifted at the age of 17.

Licensed driver statistics were not available for those who are 15 or under for the four states in the US Dept. of Transportation's annual Highway Statistics. Therefore, only drivers aged 16-18 were compared along with those 19 or older. In this analysis, drivers who were fatally injured while driving motorcycles, mopeds, and non-conventional vehicles such as all-terrain vehicles (ATVs) and farm equipment, were excluded. Table 28 compares the fatality rates of injured drivers in different states. Fatality data is used due to consistent availability.

Table 28 clearly shows fatality rates of teenage drivers aged 16-18 were significantly higher than older drivers in every state over the periods. Table 28 indicates that the trends of fatal crash rates among teenage drivers were mixed in each state. Arkansas experienced a steady increase in fatality rate among teenage drivers while Iowa, Kansas, and Missouri displayed some fluctuations across the periods. However, for drivers age 19 or older, Arkansas and Missouri experienced fluctuations while Iowa and Kansas had a steady decrease in fatal crash rates across the periods. Overall, there was no clear regional trend in fatal injury rates among drivers for both 16-18 year-olds and older drivers.

The numbers of licensed drivers are annually published in the Highway Statistics by the US Dept. of Transportation. The statistics include driving permit holders, consisting of substantial numbers of teenage drivers in particular. The statistics also have other issues. For example, drivers who move from one state to another state are sometimes counted in both states, and the purging of expired licenses or licenses from deceased drivers is not done immediately. Therefore, assuming proportions of licensed drivers among different population groups are relatively consistent, comparisons of fatal injury rates of the four states based on estimated population size by the US Census Bureau were conducted.

The results were similar to those based on the number of licensed drivers for Arkansas, Iowa, and Kansas. Missouri's driver fatality rates for both teenage drivers and older drivers were substantially higher than the rates of Iowa and Kansas, even though the rates were lower than those of Arkansas. For teenage

drivers aged 16-18, Arkansas had an increase in fatality rates while the rates of Iowa and Kansas fluctuated over the periods. However, Missouri experienced a continuous decrease in the driver fatality rate over the periods, though the difference between the years 1998-2000 and the years 2001-2003 was somewhat minimal. During the period from 1998-2000, which was before the implementation of GDL policy in Missouri, the driver fatality rate of Missouri teenagers aged 16-18 was higher than the rate of Arkansas. However, the rates of the states have been reversed since the 2001-2003 period. The fatality rates of drivers who are 19 or older show a tendency of decrease in the region even though Arkansas had a little fluctuation.

Table 28 Multi-state comparison of fatally injured drivers in crashes.

	Age 16-18			Age 19+		
	1998-2000	2001-2003	2004-2006	1998-2000	2001-2003	2004-2006
Fatality Rate per 100,000 Drivers						
Arkansas	39.9	43.2	45.1	18.9	18.2	19.8
Iowa	28.3	18.6	24.2	13.2	12.2	11.3
Kansas	24.5	30.4	20.0	15.9	14.7	13.2
Missouri	38.5	40.2	38.4	17.0	17.2	16.0
Fatality Rate per 100,000 Populations						
Arkansas	25.5	27.0	28.4	18.6	17.4	18.3
Iowa	20.6	13.4	17.0	11.5	10.6	9.9
Kansas	20.5	25.0	16.7	14.7	13.7	12.4
Missouri	26.5	26.4	25.2	15.5	15.5	14.8

Data Source: 1.US Dept. of Transportation National Highway Traffic Safety Administration, FARS (Fatal Analysis Reporting System), ftp://ftp.nhtsa.dot.gov/FARS
2. US Dept. of Transportation Federal Highway Administration, Highway Statistics 1998-2006, http://www.fhwa.dot.gov/policy/ohpi/qfdrivers.cfm
3. US Census Bureau, http://www.census.gov/popest/datasets.html and http://www.census.gov/popest/archives/1990s/#state

The results of multi-state comparison indicate Missouri teenage drivers aged 16-18 experienced a small but steady decrease in their fatality rates while the drivers in other states experienced either increase or fluctuation. This suggests Missouri's stronger GDL policy has been more effective than limited GDL policies of Arkansas, Iowa, and Kansas. This also implies that more stringent GLD policy should be able to save more lives of Missouri's teenage drivers.

III. Recommendations for Missouri's GDL Policy

1. Missouri's Current GDL Policy and Other Successful GDL Policies in the United States

Missouri's current GDL system addresses many of these facets, including extended learning, two-stage instruction, and contingent advancement. However, small improvements to current policies and providing new policies that address missing components of the current system would likely improve the overall effectiveness of Missouri's GDL system.

