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M-CASTL 2008 Synthesis Report: Volume 2, Teen Driver Safety

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16. Abstract

Teen drivers have the highest crash rates of any age-group of drivers, with the possible exception of the very oldest drivers. Motor vehicle crashes are the leading cause of morbidity and mortality among teens. Not only are teen drivers more likely to be involved in crashes, they are also more likely than any age-group of drivers to carry passengers more often and in larger numbers. As a result, crash-related injury and death among teens occurs most often to teenage passengers of teen drivers. Many factors contribute to the high crash risk of teen drivers. The purpose of this report is to review these factors and provide a synopsis of current knowledge and understanding of teen driver safety. The objective of this synopsis is to identify high priority areas and directions for research to move the field of teen driver safety forward. To accomplish this objective, topics from the literature spanning the past decade relating to teen driver safety are reviewed with the intent, not of providing a comprehensive review of all literature in this field, but of presenting a representative review of current knowledge, limitations to that knowledge, and to identify high priority areas for research in teen driver safety. Following a review of the current state of knowledge in teen driver safety, areas for future research are discussed, including: continued efforts to enhance programs that are currently having a positive effect on teen driver safety, as well as to identify additional effective programs; increased understanding of parents' attitudes and needs viz a viz the safety of their teenage children who drive; multi-disciplinary research to develop a driver education program that is effective in increasing teen driver safety; continued program development and evaluation research in the areas of teen drink/driving, safety belt use, and risks due to teenage passengers; and research to ensure that technology that is unsafe for teen drivers is identified and eliminated from the driving situation. All of these areas must be addressed with the backdrop of what is known about adolescent development, so that programs are designed to be developmentally appropriate.

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INTRODUCTION AND BACKGROUND

Motor vehicle crashes are a major contributor to teen mortality and morbidity (National Highway Traffic Safety Administration [NHTSA], 2006; Williams, 2003). Although graduated driver licensing (GDL) and other programs have shown success (Williams, 2005), rates of traffic crashes, injuries, and fatalities and the economic cost of crashes involving teen drivers are unacceptably high (Miller, Lestina, Spicer, 1998; NHTSA, 2003). Teen drivers have the highest crash rate per mile driven of any age group, except for the very oldest drivers (i.e., 70 years and older) (Ferguson, Teoh, McCartt, 2007). While the shape of the distribution of crashes by age varies depending on how age groups are formed and what is used as the denominator to calculate the rate (Williams, 2003), the high crash rate of teenage drivers is evident no matter how the rate is calculated, or whether all crashes are included or the rates are calculated by outcome severity (i.e., property damage only [PDO], non-fatal injury, fatal). Teen drivers have consistently higher crash rates than adults when calculated per capita, per vehicle miles traveled (VMT), or per person mile driven (PMD). In addition, teenage and adult males are involved in a larger volume of total crashes than females (Hanna, Taylor, Sheppard, Laflamme, 2006; NHTSA, 2006), and this is true in other countries as well (Twisk, Stacey, 2007), as indicated by crash rates per VMT and per capita, but males crash less often than women (teen and adult) when crash rates are calculated per PMD (Bingham, Shope, Parrow, Raghunathan, 2007; Shope, Bingham, 2007).

As a result of teens' high rates of crash involvement, motor vehicle crashes are the leading cause of death in this age-group, accounting for more than twice as many deaths as the next two leading causes combined (i.e., homicide and suicide), and about equal to the number of deaths due to homicide, suicide, and other non-vehicular unintentional injuries, combined (National Center for Injury Prevention and Control). Crash rates are highest among the youngest drivers, declining with each year of increasing age but not reaching the lowest levels until after age 30 (Insurance Institute for Highway Safety [IIHS], 2005).

In the year 2000, 16-year-olds had experienced 35 crashes per million VMT. This is in comparison to 17-, 18-, and 19-year-olds who had 20, 14, and 13 crashes per million VMT, respectively. Thus, per mile traveled, 16-year-old drivers had nearly three times the number of crashes experienced by 19-year-olds, and nearly eight times more than drivers ages 45-54 years who had only four crashes per million VMT. A similar pattern is seen for fatal crashes, with 16-year-old drivers having 13 fatal crashes per million VMT and 17-, 18-, and 19-year-olds having 8, 6, and 6 fatal crashes per million VMT, respectively (Williams, 2003). Per vehicle mile traveled, 16-year-old drivers had two times more fatal crashes than 19-year-old drivers, while drivers in the 45-54-year-old age group had between one and two fatal crashes per million VMT. Fatalities are not the only enduring outcome of teen crashes. Although youth are more resilient than adults and especially the elderly, the deficits in quality of life experienced by teens who survive crash-related injuries occupy a larger portion of their lives than do injuries to older individuals (Holbrook et al., 2007).

Generally, research has identified factors and conditions that while they increase crash risk for drivers of all ages, they are especially detrimental to teen drivers. Examples include driving at night or after consuming alcohol. Research has also identified conditions and factors that increase teen driver risk, but have either a neutral or slightly positive influence on the crash risk of adult drivers, such as driving with passengers (Bingham et al., 2007; Engstrom, Gregersen, Granstrom, Nyberg, 2007; Williams, 2003). Research also indicates that under-developed basic driving skills are a significant contributor to teens' crash risk (Masten, 2004). Under-developed driving skills combine with immaturity at all levels of the individual, including emotional, psychosocial, cognitive, and physiological levels, to contribute to risky driving among teens (Bingham, Shope, 2004a, 2004b, 2005, under review; Leung, Starmer, 2005). The combination of immaturity and under-developed driving skills presents the field of teen driver safety with a “catch 22,” as teens must drive in order to gain the skills needed to drive safely, but at the same time, teens are at very high risk of being involved in a crash, especially in the initial months of licensure. Both driving skills and maturity require time and experience in order to develop.

Teens learn through secondary, as well as primary experience. Teens that are exposed to high-risk driving as passengers are more likely to drive in a risky manner (Sarkar, Andreas, 2004). Experience of high-risk driving among young drivers is high, as high as 55% in one study, with many teens reporting riding with drivers who had been drinking, and being involved in drag racing, and/or reckless driving. Receiving a traffic citation is related to risky driving exposure as either passengers or as observers of others’ driving (Sarkar, Andreas, 2004), and participating in risky driving behaviors, such as drag racing, exceeding the speed limit by 20 km/h or more is associated with a greater likelihood of being involved in an injury crash (Blows, Ameratunga, Ivers, Lo, Norton, 2005; Shope, Raghunathan, Patil, 2003).

Attitudes, beliefs, and personality also play important roles in teen driving risk (Dahlen, Martin, Ragan, Kuhlman, 2005). A study funded by the National Highway Traffic Safety Association (2007) found that teens believed that distracted driving was a serious problem; however, they also believed that GDL was not enforced, that driving after a minimal number of alcoholic drinks was not problematic, and that marijuana does not negatively affect driving safety. The participants in that study also reported wearing safety belts only when police were present. Speeding was also common among the study participants, but they generally did not believe that it contributed to crash risk. Some evidence suggests that teens’ attitudes and perceptions about driving risk are affected by media exposure, with watching more television news being associated with a greater awareness of the risk associated with drink/driving, but watching music videos being associated with less perceived risk associated with driving, generally (Buellens, Van den Bulk, 2007), and playing racing video games being associated with less cautious driving, more competitive driving, obtrusive driving, and more crash involvement (Fischer, 2007). Finally, young adult driving patterns and outcomes have been found to be associated with personality factors present as early as childhood (Vassallo et al., 2007). Personality traits such as aggressiveness, traditionalism, and alienation are frequently associated with risky driving behavior and crash risk (Gulliver, 2007; Oltedal, Rundmo, 2006), demonstrating the pervasive influence of some individual characteristics on driving safety.

While the body of knowledge relating to teen driver safety is large, there is still much that needs to be learned so that teen drivers’ safety can be increased, and their involvement in crashes as drivers and as passengers of teen drivers can be avoided. The purpose of this report is to provide a synopsis of current knowledge and understanding of teen driver safety, with the objective of identifying high priority areas and directions for research as this field moves forward. To accomplish this objective, topics from the literature spanning the past decade relating on teen driver safety are reviewed with the intent, not of providing a comprehensive review of all publications in this field, but of presenting a representative review of current knowledge, limitations to that knowledge, and to identify high priority areas for research in teen driver safety.

Following, topics related to teen driver safety are reviewed. This is followed by a synthesis of the research and conclusions. High priority areas for future research are then identified based on these criteria: 1) involves issues that contribute to conditions either resulting in or preventing large numbers of teen crashes and related injuries; 2) includes issues that contribute to or reduce the current disparity between teen and adult driver crash rates and crash-related injury rates; 3) the contributing factors can be modified through policy, programs, and interventions, or can contribute meaningfully to the design of effective policies, programs, and interventions.

ISSUES RELATING TO TEEN DRIVER SAFETY

Adolescent Development

Adolescent developmental factors contribute to the risks encountered by teen drivers, and greater understanding of these factors could be used to design and enhance programs, policies and interventions to increase the safety of novice teen drivers. Risk-taking, in general, is more prevalent during adolescence than at other stages of development. Driving-related risk-taking specifically is linked with many aspects of development (Arnett, 1992), and is one mechanism by which adolescents further their own psycho social development (Jessor, 1987). This proneness for teens to be involved in high-risk behaviors relates in part to brain development.

Until recently it was believed that following prenatal development and a relatively short interval of postnatal development the human brain did not undergo any more significant developmental changes. However, with the development and improvement of brain scanning technology, it became apparent that another period of rapid brain development occurs during adolescence. During adolescence there is an over-production of neurons, especially in the prefrontal cortex of the brain. This expansion in the number of neurons is followed by pruning of unused neurons and neural pathways. During this time of rapid development, as the prefrontal cortex matures, it increasingly gains primacy over cognitive control and moderates the influence of socio-emotional regulation on cognitive processes (Steinberg, 2007).

Socio-emotional regulation takes place in the limbic and paralimbic areas of the brain. These areas are relatively well developed by adolescence, and are sensitive to social stimulation that forms rewards and punishments. This sensitivity is heightened during this time of rapid brain growth. New dimensions of this sensitivity to stimulation by social factors develop during adolescence with the onset of puberty and heightened sexual drives, giving socio-emotional regulation a strong role in adolescent decision making. Socio-emotional regulation mediates the bidirectional interactions between individual adolescents' emotions and stimuli received from their social contexts. The hypersensitivity of the socio-emotional regulation centers results in social interactions having the potential to range from being highly rewarding to deeply punishing (Steinberg, 2007).

