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Young Impaired Drivers: The Nature of the Problem and Possible Solutions

A Workshop
June 3-4, 2008
National Academy of Sciences Jonsson Conference Center
Woods Hole, Massachusetts USA

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Acknowledgment

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A special thank you to Kathryn Stewart, Chair of the TRB Committee on Alcohol, Other Drugs, and Transportation, for organizing this workshop and preparing this e-circular.

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FOREWORD

Young drivers pose particular risks in traffic – especially when they are impaired by alcohol or other drugs. Many different factors are linked to the problem of young impaired drivers: access to alcohol and drugs, access to vehicles, cultural characteristics, and the geography of a given area. In order to explore the risks posed by young impaired drivers and how these risks might be ameliorated, the Alcohol, Other Drugs and Transportation Committee of the Transportation Research Board convened a workshop to discuss these issues as they relate to traffic safety in the United States, Canada, Europe, and Australia. The workshop was held on June 3-4, 2008 at the National Academies' Jonsson Conference Center in Woods Hole, Massachusetts. This report provides an overview of the information presented and the discussions among the participants as well as the background papers prepared for the workshop.

OVERVIEW AND SUMMARY

KATHRYN STEWART
Safety and Policy Analysis International

INTRODUCTION

The US and many other countries have been stalled for several years in efforts to reduce the toll of impaired driving. Focusing on specific high-risk populations may be one way to gain a better understanding of the problems we face and better guidance regarding possible strategies for reducing risk. One population that poses particularly high risk as well as unique problems is young drivers. High crash risk for young drivers starts at the youngest age when drivers are just learning and extends into the mid twenties.

In a two-day workshop, the TRB Committee on Alcohol, Other Drugs and Transportation brought together experts from around the world to discuss issues related to alcohol and drug impairment among young drivers (16-24). The workshop covered the nature of the impaired driving problem among young drivers as well as a range of strategies to reduce the problem.

This Circular provides an overview of the workshop as well as the background papers produced for the workshop.

BACKGROUND AND STRUCTURE OF THE WORKSHOP

Young drivers pose particular risks and problems in traffic safety in general. Impairment by alcohol and drugs exacerbates these risks. Lack of experience in driving coupled with immature judgment make additional impairment by alcohol and drugs particularly dangerous. Compared to older drivers, teens drink and drive less often, but when they do drive after drinking, they are at considerably greater risk of being involved in a crash. Drugs also play a role in crashes among young drivers. The workshop was designed to shed light on the risks posed by young drivers. In order to get a fuller picture of the impaired driving problem among high risk young drivers, the workshop included discussion of young drivers who are under the legal drinking age of 21 (in the US) as well as those drivers slightly older than 21 who can legally drink. It also included discussion of the impaired young driver problem in Canada, Europe, and Australia, which have lower drinking ages as well as other differences in their legal, cultural, and geographic characteristics.

The workshop brought together experts from the U.S., Canada, Germany, and Australia to summarize and synthesize information about the risks posed by young impaired drivers: the particular factors that contribute to risks among young drivers, the characteristics of typical crashes, and the variations among different groups. Experts also discussed strategies that can be used to prevent young impaired driving and the resultant crashes. These strategies include long established legal and enforcement approaches as well as new technologies that have the potential to improve traffic safety among young drivers.

Attending the workshop were committee members as well as invited experts. Background papers on a range of related topics were commissioned to structure the discussion. These papers were presented and discussed by workshop participants who helped identify unifying themes and promising approaches. A copy of the workshop agenda appears in Appendix A. A list of participants appears in Appendix B. The background papers prepared for the workshop appear in the next section.

Overview of Discussions

Crash Risk Posed by Young Drivers

Until they reach their mid to late twenties, drivers have a higher crash risk, especially when crashes are adjusted for exposure. After the drinking age was changed to 21 in the U.S. in the 1980s, alcohol related crashes declined dramatically among drivers under 21. Thus, establishing the minimum drinking age at 21 in the U.S. has been successful in reducing alcohol impaired traffic crashes. Significant impaired driving risk remains for young drivers over 21 and when adjusted for exposure, impaired drivers under 21 are very dangerous.

Currently, when adjusted for exposure, 21-29 year old drivers in the U.S. are at highest risk for drinking driver fatalities. When drivers drink, however, the risk of crashing is much higher for the younger drivers. For example, at a BAC of .07, the relative risk of crashing is nearly 11 for drivers under 21, that is, 11 times greater than for unimpaired drivers. For driver over 21 at .07, the relative risk is 2 (that is double the risk of unimpaired drivers). That is, at a BAC of .07 (which is lower than the legal limit of .08 for drivers over 21 in the U.S.), drivers under 21 are more than 5 times more likely to be involved in a crash than drivers over 21.

The characteristics of crashes involving young drivers differ from those involving older drivers in some important ways. For example, crashes involving alcohol, speeding, and carrying of passengers are about 20 times more likely for teens than for middle aged adults. Crashes occurring at night and involving both alcohol and passengers are about 9 times more likely.

The Young Driver Problem in Australia

The situation of young drivers in Australia can be viewed in the context of its licensing system for novice drivers. Australian jurisdictions require the licensing of young drivers at a relatively late age (typically at a minimum age of 17 years old) and impose a number of specific restrictions not commonly seen in graduated driver licensing approaches in other countries. These provisions include relatively long maximum tenure of learner and provisional licences with the aim of reducing any pressure for novice drivers to progress to later licence stages through licence expiry; requirements for display of a unique identifying plate on the vehicle driven to indicate licence status to other drivers, road users and to police; speed restrictions according to licence category; and a zero alcohol requirement. The minimum purchase age for alcohol in Australia is 18.

Alcohol is the most common drug found in traffic crashes, but the indicators for drug driving are cause for concern. Overall, drivers aged 16-25 years old comprise 16% of all licensed drivers in

New South Wales, but these drivers are involved in 31% of fatal road crashes. Moreover, a drink driver aged 17-25 years is involved in 38% of all fatal crashes where alcohol is involved.

The most prominent strategy for combating impaired driving among all age groups in Australia in recent years has been vigorous enforcement, in particular, random breath testing. Interventions to address drug driving are less common, but include the recent introduction of random roadside drug testing.

The Young Driver Problem in Europe

In Europe, the drinking age is much lower than in the U.S., with most countries allowing drinking at 18 or even younger for some beverages and in some circumstances. In addition, little emphasis is placed on enforcing the drinking age. The legal age of driver licensure tends to be higher than in the U.S – typically 18. Most European young people have much less access to vehicles even after they are old enough to hold a drivers license.

Uniform statistics from country to country are difficult to find, but it appears that young people are at almost twice the average risk of being killed in a road accident compared to the average member of the respective population across the European Union countries. With the majority of the young people killed being drivers. Countries in the EU are beginning to recognize that binge drinking among young people is an increasing problem.

Legal Strategies for Reducing Impaired Driving Among Young Drivers

The dominant strategy for improving the safety of young drivers in many countries around the world has been graduated licensing laws. These laws provide a staged licensing system by which young and novice drivers are restricted in early stages with regard to how and when and under what circumstances they drive. They are allowed increasing independence and flexibility as they gain more experience. Three elements that contribute most to the effectiveness of graduated licensing are minimum holding periods at each phase of licensure, nighttime restrictions on driving, and restrictions on carrying passengers. Also key to these systems are laws prohibiting any use of alcohol during the learning and probationary phases of licensing (zero tolerance). Graduated licensing and zero tolerance laws have been shown to be highly effective in reducing crashes among young drivers. Studies consistently show a 12-40% reduction in crashes among affected drivers. In the U.S., no state has implemented what has been shown by research to be the ideal package of graduated licensing features. The primary ways that have been identified to improve state systems would be to lengthen learner periods, require more supervised driving time, start nighttime restrictions earlier in the evening, and reduce number of passengers allowed. Based on the Australian experience, the addition of special plates indicating the status of learner and probationary drivers could be an enhancement of current systems.

In the U.S., as mentioned above, the minimum drinking age of 21 has been a primary legal strategy for reducing impaired driving among young drivers. Dramatic effects of the higher drinking age have been demonstrated repeatedly both on drinking and driving and on other alcohol related harms. There do not seem to be any rebound effects of delaying the drinking age

until 21. That is, similar patterns of alcohol related crashes are found for 21-24 year olds as for 24-35 year olds.

Despite the success of age 21 laws in improving traffic safety and other health and safety outcomes, challenges of the law persist, based on claims that the higher drinking age leads to more clandestine drinking, more binge drinking, and a lack of experience in how to drink responsibly, since all drinking by people younger than 21 is considered illegal. There is no evidence that a lower drinking age would solve any of these problems. In fact, a study of the consequences of lowering the drinking age in New Zealand found that traffic crashes have increased as have other alcohol related injuries and problems. Drinking and associated problems have also trickled down to 15-17 year olds. Several countries in Europe are experiencing serious problems with binge drinking among young people.

Various strategies for strengthening implementation and enforcement have shown promise in further improving traffic safety as well as preventing other alcohol related problems among young people. These include enhanced enforcement of alcohol access laws as well as impaired driving laws, community mobilization to reduce youth access to alcohol as well as to encourage vigorous enforcement, and alcohol regulation that makes alcohol less accessible to youth.

Problems and Prevention in Special Populations: College Students and the Military

College students are at particular risk of heavy drinking and serious consequences, including impaired driving. Heavy alcohol use is much more common among college students than among young people of similar age who are not attending college.

A variety of strategies have been shown to have an impact on heavy drinking among college students. Effects have also been demonstrated on reducing impaired driving among a college population of 16-24 year olds. Strategies included stepped up enforcement of laws against sales of alcohol to minors as well as intensive impaired driving enforcement. In one study, sales of alcohol to minors were cut in half as were the number of drivers found positive for alcohol in roadside surveys. Effects were strong for both 16-20 year olds and for 21-24 year olds.

The military is another population that poses particular problems. Young recruits tend to be risk takers and primarily male. Counterbalancing these risks, the military can maintain tighter control over the environment on bases as well as over the behavior of its members. For example, additional penalties can be imposed on members of the military who violate impaired driving and other alcohol rules. Penalties can include reduction in pay, extra duty, or confinement to base. Alcohol problem prevention programs are often embraced by commanders – who have an important role in setting the tone on bases. Drugs pose a different set of problems in the military. Random drug testing is required and the prevalence of drug use is quite low because of the zero tolerance policy the military has adopted. There is speculation that this policy can push members of the military to use alcohol rather than drugs. The net safety and health effects of such a shift are not known.

The Role of Enforcement in Reducing Impaired Driving among Youth

Enforcement plays a key role in reducing impaired driving among all populations – including young drivers. For example, highly publicized sobriety checkpoints have been found to be very effective in reducing impaired driving crashes. The primary effects of enforcement come from its ability to deter illegal behavior rather than to apprehend and punish people who violate the law.

Recent enforcement campaigns to reduce impaired driving deaths have broadened beyond enforcement of impaired driving laws per se. For example, vigorous enforcement of speed limits in France appears to have reduced crashes among both impaired and sober drivers. When driving speeds are lower, even impaired drivers are more able to avoid crashes and when crashes do occur they are less likely to involve severe injuries. Enforcement of seat belt use laws also has the potential to reduce impaired driving and alcohol related deaths and injuries. Most deaths involving unbelted vehicle occupants occur between midnight and 3 AM – also prime time for impaired driving. Young drivers tend to have lower belt use rates. Thus, nighttime enforcement of seatbelt laws can be effective in encouraging greater seatbelt use as well as deterring impaired driving, if drivers become concerned about enforcement activities in general.

In Australia, enforcement of impaired driving laws is very vigorous across all driver ages. Because of the frequent use of random breath testing, all drivers, including young drivers, perceive a strong likelihood of being detected and punished for alcohol impaired driving. The addition of random drug testing may have a deterrent effect on drug use. Enforcement efforts are amplified by high visibility and publicity.

The Potential of Technology to Prevent Impaired Driving among Youth

A great deal of progress has been made in traffic safety through vehicle design and road design as well as through enforcement and education to change driver behavior. It is possible to use recently developed technologies to make further progress. Some of these technologies are particularly relevant to novice drivers - who may lack skills - and to young drivers, who may lack judgment. The first 1,000 miles of driving tend to be the most dangerous for young drivers. In addition, teen drivers tend to speed more and use seatbelts less than older drivers.

Technology can improve driving performance through three main channels:

- Forcing, that is, designing systems so that dangerous behavior is not permitted. For example, including speed governors on cars of young drivers.
- Feedback, that is, alerting the driver to dangerous behavior, for example when following too close.
- Reporting, that is, alerting parents or other authorities when dangerous driving has occurred.

Some systems are currently available that include some of these features. Others are in development. The most sophisticated systems recognize who is driving the car (e.g., the teen or his/her parents), have a data base that indicates driving context (e.g., the current speed limit), and

report dangerous behavior to an authority (usually the parents). One feature that could be valuable is the ability to prevent use of cell phones or entertainment systems while the young driver is driving.

Other technologies are being applied, usually to young drivers who have already committed offenses. These include continuous alcohol monitoring systems to prevent alcohol use and alcohol ignition interlock devices that prevent the driver from starting the car if they have used alcohol.

Conclusions

Young drivers pose a particular danger in traffic due to their inexperience and lack of mature judgment. Their already high risk is exacerbated by impairment with alcohol or other drugs. These risks occur in the U.S. as well as many other countries. Some predictable characteristics are associated with young driver crashes, including excessive speed, carrying passengers, and not wearing seatbelts.

Much progress has been made in reducing crashes and impaired driving among young drivers. Legal structures have been very important in bringing about this progress. In the U.S., raising the drinking age to 21 brought about a dramatic reduction in impaired driving crashes. Graduated licensing systems, including zero tolerance, have also been very effective. These systems gradually introduce young drivers to more difficult driving conditions and place limitations on their driving behavior.

While existing legal structures and enforcement have been very useful, newly developed technologies have the potential to further reduce risky and impaired driving among young drivers.

SECTION I. THE NATURE OF THE PROBLEM

YOUNG IMPAIRED DRIVER INVOLVEMENT IN FATAL CRASHES

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EDUARDO ROMANO
JIM FELL
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Pacific Institute for Research & Evaluation

INTRODUCTION

There is strong evidence that drivers aged 20 and younger are at increased risk of injury in highway crashes. It is the primary cause of death for that age group and has therefore received special attention from policymakers resulting in several important program and legislative actions, the most significant of which was the enactment by all 50 states of the minimum legal drinking age (MLDA) laws. In individual studies of the MLDA law and its companion law, zero tolerance (ZT) that makes any alcohol in a driver younger than 21 illegal, have been shown to reduce alcohol-related crashes for that age group. Over the last quarter century, alcohol-related crashes for all drivers have substantially declined (Dang 2008). Elder and Shults (2002) reported that between 1982 and 2001 the rate of drinking drivers in fatal crashes per 100,000 thousand population in all age groups declined by 46%. In contrast, the rate for teenagers (15 to 17 years) declined 60% and for youths (18 to 20 years), 55%.

Various explanations have been suggested for the reduction in alcohol-related crashes over the last quarter century. A study by Dang (2008), recently published by the National Highway Traffic Safety Administration (NHTSA), found evidence that two factors were of major importance: (1) demographic changes including the aging of the population and a decline in the proportion of licensed drivers who are males, and (2) the passage of several impaired-driving laws, particularly the MLDA law. Because of the evidence that drivers younger than 21 are at higher risk for involvement in crashes, particularly alcohol-related crashes, the contribution of that age group to the observed reductions in alcohol-related crashes is of special interest. Given the large number of laws and programs initiated during the last quarter century that affect drivers of all ages, there is interest in determining whether youth for whom special "status" laws were enacted benefited more than older drivers did. This topic is relevant to the current controversy over the benefits of the MLDA law. The Dang study found that the MLDA law reduced by 40% the fatal crash involvements of underage drivers with BACs of .08 or higher. The objective of this study is to update the Elder and Shults (2002) study. Because of the complex factors that influence alcohol-related crashes, this report considers several methods, other than population, for calculating crash rates to measure the trend for underage drinking drivers in alcohol-related crashes between 1982 and 2004.

Based on data from the Fatality Analysis Reporting System (FARS; NHTSA 2004) and driver licensing data from the Federal Highway Administration (FHWA; http://www.fhwa.dot.gov/policy/ohpi/qfdrivers.cfm) shown in Figure 1, the number of nondrinking drivers aged 21 and older in fatal crashes has increased with the growing number of licensed drivers in the United States, which increased by 40% between 1982 and 2004. During the same period (Figure 2), there was a smaller (15%) reduction in the number of licensed drivers aged 20 and younger

and a much smaller increase in the number of sober drivers in fatal crashes. For both groups, drinking drivers in fatal crashes declined substantially relative to the 1982 base year. Two interpretations of these data are possible. Relative to 1982, the reduction in underage drinking drivers in fatal cashes was 60%, compared to 25% for drinking drivers aged 21 and older. On the other hand, relative to the percentage of nondrinking drivers in fatal crashes in 2004, adult drinking drivers were almost 70% lower, whereas young drinking drivers (aged 20 and younger) were only 50% lower. In this paper, we explore the issue: Did the involvement of underage drinking drivers decrease more than the involvement of adult drinking drivers between 1982 and 2004?

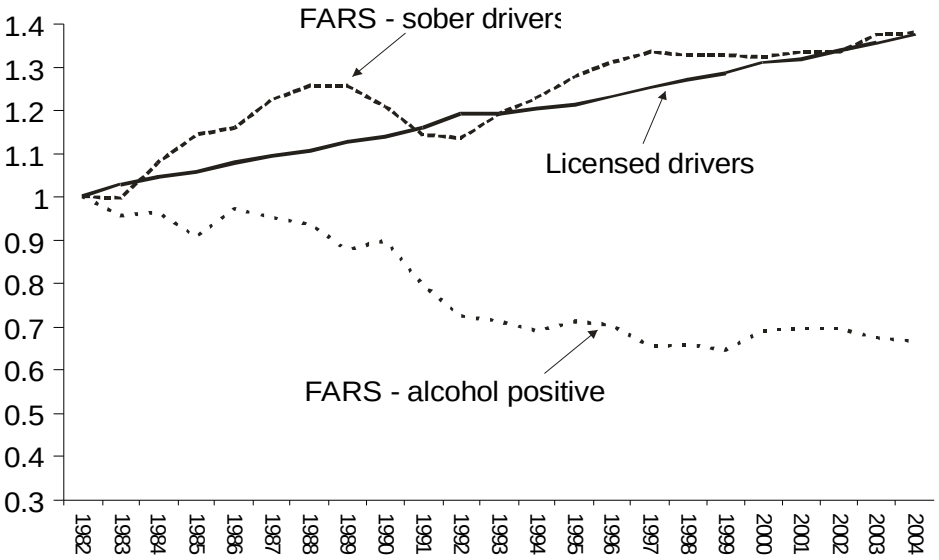

Figure 1. Drivers aged 21 and older: Change from 1982 baseline in number licensed and in fatal crashes with BACs =.00 and >.00.

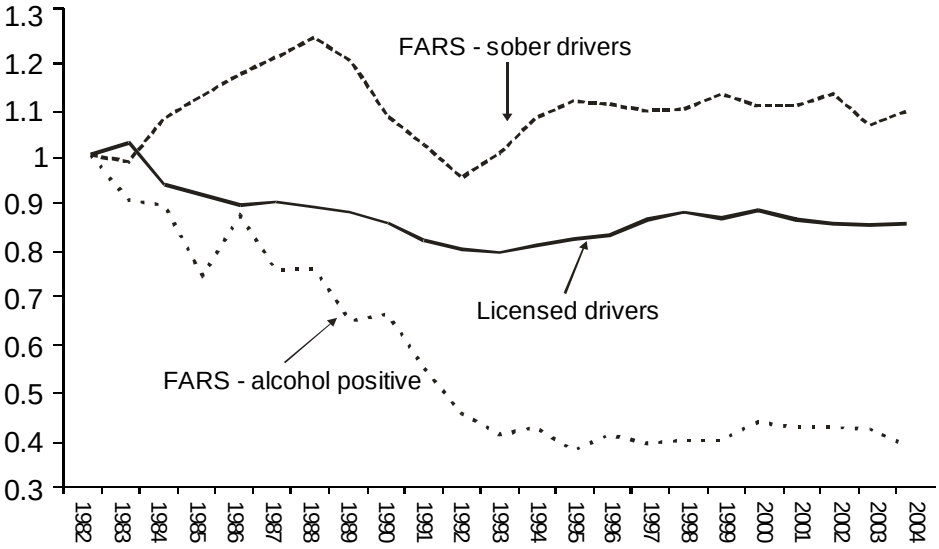

Figure 2. Drivers aged 20 and younger: Change from 1982 baseline in number licensed and in fatal crashes with BACs =.00 and >.00.

Many sociodemographic factors played a role in the impaired-driving trends shown in Figures 1 and 2. One was the variation over the 25-year period in the size of the 15 through 20 underage cohort shown in Figure 3. Note that during the 1980s, the U.S. population in the 15- to 20-year age group declined by a sixth, but since that time, it has been rising. Dang (2008) provided evidence that two other factors helped to explain the differences in the adult and underage trends. The percentage of licensed drivers who were males (Figure 4) and per capita beer consumption (Figure 5) also affected the number of alcohol-related crashes. The contribution of these factors to the reductions observed in Figures 1 and 2 is unknown, but each factor is known to be related to crash involvement. Females are less likely to be involved in crashes of all types, particularly alcohol-related crashes, whereas young drivers are overrepresented in crashes. Beer sales have been shown to be the best index for measuring the contribution of alcohol availability to fatal crashes. In addition to these demographic changes, the period beginning in 1982 saw a rapid growth in safety legislation that has been shown to reduce alcohol-related crashes (Figure 6). During that period, legal per se limits were established, first at .10 BAC and later lowered to .08. The number of states with administrative license revocation laws (ALR) also increased, as did two laws specifically targeted at underage drinking drivers—MLDA and ZT—which have been enacted by all 50 states. Clearly, from 1982 to 2004, several factors that affected impaired driving were changing. Thus, it is difficult to compare the impaired-driving trends of adult and underage drivers.

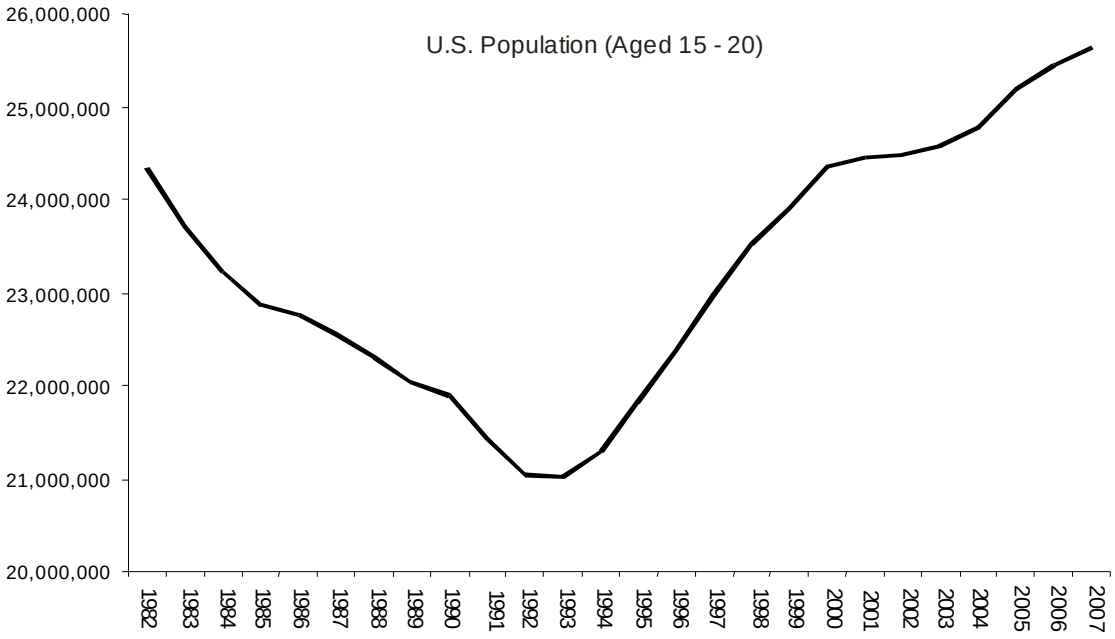

Figure 3. Trend in U.S. underage population, 1982-2007 (Source: U.S. Census)

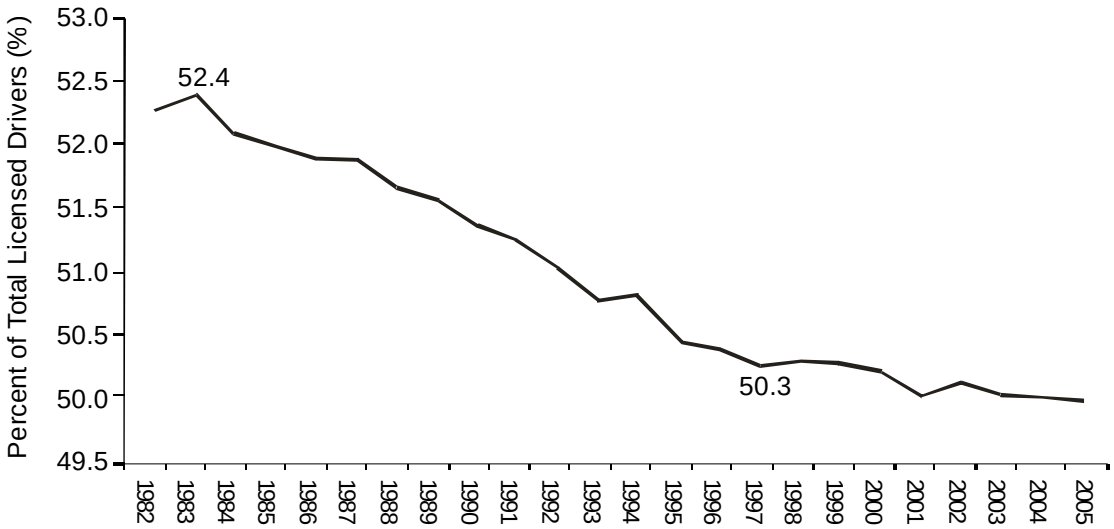

Figure 4. Reduction in the percentage of male licensed drivers, 1982-2005 (Source: Dang, 2002, p. 7)

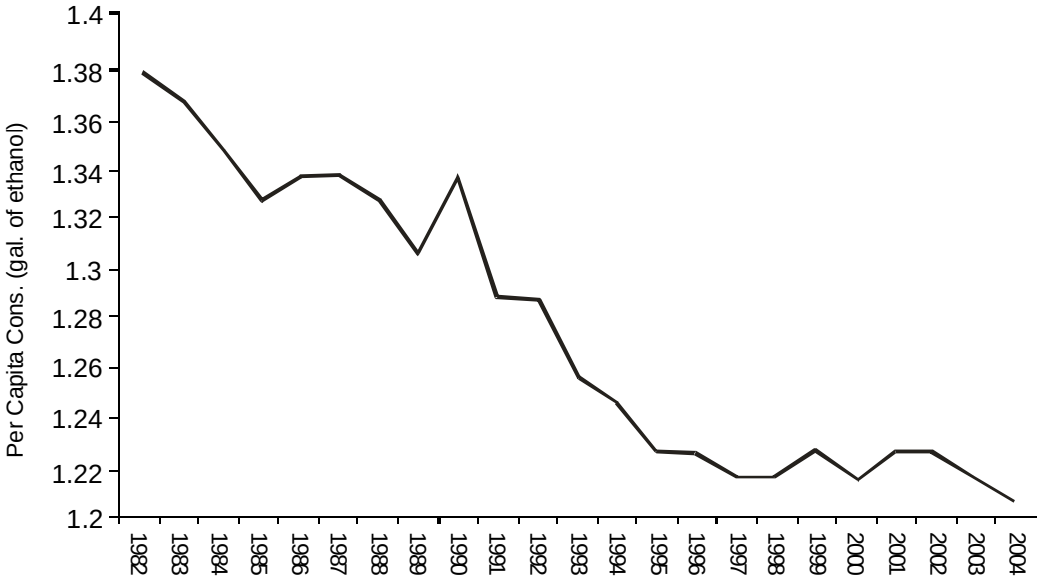

Figure 5. Reduction in U.S. per capita beer consumption, 1982-2004 (Source: Dang, 2008, p. 8)

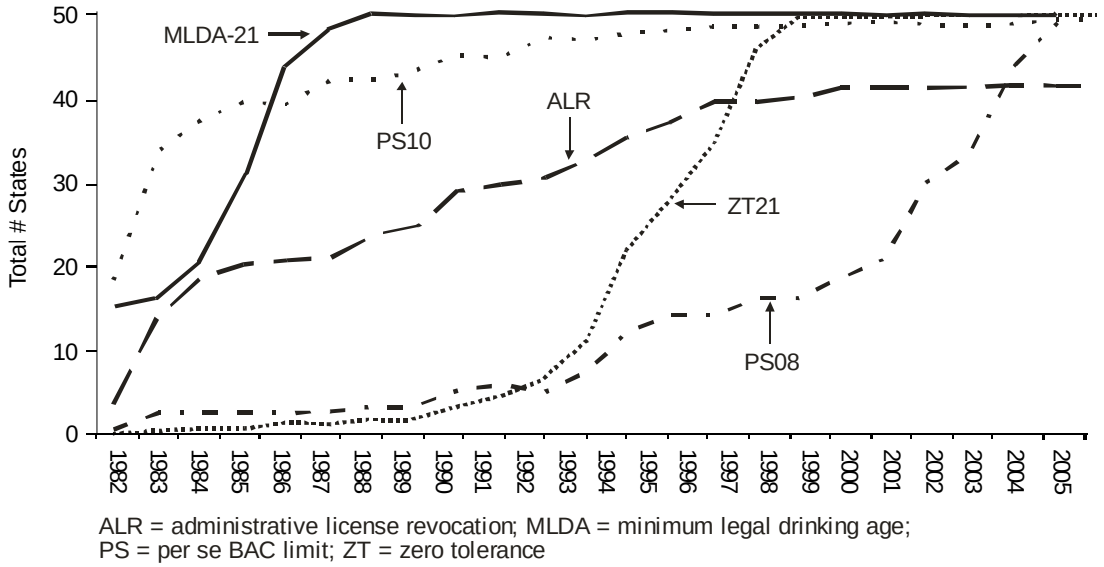

Figure 6. Increase in the number of states with alcohol laws (by year and by law) (Source: Dang, 2008, p. 34)

Methods for Analyzing Underage Driver Involvement

Because the number of licensed drivers in varying age categories changes over time and the number of miles that are driven varies with age and gender, comparing raw frequencies of younger and older drivers is clearly misleading. A method is needed for normalizing the data to make comparisons more meaningful. Crash rates per licensed driver and per vehicle mile driven are perhaps the most frequent normalizing variables used when reporting crash rates. Both, however, have significant limitations when comparing underage drivers with adult drivers. The licensing record system maintained by the FHWA to which states report their licensing data has recently been found to be inaccurate for underage drivers. This is partially because of graduated licensing laws, which require that novice drivers go through multiple license stages on the way to full licensure. This process appears to have caused some confusion in the figures being reported to FHWA. The value of data on vehicle miles traveled (VMT) as a method of normalizing data for comparing groups is also limited. The data are derived from the Nationwide Household Transportation Survey (NHTS; formerly called the National Personal Transportation Survey) conducted by the Research Triangle Institute for Federal Highway Administration. The survey was conducted in 1983, 1990, 1995, and 2001 and is therefore not available for every calendar year. Values for the missing years must be interpolated from the years of the survey. An alternative to using a measure collected through a separate data system (such as the licensing records or the NHTS) is to use an element within the FARS record system itself to normalize data for comparison. The benefit of using the FARS data is that it provides a value for every case being compared.

The result of normalizing FARS data for comparison across age groups using FHWA's data on VMT is shown in Figure 7. That figure presents the rate of *nondrinking* drivers in fatal crashes as a function of VMT, estimated from the 1995 NPTS for each age group using FARS 1990-1996 data. The U-shaped distribution is typical of this type of analysis for crashes that do not involve alcohol. It reflects the higher risk levels for underage drivers who have less driving experience

and are more likely to be risk takers. It also highlights the higher level of involvement by elderly drivers, which is partly due to their deteriorating driving skills and partially due to their greater sensitivity to injury because of their physical frailty. Finally, based on driver deaths per VMT, females aged 21 to 70 have involvement rates similar to males. Among fatally injured drivers aged 20 and younger, however, females have a lower involvement. As shown in Figure 8, when *drinking* drivers in fatal crashes are normalized by the same procedure, a different picture emerges. The graph is now L-shaped, indicating that underage and young adult drivers are overinvolved in fatal crashes. Females also have much lower rates based on VMT.

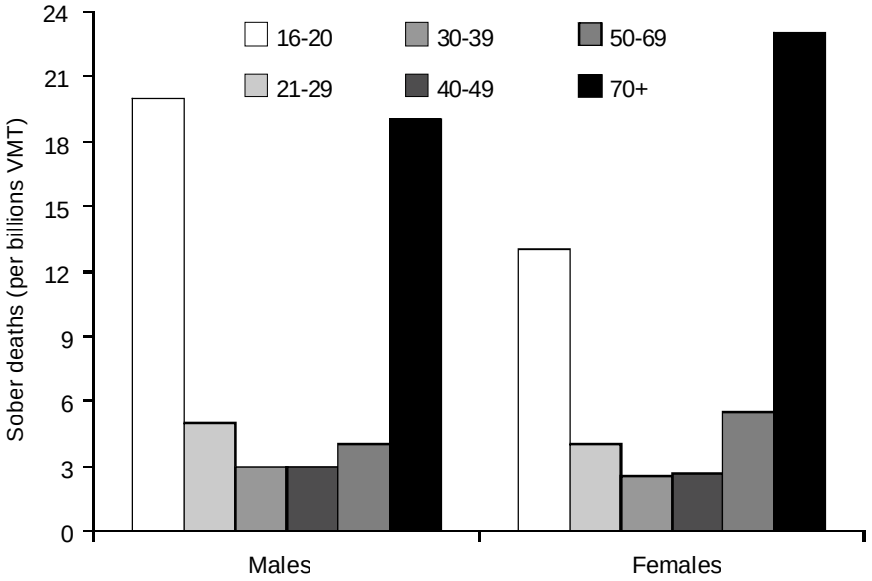

Figure 7. Annual death rates based on VMT for nondrinking drivers in fatal crashes, 1990-1996 (Source: Tippetts and Voas 2002, Fig. 1a)

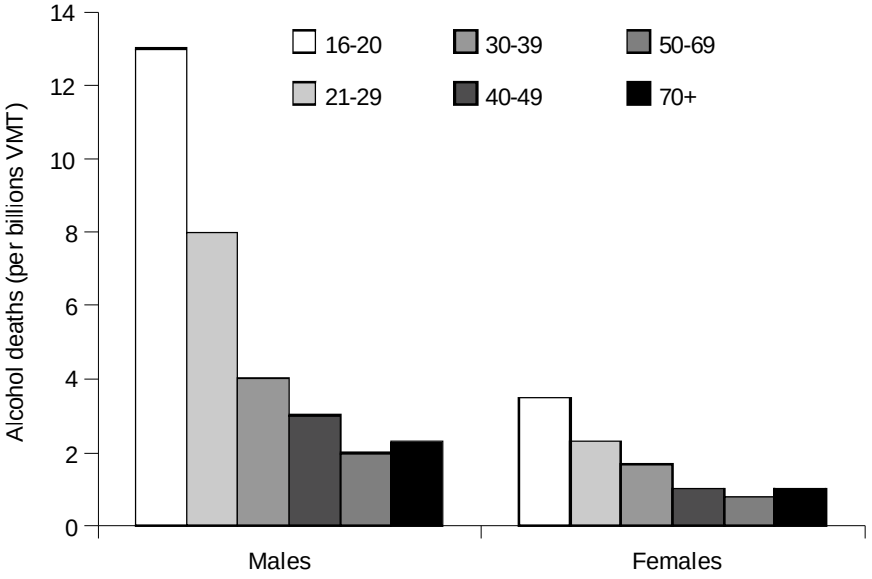

Figure 8. Annual death rates based on VMT for drinking drivers in fatal crashes, 1990-1996 (Source: Tippetts and Voas 2002, Fig. 1b)

The use of a measure for comparing different age groups contained in FARS is illustrated by the crash injury ratio (CIR). In Figure 9 (Tippetts and Voas 2002), the data from Figures 7 and 8 are presented as the ratio of drinking drivers divided by nondrinking drivers in fatal crashes for each age group. Underage drinking drivers have a lower ratio of drinking drivers to nondrinking drivers because they have a higher risk of crash involvement when not drinking than older drivers do (shown in Figure 7). On the other hand, the ratio of drinking to nondrinking drivers for young adults (aged 21 to 39) is substantially higher because they are at a lower risk when not drinking. Arguably, the nondrinking crash rate provides a better basis for comparison than VMT because it accounts for many factors (such as urban rural location, type of vehicle, and quality of roadways) that may better equate the characteristics of the exposure of the two groups—drinking and nondrinking drivers in crashes—than the number of vehicle miles of travel. The data in Figure 9 may present the best picture of the impaired-driving problem because it shows the extent to which drinking increases the risk of crash involvement.