Missouri's current GDL system is outlined in Table 29. The system contains three licensing levels, two of which are restricted driving periods intended to reduce safety risks while young drivers continue to develop driving and judgment skills. The requisites for licensure under the intermediate and full licensure stages for young drivers contain contingent advancement provisions such as requiring drivers to accumulate no traffic infractions for a period of either 6 or 12 months. Graduation to higher GDL stages also requires a valid license at the time of application, meaning drivers whose behavior has warranted license suspension or revocation will not be permitted to advance. They normally need to wait at least 6 months and must not be convicted of new violations during the extended period before moving forward.

Table 29 Missouri Graduated Driver License requisites and restrictions

Stage	Requisites	Restrictions
Instruction Permit	Successful completion of vision, road sign, and written tests	Under 16, drivers may only drive with a qualified person, guardian, or qualified driving instructor.
	A qualified person must sign a permission statement at the contract office.	Over 16, drivers must be accompanied by a person 21 years or older with a valid license
	The applicant must be 15 years of age or older.	Seat belts must be worn by the driver and all passengers.
Intermediate License	Instruction permit must be held for a minimum of 182 days (beginning the day after issuance).	During the first 6 months, no more than one non-related passenger under 19 years old.
	No alcohol-related convictions in the last 12 months and no traffic convictions within the last 6 months.	After the first 6 months, no more than three non-related passengers under 19 years old.
	40 hours of driving instruction and 10 hours at nighttime given by a parent, legal guardian, grandparent, or qualified driving instructor.	Driving prohibited between 1:00 a.m. - 5:00 a.m. except to and from a school activity, job, or for an emergency, unless accompanied by a licensed driver over 21 years old.
	The applicant must be 16 years of age or older.	Seat belts must be worn by the driver and all passengers.
Under 21 Full Driver License	Driving privilege cannot be suspended, revoked, or denied at time of application.	No restrictions other than those placed on all drivers of similar capabilities.
	No alcohol related offenses or traffic convictions within last 12 months.	
	Successful completion of the vision and road sign recognition tests.	
	The applicant must be 18 years of age or older.	

Note: Qualified person is a parent, legal guardian or certified trainer with a federal residential job training program.

Non-related means any person not a member of the driver's immediate family including only parents, grandparents, brothers, sisters, stepbrothers, stepsisters, and adopted or foster children residing in the driver's household.

Source: Missouri Department of Revenue

Many states have enacted provisions within the Graduated Driver License (GDL) system intended to improve efficiency and effectiveness. These improvements have aimed to reduce crash risk by imposing more stringent restrictions on teenage driving and offering greater incentives to practice safe driving. Specifically, states have extended the learning period, tightened nighttime driving and passenger restrictions, and imposed substantial new probationary systems which monitor driving records and provide harsher sanctions for violations.

Some states have increased the hours during which independent nighttime driving is prohibited for young drivers. Illinois, Kentucky, and Ohio have each enacted new and more stringent nighttime driving restrictions since January 2006. Illinois also differentiates weekday and weekend restrictions. Some states have also standardized passenger restrictions, lowering the volume or increasing the age threshold of qualified passengers, further limiting distractions to young drivers during early stages of learning.

Additionally, twenty states now outlaw the use of cellular phones while driving during learner and provisional stages of GDL. Four of those twenty states extend phone use limits to drivers of all ages. Research on the role of cellular phone use while driving suggests this practice increases crash risk. Driving performance suffers during cell phone use as compared with in-car passenger conversation and no-conversation in terms of reaction time and avoidance of road and traffic hazards (Charton, 2008). However, many drivers are not aware of their decreased performance while using cell phone (Lesch and Hancock, 2004). The findings of these studies raise concerns on teenage drivers who are often overly confident on their driving skills and perceive their own driving risk low. One study suggests that during periods immediately following enactment, restrictions have done little to limit cell phone use among teenage drivers in North and South Carolina (Foss et al, 2008). However, compliance may improve over longer periods of time and increase enforcement as evidenced by trends in Washington, D.C. and New York State (IIHS, 2008b). Because cellular phone provisions have only recently been implemented as part of GDL programs, their overall effectiveness has yet to be considered. However, insomuch as these restrictions may further reduce distractions, these policies are a promising if not necessary step towards increased GDL effectiveness.