Certain aspects of cognitive functioning are well developed in adolescence. For example, 15-year-olds are comparable to adults in their ability to perceive risks and estimate their vulnerability to those risks (Reyna, Farley, 2006). However, other aspects of cognitive functioning are limited, and expand as development in the prefrontal region of the brain progresses during adolescence. Cognitive control involves higher brain functions related to decision making, logical reasoning, impulse control, and integrative functions that are required for expertise, such as the ability to perceive risks and their probability, to be applied to real life situations (Keating, 2007; Steinberg, 2007).

The high sensitivity of the socio-emotional regulation centers of the brain, and the lag in development of cognitive control related to decision making, logical reasoning and impulse control combine to predispose adolescents to risk-taking. Decisions are overly influenced by socio-emotional regulation, which results in a strong desire to promote rewarding social interactions while avoiding social interactions that, because of the sensitivity of the socio-emotional regulation centers of the brain, can be unrealistically embarrassing, shaming or contribute disproportionately to feelings of inferiority. The result is impulsiveness, decisions and actions based more on emotion than logical reasoning, a decreased ability to delay gratification, increased distractibility, especially distraction related to social interactions, and the rationalization by individual adolescents that they are unlikely to experience the negative consequences of risk-taking (Clarke, Ward, Truman, 2005; Floyd-Bann, Van Tassel, 2006, Steinberg, 2007). This combines with other characteristics of teens, such as personality, anxiety level, sex (i.e., male versus female), behavior problems, social competence, school adjustment, and quality of interpersonal relationships to promote excitement-seeking, the desire to impress peers, and risk-taking behind the wheel (Gulliver, 2007; Oltedal, Rundmo, 2006; Twisk, Stacey, 2007 Vassallo et al., 2007).

Psychosocially, adolescents are also developing rapidly. This aspect of development involves individuation from parents, self-exploration and trying on new roles, and exploring new behaviors and ways of being which are important for the development of a personal identity (Erikson, 1968). These exploratory elements are necessary for healthy psychosocial development, but can also promote risk-taking, as adolescents "try-on" alternative behaviors and attitudes that involve or promote risk-taking, such as substance use, unsafe sex, and risky driving behaviors (Arnett, 1992; Bina, 2006; Bingham, Shope, 2004a, 2004b; Taubman, Mikulincer, 2007).

It is easy to imagine how these aspects of adolescent development come together to predispose adolescents to drive in a risky manner, and how they may even promote adolescents' participation in risky driving. Preoccupation with maintaining the esteem of peers, impressing members of the other sex, demonstrating their driving skill and capability, and distraction due to rumination over a perceived social faux pas committed earlier in the day are all examples of elements that together can result in teen drivers either purposefully or unintentionally driving in a manner that places themselves and others, both inside and outside the vehicle, at risk.

Fortunately there is clear evidence that driving expertise can compensate for many of the potentially negative effects of adolescent development on driving behavior. Driving risk, measured as crashes, declines rapidly in the first few months of driving (McCartt, Shabinova, Leaf, 2003; Mayhew, Simpson, Pak, 2003). Time, social support, and structure all contribute to the development of expertise, and the latter two can be used to limit risk exposure while expertise is developing (Keating, 2007). Practice driving, driver education, teen driver licensure policies and programs, such as GDL, and parental involvement, have proven effective in extending the learner phase of licensure, reducing risk exposure, and promoting the development of expertise related to driving (Begg, Stephenson, 2003; Males, 2007; Margolis, 2007; Rios et al., 2006; Simons-Morton, Hartos, 2003; Williams, Leaf, Simons-Morton, Hartos, 2006; Shope 2007; Shope, Molnar, 2003; Shope, Molnar, Elliott, Waller, 2001).

Teen Driver Licensure

Underage Driving

Many lives are shattered by underage drivers going for a joyride in the vehicles of their parents or older relatives. Underage driving is a particularly risky behavior in which the nature of the risks and the consequences to the young drivers are often overlooked. One study aimed to describe the characteristics related to crashes and crash-related injury in which the vehicle was driven by a young person under the legal age of obtaining a license. The majority of the underage drivers in the Australian study were male (79.5%) with more than slightly more than half (58.0%) aged 15 years, and nearly 30% aged 14 years (Lam, 2003). Among these, 83.6% involved the driver of the vehicle being killed or injured. Additionally, almost 75% of the injured or killed passengers were nonadult passenger under the age of 18 years.

Underage driving poses a serious problem in terms of crash outcomes. While it is obvious that underage driving is illegal and forbidden in all licensing systems, it can be considered as part of the wide spectrum of risky behaviors among young adolescents. Experimental driving and late-night outings for adolescents should be discouraged. Future research should investigate the relationship between underage driving and on road risk-taking behavior among licensed adolescents.

Age of Licensure

The legal minimum licensing age of states, as well as the age that a person is licensed are both related to crash involvement. Fatal crash data from New Jersey, Massachusetts, and

Connecticut were analyzed showing that licensing law was associated with 65 to 85 percent reductions in fatal crashes, when comparing New Jersey, where legal licensure began at age 17, with Connecticut and Massachusetts, where the legal licensure ages were 16 and 16.6, respectively (Williams, Karpf, Zador, 1983). Using driver history records of 13,794 Michigan drivers, Elliott, Raghunathan, and Shope (2002) used time-to-event models to examine the effect of licensure age on time to first crash. Each additional year of delay in licensure (up to five years) was associated with an approximately 18% delay in time to first crash. Together, these results suggest that policies and programs that delay the age of licensure of teens are likely to have a positive effect on teen driver safety.

Differences in the legal age of obtaining learner's permits and independent licenses are reflected in the average age of licensure in that state, because most teenagers obtain their permits and take road tests within a few months of becoming eligible. If licensure is delayed, the most common reasons include completing driver education requirements, lack of readiness/immaturity, and insufficient practice driving. When parents were asked what they thought should be the minimum age of licensure for teens, 33-49 percent indicated that it should be 17 years or older. This research indicates that licensing laws influence the age at which teens initiate driving (McCartt, Hellinga, Haire, 2007).

Together, these results suggest that policies and programs that delay the age of licensure of teens are likely to have a positive effect on teen driver safety. Furthermore, there appears to be support for minimum age at licensure to be older than it currently is, but this is less likely to be true in rural areas where earlier age of licensure is more desirable so that teenage children can take on farming tasks that involve the operation of a motor vehicle on public roadways. It is not common for agricultural states to have younger minimum ages at which the licensure process can commence (IIHS, 2008), and some states, such as Iowa have special provisional licenses that teens in rural areas can obtain to begin driving at a younger age. The success of graduated driver licensing, which will be discussed in detail further on in this report, in reducing teen crash involvement most likely owes much of its success to the longer licensure process that results from it (Begg, Stephenson, 2003; Males, 2007; Margolis, 2007; Rios et al., 2006; Shope 2007; Shope, Molnar, 2003; Shope, Molnar, Elliott, Waller, 2001).

Driver Education

It is widely believed that driver education increases teen driver safety, and driver education is often proposed as a means to reduce teen crash involvement. It is thought that by teaching the skills and knowledge necessary to drive will result in teens becoming safe and responsible drivers. As a result, some form of driver education is required as part of the licensing process for individuals being licensed before age 18. In some states, all novice drivers, no matter their age, are required to complete a formal driver education program as part of the licensing process. In other states beginners aged 16 to 17 are required to take driver education before they can obtain a driver license, but there is no such requirement for drivers over 18 years of age, who are only required to pass written and/or on-road driving tests. In other states, formal driver education is voluntary, with parents having the authority to teach their own children to drive (Masten, Chapman, 2004).

In reality, the scientific literature has not shown any connection between driver education and teens' driving safety. Evaluations of traditional driver education programs have not demonstrated consistent evidence that safety objectives are attained by teens as a result of completing driver education (Clinton, Lonero, 2006; Hirsch, 2006; Mayhew, 2007; Mayhew, Simpson 2002; Mayhew, Simpson, Williams, Ferguson, 1998), and the large majority of those evaluations show no effect of driver education on the safety of teen drivers (Vernick et al., 1999).

There are several reasons why driver education does not result in increased teen driver safety. One possibility is that driver education plays an instructional role that helps beginning drivers prepare for the tests required to be licensed. Because many driving schools are for-profit in the US and would lose business if their students were unable to pass the required driving tests, it is possible that driver schools "teach to the exam," focusing less on teaching safe driving skills and more on conveying the fundamental skills and knowledge necessary to pass on-road and written licensing exams. Finally, it is clear that driver education curricula in the US, as well as in many countries, do not utilize methods and approaches that are known for the fields of education and public health to effectively convey knowledge and skills, and that change behavior. Research has shown that programs designed specifically to train teens to effectively scan for hazards, and that teach them how to detect potential hazards are effective in increasing teen driving performance (Fisher, Pollatsek, Pradhan, 2006; Fisher, Pollatsek, Pradhan, Narayanaan, 2004; Sagberg, Bjørnskau, 2006).

The link between driver education and driver licensing has been strengthened in recent years with the rapid proliferation of graduated driver licensing (GDL) programs. The relationship between driver education and GDL has taken several forms. In 1994, NHTSA recommended a two-phase driver education program as part of GDL. The premise behind the multi-stage program was that beginning drivers are not able to benefit fully from the safety education in driver education because of their inexperience; hence, the tasks of learning to drive and control a vehicle are so demanding that safe driving concepts cannot be learned and applied. In the two-phase program, the initial phase would focus primarily on the skills and knowledge necessary to handle and drive a vehicle on the road, and the second phase would be introduced later after basic driving skills had been learned, and would focus on driving safely. In this program, phase one would occur during the learner stage and phase two during the intermediate stage of the licensing process. Michigan is the only state to have adopted a two-phase driver education program (IIHS, 2008).

Time discounts are part of some driver education programs. These discounts are intended as an incentive to teens for taking driver education by reducing the length of time that a learner's permit must be held by four months. Like many programs that either promote beginning to drive at an earlier age or reduce practice driving, time discounts compromise the overall safety benefit of GDL programs and result in higher risk driving among novice teen drivers (Boase, Tasca, 1998; Mayhew et al. 2003; Wiggins, 2004).

Senserrick (2007) reviewed Australian driver education and training initiatives and concluded that programs initiated by licensing authorities have increased, there has been a move to start younger during the pre-learner period, and to actively include parents and rewards programs while continuing to tighten penalties for traffic violations. While the majority of driver education programs have not been evaluated, some studies suggest positive outcomes including increased supervised driving, delayed licensure, and potentially crash reduction for higher-risk young drivers. Future research may examine ways to better integrate driver education with GDL programs, and determine the role of driver education in providing young drivers with the skills needed for safe driving.

Teen Driver Programs

Program Evaluation

Policies, programs and interventions aimed at reducing teen involvement in crashes are challenging to design, because of the many factors that contribute to teen crash risk, including behavioral and situational factors (Ferguson, 2003). Policies, programs and interventions have targeted many traffic safety issues in an attempt to modify driver, passenger, and pedestrian behaviors, reduce hazardous situations, and prevent crashes. Targets of these policies, programs and interventions have and do included failure to wear a seat belt, talking on a cell phone, passenger distractions, fatigue, driving after drinking, and speeding, to name a few.