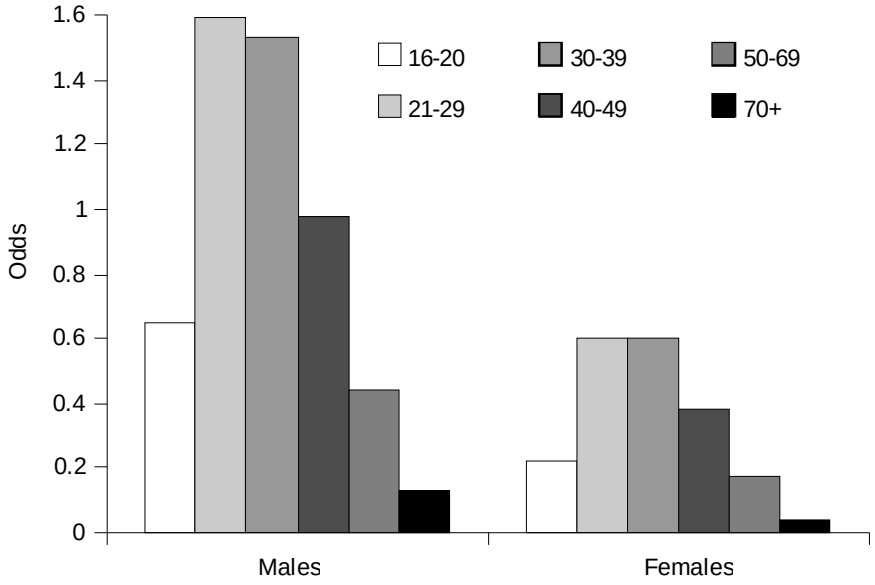

Figure 9. Ratio of drinking to nondrinking drivers in fatal crashes by age group, FARS 1990-1996 (Source: Tippetts and Voas 2002, Fig. 2)

Another application of the CIR concept is illustrated in Figures 10 and 11. The FARS data on the BACs of crash-involved drivers are compared by creating the ratio of 15- to 17-year-old crash-involved drivers to adult drivers aged 21 and older for each of the three BAC categories. Figure 10 shows this relationship for drivers in single-vehicle crashes for each year from 1982 to 2005. (Single-vehicle crashes are used in this comparison because responsibility can be more clearly assigned to the driver when only one driver is involved.) The ratio for the zero BAC crash-involved drivers remains close to 1 throughout the period, indicating little change in the relationship between novice drivers and adult drivers during that period. Over the last 10 years, there is a slight decline in zero BAC drivers, despite an increase in the number of underage drivers during that period (Figure 3). Although the proportion of zero BAC 15- to 17-year-old drivers in crashes compared to zero BAC drivers aged 21 and older showed little change, the proportion of 15- to 17-year-old drivers with positive BACs compared to adult drivers with positive BACs was reduced by close to 50%. Figure 11 shows a similar trend for 18- to 20-year-olds when compared with adult drivers.

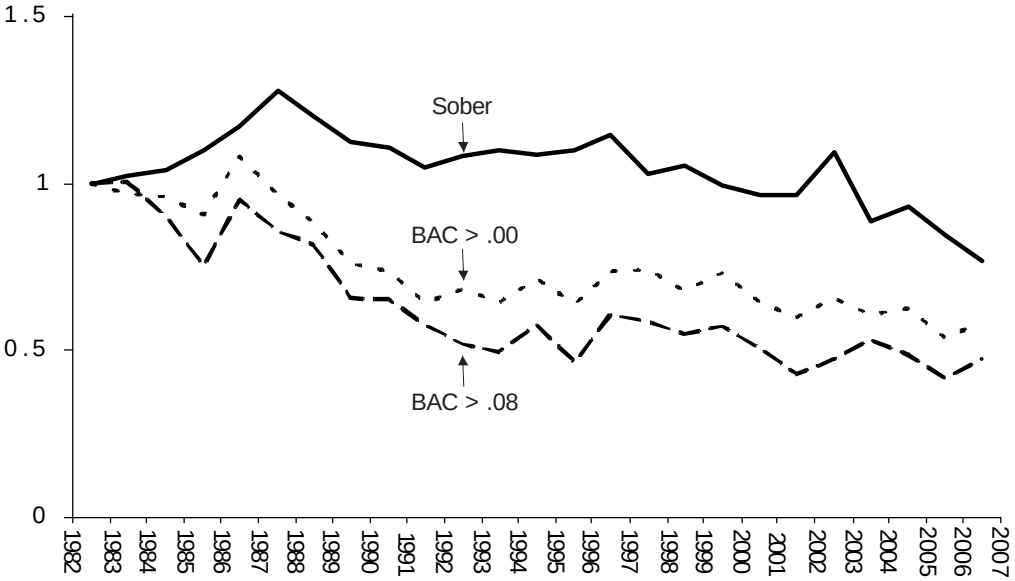

Figure 10. Ratio of drivers aged 15 to 17 years to drivers aged 21 years and older in single-vehicle fatal crashes by crash BAC (Source: FARS)

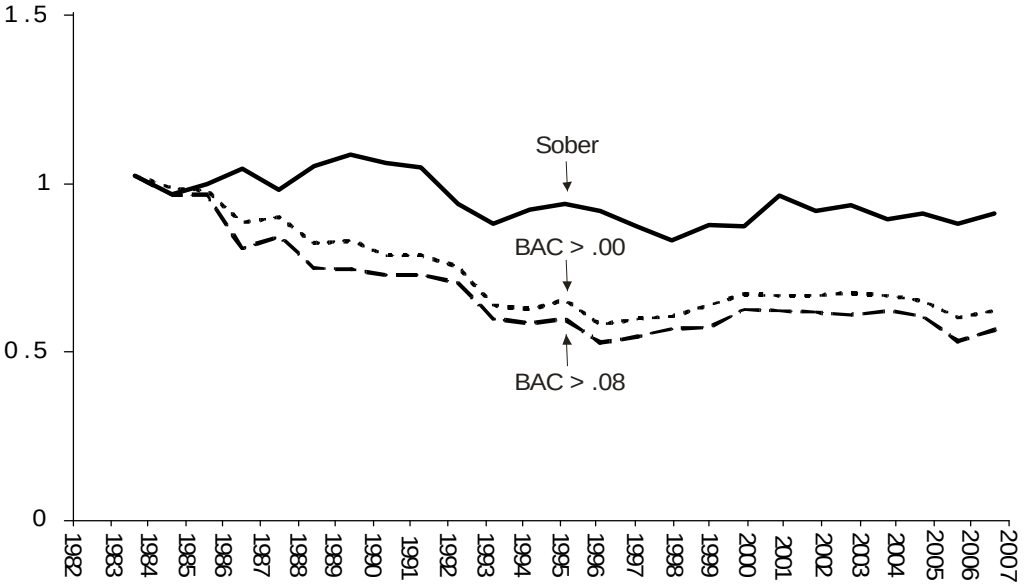

Figure 11. Ratio of drivers aged 18 to 20 years to drivers aged 21 years and older in single-vehicle crashes by crash BAC (Source: FARS)

Discussion

As shown in Figures 1 and 2, the percentage of underage drivers who were drinking decreased twice as much as the percentage for adult drivers in fatal crashes (60% compared to 30%). By the end of the 25-year period, the difference between the percentage of drinking and nondrinking drivers was the same for adult and underage drivers (1.4–.7=79% versus 1.1–4=70%). The role of traffic safety programs in these reductions in fatal crashes relative to the 1982 baseline year is clouded by variations in several important sociodemographic factors that varied over that time. The strongest evidence for a greater reduction in the percentage of underage drinking drivers in

fatal crashes relative to adult drivers comes from the data shown in Figures 9 and 10: from 1982 to 1996, the ratio of nondrinking young drivers to nondrinking adult drivers in single-vehicle fatal crashes remained close to 1, whereas the ratio for young drinking drivers to adult drinking drivers declined to .5. For both the 15- to 17-year-olds and the 18- to 20-year-olds, the decline relative to adult drivers was greater for drivers with BACs of .08 or higher. The fact that the underage-to-adult ratio for crash-involved drivers with zero BACs remained close to 1 suggests that the reduction in the ratio for drinking drivers cannot be explained by changes in the population of young drivers. Thus, the results reported here confirm the results reported by Elder and Shults who suggested that underage drivers benefited more than adults from the increased number of drinking-driving laws enacted in the 1980s. Figures 10 and 11 indicate that over the last decade the trends for the underage-to-adult ratios for the nondrinking drivers and for drinking drivers in fatal crashes have been parallel. Although at first sight this might suggest that underage drivers are no longer benefiting more than adults from safety legislation. However, the increase in the U.S. population of youth aged 15 through 20 since the mid-1990s (Figure 3) should have resulted in the underage-to-adult ratio rising, but that has not occurred. This suggests that there may be some continuing additional benefits from the 1980s safety legislation. In addition, graduated licensing laws enacted in the 1990s may also have played a role as indicated by the continuing downward trend in impaired-driving fatal crashes for 15- to 17-year-old drivers.

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FEMALES AND ALCOHOL-RELATED FATAL CRASHES: EXPOSURE-ADJUSTED TRENDS

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TARA KELLEY-BAKER
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INTRODUCTION

Despite significant progress in traffic safety during the past decades, motor vehicle crashes (MVCs) remain a major source of injury. Of the many factors the literature recognizes as contributing to the likelihood of MVCs, gender is one. Although men have long been recognized as holding the lead in MVCs, women are closing the gap (Attewell 1998; Hill and Maclay 1997; Laapotti, et al. 2001; Romano, Kelley-Baker and Voas 2008, in press). Questions regarding the extent, characteristics, and determinants of such involvement have arisen.

Some researchers view the increase in female involvement in MVCs as merely associated with their increased exposure to crashes (Bergdahl 1999; Mayhew, Simpson and Pak 2003). For these researchers, women's expanded role in society is the main reason for their increased involvement in crashes, as their expanded role has translated into an increased use of personal vehicles. In 2003, Mayhew et al. used the Fatality Analysis Reporting System (FARS) to study this issue. The authors reported that, although the overall prevalence of female drivers in fatal crashes increased more than for males between 1975 and 1998, such relative increase disappeared when adjusted by the number of licensed drivers. Is crash exposure the sole explanatory factor for the observed increased involvement of females in MVCs?

There is evidence that the involvement of female drivers in MVCs is not homogeneous across all groups. Socioeconomic status and cultural factors also affect the involvement of female drivers in MVCs. For instance, Latinas in general and Latinas of low acculturation levels tend to be much less exposed to driving and driving-related risks than their male counterparts. However, as Latinas become more acculturated, their crash exposure as well as their risk-taking driving (drinking and driving in particular) increases (Romano, Tippetts and Voas 2006).

More relevant to this study, age has been identified as an important modifier to female driving behavior. An Internet-based survey of Ohio drivers reported that middle-aged women caught in summer traffic with children in the vehicle were more likely to drive aggressively than their male counterparts (Progressive Insurance 2000). Further, some U.S. research efforts on older women have suggested that they may be increasingly vulnerable to crash-related injuries (Kelley Baker, et al. 2003). But perhaps young females is the group of drivers on which the most attention has recently been focused. Studies in New Zealand suggest that female drivers have become more risk inclined over time, so their behavior now more closely matches that of the greater risk-taking driving behavior of men (e.g., Wylie 1995). In the United States, data from Michigan show that the rate of aggressive, risky driving, and speed-related collisions among female drivers (particularly young women) is increasing (Kostyniuk, Molnar and Eby 1996; Waller, et al. 2001).

Thus, the picture depicting increasing female involvement in MVCs is still blurred. There is strong evidence that increased crash exposure explains a sizable portion of such trend. Some other evidence, however, suggests that changes in attitudes toward risk cannot be ignored as explanatory factors for such trend. In this study, we first briefly review the vulnerability of female drivers to fatal crashes and how the involvement of female drivers in those crashes has evolved over time. We compare this evolution against that of male involvement in fatal crashes. Then, we examine more closely how the vulnerability of female drivers varies across states. Special focus is devoted to young female drivers, a group postulated to be increasingly at risk of involvement in MVCs (Romano, et al. 2008, in press).

METHODS

Data for this study were obtained from the 1982–2006 FARS, which is a record system for fatal crashes (defined as a crash on a public roadway causing a death within 30 days of the event). FARS provides detailed information about the fatally injured drivers' gender, age, level of alcohol consumption, and maneuvering skills. FARS also contains information about the number of vehicles involved in the crash. Of the 1,433,014 drivers in the 1982–2006 FARS file, we were interested only on those with gender information who were driving passenger cars, minivans, or sports utility vehicles. There were 891,593 of those drivers. To ensure a proper identification of crash responsibility, we considered only drivers who were involved in single-vehicle crashes (with no involvement by pedestrians or other road users). The final data set had 492,000 drivers from 1982 to 2006, about 77% of whom were males.

Blood alcohol concentration (BAC) measures were used to identify female involvement in alcohol-related crashes. FARS contains actual BAC measures but only for a fraction of the drivers. For those with no actual measure available, the FARS provides imputed BAC measures developed using a multiple imputation technique by Subramanian (2002). We applied these imputed variables to our evaluation.

FARS variables were used to identify driver involvement in crashes associated to the following non-alcohol-related risk conditions: improper maneuvering, speeding, and seatbelt nonuse. We used FARS Driver Condition Factor (DR_CF1 - DR_CF4) variables to assign an improper maneuvering or speeding condition to each driver in the file. For seatbelt nonuse, we relied on variables aut_rest (from 1982 to 1990) and rest_use (from 1991 to 2006) (see Table 1).

Based on this information, we estimated the annual percentage of drivers killed in single-vehicle crashes who were females and obtained curves showing the evolving trends. We obtained these curves for all single-vehicle crashes, as well as for the different crash types under consideration (speeding, improper maneuvering, seatbelt nonuse, BAC>.00, and BAC$\geq$ .08). The evolution of the percentage of females involved in those crashes over time was then investigated separately for all female drivers and for underage female drivers.

TABLE 1 FARS variables used to create three driving conditions

Condition	Year	FARS Variable	Criteria for Inclusion	Reference Level
Seatbelt	1991-2006	Rest_use(1)	1=Shoulder Belt; 3=Lap & Shoulder Belt(2)	0=None Used/Not Applicable(3)
	1982-1990	Aut_rest(1)	1=Automatic Belt in Use	2=Automatic Belt Not in Use
Maneuvering	1982-2006	DR_CF1, DR_CF2, DR_CF3, or DR_CF4 (since 1997) (4)	26 to 37 : (26 – Following Improperly; 27 - Improper or Erratic Lane Changing; 28 - Failure to Keep in Proper Lane or Running off Road; 28 - Failure to Keep in Proper Lane *(since 2000);* 29 - Illegal Driving on Road Shoulder, in Ditch, or Sidewalk, or on Median; 30 - Making Improper Entry to or Exit from Trafficway; 31 - Starting or Backing Improperly; 32 - Opening Vehicle Closure into Moving Traffic or Vehicle Is in Motion; 33 - Passing Where Prohibited by Posted Signs, Pavement Markings, Hill or Curve, or School Bus Displaying Warning Not to Pass; 34 - Passing on Wrong Side; 35 - Passing with Insufficient Distance or Inadequate Visibility or Failing to Yield to Overtaking Vehicle; 36 - Operating the Vehicle in an Erratic, Reckless, Careless or Negligent Manner or Operating at Erratic or Suddenly Changing Speeds) 47 to 48: (47 - Making Right Turn from Left-Turn Lane or Making Left Turn from Right-Turn Lane; 48 - Making Improper Turn) 52: (Operator Inexperience)	0=None
Speeding	1982-2006	DR_CF1, DR_CF2, DR_CF3, or DR_CF4 (since 1997)	44: (44 Driving too Fast for Conditions or in Excess of Posted Speed Limit) 46: (Operating at Erratic or Suddenly Changing Speeds (until 1994))	0=None

Although informative of the relative involvement of females in these crash types, these curves did not indicate if the changing involvement of female drivers over time was caused by an increase in exposure or by changes in driving patterns and/or attitudes toward risk. To resolve this issue, we investigated if the proportion of female drivers with a valid license in FARS changed/increased over time (compared with that of male drivers), and compared any changes/increases with the change in female involvement observed for the crash types under study. For comparison, we divided the annual percentage of female involvement for each of the crash types under consideration by the annual percentage of female drivers with a valid license in FARS and observed the resulting trend: a downward trend would indicate that the denominator (percentage of licensed females) was increasing faster than any change in the numerator (percentage of female involvement in each crash under consideration). However, an upward trend suggested that the participation of females in those crashes was larger than the increase in the number of licensed female drivers.

RESULTS

Figure 1 shows the evolution, from 1982 to 2006, of the proportion of underage female drivers (relative to underage male drivers) involved in single-vehicle fatal crashes over time, for the different crash types under consideration. Figure 1 illustrates that, overall, for underage drivers, the relative involvement of female drivers in these crashes increased ("all" line). Such overall increase was paralleled by an increase in their participation in most crash types, except for BAC≥.08 crashes, which remained stable over time.

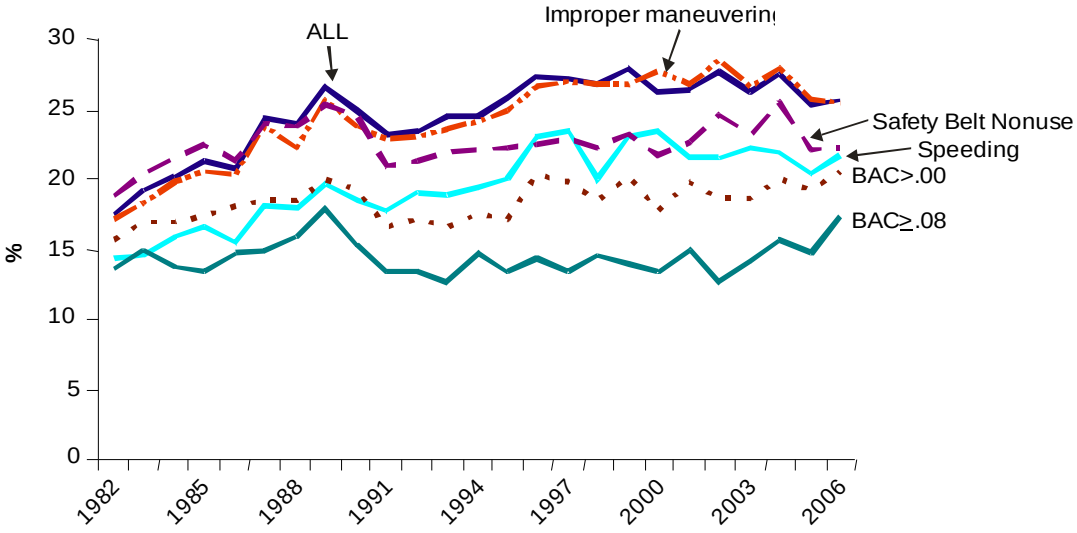

FIGURE 1. Percentage of underage female drivers involved in single-vehicle fatal crashes, 1982-2006

Attempting to adjust for exposure, Figure 2 shows the effect of dividing the percentages in Figure 1 by the percentage of females with a valid license in each year. Figure 2 shows that, when adjusted by exposure, the increasing trends in Figure 1 flatten.

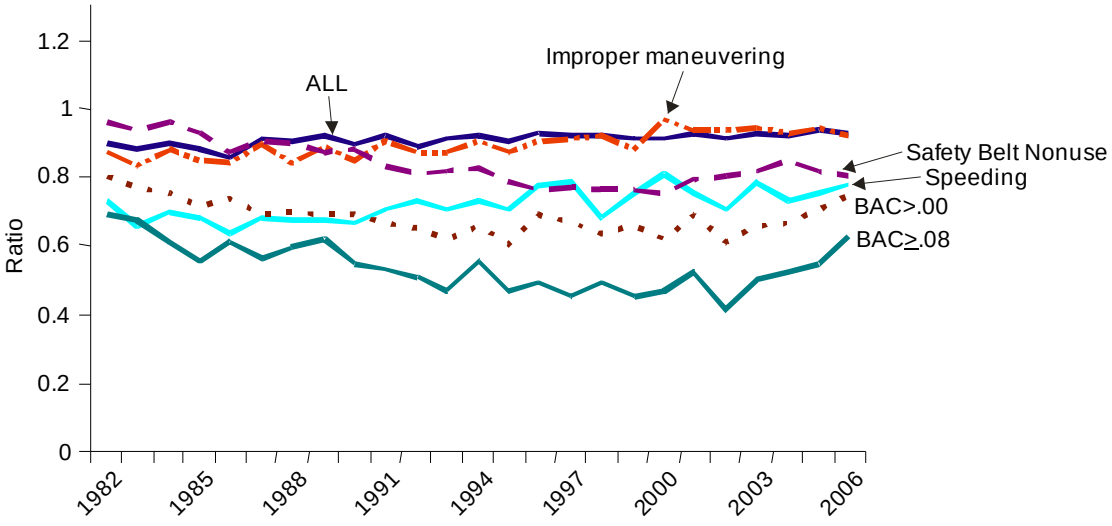

FIGURE 2. Ratio of underage female drivers with a valid license involved in single-vehicle fatal crashes, 1982-2006

To gain more insight into this adjustment, Figure 3 displays the same curves shown in Figure 2 but relative to their value in 1982. In other words, Figure 3 shows how much different from their initial 1982 baseline the relative participation of underage female drivers (relative to underage male drivers), once adjusted by exposure, evolves over time.

Figure 3 shows that the evolution observed in Figures 1 and 2 could be separated into two categories. Crashes associated to improper maneuvering and speeding follow a higher trajectory than those alcohol-related or associated to seatbelt nonuse.

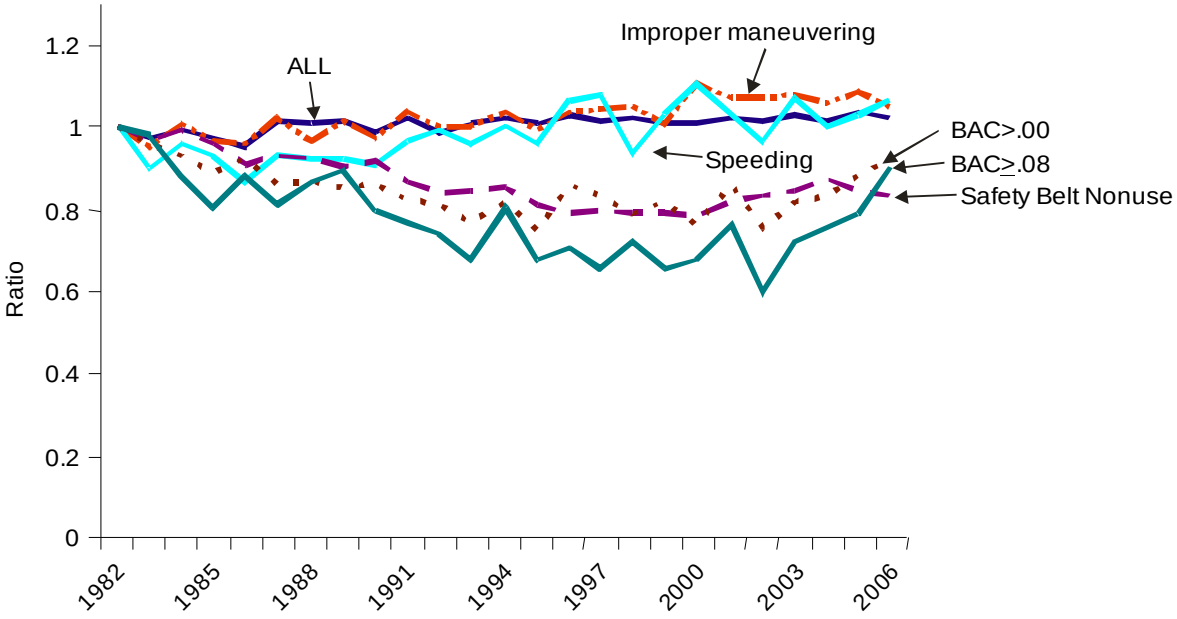

FIGURE 3. Ratio of underage female drivers with a valid license involved in single-vehicle fatal crashes, 1982-2006; baseline: 1982

SUMMARY

This study corroborates previous findings showing an increased participation of underage female drivers in fatal crashes. Once adjusted by exposure, however, such increase disappears for most crash types under consideration. Interestingly though, the effect of such adjustment on the participation of underage female drivers involved in fatal crashes varies depending on the type of crash under consideration. Compared with underage male drivers (Romano, et al. 2008, in press) and despite the adjustment by exposure, underage female drivers were increasingly involved in "speeding" and "improper maneuvering" crashes but not in alcohol-related and seatbelt nonuse crashes. In other words, this study suggests that the increased involvement of young female drivers in fatal crashes was partially caused by an increase in their crash exposure. This study further indicates that young female drivers might also become more prone to involvement in "improper maneuvering" crashes and in risk-taking crashes, such as those related to speeding.

ACKNOWLEDGEMENT

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THE NATURE OF THE YOUNG IMPAIRED DRIVER PROBLEM IN EUROPE

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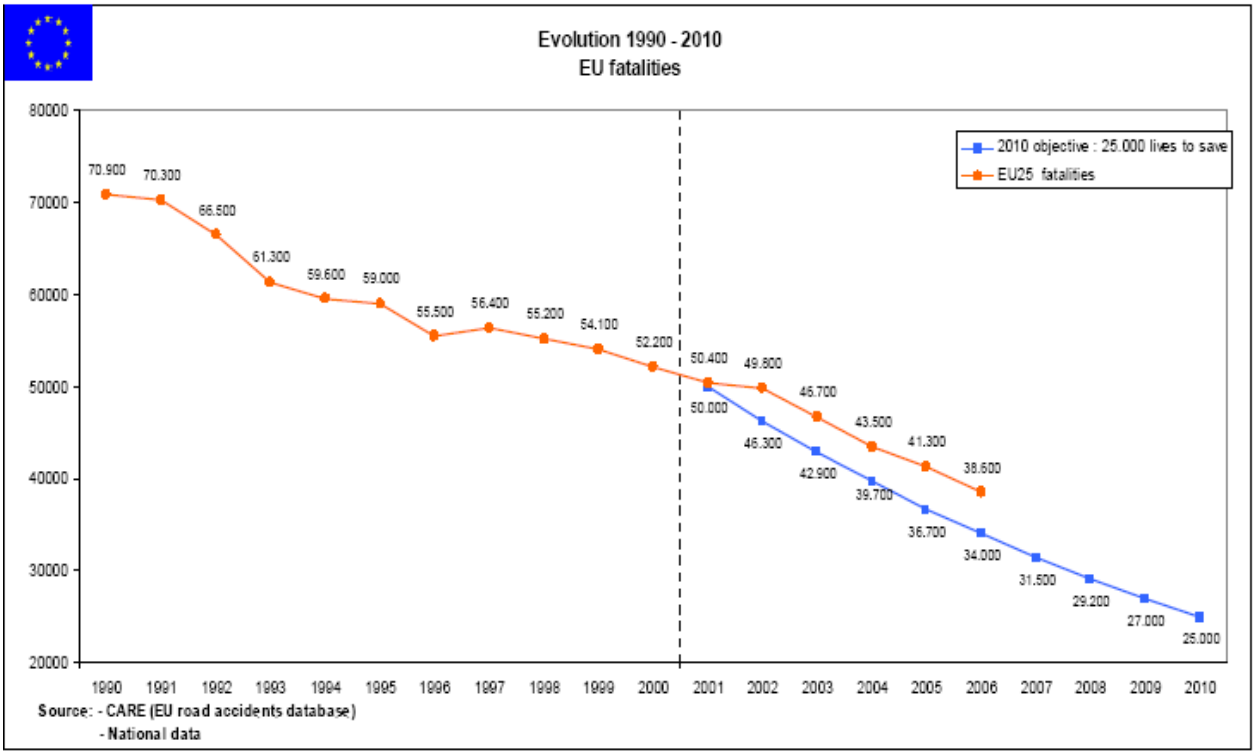
Introduction

European statistics in general and crash data are difficult to compare internationally. There are many reasons underlying this difficulty: national, cultural, economic and societal development, history, political systems, legislations etc. Therefore any overview of the European situation lacks representativeness in one way or another. At the same time a selection of EU countries is problematic because several countries do not yet collect statistics in a comparable manner and some do not deliver the relevant data to the EU. Therefore, a valid and representative overview is hardly achievable.

The goal of the European Union - as documented in the European Road Safety Charter (Dublin 2004) - of reducing fatalities until 2010 by 50% was set not knowing when and which countries would have joined the Union by 2010. This, however, is only one of the reasons why the goal will most likely not be achieved although a highly significant progress is observable[1] (Picture 1)



[1] Most importantly, traffic safety in new member states is not always first priority; in many of the EU 14 member states significant progress in traffic safety has been achieved in past years which makes further progress much more difficult

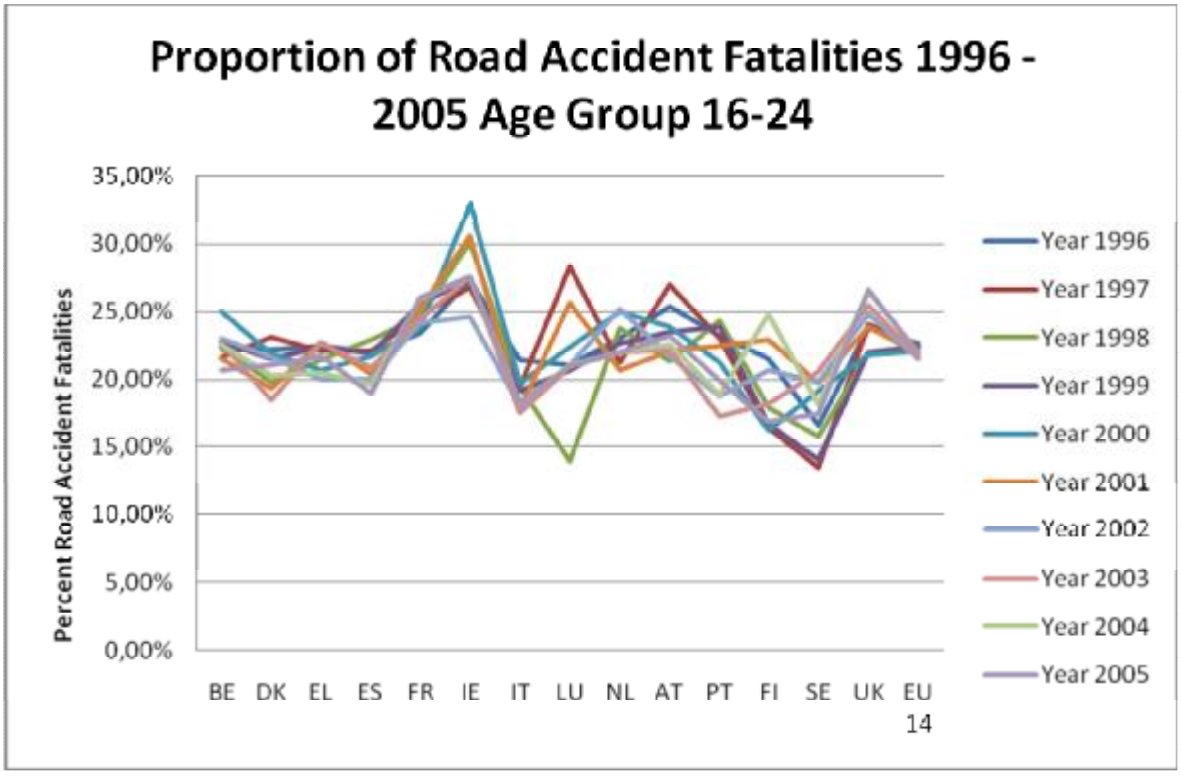
Picture 1: Evolution of EU fatalities: Goal and actual development (EU Commission)

With all these restraints, the goal in this paper will be set on (1) depicting the situation of young impaired drivers in the EU and in selected member states, (2) whenever possible and meaningful differentiate between types of impairment, and (3) predominantly name and describe selected best practice primary and secondary prevention measures.

Overview of the problem of impaired drivers and proportion of young drivers

As there is no internationally valid definition of the "young driver", the age range from 16 to 24 years – according to the definition in the CARE database - is chosen in this paper although many German statistics define them as being between the ages of 18 and 24. IRTAD defines this group as between 15 and 24 (IRTAD, 2000).

As is shown in picture 2 the problem is a considerable one: more than 20 % of all road fatalities in Europe, i.e. EU 14, affect the young driver group although demographically this group is gradually becoming a minority.



Picture 2: Proportion of road accident fatalities, 16-24 age group, 1996 – 2005 in 14 EU member states, CARE (2007)

The most essential reasons for the young drivers' involvement in accidents have been listed by Briem et al. (2000):

1. Young drivers are more frequently involved in accidents due to lack of driving experience and understanding of how to solve acute problems that arise in traffic situations
2. The significant differences between the accident and offence frequencies of younger and older drivers are mainly due to the contribution of a relatively small number of individuals
3. Differences in the relative frequency of men and women in traffic (approximately 2:1) are reflected in their accident involvement
4. Differences in the observed accident frequencies of male and female drivers are related to a number of psychological traits which may be associated to different driving styles
5. Although superficially, a driver's age and sex may appear to be the main determinants of the risk of accidents and offences, this risk is, rather, determined by the driver's traffic exposure and experience, as well as by a number of "chronic" and "tonic" character traits of which some, in turn, are linked to age and sex.

The estimate of the proportion of alcohol/drug-related fatalities in all EU member states depends on the type of national data collection and data reporting to the EU. As there is no common rule for data collection and reporting, EU statistics particularly on age-related data are highly unreliable. Furthermore, statistics do not always show exactly whether they were computed from the EU 14, the EU 18 or the (new) EU 25. Based on a questionnaire sent to all IRTAD members, the known causes of underreporting and the experience of the 22 responding countries to assess the magnitude of underreporting were reviewed. Most countries responded that the reporting rate was unknown. The authors of this study suggested a method to estimate the rate of underreporting (Derriks and Mak, 2007). Finally the report provides a set of recommendations to improve the data reporting mechanism. However, as of now, no progress in the reporting mechanism is observable.