The Insurance Institute for Highway Safety (IIHS) suggests optimal age and restriction parameters in GDL systems. In these optimal systems, the minimum age for a learners permit is 16 and the learner's stage lasts a minimum of 6 months during which guardians must provide 30 to 50 hours of supervised driving; intermediate stages should last until 18 and include both nighttime driving restrictions which begin at either 9:00 or 10:00 p.m. and passenger restrictions of one or less teenaged passengers (IIHS, 2008a).

Though many details within these GDL programs vary, each state has enacted stringent standards, often above and beyond those recommended by IIHS. Several states have pushed minimum age requirements for the Learner's Permit back to 16, delaying independent driving to 16-and-a-half or 17 years of age in some cases. Related to teens' level of maturity and ability to reason, research has shown great advances often take only a few months to develop. Thus, relatively short periods of licensing delay can maximize safety effects.

States like Illinois, New York, and North Carolina have made the provisional stages of GDL only slightly more independent than the learner's stage, greatly limiting teens' risk exposure. Most of these states have also ensured teenage drivers are able to focus on driving by restricting in-car distractions such as passengers and cellular phones. The minimum age of graduation to full licensure has been set closer to 18 in most states to ensure young drivers acquire adequate skill and experience as well as maturity before driving without restriction.

Table 30 Model Graduated Driver License restriction programs

State	Learner Stage			Intermediate Stage				Minimum Age At Which Restrictions Expire	
	Min. Entry Age	Holding Period	Supervised Driving	Min. Age	Nighttime Restriction	Passenger Restriction	Cellular Phones	Nighttime Restriction	Passenger Restriction
Georgia	15	12 months	40 hours, 6 of which must be at night	16	16: 11PM–6AM 17: 1AM–5AM	1st 6 mo: no passengers; 2nd 6 mo: 1 passenger under 21; 3 or less thereafter	Allowed	18	18
Illinois	15	9 months	50 hours, 10 of which must be at night	16	Starts 10PM SU–TH, 11PM FR–SA, ends 6AM	1 passenger or less under 20 during first 12 months	Not Allowed	18	17
Kentucky	16	6 months	60 hours, 10 of which must be at night	16.5	12AM–6AM	1 passenger or less under 20	Allowed	17	17
New Jersey	16	6 months	None	17	12AM–5AM	1 passenger or less	Not Allowed	18	18
New York	16	6 months	20 hours	16.5	9PM–5AM	2 passengers or less under 21	Not Allowed	17	17
North Carolina	15	12 months	None	16	9PM–5AM	1 passenger or less under 21	Not Allowed	16.5	16.5
Ohio	15.5	6 months	50 hours, 10 of which must be at night	16	16: 12AM–6AM 17: 1AM–5AM	1 passenger or less	Allowed	18	17
Rhode Island	16	6 months	50 hours, 10 of which must be at night	16.5	1 AM –5 AM	1 passenger or less under 21	Not Allowed	17.5	17.5
Virginia	15.5	9 months	45 hours, 15 of which must be at night	16.25	12AM–4AM	3 passengers or less under 19	Not Allowed	18	18

Sources: Insurance Institute of Highway Safety (2008b), Illinois Office of the Secretary of State, Kentucky Transportation Cabinet, New Jersey Motor Vehicle Commission, North Carolina Department of Transportation, and Ohio Bureau of Motor Vehicles.

Along with more stringent restrictions, some states have instituted “Probation Before Judgment,” or PBJ programs, which carefully monitor the driving behavior of young drivers. These probationary programs make advancement to the next stage of licensure contingent upon driving performance and compliance with traffic laws and GDL provisions during the learner and provisional stages. Violations in these programs elicit intervention at lower thresholds and include more stringent sanctions to more effectively address unsafe driving.

These probationary programs encourage compliance and thus safer driving, but also ensure young drivers meet a uniform level of skill and acumen before becoming more independent behind the wheel. Early intervention programs impart more extensive sanctions for teenage drivers compared to older drivers. The deterrent effect of these sanctions may be limited. However, the incidence of recurrence is expected to be

less than it would be without such penalties. Lawmakers have hoped to correct unsafe behavior by "shocking" young drivers with harsher penalties. Contingent advancement requires all drivers to adhere to driving laws for a specified period of time before graduating to full licensure.

The six state probationary programs in Table 31 represent some but not all of young driver probation policies. These states provide policies that implicitly address two important components of GDL programs: early intervention and contingent advancement. The structure and sanctions of these programs have been well tuned so they are sufficiently severe to correct or deter unsafe driving but not so stringent as to impede continued learning. Probationary programs in these six states are well developed and stand out as explicit components of states' GDL programs.