Evaluation is an essential component of traffic safety. Policies, programs and interventions must be evaluated in order to determine their effectiveness. Many policies, programs and interventions do not have their effectiveness evaluated, and this is especially true of those sponsored by private organizations, but is also true of some sponsored by state governments. Evaluation not only identifies which policies, programs and interventions are effective, but can also identify components of policies, programs and interventions that contribute to overall effectiveness. Evaluation should be employed in combination with efforts to enhance traffic safety in a cyclical manner in which programs are evaluated for effectiveness, and their effective components identified. Changes should then be made to the policy, program or intervention to enhance their effective components, and to introduce new components. This should then be followed with more evaluation. In this way, effective policies, programs and interventions are identified and enhanced.

In order for an evaluation to provide conclusive information, it must include a minimum of two characteristics. One is some form of comparison to which the policy, program or intervention being evaluated can be compared. This comparison could involve taking measurements of a population before and after a new law is passed to determine its impact on safety, or a program or intervention might be introduced in one area, and then measures from that area are compared with those taken from another area to determine if there has been an effect. The second characteristic that an evaluation must include if it is to provide useful information is valid measurement of appropriate outcome variables. Too often programs claim to have been evaluated, but the evaluations either do not include an appropriate comparison, have no comparison at all, or the outcomes measured are not appropriate to evaluate safety enhancements (i.e., measures of approval of a program rather than whether the program had its intended effect on safety). Following, two teen driver safety programs are introduced. Both have been evaluated repeatedly using strong evaluation methods, and found to be effective.

Graduated Driver Licensing

Some form of graduated driver licensing is currently in place in 46 US states and the District of Columbia, but the systems vary broadly in strength. Graduated driver licensing is a program designed to delay full licensure, provide more time for supervised practice driving, and restrict driving privileges so that the exposure of newly licensed independent drivers to higher risk driving conditions is limited. GDL has three stages: a minimum supervised learner's period, an intermediate license with restrictions on unsupervised driving, and a full-privilege driver's license that is available after the first two stages are completed. Beginners must remain in each of the first two stages for set minimum time periods. As of April 2008, forty-six US states and the District of Columbia have GDL programs that include all three stages, but the systems vary in strength (Insurance Institute for Highway Safety, IIHS, 2008).

IIHS defines an optimal GDL program as having a minimum age of 16 years for a learner's permit; a learner stage that lasts at least six months, that requires parents to certify that the teen completed at least 30-50 hours of supervised driving, and an intermediate stage that lasts until at least age 18 and includes both a night driving restriction beginning at 9 or 10 pm and a teenage passenger restriction that allows no teenage passengers, or no more than one teenage passenger.

There has been consistent and uniform evidence that GDL programs have resulted in decreased fatal crash rates among teen drivers under age 18, with the youngest drivers experiencing decreases in crash risk of 20-40%. This corresponds with decreased rates of hospitalization and hospital charges among 16-17-year-old drivers (Begg, Stephenson, 2003; Males, 2007; Margolis, 2007; Rios et al., 2006; Shope 2007; Shope, Molnar, 2003; Shope et al., 2001; Zhao et al., 2006). Very little evidence exists to suggest that GDL has either been ineffective, or that is has had unintended deleterious effects (Males, 2007).

Although effective as it currently stands, there are several ways in which GDL can be improved. One is by including protective restrictions that reduce teen driver exposure to more of the conditions that result in increased crash risk for teen drivers. As of April 2008, there were only three states with GDL laws that did not include a nighttime restriction and only seven that did not have a passenger restriction, but only 18 had restrictions on cell phone use for teen drivers (IIHS, 2008). There is broad variation in these restrictions across states, with some restrictions being very minimal either in the length of time for which they are imposed, or in providing only a slight reduction in exposure to high risk driving conditions. Restrictions on teen passengers, nighttime driving, and cell phone use could be strengthened by either lengthening the restriction (e.g. extending the length of time that the restriction is in place) or making it more rigorous (e.g. allowing no passengers rather than one, restricting driving after 10pm rather than midnight, or not allowing any cell phone use rather than banning only hand-held phones).

Driving either at night or with a teenage passenger both increase teen crash risk. Research has shown that teens' crash risk increases considerably when these two conditions are combined, and teens drive with passengers at night. Driving on the weekend with either passengers, at night, or with both conditions results in an even greater increase of crash risk for teens. This suggests that GDL laws might be improved by combining nighttime and passenger restrictions with restrictions on weekend driving (Bingham et al., 2007; Bingham, Shope, 2007).

Compliance with GDL could also be enhanced. Implementing protective restrictions that are supported by parents and teens, and linking advancement through GDL to demonstrated responsible driving will likely promote greater compliance. Parental support of protective restrictions could be addressed by considering parents' concerns and needs when restrictions are designed, and through public education and information programs and campaigns. Linking advancement through GDL to compliance would have to be paired with strong enforcement in order to be effective. Programs to assist parents in monitoring their teen drivers, selecting appropriate vehicles for their teen drivers, and in enforcing the GDL restrictions, as well as high visibility law enforcement activities would encourage compliance (Ferguson, 2003; Foss, 2007; Foss, Goodwin, 2003; McKnight, Peck, 2003; Simons-Morton, Hartos, 2003; Shope, 2007; Williams, Leaf, Simons-Morton, Hartos, 2006; Williams, 2007).

Further research is needed to identify the modes through which GDL has its effect on teen driver safety. Research evidence indicates that passenger and nighttime restrictions are one effective component (Lin, Fearn, 2003). Other potential sources of GDL's effectiveness include lower exposure to higher risk driving conditions, an extended learning period, early intervention, supervised driving, multi-stage instruction, and greater opportunity for maturation to occur due to the length of time that GDL requires for teens to become licensed (McKnight, Peck, 2003). Research should also examine the efficacy of extending GDL to address additional risk factors by including more stringent tests for advancement, hazard perception tests, speed restrictions, limits on vehicle power, and limits on roadway access (Ferguson, 2003; Ferguson et al. 2007).

Parental Involvement

Simple motivational strategies can increase parents' use of driving agreements with their teens, and encourage parents to impose greater restrictions on early teen driving (Simons-Morton, 2007; Simons-Morton, Hartos, 2003; Williams, Leaf, Simons-Morton, Hartos, 2006). Research has repeatedly shown an association between parental supervision and driver safety outcomes. Teen drivers' intentions to violate driving rules are less when parental supervision is greater (Desrichard, Roché, Bègue, 2007). Also, parental monitoring during adolescence has been shown to predict young adult driving outcomes, including risky driving practices, receipt of traffic offenses, and crash involvement (Bingham, Shope, 2004a 2004b, 2005, 2006); however, parent-teen discord regarding driving rules and restrictions is associated with more rule violations by teens (Beck, Hartos, Simons-Morton, 2006). These data suggest that approaches that increase parental involvement in teens' driving while limiting parent-teen conflict may hold promise as a means of reducing teen crash risk, not only in the early stages of driving, but potentially for years to come (Beck, Hartos, Simons-Morton, 2005; Williams, Leaf, Simons-Morton, Hartos, 2006).

One parent intervention to promote teen driver safety was employed as part of the Raising Healthy Children project (Haggerty, Fleming, Catalano, Harachi, Abbott, 2006; Simons-Morton, Ouimet, Catalano, 2008). That intervention consisted of two targeted family sessions held during home visits, one before and a second after teenagers received their driver licenses. The sessions focused on improving decision-making skills (session 1), and establishing a parent-teen driving agreement that stated family expectations, provided a plan for monitoring teens' compliance with the expectations, and consequences for compliance or non-compliance (session 2). The results were positive, providing evidence that enhancing parent and teen decision-making skills and promoting the development of a parent-teen driving agreement increases the likelihood of having a written agreement, making driving rules, and reducing risky driving behaviors, including driving after drinking and riding with a driver who had been drinking.

While effective, the intervention just reviewed was very intensive, would be expensive to deliver on a large scale and to sustain. A program called Checkpoints, is less intensive than the intervention used in the Raising Healthy Children project, but it has yielded promising results in several effectiveness evaluations. The Checkpoints Program provides parents with a motivational message promoting the monitoring of teenage drivers, and the development of a written parent-teen agreement. The intervention materials provide a structured approach to guide parents and teens in the development of an agreement, identification of rules, and establishment of consequences for breaking the agreement and rules. Evaluations of the Checkpoints Program indicate that it results in more parents and teens establishing written agreements, greater limit-setting on teen driving privileges, lower rates of risky teen driving, and receiving fewer traffic violations by teens. In addition, Checkpoints has resulted in higher levels of monitoring teen driving by parents, more discussion of driving rules between parents and teens, and greater risk perception (Hartos, Beck, Simons-Morton, 2004; Simons-Morton, Hartos, Leaf, Preusser, 2006a, 2006b). Research on the Checkpoints Program also indicates that it is more effective in states with GDL programs than in states without, indicating that it is enhanced by GDL (Hartos, Simons-Morton, Beck, Leaf, 2005).

Vehicle Type

While many behavioral and situational factors increase teen drivers' risk of crash involvement, the type of vehicle they drive (e.g., passenger car, sports utility vehicle (SUV), or pickup) may also affect both the likelihood of a crash, and the severity of the outcomes (e.g., injuries, fatalities). Vehicle characteristics contribute significantly to the safety of teen drivers. Vehicle characteristics that increase risk for teens include high horsepower, being designed for high performance, older models, and high-profile/high center of gravity. Drivers of vehicles built for speed, power, and high performance are faced with the temptation to "step on it," and having such vehicles is nearly presumptive evidence of the intention, or at least a very high likelihood of speeding and committing other driving infractions (Balsley, 1950; Ferguson, 2003). Pushing any vehicle to its limits is a bad idea for teen drivers who are still lacking in the maturity, skill and experience needed to drive safely. Older model vehicles often end up being driven by teens (Gonzales, Dickinson, DiGuiseppi, Lowenstein, 2005). The old family car is kept for the teen to drive, rather than being traded in, or an older model used car is what either the parents or the teen can afford to buy. But, older model vehicles have fewer of the safety features that newer models include. These safety features not only include electronic technology, such as electronic stability control or anti-lock brakes, but older vehicles lack engineering innovations that make newer models safer in a crash, such as pre-tensioning safety belts, airbags, and crumple zones that are designed to absorb the energy of a crash while limiting intrusion into the passenger cabin of the vehicle. Nevertheless, teens are more likely than adult drivers to have an older car (Gonzales et al., 2005).