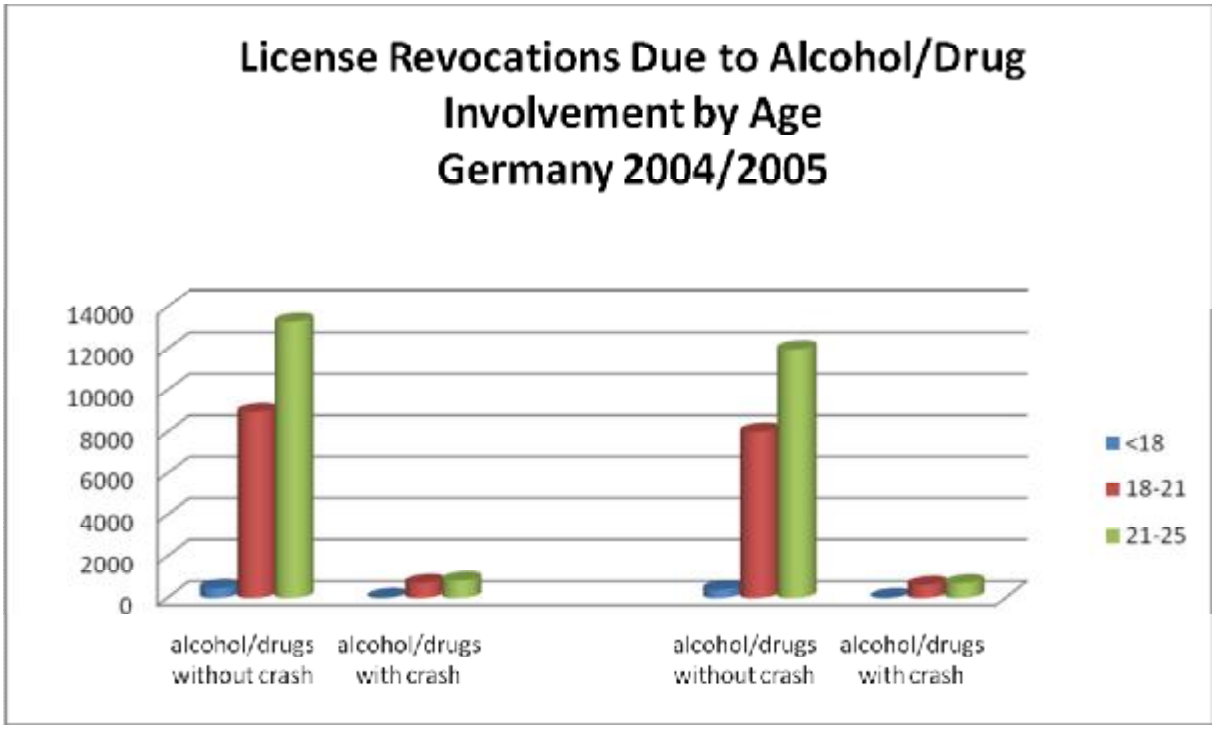
Apart from these estimation problems the situation of the young impaired driver in Europe is generally characterized by an overall increase of alcohol as well as drug use in almost all age groups (ETSC). Although age related data are rarely provided by the member states all seem to be aware of the problem.

Young people are at almost twice the average risk of being killed in a road accident compared to the average member of the respective population across the EU-18 countries (% young people fatalities divided by % young people population) in 2005. The majority of the young people killed in road accidents in the 18 European countries were drivers (4.279 persons), whereas only 484 persons aged 16-24 were pedestrians in 2005[1]. Males account for the majority of the overall fatalities (88,5 fatality rate). According to EUROCARE[2] binge drinking is rising all across Europe (Settertobulte, 2001), Kemp (2004) blamed "the marketing of these new products that don't look like alcohol and don't taste like alcohol. It's the alco-pop culture." She added, "Adults don't drink these things -- it's young people." The issue is still being discussed within the EU; some member states have introduced countermeasures (e.g. server responsibility), others are in the process of discussion.

[2] **EUROCARE was formed in 1990 as an alliance of voluntary and non-governmental organizations representing a diversity of views and cultural attitudes and concerned with the impact of the European Union on alcohol policy in Member States; the acronym stands for: European Council for Alcohol Research Rehabilitation and Education**

Driving under the influence of alcohol contributes to at least 10,000 deaths on EU roads annually.

As age related data, again, are rarely provided a German example of the combined number of all alcohol and drug related license withdrawals in the age group of below 18 to 25 is chosen to demonstrate that progress is possible (picture 3)



Picture 3: alcohol and drug related license withdrawals in the age group of below 18 to 25 showing a decrease by 10% from 2004 to 2005 in Germany Source: KBA, 2006

Countermeasures and Prevention

Enforcement with increased drink driving as well as drug driving checks is an effective tool to reduce the number of alcohol and drug related fatalities. The European Commission's cost-benefit analysis found that with increased enforcement of drink driving, 3,900 deaths could be prevented in the EU 15 alone (ETSC, 2008).
In the EU as a whole, 2-3% of rides are associated with an illegal blood alcohol concentration, resulting in 30-40% of driver deaths. A minor reduction of driving under the influence of alcohol would have a large effect on collision occurrence (ETSC, 2008).

Enforcement is one of the major topics of the EU project DRUID (2007); results of the work package "enforcement" will expectedly present objective data on enforcement practice and status and this enable decision makers to take decisions on the background of solid and reliable data.

In relation to other measures the most effective ones to reduce alcohol related road traffic accidents are: lowering the legal blood alcohol concentration limit, deterrence through

unrestricted powers for breath testing and reducing the availability of alcohol. License suspension and vehicle actions can be effective when combined with remedial programs. Separating drinking from driving through educational programs alone, server interventions alone and alternative transportation programs are the "least effective" (EuroCare, 2003).

A Dutch study (Smink, 2003) presents the test results of blood and urine samples of impaired drivers in the Netherlands between January 1995 and December 1998. In this period, the blood alcohol concentrations of 11,458 samples have been determined and 1665 samples have been analyzed for drugs. The median alcohol concentration was between 1.7 and 1.8 mg/ml blood. In 80% of the 1665 analyzed samples drugs were detected. At least 42% of the impaired drivers were poly-drug users, with cocaine present in the most frequent combinations. In the Netherlands, the procedure to prove driving under the influence is complex. The author suggests to render the procedure more efficient and more effective by embedding the analytical test results, needed to prosecute an impaired driver, in the law. In Belgium and Germany, such laws already are in force. If the qualifications of the new Belgian law were applied to the analytical data of the study, 67% of the impaired drivers included in the comparison could have been prosecuted without discussion in court.

Demerit Point systems

A large number of member states of the EU have introduced demerit/penalty point systems (DPS) as a means of deterrence, individual feedback and as a precondition for additional individual measures (Holbek, 2007; Kaltenegger, 2007; Sardi, 2007; Schade, 2006; Gégény, 2007; Moreno Ribas, 2007). Whereas some DPS have been developed and implemented some 50 years ago, others were only introduced during the past 5 years. Some of the DPS seem to have been developed for political reasons and do not follow the necessary criteria. Unfortunately evaluation strategies for DPS have not been conducted by uniform criteria either; therefore outcome measures are not comparable. Systems like the one in Italy have not been successful at all and there is a tendency to change the relevant law (Sardi, 2007).

The European Council's Pesrpective

The purpose of a Council recommendation (EC, 2001) was to sensitize all levels of society to the dangers of alcohol abuse among young people, including manufacturers and retailers of alcoholic beverages, as well as parents. It also addresses the different aspects of the problem, from irregular binge-drinking to alcohol dependency among young people. The strategies proposed are to:

- promote research into all the different aspects of problems associated with alcohol consumption by young people with a view to identifying and evaluating measures to deal with them;
- ensure that general health promotion policies targeted at all the groups concerned (children, adolescents, parents, teachers, etc.) should include the alcohol issue;
- foster a multisectoral approach to educating young people about alcohol involving, as appropriate, the education, health and youth services, law enforcement agencies, non-governmental organizations, the media, etc.;

- encourage the production of advisory materials for children, adolescents and parents;
- increase young people's involvement in youth health-related policies and actions;
- develop specific initiatives addressed to young people on the dangers of drink-driving;
- take action as a matter of priority against the illegal sale of alcohol to under-age consumers.

There are numerous examples of how the Commission takes action on this strategy. One outstanding example was the funding of the EU project SUPREME (see 3.2).

Recent research on best practice

As young novice drivers display a lack of driving experience as well as social and biological immaturity they are often impaired while driving. This impairment results from alcohol and drug use, fatigue and distraction. Alcohol influences the young driver's performance to a larger extent. Illicit drug use is on the increase in this age group (with slight differences in various member states of the EU), thus leading to an increased crash risk, particularly when different drugs and alcohol are used in combination. Members of this age group are also more often affected by loss of sleep, the task duration and the biological clock (driving during sleeping hours), with all these factors contributing to increased fatigue and increased risk. Distraction as a cause of driving error is typical for novice drivers. (ERSO, 2008).

The EU project SUPREME (**SU**mmary and publication of best**P**ractices in **R**oad safety in the **E**u **ME**mber States) aimed at the identification and description of best practice measures in road safety in the 25 EU member states and in addition Norway and Switzerland. A second goal was to implement these measures in as many countries as possible. In order to achieve this goal, so called “country experts” from 27 states collected 250 potential best practice measures. As no criteria for the definition of best practice existed, new criteria were developed: (1) the objective of a measure, the extent of the safety gain and the expected benefit should have been defined before the implementation of the measure, (2) a rigorous evaluation should have analyzed the safety gain and the cost-benefit ratio. (3) The measure should be accepted by the population and by decision makers and it should be sustainable and transferrable. Many of the selected measures were not categorized as best practice because an evaluation was neither planned before the implementation of the measure nor conducted afterwards. This is an important result not only from the viewpoint of the scientist: excellent ideas may not prevail because there is no and possibly never will be any evidence of the effect.

The project revealed 25 best-, 20 good- and 10 promising practice measures. As additional measures may be added after an evaluation process and existing measures may need change or adaptation in the course of time, it is recommended that the list of all measures is kept in the European Road Safety Observatory (ERSO). The list will contain measures regarding:

Education and campaigns
Driver education, training, licensing
Rehabilitation and diagnostics
Vehicles
Infrastructure

Enforcement
Statistics and in depth analysis
Institutional organization
Post accident care

The SUPREME collection contains numerous examples of best practice measures; table 1 shows a selection of **rehabilitation programs** evaluated by the SUPREME project

Country	**Target Group and Goal**	**Best Practice Evaluation**
Belgium	Drivers 18-25 (BAC < 0.05‰) Optional Social workers, psychologists	"fulfilling quite a good part of BP guidelines"
Portugal	DUI drivers + negligent homicide Psychological background of negligent behavior Not individually tailored	"only few elements of best practice"
Austria	DUI & DUID drivers Psychological and therapeutic measure Conducted by specially trained psychologists	"corresponds to large extent to BP criteria"
Switzerland	DUI recidivists Optional Specially trained psychologists	„complying to large extent to BP guidelines"
Germany	Novice drivers with offences Mandatory by law No evaluation as yet. *(NAFA: evaluation showed highly significant effects of rehab courses for novice driver alcohol offenders)*	"several elements in line with BP" *(not included in SUPREME)*
Latvia	All traffic offenders, including DUI Mandatory Course leaders need "higher education"	"moderately well corresponding to BP criteria"

Table 1: selection of rehabilitation programs evaluated by the SUPREME project

Possibly because of the selection of country experts, some highly efficient measures are not listed in the project; this applies e.g. to a German measure (NAFA: Rehabilitation of young

novice drivers with alcohol offence/s). The evaluation of this measure had shown a highly significant reduction of alcohol-related offences as well as alcohol-related accidents compared to non- participants (Evers, 2000). The program has been in use ever since 1989.

Other measures in the categories "Education and campaigns", "Driver education, training, licensing" and "Diagnostics" are not described in this paper; a comprehensive picture of the status of those measures is given in the SUPREME report (Siegrist, 2007). SUPREME highlighted interlock devices, Swedish Safety Halls (Nyberg et al., 2005) – meanwhile also implemented in Luxembourg and Finland -, demerit point systems (Nickel, 2006), the probationary license for novice drivers, a zero alcohol limit for young drivers and diagnostic assessment in case of drug driving as at least promising measures. The question whether campaigns like the Bob Campaign (designated driver program included in the listed measures) will have sustainable effects for a larger proportion of novice drivers and thus cut down the fatality rate remains yet to be answered. There has not been any research on the combined effects of a variety of measures selected and recommended in SUPREME; the sustainability of positive effects also depends on the number and types of side effects which therefore should be observed and controlled.

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A REVIEW OF THE YOUNG IMPAIRED DRIVER PROBLEM IN AUSTRALIA, WITH A PARTICULAR FOCUS ON NEW SOUTH WALES

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This paper reviews the status of alcohol, drugs and traffic safety in Australia, with a focus on the problems posed by young impaired drivers. Alcohol remains the most critical drug for road trauma. The use of common impairing substances other than alcohol among young drivers in Australia will be reviewed. Strategies for combating impaired driving in Australia in recent years include enforcement strategies such as random breath testing, responsible service of alcohol programs, alcohol ignition interlock programs and interventions targeting repeat drink driving offenders for assessment of alcohol-dependence, and promotion of the use of personal alcohol breathalyzer devices. Interventions targeting the alcohol industry are also being pursued. Interventions to address drug driving are less common, but include the recent introduction of random roadside drug testing as well as interventions to promote safe celebrating.

This paper provides a brief review of the nature of impaired young drivers in Australia, with a particular focus on the situation in New South Wales.

It is proposed that the nature of the impaired young driver cannot be understood without reference to adolescence (and particularly the context in which use of alcohol and other drugs may commence), and to the driver licensing system in which a young person commences to drive a motor vehicle. It is further proposed that the entry into the driver licensing system in New South Wales (described as a graduated driver licensing system) might well be considered a blue ribbon model for such systems in the management of new drivers.

Driver licensing systems

The development of a regulatory system for licensing drivers to drive motor vehicles on public roads arose more than a century ago, and that the development of an organised driver licensing system is a feature of all motorised societies (Faulks, 1997; Faulks, Smith & Smith, 1997; STAYSAFE 37, 1997). The trend over time has been for increasing sophistication within driver licensing systems, with increasing restrictions upon drivers in different licence classes regarding the type and degree of driving experience and regarding the type of vehicle that can be driven. Typically, such developments and elaborations of the driver licensing system have been piecemeal, and developed and implemented in response to community pressures and demands for improvements in drivers' safety behaviour on public roads. It is now true to say that it would

now be impossible for any motorised nation to remove or dismantle its driver licensing system, yet there is increasing recognition that modern approaches to driver licensing do not sit well within regulatory and administrative frameworks that often have antecedents extending back to the end of the 19th century.

An examination of the functions of a driver licence system in modern motorised societies reveals that from the time of introduction of the most basic of driver licensing requirements in most motorised nations, a driving licence served a very necessary and continuing purpose in providing a means of personal identification. The development of a reliable means of identifying drivers meant that all drivers could be better monitored and their driving behaviour better managed. In particular, instances of bad driving behaviour usually excessive or inappropriate speeding could be addressed and the legal obligations of a driver to observe traffic law could be enforced.

Importantly, driving licences offered a ready mechanism for penalising bad behaviour: offending drivers could now be removed and prohibited from driving through the mechanisms of licence disqualification, suspension and cancellation.

Other important features of a driving licence soon developed. First, to obtain and continue to hold a driving licence signified that a person had agreed to act in a law abiding and safe manner by voluntarily participating in a regulatory system that restricted access to public roads. And second, to obtain and continue to hold a driving licence signified that a person had acquired and maintained the requisite competencies to drive a motor vehicle. A driving licence thus came to be seen as a document of privilege, not a document of right. No longer did a driver of a motor vehicle have the same automatic rights of access to the road network as did other road users such as a pedestrian, a bicyclist or a horse rider. Certainly, with only limited exceptions any person might aspire to obtain a driving licence, but the granting of that licence and its continued tenure required that each driver observe defined administrative and legal obligations. Individuals intending to become drivers began to be subject to medical tests, tests of their driving ability, and tests of knowledge of road traffic law. Driving a motor vehicle on public roads became, and remains today, a generally accepted privilege to which the majority of the population aspires as of right.

Later, further features of the driving licence emerged. In particular, the restriction upon the ability to gain first access to a driving licence to teenagers, and the process of transition and maturation into adulthood through those same teenage years, provided a nexus that inexorably led to the process of procedure of obtaining a driving licence becoming a significant part of the process of entry into the adult world, that is, of 'growing up'.

As well, licence administrators recognise that the requisite competencies to drive a motor vehicle extend beyond basic car control skills and a cursory knowledge of road traffic law. This recognition led to the development of the concept of a graduated driving licence for new drivers, typically involving three substantive phases: a stage of learning, a stage of probation or provisional licensure, and a stage of full licensure (Faulks, 1997; STAYSAFE 37, 1997; Waller, 2003). In some jurisdictions, including New South Wales, the full implications of a graduated licensing approach are being recognised and explored for the ‘whole of driving life' (Faulks,

1997), with the introduction of various types of restricted or limited licensure for older drivers as their capacities for driving wanes with age or disease.

The various features that are now incorporated into the modern concept of a driving licence have emerged only slowly, and at different times in different jurisdictions. This process is ongoing.

Certainly, there is a core tension within driver licensing systems (Faulks, 1997):

- On the one hand, licence administrators seek to maintain the integrity of databases that provide a unique identifer and a reliable record of information for each driver (including currency of licence, category of licence, information on proven traffic offences, etc.)— this, in fact, was the initial justification for the development of driver licensing systems in the early 20th Century;
- On the other hand, road safety concerns now prescribe that the licensing of drivers must involve the management of each driver to ensure that defined safety and competency standards are attained and maintained.

This tension between driver identification and the management of safe, competent drivers is perhaps most evident for entry into driver licensing systems, that is, for novice drivers (Faulks, 1997; Mayhew, Simpson, Williams & Ferguson, 1998; Stevenson, Palamara, Morrison & Ryan, 2001; Senserrick & Whelan, 2003; Simpson, 2003; Waller, 2003; Williams, 2003; Senserrick & Haworth, 2004; Blows, Ameratunga, Ivers, Lo & Norton, 2005; Senserrick, 2006; Williams, 2007).

Graduated driver licensing

Graduated driver licensing systems were introduced in Australian jurisdictions from the mid 1960s, and there is thus more than five decades of experience with different forms of this licensing approach. A rudimentary graduated driver licensing system was introduced in New South Wales in 1965, and it is useful to examine the features of this basic system. The graduated driver licensing system required novice drivers to complete a period of provisional licensing where several restrictive conditions were imposed (a learner drivers licence had been a requirement for novice drivers since the late 1940s):

- Compulsory carriage of drivers licence;
- Minimum age for obtaining a learner drivers licence of 16 years 9 months;
- Knowledge test of road rules before issuing a learner drivers licence;
- Three months tenure of learner drivers licence;
- 40 mph maximum speed limit for learner drivers;
- Requirement to display an L plate on the front and rear of the vehicle to indicate licence status of driver;
- Must be accompanied by a supervising driver in the front passenger seat who is fully licensed;
- On road test by a driving examiner before issuing a provisional drivers licence;
- 12 month period of provisional licensure;

- Requirement to display a P plate on the front and rear of the vehicle to indicate licence status of driver;
- 40 mph maximum speed limit for provisional drivers.

To summarise, this early form of a graduated driver licensing system was focused on, first, a requirement to provide for the unambiguous identification of novice drivers to other road users, and, as a consequence, the enabling of police enforcement of speed restrictions as facilitated by the open identification of novice drivers.

Since the mid 1960s there have been several elaborations of graduated driver licensing. For most of this period, the regulation of young drivers in the driver licensing system in New South Wales was little changed from the introduction of graduated licensing, despite an enormous increase in motorisation and consequently, an enormous increase in the complexity of the traffic system. Mandatory seat belt wearing laws were introduced in the 1970s, and applied to all drivers. Drink driving interventions such as a prescribed concentration of alcohol law at 0.08 gm/100ml BAC again applied to all drivers. This BAC limit was later dropped to 0.05 gm/100ml BAC for all drivers. An 'effective zero' limit of 0.02gm/100ml BAC was introduced for both learner and provisional drivers in the early 1990s, and a 0.00 gm/100ml BAC was introduced more recently for all learner and provisional drivers.

A two stage provisional licensing system (P1 and P2 licences) was introduced in July 2000 following the exhaustive work of the STAYSAFE Committee in New South Wales Parliament (STAYSAFE 37, 1997; see also Faulks, 1997; Faulks et al., 1997; Faulks, 2000), extending the overall provisional licensing period to a minimum of three years (one year as a provisionally licensed P1 driver, and two years as a provisionally licensed P2 driver) and a maximum period of provisional licensure of up to five years. The tenure of a learner licence was extended to a maximum of three years. A log book system was introduced, requiring the documentation of completion of a minimum of 50 hours of supervised driving. In line with the Australian approaches to graduated driver licensing, the licence classes for young drivers were subject to particular speed limits: learner licence (80 km/h), provisional P1 licence (90 km/h), and provisional P2 licence (100 km/h); and to a general requirement for display of L, P1, and P2 plates on the front and rear of the vehicle being driven. In October 2004, the State Government announced that all Year 9 and 10 students would be taught about personal responsibility on the roads, decision-making and crash causes in a program called 'Shifting Gears'. Later, restrictions on novice drivers being able to drive certain high-powered vehicles were introduced, as well as a requirement for provisional drivers who lose their licence to be able to carry one passenger for the 12 months following the reinstatement of their licence. In addition, the P-plate will show a driver's allowable speed limit.

In the most recent elaboration of the New South Wales graduated driver licensing system, the following changes came into effect on 1 July 2007:

- A peer passenger restriction for provisional P1 drivers under 25 years of age, where only one passenger aged under 21 years of age can be carried from 11:00 p.m. to 5:00 a.m.;
- A licence suspension of at least three months for a provisional P1 driver or motorcycle rider licence holder who commits any speeding offence;

- The clear display of L and P plates on the exterior of the vehicle and adjacent to the vehicle restriction plates;
- A prohibition on the use of mobile telephones (cell phones)—hand held and hands free—for learner and provisional P1 drivers and riders;
- An increase in the mandatory period of supervised driving for learner drivers from 50 hours to 120 hours, and including a minimum of 20 hours of night time driving;
- An increase in the minimum tenure period for learner drivers under the age of 25 years old from six months to 12 months before they can apply for a provisional P1 licence; and
- An increase in the maximum length of the licensing period for learner drivers from three years to five years.

These changes are unlikely to be the last for the New South Wales graduated driver licensing system. A particular issue that has arisen relates to the requirement for 120 hours of supervised driving, and it is proposed that tuition obtained from professional driving instructors may qualify as a three hour award for each hour of instruction, up to a maximum of ten hours tuition from a driving instructor (the '3 for 1' proposal; such a scheme is in operation in Queensland; Stapleton, 2008). As well, the federal Australian government recently announced that it would fund a one hour tuition for all learner drivers from a professional driving instructor provided that a parent or other supervising driver is also present to be introduced to the concept of a methodical and appropriate curriculum of instruction for the training of a novice driver (the keys2drive program; Jerrim, 2008). In Tasmania, it is proposed that a two-stage learner driver licensing process be introduced, with L1 and L2 stages associated with phases of on-road testing. As well, the possibilities offered by intelligent transport systems, particularly in terms of on-board data recorders and intelligent speed adaptation (ISA) are also under consideration and examination.

It is recognised that the newly-licensed driver is over-represented in road crashes, so there is an urgent need for evaluation and change to training, testing and licensing requirements. But as well, it is recognised that personal, social, cultural and environmental factors can exercise a strong influence on safe and unsafe behaviour. Relationships with family and friends, the school and educational environment, and also for many young people the work environment, are important to consider, and there is a focus on developing and delivering effective programs in these areas. Finally, government such as the New South Wales administration recognise the need for public education, and there are specific campaigns aimed at young drivers (see Redshaw, Irwin & Faulks, 2008). These include the 'Speeding: No-One Thinks Big Of You' campaign, featuring:

- the 'Little Pinky' advertisement on television and outdoor advertising (roadsigns, and busbacks), which shows a series of young men speeding and the disapproval reaction of the community to such behaviour—depicted by people crooking their little finger in a judgment of masculinity; and,
- the 'Hectic' internet advertisement, which shows a series of speeding vehicles and offers the drivers of these vehicles very small condoms;

as well as:

- the 'Speed Notes' cinema advertisement, which prompts emotional reactions to post-it notes and other messages left by young drivers to family members as they rush off to school, university, sporting events, or to meet up with friends, and who have been killed in roach crashes during their trip; and,
- the 'Please Slow Down' campaign which comprises two 15-second television advertisements supported by outdoor advertising that shows first a police officer booking a P-plate driver for speeding and second shows the same police office attending a fatal crash involving a P-plate driver.

Despite this continuing evolution, there are some fundamental features of Australian approaches to graduated driver licensing:

- Licensing at relatively later ages, with a minimum age of 17 years old for unsupervised driving in most jurisdictions;
- Modification to the minimum and maximum tenure of learner and provisional licences, with the aim of reducing any pressure for novice drivers to progress to later licence stages through licence expiry;
- The clear identification of novice drivers to other road users, and to traffic enforcement action;
- A focus on restrictions on speed; and
- Zero tolerance for alcohol.

These approaches to graduated driver licensing also occur within the context of other strong road safety interventions affecting all drivers, including:

- Mandatory wearing of seat belts (and for motorcycle and bicycle riders, mandatory wearing of helmets);
- Specific targeted traffic enforcement actions in the areas of speeding (speed cameras, LIDAR), drink driving (random breath testing), and drug driving (random roadside drug testing).

Adolescence, driving and driver licensing

Entry into the driver licensing system is a defining feature of the transition from childhood to adulthood. In developmental terms, this transition from child to adult can be defined as efforts to achieve goals related to the expectations of the mainstream culture; and by spurts in physical, mental, emotional and social development. The transition period is commonly termed adolescence or youth, and is characterised by striking personal changes: physical development (puberty and sexual and reproductive maturation, increases in body height and mass); psychological development (intellectual growth, the development of new cognitive strategies, development of adult relationships); and a move from dependence (reliance on parents, compulsory schooling) to independence (focus on career and work).

One of the most striking aspects of adolescence and youth is the desire to participate in the driver licensing system (Faulks, 1997). An early choice faced by an adolescent wishing to drive a motor vehicle is whether to participate in the driver licensing system, or whether to simply start to drive a motor vehicle without authorisation or licensing. Fortunately, and importantly, a feature of

driver licensing systems in motorised nations is that universally adolescents actively seek to become new drivers through entry into, and continued participation within, a driver licensing system. At a period of life where the changes and challenges facing young people are at the most intense, and at a time when the questioning of societal and individual values is at its most vigorous, adolescents identify with, and participate in, the social convention of driver licensing (Watson, 2004). In fact, it is of particular interest that comparatively little is done within pre-driver and other school-based road safety education programs to introduce and reinforce the notion that a drivers licence must be obtained before driving a motor vehicle is authorised. However, the desire to engage with, and participate in, driver licensing systems develops and is maintained strongly during adolescence.

Adolescence is also a time when more deleterious behaviour may be shown. In particular, adolescence is a time when the drinking of alcohol commences. Further, on average, an adolescent's increasing consumption of alcohol is associated with pre driver and new driver ages. Fortunately, the success of drink-driving deterrence strategies, based heavily on the police conducting random breath testing operations to screen drivers for illegal blood alcohol concentration, has proven a ready counter to alcohol impaired driving. Nonetheless, concern still remains about alcohol use by new drivers, and the possibility of drug impairment of drivers after consumption of drugs other than alcohol (Faulks & Irwin, 2007).

The nature of the problem

It is appropriate to review some background statistics on the New South Wales road transport system. It is likely that, in general terms, the issues arising in New South Wales are typical of those experienced in the other Australian States and Territories:

- In 2006, there were 3,344,000 passenger vehicles registered in NSW, comprising about 80% of the vehicle fleet;
- In 2006, there were 651,600 licensed drivers in NSW between 17-25 years of age, comprising about 14.6% of all licensed drivers;
- 78.0% of persons aged 17-25 years old hold a drivers licence;
- Most of these hold only a drivers licence—629,270, with 22,330 holding a motorcycle and drivers licence (90% of whom are males); and
- In 2007, there were 728,500 persons residing in New South Wales and aged 16-25 years old who held a New South Wales driving licence. The type of licence held by these drivers is shown in Table 1.

TABLE 1: Type of licence held by NSW drivers aged 16-25 years old, as at 30 June 2007 (Source: Roads and Traffic Authority)

Type of driving licence	*No.*	*% of total*
Learner	182,763	25.1
Provisional – P1	122,120	16.8
Provisional – P2	122,120	24.2
Unrestricted	122,120	34.0
Total	728,518	100.0

Overall, drivers aged 16-25 years old comprise 16% of all licensed drivers in New South Wales (i.e., persons licensed to drive a light motor vehicle or ride a motorcycle), but these drivers are involved in 31% of fatal road crashes. Moreover, a drink driver aged 17-25 years is involved in 38% of all fatal crashes where alcohol is involved.

While crashes involving learner drivers are uncommon, 14% of all fatal crashes involve provisionally licensed drivers (P1 and P2), even though these novice drivers hold only 7% of the driving licences. Moreover, fatal crashes involving provisionally licensed drivers account for 19% of road fatalities.

P1 licensed drivers are involved in almost three times the number of fatal road crashes than all drivers holding an unrestricted driving licence (in terms of involvement in a fatal crash per 100,000 licence holders), while P2 provisionally licensed drivers have twice the fatal crash involvement compared to holders of unrestricted driving licences. These data reflect the experience in other jurisdictions. The fatality rate was more than three times that of all drivers with 11.1 fatalities per 100,000 population for young drivers aged 17-21 years old, compared to 3.6 per 100,000 for all drivers. Young males are very highly overrepresented in road fatality statistics, with at least three times as many male drivers as female drivers killed each year. Young males are overrepresented in the young driver injury statistics and are at greater risk of more serious injury.

Driver impairment

Impairment to drivers can arise from a variety of causes, including alcohol and other drugs, fatigue and tiredness, and impairments to safe and effective decision making through distraction, stress and inexperience.

Alcohol

Alcohol is legally available for purchase and consumption by adults in New South Wales—the legal age of adulthood is 18 years old. The consumption of alcohol plays a large role in young people's celebrations, and can thus impact on their behaviour as drivers, passengers, and pedestrians to a significant extent. As a driver's blood alcohol concentration increases, so does the risk of crashing (McLean, Holubowycz & Sandow, 1980): at a BAC of 0.05 gm/100ml (low range drink driving in New South Wales), the risk is doubled compared to a sober driver; at 0.08 gm/100ml BAC (mid range drink driving) the risk is seven times, and at a BAC of 0.15 gm/100ml (high range drink driving) the risk of crashing is 25 times that of a sober driver.

As noted earlier, Australian jurisdictions have adopted a zero tolerance approach to drink driving involving novice drivers, for example, in New South Wales the novice range BAC for drink driving is 0.00 gm/100ml.

Strategies for combating drink driving in Australia in recent years include responsible service of alcohol programs, alcohol ignition interlock programs and interventions targeting repeat drink driving offenders for assessment of alcohol-dependence, and promotion of the use of personal alcohol breathalyzer devices. Interventions targeting the alcohol industry are also being pursued. As well, safer celebrating interventions are being developed, as parties and celebrations are an

inherent part of becoming an adult, and provide young people with an opportunity to socialise with friends, meet people and to celebrate significant life events (Faulks & Irwin, 2007).

Drugs other than alcohol

The incidence of drug driving is not well reported in Australian road trauma statistics, and, unlike alcohol, the relationship between drug use and driving performance is not well established. There is a wide range of drugs that can reduce a driver's performance or increase the likelihood that the driver will engage in risky behaviour, including over-the-counter medication, prescription medication, illicit drugs, and other legal drugs that are misused. Drugs that affect driving include cannabis, amphetamines, benzodiazepines, hallucinogens, antihistamines, amphetamines and opiates. Many drivers appear unaware of the effects that drugs can have on their alertness, vigilance and ability to react rapidly to unexpected events. Some drugs can also increase the impairing effects of alcohol and fatigue (Faulks & Irwin, 2007; Mallick, Johnston, Goren & Kennedy, 2007).

The reporting of drug driving across the Australian jurisdictions is somewhat sparse, and is more associated with specific research projects than with routine road trauma statistical reporting. Some routine reporting does occur. In Tasmania in 2006, for example, inattentiveness, excessive speed for the conditions, alcohol, inexperience, exceeding the speed limit and drugs were identified as the leading crash factors. Alcohol was considered to be involved in 19% of the crashes, and other drugs in 10% of the crashes. In Victoria in 2003, 31% of drivers killed in road crashes tested positive to drugs other than alcohol. In South Australia in 2004, 28% of driver and motorcycle rider fatalities tested post-mortem had either THC (the active ingredient in cannabis) and/or methamphetamines in their blood at the time of the crash. If these data are reliable indicators, then it would appear that in terms of risk of involvement in fatal road crashes then drugs other than alcohol pose a significant problem (Faulks & Irwin, 2007).

Unlike the situation regarding alcohol, road safety education actions regarding drug driving remain a relatively under-developed area of approach. While young people are aware of the risks and legal ramifications of drinking and driving, when it comes to illicit drugs there seems to be less understanding. In a recent study by the National Drug and Alcohol Research Centre of nightclub patrons in Sydney, New South Wales, just under 40% of those surveyed (average age of 23 years old) admitted driving under the influence of drugs, and just over 70% of young people admitted to being passengers in a car while knowing the driver was drug-affected. Young people admitted to driving after using drugs such as: ecstasy (four in ten); methamphetamines (three in ten) and cocaine (two in ten). Most people admitted to driving just two hours after taking ecstasy and less than an hour after taking ice, cocaine or speed (Ross, Campbell, Degenhardt & Dillon, 2007).

Cognitive and attentional impairments (driver fatigue and tiredness, distraction, etc.)

Driver impairment can also occur through fatigue and tiredness, and unsafe and erroneous decision making through distraction, stress and inexperience. It appears that there may be an over-representation of young drivers aged 17-25 years in crashes that are judged to be fatigue-related. Driving at night time is associated with an increased risk of crashes by young drivers, which may be related to fatigue and tiredness, although other factors such as the presence of peer passengers, driving for recreational purposes, poorer visibility of the road environment and other

vehicles and road users, inexperience and unfamiliarity with the road system, etc., may have a significant bearing on the risk of crashes.

Speeding

Excessive or inappropriate speeding is the largest single behavioural factor identified as contributory to road trauma in New South Wales. It is judged to be contributory to more than one third of fatal crashes involving young people aged 17-25 years old. This is not surprising: novice drivers are in the process of developing their driving control, knowledge of risks, hazard perception skills, and driving experience. A learner driver, subject to the control and advice of a supervising driver, is unlikely to drive at an inappropriate speed, let alone exceed the posted maximum speed limit. However, a provisionally licensed driver, driving solo or with passengers, may chose to drive at an increased speed that is inappropriate or in excess of the posted maximum speed limit.

The risks of excessive or inappropriate speeding are now well established: travelling at 5 km/h over the posted maximum speed limit doubles the risk of an injury crash, and the risk doubles again for each additional 5 km/h over the speed limit (Paine & Faulks, 2007). This, of course, in part due to drivers travelling at higher speeds having less time to react to dangerous situations and, in the event of a crash, and increased likelihood of injury.

In New South Wales, provisional drivers are over-represented in speeding violations. Provisionally licensed drivers comprise 34% of all speeding infringements in excess of 30 km/h over the posted maximum speed limit, and a staggering 41% of all speeding infringements in excess of 45 km/h over the posted maximum speed limit. It is known that young drivers not only drive faster than older drivers, but also are more likely to receive traffic violations for speeding. To counter this, there is an automatic loss of licence for at least three months for provisionally licensed P1 drivers in New South Wales who are caught speeding.

Other areas of intervention for drink drivers and drugged drivers

There are also approaches that might be contemplated for enhancing the road environment. Roadsides are often unforgiving for mistakes made by impaired drivers, especially when inebriated or drugged drivers chose to drive, but also when drivers are distracted, inattentive, fatigued or just plain inexperienced. Crashes where a vehicle strikes a fixed object such as a utility pole or tree are often found to be alcohol-related. It has been suggested that improvements in road information might help inebriated drivers, including chevron alignment signs and a wide edgeline, but little progress has been achieved in this area. Opportunities to reduce the hazardous nature of roadsides, for drivers who stray from the roadway, or lose control, include the use of wire rope safety fencing and other barriers, and the removal, relocation or guarding of roadside furniture such as utility poles. It appears that progress is unduly slow in selecting and correcting problems on roadsides (Rechnitzer & Grzebieta, 1999).

The principal vehicular countermeasure to drink-driving is the breath alcohol ignition interlock, which is a device that, when fitted appropriately to the ignition system of a motor vehicle, will not allow a driver to start the vehicle if breath alcohol is present. Breath alcohol ignition

interlocks are usually considered as a measure for the management of a convicted drink-driver, rather than as preventive measure for all drivers who might otherwise drive drunk (Griffiths, Brown, Wilson & Bailey, 2004).

The incidence of seat belt wearing by alcohol-affected drivers is lower than for the general driving population and are therefore more at risk of severe injury or death, so vehicle-based interventions such as seat belt interlocks might be expected to yield some overall road safety benefits through trauma reduction involving impaired drivers. To date, this issue has not been well explored in Australian jurisdictions.