Table 31 Model Graduated Driver License probationary programs

	Early Intervention		Contingent Advancement	
State	Violation	Sanction	Violation	Penalty
California	2 or more points in 12 months	30 day license restriction	3 or more points in 12 months	6 month suspension of license and 1 year delay of full licensure, during which drivers must not accumulate any new points or be at-fault in an crash.
Illinois	1st moving violation 2 violations in two years or less	Traffic safety school One month license suspension, remedial education course, $70 license reinstatement fee	Moving violation within 6 months of provisional licensure	6 month delay to full licensure
Maryland	1st moving violation 2nd moving violation 3rd moving violation	Driver Improvement Program 30 day license suspension or revocation 180 day license revocation	Each new moving violation	18 month delay of full licensure
New York	3 points or more than 2 violations	60 day license suspension	Only for drivers who pass road test after turning 18	
North Carolina	For each new violation, graduation to an unrestricted license is delayed 6 months from date of conviction.			
Ohio	3 moving violations before 18	1 year license suspension	Alcohol related offenses	6 month license suspension

Sources: California Department of Motor Vehicles, Illinois Office of the Secretary of State, Maryland Motor Vehicle Administration, New York Department of Motor Vehicles, North Carolina Department of Transportation, Ohio Bureau of Motor Vehicles.

2. Possible enhancements of Missouri's GDL Policy

This study found that Missouri's GDL policy has been associated with a substantial decrease in crash involvement rates among drivers aged 15-18 while drivers 19 or older have had a moderate decrease in the rates. Comparison of fatality rates of Missouri's teenage drivers aged 16-18 with those of Arkansas, Iowa, and Kansas shows the rate of Missouri had a small but steady decrease while the rates of the other states either increased or fluctuated. These results reflect the effectiveness of Missouri's GDL policy.

However, Missouri's GDL policy still has areas of enhancements for teenage drivers' traffic safety. As aforementioned, the Insurance Institute for Highway Safety (IIHS) suggests optimal parameters in GDL systems. The parameters include a minimum age of 16 for a learner's permit, a minimum of 6 months for

the learner's stage with 30 to 50 hours of supervised driving, intermediate stage until 18 and with both nighttime driving restrictions which begin at either 9:00 or 10:00PM and passenger restrictions of one or less teenaged passengers (IIHS, 2008a). Each state has enacted stringent standards, often above and beyond those recommended by IIHS. For example, several states prohibit cell phone use while driving among teenage drivers as shown in Table 29. Clearly, these parameters are more stringent than Missouri's GOD policy.

Missouri's GDL system addresses many crucial components of Graduated Driver Licensing, and is currently ranked "Good" according to IIHS. However, since previous data show benefits to stronger provisions, the restrictions, sanctions, and interventions need to be more stringent and more explicit. Based on the findings of this study and recommended practices outlined by IIHS, Missouri may consider the following:

1) Expand restricted nighttime driving hours from the current hours of 1:00 a.m. to 5:00 a.m. to 9:00 p.m. to 5:00 a.m. Current exemptions to this restriction can be maintained. Also, address times of the day with high collision-rate (e.g. 7:00 a.m. and 3:00 p.m., during the school-day commute).

Restricted nighttime driving is recommended by IIHS as an optimal parameter. Also, as shown in Figure 6, the proportion of teenage drivers aged 15-18 involved in crashes from 9 p.m. to midnight in their total crashes are substantially higher than drivers aged 19 or older over the years. This indicates that nighttime driving increases the crash risk among teenage drivers. While collisions for all ages substantially increases in morning and afternoon peak times, they are led by those involving teenagers. More strict enforcement and education are necessary to limit collisions at these times.

2) Prohibition of cellular phone use while driving under a learner's permit or intermediate license needs to be considered.

Twenty other states prohibit the use of cellular phones while driving during learner and provisional stages of GDL. Existing studies have consistently reported that cellular phone use increases crash risk while many drivers are not aware of the risk. Teenage drivers who are often overly confident of their driving skills and perceive their own driving risk low have a greater crash risk associated with cell phone use. Since cellular phone provisions have only recently been implemented as part of GDL programs, their effectiveness is not clear. However, it is clear that this restriction may reduce distractions, thus reducing crash risk of Missouri's teenage drivers.