High profile/high center of gravity vehicles, such as pick-up trucks, SUVs and vans are associated with a much higher rate of rollover crashes than are cars and other lower profile vehicles (McGinnis, Davis, Hathaway, 2001). In addition, teen drivers of SUVs, vans, and pick-up trucks are less likely to wear their safety belts (McCartt, Northrup, 2004). For this reason, this type of vehicle is not the best choice for teen drivers, but larger vehicles do appear to offer a protective advantage in the case of a crash. Recent research examined the fatality risk of teens driving different vehicles and found that per mile driven, the fatality risk for both male and female teens driving SUV's was decreased relative to passenger cars (Trowbridge, McKay, Maio, 2007). Fatality rates for male teens driving pickups were also lower per mile driven when compared with males driving passenger cars. Fatality rates for female teens driving pickups and passenger cars were not statistically different but appear potentially higher for passenger cars. Both SUVs and pickups demonstrated significantly higher rates of fatal rollovers than passenger cars. Female teen drivers of SUVs and pickups were at particularly high risk for fatal rollovers per vehicle mile driven compared with passenger cars.

Perhaps one of the most important decisions parents can make about their teen's safety is the vehicle they drive. Selecting a vehicle that may reduce the risk of a crash and the risk of injury in the event of the crash is especially important for newly licensed drivers. Vehicle choice should be further explored as a potentially modifiable risk factor in interventions to address teen driver safety. Also, research developing and evaluating programs to educate parents on the features to look for when selecting a vehicle for their teenage drivers is needed (Hellinga, McCartt, Haire, 2007).

Distraction and Driving

Driver inattention is a major contributor in at least 25% of police-reported crashes. Driver distraction is one form of inattention and is involved in over half of these crashes. Teen drivers are the most likely to be involved in distraction-related crashes, with the majority of the distraction contributing to these crashes being on-board and nomadic infotainment devices, such as the radio, cassette or CD player, MP3 player, and cellphone/texting (Stutts, Reinfurt, Staplin, Rodgman, 2001). The majority of teens involved in crashes are found to be at fault, and in many cases the crashes involved distraction resulting in the failure to detect other vehicles, unawareness of traffic control devices, and not examining the traffic scene thoroughly – a narrowed functional field of view is one result of cell phone distraction (Atchley, Dressel, 2004) -- being common outcomes (Braitmann, Kirley, McCartt, Chaudhary, 2008).

Passengers, in-vehicle technology, and nomadic devices are common distractions to teen drivers. Interacting with technology or passengers while driving influences the likelihood, type, and severity of crashes. When teens are distracted at intersections, they are more likely to be involved in rear-end and angular collisions; in-vehicle distractions are associated with more angular collisions, and distraction due to cell phones result in a higher likelihood of a rear-end collision. Also, injuries received by teen drivers when distracted by a cell phone or by passengers are more likely to be serious than if the distraction is related to in-vehicle devices, or driver inattention. This same injury pattern holds for the passengers of teen drivers, as well (Neyens, Boyle, 2007, 2008; Rice, Peek-Asa, Kraus, 2003), and severe injuries to passengers of teen drivers are especially likely when the passengers are children (Chen, Durbin, Elliott, Senserrick, Winston, 2006; Senserrick, Kallan, Winston, 2007).

Teen Passengers

Having teenage passengers is associated with an increased risk of crash involvement by teen drivers (Masten, 2004; Williams, Ferguson, McCartt, 2007; Simons-Morton, Lerner, Singer, 2005). Teens, and especially younger teens, are the most likely of any age-group of drivers to carry passengers and to carry them in larger numbers (Williams et al., 2007). Compared with same-age drivers without passengers, 16-year-old drivers with 1 passenger were 1.38 times more likely to be in a fatal crash, 1.86 times more likely with two passengers, and 2.82 times more likely when three or more passengers were present. Seventeen-year-old drivers with 1 passenger were found to be 1.48 times more likely, 2.58 times more likely with 2 passengers, and 3.07 times more likely to be in a fatal crash when three or more passengers were present in the teen's vehicle (Chen, Baker, Braver, Li, 2000). As a result of rates of teen passenger carriage and the increased crash risk when teen drivers have teenage passengers, 61 percent of teenage passenger deaths in 2005 (1,222) occurred in vehicles driven by other teenagers (Williams et al, 2007).

Figure 1 shows rate ratios based on crash rates reported by Doherty, Andrey and MacGregor (1998) comparing the rates of crashes when teen drivers have 0 versus 1 and 0 versus 2 or more passengers. The increase in risk is greater for male than female teens, and more for fatal and injury crashes than for property-damage-only (PDO crashes). Crash risk with one passenger ranges from 50 to 115 percent greater than having a crash when no passengers are present. When two or more passengers are present crash risks are from 147 to 585 percent greater than with no passengers.

Teenage drivers' crash risk is especially high when passengers are teenage males (Chen et al., 2000; Simons-Morton, Lerner, Singer, 2005; Williams et al., 2007). Teen drivers were observed to drive faster and allowed shorter headways than the general traffic, and these differences between teenage and other drivers were exacerbated by the presence of male teenage passengers. Relative to other drivers, the observed rates of speed limit exceedence by 15 mph or more and headways of 1.0 second or less were about double when teenage male passengers were riding with teenage male passengers (Simons-Morton et al., 2005).

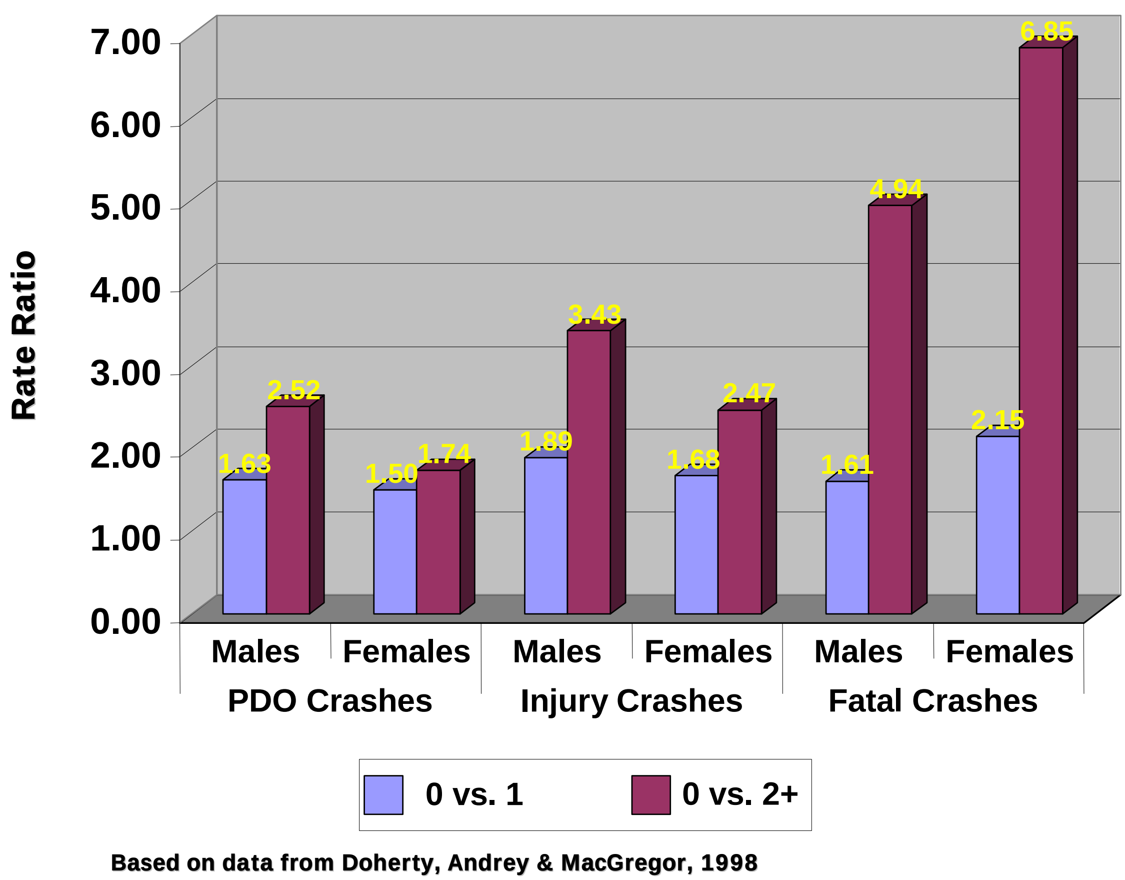

Figure 1. Rate ratios for male and female teens by sex and number of passengers

Teen crash rates were compared to those of adults in a study using Michigan State Police Crash Records for all drivers involved in a crash between 1989 and 1996 who were ages 16-19 (teens) or 45-65 years (adults). Crash rates were based on person miles driven, which were estimated using the National Personal Travel Surveys for 1990 and 1995, and the National Household Travel Survey for 2001. Rate ratios comparing teen and adult drivers showed that teenage males were 3.9 times more likely than same sex adults to be involved in a crash when passengers were present, and teenage females were 3.2 times more likely than adult females to be in a crash when transporting passengers. Nighttime driving by teens is often for recreational reasons, and often involves having teenage passengers riding with a teenage driver (Clarke, Ward, Bartle, Truman, 2006). For driving at night, rate ratios indicated that teenage males and females were 3.7 and 3.2 times more likely than their adult counterparts to be involved in a crash. When nighttime crashes in which at least one passenger was present in the vehicle were examined, teenage males and females were both 6.8 times more likely to be in a crash than were adults. Teenage males were 4.1 times more likely to be in a casualty crash (i.e., a crash involving at least one injury of any severity) when driving with at least one passenger, 4.7 times more likely to be in a casualty crash when driving at night, and when driving with passengers at night they were 9.0 times more likely than adult males to be in a casualty crash. Teenage women were 2.6 times more likely to be involved in a casualty crash when driving with at least one passenger, 3.4 times more likely when driving at night, and when driving at night with at least one passenger they were 7.9 times more likely to be involved in a casualty crash compared to adult female drivers (Bingham et al., 2007). Driving between 10pm and midnight is especially risky for teen drivers and their passengers (Rice et al., 2003).

Numerous factors contribute to the high crash risk observed among teenaged drivers when they have passengers, and several of these have already been addressed in the section on adolescent development. Fundamentally, compared to adults, teenagers are more susceptible to peer influences, more easily distracted, especially by social interactions, their decisions are motivated more by emotion than reasoning, and teens are more likely than older individuals to take risks, especially true when peers are present (Steinberg, 2007, Williams et al., 2007). Couple these factors with skills that are still developing and experience that is still lacking, and teens are at substantially greater risk of being in a crash when passengers are present, at night, and especially when both these conditions co-occur (Bingham et al., 2007).