Alcohol and other drugs in context

It is instructive to consider alcohol and other drugs and the traffic safety of young drivers in the context of their use, misuse and abuse within communities. Again, New South Wales is a good example, as the government has held two important community and research summits: drugs, in 1999; and alcohol, in 2003. These summits have provided unique opportunities to subject to scrutiny, and to rethink and reconsider, drug and alcohol policies in New South Wales. In response to the outcomes and recommendations of these summits, public sector agencies were required to review existing policies and programs, if necessary, refocus services or create new services, and each drug or alcohol program was to be evaluated under an evidence-based approach.

The 1999 drug summit involved politicians, health workers, police and the community, and considered a wide range of drug programs and strategies targeting illicit drugs, including in the areas of: drug prevention and education; drug treatment; health and welfare training; research; and law enforcement. The results were encouraging, with review studies reporting reductions in drug-related crime and drug-related adverse health outcomes.

The 2003 summit on alcohol abuse again involved politicians, health and safety workers, police and the community, but also included the alcohol and entertainment industry. As alcohol is a legally available drug within the community, the actions proposed under the plan were qualitatively different to those which emerged from the Drug Summit in 1999, with its focus on new resources and new programs. The focus was to develop a plan to change the culture of alcohol use through tackling alcohol abuse, and coming to a considered response about alcohol use with the community. The general concept was to place the emphasis on greater awareness and responsibility for the use of alcohol in the community.

The New South Wales summits on drugs and on alcohol are instructive, as they illustrate attempts for a whole of government approach to dealing with illicit drugs and alcohol, respectively. The outcomes arising from the summits, in terms of publications of contributed papers, and recommendations for action, where subjected to an open process of consideration and public reporting. New strategic plans were developed, and the process of implementing these plans is ongoing, both in terms of explicit actions and also through influence on later policy and program development (e.g., the publication of a new State Plan for New South Wales in 2006). There have been some dramatic changes (e.g., the establishment of a safe injection facility for intravenous drug users), but most changes have been incremental, not dramatic, and the

course of change has been a combination of existing measures, ideas implemented since the Summit and new initiatives.

Similar events have taken place around Australia. For example, in Queensland In March 1999, the first Youth Drug Summit was organised by Queensland Health with about 70 delegates including youth workers, young people and health and community service workers. A second Youth Drug Summit was held in October 2001 with over 50 young people participating from all over Queensland - from Brisbane and the Gold Coast to the Burdekin and the tip of Cape York Peninsula. A national Alcohol Summit is proposed for the near future. It is of interest to note that even prior to such a summit, the Australian government has announced that it is planning to unify laws across all states and territories to control the supply of alcohol to minors (under 18 years of age) but has ruled out banning young people aged 18 to 21 years from purchasing, possessing and consuming alcohol (Hall, 2008).

Comment

This paper has briefly discussed some of the approaches undertaken in Australia (and particularly New South Wales) to manage alcohol, other drugs and traffic safety, with a focus on the problems posed by young impaired drivers (see also Faulks & Irwin, 2007). Alcohol remains the most critical drug for road trauma, but the indicators for drug driving are cause for concern. Strategies for combating impaired driving in Australia in recent years include enforcement strategies such as random breath testing, responsible service of alcohol programs, alcohol ignition interlock programs and interventions targeting repeat drink driving offenders for assessment of alcohol-dependence, and promotion of the use of personal alcohol breathalyzer devices. Interventions targeting the alcohol industry are also being pursued. Interventions to address drug driving are less common, but include the recent introduction of random roadside drug testing as well as interventions to promote safe celebrating. While enforcement actions for drug driving have generally been introduced with little public concern, there have recently been some critical comments (see, e.g., Hall & Homel, 2007), and indeed, a formal inquiry to investigate civil libertarian concerns by the Australian Capital Territory government.

This paper has proposed that the nature of the impaired young driver cannot be understood without reference to adolescence (and particularly the context in which use of alcohol and other drugs may commence), and to the driver licensing system in which a young person commences to drive a motor vehicle (see also Sweedler, 2008). Overall, the management of impaired young drivers in Australia occurs in the context of what can be described as Australian graduated driver licensing systems (for a contrasting perspective, see, e.g., Waller, 2003). Australian jurisdictions require the licensing of young drivers at a relatively late age (typically at a minimum age of 17 years old) and impose a number of specific restrictions not commonly seen in overseas graduated driver licensing approaches, including relatively long maximum tenure of learner and provisional licences with the aim of reducing any pressure for novice drivers to progress to later licence stages through licence expiry; requirements for display of a unique identifying plate on the vehicle driven to indicate licence status to other drivers, road users and to police; speed restrictions according to licence category; and a zero alcohol requirement. Such systems might well be considered a blue ribbon model in the management of new drivers.

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SECTION II. CHARACTERISTICS OF YOUNG DRINKERS, DRIVERS, AND CRASHES

YOUNG DUI OFFENDERS SEEN IN SUBSTANCE ABUSE TREATMENT

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Introduction

Despite considerable efforts to reduce the burden of driving while under the influence of alcohol or drugs, Driving Under the Influence (DUI) crashes remain a major road safety problem (Chou et al., 2006). While research has demonstrated that apprehended DUI offenders are often a heterogenic group (Begg et al., 2003; Nochajski & Stasiewicz, 2006), young offenders remain an "at risk" group and continue to be disproportionately represented in DUI statistics (Chou et al., 2006; Chirstoffersen et al., in press; Greening & Stoppelbein, 2000; Horwood & Fergusson, 2000). Young men ages 18 to 20 reported DUI more frequently than any other age group (Shults et al., 2002; Quinlan et al., 2005), and not surprisingly, age and DUI have a negative relationship (Chou et al., 2006). Being involved in an alcohol-related crash at a young age does not appear to be a significant deterrent against re-offending, as research has indicated such individuals are in fact more likely to drink and drive as well as crash again in the future (Ferrante et al., 2001). And young males are at a higher risk of engaging in DUI offenses than females (Chou et al., 2006), although an increasing number of females are being apprehended for DUI offenses and entering treatment programs as a result of a DUI (Maxwell et al., 2007).

In regard to the changing risk factors associated with DUI within this population, research is beginning to demonstrate that young drivers may in fact be more likely to drive after consuming drugs rather than alcohol (Fergusson et al., in press). Historically, there has been the general assumption that alcohol plays a greater role in DUI crashes than other substances (National Traffic Safety Administration, 1999; Sexton et al., 2002), and DUI education programs have traditionally reflected this assumption. As a result, many communities have focused on investing funds into drink driving legislation and awareness campaigns with little attention directed towards other drugs such as cannabis (Fergusson et al., in press). More recently, a growing level of focus on drug driving behaviors has resulted in an increasing body of evidence that suggests motorists, in particular younger drivers, are in fact more likely to consume illicit substances and then drive rather than drink and drive (Davey et al., 2007; Fergusson et al., in press). These younger drivers are 2.5 times more likely to drug and drive than drink and drive (Fergusson et al., in press), and research is beginning to demonstrate that drugging drivers are more likely to persist with their offending behavior than drinking drivers (Christophersen et al., 2002; Nochajski, 1999).

Pooled data from the 2002 and 2003 U.S. National Survey on Drug Use and Health found that 21 percent of those ages 16 to 20 reported DUI involving either alcohol or illicit drugs in the past

year. In this age group, 17 percent reported past year DUI involving alcohol, 14 percent reported DUI involving illicit drugs, and 8 percent reported DUI involving a combination of alcohol and illicit drugs used together (SAMHSA, 2004).

Sanctions for driving under the influence include fines and incarceration to deter drinking and driving, incapacitating actions such as license suspensions and vehicle actions, education programs, and treatment. Education programs assume the driver committed the offense because of lack of knowledge about the laws, the effects of alcohol or drugs on driving, and ways to avoid driving under the influence. The education programs are targeted to first-time offenders and are generally delivered in a classroom setting of 10 to 14 hours (Voss & Fisher, 2001).

Recently, research has been directed towards developing effective technologies to detect individuals who have consumed drugs before driving (International Council on Alcohol, Drugs, and Traffic Safety's Working Group on Illegal Drugs and Driving, 2005). These research initiatives have been complemented with new legislation in a number of countries that involve random roadside drug testing of motorists and/or testing of drivers suspected of being under the influence of drugs. The increased attention on drug driving behavior (especially through improved detection methods) is proving fruitful as it is highlighting the extent of the problem in Australia as well as other countries that are embracing new testing approaches (Davey et al., 2007). However, questions remain as to the characteristics of these young drivers, changes in their substance use patterns over time, and whether the use of drugs is being adequately reflected in the DUI education programs.

To increase the effectiveness of these DUI education programs, more information is needed on the characteristics of minors arrested for driving under the influence. Between September 1, 2002 and July 1, 2006, 10,532 young Texans under age 21 were arrested for a DUI; they composed 7.5% of all DUI arrests in Texas during that time period. Of this young population, 5 were age 15, 25 were age 16, 821 were age 17, 2249 were age 18, 3362 were age 19, and 4071 were age 20. Some 2.5% were Black males, 0.5% were Black females, 69% were White males, and 15% were White females (Maxwell, 2008). The ethnicity was not reported, which is a major problem, given 36% of the Texas population in 2006 was Hispanic (American Community Survey, 2006). The driving record also does not provide information on the substances found in the driver. Further, no demographic information on students mandated to DUI education programs in Texas is collected. Because of the lack of available data, this article used data on young DUI offenders who entered alcohol and drug treatment programs to begin to learn more about the characteristics of impaired drivers in Texas who were under the age of 21.

The study focuses on two research questions:

- Have changes in demographic and consumption patterns occurred over time?
- What are the risk factors that influence treatment entrance, completion, and abstinence 90 days after discharge from treatment?

Methods

Subjects

This is a secondary analysis of an administrative dataset containing records on 131,505 minors under age 21 admitted to treatment programs funded by the Texas Department of State Health Services (DSHS) between 1990 and 2007. Of these young clients, 5,927 were (a) on probation for driving under the influence (DUI) at the time of their admission to treatment, (b) were referred to treatment by a DUI probation officer, or (c) reported at least one DUI arrest in the past year. For brevity, they are referred to as "DUI clients." Changes in demographics over this 17 year period were examined, followed by a more in-depth comparison of DUI and non-DUI minor clients admitted in 1997 and in 2007. The 1997-2007 time period was chosen because new variables of interest, including the Addiction Severity Index (ASI) (McLellan et al., 1980), were added to the dataset in 1996.

The dataset was extracted from the Behavioral Health Integrated Provider System (BHIPS), which is an Internet-based reporting system developed by DSHS. BHIPS provides record keeping and support of state and federal administrative data reporting requirements, including the federally-mandated Treatment Episode Data System (TEDS). Reimbursement for services is tied to submission of the required client data forms. Local treatment providers submit the data on individual clients on-line and the BHIPS system edits data at submission. The treatment programs reporting to BHIPS provide services across the state and eligibility is based on clinical and financial need. Private programs that serve individuals with means to pay for their treatment do not report to this dataset.

DSHS provided a copy of the dataset to the lead author. No identifying information was received on any client and this research was approved by the Institutional Review Board of the University of Texas at Austin.

Data collected at admission in 1997 and in 2007 reflect the living and economic status of DUI and non-DUI clients at that time, as well as substance use of the client in the month before admission, and the number of days in that last month that the client experienced any of the six domains of the ASI. Past-year questions include number of DUI and public intoxication arrests and number of months employed. Questions about conditions more than a year ago include age at first use of primary, secondary, and tertiary problem substances and number of prior treatment admissions.

Analysis

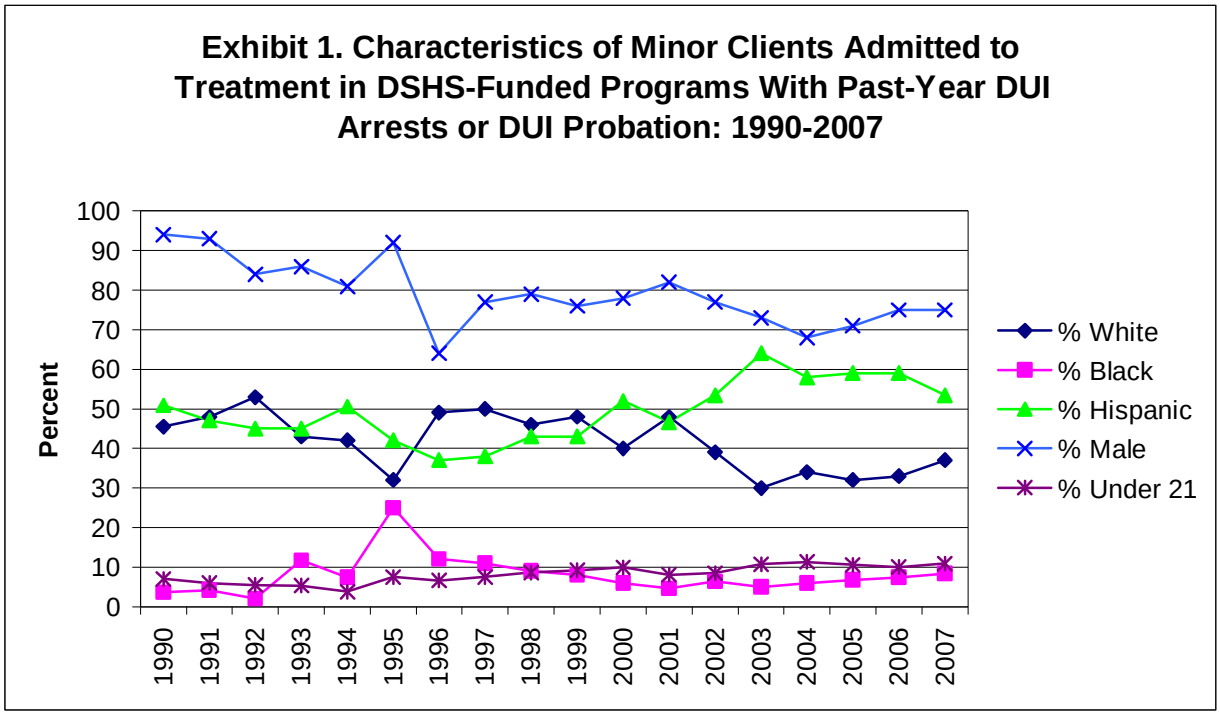
Means are reported for continuous data and categorical variables. When comparisons between clients are made, t-tests are used for comparisons between normally distributed continuous data and χ^2 for categorical data. Bivariate and multivariate odds ratios were calculated using SAS v9.13 PROC GENMOD (SAS Institute, Inc., Cary, NC), which can model categorical, ordinal, and continuous responses. Variables that approached a significance of $p<0.10$ were included in multivariate logistic regression analyses to identify risk factors associated with treatment admission and completion. Because clients within a local program might have characteristics

more similar to each other than those randomly selected from other programs, the Generalized Estimating Equation (GEE) model was used to account for the variation in user characteristics due to treatment programs. Significance was set at $p<0.05$ using the GEE parameter estimates.

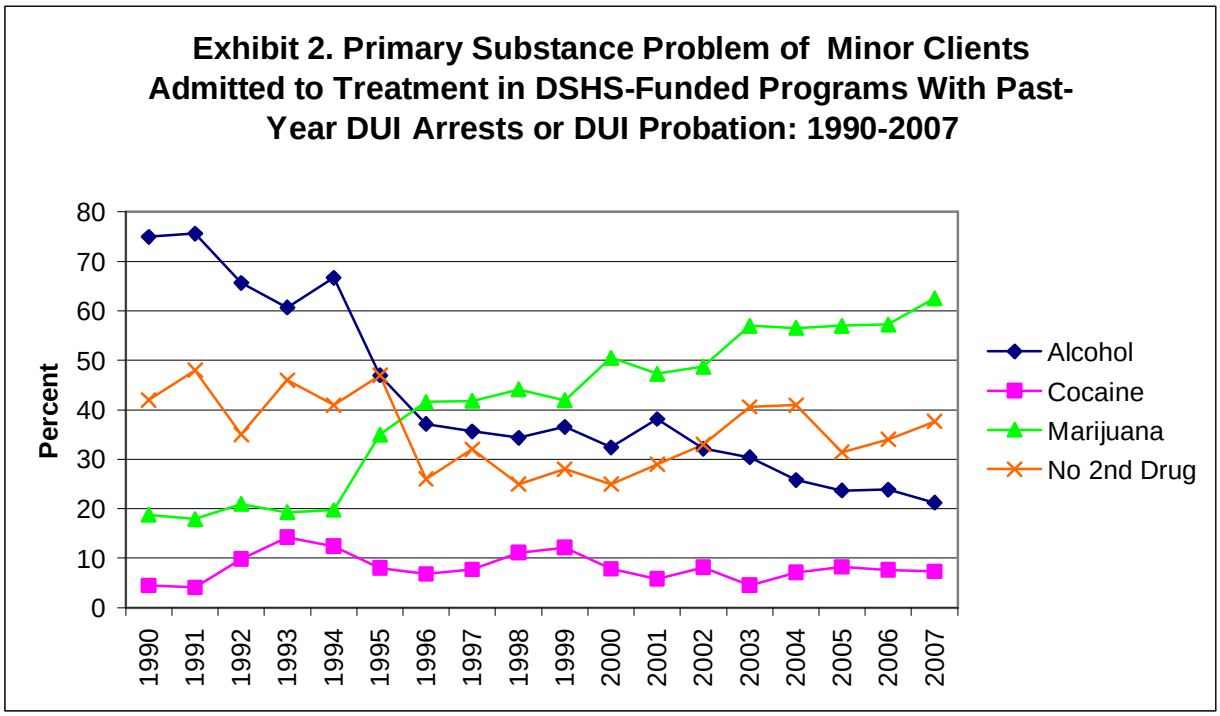
Results

Changes in DUI Clients at Admission to Treatment from 1990-2007

The first aim of the study was to examine the changes over time in the characteristics of youths under age 21 who entered treatment as DUI clients (Exhibit 1). Between 1990 and 2007, the proportion of all DUI admissions who were under age 21 increased from 7% to 11% (p<.0001), the proportion that was male decreased from 94% to 75% ($p<.0001$), and the proportion that was White decreased from 46% to 37%, while the proportion of Hispanics increased from 51% to 54%, and the proportion of Blacks increased from 4% to 8% ($p<.0001$).



As seen in Exhibit 2, between 1990 and 2007, the proportion of young DUI reporting a primary problem with alcohol decreased from 75% to 21% ($p<.0001$), the proportion with a primary problem of marijuana increased from 19% to 63% ($p<.0001$), and the proportion with a primary problem with cocaine increased from 5% to 7% ($p=.0003$). This population was also becoming more likely to be polydrug users: in 1990, 58% reported they had problems with more than one substance, but by 2007, 62% had problems with multiple substances ($p<.0001$).



Characteristics of DUI Clients at Admission to Treatment from 1997-2007

Table 1 compares the characteristics of individuals under age 21 who entered treatment as a DUI client in 1997 to those who entered in 2007. Clients in 2007 started their drug use at an earlier age, were more likely to be Hispanic, were less likely to have a primary problem with alcohol, and were more likely to report more days of problems on three of the six ASI scales.

Table 1. Demographic Characteristics of Minor Clients Admitted to Treatment in DSHS-Funded Programs With Past-Year DUI Arrests or DUI Probation: 1997 and 2007

	1997	2007	*p*
n	258	1011	
Average Age	17.5	17.3	
Average Age First Use	14.6	13.9	***
% First Treatment	86.9	87.8	
% Male	77.4	74.8	
% Black	10.7	8.4	
% White	50.2	37.2	**
% Hispanic	38.0	53.5	***
Months Employed Past Year	5.8	4.7	*
Mean Years Education	9.7	9.6	
% Homeless	3.9	7.3	*
% Primary Alcohol Problem	35.7	20.2	***
% Primary Stimulant Problem	3.0	3.0	
% Primary Cannabis Problem	41.8	62.7	***
% Primary Powder Cocaine Problem	7.7	7.3	
% No Secondary Drug Problem	31.8	37.6	
% History IV Use	16.5	4.5	***
Days of Health Problems in Last 30	1.9	1.4	
Days of Employment Problems in Last 30	7.7	10.5	**
Days of Family Problems in Last 30	6.9	9.2	**
Days of Social Problems in Last 30	3.7	7.6	***
Days of Psychological Problems in Last 30	8.7	3.1	***
Days of Drug/Alcohol Problems in Last 30	8.9	10.2	
Used Daily in Last 6 Months	31.4	30.8	
# Public Intoxication Arrests Past Year	0.9	0.2	***

**p=.05*

***p=.01*

****p<.0001*

In comparison to those clients under age 21 who did not come to treatment in 2007 as a result of a DUI (Table 2), the young DUI clients in 2007 were more likely to be male, White, to have a primary problem with alcohol, to have worked more months in the past year, to have had more arrests for public intoxication (PI) in the past year, and to report more days of problems in the 30 days before admission on four of the ASI scales. Those clients who had not had a DUI started using drugs at a younger age, were more likely to be Black, to have a primary problem with powder cocaine, a history of injecting drug use, and to use their primary drug daily.

Table 2. Demographic Characteristics of Minor Clients With or Without Past-Year DUI Arrests or DUI Probation Admitted to Texas DSHS-Funded Programs: 2007

	2007 DUI	2007 Non-DUI	*p*
n	1011	13418	
Average Age	17.3	17.2	
Average Age First Use	13.9	13.6	**
% First Treatment	87.8	91.6	***
% Male	74.8	70.8	**
% Black	8.4	14.6	***
% White	37.2	30.0	***
% Hispanic	53.5	54.2	
Months Employed Past Year	4.7	3.5	***
Mean Years Education	9.6	9.4	**
% Homeless	7.3	7.4	
% Primary Alcohol Problem	20.2	7.7	***
% Primary Stimulant Problem	3.0	4.5	
% Primary Cannabis Problem	62.7	65.2	
% Primary Powder Cocaine Problem	7.3	10.2	**
% No Secondary Drug Problem	37.6	39.8	
% History IV Use	4.5	6.6	**
Days of Health Problems in Last 30	1.4	1.4	
Days of Employment Problems in Last 30	10.5	7.7	***
Days of Family Problems in Last 30	9.2	6.6	***
Days of Social Problems in Last 30	7.6	5.2	***
Days of Psychological Problems in Last 30	3.1	3.6	
Days of Drug/Alcohol Problems in Last 30	10.2	8.8	**
Used Daily in Last 6 Months	30.8	42.0	***
# Public Intoxication Arrests Past Year	0.2	0.1	***

**p=.05*

***p=.01*

****p<.0001*

Over time, the percentage of DUI clients entering residential treatment dropped from 33% in 1997 to 23% in 2007, and the percentage entering outpatient treatment increased from 54% to 76%, which reflects changes in the State's funding priorities.

To determine which demographic and impairment characteristics predicted entering treatment as a DUI client in the period 1997-2007, bivariate and multivariate logistic regression models were constructed with past year arrest (0 = no DUI and 1 = DUI) as the dependent variable. As shown in Table 3, having a primary problem with alcohol and being male were the strongest predictors

of entering treatment as a DUI client, while being African American and having a history of injection drug use predicted not being a DUI offender at admission to treatment.

Table 3. Multivariate Prediction of Entering Treatment with an DUI: 1997-2007

			95% CI	
Risk Factor	Odds Ratios	Pr>Z	Lower	Upper
Alcohol	4.43	***	3.90	5.04
History of Past Needle Use	0.76	**	0.64	0.90
# Days Psychological Problems at Admission	0.99	**	0.98	0.99
Number of Public Intoxication Arrests	1.17	***	1.08	1.26
Age at Admission	1.12	**	1.05	1.20
African American	0.46	***	0.37	0.58
Male	2.18	***	1.87	2.54

**p=<.05*
***p=<.01*
****p=<.0001*

Characteristics of Clients at Discharge from Treatment

The average length of stay in treatment for DUI clients under age 21 dropped from an average of 74 days in 1997 to 65 days in 2007. As would be expected, clients who completed treatment stayed there longer: 75 days for completers versus 55 days for non-completers (p<.0001).

The environment influenced outcomes at discharge: 70% of the DUI patients who entered residential services between 1997 and 2007 completed treatment, as did 51% of those who entered outpatient services (p<.0001). Eighty-eight percent of those DUI clients in residential services were abstinent at discharge, as were 66% of those in outpatient services (p<.0001).

As depicted in Table 4, being abstinent in the month prior to discharge from treatment was the strongest predictor of treatment completion (1 = completed and 0 = non-completion).

Table 4. Multivariate Prediction of Treatment Completion for Minor DWI Clients: 1997-2007

			95% CI	
Risk Factor	Odds Ratios	Pr>Z	Lower	Upper
Length of Stay	1.01	***	1.01	1.02
12-Step Meetings Attended in Last 30 Days	1.04	***	1.02	1.06
# Friends and Family Involved in Treatment	1.25	***	1.14	1.36
Abstinent at Discharge	9.18	***	6.39	13.20
Residential Treatment	1.46	*	1.02	2.10

**p=<.05*
***p=<.01*
****p=<.0001*

Status of Clients at 90 Day Follow-up

The status of clients 90 days after their last treatment episode was then examined. Between 1997 and 2007, 69% of the clients or their families or their probation officers were contacted at

follow-up and 38% of the clients self-reported they had not used their primary problem substance in the month prior to follow-up.

A third logistic regression model was constructed to determine factors associated with being abstinent in the month prior to follow-up (0=use and 1=no use). The strongest predictor of abstinence at follow-up was not having used in the last month of treatment. The strongest risk factors were living in a household at follow-up where the individual was exposed to alcohol abuse or drug use and having been treated in a residential setting (see Table 5).

Table 5. Multivariate Prediction of Past Month Abstinence from Primary Problem Substance at 90 Day Follow-Up for Minor DUI Clients : 1997-2007

			95% CI	
Risk Factor	Odds Ratios	Pr>Z	Lower	Upper
Abstinent Last 30 Days of Treatment	2.79	***	1.89	4.12
Living in Household Where Exposed to Alcohol Abuse or Drug Use	0.31	***	0.19	0.49
ASI Drug Problems at Follow-up	0.89	***	0.86	0.92
ASI Family Problems at Follow-Up	0.95	***	0.93	0.97
ASI Psychological Problems at Follow-Up	1.03	*	1.00	1.06
12-Step Meetings Attended in Last 30 Days	1.10	**	1.04	1.17
Residential Treatment	0.34	***	0.23	0.50

**p=<.05*
***p=<.01*
****p=<.0001*

Discussion

The present research aimed to profile young Texas DUI offenders whose level of impairment was sufficient for them to enter treatment for their alcohol or drug problems.More specifically, the research aimed to determine whether the characteristics of DUI offenders under the age of 21 were changing as well as determine what factors were associated with treatment completion and abstinence.

First, it is noteworthy that over time the proportion of all DUI admissions who were under the age of 21 increased significantly, which is consistent with the general body of research which indicates young drivers remain at a heightened risk of engaging in DUI offences (Chou et al., 2006; Chirstoffersen et al., in press; Greening & Stoppelbein, 2000; Horwood & Fergusson, 2000). However, a more striking finding was the significant reduction in the number of young DUI admissions reporting a primary problem with alcohol and an increasing tendency to report problems with drugs and to have problems with more than one substance. The findings support the assertion that drug use among younger cohorts not only remains a serious problem, but more specifically, indicates that drug use is an increasing proportion of the DUI problem.

Besides supporting previous findings that a growing number of young drivers are likely to consume illicit substances and drive (Davey et al., 2007; Fergusson et al., in press), the results provide evidence that DUI education programs need to focus on drug consumption and the effects of drugs on driving, rather than continuing to primarily focus on the misuse of alcohol. In

regard to this issue, the present study's findings also indicate that DUI program attendee's severity of drug problems may be increasing, as clients in 2007 reported that they started using drugs at an earlier age and were more likely to report more days of problems associated with such usage than the 1997 admissions. Once again, the results show that the DUI offender is changing, and DUI education and intervention initiatives need to recognize and respond to the changes.

Another key finding was that the proportion of females presenting for DUI treatment between 1990 and 2007 increased. This result is similar to contemporary research showing increasing DUI offenses and drug consumption problems among females (Maxwell & Freeman, 2007). This 2007 study of adult females entering treatment in Texas because of a DUI found they were more impaired and experienced more problems than their male counterparts and that additional resources, including treatment for co-occurring mental health problems and living in sober households, may be keys to helping these women achieve abstinence and prevent additional DUI episodes.

In addition to the changing gender distribution of DUI offenders presenting for treatment, this study documented the increasing proportion of Hispanics entering treatment with a DUI. Part of this increase is due to the growing Hispanic population in Texas (from 26% of the Texas population in 1990 to 36% in 2006), and it may also reflect the drinking pattern of Hispanics. Mexican Americans report higher rates of DUI and DUI arrests than other Hispanic groups, have higher rates of drinking and frequency heavy drinking (Caetano, 1988; Caetano & Galvan, 2001), higher mean frequency of drinking, and a higher mean frequency of drinking five or more drinks on the same occasion (Dawson, 1998; Marin & Posner, 1995) than other Hispanic groups. Mexican Americans (who may show relatively high rates of drunk driving) were less likely than Whites to believe that they would be arrested for a DUI even if stopped by the police; they were also less likely to believe that "people they know" consider drinking and driving a social problem (Cherpitel & Tam, 2000). Future research on DUI among Hispanics should include locale of arrest, pattern of DUI enforcement for local police, and the relationship between locale of arrest and prevalence of bars (Caetano et al., 2008). In addition, DUI education programs need to not only be culturally sensitive, but they need to be tailored to the behaviors and beliefs of this specific population, along with a separate curriculum for non-English speaking offenders. Some 23% of clients under the age of 21 entered residential treatment and this paper found that being in a residential program predicted completing treatment. However, it also found that having been in a residential program was a risk factor for not being abstinent at follow-up. These seemingly contradictory findings may point to the chaotic lifestyles of these clients before treatment and after they leave a structured treatment environment, and the potential for more intensive supervision by probation to ameliorate these risky conditions.

The study's limitations should be considered when interpreting the results. First, DUI clients who come to substance treatment are not only a subset of all DUI arrestees, but they are more impaired than most, since they need treatment services. In addition, this study is based on an administrative dataset that is representative only of lower income clients who entered publicly-funded treatment in Texas. The 90 day follow-up data were self-reported and no information was available as to whether or not the results were validated through urinalysis or breath tests. The study was also hampered since it only could report on past-year DUI arrests. The relationship

between being a DUI client and the number of PI arrests in the past year as seen in Tables 1 and 2 may reflect DUI arrests which have been "pleaded down" to a PI, or a PI arrest may be another indication of a severe substance abuse problem that leads to arrests on the street as well as behind the wheel. However, the dataset provided insight into treatment characteristics and the short-term outcomes of those individuals who came to treatment as a result of driving under the influence.

As highlighted within this research study, and similar to an increasing body of international findings (Walsh et al., 2004), a growing issue is the act of drug driving and the presenting abuse and dependence issues that often accompany such a behavior. Therefore, there is a need to ensure contemporary DUI programs account for these substance abuse problems in order to identify and address the underlying problem as well as reduce the risk of further DUI recidivism. In addition to the DUI education process, probation personnel may need to reemphasize that driving under the influence does not just mean alcohol, but also includes other drugs, and the urines of all DUI clients should be monitored for shifts in patterns of substance abuse, such as from alcohol to cannabis (Maxwell et al., 2007).

Despite such limitations,this research paper found that the young DUI population is changing, in particular, their presenting substance abuse problem when they enter treatment. There is a need to direct a greater level of focus towards meeting the needs of this young population. Such research should to be complemented with a closer examination of the core aims and content of DUI education programs. DUI curriculum may have been written more than 10 years ago and not be that relevant to a population which is more likely to drive drugged than to drive drunk. Furthermore, young DUI offenders' characteristics and needs may be quite different to those of adult DUIs, which places a greater level of burden on both program instructors and the referral process.

While current apprehension and enforcement techniques in some countries are reflecting the growing focus on drug driving and substance abuse problems (e.g., random roadside drug testing), questions remain as to whether this focus is also being reflected in the contemporary DUI education curriculum and supervision processes. While the complexity of the DUI problem will always require multi-modal interventions, the continued demonstration of a young DUI group with unique (and increasing) substance misuse problems will further emphasize the importance of not only education, intervention, and treatment, but also the supervision and release process. Currently, it appears further research that focuses on determining the characteristics and needs of young DUI offenders can only benefit the development of effective programs to reduce the impact of substance-related illness.

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PSYCHOSOCIAL/BEHAVIORAL FACTORS THAT PREDICT IMPAIRED AND OTHER RISKY DRIVING: FINDINGS FROM A LONGITUDINAL STUDY

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Introduction

In 2005 in the US, there were 16,885 fatalities in alcohol-related traffic crashes, an estimated 39% of the total fatal crashes, and an additional 254,000 persons injured in alcohol-related crashes. Although alcohol-related crashes have decreased since 1982, they have leveled off in recent years. Young adults ages 21-34 continue to have the highest rates of driving under the influence of alcohol and are involved in more fatal alcohol-related crashes than any other age group of drivers (National Highway Traffic Safety Administration, 2006). While alcohol is the most common substance impairing driving, there are indications that marijuana and other drug use may be increasing, and that the rates of driving under the influence of marijuana and other drugs may also be increasing (Albery, Strang, Gossop, Griffiths, 2000). Thus an understanding of the factors associated with and predictive of impaired driving among young adults is imperative in the search for effective prevention and intervention strategies.

This paper will first describe a longitudinal study of a large cohort of young people that included multiple measures over time of psychosocial and behavioral factors, as well as driving records of study participants from licensure well into young adulthood. Then, results from several study analyses will be summarized.

Problem Behavior Theory (PBT; Jessor, 1987; Jessor, Donovan, Costa, 1991), an approach to understanding adolescent and young adult behavioral development, guided much of the research. This theoretical framework views problem behavior as purposeful, psychologically meaningful, and a component of individual development. Individuals may take part in problem behaviors while "trying on" alternative behaviors, roles, and attitudes, or in testing the limits of social norms. PBT postulates that for problem behavior to persist, it must be supported by contextual components (e.g., parental and family attitudes, peer pressure, or peer support). The authors have replicated and expanded on Donovan's earlier findings (Donovan, 1993), and demonstrated empirical support for the inclusion of drink driving and problem driving (drink driving, drug driving, and high-risk driving) constructs in an extended model of PBT (Shope, Bingham, 2002).

The goal of the longitudinal research study has been to understand the predictors of substance use and impaired driving, so that appropriate, timely, theory-based interventions can be developed, tested, and implemented to reduce the fatalities and injuries from impaired driving traffic crashes. After the study results have been reported, they will be summarized and discussed in terms of their contribution, limitations, and implications for future work.

Longitudinal Study

The longitudinal study of at-risk drinking, risky driving, and drink driving began as a follow-up of two large studies evaluating school-based substance abuse prevention efforts among several Michigan high school graduating classes of 1991-1994. From 1984 onward, both studies periodically collected self-administered questionnaires from public school students (N = 17,099), beginning in grade 5 and continuing through grade 12 (Shope, Copeland, Kamp, Lang 1998; Shope, Copeland, Maharg, Dielman, 1996; Shope, Copeland, Marcoux, Kamp, 1996; Shope, Dielman, Butchart, Campanelli, Kloska, 1992). As the study participants reached age 16 and began to acquire Michigan driver licenses (n = 14,032), their driver license history and crash data were obtained from the state kept updated, and matched to each individual's questionnaire data. Complete driver records have been maintained to date on all participants who retain a Michigan driver license. A series of three telephone surveys, ending in 2006, were conducted with the study participants as young adults (average ages 24.3, 29.4, and 32.3 years). Although the study sample was not drawn to be representative of the general population, comparisons of the study data with statewide data show it to be quite representative.

The study's self-administered questionnaires and telephone survey interviews obtained much self-reported information. Basic demographic data were collected, appropriate to each age level (e.g., age, race, sex, family structure/living situation, education, income, marital status, etc.), as well as miles driven in the past year. PBT categorizes psychosocial and behavioral characteristics into three systems: *perceived environment, personality, and behavior*. The *perceived environment and personality systems* motivate involvement in, or avoidance of, problem behaviors and include the social and physical environment, parent and peer influences, connectedness to conventional social institutions, and individual feelings, perceptions, and attitudes that influence problem behavior. The *behavior system* encompasses both conventional and problem behaviors.