3) Missouri needs to implement a teenage driver probationary program to more carefully monitor driving behavior under the learner's permit and intermediate license. The key component of this program is inclusion of violations of GDL restrictions as well as violations of traffic laws in delaying graduation to full licensure.

Currently, in Missouri violations of GDL provisions are by statute infractions and are not point assessable. Therefore, drivers violating these provisions are not delayed from graduating to a full license. Only traffic convictions (point contacts) or alcohol related offenses within the 12 month period prior to application will prevent the driver from graduating until the 12 month points and alcohol contact free period has been met or until the driver reaches age 21, whichever one comes first. This study found that GDL compliance rates still need to be improved. For example, the percent of drivers aged 15 in crashes having a qualified front seat passenger increased substantially over the years; however, it was only 63.3 percent in 2007. Also, the compliance rate on the not-driving-alone restriction on early morning (1:00 a.m.-5:00 a.m.) has been low and the rate was merely 9.5 percent in 2007. The inclusion of GDL violations in delaying graduation to full licensure may substantially improve the compliance of GDL restrictions or requirements among teenage drivers under the learner's permit and intermediate license,

thus improving their safety.

4) More efforts to improve traffic safety of teenage drivers in rural counties are necessary in relation to GDL implementation.

This study found that percent change in the number of crash-involved drivers aged 15-18 decreased in most of Missouri's counties between 1998-2000 and 2004-2006. The at-fault crash rate for drivers aged 15-18 was also lower than that of drivers aged 19 or older in all but 10 counties during the same period. This study found that there are significant variations among counties in terms of crash rates among drivers aged 15-18. Urban counties with major cities and higher median household income had higher percent change in both reduced crash involvement rate and reduced at-fault rate in crashes compared to rural counties with lower median household income. This indicates that rural counties need more resources for educational programs and enforcement to promote teenage drivers' traffic safety in GDL implementation.

IV. Conclusions:

Vehicle crash involvement is the leading cause of death among teenagers in the U.S. Teenage drivers have significantly higher fatal and police-reported crash rates compared to adult drivers. Graduated Driver's Licensing (GDL) policy mitigates the risks of teenage driving through a licensing structure that promotes extended supervised learning and limits teenagers' exposure to high risk situations such as driving late at night.

In order to promote teenage drivers' traffic safety, Missouri introduced its GDL in 2001. Missouri is considered a state that has implemented "good" driver's licensing programs for teenage drivers by the Insurance Institute for Highway Safety (IIHS). In Missouri, teenage drivers may obtain a learner's permit beginning at age 15. Missouri's mandatory permit holding period lasts 6 months or until the driver turns 16, whichever is longer. After reaching 16 and completing the learner's stage without incident, drivers aged 16 to 17 are eligible for an intermediate license with provisional restrictions involving nighttime driving and number of teenage passengers. Upon passing the vision and road sign tests along with having no alcohol-related offenses or traffic convictions in the last 12 months, the driver may then apply for an under-21 full driver license at 18.

This study evaluated the effectiveness of Missouri's GDL policy using Missouri crash data and driver's license statistics. These data combined together showed teenage drivers' crash involvement frequency and rate as well as crash involvement patterns. The data also showed if teenage drivers follow restrictions associated with GDL laws. The analysis results revealed the effectiveness of Missouri's GDL policy. For example, drivers aged 15 have had a dramatic decrease in crash involvement and at-fault rates since 2001. Both crash involvement and at-fault rates decreased by approximately half between 2001 and 2007. Drivers aged 16-18 also have shown a significant decrease in crash involvement rates since 2002 while drivers aged 19 or older have shown a moderate decrease in the rates. Since 2002, injury rates of drivers aged 15-18 per valid driver's license and permit holder have declined and the magnitudes of the declines of the drivers have been greater than those of older drivers. These results show positive outcomes of Missouri's GDL policy.

This study conducted a multi-state comparison to examine if changes in teenage drivers' crash involvement were due to unobserved regional trends or effects. Thus, the crash rates of fatally injured teenage drivers aged 16-18 in Missouri were compared to the rates of three neighboring states (Arkansas, Iowa, and Kansas) where weaker GDL policies have been implemented. According to the Insurance Institute for Highway Safety (IIHS), the GDL provisions for Arkansas and Kansas are considered "marginal," and Iowa has a "fair" level of licensing provisions. The results of indicate Missouri teenage drivers aged 16-18 experienced a small but steady decrease in their fatality rates while the drivers in those states experienced either increase or fluctuation. This suggests Missouri's stronger GDL policy has been more effective than limited GDL policies of Arkansas, Iowa, and Kansas. This also implies that more stringent GLD provisions can save more lives of Missouri's teenage drivers.