Restrictions on nighttime driving and passenger carriage have been imposed by many states, either singly or together, as part of GDL programs (IIHS, 2008). Due to the heightened risk experienced by teens between 10pm and midnight, nighttime restrictions should begin no later than nine or 10pm and extend to 6am (IIHS, 2008; Rice et al., 2003). Passenger restrictions are also important to the protection of novice teen drivers, and have been shown to be effective (Williams et al., 2007). In California, three years following implementation of passenger restrictions, the number of teenage passengers carried by 16-year-old drivers decreased by approximately 25%, resulting in an estimated eight lives saved and 684 injuries prevented (Cooper, Atkins, Gillen, 2005). However, in order to be effective, restrictions must be enforced. In spite of passenger restrictions being in place in a majority of states, 42% of 16- and 17-year-old drivers in fatal crashes in 2005 were driving with teenage passengers and without an adult (Williams et al., 2007).

The prevalence of peer-to-peer intervention into risky driving has been investigated to determine the potential for peer-directed intervention programs to reduce rates of risky driving among teens. Female teenage passengers were more likely than males to report having asked the driver to drive more carefully when they felt unsafe in the car. This was not as true of males, who feared negative consequences of addressing unsafe drivers, had less confidence in their ability to influence a peer who was driving in an unsafe manner, were more accepting than females of risk-taking by drivers, and perceived less risk than females (Ulleberg, 2004).

An intervention using a peer-to-peer approach to increase safe driving by teens has demonstrated promising results. *You Hold The Keys* resulted in significant immediate and long-term increases in teen safety belt use, safe driving, and perceived confidence in preventing drunk driving. Students at immediate and long-term posttests more often wore safety belts when driving or riding, required passengers to wear safety belts, and limited the number of passengers to the number of safety belts in the vehicle (King, Vidourek, Love, Wegley, Alles-White, 2008).

Cell Phones and Texting

People often engage in a variety of multitasking activities while behind the wheel, with cell phone use being one of the most popular. In a 2007 insurance study of dangerous driver behavior, 73 percent of the 1,200 drivers surveyed talk on cell phones while driving.

Studies about cell phone use while driving have focused on several different aspects of the problem. Some have looked at its prevalence as the leading cause of driver distraction. Others have looked at the different risks associated with hand-held and hands-free devices. Still others have focused on the seriousness of injuries in crashes involving cell phone users and the demographics of drivers who use cell phones.

Motorists who use cell phones while driving are four times as likely to get into crashes serious enough to injure themselves, according to a study of drivers in Perth, Australia, conducted by the Insurance Institute for Highway Safety. The results, published in July 2005, suggest that banning hand-held phone use won't necessarily improve safety if drivers simply switch to hand-free phones. The study found that injury crash risk didn't vary with type of phone.

Many studies have shown that using hand-held cell phones while driving can constitute a hazardous distraction. However, the theory that hands-free sets are safer has been challenged by the findings of several studies. A study from researchers at the University of Utah concluded that talking on a cell phone while driving is as dangerous as driving drunk, even if the phone is a hands-free model. An earlier study by researchers at the university found that motorists who talked on hands-free cell phones were 18 percent slower in braking and took 17 percent longer to regain the speed they lost when they braked.

Increasingly, teens' use of cell phones while driving has become a concern, and the combination of text messaging and driving further increases concern about the effects of cell phones on teens' driving safety. While teens are aware of and concerned about the risks associated with using a cell phone while driving, this awareness and concern does not appear to influence their behavior (Martha, Griffet, 2007). However, there is good evidence that adults' driving safety is as severely impaired by cell phone use as is that of teens (Strayer, Drews, 2004). In fact, the level of impairment resulting from cell phone use while driving have been shown to be as profound as those associated with driving while legally drunk (i.e., BAC≥.08 g/dl), and this effect was the same for both hand-held and hands-free cell phones. When using a cell phone on a simulator, drivers' braking reaction time was delayed, their functional field of view was narrowed (Atchley, Dressel, 2004), and their involvement in crashes was greater than when they were not using a cell phone. Intoxicated drivers exhibited more aggressive driving, including following lead vehicles more closely and braking more forcefully. In both cases, the detriment to driver safety was the same (Strayer, Drews, Crouch, 2006).

Onboard Technology

There are multiple ways in which onboard technology interacts with teen driving outcomes, and these include both positive and negative effects on safety. Technology has the potential of interfering with the driving task through distraction or other mechanisms that reduces driver safety. Driver distraction, while having received substantial research regarding adult drivers, has not been extensively addressed with teen drivers who are frequent users of electronic devices. The rapid evolution in electronic devices has considerable potential to increase the demands of the driving task and be a cause of distraction. New technology, especially in the form of infotainment devices, is highly likely to affect the safety of teen drivers, who rapidly adopt new technology and use it frequently (Olsen, Lerner, Perel, Simons-Morton, 2004), and are also less experienced drivers and may lack the spare attentional capacity needed to interact with technology while maintaining control of the vehicle and anticipating and managing hazards (Lee, 2007). Research has found that teens are more willing to use nomadic electronic devices while driving than are older drivers, and the presence of passengers may actually increase the use of certain devices, such as cell phones (Olsen et al., 2004).

The implications of nomadic device use while driving for driver safety could be argued two ways. First, teen drivers may be at no greater risk or may even be at lower risk than older drivers because they are frequent and proficient users of electronic technology. Alternatively, teens are at greater risk of being in crashes, generally, and routine use of electronic devices while driving may increase that risk. Studies suggest that both these implications are to some degree true; however, there is evidence that while adults' and teens' driver safety is impaired by the use of electronic devices, teens' driving safety is more seriously affected (Strayer, Drews, 2004). Compared to older drivers, teens completed technological tasks faster (McPhee, Scialfa, Dennis, Ho, Caird, 2004; Tsimhoni, Smith, Green, 2004), but younger individuals made more errors, were less accurate in the completion of the electronic task, and their reaction time suffered more than that of adults (Greenberg et al., 2003; McPhee et al., 2004).

One potential approach to reducing the impact of electronic devices on teen driver safety is to apply proven methods for enhancing young driver safety to the issue of electronic device use. GDL has been successful in reducing teen driver crash risk by using protective restrictions to limit teen drivers' exposure to the highest risk driving conditions (Lee, 2004). A similar approach has been applied through legislation placing limits on cell phone use by teen drivers, which has been passed in seventeen states as of April 2008 (IIHS, 2008). As with GDL, enforcement of such programs would be reliant on parents as well as police, and police enforcement would be difficult; however, many electronic devices use date and time stamps to indicate when functions are accessed. These records could potentially be used by the police and the courts to enforce limits on teen drivers' use of technology.

ADHD

Attention deficit hyperactivity disorder (ADHD) is a highly publicized childhood disorder that affects approximately 3 to 5 percent of all children. Difficulties with attention, inhibition, and/or hyperactivity characterize children diagnosed with this disorder. What is much less well known is the probability that many children who have ADHD will still have the condition as adults. It has been estimated that between 30 percent and 70 percent of children with ADHD continue to exhibit symptoms in the adult years (Silver, 2000). As symptoms of the disorder persist, impairments in major life activities such as education, social relations, and occupational functioning often result (Barkley, 2004; Weiss, Hechtman, 1993). The relationship between another major life activity, driving, and children with ADHD followed to adulthood has been explored.

Studies of children with ADHD who have hyperactivity and impulsivity symptoms that continue into adulthood have been found to be at increased risk for traffic citations and automobile crashes (Thompson, Molina Pelham, Gnagy, 2007). They exhibit poorer impulse control, attention, motor coordination, less safe driving habits, and more impulsive errors while operating a vehicle as young adults (Fischer, Barkley, Smallish, Fletcher, 2007). Adults who had ADHD as children and continue to experience symptoms as adults are also more likely to drive in a risky manner, receive traffic citations, and be involved in crashes (Thompson et al., 2007).

It is easy to imagine how the characteristics of ADHD would predispose adolescents to drive in a risky manner. Inattention is a major contributor to driving errors and is especially problematic among adolescent drivers with ADHD. Teen drivers with ADHD have 2 to 4 times higher incidence of collisions (Barkley, Guevremont, Anastopoulos, DuPaul, Shelton, 1993; Barkley, Murphy, Kwasnik, 1996; Barkley 2004), are 4 times more likely to be at fault in the collision (Barkley et al., 1993), and are more than 3 times more likely to receive injuries as a result of the collision (Murphy, Barkley, 1996) compared to their peers without ADHD. They are also more likely to have driven an automobile illegally before the time they became eligible as licensed drivers. Teens with ADHD also report that they are less likely to employ safe driving habits, more likely to have experienced license suspension and/or revocation, and receive repeated traffic citations, most notably for speeding (Barkley, 2004).

Clinical evidence suggests that ADHD adolescents are more likely to be inattentive while driving an automatic rather than a manual transmission. Cox and associates (2006) examined this issue in a sample of teens with ADHD, and concluded that driving a manual transmission may help teens with ADHD to maintain their attention on the process of driving, with the task of manually changing gears either preventing their attention from drifting away from driving or by refocusing their attention back to driving when changing gears was required. The processes involved in driving a manual transmission, such as controlling the clutch, gas pedal, and gear shift during times when the speed of the vehicle is changing, may help young drivers with ADHD stay attuned to the driving task at times when vehicle control is highly important. More research in the area of teen drivers with ADHD is needed to examine effects of medication for treating ADHD on enhancing or diminishing driving performance, and to identify additional methods of improving the attention and driving performance and reducing the driving risks among this high risk population.

Impaired Driving

Drink/Driving

Drink/driving (i.e., driving after consuming any alcohol) is a considerable threat to teen novice drivers, however, this is not due to high rates of drink/driving. On the contrary, teens are less likely than older drivers between the ages of 21 and 55 years to drink/drive. However, when teens do drink and drive, their risk of being involved in a motor vehicle crash is greater than that of older drink/drivers (Gonzales et al., 2005; Mayhew, Donelson, Beirness, Simpson, 1986; Williams 2003). There are several factors that are likely to play a role in moderating the risks associated with drink/driving, including differences in how adolescent and adult brains are affected by alcohol, that teens are inexperienced in both drinking and in driving, and that when teens drink, they are more likely than adults to drink large amounts (Centers for Disease Control and Prevention, 2002; Williams 2003; Zador, Krawchuk, Voas, 2000).

The age of drinking onset has been shown to correlate with several negative alcohol-related outcomes, including a greater risk of developing an alcohol use disorder. Another negative outcome associated with earlier onset of drinking alcohol is a greater likelihood to drink/drive and ride with a drink/driver (Zakrajsek, 2006), with earlier onset predicting 1.6 to 2.2 times higher odds of participating in these two behaviors, respectively (Lynskey, Bucholz, Madden, Heath, 2007).