The measures in this study assessed the components of PBT as follows. The *perceived environment system* measures included parental monitoring, parental permissiveness, parental nurturing, parents' attitude toward young people's drinking, and parents' drinking habits, all as perceived by the participants. Perceived risk of drink driving and social support for drinking and for drink driving were also measured. The *personality system* was assessed by participants' risk-taking propensity, physical/verbal hostility, general aggression, susceptibility to peer pressure, and competitive attitude toward driving, as well as their connectedness to school and societal behavioral norms, through measures of parent/peer orientation, family connectedness, tolerance of deviance, marks in school, and expectations for achievement. The *behavior system* measures included substance use (frequency of cigarette smoking and marijuana use, other drug use, alcohol quantity/frequency, alcohol misuse, alcohol consequences), delinquent behavior, problem driving (high-risk driving, drink driving, drug driving), risk-taking driving, driving aggression, and safety belt non-use. Details regarding the specific items and scales used can be found in the study references cited below.

Driver license history data provided information on ticketed moving violations, which were categorized as serious offenses, minor offenses, and alcohol offenses. Points were also

recorded for traffic violations. Crashes, serious crashes, and alcohol-related crashes were also available from the driver license records.

Extent of Impaired and Other Risky Driving

The extent of self-reported impaired and other risky driving among the study sample is shown in Table 1. Higher percentages of men than women reported impaired driving and had serious and alcohol offenses and serious and alcohol crashes on their driving records from age 18 through age 32. The overall percentages of young people who reported driving after drinking at least once in the past year increased from 27% at age 18, to 54% at age 24, to 50% at age 29, and remained high at 48% at age 32. The three young adult survey waves showed 21%, 18%, and 17% of participants reporting driving at least once when high/light headed, or when their coordination was affected; 9%, 8%, and 6% reporting driving at least once while drinking in their cars; 13%, 8%, and 7% reporting driving at least once after using marijuana; and 4%, 5% and 4% reporting driving at least once after using other drugs.

Gender differences in the extent of risky and impaired driving, with men having higher rates than women, is also the case with substance use in these study participants. These differences were explored in one paper (Elliott, Shope, Raghunathan, Waller, 2006), which shed light on some important issues. Analyses demonstrated that the associations between risky driving (offenses, serious offenses, crashes, and single-vehicle crashes) in the first four years of licensure and substance use/environmental influences were generally stronger among women than among men. Interestingly, young women who exhibited risky driving behavior deviated more from the general population of young women with respect to alcohol use, alcohol misuse, and marijuana use than risky-driving young men differed from other young men. Yet, even if young men and women were to eventually have equal levels of substance use, women would likely retain their less risky driving profiles.

Several studies are summarized briefly below that each assess various predictors of impaired (alcohol, marijuana, and other drugs) and other risky driving behavior. The driving outcomes reported come from both self-reported data and state driver license records. Risky driving behavior is included because impaired driving is not always captured in official records – violations may be ticketed at a less serious level and crashes may not be noted as alcohol related or drug impaired. Studies below are presented in the general order of adolescent predictors first, followed by predictors from the first of the young adult surveys.

1. Adolescent Antecedents of Risky Driving Behavior (Shope, Waller, Raghunathan, Patil, 2001)

Study Purpose. This study sought to identify significant adolescent predictors of high-risk driving throughout the early driving years, from first licensure into young adulthood.

Outcomes. The risky driving outcomes predicted were serious offenses (including alcohol-related) and serious crashes (including alcohol-related) that were recorded over an average of seven years of participants' driver histories, from age 16 through age 23/24.

Predictors. Predictors were assessed in the fall term of tenth grade with a self-administered questionnaire. Substance use predictors included alcohol use/misuse, as well as cigarette and marijuana frequency of use in the past year. Parental influence predictors included parental monitoring, parental nurturing, family connectedness, parental permissiveness, parents' attitude toward young people's drinking, and parents' drinking habits as perceived by the study participants.

Methods. Data were analyzed for 4,403 study participants. Sex-specific Poisson regression models (adjusted for age, race, and length of licensure) were conducted in three steps (first substance use variables, then parental variables, and then substance use and parental variables combined). Predicted probabilities were also calculated for positive, average, and negative parental influences and separately for low, average, and high substance use. Joint predicted probabilities were also calculated.

Findings. Tenth grade substance use (alcohol, cigarettes, and marijuana) and negative parental influences (lenient attitude toward young people drinking; low parental monitoring, parental nurturing, and family connectedness) predicted excess risk of serious offenses and serious crashes for both men and women. The combined effect of having both negative parental influences and high substance use in tenth grade were associated with the highest probabilities of having a serious offense or serious crash in the first seven years of driving.

2. Trajectories of Adolescent Risk Factors as Predictors of Risky Driving (Shope, Raghunathan, Patil, 2003)

Study Purpose. This study sought to identify changes over time (trajectories) in adolescent risk factors that predict risky driving in the initial years of licensure.

Outcomes. The risky driving outcomes predicted were serious offenses, alcohol-related offenses, serious crashes, and alcohol-related crashes that were recorded in the first year and first three years of driving.

Predictors. Trajectories (from fifth to tenth grade) of adolescent risk factors (alcohol use, friends' support for drinking, susceptibility to peer pressure, and tolerance of deviance), assessed through school-based questionnaires, were used as predictors.

Methods. Data were analyzed for 4,813 participants. Individual trajectories for each predictor variable were obtained from the slope over time and the last value, and used in regression models. Logistic regression models were used for one-year outcomes and both one- and three-year alcohol-related outcomes. Poisson regression models were used for the three-year outcomes of serious offenses and serious crashes. Analyses were adjusted for demographic measures. The probabilities of having a serious offense or serious crash for five sample trajectories were calculated.

Findings. All four predictor measures (trajectories of alcohol use, friends' support for drinking, susceptibility to peer pressure, and tolerance of deviance) were important, particularly in predicting serious offenses, alcohol-related offenses, and alcohol-related crashes. The highest

probabilities for young adult risky driving were found among those participants with consistently high or increasingly high adolescent trajectories of friends' support for drinking, susceptibility to peer pressure, and tolerance of deviance.

3. Predictors of Alcohol and Other Traffic Offense Patterns (Bingham, Shope, Raghunathan, 2006)

Study Purpose. This study sought to determine adolescent psychosocial and problem behavior factors that predict traffic offense patterns from licensure into young adulthood.

Outcomes. Ticketed minor, serious, and alcohol traffic offenses were counted during two intervals: licensure through age 19, and age 20 to about age 24 from driver license records. Change scores in each offense category from the first to the second intervals were also studied as outcomes.

Predictors. Psychosocial and problem behavior measures averaged from tenth and twelfth grade surveys included parental monitoring, parental permissiveness, parent/peer orientation, marks in school, tolerance of deviance, and a combined substance use measure (seven levels, ranging in seriousness from no substance use to the most serious - cigarette smoking, alcohol misuse, and marijuana use).

Methods. Regression modeling, adjusted for driving exposure (from the telephone survey), tested hypotheses regarding predictors. Poisson regression tested models predicting the number of minor, serious, and alcohol traffic offenses in each interval. Normal regression tested models predicting the change in number of offenses from the first to the second interval. Logistic regression models were constructed to predict the odds of having more offenses in the second interval than the first. All models were tested separately by sex on the 1,956 participants.

Findings. The number of serious offenses decreased across the two intervals, but the number of minor and alcohol offenses increased. For men, more minor offenses were predicted by poorer marks in school and greater substance use in the first interval; and poorer marks in school, greater substance use, lower parent orientation, and lower parental permissiveness in the second interval. More serious offenses were predicted in men by less parental monitoring, poorer marks in school, and greater substance use in the first interval; and poorer marks in school and greater substance use in the second interval. More alcohol offenses were predicted in men by greater substance use in the first interval; and less parental monitoring, poorer marks in school, and greater substance use in the second interval. For women, more minor offenses were predicted by poorer marks in school, greater tolerance of deviance, and greater substance use in the first interval; and poorer marks in school in the second interval. More serious offenses were predicted in women by less parental monitoring and poorer marks in school in the first interval; and lower parent orientation in the second interval. More alcohol offenses were predicted in women by greater substance use in both intervals. When predicting change in numbers of offenses from the first to the second intervals, results showed that an increase in minor offenses was predicted by lower parental permissiveness, lower parent orientation, and poorer marks in school for men; and poorer marks in school for women. Increases in serious offenses were predicted by poorer marks in school for both sexes; and increases in alcohol offenses were

predicted by lower parent orientation and greater substance use for men, and greater substance use for women.

4. Underage Drinking and Subsequent Alcohol Use, Misuse and Traffic Offenses (Zakrajsek, Shope, 2006)

Study Purpose. Updating a preliminary study that showed early age of drinking onset to predict young adults' self-reported drink driving (Shope, Zakrajsek, 2002), these analyses examined the effects of underage drinking onset on alcohol use, alcohol misuse, and risky driving from adolescence into young adulthood.

Outcomes. Outcomes of interest included alcohol frequency/quantity, alcohol misuse, and risky driving (risky offenses, alcohol offenses, crashes, alcohol crashes) within three age periods (under 21, 21-25, and 26 and above).

Predictors. From school-based and young adult surveys, an onset of drinking (at least three occasions in the previous year) category in time was determined for each participant: non-drinker (6%), school non-drinker (4%), grade 12 onset (7%), grade 10 onset (24%), or early onset (under about age 14; 58%).

Methods. Among 1,738 participants, differences in alcohol use and alcohol misuse among drinking onset groups were examined with analysis of variance. Log-binomial regression models were used to examine drinking onset and the likelihood of having a risky offense, alcohol offense, crash, or alcohol crash during each of the three age periods. Models were controlled for sex and educational attainment.

Findings. The earliest drinking onset group reported the highest alcohol quantity/frequency and the most alcohol misuse over time, persisting into young adulthood. They also were more likely than other drinking onset groups to have had a risky driving offense before age 21. The earliest drinking onset group was 2.2 times more likely than all other groups to have an alcohol offense before age 21, 1.6 times more likely to have an alcohol offense between age 21-25, and 2.8 times more likely to have an alcohol offense from age 26 onward. Only 3% of the participants had an alcohol crash, yet all the alcohol crashes were in the driving records of those who reported drinking earliest.

5. Adolescent Developmental Antecedents of Young Adult Risky Driving (Bingham, Shope, 2004a)

Study Purpose. This study examined the longitudinal patterns of adolescent psychosocial factors and substance use in five risky driving groups, which included drink driving and drug driving.

Outcomes. Young adult risky or problem driving data came from self-reported questionnaire measures regarding behavior occurring in the previous 12 months: high-risk driving, drink driving and drug driving. Five driving groups were created that reflected relative driving risk from low to high: Low-Risk Drivers who reported no drug driving and were below the median on high-risk driving and drink driving; High-Risk Drivers who reported no drug driving and

were above the median on high-risk driving and below the median on drink driving; Low-Risk Drink Drivers who reported no drug driving and were above the median on drink driving and below the median on high-risk driving; High-Risk Drink Drivers who reported no drug driving and were above the median on high-risk driving and drink driving, and Drug Drivers who reported any drug driving.

Predictors. Adolescent factors assessed in both tenth and twelfth grades included parental monitoring, parental permissiveness, parent/peer orientation, tolerance of deviance, marks in school, alcohol misuse, cigarette use, and marijuana use. Changes in these measures over time reflected normative developmental patterns: parental control and conventional behavior decreased, and substance use increased from tenth to twelfth grade.

Methods. Data were analyzed for 2,085 participants surveyed in high school and young adulthood. Men and women were analyzed separately. Mixed methods were used to test single level, fixed effects, repeated measures models.

Findings. The most risky young adult driving groups tended to have had the least parental monitoring, the most permissive parents, and the least parent orientation as adolescents. They also tended to have had the greatest tolerance of deviance, and lower marks in school. Finally, young adults in the most risky driving groups tended to have had the greatest increases in alcohol misuse, cigarette use, and marijuana use.

6. Adolescent Problem Behavior (Bingham, Shope, 2004b)

Study Purpose. This study sought to test a hypothetical model hypothesizing that lower parental monitoring and higher parental permissiveness would predict greater tolerance of deviance, lower parent orientation, and lower school performance, which would predict greater substance use (cigarette use leading to alcohol misuse with both predicting marijuana use), which would predict young adult problem driving.

Outcomes. The telephone survey of young adults assessed problem driving during the previous 12 months (high-risk driving, drink driving and drug driving).

Predictors. Fall of tenth grade survey data provided measures of parental monitoring and parental permissiveness, tolerance of deviance, parent/peer orientation, school performance, cigarette use, marijuana use, and alcohol misuse.

Methods. Observed variable path analysis was conducted using data from 1,845 young adults. Hypotheses were tested and a final model developed through several steps that confirmed that the same model predicted problem driving in both men and women.

Findings. Drink driving and drug driving in young adulthood were predicted by adolescent marijuana use, as well as greater alcohol misuse and tolerance of deviance. High-risk driving was predicted by greater alcohol misuse, less cigarette use, greater tolerance of deviance and better school performance during adolescence. These results highlight the qualitative difference

between substance-related driving behavior, which is socially proscribed, and high-risk driving behavior, which is more normative.

7. Personality Characteristics (Patil, Shope, Raghunathan, Bingham, 2006)

Study Purpose. The goal of this study was to examine the association between young adults' personality-related characteristics and risky driving behaviors, including drink driving.

Outcomes. Data from driver license records were used to create counts for the three pre-survey years of all offenses, serious offenses, driver license points, crashes, and serious crashes. Telephone survey data provided measures of competitive attitude toward driving, risk-taking driving, high-risk driving, driving aggression, and drink driving.

Predictors. Telephone survey data provided measures of risk-taking propensity, physical/verbal hostility, general aggression, tolerance of deviance, and expectations for achievement.

Methods. Using the data collected on 5,362 young adults (mean age 23.5 years), multivariate regression analyses, adjusting for age, race, and marital status, were conducted separately by sex.

Findings. For men and women, greater risk-taking propensity, physical/verbal hostility, aggression, and tolerance of deviance were significant predictors of a competitive attitude toward driving, risk-taking driving, high-risk driving, driving aggression, and drink driving. Greater risk-taking propensity, physical/verbal hostility, aggression, and to a small degree, expectations for achievement predicted higher numbers of offenses, serious offenses, and points.

8. Social and Behavioral Characteristics (Bingham, Elliott, Shope, 2007)

Study Purpose. Alcohol use and drink driving are positively correlated and share risk factors or predictors. The goal of this study was to distinguish the contribution of personal risk factors from the level of alcohol use in the prediction of drink driving.

Outcomes. Self-reported measures from the telephone survey were used to create four groups of drink drivers based on their prior 12-month maximum severity of drink driving: 1) never drink drove, 2) drove at least once within an hour of one or two drinks, 3) drove at least once within an hour of three or more drinks or while feeling the effects of alcohol, and 4) drank at least once while driving.

Predictors. In addition to measures of alcohol consumption, several self-reported predictors from the telephone survey were studied: risk-taking propensity, hostility, tolerance of deviance, competitive attitude toward driving, perceived risk of drink driving, social support for drinking and drink driving, delinquent behavior, drug use, cigarette smoking, high-risk driving, drug driving, risk-taking driving, driving aggression, and safety belt use.

Methods. Data from 3,480 young adults who were drinkers were analyzed. Multinomial logistic regression models were tested separately for men and women, and examined the attributable risk associated with predictors of drink driving while adjusting for alcohol use.

Findings. Lower perceived risk of drink driving, greater social support for drinking and drink driving, greater aggression, more delinquent behavior, more cigarette smoking, and more high-risk driving uniquely predicted drink driving severity in models adjusted for alcohol use. The largest attributable risks were associated with social support for drinking and drink driving, and perceived risk of drink driving.

9. Substance-Involved Driving: Alcohol, Marijuana, and Other Drugs (Bingham, Shope, Zhu, in press)

Study Purpose. This study had four objectives: 1) Examine the extent of self-reported driving under the influence of alcohol (DUIA), driving under the influence of marijuana (DUIM), and driving under the influence of drugs (DUID); 2) Identify individual psychosocial characteristics that predict involvement in DUIA, DUIM, and DUID, while adjusting for driving behavior and the use of each substance; 3) Identify individual psychosocial characteristics that predict the degree of substance-involved driving (SID), while adjusting for driving behavior and the use of each substance; and 4) Determine whether the degree of SID predicted driving outcomes, and whether psychosocial characteristics and driving behavior account for that association.

Outcomes. Self-reported substance-involved driving (DUIA, DUIM, DUID) was the outcome of interest. Degree of SID in four levels (never any; DUIA, but not DUIM or DUID; DUIM with or without DUIA, but not DUID; and DUID with or without DUIA and/or DUID) was also an outcome studied, as were traffic offenses from driver license records in a three-year interval centered on each participant's telephone interview date.

Predictors. Measures from the first young adult telephone survey were used as predictors: tolerance of deviance, parent/peer influence, risk-taking propensity, hostility, high-risk driving, and driving aggression. Alcohol frequency-quantity, and marijuana and other drug use were also important.

Methods. There were 5,244 study participants who averaged 24 years old. Analyses were conducted separately by sex, and included logistic regression models for objectives 2 and 4, and multinomial logistic regression models with a general logit link for objective 3.

Findings. Objective 1. For the past year, 61% of men and 45% of women reported at least one DUIA; 17% of men and 5% of women reported at least one DUIM; and 10% of men and 3% of women reported at least one DUID. Objective 2: After adjusting for alcohol quantity-frequency and driving behavior, DUIA in men was predicted by more tolerance of deviance, more high-risk driving, and higher alcohol consumption, and DUIA in women was predicted by more tolerance of deviance, higher risk-taking propensity, more high-risk driving, and higher alcohol consumption. After adjusting for marijuana use and driving behavior, DUIM in men was predicted only by marijuana use, and DUIM in women was predicted by more high-risk driving and marijuana use. After adjusting for other drug use and driving behavior, DUID in men was predicted only by other drug use and age, and DUID in women was predicted only by other drug use. Objective 3. After adjusting for driving behavior and substance use, the degree of SID in men was predicted by more tolerance of deviance, more high-risk driving, and more driving

aggression, and the degree of SID in women was predicted by more tolerance of deviance, more peer influence, higher risk-taking propensity, and more high-risk driving. Objective 4 Having had a traffic offense was predicted by degree of SID, and after adjusting for levels of alcohol, marijuana, and drug use, more hostility and more high-risk driving were significant predictors for men, and for women more high-risk driving and higher age were significant predictors.

Summary and Discussion

All the studies reported above sought to identify significant predictors of adolescent/young adult impaired driving and/or risky driving, using the PBT framework and analyzing data from the longitudinal study. It was indeed possible to identify significant predictors, often of subsequent as well as concurrent outcomes, and there was considerable consistency and fit within PBT among those predictors. Factors in the *perceived environment system* that predicted impaired driving included more social support for drinking and drink driving, less adolescent parental monitoring, more parental permissiveness, and less perceived risk of drink driving. These factors, as well as less parental nurturing in adolescence, also predicted risky driving outcomes. Factors in the *personality system* that predicted impaired driving included more tolerance of deviance, less parent orientation, more susceptibility to peer pressure, more risk-taking propensity, more hostility, more aggression, and poorer marks in school. These factors, as well as less family connectedness, also predicted risky driving outcomes. Factors in the *behavior system* that predicted impaired driving included many measures of adolescent and young adult substance use. The significant factors were early onset of drinking, more (and an increasing trajectory of) alcohol use, more (and increasing) adolescent alcohol misuse, cigarette and marijuana use (and increasing trajectories of use), and more use of other drugs, as well as more delinquent behavior, and more driving aggression. These factors also predicted other risky driving outcomes. In sum, there are a host of important and potentially useful findings from this work that fit well with the findings of other studies. There are, however, several unique features of the study that should be borne in mind,

Limitations of the longitudinal study that should be considered include the fact that the variables studied could not possibly include all those of potential interest, even though the measures selected often came from previous work. Many measures were collected by self-report, which has limitations, although care was taken to assure confidentiality, and objective measures from the driving records were also used (which correlate well with similar self-reported measures). Across the periodic follow-ups, there was study attrition, particularly after high school, due to difficulty contacting participants, although once contacted, almost all continued participating. Care was taken in the analyses and reporting to consider the effects of attrition, and in the ongoing analyses using the last two telephone surveys, multiple imputation for missing data is being used.

What are the implications of these findings? PBT provides an understanding, even an explanation, of impaired and other risky driving in the predictors identified, but does not necessarily guide interventions to prevent impaired and other risky driving. Knowing the characteristics, however, of those who engage in these dangerous behaviors provides us with target groups for interventions. Variables that can be modified should be addressed. Even if some of the predictors, particularly in the personality system, are not amenable to change, they

will be useful in the design and formulation of interventions to assist people in responding to their personality-based proclivities with behavior that does not place themselves and others at risk of injury and death. It is also clear that the impaired driving of young adults has precursors from adolescence, therefore early interventions that prevent the precursors are most important (e.g., to prevent early substance use). Many of the study predictors also point toward parental influences as targets for adolescent interventions. Parents often erroneously assume that their influence is minimal in adolescence as peers become increasingly important. Studies in several areas have shown the importance of parents to adolescents, therefore providing parents with support and parenting tools is essential. Other interventions can target young adults, using some of the study findings. Drink driving behavior, for instance, could be influenced by addressing young adults' perceived risk of drink driving and/or social support for drink driving. In an ongoing study being conducted by the authors (Barretto, Bingham, Shope, Goh, submitted), college students who participated in a brief motivational web-based intervention to reduce or prevent high-risk drinking and drink driving reported positive results following the intervention. The extent of impaired driving and the seriousness of its consequences require that innovative interventions be developed and be well evaluated, and that effective interventions are widely implemented.

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Table 1. Self-reported impaired driving and state-recorded offenses and crashes across four survey waves[1].

	Grade 12			Young Adult 1			Young Adult 2			Young Adult 3		
	Men n=2050	Women n=1985	All n=4035	Men n=2662	Women n=2802	All n=5464	Men n=1131	Women n=1211	All n=2342	Men n=1061	Women n=1341	All n=2402
Mean age (sd)	18.0(.5)	17.9(.5)	18.0(.5)	24.4(.8)	24.3(.8)	24.3(.8)	29.4(1.1)	29.4(1.0)	29.4(1.1)	32.2(1.1)	32.3(1.0)	32.3(1.1)
Drove after drinking	30.7	22.5	26.6	61.8	47.2	54.3	61.6	39.6	50.3	59.7	39.4	48.3
Drove within 1 hr of 1-2 drinks				58.3	43.9	50.9	58.8	36.9	47.5	57.8	36.7	46.0
Drove within 1 hr of 3+ drinks				36.9	16.4	26.4	33.0	12.1	22.2	31.8	10.4	19.9
Drove when high/light-headed				26.9	14.9	20.8	23.1	12.5	17.6	22.9	11.9	16.7
Drove when coordination affected				27.0	15.4	21.1	24.0	12.7	18.2	22.5	11.9	16.6
Drove while drinking in car				13.0	4.9	8.8	11.7	4.0	7.7	8.8	3.7	6.0
Drove after using marijuana				16.7	10.0	13.3	10.5	5.9	8.1	9.5	4.1	6.5
Drove after using other drugs				4.6	2.8	3.7	5.8	4.4	5.0	4.0	3.9	4.0
Serious driving offenses[2]	11.4	4.4	8.0	6.5	3.5	5.1	3.4	1.9	2.7	2.2	1.3	1.8
Alcohol driving offenses	0.8	0.1	0.4	3.3	0.8	2.1	1.9	0.4	1.2	0.9	0.3	0.6
Serious crashes	10.2	7.0	8.7	6.4	4.1	5.3	4.2	2.6	3.4	2.8	1.9	2.4
Alcohol crashes	0.5	0.1	0.3	0.6	0.1	0.4	0.4	0.0	0.2	0.3	0.1	0.2

[1]All values are percentages of respondents with at least one event during the previous 12 months, except Age, which is mean (sd).

[2]Serious driving offenses, Alcohol driving offenses, Serious crashes, and Alcohol crashes are from state driving records. Values are percentages of participants with at least one event during the previous 12 months. Sample is not limited to young adult survey respondents, but includes all study participants (men n=7,293, women n=6,739, total n=14,0

CRASH TYPES: MARKERS OF INCREASED RISK OF ALCOHOL-INVOLVED CRASHES AMONG TEEN DRIVERS

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Introduction

Overall rates of driving after using alcohol have been steadily decreasing in the US for the past two decades, resulting in a steadily decreasing trend in fatalities alcohol-related motor vehicle crashes. This decreasing trend was also true of teen drivers (i.e., those ages 16-20 years) until the early to mid 1990s when the declining rate of alcohol-related crashes for this age group leveled out. Since that time there has been no consistent decrease in alcohol-related crashes among teen drivers (NHTSA, 2006a). Failure to make further reductions in alcohol-related crashes in this youngest age-group of drivers points to the need for better understanding of alcohol-related driving and its association with crashes among teen drivers, so that policy and intervention can more effectively address this problem.

Alcohol-related crashes are less frequent among 16-20-year-olds than older age-groups. Rates of alcohol-related driving and crashes peak among drivers in their early 20s, and then decline monotonically with increasing age; however, it is not until around age 55 that rates of alcohol-related driving fall below levels seen among 16-20-year-olds. Compared to older drivers, teens drink and drive less often, but when they do drive after drinking, they are at considerably greater risk of being involved in a crash, and this is true at all blood alcohol concentrations (Gonzales et al., 2005; Mayhew, Donelson, Beirness, Simpson, 1986; Voas, Wells, Lestina, Williams, Green, 1998; Williams 2003; Zador, Krawchuk, Voas, 2000). The increased risk among teen drivers of being involved in a crash when driving after drinking may result from several factors. One factor may be inexperience and under-developed driving skills (Committee on Injury and Poison Prevention and Committee on Adolescence, 1996; Jonah, 1986; Ulmer, Williams, Preusser, 1997). Another factor may be the consumption patterns of underage drinkers, who typically consume larger amounts of alcohol in a single sitting compared to older drinkers (National Survey on Drug Use and Health, 2003); hence, when they do drink and drive, they are likely to have a higher blood alcohol concentration (BAC) than adults. It is also possible that other variables related to driving, alcohol use, or the characteristics of crashes themselves combine to have a greater effect on teen than adult drink/drivers. Such a unique effect on teen drivers is not unheard of. An example is passengers. Adult drivers experience

either no change in risk or a small safety benefit from having passengers; however, teen passengers greatly increase the crash risk of teen drivers, and that risk increases significantly with each additional passenger (Chen, Baker, Braver, Li, 2000; Masten, 2004; Simons-Morton, Lerner, Singer, 2005; Williams, Ferguson, McCartt, 2007). As with teen drivers and passengers, it also possible that teens who drive after drinking have a greater likelihood of crashing due to combinations of factors that either have a less negative effect or do not result in any additional crash risk for adult drink/drivers. The purpose of this study is to examine crash rates to identify crash types that are associated with a greater risk of being in an alcohol-related crash for teen drivers compared to adults.

Methods

Michigan Crash History Data

Michigan State Police (MSP) crash records were obtained for each calendar year from 1989 to 1996 for all MSP-reported crashes. These data represented crashes for drivers ages 16-20 (teens) (n=634,359; 44% male), and 45-65 years (adults) (n=1,420,828; 56% male) at the time of the crash.

Alcohol Crash Types

Alcohol crash types were formed by combining single crash characteristics (crash elements), such as occurring at night or in bad weather conditions. The crash elements were identified based on four criteria: 1) represented drivers' behaviors well enough to identify likely causes of the crash (e.g., speeding); 2) known from prior research to be a threat to teens (e.g., driving with passengers); 3) provided information about the surrounding context of the crash (e.g., bad weather conditions); and, 4) provided information about crash outcome/severity (i.e., fatal and non-fatal injuries [casualties]). Table 1 lists and briefly describes the alcohol crash types examined in this study.

Data Analysis

Estimating Person Miles Driven

Person miles driven (PMD) was estimated using data from the 1990 and 1995 National Personal Travel Surveys (NPTS), and the 2001 National Household Travel Survey (NHTS). Based on data for the northern mid-west region of the US (i.e., Wisconsin, Illinois, Indiana, Ohio, and Michigan), respondents of the age ranges included in this study were identified (i.e., 15-19 and 45-65 years of age), and their data were weighted to provide estimates of annual miles traveled that were representative of the population of drivers in the area examined. Annual miles driven were summed by year of age, sex, and state to obtain total miles driven for each group. Population sizes were calculated by summing the weighted sample sizes by year of age, sex, and state. The two data sets, annual miles traveled and population size, were merged. This process was repeated for each survey (NPTS 1990, 1995, and NHTS 2001), and the resulting three datasets were appended into a single file. Raw person miles were calculated for each year of age by sex by state group by dividing total annual miles driven by the population size for that group. Final estimates of PMD were then calculated using a mixed model predicting raw person miles

driven with all main effects and interactions of year of age, sex, state, and survey year as random effects. The model was weighted by the square root of the population size for each group. The predicted values from this model provided estimates of PMD by year of age and sex that were used to calculate rates and rate ratios. Up to this point, the data for states other than Michigan had been included in the estimation process in order to yield more stable estimates of PMD. Those data were now dropped from the dataset, and only Michigan data were used to estimate the crash rates and rate ratios used in this study.

Table 1
Crash elements and alcohol crash types

Crash Types	Description
Alcohol Crash Types	
Alcohol	Any crash involving alcohol
Alcohol/Nighttime	At night.
Alcohol/Nighttime/ Weekend	At night on the weekend.
Alcohol/Nighttime/Passenger	At night with at least one passenger.
Alcohol/Nighttime/Speeding	At night and involved speeding.
Alcohol/Passenger	At least one passenger on board.
Alcohol/Passenger/Speeding	At least one passenger and involved speeding.
Alcohol/Passenger/Weekend	At least one passenger and occurred on the weekend.
Alcohol/Speeding	Involved speeding.
Alcohol/Speeding/ Weekend	Involved speeding and occurred on the weekend.
Alcohol/Weekend	Occurred on the weekend.
Alcohol Casualty Crash Types	
Alcohol/Casualty	Involved at least one casualty in any vehicle involved.
Alcohol/Casualty/Nighttime	Casualty crash at night.
Alcohol/Casualty/Passenger	Casualty crash with at least one passenger.
Alcohol/Casualty/Speeding	Casualty crash that involved speeding.
Alcohol/Casualty/Weekend	Casualty crash and occurred on the weekend.

In the final step of data preparation, the change in PMD between surveys, from 1990 to 1995 and from 1995 to 2001, was divided by the number of intervening years and summed with the PMD for each previous year to obtain linear estimates of annual PMD over the interval examined in this study (i.e., 1989 to 1996).

Estimating Rates and Rate Ratios

A Poisson regression model was used to estimate the rates and relative risk or rate ratios. The numerator of the Poisson distribution was the number of crashes and the denominator was annual Person Miles Driven (PMD). In the regression model for the logarithm of the rates, the primary predictor variable was age group: 1=teen and 0=adult. Denoting this dummy variable as x, the regression model to predict the expected number of occurrences (on the log scale) is

$$\log m = l_0 + l_1 x + \log(\text{PMD}),$$

The parameters were estimated using maximum likelihood. The rates for adults and teens are estimated by substituting the estimated parameters in the expressions $\exp(l_0)$ and $\exp(l_0 + l_1)$, respectively. These two rates were multiplied by 100,000 to express the rates as per 100,000 PMD. The relative risk or rate ratio (r.r.) was calculated as $\exp(l_1)$, the ratio of the two estimated rates given above. Since the rates and rate ratios were estimated using a regression model and not calculated directly, the rate ratios from this study are not a simple ratio of teen to adult crash rates.

Results

Sample Description

Overall, 4.6% of all crashes were alcohol-related. This amounted to 4.5% of all teen driver crashes, and in 4.7% of all crashes with adult drivers. By age group and sex, 5.5% and 3.0% of all crashes were alcohol-related for teenage male and female drivers, respectively. For adults, these figures were 6.2% (males) and 2.6% (females).

Frequencies and percentages of teen and adult drivers who were involved in each of the alcohol-related crash types included in this study are listed by sex in Table 2. Consistently, teen and adult males were involved in a higher percentage of alcohol-related crashes of all types than women. Alcohol/nighttime crashes were the most prevalent for both teenage males and females, and alcohol/casualty was the most prevalent type for adult males and females. The least common alcohol-related crash types were alcohol/speeding/weekend for teen and adult males and teenage females, and alcohol/speeding/weekend and alcohol/passenger/speeding for adult females.

Alcohol Crashes – Men

Table 3 shows the rates and rate ratio (RR) values for alcohol crashes involving teen and adult male drivers. The alcohol crash type with the highest rate was alcohol/nighttime, followed by alcohol/passenger, alcohol/weekend, alcohol/passenger/nighttime, alcohol/nighttime/casualty, and alcohol/weekend/nighttime. Overall, rates for alcohol crashes were low compared to general crash types, and this was true for teenage and adult male drivers. The rate ratio for alcohol-related crashes was RR=2.13, which was statistically significantly less than the rate ratio for all crashes (RR=2.41). The overall RR=2.13 for alcohol-related crashes represents a baseline difference between teen and adult drivers to which the rate ratios of specific alcohol-related crash types can be compared. Alcohol crash types showing the largest differences between teen and adult males included alcohol/passenger/speeding (RR=18.16), alcohol//passenger/nighttime (RR=9.08), alcohol/nighttime/speeding (RR=8.03), alcohol/speeding weekend (RR=5.44), alcohol/passenger/weekend (RR=5.12), and alcohol/speeding (RR=5.10). The smallest difference in alcohol-related crash rates was observed for alcohol/weekend crash types (RR=2.40).

Table 2
Frequencies and percentages of the Michigan population ages 16-19 and 45-65 who experienced a crash type at least once between 1989 and 1996.

	Men				Women			
	Teens		Adults		Teens		Adults	
	n	%	n	%	n	%	n	%
Alcohol Crash Types								
Alcohol/Nighttime	14875	1.01	13154	0.89	4892	0.33	3547	0.24
Alcohol/Nighttime/ Weekend	6985	0.47	5499	0.37	2311	0.16	1476	0.10
Alcohol/Nighttime/Passenger	8072	0.55	2914	0.20	2927	0.20	1014	0.07
Alcohol/Nighttime/Speeding	3862	0.26	1576	0.11	637	0.04	270	0.02
Alcohol/Passenger	10906	0.74	7307	0.50	4323	0.29	2442	0.17
Alcohol/Passenger/Speeding	2587	0.18	467	0.03	455	0.03	97	0.01
Alcohol/Passenger/Weekend	5067	0.34	3243	0.22	2098	0.14	151	0.07
Alcohol/Speeding	4760	0.32	3061	0.21	784	0.05	494	0.03
Alcohol/Speeding/ Weekend	2078	0.14	1251	0.09	352	0.02	186	0.01
Alcohol/Weekend	9205	0.63	12560	0.85	3463	0.24	3463	0.24
Alcohol Casualty Crash Types								
Alcohol/Casualty	9827	0.67	14940	1.02	4088	0.28	4588	0.31
Alcohol/Casualty/Nighttime	7229	0.49	6482	0.44	2727	0.19	1854	0.13
Alcohol/Casualty/Passenger	5490	0.37	3892	0.26	2377	0.16	1375	0.09
Alcohol/Casualty/Speeding	2416	0.16	1562	0.11	467	0.03	262	0.02
Alcohol/Casualty/Weekend	4449	0.30	6056	0.41	1799	0.12	1787	0.12

To gain a more complete representation of teen alcohol-related crash risk, both the rates and rate ratios were considered. Crash types with high rates but low rate ratios have implications for driver safety, generally, but not for teen drivers specifically, because both teens and adults have equally high rates of such crashes. Crash types for which the teen crash rate is moderate to high, and the rate ratio is medium to large are of particular interest where teen driver safety is involved. The combination of a high rate and a large difference in the rate ratio values of teens and adults indicates that these crash types should be targeted with teen-specific policies, programs and interventions.

The crash types of greatest combined risk when rates and rate ratios were considered together included alcohol/nighttime/passenger (RR=9.08, rate=0.32), alcohol/nighttime/weekend (RR=8.03, rate=0.28), alcohol/passenger (RR=4.89, rate=0.44), alcohol/nighttime (RR=3.71, rate=0.59), and alcohol/casualty/nighttime (RR=3.66, rate=0.29).