Missouri GDL laws have specific provisions to restrict driving in certain conditions. This study investigated how teenage drivers with instruction permits or intermediate licenses comply with GDL restrictions or requirements. Drivers with instruction permits should have a qualified front seat passenger (e.g., parent, grandparent, driving instructor) who is at least 21 years old. This study found about 17. 3 percent of drivers with instruction permit who were involved in crashes between 2001 and 2007 had a possible qualified front seat passenger. A notable finding is that the percent began to increase substantially in 2006, and it reached 63.3 percent in 2007. However, still 36.7 percent of the drivers did not comply with their restrictions. The compliance rate among crash-involved drivers aged 16-17 on the teenage passenger limit has been greater than 99%. However, the compliance rate on the not-driving-alone restriction on early morning (1:00 a.m.-5:00 a.m.) among crash-involved 16-17 year-old drivers has

been very low and the rate was merely 9.5 percent in 2007. Also, the proportion of drivers aged 15-18 involved in crashes from 9 p.m. in their total crashes have been much higher than drivers aged 19 or older consistently since 1998. This implies that nighttime driving consistently poses a significant crash risk among Missouri's teenage drivers and it is necessary to find strategies to reduce the risk.

GDL is an important traffic safety policy tool specifically designed for teenage drivers. This study found positive outcomes of Missouri's GDL policy in terms of decreased crash involvement and lower injury rates among drivers aged 15-18. However, the policy can be further strengthened. Based on the findings of this study and recommended practices outlined by IIHS, Missouri may consider the following:

1) Expand restricted nighttime driving hours from the current hours of 1:00 a.m.-5:00 a.m. to 9:00 p.m.-5:00 a.m. This is recommended by IIHS as an optimal parameter. Also, this study found the proportion of teenage drivers aged 15-18 involved in crashes from 9 p.m. to midnight in their total crashes were substantially higher than drivers aged 19 or older over the years. Address times of the day with high collision-rate (e.g. 7:00 a.m. and 3:00 p.m., during the school-day commute). While collisions for all ages spikes at these times, they are led by those involving teenagers. Further study should be done to determine solutions to limit collisions at these times including more strict enforcement and education.

2) Prohibition of cellular phone use while driving under a learner's permit or intermediate license needs to be considered. Twenty other states prohibit the use of cellular phones while driving during learner and provisional stages of GDL due to teenage drivers' higher risks of crash involvement linked to their cognitive development and cultural factors. Existing studies have consistently reported that cellular phone use increases crash risk while many drivers are not aware of the risk. This restriction may reduce distractions, thus reducing crash risk of Missouri's teenage drivers.

3) Missouri needs to implement a teenage driver probationary program to more carefully monitor driving behavior under the learner's permit and intermediate license. The key component of this program is inclusion of violations of GDL restrictions as well as violations of traffic laws in delaying graduation to full licensure. At present, in Missouri, violations of GDL provisions are by statute infractions and are not point assessable. Therefore, drivers violating these provisions are not delayed from graduating to a full license. This study found that GDL compliance rates still need to be improved. For example, the percent of drivers aged 15 in crashes having a qualified front seat passenger was only 63.3 percent in 2007. Also, the compliance rate on the not-driving-alone restriction on early morning (1:00 a.m.-5:00 a.m.) has been extremely low and the rate was merely 9.5 percent in 2007. The inclusion of GDL violations in delaying graduation to full licensure may substantially improve the compliance of GDL restrictions or requirements, thus improving their traffic safety.

4) Missouri should enact more efforts to improve traffic safety of teenage drivers in rural counties by means of activities such as hosting a Partnering for Innovative Efficiencies (PIE) meeting dedicated to improving the effectiveness of Missouri's GDL policy. Counties should work together to share their successes and failures and create innovative ways to improve traffic safety. This study found that there were significant variations among counties in terms of crash rates among drivers aged 15-18. Urban counties with major cities and higher median household income had higher percent change in both reduced crash involvement rate and reduced at-fault rate in crashes compared to rural counties with lower median household income. These results warrant more dedicated efforts to promote teenage drivers' traffic safety in rural counties including educational programs and enforcement in GDL implementation.

This study found GDL policy reduces teenage drivers' crash involvement and saves their lives. The results of this study demonstrate the effectiveness of Missouri's GDL policy. Further improvements of the policy should bring better outcomes and save lives.

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