Greater alcohol consumption and higher levels of heavy-episodic drinking have also been shown to be related to an increased likelihood of drink/driving among young drivers, as has cannabis use (Asbridge et al., 2005; Lewis, Thombs, Olds, 2005; van Beurden, Zask, Brooks, Dight, 2005). However, conflicting findings have emerged regarding the manner in which alcohol consumption is associated with drink/driving among young drivers. One study found that the effects of all predictors of drink/driving behavior were mediated through consumption (Walker, Waiters, Grube, Chen, 2005), while other research has shown that several variables have both direct and indirect associations with drink/driving, and remain significantly associated with drink/driving even after models have been adjusted for alcohol use. Specifically, lower perceived risk of drink/driving, greater social support for drinking and drink/driving, greater aggression and delinquency, more cigarette smoking, and more risky driving behavior uniquely predicted drink/driving in models adjusted for alcohol use (Bingham, Elliott, Shope, 2007).

Riding with a drink/driver has been reported by one fifth to one quarter of teens. Riding with a drink/driver is associated with lower family SES, rural residence, substance use, driving under the influence, lower school support, higher quantity and frequency of drinking, more cigarette smoking, more drug use, and less safety belt use, as well as neighborhood characteristics, including prevalence of driving under the influence of alcohol and low educational attainment (Poulin, Boudreau, Asbridge, 2007; Sabel, Bensley, Van Enwyk, 2004).

Personality characteristics related to greater sensation seeking and aggressivity have also been found to be related to higher rates of voluntary risk-taking, including drink/driving (Begg, Langley, 2004; Guilliver, Begg, 2004; van Beurden, Zask, Brooks, Dight, 2005). Teen drink/driving and riding with a drink/driver are also associated with teens' normative beliefs regarding other teens' experience with these behaviors (Nygaard, Waiters, Grube, Keefe, 2003).

Several factors are related to lower rates of drink/driving among teens and young adults. One is zero-tolerance laws. Following the implementation of zero-tolerance laws, there have been substantial increases in the arrests of underage drink/drivers, especially those with low BACs. Underage offenders are also much more likely to receive alcohol-related convictions and/or license suspensions (McCartt, Blackman, Voas, 2007). Clearly, increased enforcement of drink/driving laws and the perceived risk of being caught if one does drink and drive both reduce teens' likelihood to drink/drive (Bingham et al., 2007; Nygaard et al., 2003). In addition, lower alcohol outlet density, including both on- and off-premises licensed establishments, is associated with both drink/driving and riding with drink/drivers (Treno, Grube, Martin, 2003).

Drowsy Driving

Changes in the circadian system and sleep-wake processes during puberty have substantial influences on teens' sleep patterns. While there is no evidence suggesting that teens need more sleep than adults, there is good evidence that their circadian rhythms shift slightly later, so that it is more natural for teens to go to bed later at night, and wake up later in the day than adults (Jenni, Achermann, Carskadon, 2005). These changes in sleep patterns have the potential to result in excessive sleepiness, poorer mood regulation, lower academic performance, learning difficulties, school tardiness and absenteeism, and accidents and injuries (Carskadon, Acebo, Jenni, 2004; Wolfson, Carskadon, 1998). This is especially true because traditional school start times result in teens arising earlier than they would choose, even though they regularly follow their natural inclination to go to bed later at night. The resulting sleep deficit contributes to teens increased risk of motor vehicle crashes due to drowsiness (Carskadon, 1999; Groeger, 2006).

Getting more versus less sleep is predictive of involvement in motor vehicle crashes among teens, and combining the tendency to drive alone with driving while drowsy further increases crash risk (Hutchens, Senserrick, Jamieson, Romer, Winston, 2008). Young adult drivers also often drive while they are sleepy. Although the safety outcomes for young adults are identical to those of teens, the causes are distinct, with sleep deprivation being more often related to schedules around school, work and family. Although young adults are aware of the risks associated with driving while drowsy, many of them ignore this risk (Smith, Carrington, Trinder, 2005).

Technology Measurement and Safety

Driving Exposure

Urban sprawl and living in remote rural areas both result in teens living in those locations driving more miles than teens living in more compact residential areas. Based on the National Household Travel Survey teens, overall, drive an average of 16 miles per day, but teens living in population-dispersed counties are more than twice as likely as teens living in population-compact areas to drive more than 20 miles per day (Trowbridge, McDonald, 2008).

Clearly, more driving, both in terms of time spent driving and miles traveled increase teen drivers' exposure to driving risk, and results in a greater chance of crash involvement. While the association between exposure and crash risk is true of all age-groups of drivers, it is most especially true for teens who are still maturing and developing the skills required to drive safely; hence, exposure is an important factor in understanding teen crash risk. However, driving exposure is difficult to measure accurately. When teens are asked to estimate their exposure, they consistently underestimate how far they have driven, and how much time they have spent behind the wheel. However, if provided with a structured means of measuring driving exposure, such as a mileage log or a driving diary, the accuracy of teens' self-reports of exposure is increased, but still biased in the direction of under-reporting (Leaf, Simons-Morton, Hartos, Northrup, 2008).

Due to the difficulty in accurately measuring crash risk, especially in large sample, two methods are often used to estimate crash rates that reflect driving exposure at the group level, rather than the level of the individual driver. Denominators that are commonly used in transportation research are total vehicle miles traveled (VMT), and per capita (i.e., licensed drivers, total population). Fatal crash rates provide different information depending on the way they are calculated. VMT is a measure of the total miles traveled on a specific roadway, or by a population on all roadways. The most common means of estimating VMT are: 1) with traffic count sensors that record the number of vehicles traveling a specific segment of roadway; 2) using traffic flow models that take into account variables such as housing and employment patterns and roadway capacities; and 3) based on area fuel use data. The Environmental Protection Agency recommends the use of vehicle count data to obtain reliable estimates of actual VMT (Vadlamani, 2005). If population VMT estimates are to be made, roadway segments are selected at random using a complex sampling design to obtain measures that are representative of the population. Because of the manner in which VMT is typically measured, rates based on VMT have limited application in comparing the driver safety of different groups. This is because, while crashes can be accurately identified by group (e.g., age, sex), the contribution of each group to the total VMT cannot be determined. Therefore, between group comparisons using VMT are useful in demonstrating the total contribution to crashes for a group given total VMT for all groups.

Per capita-based crash rates are useful in understanding the relative per person contribution to crash rates. Per capita crash rates provide a more sensitive measurement of group differences in crash rates, as both the count of crashes, and the count of population members can be subdivided by group. Comparisons of men's and women's crash rates per population of licensed drivers for example indicate the crash rate for each group, given that groups' size.

While useful for certain purposes, such as measuring the contribution to the total volume of crashes, rates based on VMT and per capita are not useful measures of exposure for understanding the contribution of individual driver behaviors to crash risk. Crash rates per VMT tell us that men contribute more to the total number of crashes than women, but this could be due to men driving more than women, or there being more men who are drivers than there are women drivers. Likewise, crash rates per licensed driver accurately indicate that men contribute more to the total number of crashes when the number of men is held constant, but this may be because men drive more, either in time or distance, than women.

A third method of estimating crash rates that allows some insight into the contribution of individual drivers to crash risk used person miles driven (PMD) as the denominator in rate estimation. This can be accomplished using exposure data from nationally representative samples, such as the National Personal Travel Survey and the National Household Travel Survey to derive aggregate estimates of person miles driven by specific groups, such as 16-

year-old women living in the northern Midwest region of the US. This approach to crash rate estimation yields results that look very different from rates estimated using other methods, and provides a better estimate of individual crash risk. For example, using this method, male teen drivers in Michigan had a crash rate of 14.92 per 100,000 PMD and female teen drivers had a rate of 22.49 per 100,000 PMD between 1989 and 1996, which would be interpreted as about 15 crashes involving teenage males for every 100,000 miles driven by all teenage males, and teen females crashing about 23 times in every 100,000 miles driven by all teenage females (Bingham et al. 2007; Bingham, Shope, 2007). These rates indicate that the crash rate per PMD, and therefore the crash risk, is about 50% greater for teenage female drivers than it is for teenage males. While rates based on VMT and per capita show that teenage males contribute more to the total volume of crashes than do teenage female drivers, rates per PMD demonstrate that female drivers in the sample used for this example actually experience greater crash risk per mile driven.

In spite of its benefits, estimating rates based on PMD is limited by the availability of driving exposure data in miles driven for the population in question. Rates per PMD are further limited because they provide only aggregate data, not individual data. As a result, rates per PMD are not useful for the study of individual driving behaviors, and yet, if we are to make meaningful headway in reducing teen crash risk, accurate measures of individual exposure are necessary so that the effects of programs and interventions on individual crash risk can be measured while holding constant the level of driving exposure. Recent advances in technology are providing new alternatives and more accurate methods of measuring individual drivers exposure, both in terms of miles driven and time spent driving. A variety of after market devices are now available for purchase at relatively low cost that use data captured from the OBD II Buss Port on modern vehicles to take accurate recordings of exposure in terms of distance traveled and time spent on the road. Many of these devices are still limited in their accuracy if a single vehicle is used by multiple drivers, as it is impossible to tell how many of the miles recorded were driven by which driver, but even this limitation is surmountable with available technology that could be used to link the identity of the driver with the exposure record (e.g., photographic or video record, key fob, key chip). If such approaches to recording exposure can be used in research, the ability to draw conclusions about driving risk and how to reduce it will increase, providing the information needed to develop and evaluate policies, programs, and interventions that accurately target specific risk factors contributing to teen crashes.

Belt Use

It is widely known that teens have the highest motor vehicle crash (MVC) rate of any age-group. What is less often recognized is that teens also have the lowest rate of safety belt use of any age-group. Together, these two characteristics of teen drivers contribute significantly to the number of MVC-related injuries, both fatal and non-fatal, suffered by teens each year, and are largely responsible for MVCs being the leading cause of morbidity and mortality among teens.

The effectiveness of safety belts in protecting motor vehicle occupants from MVC-related injury and death is well established, with reductions in fatality ranging from 35% to 73%, depending on vehicle type, seating position, and point of impact (NHTSA, 1999; 2000). By taking the simple precaution of fastening their safety belts when riding in motor vehicles, teens can significantly reduce their risk of injury, disability, and death; yet, many teens choose not to buckle this life-saving device.

In 2005 (NHTSA, 2006), safety belt use by teens over age 16 years averaged approximately 10 percentage points lower than both adults, and children ages 8-15. In 2005 (NHTSA, 2006), teens were killed at a rate nearly four times greater than adults ages 25 through 69. The tragedy is that nearly two-thirds of teens killed or injured in MVCs in 2005 were not wearing safety belts at the time of their crashes (NHTSA, 2006). Clearly, failure to use safety belts is a significant contributor to teens' high rates of MVC-related injury and death.

What is completely unclear from the extant data is at what point during the second decade of life decreases in teen safety belt use occur. Observational studies of safety belt use conducted nationally often combine young teens ages 13-15 with children ages 8-12. What is observed, perhaps as a result of this grouping, is that rates of restraint use are high for the 8-15-year-old group, typically matching adult use rates, while rates for the 16-20-year-old group are substantially lower. As a result of these age groupings, it is impossible to ascertain whether safety belt use is already declining before age 16, or whether rates are high until teens reach 16 years of age, at which point the rates change rapidly.