Table 3
Alcohol crash type rate ratios and 95% confidence intervals for teen and adult men

Crash Types	Rate Ratio	95% CI		Rate[1]	
		Lower	Upper	Teens	Adults
Overall	**2.41**	**2.40**	**2.42**	**14.92**	**6.19**
Overall Alcohol	**2.13**	**2.10**	**2.16**	**0.81**	**0.38**
Alcohol Crash Types					

Alcohol/Passenger/Speeding	18.16	16.45	20.04	0.10	0.01
Alcohol/Nighttime/Passenger	9.08	8.70	9.47	0.32	0.04
Alcohol/Nighttime/Weekend	8.03	7.57	8.52	0.28	0.07
Alcohol/Speeding/ Weekend	5.44	5.08	5.84	0.08	0.02
Alcohol/Passenger/Weekend	5.12	4.90	5.35	0.20	0.04
Alcohol/Speeding	5.10	4.87	5.33	0.19	0.04
Alcohol/Passenger	4.89	4.75	5.04	0.44	0.09
Alcohol/Nighttime/Speeding	4.16	4.02	4.31	0.15	0.02
Alcohol/Nighttime	3.71	3.62	3.79	0.59	0.16
Alcohol/Weekend	2.40	2.34	2.47	0.37	0.15
Alcohol Casualty Crash Types					
Alcohol/Casualty	**2.16**	**2.10**	**2.21**	**0.39**	**0.18**
Alcohol/Casualty/Speeding	5.07	4.76	5.40	0.10	0.02
Alcohol/Casualty/Passenger	4.62	4.44	4.82	0.22	0.05
Alcohol/Casualty/Nighttime	3.66	3.53	3.78	0.29	0.08
Alcohol/Casualty/Weekend	2.41	2.32	2.50	0.18	0.07

1- Rates are based on 100,000 PMD.

The association between speeding, passengers, nighttime driving and weekend driving were examined to determine their association with the occurrence of a casualty in an alcohol-related teen crash. All four crash-related factors resulted in a statistically significant increase in the likelihood of a casualty occurring in the crash (RR=2.16 for alcohol-related casualty, overall). Speeding, and passengers were associated with the greatest increases in the rate ratios for male drivers (RR=5.07 and RR=4.62, respectively). Alcohol/casualty/nighttime was the only alcohol-related casualty crash type that demonstrated moderate to high levels of both the rate (0.29) and rate ratio (RR=3.66) (Table 3).

Alcohol Crashes – Women

Table 4 contains rates of alcohol crash types for female teens and rate ratios comparing the crash rates of teen and adult females. Like teenage and adult males, the rate ratio for alcohol-related crashes, generally, was lower than the rate ratio for all crashes, demonstrating that alcohol-related crashes are relatively rare for teen drivers. The alcohol crash types with the largest rate ratios were alcohol/passenger/speeding (RR=10.87), alcohol/nighttime/speeding (RR=5.47), alcohol/passenger/weekend (RR=4.62), alcohol/speeding/weekend (RR=4.38), alcohol/passenger (RR=4.10), and alcohol/nighttime/passenger (RR=4.01). Basing risk on a combination of rate and rate ratio, the highest risk alcohol crash types for teenage females were alcohol/passenger (RR=4.10, rate=0.38), and alcohol/nighttime (RR=3.20, rate=0.43).

Table 4
Alcohol crash type rate ratios and 95% confidence intervals for teen and adult women

Crash Types	Rate Ratio	95% CI		Rate[1]	
		Lower	Upper	Teens	Adults

Overall	**1.75**	**1.74**	**1.76**	**22.49**	**12.84**
Overall Alcohol	**1.97**	**1.91**	**2.03**	**0.67**	**0.38**
Alcohol Crash Types					
Alcohol/Passenger/Speeding	10.87	8.73	13.53	0.04	0.00
Alcohol/Nighttime/Speeding	5.47	4.74	6.30	0.06	0.01
Alcohol/Passenger/Weekend	4.62	4.29	4.98	0.19	0.04
Alcohol/Speeding/Weekend	4.38	3.67	5.24	0.03	0.01
Alcohol/Passenger	4.10	3.90	4.31	0.38	0.09
Alcohol/Nighttime/Passenger	4.01	6.23	7.18	0.26	0.04
Alcohol/Speeding	3.68	3.29	4.11	0.07	0.02
Alcohol/Nighttime/Weekend	3.63	3.40	3.87	0.20	0.06
Alcohol/Nighttime	3.20	3.06	3.34	0.43	0.14
Alcohol/Weekend	2.40	2.34	2.47	0.30	0.13
Alcohol Casualty Crash Types					
Alcohol/Casualty	**2.06**	**1.98**	**2.15**	**0.36**	**0.18**
Alcohol/Casualty/Speeding	4.13	3.55	4.80	0.16	0.07
Alcohol/Casualty/Passenger	4.01	3.75	4.28	0.04	0.01
Alcohol/Casualty/Nighttime	3.41	3.21	3.61	0.24	0.07
Alcohol/Casualty/Weekend	2.33	2.18	2.49	0.21	0.05

1- Rates are based on 100,000 PMD.

Higher alcohol-related casualty crash rates for teens were associated with speeding, passengers, nighttime driving, and weekend driving when compared to all alcohol-related casualty crashes (RR=2.06). The highest rate ratios were observed for alcohol/casualty/speeding and alcohol/casualty/passenger crash types (RR=4.13 and RR=4.01, respectively). The highest combined rate and rate ratio was for alcohol/casualty/nighttime crashes (RR=3.41, rate=0.24) (Table 4).

Discussion

The purpose of this study was to compare teen to adult drivers' risk of having an alcohol-related crash. The results are consistent with past research. The lower rate ratios found for alcohol-related crashes compared to all crashes indicated that teens are less likely to be involved in alcohol-related crashes relative to other types of crashes. Male drivers were at greater risk of crash involvement than women (NHTSA, 2006a), and when they did drink and drive, teens were more likely than adults to experience an alcohol-related crash (Gonzales et al., 2005; Mayhew et al., 1986; Voas et al., 1998; Williams 2003; Zador et al., 2000). Finally, for both men and women, speeding and passengers contributed most to an increased likelihood that an alcohol-involved crash would result in a casualty (Chen et al., 2000; Doherty, Andrey, MacGregor, 1998; NHTSA, 2006b).

The results of this study also quantify the differences between teens and adults, showing that when all alcohol-related crashes are considered together, teens experienced two times greater risk than adults. When alcohol is coupled with other conditions, the risk of being

involved in an alcohol-related crash was as much as 18 times greater for male teenagers and 11 times greater for female teen drivers compared to adults of the same sex. The increases in crash risk observed in this study when drink/driving is combined with other hazardous driving conditions emphasizes the importance of preventing teens from driving after they have been drinking, justifies the many efforts and resources used to reduce the incidence of teen drink/driving, and demonstrates the need for continued research, program development and evaluation to further reduce drink/driving by teens. It is equally important, given the frequency with which teens ride as passengers of a teen driver, the tendency for teen drivers to have multiple teenage passengers (Williams et al., 2007), and the association observed in this study between driving with passengers and greater crash risk, to also continue current efforts and explore new approaches to prevent teens from riding with drivers who have been drinking.

Various intervention and prevention approaches have been used to reduce drink/driving, with varying levels of success. Some interventions have their effect indirectly by preventing or reducing underage drinking. Traditionally, adolescent alcohol interventions have been provided through school programs that attempted to prevent alcohol use by providing information and using teaching strategies to change attitudes and beliefs about alcohol use. Environmental strategies have been increasingly used to reduce adolescent alcohol use through policy, regulation, and enforcement. Effective strategies that have taken this approach include increasing the minimum drinking age, greater taxation on alcoholic beverages, and price increases (Grube, Nygaard, 2001; Holder et al., 1997; Komro, Toomey, 2002). Changes in minimum drinking age laws have been shown to not only influence underage drinking, by either increasing or decreasing availability to even younger underage individuals, but also to result in substantial changes in rates of alcohol-involved motor vehicle crashes (Kypri et al., 2006; Voas, Tippetts, Fell, 2003). Interventions to reduce sales to underage individuals at bars and restaurants have also shown some effectiveness (Toomey et al., 2001).

Some of the approaches just mentioned have also been used to target drink/driving, directly. In addition are approaches that are more specific to the prevention of drink/driving. Alcohol interlocks, though not used specifically to target underage drink/drivers, have shown effectiveness with older populations of drivers, and may represent a useful approach with underage offenders (Beirness, Marques, 2004; Bjerre, Kostela, Selén, 2007; Bjerre, Thorsson, 2008; Coben, Larkin, 1999; Voas, Marques, Tippetts, Beirness, 1999). Changes in policies and legislation setting minimum per se BAC levels have also proven effective in deterring drink/driving in the general population (Schults et al., 2001), as well as among underage drivers. Evaluations of zero tolerance laws for underage drivers have repeatedly shown effectiveness (Zwerling, Jones, 1999), and are perhaps among the most effective approaches for this age-group of drivers (Grube, Nygaard, 2001; Shults et al, 2001).

The results of this study also suggest that the application of other existing, evidence-based, approaches should be expanded, to further reduce drink/driving among underage drivers. One approach is graduated driver licensing (GDL) (Grube, Nygaard, 2001). GDL is a program that has been implemented in some form in 46 US states and the District of Columbia, but the systems vary broadly in strength. GDL 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 (IIHS, 2008). Restrictions on driving privileges that are commonly imposed by GDL programs include nighttime and passenger restrictions. Another common provision of GDL programs is a stipulation that driving records remain clean in order for the teen to advance to the next licensure level. The results of this study show that nighttime driving and driving with passengers are elements of alcohol-involved crash types with the highest risk to teens. A third that is not included in any GDL program, currently, is restricted driving on weekends. Finally, while traffic offenses prevent teens in GDL from advancing to the next level of licensure, none of the programs have special stipulations for alcohol-involved driving offenses. The results of this study indicate that GDL's positive effect in reducing teen crash risk, generally, and alcohol-involved crash risk, specifically, could be enhanced by two changes to GDL program policies. The first change would be to impose restrictions on weekend driving at night and/or with passenger (where passenger restrictions don't already exist), so that these three common elements of increased alcohol-involved crash risk among teens are covered by GDL. The second would be to add to GDL contingencies that delay advancement for teens who are cited either for driving with a BAC of 0.02 g/Dl or greater (i.e., zero tolerance) or who receive a speeding-related traffic offense. For example, offenses for exceeding the speed limit by more than 10 mph could result in teens being restricted from licensure beyond the intermediate licensure level of six months, and alcohol-related offenses could result in licensure at levels beyond supervised driving being delayed for one year following the offense. These two enhancements to GDL would potentially reduce teen drivers' exposure to the alcohol-involved crash types that present the highest crash risk to teens.

Another genre of programs and interventions that are showing effectiveness, and should be applied more vigorously to underage drink/driving are parent-directed interventions. 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, greater parental monitoring during adolescence has been shown to predict safer young adult driving outcomes, including fewer high-risk driving practices, traffic offenses, and crashes (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 et al., 2006).

The Checkpoints program is one parent-directed intervention that has yielded promising results in several 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 that includes the identification of driving privileges and rules, and the establishment of consequences for breaking the agreement. 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 fewer traffic violations by teen drivers. 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, suggesting that Checkpoints is a good partner program to GDL (Hartos, Simons-Morton, Beck, Leaf, 2005).

The apparent synergy between GDL and the Checkpoints program suggests that multi-component approaches to intervention that combine several intervention modes and methods into a single intervention effort are more likely to be effective. These approaches include directing multiple interventions that target the same outcome at different levels of the environment and using distinct methods. For example, such an approach might strengthen restrictions on alcohol sales to underage patrons, impose zero tolerance limits on teenage drivers, implement an enhanced GDL programs with stronger restriction, and provide the Checkpoints Program to parents when their teenage children are licensed to drive. Such a program would simultaneously reduce teens' access to alcohol, provide GDL programming that reduced teen drivers' exposure to more of the highest risk driving conditions, and help parents to place safe driving restrictions on their teens and better monitor their teens' driving.

There are several limitations in the research presented here that should be addressed in future studies examining teen crash types. First, while this study was based on data from a large population, it included only data from Michigan, and examined teen crashes during a period that predated the implementation of GDL in Michigan. Research on other populations, and studies that would allow data pre- and post-GDL to be compared would expand and refine the information available from this study. Second, while the methods used in this study were effective in identifying alcohol-involved crash risk associated with constellations of crash characteristics, the results did not provide information about the circumstances and processes that link those characteristics, or the mechanisms through which the characteristics studied contribute to increased crash risk. Future research using distinct designs and methods is needed to examine these issues. Nevertheless, this study did provide unique information related to the characteristics of alcohol-related crashes for which teens experience the greatest risk using a novel and useful approach to measure driving exposure. Future research should further study and develop this and other measurement techniques that provide a clearer picture of how driving outcomes relate to individual exposure to driving.

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LACK OF INFORMATION FROM NATIONAL SURVEYS: WHAT WE STILL NEED TO LEARN ABOUT TRANSITION TEENS

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Background

The dangers for adolescents and young adults increase as teen independence increases and parental supervision decreases. Teens become exposed to new and more risky environments and potentially negative peer influences, including experimentation with sex, alcohol, smoking, and legal and illegal drugs. Further, the ability to drive and the availability of a vehicle provide the means of moving away from parental and community controls, possibly contributing to these risks. Ample research exists relating not only young drivers' attitudes and behaviors to risky driving (e.g., Bingham & Shope, 2004b; Bingham & Shope, 2004a), but also relating the extent to which alcohol use increases crash-involvement risk (Peck, Gebers, Voas, & Romano, 2008). A less-studied issue (beyond crash injury), however, is whether the opportunity to drive increases other health risks, such as alcohol and drug use and sexual risk-taking (Voas & Kelley-Baker, 2008).

The initiation of teen driving, which usually occurs between the ages of 15 and 17, has been studied primarily in relation to crash-injury reduction. Because of the increased opportunities for risk-taking behaviors, this particular age (15-17), when teens begin to drive without parental supervision and to ride with peers, may be one of the most important periods in the development between puberty and emerging adulthood. Gaining access to vehicles increases adolescents' and young adults' mobility, thus, possibly facilitating experimentation with risky behaviors. This hypothesis may be particularly true in the United States where geographic distances are greater than in Europe and where public transportation is not a well-developed alternative. In this paper, we refer to this period as "transition teens" (Voas & Kelley-Baker, 2008).

Some recent evidence supports this understudied area. The most directly relevant study, conducted by McCarthy and Brown (McCarthy & Brown, 2004), found that obtaining a driver's license was associated over the long term with an increase in the use of alcohol, cigarette, and marijuana. Researchers have largely ignored this area of research, however, perhaps because of data limitations (e.g., until recently, most national surveys on the risky behaviors of teenagers did not include information on motor-vehicle availability and usage). Thus, it was formerly impossible to measure directly the effect of motor-vehicle access and exposure to nonhighway health risks, such as alcohol and drug use and other risky behaviors (e.g., sex, violence).

The Transition to Driving

Reaching the age (15-17) when a teen begins to drive or travels in a vehicle driven by a peer initiates a period of increased opportunity for participation in adult activities while avoiding

adult supervision. Once driving a vehicle or riding with a peer is possible, a substantial amount of control over personal activities passes from parents and/or supervising adults to the teenager. Although this period provides an important opportunity for growth in maturity, it also exposes the teenager to two significant additional health-risk areas. The first risk is the crash injury associated with being a novice driver or riding with one. The second risk is the increased access to alcohol, drugs, and sexual risk-taking made available through the gain in privacy and mobility and the subsequent ability to move into more high-risk environments away from parental or adult supervision.

This mobility issue is most salient in suburban American locations where students in the first 2 or 3 years of high school are likely to have access to vehicles. Underprivileged teenagers living in inner city locations are less likely to have access to a vehicle and may be exposed to a wider set of risks at an earlier age. Although the role of mobility on risk exposure for disadvantaged adolescents has also been understudied (and therefore also in need of attention), this paper begins by focusing on the transition-teens concept as defined by Voas and Kelley-Baker (2008): a subgroup of all 15- to 17-year-olds who reside in middle-class suburban and rural areas where families can afford a car and where a vehicle is needed for reasonable mobility. There are two broad areas of increased risk from transition-teens driving.

***Novice driving*:** Learning to drive is a high-risk activity for 16- and 17-year-olds. Risk of being in a crash is at a lifetime high during the early years of driving. Williams (1999) found that the crash involvement rate for 16-year-olds was four times that of drivers in their 20s. The high-crash involvement appears to be caused by inexperience and risk-taking, particularly by male teenagers. The risk is increased by the failure to fasten safety belts (Womack, Trout, & Davies, 1997), nighttime driving (Williams & Preusser, 1997), and distractions created by teen passengers (Farrow, 1987). The threat extends to the passengers that ride with novice drivers who are also less likely to buckle up and share the same risks from driver errors.

***Expanded horizons*:** Once teenagers gain access to a vehicle, they are away from parental or adult supervision and are more subject to the influence of their peers. Whether seeking a license or not, 15- and 17-year-olds are likely to be riding with peers that opens new opportunities for recreational and cultural activities but with concomitant risks for non-highway-related problems.

Transition Teens

In a publication presenting the development sources of crash risk for young drivers, Arnett et al. (2002) argued that "the difference between 16-17 year olds and 18-19 year olds is so stark that they should be considered to be in two separate periods of life…" Yet, Arnett continued, most driving patterns or trends are reported in one age category, 16 to 20 years. Early teen driving, which occurs between ages 15 and 17, may be the most important period between puberty and emerging adulthood. In a publication focused on the theory and science of emerging adulthood, Tanner (2006, p. 49) noted: "Prior to emerging adulthood, the individual is dependent on and regulated by parents, teachers, and the laws of society. During emerging adulthood, the individual accrues experience and prepares for self-governance with variable amounts of support still available from parents (i.e., financial gifts) and institutions (i.e., college)." The 15- to 17-year-old period is where the developing person first experiences a reduction in parental control

over social behavior and where the experiences and opportunities for risk-taking are greatly increased (Voas & Kelley-Baker, 2008). For the 15- to 17-year-olds, the transition from being transported by parents to driving or riding with a peer has the potential for modifying three important factors that have been shown to be important in determining alcohol and drug use: parental influence, peer influence, and the environment (availability). Teen driving or riding with a peer may transport the youth to an environment where parental influence is weakened, peer influence is strengthened, and alcohol and drug availability is increased. With these features, the Transition-Teen period is analogous to the "Emerging Adult" transition period, which is initiated 2 years later with the transition to independent living.

In New Zealand, Kyprie et al. (2004) examined the transition to independent living by New Zealand youths that occurred at an average age of 17.7 – during the period of emerging adulthood. They followed the substance use patterns of the teen sample for up to 6 years and compared drinking and drug use in the pre-transition period with the post-transition period. They reported that regular drinkers who consumed 2.3 drinks per week pre-transition increased to 10.1 post-transition ($p<.01$). Both the exposure to an environment where alcohol was more available and peer alcohol use were significant factors in the increase in post-transition drinking. Although the transition to independent living is clearly a more substantial transition than the transition to driving or riding with peers, the latter clearly contains some of the same factors inherent in independent living.

Potential Effect of Driving on Noncrash Risks

Research on teen driving has traditionally focused on crash-injury reduction. Although considerable resources have been and continue to be devoted to the risks associated with highway crashes that result from youthful inexperience and risk-taking, little attention has been given to the effect of driving on the quality of life and on the nontraffic health risks of teenagers. Aside from traffic safety studies that examine driving skills, risk-taking, training, and licensing, several developmental studies relating attitudes and behaviors (including alcohol and drug use) to teen crash involvement have been conducted (Bingham & Shope, 2004a; Shope, Elliott, Raghunathan, & Waller, 2001; Shope & Bingham, 2002). What is missing or scarce is the effect that driving has on a teen's lifestyle and problem behaviors.

In our review of teen-driving studies, we found only a few reports relevant to the effects that driving has on the lifestyle of young teens. The most directly relevant study was by McCarthy and Brown (2004), in which they collected high school students' responses to a questionnaire on alcohol and other drug consumption and driver licensing. They compared reported drinking behaviors of unlicensed students, newly licensed students, and longer-term licensed students. They also studied the change in reported behavior between initial unlicensed and later licensed status. The immediate effect of licensing on new drivers was associated with negative attitudes toward drinking and driving and reduced alcohol consumption; however, reported instances of drinking-and-driving behavior increased with driving experience. McCarthy and Brown also found that, over the longer term, obtaining a driver's license was associated with increases in the use of alcohol, cigarettes, and marijuana. The authors interpreted their results as indicating that teens have more opportunities for substance use and less parental monitoring of behavior by

having access to a vehicle. Additionally, they noted a not-surprising tendency for teens to be less likely to ride with a drinking driver after obtaining a license.
Indirect evidence of the potential significance of teen driving to alcohol consumption and risky behavior comes from two economic analyses conducted by Carpenter (2004, 2005). In his 2004 study, Carpenter examined the effect of the zero-tolerance (ZT) law (which makes it an offense for those aged 20 and younger to have any alcohol in their body while driving) on heavy episodic (binge) drinking by 18- to 20-year-olds (experimental group) compared to 22- to 24-year-olds (comparison group) using information on alcohol consumption from the Behavioral Risk Factor Surveillance System (BRFSS) from 1984 to 2001. Results indicated that, for the underage group, the presence of a ZT law reduced binge drinking by 13 to 20%. Moreover, he bolstered this result by demonstrating that ZT laws reduced per capita beer purchases by 15- to 19-year-olds and the proportion of public drunkenness arrests of 18- to 20-year-olds.

In 2005, Carpenter conducted a second panel study relating state ZT laws to state gonorrhea rates. He compared males and females separately in two age groups: 15 to19 years (affected group) and 20 to 24 years (control group). He found that gonorrhea rates for 15- through 19-year-old White, non-Hispanic males were significantly lower (by 14%) in states with ZT laws, whereas the rates for 20- to 24-year-olds were not significantly lower. He interpreted the results of the two studies as indicating that ZT laws affect gonorrhea by reducing heavy drinking among the affected youth, which reduces their incidence of sexual activity. Few studies exist in which driving or driving laws are the independent variable, and alcohol and other (AOD) use or other problem behavior is the outcome measure. Much more interest has been shown in the use of impaired driving or crash involvement as an outcome measure to study the significance of various characteristics of teen AOD users.

Another study relevant to the transition-teens concept was one by Preusser et al. (2000). They conducted a study in four states with varying laws that produced differing teen-licensing rates. They surveyed high school students to obtain reports on their driving and their activities in Delaware, Connecticut, and New York, where learner's permits and full licenses could be obtained before age 17, and in New Jersey, which at the time was the only state in the union that did not license teens before age 17. Their comparison of data from New Jersey with data from the other three states confirmed that there were large differences in the percentage of licensed high school sophomores and juniors and in the amount of their driving (by the senior year, the license status and driving was similar in all four states). The effect of these differences in driving on teen activities was somewhat less than might be expected. Students in New Jersey were less involved in doing family errands but were not significantly different in their weekday activities (i.e., holding jobs, being involved in sports, or visiting friends). There were, however, some differences in weekend activities, such as going out on dates, but surprisingly, no differences in going to parties, participating in school clubs, and going shopping.

The Preusser et al. (2000) study clearly demonstrated that the teens in states with delayed licensing had to rely more on parents to provide transportation. The authors suggested that this "may have promoted additional opportunities for interaction between parents and teens and additional opportunities for parents to monitor the comings and goings of their adolescent children … thus, it is possible that crash reduction may not be the only benefit from delayed teenage licensure" (p. 237). The lack of a strong effect of delayed licensure on the activities of

teens may at first suggest that the role of the automobile in the transition-teens concept is not as central as suggested by the model we propose; however, the Preusser et al. study did not consider AOD use or other behavioral problems and did not relate individual driving status to teen problems. They did cite a study on teen vehicle ownership (Williams, Preusser, Lund, & Rasmussen, 1987), which found that teen vehicle ownership was associated with lower academic performance. Thus, the Preusser et al. (2000) study paved the way for more intensive analysis of the role of driving and access to vehicles in the maturation and risk behavior of 15- to 17-year-olds.

National Surveys of Youth

As with all research, data are necessary to examine the concept of transition teens. Fortunately, the traffic safety field has enormous data sets available that report crash injuries and fatalities (NHTSA, 2007; http://www.nhtsa-tsis.net/projects/NHTSA/ NHTSA_FARS.htm). For example, intervention success can quickly be assessed (i.e., reduction in fatalities) by reviewing the information and trends in these data sets. Unfortunately, as useful as these objective measures are at assessing the effect of interventions, they do not necessarily help us in understanding the causes and correlates of risky behaviors. For this, we typically must rely on self-reported data derived from public health surveys.

Over the past few decades, several national surveys have been and are currently used to assess health behaviors among youth. We identified the National Survey of Drug Use and Health (AOS/SAMSHA; http://www.oas.samhsa.gov/nsduh.htm); the Youth Risk Behavior Survey (CDC; http://www.cdc.gov/HealthyYouth/yrbs/index.htm); the CORE Alcohol and Drug Survey (Core Institute, http://www.siu.edu/departments/coreinst/ public _html); and Monitoring the Future (funded by NIDA; http://www.monitoringthefuture.org/). Many others exist, but these are generally the surveys that the public and the researchers in the public health field rely on for understanding of young adult behaviors. These surveys are used to assess risky behaviors, identify problem areas, and learn about the progress that has been made to remediate risks. Through the years, many of these surveys have been modified to assess emerging issues, address the existing risks, etc., and they will likely to continue to be modified. Yet, to the traffic safety researcher, these surveys are still limited.

In examining these four surveys, we found (see Table 1) little uniformity between the subject items. Generally, these surveys only included a few vehicle or traffic safety-related items (between two and three). Three (SAMSHA, CDC, and CORE) of these surveys inquired about impaired (alcohol and/or drug) driving, and two (CDC and CORE) included an item on riding with an impaired driver; one survey inquired about seatbelt use (CDC). Although the Monitoring the Future Survey (NIH) included several vehicle and traffic safety-related items, most were limited to whether or not the participant received a ticket or was in an accident while they were impaired. Interestingly, this same survey (NIH Monitoring the Future) was the only one to inquire about general driving – that is, access or exposure to a vehicle. Given that motor vehicle accidents are the leading cause of death among young people, one would think that these surveys would probe more deeply into the driving habits of those surveyed.

Although traffic-related surveys are available (NHTSA, 1996), these data generally represent adult drivers (aged 18 or older). In 2006, Children's Hospital of Philadelphia and State Farm Insurance conducted a large-scale study titled "Driving: Through the Eyes of Teens." This survey included several interesting items including trip purpose, exposure (access to vehicle, hours driven by week), crash experiences (noninjury/injury), distractions, impaired driving (fatigue, cigarettes, alcohol, and other drugs), and other behaviors (emotions – road rage; speeding; seatbelt use). Unfortunately, these data are not currently publicly available. Further, not included in this data set are items related to non-traffic-safety behaviors, alcohol and drug use, exposure to violence, etc. A merging of these two types of surveys (public heath and traffic) areas would allow us to see the full picture, as well as to collaborate in our efforts to understand and prevent these needless deaths.

Table 1: National Youth Surveys – traffic safety items

Item #	Question
2006 National Survey of Drug Use and Health (OAS/SAMSHA)	
SP06a	During the past 12 months, have you driven a vehicle while you were under the influence of a combination of alcohol and illegal drugs together?
SP06b	During the past 12 months, have you driven a vehicle while you were under the influence of alcohol?
SP06c	During the past 12 months, have you driven a vehicle while you were under the influence of illegal drugs
2007 Youth Risk Behavior Survey (CDC)	
9	How often do you wear a seatbelt when riding in a car driven by someone else?
10	During the past 30 days, how many times did you ride in a car or other vehicle driven by someone who had been drinking alcohol?
11	During the past 30 days, how many times did you drive a car or other vehicle when you had been drinking alcohol?
2004 CORE Alcohol and Drug Survey (High School –HC and College – C) (CORE Institute)	
18 g (HS/C)	Please indicate how often you have….driven a car or bicycle while under the influence?
18h (HS)	Please indicate how often you have….ridden with someone who has been drinking
2006 Monitoring the Future (12 Grade) (NIH/NIDA)	
C27	During an average week, how much do you usually drive a car, truck, or motorcycle?
C28	Within the last 12 months, if any, have you received a ticket (or been stopped or waned) for moving violations, such as speeding running a stop light or improper passing?
C29a	How many of these tickets or warning occurred after you were drinking alcohol beverages?
C29b	How many of these tickets or warning occurred after you were smoking marijuana or hashish?
C29c	How many of these tickets or warning occurred after you were using illegal drugs?
C30	We are interested in any accidents that occurred while you were driving a car, truck, or motorcycle. During the last 12 months, how many accidents have you had while you were driving?
C31a	How many of these accidents occurred after you were drinking alcohol beverages?
C31b	How many of these accidents occurred after you were smoking marijuana or hashish?
C31c	How many of these accidents occurred after you were using illegal drugs?

Conclusion

Recently, a report on a National Young Driver Survey of 5,665 teens, aged 16 to 19, by The Children's Hospital of Philadelphia (The Center for Injury Research and Prevention at The Children's Hospital of Philadelphia and State Farm Mutual Automobile Insurance Company, 2007) noted that "to teens, driving is considered an essential coming of age experience, and it has become an established aspect of teens' maturation and socialization process." The authors noted that, although half of that age group drives to school and more than three-fourths use a car for errands, 60% say they drive to relax and 50% report driving without a destination in mind, suggesting substantial unsupervised recreational driving. Further, driving is a significant aspect

to teens' lives. McCarthy and Brown (2004) concurred: "the acquisition of a driver's license is one of several important developmental transitions for youth" (p.289). Yet, the implications of this transition have not been fully investigated.

The transition-teens concept can generate a number of interesting possibilities for testing the basic assumption that the availability of a vehicle is a risk factor for AOD problems outside of those that are the direct consequences of highway crashes. There exists a critical period when teens begin to drive or to ride with teens that deserves to be more fully examined—one that cannot be categorized as middle teen or emerging adulthood. Today's transition teens are mobile and, thus, faced both with greater opportunities and greater risk.

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SECTION III. PREVENTION/INTERVENTION STRATEGIES: LAWS AND REGULATIONS AFFECTING TRAFFIC SAFETY AMONG YOUNG DRIVERS

HISTORY AND EFFECTS OF GRADUATED LICENSING AND ZERO TOLERANCE

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INTRODUCTION

Safety researchers and policy makers have recognized for some time that young and inexperienced drivers are overrepresented in traffic crashes. Of all the strategies to reduce these crashes, those that affect a young person's freedom to drive hold the greatest promise. A driver's license is among the most prized possessions of youth. It follows that young people will be attentive to driving safety programs that attempt to control the conditions under which they can drive--including program components that, independently, might have little appeal. This "carrot and stick" strategy has been incorporated into a number of programs for licensing young drivers (Sweedler, 1990).

This paper will discuss two interrelated legislative approaches to the young driver problem:

- graduated drivers licensing (GDL), which is intended to help young drivers ease into driving under less risky circumstances as they develop their driving skills, and
- zero tolerance, which attempts to reduce the possibility that young drivers will drink and drive.

Often, zero tolerance is one of the elements of GDL, although they are sometimes legislated separately. The paper will discuss the history of these legislative approaches and research showing their effectiveness. It will then discuss how to move forward in improving these laws and ultimately the safety of young drivers.

BACKGROUND OF GDL AND ZERO TOLERANCE

The concept of a graduated licensing system was first described by Waller, based on research conducted in North Carolina in the early 1970s. A model system was developed by the National Highway Traffic Safety Administration in 1977. This model was never adopted by any of the states at that time, although a few states introduced elements of it (Simpson, 2003).

The first comprehensive graduated licensing system anywhere in the world was implemented in 1987 in New Zealand. It was a three-stage system that applied to all new drivers aged 15-24. The essential elements were a 6-month learner license, and an 18-month restricted stage (with restrictions on night driving and carrying passengers). A BAC of .03% applied at both stages (Begg and Stephenson, 2003).

One element that helped move GDL systems forward was a 1993 report on young driver safety developed by the National Transportation Safety Board (NTSB, 1993). The report stated,

> "The Safety Board believes that there are two general types of legal and policy approaches that can be taken to reduce traffic crashes among youth: those designed to

> reduce youth access to alcohol; and, those designed to reduce driving by youth or to restrict the circumstances under which they drive."

In 1980, 53 percent of the teenage drivers who died in highway crashes had a BAC of 0.10 percent or higher. By 1987, the 53-percent figure had dropped to 28 percent, a reduction of nearly half (IIHS, 1992). This reduction in alcohol-related fatal crashes involving teenage drivers has been attributed to raising the legal minimum age for the sale of alcohol to 21 in all States (GAO, 1987).

However, by 1989, the percentage of fatally injured teenage drivers with a BAC of 0.10 or higher had increased to 33 percent (IIHS, 1992). In 1991, 9,156 persons died in traffic crashes involving 8,207 15- to 20-year-old drivers. Of the 8,207 drivers, both surviving and fatally injured, an estimated 2,419 had a positive BAC. Among fatally injured 15- to 20-yearold drivers, an estimated 40 percent (1,421 of 3,568) had a positive BAC. The Board noted that although this is less than the positive test rate for drivers of all ages (44 percent in 1991), alcohol isillegal for persons under age 21 and any BAC should be prohibited.

In 1990, according to the NHTSA, drivers aged 15-20 years comprised only 7.1 percent of licensed drivers (11.9 million of 168.99 million), but accounted for 14.9 percent of all driver fatalities (3,568 of 23,904 driver fatalities). Further, while young drivers do only 20 percent of their driving at night, over half the crash fatalities of adolescent drivers occur during nighttime hours (OTA, 1990). A large proportion of teen fatalities (ages 15 to 17) occur on Friday, Saturday, and Sunday (46 percent in 1988). First-year drivers (primarily ages 16 and 17) have twice the average number of crashes and, on a miles-driven basis, four times the number of crashes involving more experienced drivers (NHTSA, 1985).

Thus, concerned about both the total number of teenage drivers in crashes and those with a positive BAC, the Safety Board concluded,

> "…that despite improvements in the 1980's in highway crashes among young drivers, including alcohol-related crashes, continue to be a serious and persistent problem. Research indicates that several legislative and policy actions can be effective in reducing the crashes. These include: Enacting laws establishing lower BAC levels for youth and administrative license revocation for low BAC alcohol-related youth traffic violations; Eliminating deficiencies in, and providing for more vigorous enforcement of, minimum purchase age laws, and decreasing alcohol availability to youth; Developing carefully targeted multi-media community information and education campaigns and programs directed at youth, and Enacting laws establishing a provisional license system in conjunction with nighttime driving restrictions for young novice drivers. TheSafety Board's experience indicates that the most effective combination is tough, fair laws, vigorous enforcement, and intensive and targeted educational campaigns".

As a result, the Safety Board recommended to the Governors and legislative leaders of the states that, among other steps, they:

> 1) Enact comprehensive laws that prohibit drivers under the age of 21 from

driving with any measurable blood alcohol concentration (any level above 0.00 BAC), to include:

(a) provisions for administrative license revocation (H-93-5);

(b) a period of extended license suspension/revocation (including a period of loss of driving privileges without exemption) for underage offenders in addition to any criminal sanctions that may be specified (H-93-6); and,

(c) public information programs targeted to youth to enhance the effect of the new law. (H-93-7)

2) Enact laws to provide for a provisional license system for young novice drivers. (H-93-8)

3) Enact laws that prohibit driving by young novice drivers between certain times, especially midnight to 5 a.m. (H-93-9)

With a sustained push from various safety organizations, U.S. interest in graduated licensing was increasing. In 1995, Williams and Sweedler wrote, "The National Highway Traffic Safety Administration (NHTSA) is promoting graduated licensing, as it has done in the past, and is providing funding to Alaska and North Carolina to implement and evaluate licensing systems… The model system described by NHTSA and the American Association of Motor Vehicle Administrators includes a permit stage of 6 months, a 12-month restricted licensing stage, a night driving curfew, and zero alcohol tolerance. The National Transportation Safety Board has recommended that states enact graduated licensing, especially with night driving curfews, and has been promoting such legislation in letters to governors and state legislative leaders. The National Administrative License Revocation Coalition, comprised of 35 public and private safety and health organizations, has endorsed the concept and recommended that its members support state action on graduated licensing."

The research base also was growing. For example, the Traffic Injury Research Foundation (TIRF) and the Insurance Institute for Highway (IIHS) had been conducting parallel research on young drivers in Canada and the United States in the 1980s and 1990s, and this continued.

The first North American GDL system was introduced in the province of Ontario in Canada in 1994. The first comprehensive U.S. GDL program was started in Florida in 1996. Then the GDL movement took off in the U.S. A bandwagon effect developed as legislators rushed to enact legislation that was being enacted in other states. Five laws were enacted in 1996, followed by 8 in 1997, 12 in 1998, 11 in 1999, 7 in 2000, 2 in 2001, and 2 in 2002 (Williams, 2005). By 2006, all states had some GDL elements in place. All major Canadian and Australian jurisdictions also have GDL licensing systems, but their systems like, in the U.S., vary.

LOWER BAC LIMITS FOR YOUNG DRIVERS: ZERO TOLERANCE

The Board noted that even though no State allowed the sale of alcohol to persons under age 21, most States still permitted a driver under age 21 to drive legally with alcohol in their system, as long as their BAC does not exceed the State's adult legal limit (usually 0.10 percent). Young persons were overrepresented in both fatal crashes and motor vehicle fatalities (Hingson, et al., 1989). Research had shown that young drivers were particularity susceptible to impairment by small amounts of alcohol (Hingson et al., 1986). For example, male drivers aged 16 to 20 had 6

times the driver fatality risk in single vehicle crashes at BACs from 0.01 to 0.04 percent compared to male drivers age 25 and older at these low levels (Zador, 1991). One study indicated that the risk of a crash, especially a fatal crash, increases with increasing BAC levels, but that drivers age 16-19 had a higher risk of fatal crash than older drivers at all BACs (Simpson, 1985). Further, the study noted that drivers age 16 and 17 at low BACs (0.01 to 0.049 percent) had a crash risk three times that of drivers age 18 to 24 at the same BAC levels. The report's summary on young drivers and alcohol states that: "Although young people drink and drive less often than people of other age groups, the young who do choose to drink and drive are at significantly higher risk of fatal crash than other age groups of drinking".

At the time of the Board's report, 15 States had laws to prohibit vehicle operation by underage drivers with a BAC level lower than the BAC level specified for drivers over 21. The lower BAC levels and age of application varied substantially from State to State. A law lowering the BAC for underage drivers had been found to be effective in reducing nighttime fatal crashes among teenagers in Maine, even though only 40 to 50 percent of teenagers knew about the law (Hingson et al., 1986). A study of the Maryland 0.02 percent BAC law found statistically significant reductions (a minimum 11 percent reduction) in alcohol related crashes in the affected age group. When combined with a public information and education campaign, the Maryland law resulted in a nearly 50 percent reduction in underage alcohol-related crashes over a 2-year period, 1989-1990 (Blomberg, 1992).

Following the Board's report and recommendations, a Federal law was adopted in 1995 that required all states to pass zero tolerance laws (.02 BAC or less) before October 1, 1998 or risk the loss of a percentage of their highway safety funds. All States and the District of Columbia have enacted low BAC limits for young drivers.

Evaluation of the Effectiveness of Zero Tolerance laws

Studies of zero tolerance laws indicate they reduce crashes among drivers younger than 21. A study of 12 states that passed zero tolerance laws reported a 20 percent reduction in the proportion of fatal crashes that were single-vehicle nighttime events (crashes likely to involve alcohol impairment) among drivers ages 15-20 (Hingson et al., 1994).

Improving Effectiveness of Zero Tolerance Laws

The Insurance Institute for Highway Safety (IIHS) research has shown that the potential of zero tolerance laws has not been realized. Researchers found such laws difficult to enforce in some states because police must suspect that a young driver has a high BAC before administering an alcohol test for any measurable BAC (Ferguson, et al., 2000). Enforcement of zero tolerance laws reinforces enforcement of underage drinking laws. However, zero tolerance laws are difficult to enforce independent of DUI because offenders with low BACs are not likely to display the erratic driving that results in drivers with high BACs being stopped (McCartt and Kirley, 2007). Institute surveys of young people in three states found limited knowledge about zero tolerance laws, and many of those who knew about the laws did not believe they often were enforced (Ferguson and Williams, 2002). When zero tolerance laws are enforced they are effective. Washington State's zero tolerance law found that the law increased the likelihood that

an underage person would be sanctioned for drinking and driving, especially among drivers with BACs less than 0.08g/dL (McCartt, et al., 2007).
Full enforcement of zero tolerance laws accompanied by publicity about the enforcement will be needed to increase effectiveness. Changes to the laws may encourage enforcement efforts.

GRADUATED LICENSING SYSTEMS

Graduated licensing is a system designed to delay full licensure while allowing beginners to obtain their initial experience under lower risk conditions. There are three stages: a minimum supervised learner's period, an intermediate license (once the driving test is passed) that limits unsupervised driving in high-risk situations, and a full-privilege driver's license available after completion of the first two stages. Beginners must remain in each of the first two stages for set minimum time periods. Forty-six U.S. states and the District of Columbia currently have all three stages, but the systems vary in strength (IIHS, 2008b).

In an optimal system, the minimum age for a learner's permit is 16; the learner stage lasts at least 6 months, during which parents must certify at least 30-50 hours of supervised driving; and the intermediate stage lasts until at least age 18 and includes both a night driving restriction starting at 9 or 10 p.m. and a strict teenage passenger restriction allowing no teenage passengers, or no more than one teenage passenger (IIHS, 2008b).

During the 1990s, many states moved toward graduated licensing. Some have enacted virtually all the elements of graduated licensing, while others have enacted only parts. Another area in which the laws differ is enforcement. Some states prohibit police from stopping young drivers solely for night driving violations or passenger restrictions (secondary enforcement). The IIHS has evaluated the licensing systems using criteria designed to estimate the strength and likely effectiveness of the systems in reducing injuries. As of May 2008, only 29 states had systems that were rated "good" by IIHS and no state had an optimal system (IIHS, 2008a).

Effectiveness of GDL Systems

Research has demonstrated conclusively that GDL reduces teenage driver crashes and fatalities. The first evaluation of the first true GDL program in New Zealand was reported in 1992. Frith and Perkins showed that there was a continuing 8% reduction in the proportion of crash involved drivers aged 15-19 years. More recently, Williams (2007) reported that three GDL elements clearly contribute to its effectiveness: an extended holding period for the learner's permit and nighttime and passenger restrictions during the intermediate license period. Other GDL components, (such as supervised driving requirements, cell phone restrictions, seat belt use requirements and contingent advancement penalties) do not yet have sufficient evidence to demonstrate their effectiveness, but may be effective.

Preusser asked the question, "What might be expected from the increasing number of states that have adopted GDL? His answer was, "First and foremost, we would expect fewer fatal crash involvements for 16 year-old drivers and, though to a lesser extent, 17 year-old drivers. We would also expect that any reduction would be seen most strongly among late night crashes (night driving restriction) and among crashes where the young driver was carrying passengers

(passenger restriction)". He reported that evidence to support each of these provisions existed prior to 1996 and has been largely confirmed with the evaluation of each new state to implement GDL. Nationally, fatal crash involvements of 16 year-old drivers have decreased 23% (1993-1995 vs. 2003-2005). Greater reductions have been seen for crash involvements at night and with passengers. The single most effective GDL provision appears to be the extension of the learners period when this extension has the effect of delaying the time at which unsupervised driving is permitted (Preusser and Tison, 2007).

In 2007, Shope reviewed 21 studies of GDL within 14 individual jurisdictions, and six studies of GDL in the U.S. nationwide that had been conducted in the previous five years. Positive results (usually crash reductions) of varying degrees were reported from nearly all the studies. Given differences in approaches, study goals, methods, and analyses, the results are surprisingly consistent. Overall, GDL programs have reduced the youngest drivers' crash risk by roughly 20 to 40%.

Also in 2007, Ferguson, Teoh and McCartt examined recent data on teenagers' fatal and nonfatal crashes to determine current crash rates and changes in these rates over the past decade. They reported that between 1996 and 2005 fatal and police reported crashes per population declined about 40% for 16 year-old drivers. There was a 25% decline for 17 year-old drivers and a 15-19% decline for 18 year-old drivers. For 16 year-olds, the greatest decline occurred in nighttime crashes, alcohol-related fatal crashes and fatal crashes involving multiple teenage passengers. In 2005, 3,889 16 to 19 year-old passenger vehicle occupants were killed in the United States and an estimated 1.89 million were involved in police-reported crashes. This compares with 4,212 deaths in 1996 (8% fewer) and 2.37 million police-reported crashes (20% fewer). They further reported that the number of teenagers fatally injured in crashes in 2005 was the lowest since 1992. These reductions occurred despite the fact that the United States had the largest population of teenagers since 1977.

Improving GDL Effectiveness

Hedlund, in summarizing the information presented at the 2007 symposium on novice teen driving in Tucson, AZ, discussed the next steps that should be taken to improve GDL systems and further reduce young driver crashes. He noted that the GDL components that have been shown to be effective should be implemented in all states. He further noted that the many organizations that are supporting GDL need to coordinate their education and advocacy activities. This will make their work more efficient and led to each of the organizations presenting the same message. Other steps include, 1) defining and agreeing on the core elements of a good GDL program, 2) making effective GDL support material available, 3) improving how the GDL system operates in some states, 4) continue to evaluate the effectiveness of individual GDL elements and implementation practices, 5) continue research and other activities to improve GDL and 6) continue basic research on teens and teen drivers (Hedlund, 2007).

Williams 2008 reported that to strengthen GDL core elements, it would desirable to lengthen learner periods, have more supervised driving, start night restrictions earlier, reduce number of passengers allowed and lengthen passenger restrictions (Williams, 2008)

CONCLUSIONS

Research and evaluation have conclusively shown the both zero tolerance and GDL laws are effective in reducing both alcohol-related crashes and total crashes among teen drivers. However, while these reductions have been significant, greater progress can and should be accomplished.

Improved and enhanced enforcement of zero tolerance laws accompanied by publicity about the laws and how they are being enforced will be necessary to increase their effectiveness and further reduce alcohol-related crashes by young drivers. Changes to the laws may encourage the needed improved enforcement efforts.

The effectiveness of GDL programs can also be enhanced by greater and improved implementation of the elements and procedures that have been documented by researchers. Continued research and evaluation of other potential countermeasures will also be required to continue the progress that has already been made.

As we have repeatedly found, evaluations showing that a particular system or element is effective is just one step in the journey to reduce teen driver crashes. Coordinated and effective advocacy will be key to making sure that what we know works actually gets put into practice.

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SINGLE VEHICLE FATAL CRASHES INVOLVING YOUTH: TRENDS AND A PRELIMINARY ANALYSIS OF THE ROLE OF GRADUATED DRIVER LICENSING LAWS

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Background

Motor vehicle crashes are the leading cause of death for young people aged 15 to 20 in the United States, accounting for approximately 36% of their deaths (Subramanian, 2005). Young drivers aged 15 to 20 make up between 8 and 9% of the U.S. population but only about 6 to 7% of the licensed drivers; however, they are involved in between 13 and 14% of the fatal traffic crashes each year (National Center for Statistics and Analysis [NCSA], 2003b). In recent years, between 6,000 and 7,000 young drivers and passengers aged 15 to 20 have been fatally injured in motor vehicle crashes, accounting for more than a third of their total deaths (NCSA, 2003a). Crashes involving young drivers aged 15 to 20 cost the U.S. economy an estimated $42.3 billion each year (Blincoe et al., 2002). About 23 to 24% of young drivers (aged 15-20) involved in fatal crashes are estimated to be drinking before their crash (Subramanian, 2005). Sixteen-year-old drivers have crash rates that are three times greater than 17-year-olds, five times greater than 18-year-olds, and twice those of drivers aged 85 (McCartt, Shabanova, & Leaf, 2003). Research has indicated that three factors play a prominent role in crashes involving teenagers: (1) inexperience, (2) immaturity and risk taking, and (3) greater exposure to risk (Masten, 2004; Senserrick & Haworth, 2004).

Young drivers start out with very little knowledge or understanding of the complexities of driving a motor vehicle. Many young drivers act impulsively, use poor judgment, and participate in high-risk behaviors (Beirness, Mayhew, Simpson, & Desmond, 2004). Teens often drive at night with other teens in the car, which substantially increases their risk of a crash (Chen, Baker, Braver, & Li, 2000). When these factors are combined with inadequate driving skills, excessive speeds, drinking and driving, distractions from teenaged passengers, and a low rate of safety belt use, crash injury rates accelerate rapidly (Masten, 2004; Masten & Chapman, 2004).

The high crash rate of youthful novice drivers has been recognized for some time. Initially, the official response to that problem was to require a driver education program for high-school sophomores as a prerequisite for obtaining a driver's license. Experience demonstrated, however, that universal driver education in the public schools, though providing some driving skills, was not effective in reducing crashes (Williams & Ferguson, 2004) because it resulted in earlier licensing and increased exposure to crashes for many novice drivers. Without the incentive provided by drivers' education, many of these teens would not have obtained a license until they needed it for employment or college. Thus, many viewed driver education as counterproductive,

and support for it as a mandatory requirement for licensing has declined (Williams, 1996; Mayhew & Simpson, 2002; Mayhew, Simpson, Williams, & Ferguson, 1998; Williams & Ferguson, 2004).

Over the last decade, the alternative strategy of extending the period of supervised driving and limiting the novice's exposure to higher-risk conditions, such as nighttime driving, has effectively reduced crash involvements (Williams & Ferguson, 2002). Research around the world has shown that the first few months of licensure for young novice drivers entail the highest crash risk (Mayhew, Simpson, & Pak, 2003; McCartt et al., 2003; Sagberg, 1998). This high crash rate of novice drivers in the first few months (Figure 1) suggests that restricting driving in situations known to be risky during this initial licensure period is one option for dealing with this vulnerability. To address this issue, many states have recently adopted graduated driver licensing (GDL) systems requiring that progression to full license privileges occur in stages (NCSA, 2003a). The rationale for GDL is to extend the period of supervised driving, thus permitting beginners to acquire their initial on-the-road driving experience under lower-risk conditions; in contrast, the historic licensing systems in most states generally allow a quick and easy path to full driving privileges at a young age, resulting in extremely high crash rates for beginning drivers.

GDL systems in the United States vary widely, but typically, there is a required supervised learning stage of 6 months or more, followed by an intermediate or provisional license stage of at least several months with restrictions on high-risk driving before a driver "graduates" to full license privileges. The National Highway Traffic Safety Administration (NHTSA)—along with the Insurance Institute for Highway Safety (IIHS), the National Safety Council (NSC), and the National Transportation Safety Board (NTSB)—has established such a three-stage national model for GDL to introduce driving privileges gradually to beginning drivers. Under these systems, novice drivers are required to demonstrate responsible driving behavior (no traffic offenses) in each stage before advancing to the next stage. After novice drivers have graduated from supervised driving and independent driving, most GDL systems restrict nighttime driving and carrying passengers among other provisions until the novice driver is fully licensed.

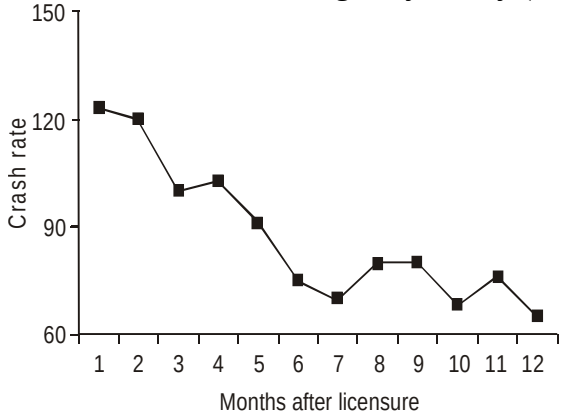


Figure 1. Novice Drivers' Crash Risk Begins to Drop with Experience (Source: Mayhew, et al., 2003)

Evaluations of state programs clearly show the benefits of adopting GDL systems. The Florida law resulted in a 9% reduction in crashes for 16- and 17-year-old drivers (Ulmer, Preusser, Williams, Ferguson, & Farmer, 2000). Evaluations in North Carolina (Foss, Feaganes, & Roggman, 2001; Foss & Goodwin, 2003) and Michigan (Shope, Molnar, Elliott, & Waller, 2001; Shope & Molnar, 2004) indicated reductions of 26 to 27% in crashes for 16-year-old drivers in the GDL systems. Under the GDL system in Nova

Scotia, Canada, researchers reported a 24% reduction in crashes for 16-year-old drivers (Mayhew, Simpson, Des Groseilliers, & Williams, 2001). Earlier independent studies have shown that nighttime restrictions for teenage drivers are effective in reducing crashes (Williams & Preusser, 1997), as are teen passenger restrictions (Preusser, Ferguson, & Williams, 1998; Chen et al., 2000)—two key components in GDL systems. Recently, Chen, Baker, and Li (2006), in the only national evaluation of GDL programs, found that the presence of GDL programs in the states was associated with an 11% decrease in the fatal crash rate involving 16-year-old drivers.

Despite this promising evidence for the effectiveness of GDL, the policy faces a number of hurdles. Although 44 states have adopted a three-phased program, the elements within each phase adopted by states vary considerably. Two of the GDL components involve a practical cost to some families: "no teen passengers" means big brother cannot drive sister to piano lessons, and "no nighttime driving" means daughter cannot pick up and drive mom home from her evening job. Legislators and parents must have a clear appreciation for the safety benefits if they are to accept the trade-offs required by GDL restrictions. More significantly, the GDL system places the major part of the enforcement effort on the parent. Police may on occasion stop a vehicle with a young-looking driver to check driving permit status, but the GDL limitations are likely to be ignored much of the time unless the parent takes a personal interest in enforcing the rules. In addition to strengthening their GDL laws if justified, states will need to invest in public information programs to gain parental support for supervising their teen drivers. To support programs directed at persuading parental investment in such activities, additional evidence on the extent that GDL and its two more onerous provisions, passenger and nighttime restrictions, are significantly reducing novice driver deaths is needed.

In this brief report, we examine the trend in crash involvement for two groups of underage drivers (15- to 17-year-olds and 18- to 20-year-olds) in relation to the growth in the number of states enacting GDL laws since 1995.

Methods

Data Sources

The Fatality Analysis Reporting System (FARS). Crash data for this study were obtained from the 1982-2006 FARS (NHTSA, 2007). FARS is a record system for fatal crashes (defined as a motor vehicle crash on a public roadway causing a death within 30 days of the event). FARS provides detailed information about the drivers involved in these crashes, including gender, age, race/ethnicity (if killed), level of alcohol consumption, maneuvers before the crash, and sources of distraction, such as cell phone use. FARS also contains information about the time of the crash, the type of roadway on which it occurred, and the number of vehicles involved in the crash. The dataset provides a large representative source of information that allows us to confidently make inferences at the national level, as well as on changing trends over time.
Driver responsibility. There were 1,433,014 drivers involved in fatal crashes between 1982 and 2006. Of these drivers, we were interested only on those for which the age and gender were known and the vehicle being driven was a passenger car, a minivan, or a sport utility vehicle (885,747). About 66% of them were males (n=584,386) and 34% females (n=301,361). To evaluate trends affecting the likelihood of driver involvement in fatal crashes, it would be

desirable to have a correct identification of crash responsibility. Although FARS contains information that could be used for such an assessment (e.g., information on the precrash maneuvers by the drivers; road and weather conditions at the time of the crash; and the crash configuration), assigning crash responsibility in multivehicle crashes when the actual detailed police reports are not available is problematic. Thus, to ensure a proper identification of crash responsibility, we considered only drivers who were involved in single-vehicle fatal crashes (SVFCs) (with no involvement by pedestrians or other road users). We assumed that almost all of these drivers were responsible or at least contributed to their crashes (see Hendricks, Fell, & Freedman, 2001). Single-vehicle crashes have been commonly used by researchers for more than 40 years to assign crash responsibility (e.g. McCarroll & Haddon Jr., 1962).

Blood alcohol concentration (BAC). BAC measures were used to identify alcohol involvement by drivers in single-vehicle crashes. Actual BAC measures are present in the FARS, but for only about half of the drivers. For those with no actual BAC measure available, the FARS provides imputed BAC measures developed using a multiple imputation technique by Subramanian (2002). We applied these actual and imputed BACs to this study.

Graduated driver licensing (GDL) laws. We used the IIHS website (www.iihs.org), NHTSA's *Digest of State Alcohol-Highway Safety Related Legislation,* Lexis-Nexis, and other appropriate sources to identify states that have GDL laws, the dates these laws were adopted, and whether the laws provide for a nighttime restriction and/or a passenger limitation. NHTSA reported that 17 states adopted a three-stage GDL system with nighttime restrictions between 1996 and 1999 (CA, DE, FL, GA, IL, IN, IA, LA, MD, MA, MI, NH, NC, OH, RI, SC, and SD). The periods for the restrictions and the duration of the restrictions vary by state. The remaining 33 states and DC did not have a three-stage GDL during that timeframe. This provided at least 7 years of post-GDL data (2000-2006) for analyses for the states implementing GDL laws by 1999. Since 1999, some 26 states plus DC have adopted a three-stage GDL with a nighttime restriction (AL, AK, CO, CT, DC, HI, ID, ME, MS, MO, MT, NE, NV, NJ, NM, NY, OK, OR, PA, TN, TX, UT, VA, WA, WV, WI, and WY). Currently, only one state has a three-stage GDL with no nighttime restrictions (VT). Finally, the remaining six states do not currently have a three-stage GDL (AZ, AR, KS, KY, MN, and ND).

Normalizing variables. One of the most commonly used measures of driving exposure in traffic safety research is the number of licensed drivers (e.g., Braver, 2001), a measure which is not free of problems. Our preliminary examination of the Federal Highway Administration data file on licensed drivers by age and state showed substantial fluctuations in some states from one year to the next for 16-year-olds. This could indicate that some state officials are not reporting on the same license status: some may be reporting full licenses only, some may be reporting intermediate or provisional licenses, and still others could be reporting driving permits only. Some states may be reporting all three categories. Clearly, reporting does not seem to be consistent among states. To address some of these limitations, an alternative measure of exposure has been recently suggested for the analysis of alcohol-related crashes: the "crash incidence ratio" (CIR). Introduced and applied by this research team to the evaluation of alcohol-related traffic laws (Voas, Tippetts, & Fell, 2000; Tippetts & Voas, 2002, Voas, Tippetts, & Fell, 2003; Tippetts, Voas, Fell, & Nichols, 2005; Voas, Tippetts, Romano, Fisher, & Kelley-Baker, 2007), the CIR can be defined as the ratio of the percentage of drivers showing some trait of

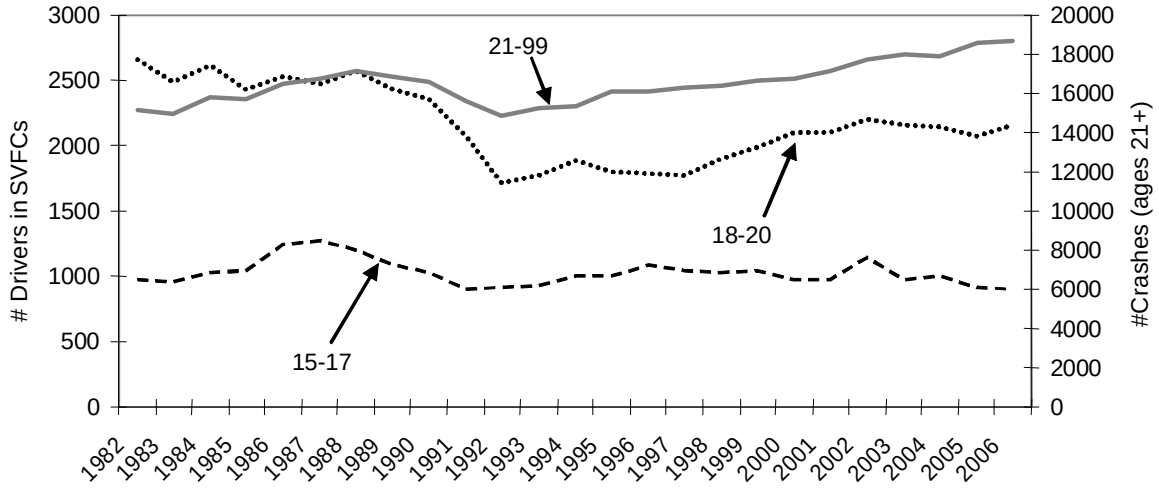
interest (e.g., underage drivers) among all drivers in a specific subgroup (e.g., in a certain year) compared to the percentage who do not have the trait of interest (i.e., adult drivers) in the same subgroup (year). Voas et al. (2007) showed that when compared against a certain benchmark (i.e., the year 1982), the CIR becomes identical to the quasi-induced exposure technique known as the relative accident involvement ratio (RAIR). Trend studies face problems when data-collection procedures and/or variable definitions shift over time. Thus, the advantage of the CIR/RAIR for this study is that it eliminates much of the bias that could arise from such problems. By pairing underage drivers involved in SVFCs in a year with that of adults in the same year and dividing the former by the latter, the CIR/RAIR cancels out some of the data-related biases.

Data Analyses

To study the role of GDL on the drinking-driver crash involvement of the affected age group 15 through 17, we conducted two analyses. One covered the last 25 years beginning before the minimum legal drinking age of 21 (MLDA-21) federal law was enacted, administrative license revocation (ALR) laws, laws lowering the BAC limit for driving to .08 g/dl, and zero tolerance for youth laws were adopted. The other covered the last 12 years as most of the GDL laws were enacted by the states. Because of the many demographic, economic, and law changes that occurred during the 25-year period, we used the CIR as the measure to compare crash levels for three age groups (15-17, 18-20, and 21-99) from 1982 to 2006 in the first study. For the second study, we used the number of annual nighttime and annual daytime crashes for two age groups (15-17 and 18-20) normalized by the 1995 base year frequency. Pair-wise t-tests were used to determine if the differences in the normalized nighttime and daytime crashes of the three age groups were significant.

Results

Figure 2 shows the evolution of the number of drivers involved in SVFCs for the years 1982 to 2006 by age group: 15 to 17, 18 to 20, and 21 and older. As can be seen, the SVFCs of drivers aged 21 and older steadily increased over the period with a slight dip in the early 1990s commensurate with the recession we experienced in the United States. The 18- to 20-year-old drivers showed a significant decrease from the late 1980s through early 1990s commensurate with the raising of the MLDA to 21 in 36 states (Fell, Fisher, Voas, Blackman, & Tippetts, 2008) and then a steady increase up to 2006. The 15- to 17-year-old drivers experienced an increase in the mid-1980s, then a decrease from the late 1980s through the early 1990s (when the MLDA was raised) and then a slight increase in the mid-1990s, followed by a decrease in the early 2000s. The decrease in the early 2000s appears to be related to the adoption of GDL laws, as shown in the following figures.



Source: Computed from FARS data sets (downloaded from the web http://www-nrd.nhtsa.dot.gov/departments/nrd-30/ncsa//fars.html). Fatalities in this figure are not mutually exclusive (i.e., they did not add up to "all").

Figure 2: Number of Drivers Involved in SVFCs by Age Group – 1982-2006

Comparisons between the involvement of young (15-17 and 18-20) relative to adult (21+) drivers in SVFCs are also shown in Figure 3, which depicts the evolution of the CIR/RAIR for the same groups of drivers in Figure 2.

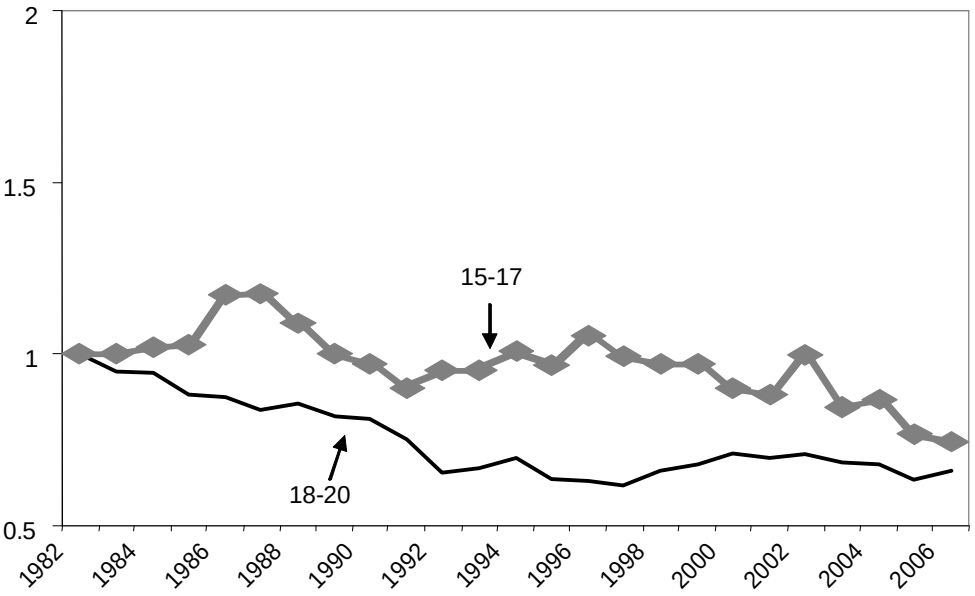


Figure 3: Odds of Young Driver SVFC Involvement Relative to Older Driver (21+) Involvement

In Figure 3, the odds of being involved in a SVFC for 18- to 20-year-old drivers relative to adult (age 21+) drivers decreases commensurate with the growth of MLDA 21 laws and then levels off in the years following 1995. The trend in the odds of being involved in a SVFC for 15- to 17-year-old drivers showed a very different pattern: there was very little change between 1982 and 1997 (excluding the increase in 1986-1988) and then a fairly steady decrease in the last 10 years.

The contrast between the two age groups from 1997 to 2006 appears to be associated with the widespread adoption of GDL laws that specifically targeted 15- to 17-year-old drivers. The lack of a relationship with the SVFC for 18- to 20-year-old drivers suggests that there is no apparent carryover effect of GDL.

Figures 4 and 5 show the evolution of SVFCs by alcohol content of the young drivers relative to the older drivers. First, Figure 4 shows the odds of being in a SVFC for drivers aged 15 to 17 compared to adults (aged 21+) when their BACs are zero (sober), when their BACs are >.00; >=.08; >=.05; and >=.15. As can be seen, there is a decrease in the odds for drinking by 15- to 17-year-olds commensurate with the BAC level during the period when the MLDA 21 laws were coming into affect and then a leveling off over the last 10 to 15 years. However, the sober (zero BAC) 15- to 17-year-old drivers experienced the same pattern as shown in Figure 3, a drop during the period following 1997, indicating that GDL laws seem to be working better for nondrinking 15- to 17-year-old drivers compared to drinking 15- to 17-year-old drivers. Figure 5 shows the 18- to 20-year-old drivers. The MLDA 21 law appears to have affected the drinking drivers but not so much the sober 18- to 20-year-old drivers, as would be expected. The GDL laws do not seem to have affected drinking or nondrinking 18- to 20-year-old drivers in SVFCs.

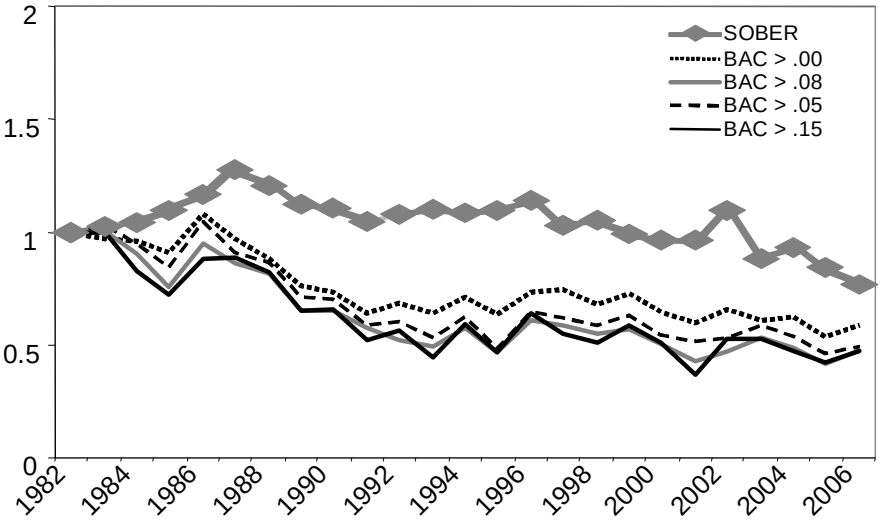


Figure 4. Odds of a SVFC for 15- to 17-Year-Olds by BAC

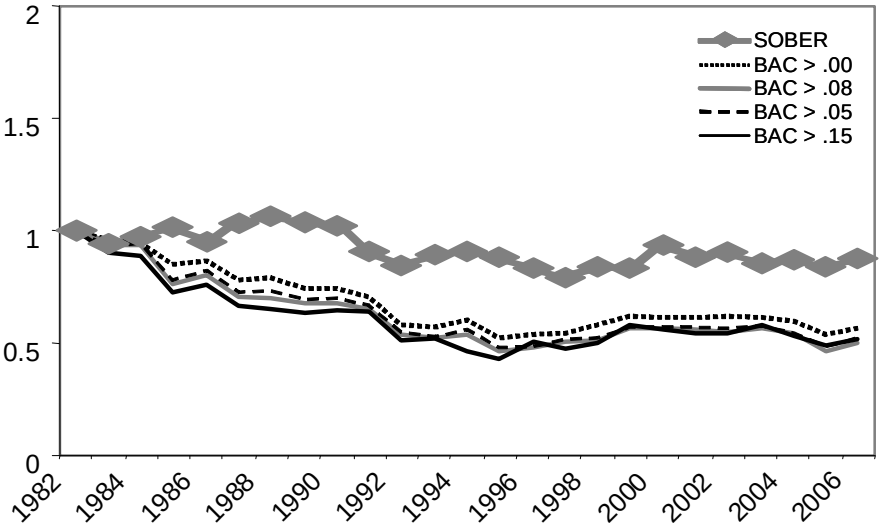
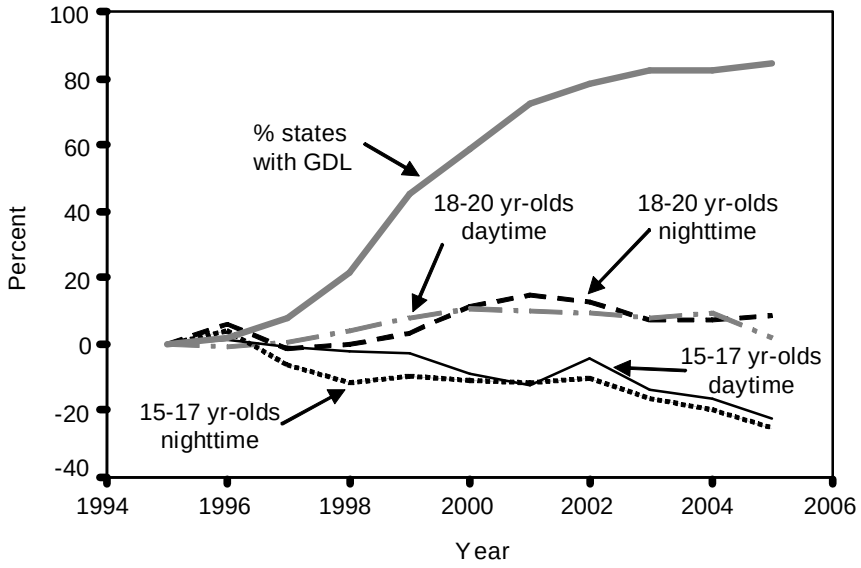


Figure 5. Odds of a SVFC for 18- to 20-Year-Olds by BAC

An alternative and more illustrative way to display the trends shown in Figures 2 through 5 is to calculate them relative to the base year of 1995 when the growth in the number of states with GDL laws began. Figure 6 shows in greater detail how the post-1995 trends in Figure 2 evolved from the 1995 base year. The plots in Figure 6 represent the percentage of states that had the GDL law in each year from 1995 to 2005, and the percentage of change in underage drivers involved in daytime and nighttime fatal crashes, relative to 1995. The crash data were taken from the 1995-2005 FARS, and the underage drivers were again broken into two age groups: 15- to 17-year-olds and 18- to 20-year-olds. Thus, there are two plots (daytime and nighttime) per age group.

It can be seen that fewer 15- to 17-year-old drivers were involved in fatal daytime and nighttime crashes, from 1996 to 2005, than in 1995. The opposite is true for the older underage group: more were involved in fatal crashes after 1995. There were significant differences between the two age groups daytime normalized crashes ($p = .002$) and nighttime normalized crashes ($p = .001$).