Gradual declines in use during the second decade of life may be due to multiple developmental factors, including changes that adolescents experience in cognitive functioning, greater autonomy from parents, increased moral reasoning, a greater sense of identity and sense of self, not to mention extensive brain development and physiological maturation. Adolescence is also when people typically learn to drive. The advent of driving might result in sudden changes in belt use as teens transition from full-time passengers to part-time drivers of motor vehicles, decreased direct parental supervision of in-car behavior as teens begin driving independently and/or riding with peers who are independent drivers. Where program design, development, and delivery are concerned, the poor understanding of the timing and reasons for changes in safety belt use that occur during the teen years constitutes a critical knowledge gap. The age groupings commonly used in research effectively mask the risk to young teens, making it impossible to determine which teens should be targeted, and with what techniques (e.g., age/development-appropriate, type of message, purpose of program, etc.). This information is vital, as programs are most effective when they are carefully tailored for the target audience, and poorly targeted programs can result in low effectiveness, both economically and in terms of changing target behaviors.

Another gap in the knowledge base is teens' reasons for safety belt use, non-use, and what factors would motivate teens to wear their safety belts more consistently. Available research identifies a variety of situational factors that are related to teen safety belt use and non-use. For example, teens are less likely than adults to use safety belts when driving/riding in higher risk situations, such as after drinking (Spain et al., 1997). Teens' safety belt use decreases as the number of vehicle occupants increases, even when the number of occupants does not exceed available belted seating positions, and unbelted occupants place themselves and other occupants at risk of injury by being unbelted (Cummings, Rivara, 2004; MacLennan, McGwin, Metzger, Moran, Rue, 2004). Vehicle occupants have an especially dramatic rate-lowering effect on safety belt use if they are in their teens and 20s (Williams, Shabanova, 2002), while teens are most likely to wear safety belts when riding with occupants age 30 or older. However, riding with an adult does not guarantee safety belt use, as shown by a study in which only 46% of teens riding with an adult occupant were wearing safety belts (Williams, 2001; Miller, Spicer, Lestina, 1998).

Sex, SES and age are consistently related to safety belt use, with male boys having lower rates than girls, and higher SES teens having higher use rates than lower SES teens (NHTSA, 2006, 2005a, 2005b; McCartt, Northrup, 2004; Shin, Hong, Waldron, 1999; Williams et al., 1997; Williams, Shabanova, 2002).

Studies have also suggested that failure to perceive risk is apparently not a factor that reduces safety belt use by teens. Indeed, teens can accurately rate risk based on road type, potential consequences of a crash, usefulness of safety belts, self responsibility, warning of a crash, dangerous driving behavior, and sex of the driver. Nevertheless, these perceptions, although correct, do not predict teens' safety belt use (Calisir, Lehto, 2002).

Reasons for safety belt use and non-use have been studied among adults (Eby, Molnar, Kostyniuk, Shope, Miller, 2004) and in some cases teens age 16 and older have been included (NHTSA, 2004). Common reasons given for safety belt use include safety enhancement, ticket and fine avoidance, setting a good example for children, because it's the law, pressure from others, crash involvement, because it's a habit, and while driving after drinking. Reasons for non-use include discomfort, forgetting, driving a short distance, personal independence/not wanting to be told what to do, belief that safety belts increase injury risk, low perceived crash risk, and simply not wanting to wear a safety belt.

While informative, these research results do not provide several pieces of information that are necessary if effective programs are to be developed. First, most of the research on reasons for use and non-use has focused on adults. Second, research that included teens neither focused on teens separately from adults, nor provided reasons for safety belt use/non-use unique to teens.

It is clear that a greater understanding of teen safety belt use and the factors that influence that behavior are urgently needed so that teens' fatal and nonfatal injuries from MVCs can be prevented. More research must be conducted so that effective teen-specific intervention and/or policy programs can be developed using a sound basis of empirical data.

Electronic Monitoring

Electronic devices to monitor teenagers' driving are becoming increasing available. These devices are often promoted as helping keep teen drivers safe by increasing parents' ability to monitor them. Many of these devices were initially developed for use by fleet operators, but have transitioned to also cater to parents; however, recently devices have increasingly been developed specifically for the teen driver market. One teen driver monitoring device has been studied. Twenty-six teen drivers, 12 male and 14 female, between the ages of 16 and 17 and their parents participated in the study. An event-triggered device was installed in each teen participant's vehicle. The palm-sized device integrated two video cameras (forward and interior view), a two-axis accelerometer, a 20-second data buffer, and a wireless transceiver. Audio and video data were continuously captured and temporarily stored in the video buffer. Lateral and longitudinal acceleration, date, and time were also recorded. When acceleration due to lateral, longitudinal, or shock exceeded a pre-set threshold, the device captured 20 seconds of data (10 seconds before the event and 10 seconds after) from the data buffer and stored it in the device's memory. The events stored in the device's memory were automatically downloaded via a secure wireless connection whenever the participant parked in the high school parking lot. The downloaded data were sent to a laboratory for coding. Data were collected in three phases over the course of 1 year: Baseline; intervention; second baseline. A CD containing video clips of all safety-relevant events from the intervention phase with a graphical 'Report Card' was mailed to the parents/guardians and teens at the end of each week. Incidents were described briefly and suggestions were given for mitigating the unsafe behavior where appropriate, and graphs of the participant's safe driving performance and seatbelt use were provided. Parents were asked to review each video clip with their teen and discuss the information provided. Results showed a rapid decline in the number of events following the installation of the device in the teens' vehicles, suggesting that combining this technology with parental review of safety-relevant incidents may be associated with significant decreases in events (McGehee, Raby, Carney, Lee, 2007). These results, while promising, are highly preliminary, in that neither participant selection nor group assignment were randomized and the study did not include a control group condition. Several alternative explanations of the observed decline in event frequency exist, and remain to be tested. One is that the observed decline was a result of the natural rapid decline in teen driver risk that occurs during the first months and years of licensure (see Figures 2 and 3) (Mayhew et al., 2003; McCartt et al., 2003).

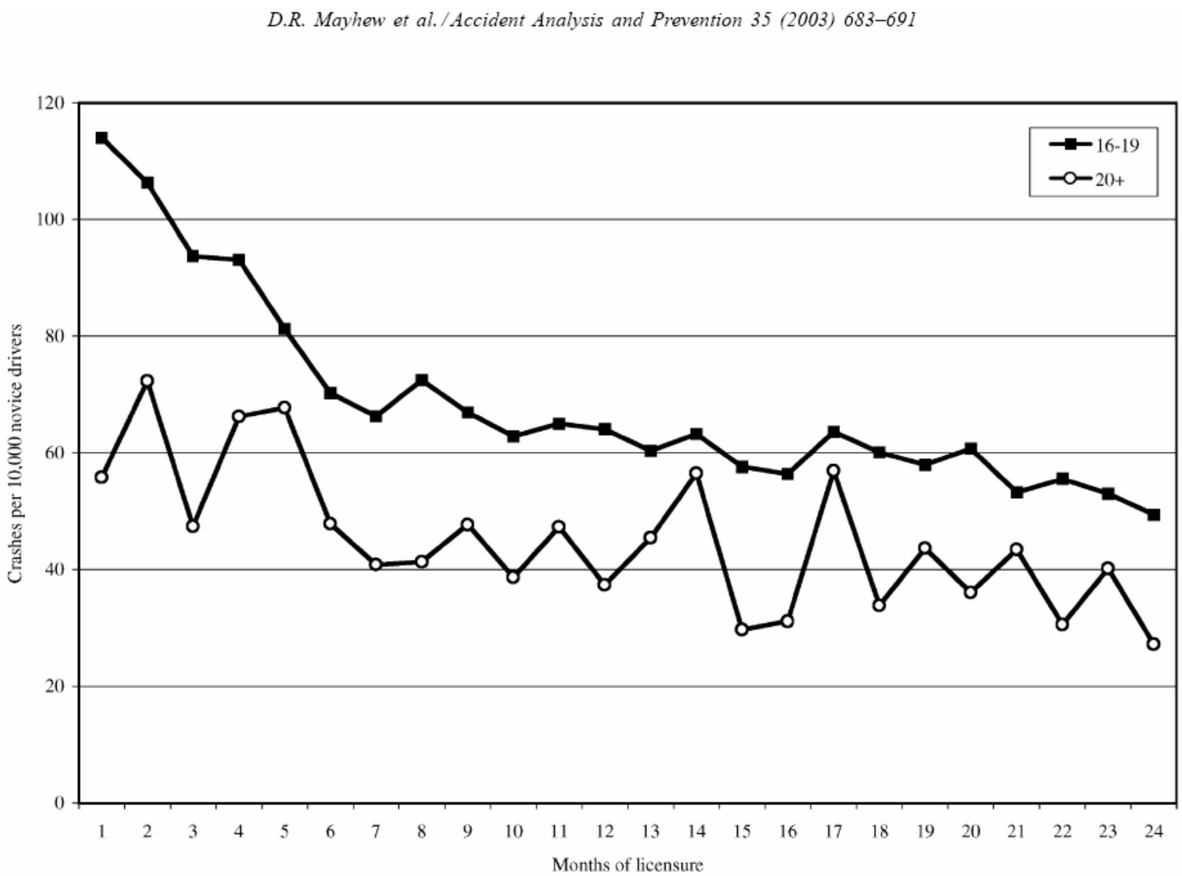

Figure 2. Crash rates of 16-19 year olds compared to drivers over 20 years of age by month of licensure.

Devices that provide data such as acceleration, deceleration, braking, speeds and miles driven without video footage are unlikely to be helpful to parents. Without video data, it would be impossible for a parent to tell if a particular acceleration or deceleration represented risky driving, or resulted from the teen maneuvering to avoid a traffic hazard, such as hard braking to avoid a vehicle that pulled out in front of the teen. Without a video record there would be some useful information in the record of the vehicle's velocity, but it would only be useful for velocities at the high end of speed limit ranges to which a particular teen is exposed. At lower speeds the information would be impossible to interpret. Parents would be unable to determine if a record of the teen driving at 45 mph occurred in a zone with a speed limit of 45 mph or greater, or whether it occurred in a residential area or school zone. Hence, parents should probably not be encouraged to use devices that do not capture some sort of video or photographic record of the events in question.

Resent research found that most parents are not in favor of using electronic devices to monitor their teens' driving (McCartt et al., 2007). However, if parents do choose to use a device that captures video data they should be encouraged to respect their teen's privacy by selecting a device that would only record when triggered. In this way, the teen maintains some control over their privacy. Parents should also be encouraged to use the video record as a coaching and teaching tool and not as a means of identifying and punishing misbehavior.

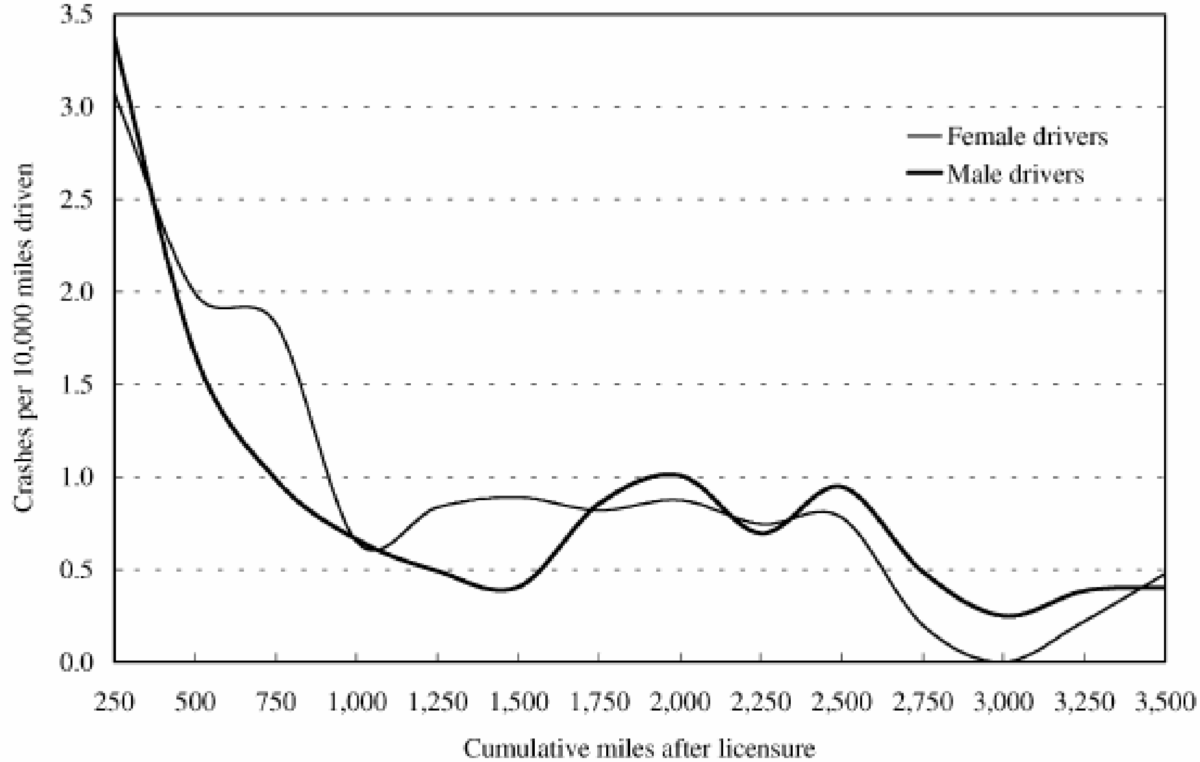

Figure 3. Crash rates of male and female teenage drivers by cumulative miles driven after licensure.

Parents choosing to use a video data recorder in their teens' cars should also consider the potential risks and benefits of having their teens' driving events recorded. In the event of a crash, the record could be subpoenaed to provide strong evidence that the teen was at fault. On the other hand, the video footage could be used to exonerate the teen if s/he were not at fault. One final issue that is relevant where data recording devices are concerned is the trust between parent and teen and the teen's development of trustworthiness. If used inappropriately, data recording devices could erode trust between parents and their children and interfere with the teen's development of trustworthiness.

Safety Enhancements

Electronic safety systems are becoming increasingly common in new vehicles. These include electronic stability control, collision avoidance systems, intelligent speed adaptation, and vehicle tracking systems, as well as others that are currently under development (Brovold et al., 2007; Lee, 2007). Many behaviors that contribute to teen crashes, such as speeding, low safety belt use, and alcohol impairment could be addressed using in-vehicle technology. Certain technologies may also be able to address issues related to teen drivers' inexperience (Brovold et al., 2007). The acceptability of technologies that address these issues were examined with focus groups of Australian novice teen drivers. The participants indicated that alcohol interlocks and seat belt reminders were the most acceptable technologies, while fatigue warning, intelligent speed adaptation and lane departure warning were the least acceptable (Young, Regan, Mitsopoulos, 2004). These issues should be considered as new safety technologies are introduced so that they can be made more acceptable and more effective with teen drivers.

New Standard Technology

There has been little evaluation of electronic systems and devices intended to increase driver safety to determine whether or not it has the intended effect for teens. New technology intended to enhance driver safety is not systematically tested with young drivers by the industries that develop these devices. This omission could inadvertently result in safety systems being placed in vehicles that actually have detrimental effects on teen driver safety. Just as passengers have a neutral or slightly positive safety advantage for adults, but reduce teen driver safety dramatically (Chen et al., 2000), technology that enhances adult driver safety may also have unintended negative effects for novice teen drivers.

SYNTHESIS AND CONCLUSIONS

In this section we draw upon the literature, topics and issues just reviewed to identify high priority areas for future research. These areas will be identified using three criteria: 1) involves issues that contribute to conditions either resulting in or preventing large numbers of teen crashes and related injuries; 2) includes issues that contribute to or reduce the current disparity between rates of teen and adult driver crashes and crash-related injuries; 3) the contributing factors can be modified through policies, programs, or interventions, or can contribute meaningfully to the design of effective policies, programs, and interventions.

One area that could contribute greatly to reduced crash-related morbidity and mortality among teen drivers and their passengers includes the currently available policies, programs and interventions that have shown effectiveness in reducing risky driving by teens. As already reviewed, GDL has consistently resulted in clear declines in teens' involvement in the most serious crashes, and there has been little evidence that there are any unintended negative consequences of this very effective program. Yet, there are directions that research should take to enhance this program's effectiveness. One is to identify the mechanisms through which GDL exerts its positive effect on teen crash involvement. From a public health perspective it's wonderful to have a program that works, but the research cannot end there. Looking ahead, research must lead to an understanding of how the program has its effects so that this knowledge can be used to enhance and build upon the most important life saving processes that result from GDL.

GDL is highly reliant on parental involvement. The current point in history is far from the time when the state accepted the responsibility of teaching teens to drive, with a great deal of responsibility now being rightfully placed on parents. Parents of teens who are learning to drive are now asked to take a lead position in training their children, shaping their attitudes, helping them develop skills that contribute to safe driving, and then monitoring their teenage children's driving to ensure that the highest risk driving conditions are avoided. Programs such as Checkpoints have shown the feasibility of influencing teen driving behavior and outcomes by increasing parental involvement in the teens' driver training. Intervention development and evaluation research in this area should be vigorously pursued. The research indicates that parents are not opposed to GDL or its restrictions, and are not averse to being involved in training their teens to be safe drivers. What does seem to be the case is that parents need to know how to approach this process. Programs and interventions that give parents the tools and instruction needed to make an effective contribution to their teens' driving safety should continue to be pursued, and translation research that moves these programs and interventions into sustainable components of the driver licensure process for teens need to be found.

In all of this, research to better understand parents' attitudes and needs surrounding issues related to teen driving is also needed. There is apparent resistance to the imposition of stronger restrictions as part of GDL laws and programs, but to what extent this is a result of what parents, as constituents, really want, or is actually a result of political agendas existing in state governments is not completely clear. There is currently evidence that parents are supportive of GDL restrictions, but greater understanding of parents' attitudes and needs is essential for the development of public education programs to provide parents with more accurate information, the initiation of advocacy to bring parental desires for stronger restrictions to the attention of state legislatures, and the ongoing evolution of GDL programs so that they address parents' needs as well as teen driver safety. Public opinion research to generate knowledge and understanding in this area is needed.

Driver education currently appears to be an utter failure as a driver safety program. While it accomplishes some outcomes very well, such as providing teens with the information they need to pass licensure exams, it does not seem to improve their safety as novice drivers. Multi-disciplinary research in this area is vital for the enhancement of teen driver safety. The solutions that would come out of such research are unclear, but what does seem apparent is the need to change the driver training process so that it incorporates elements that have clear positive effects on teen driver safety. Knowledge from other disciplines, such as education and public health, and approaches and methods from those fields to educate, promote the development of skills necessary to accomplish complex tasks, and to guide and modify behaviors have, so far, been largely ignored in the design and development of driver education programs. Future research should focus on changing this situation. Mandatory driver training programs that are effective in improving teen driver safety and decreasing crash involvement would have the potential of preventing hundreds of thousands of injuries every year, including thousands of fatal injuries that result from crashes involving teen drivers.

Research on policy, program and intervention efforts to address the risks posed to teens by teenage passengers, drink/driving, and the non-use of safety belts must continue. The best approaches for limiting teen driver distraction resulting from passengers are needed. Program development and evaluation research should continue to vigorously explore ways to further reduce underage access to alcohol, and teen drink/driving. Similar research is needed to better understand reasons why teens do not use safety belts and then develop and evaluate programs that will address these issues and effectively increase teen safety belt use so that it is on par with adult use.

Technology, whether it's onboard or nomadic, factory-installed or after-market needs to be the focus of research to identify and quantify its negative effects on driver safety, generally, but on teen and young adult driver safety especially, as these younger-aged drivers are, and most likely will continue to be, the most enthusiastic users of new technologies. Based on the research currently available, it would seem that the use of cellphones, hand-held or hands-free while driving, should be completely restricted for non-professional drivers of all ages, while professional drivers that use cellphones and other communication devices as part of their jobs should receive specific training on how to use these devices safely. Research in this area should focus on understanding public resistance to such bans so that resistance can be addressed and reduced through public education programs. Research is also needed on technologies, tools and methods that can be used to effectively enforce bans on cellphone use by non-professional drivers. Finally, research industry and/or others, should examine new standard technology that is to be placed in motor vehicles to ensure that it does not have unintended adverse safety effects on teen drivers.

The backdrop to all of these research foci is the issue of adolescent development. Current understanding of how all levels of teens' development from the broad social/ecological to the narrow focus on specific aspects of brain development and function is important to the design of effective safety policies, programs, and interventions for teen drivers, and is essential to enhance existing effective approaches to increase teen driver safety. Emerging understanding in this area should be applied as it develops. Knowing what makes teens "tick" and applying that knowledge needs to be at the center of all efforts to improve teen driver safety.

All efforts to the reduction of teen driver risk and the resulting crashes and injuries will have to struggle against an ideology that says driving is a right, and not a privilege. Perhaps current events and conditions, including global warming, efforts to address that issue, and rapidly rising fuel prices will change this ideology, but so also should driver safety programs convey this message. If driving is seen as a privilege, resistance to restrictions that enhance safety and public well-being will be lessened, and progress will be much easier to achieve.

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