Note: Nighttime is defined as 10 PM to 2:59 AM.

Figure 6. Percentage of change over the base year 1995 in the number of 15- to 17- and 18- to 20-year-old drivers in fatal crashes in relation to the growth of GDL laws in the 50 states.

Discussion

These findings suggest that GDL laws are having a significant effect on the fatal crash involvement of 15- to 17-year-old drivers, but there is apparently little carryover to 18- to 20-year-old drivers. GDL laws appear to affect nondrinking rather than drinking 15- to 17-year-old drivers involvement in SVFCs. This is reflected in the reduction in daytime SVFCs rather than nighttime SVFCs for these young drivers. Although some GDL laws restrict nighttime driving, and studies have suggested that such laws are effective in reducing underage crash involvements (Williams & Preusser, 1997), we did not include whether the GDL laws had night restrictions in these preliminary analyses.

Our complete study, funded by the National Institute of Child Health and Human Development (NICHHD), will go beyond this preliminary analysis by (1) determining the influence of GDL on the teen licensing rate; (2) specifically evaluating nighttime and passenger restrictions; and (3) determining the role of age, gender, and ethnicity on the impact of GDL. We plan to use longitudinal panel models, which some refer to as cross-sectional time-series models. Drawing on the FARS, the ratios of 15- to 17-year-old drivers in nighttime fatal crashes to drivers in daytime fatal crashes will be aggregated into a data set in which the structure can be conceptualized as representing a two-way matrix: by jurisdiction, and within jurisdiction by period (year). Using the ratio of nighttime to daytime or positive to zero BAC as dependent measures controls for general driving and safety trends and the need for covariates for potentially confounding factors. It also controls for differences among jurisdictions in size.

The available data will permit the examination of a number of models focusing on the overall influence of a GDL law and the more specific effects of two of the primary components: the nighttime restriction and the passenger restriction. To evaluate each of these will require multiple

analyses, each featuring a 16-year-by-51-jurisdiction panel study with two outcome measures: one model for the target group of 15- to 17-year-old drivers, and one model for the comparison groups of 19- and 20-year-old drivers and 21-year-old and older drivers. The results of each such paired analysis will be compared to determine whether the relationship obtained for the 15- to 17-year-old group is statistically greater than that observed for the 19- and 20-year-old group and/or the 21-year-old and older group. This will be accomplished by testing the difference between the two models' coefficients for the GDL dummy variable, divided by the pooled standard errors for those dummies, against a t-distribution having the combined degrees of freedom for both models pooled.

We plan to conduct four such pairs of analyses: (1) all GDL; (2) GDL with nighttime restriction; (3) GDL with passenger limitation; and (4) GDL with both nighttime restriction and passenger limitation. For these analyses, our seven crash measures will be (1) all fatal crashes involving 16- and 17-year-old drivers, (2) nighttime fatal crashes, (3) fatal crashes involving teen passengers, (4) drinking-driver fatal crashes, (5) the ratio of fatal nighttime versus fatal daytime crashes, (6) the ratio of fatal crashes with teen passengers versus fatal crashes with no teen passengers, and (7) the ratio of drinking drivers versus no drinking drivers in fatal crashes. The coefficients for the dummy variables for 16- and 17-year-old involvements that are significantly higher than the corresponding values for the 19- and 20-year-olds and 21-year-old and older drivers will provide estimates of the effect (if any) of GDL laws, and specifically the effects of the nighttime restriction and passenger limitation. Although the nighttime and passenger restrictions are confounded in that some states have both provisions, the use of the separate nighttime and passenger crash series from the FARS data will help to clarify the relative role of each restriction.

We believe these analyses will help state officials craft effective GDL legislation that will provide maximum safety benefits for youthful drivers in their states.

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CRIMINAL SANCTIONS FOR YOUNG IMPAIRED DRIVERS

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Introduction

Alcohol consumption in general and impaired driving in particular among youth aged 16-24 is an issue of historical concern in North America. In the past two decades, high rates of alcohol consumption and heavy drinking among youth have been well documented in a variety of surveys (Centre on Addiction and Mental Health 2005; National Center on Addiction and Substance Abuse 2007) and research on drinking and driving among youth has clearly demonstrated that young drivers have an increased crash risk relative, to other drivers, even at low blood alcohol concentrations (BACs) due to their immaturity and inexperience (Mayhew and Simpson 1999; Mayhew et al. 2006). As a result, although many youth refrain from drinking and driving, and this behaviour is less prevalent among youth relative to adults, it remains a source of concern and an important social issue.

Efforts to address impaired driving among youth over the past two decades have focused largely on the development of prevention, education, enforcement, and community-based intervention strategies aimed at reducing the risks associated with alcohol and driving while also seeking to reduce the number of impaired driving offences within this age cohort (insert references). By contrast, less attention has been directed towards the nature of sanctions that are applied to these offenders once they have been arrested and convicted, and the extent to which they are effective with this population. Indeed, little is known about what happens to these offenders once they enter the justice system, or whether the sanctions and programs imposed upon them are having the desired effects.

It is likely that the lack of research in this area is largely a function of the progress that has been achieved in reducing offending among this group, and the smaller number of young impaired driving offenders. However, it is important to recognize that there are a certain number of youth who, despite prevention and enforcement efforts, engage in drunk driving -- i.e., those who are formally charged with impaired driving, processed through the criminal justice system and to whom criminal sanctions are applied.

The paucity of information about young impaired driving offenders in the criminal justice system is somewhat surprising given the proportion of youth who continue to be involved in alcohol-related crashes, the important role of age of onset in predicting future criminal behaviour, and the fact that impaired driving is one of top five offences committed by young male recidivists (Thomas et al. 2002).

There are important consequences associated with this apparent gap in existing research. Today, in many jurisdictions across Canada and the United States, young impaired drivers are frequently subject to the same traditional sanctions that are applied to adult offenders (e.g., fines, probation, community service, treatment, and incarceration) despite limited evidence of the effectiveness of these strategies even with adults. This has important implications for young

impaired drivers and the criminal justice practitioners who process them. Limited knowledge about effective strategies for these offenders has led to inconsistent and possibly ineffective approaches being applied to this population. And, without effective strategies, these young offenders are at risk of becoming tomorrow's adult drunk drivers who will continue to be involved in the justice system.

Based on existing evidence that demonstrates that young impaired drivers pose a greater crash risk to the public on the roadways, and the possibility that these offenders can potentially have longer impaired driving careers, it is important that existing sanctions and programs that are applied to these offenders be evaluated to determine whether they are effective in reducing recidivism, and to guide the development of effective programs to reduce offending among this population.

The Problem

Alcohol-related crashes. In Canada, youth account for a not insignificant percentage of people killed in alcohol-related crashes. Young people aged 16-19 accounted for 10% of all people killed in alcohol-related crashes in 2005; those aged 20-25 represented 24.6% of all people killed in such crashes (Mayhew et al. 2008). Youth in these age cohorts also represent approximately ¼ of all fatally injured drivers -- in 2005, youth aged 16-19 made up 8.6% of all fatally injured drivers; youth aged 20-25 accounted for 16.7%. And a significant portion of these fatally injured drivers tested positive for alcohol. For example, among 16-19 year old fatally injured drivers, 35.7% tested positive for alcohol, with only 6% having a BAC under 80mg%. And, among fatally injured drivers aged 20-25, 50.1% tested positive for alcohol with only 8% having a BAC under 80mg%. BACs over the legal limit are not uncommon among young drivers in Canada, with some 34% of all fatally injured legally impaired drivers being between the ages of 16-25.

Similarly, in the United States, FARS data reveal a youth impaired driving problem that is comparable to that in Canada. In 2005, youth aged 16-19 accounted for 7.3% of all people killed in alcohol-related crashes; those aged 20-25 represented 17.2% of all people killed in such crashes. Youth in these age cohorts account for approximately ¼ (27.3%) of all fatally injured drivers -- in 2005, youth aged 16-19 represented 9.5% of all drivers in this category; youth aged 20-25 represented 17.8%. A comparable proportion of fatally injured drivers who are young also test positive for alcohol. Among 16-19 year olds, 27.9% tested positive for alcohol with only 5.7% having a BAC under 80mg%. In the 20-25 age group, 53.8% tested positive for alcohol and only 7.3% had a BAC less than 80mg%. BACs over the legal limit are also not uncommon among young drivers in the U.S. with some 29.7% of all fatally injured legally impaired drivers being between the ages of 16-25.

Impaired driving charges. The magnitude of the problem is also clearly illustrated by the volume of impaired driving charges and court cases among youth on both sides of the border. In Canada in 2003/04 there were 1,528 youth under the age of 18 arrested for impaired driving (Thomas 2005). Data from 2002 show that the rate of persons charged with impaired driving was highest among those aged 19-24 (416 charged per 100,000 population) and those aged 21 had the highest single-age charging rate for impaired driving (449 per 100,000) (Janhevich et al. 2003). In the United States, Uniform Crime Reports for 2006 from the Federal Bureau of Investigation

(FBI) reveal that a total of 14,292 charges were laid against youth under age 18 for impaired driving and that youth aged 21 were most frequently charged with impaired driving, accounting for 17% of the charges laid against young impaired drivers (those under 18 years) (FBI 2007). A total of 311,164 youth aged 16-24 were charged with impaired driving in 2006 (FBI 2007).

An examination of youth court statistics (2003-2004) in Canada provides further insights into the issue. Criminal code traffic offences account for just 2% of all youth court cases (86.5% of these involved offenders ages 16-17); only 0.8% of all youth court cases involved impaired driving charges. However, of the 1,528 impaired driving charges laid against Canadian youth under the age of 18 (Thomas 2005), 585 of these cases were eventually processed in youth court, and 434 resulted in a conviction.

Of greater concern, a Canadian pilot analysis of recidivism among convicted youth and young adults (ages 18-25) in 1999-2000 (Janhevich et al. 2003;Thomas et al. 2002) revealed that 36% of young impaired drivers had one or more previous convictions either in adult or youth court. While for many offences data showed that the distribution of offences was similar among first and repeat offenders, convictions for impaired driving were more common among first offenders (19%) than repeat offenders (7%). And, impaired driving is one of the top five offences committed by young male recidivist offenders (Thomas et al. 2002).

Sentencing. Sentences imposed by Canadian courts for youth impaired driving offences involve a range of dispositions. Traditional sanctions, such as fines and probation, are commonly imposed in these cases (71.4% and 25.6%, respectively). Community service orders are somewhat less common (16.1%) and custody (0.7%) was rare. “Other dispositions” were issued in a majority of these cases (92.6%) and frequently involve a range of activities including reprimands, absolute discharges, restitution, prohibition orders, seizure/forfeiture, compensation, essays, apologies, counselling, deferred custody and supervision, attendance at non-residential programs, intensive support and supervision orders, and conditional discharges (Thomas 2005).

In the United States, limited national data regarding convictions and dispositions for youth impaired drivers are readily available. However, what are available show that approximately 1% of youth arrested are charged with impaired driving (Snyder 2006), highly comparable to Canadian data that 0.8% of youth court cases involved impaired driving charges.

In the United States, juvenile impaired driving cases can actually be handled in different types of courts, including specialized traffic courts, municipal courts, or juvenile courts depending on the court structure in a given jurisdiction, hence data can be diffcult to gather. Data from 1994 reveal that approximately 28% of impaired driving cases referred to juvenile courts were handled informally and nearly half of these cases were dismissed. In the other half of cases that were processed, youth voluntarily complied with probation conditions, fine payment/restitution orders, or entered a variety of residential treatment programs. The other 72% of juvenile impaired driving cases that were referred to juvenile courts were formally processed; only a small percentage (2%) was transferred to adult criminal courts. In 66% of cases formally processed in the juvenile courts, the youth was adjudicated delinquent and the court imposed sanctions. A majority of youth (68%) received a term of probation, 11% were placed in a residential facility, and others were ordered to pay a fine or restitution (Snyder 1997).

Summary. In sum, despite considerable declines in youth impaired driving in the past two decades, available data in both jurisdictions demonstrate that youth continue to be arrested and convicted of impaired driving. As such, impaired driving among youth remains an important problem in both Canada and the U.S and there is a need for effective sanctions and programs to address these offenders.

Although judges in both jurisdictions have a range of sentencing options available to them, the limited availability of research regarding effectiveness makes it difficult for judges to select the most appropriate options. Practitioners really do not know whether they are being effective in reducing recidivism among this population and this information gap has led to some disparity in how young impaired drivers are adjudicated by the Courts. This is cause for considerable concern in light of the potential decades of offending that could result.

An overview regarding some of the available options for judges in Canada and the United States, and what is known about their effectiveness -- if anything -- is described below.

Traditional Dispositions Among Youth

All youth aged 18 and under who are convicted of impaired driving in Canada are subject to the provisions of the *Youth Criminal Justice Act (YCJA)*-- legislation designed to address the specific needs of young offenders. The Act first came into effect in 2002 and was preceded by the *Young Offenders Act (YOA)*. The *YCJA* is guided by a set of principles that emphasize rehabilitation as well as accountability. Under the *YCJA*, the goal of the youth criminal justice system is to prevent crime by addressing the circumstances that underlie the commission of an offence. The focus is on rehabilitating young people and reintegrating them into society while ensuring that they are also subject to "meaningful consequences" for their actions in order to promote long-term protection of the public (YCJA, 2002). As a result of this emphasis, the *YCJA* is viewed as being less punitive than the earlier *YOA*. Incarceration is deemed undesirable in almost all cases – under section 39 a custodial sentence is only an option when all other possible alternatives have been exhausted (Endres 2004). If instances where a custodial sentence is warranted, sections 84 and 89 of the Act specify that youth are to be held in separate facilities until age 20, at which point they would be transferred to an adult provincial or federal institution.

Generally speaking, a somewhat similar albeit more punitive approach is followed in the United States with youth inasmuch as custody sentences are more common and transfers to adult court occur more frequently and for a broader range of offences.

While disposition data in the U.S. are not readily available, some examples of how the penalties among youth convicted of impaired driving vary across jurisdictions are provided below. For example:

a) in Massachusetts youth typically receive fines, a year of probation, license suspension for 210 days, mandatory attendance at a 16-week alcohol education program, and possibly mandatory attendance at an alcohol treatment program (Matson 2007);
b) in Arkansas, a first-time young impaired driver may receive a fine of up to

$500, mandatory substance abuse education and public service as well as a suspension of their license (City of Little Rock 2005);

c) in Washington, a youth will receive a maximum sentence of 90 days in jail and a $1000 fine (Washington State DUI 2008).

Fines. Fines appear to be a common sanction imposed by judges adjudicating youth impaired driving cases. In Canada, when a youth is sentenced to pay a fine they are required to pay a specific amount to the court that does not exceed $1000 (YCJA 2002). In general, fines for traffic offences among youth are typically $500.00 (CAD). Fines were ordered in 310 impaired driving cases which amount to more than 70% of convicted offenders (Thomas 2005). In this regard, the literature suggests that fines can be effective in reducing recidivism for adult DUI offenders (NHTSA 2008). However, Voas and Fisher (2001) argue that to maximize the deterrent effect, fines need to be substantial and enforced swiftly. It can be argued that fines may not be an effective method of deterring youth impaired driving because parents often pay the court on their child's behalf.

Probation. Probation is another traditional sentencing option that is available to judges in both Canada and the U.S. In ¼ of youth impaired driving cases in Canada, probation was imposed (Thomas 2005). A young person who is subject to a probation order is permitted to remain in the community but is subject to a number of conditions that are in effect for the term of probation and can be modified by the judge as appropriate and necessary. Compulsory conditions of probation include keeping the peace and appearing in court when required to do so (Endres 2004). Optional conditions (outlined in section 56 of the *YCJA*) that may be imposed at a judge's discretion include the imposition of a curfew, the requirement to report to a probation officer, abstaining from drugs/alcohol, and attending school (YCJA 2002). The maximum length of a probation order for youth in Canada is two years and a probation order was imposed in 111 youth impaired driving cases in 2003-2004. The average length of the probation order was 310 days with a median of 360 days (Thomas 2005). In some jurisdictions in the United States, parents can also be placed on probation along with their child; this is not an option in Canada.

Community service. In Canada, a judge has the discretion to impose a community service order of up to 240 hours with a maximum completion term of 12 months (YCJA 2002). In 2003-2004, youth courts ordered community service in 70 impaired driving cases (Thomas 2005). These orders are often overseen by community organizations, such as the John Howard Society, that have youth attendance/ intervention centres which provide structured and supervised programming in the community that address issues such as anger management, life skills, substance abuse, employment/job search skills, etc. (Ministry of Children and Youth Services 2008). A community service order is commonly combined with extrajudicial measures such as writing apologies or essays regarding the youth's behaviour. Studies have found that completion rates are high and there is evidence to suggest that having contact with the beneficiaries of the work or seeing the social value that the work has is correlated with higher levels of compliance (Schiff 1998).

Treatment. Treatment may be combined with non-residential, open-custody and closed-custody arrangements. For example, a judge may order a youth convicted of impaired driving to attend a non-residential program for a specified amount of time and under specific conditions.

These attendance programs provide structured and supervised programming within the community to address issues that include substance abuse (Ministry of Children and Youth Services 2008). This particular type of programming is viewed as a good alternative to incarceration because it still provides the youth the opportunity to attend school and fulfill other commitments. Parents are often encouraged to be part of any treatment that a youth is ordered to attend as studies have shown that successful treatment incorporates both parental and community involvement (Alexander 2000; Health Canada 2004).

An example of a program that incorporates treatment for young offenders is the Prince George Youth Custody Centre (PGYCC). This facility is designed as a residential facility that serves offenders sentenced to open- or closed-custody, and has beds reserved for young offenders that have different security classifications. The PGYCC operates a Youth Substance Abuse Management program that focuses on issues related to substance use and its impact on the youth's health, decision making, and relationships. This program targets those offenders for whom alcohol consumption played a role in their offending and includes youth convicted of impaired driving. Individual and group therapy techniques are utilized to challenge youth in the program to make better choices and find alternatives to alcohol use.

Similarly, an example of an in-custody treatment program in the United States is the San Juan County Detention and Treatment Program that operates in New Mexico. The program incarcerates first-time DUI offenders who are aged 18 or older in a minimum-security institution and provides treatment and programming that addresses alcohol abuse, the psychological effects of addiction, drinking and driving awareness, and other factors. (Kunitz et al. 2002). Results suggest that the program has had a significant effect on DUI re-arrest rates as the probability of not being arrested after five years for treatment participants was 76.6% compared with 59.9% for individuals who did not receive treatment (Kunitz et al. 2002).

Licence suspension. Youth in Canada and the U.S. are both often subject to some type of driver licence suspension. In Ontario, completion of a remedial measures program, called *"Back on Track"*, is required by all drivers convicted of an impaired driving offence, including young offenders, is required for licence reinstatement. The program uses the approach outlined by Health Canada (Health Canada 2004) as it combines licence suspension with an assessment followed by either an education or treatment program depending on the needs of the individual. The program can take up to 10 months to complete and any youth convicted of impaired driving is forced to enter the program if they hope to regain their licence (Back on Track 2008).

Incarceration. Incarceration is the most punitive sentence that can be given in an impaired driving case and it is an option that is not commonly used. In 2003-2004, only 3 youth were incarcerated on impaired driving charges in Canada. The mean amount of time that they were held in custody was 57 days (Thomas 2005). Presumably, these cases were of such a severe nature that no alternative sanction was viewed as appropriate. For these young offenders, incarceration could provide the needed "shock-value" to deter them from recidivating, but without supplementary programming and treatment, rehabilitation is thought to be unlikely (Nichols and Ross 1990).

Research has found that the use of incarceration by itself will not necessarily prevent recidivism, particularly in cases where the offender suffers from alcohol dependence or addiction (Kunitz et al. 2002). Rather, comprehensive programs that employ multiple intervention components are more effective in reducing recidivism than incarceration without treatment, particularly among first-time adult offenders (Kunitz et al. 2002). Mandatory two-day jail terms have appeared to reduce recidivism among adult offenders, although the effect of such "weekend intervention" sentences has not been tested among youth (Voas and Fisher 2001). Studies examining the effectiveness of incarceration on adult impaired driving offenders have produced mixed results. Some studies suggest that, as a specific deterrent, the use of incarceration is no more effective in reducing recidivism among both first-time and repeat offenders than other less punitive sanctions (NHTSA 2008). Other researchers have found that short-term periods of incarceration have acted as a general deterrent for first-time offenders (Voas and Fisher 2001).

Non-Traditional Dispositions For Youth

There are a number of non-traditional dispositions that are applied to youth impaired drivers in Canada and the United States. These sanctions include restorative justice initiatives.

Restorative justice initiatives. In recent years there has been a trend towards restorative measures to address youth crime. Restorative and/or transformative justice has many benefits as it seeks to give all parties involved a voice and allows for the reduction of system costs. Transformative justice may be a particularly good option for addressing young impaired drivers as it includes victims, offenders, families of both, and the community, while holding the offender accountable and looking for ways to "heal" all parties and prevent future offences from occurring. Measures such as family group conferencing have been used in drunken driving cases causing death for both youths and adults, with successful outcomes (Morris 2000).

An example is the Collaborative Justice project in Ottawa, a victim-offender mediation (VOM) initiative that focuses on reconciliation post-conviction. It has been involved in several youth impaired driving cases. Staff members work with adults or youths who accept responsibility for their actions and are willing to make amends for any harm that they have caused (CJP 2006). If the victim is willing to participate, both parties can work together to achieve a resolution that is amenable to all involved. The ultimate goal is to facilitate healing while also preventing future offending. Referrals to the program can be made by judges, crown attorneys (i.e., prosecutors), defence counsel, as well as police and probation officers (CJP 2006).

VOM can take place at various stages in the justice process. VOM is designed to provide victims and offenders with an opportunity to reconcile and mutually agree on reparation (Schiff 1998). As an alternative, VOM departs from the traditional criminal justice mentality in that it recognizes that an offence creates conflict between individuals as opposed to conflict between the individual and the state. In a multisite study in the United States of 1,131 VOMs involving juvenile offenders, researchers found that the recidivism rate was lower among offenders who participated in mediation (18%) compared to similar offenders who did not have interaction with their victims (27%) (NHTSA 2008). A common measure of success for VOM is the level of compliance with agreements; this varies from one program to another but averages about 80%

(Schiff 1998). These types of programs which also include Victim-Offender Reconciliation (VOR) tend to have high success rates among young offenders, as they were originally designed to target this population (Morris 2000).

Other alternative sanctions that focus on educating young impaired drivers are attendance at Victim Impact Panels (VIPs) and Emergency Room Visitation programs. Attending VIPs allows offenders to consider the consequences of impaired driving by hearing first hand the effect that it has had on the lives of others (Sprang 1997). The ultimate goal is not just to expose the offender to the potential consequences of their actions, but to ultimately motivate them to change their behaviour. A study done by Sprang (1997) reveals that 9.3% of those who attended a VIP were re-arrested for a DUI offence in the following year compared to 18.7% in a comparison group. A study has yet to be done to determine the effectiveness of these panels with young offenders.

An example of the emergency room visitation program is the Youthful Drunk Driving Program in Tulsa, Oklahoma which requires first-time DUI offenders between the ages of 16 and 25 to visit an emergency room and a rehabilitation centre for patients with spinal cord injuries (NHTSA 2008). They are also required to attend a VIP, an alcohol education session, DUI School, and undergo an alcohol assessment, after which the youth is required to compose a 500-word essay about their experiences and how what they have seen and heard has affected them. During 2003, 463 offenders participated in the program and more than 3,300 people have participated since its inception (Community Service Council 2008). The successful completion rate of the program is 83.45% and NHTSA (2008) has reported that the recidivism rate among participants is markedly lower than the national average. Another program similar to the YDD in Tulsa is the Youthful Intoxicated Driver's Visitation Program in Illinois that also has young offenders visit emergency rooms (Illinois Secretary of State 2006)

Conclusions

Despite significant declines in alcohol-impaired driving among youth in the past decade, a not insignificant number continue to engage in this high-risk and illegal behaviour. And although prevention, education and enforcement initiatives are an important component of any strategy to address this problem, those youth who are formally arrested and convicted of this behaviour, and sanctioned by the justice system also warrant attention.

To date, it appears that youth are more often subject to the same traditional sanctions that are typically applied to adults, many of which have not been proven effective even with the adult population. In addition, there is some evidence that a trend towards alternative and innovative approaches to sanctioning young impaired drivers is emerging. While this trend ultimately provides judges with more options for dealing with offenders, it is also resulting in a somewhat inconsistent approach to sentencing. More importantly, while there is some evidence to suggest that these alternatives may be effective, more research is needed to draw definitive conclusions. Hence there is a substantial need for research to identify optimal strategies (both traditional and non-traditional) for dealing with youth impaired drivers and preventing recidivism, and to help establish consistency in sentencing.

While prevention, enforcement, and education are all important elements in addressing the young impaired driver problem, it is important not to forget about those who have already come in contact with the justice system. More research in this area can contribute towards the development of effective strategies and the implementation of appropriate programs and sanctions to reduce recidivism among young impaired drivers. Providing practitioners with solid information about effective sanctions for youth is one more way to prevent offending and reduce the number of young people killed as a result of impaired driving, by those at greatest risk of recidivism.

A further consideration is that judges must weigh the costs and benefits of relying upon the various traditional sentencing options and alternative measures that are available to them. Formally processing youths through the criminal justice system can ensure that youth are held accountable for their actions; however, these sanctions have had mixed success with adult offenders and research on their effectiveness with youth is yet to produce conclusive results. Conversely, alternative sanctions can reduce costs and allow offenders to avoid the consequences of a criminal conviction (e.g., impact on educational and employment opportunities) and some of these measures have demonstrated success in reducing recidivism in youth (Morris 2000; Matson 2007). More importantly, by adopting creative solutions and dealing with young offenders in the community, they are less likely to incur a criminal label which in itself has been thought to be a factor in recidivism (Williams and McShane 2004).

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EFFECTS OF 21 MINIMUM LEGAL DRINKING AGE LAWS ON ALCOHOL-RELATED DRIVING IN THE UNITED STATES

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ABSTRACT

Minimum legal drinking age (MLDA) laws underwent many changes during the 20th century in the United States. Since July 1988, MLDA has been 21 in all 50 states and the District of Columbia. A preponderance of evidence shows that MLDAs of 21 are an effective deterrent to underage drinking and driving and have reduced alcohol-related crashes among young drivers. Yet many underage people still drink, many drink and drive, and alcohol remains an important risk factor in serious crashes of young drivers, especially as they progress through the teenage years. Stepped-up enforcement of MLDA and drinking and driving laws can reduce underage drinking. Recent efforts to lower MLDAs to 18 and issue licenses to drink upon completion of alcohol education have gained local and national media attention. There is no evidence that alcohol education can even partially replace the effect of 21 MLDA.

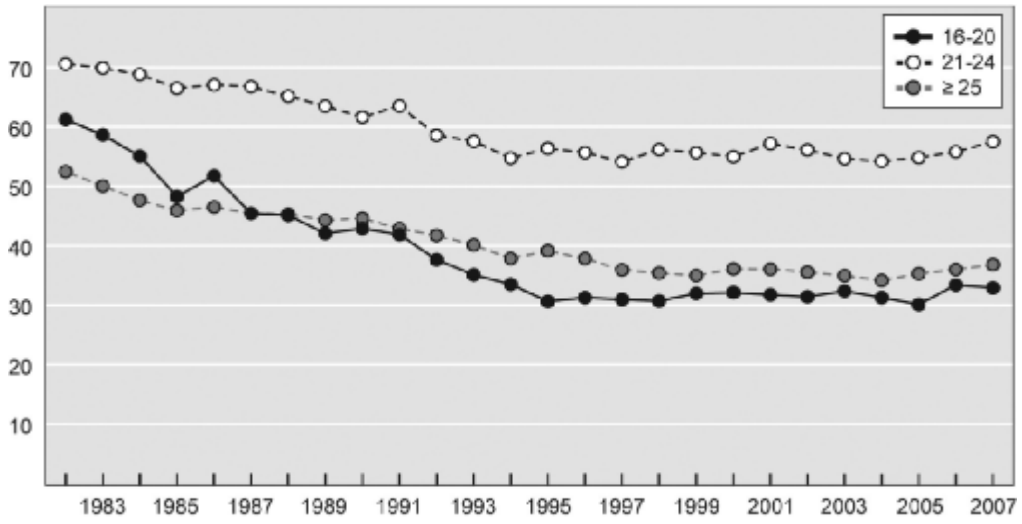
INTRODUCTION

Drivers younger than 21 are more vulnerable than older drivers to the impairing effects of alcohol. At the same blood alcohol concentration (BAC), young drivers are far more likely to get into fatal or nonfatal crashes (Zador et al., 2000; Peck et al., 2008). Since July 1988, all US states and the District of Columbia have had laws that require people to be at least 21 years old to purchase alcohol. In contrast, minimum legal drinking ages are 16-18 in most European counties, 18-19 in Canada, and 18 in Australia and New Zealand. All US states and the District of Columbia also have "zero tolerance" laws that prohibit people younger than 21 from driving after drinking. Typically, these laws prohibit driving with a BAC of 0.02% or greater. The zero tolerance and minimum legal drinking age (MLDA) laws are the primary legal countermeasures against underage drinking and driving in the United States.

There is a preponderance of evidence showing that 21 MLDA has been an effective deterrent to underage drinking and driving in the United States and has substantially reduced alcohol-related crashes among young drivers. Despite this evidence, a movement to lower the drinking age appears to have gained some traction. This paper summarizes historical trends in alcohol-related driving among people younger than 21 in the United States, the history and effects of minimum drinking age laws, and current initiatives to lower the minimum drinking age to 18. In this paper the term "underage people" refers to people 20 and younger. Laws prohibit the purchase, consumption, or possession of alcohol by underage people; for simplicity, the terms "drinking age" and "minimum legal drinking age," abbreviated as MLDA, refer collectively to all of these types of laws.

TRENDS IN UNDERAGE DRINKING AND DRINKING AND DRIVING

In the United States in 2007, an estimated 891 16-20-year-old passenger vehicle drivers fatally injured in crashes had positive BACs. This represented 33% of all fatally injured drivers ages 16-20 (Insurance Institute for Highway Safety (IIHS), 2008). As shown in Figure 1, between 1982 and the mid-1990s there were substantial declines in the proportions of fatally injured drivers with positive BACs for drivers ages 16-20, 21-24, and 25 and older. For all three age groups, there has been little subsequent progress. Among fatally injured passenger vehicle drivers ages 16-20, 61% had positive BACs in 1982 compared with 31% in 1995 and 33% in 2007. The proportion of drivers with positive BACs declined during 1982-2007 by 46% for drivers ages 16-20, by 18% for drivers 21-24, and by 30% for drivers 25 and older.

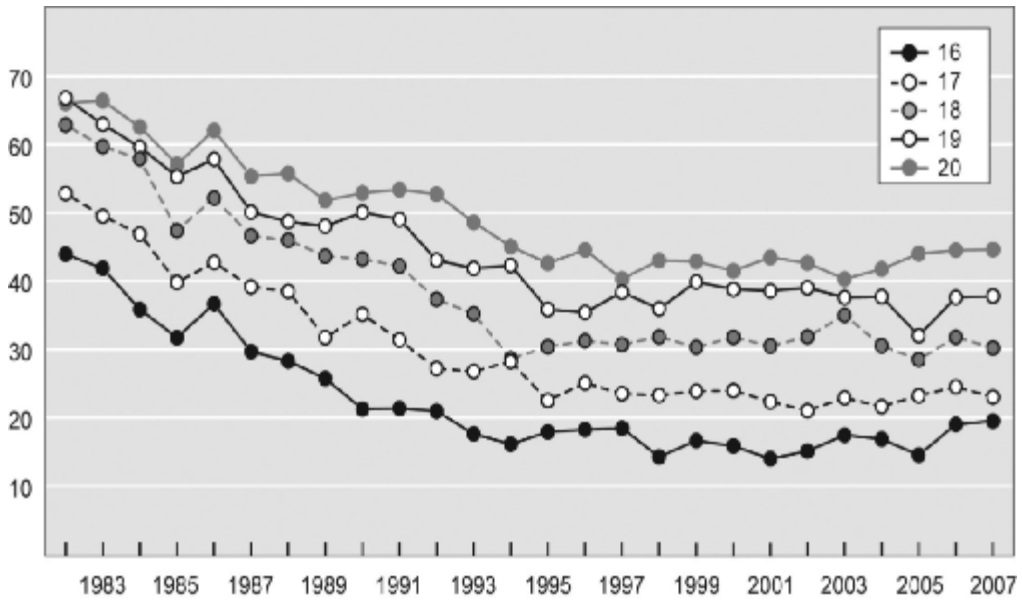


Source: Fatality Analysis Reporting System (FARS), 1982-2007 (IIHS, 2008)

FIGURE 1 Percent of fatally injured passenger vehicle drivers with positive BACs by age, 1982-2007.

There are similar trends among fatally injured passenger vehicle drivers with BACs of 0.08% or higher. Among fatally injured passenger vehicle drivers younger than 21, the proportion with BACs of 0.08% or higher was 53% in 1982, 24% in 1995, and 28% in 2007 (figure not shown) (IIHS, 2008).

Summary statistics for young drivers often do not distinguish among different years of age. During 1983-2007, the proportion of fatally injured passenger vehicle drivers ages 16-20 with positive BACs increased with each year of age such that the proportion for 20 year-olds was much larger than the proportion for 16 year-olds (Figure 2). Among all ages the proportion who had been drinking declined during 1982-2007. The decline was largest among 16 and 17 year-olds (56%) and smallest among 20 year-olds (33%).



Source: Fatality Analysis Reporting System (FARS), 1982-2007 (IIHS, 2008)

Figure 2 Percent of fatally injured passenger vehicle drivers ages 16-20 with positive BACs by years of age, 1982-2007.

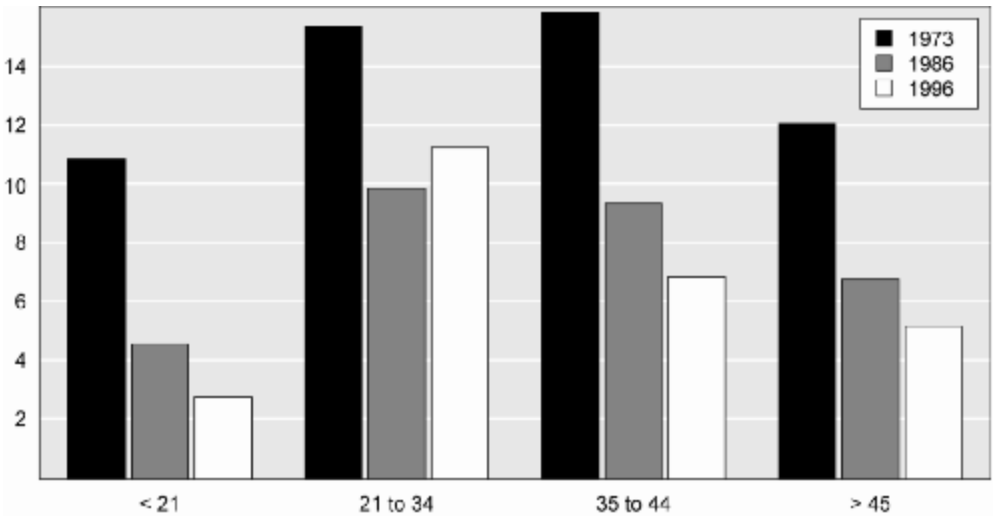
Table 1 summarizes changes in the number and per capita rate of fatally injured passenger vehicle drivers with positive BACs during 1982-95 and 1995-2007. During 1982-95, declines occurred among drivers of all ages, whether based on the number of deaths or per capita death rates. The largest declines in the number of fatally injured drivers with positive BACs occurred among the youngest drivers (ages 16-20), but there also were sizeable declines among drivers ages 21-24. The per capita death rate decreased during 1995-2007 among all age groups, but the number of deaths increased among 21-24 year-olds.

TABLE 1 Percent Change in Fatally Injured Drivers with Positive BACs by Driver Age: 1995 vs. 1982 and 2007 vs. 1995

	1995 vs. 1982		2007 vs. 1995	
	Number	**Per Capita**	**Number**	**Per Capita**
Age 16-20	-57	-50	-2	-18
Age 21-24	-39	-26	+10	-6
Age 25 and older	-9	-25	-11	-24

Source: Fatality Analysis Reporting System (FARS) and US Census, 1982-2007

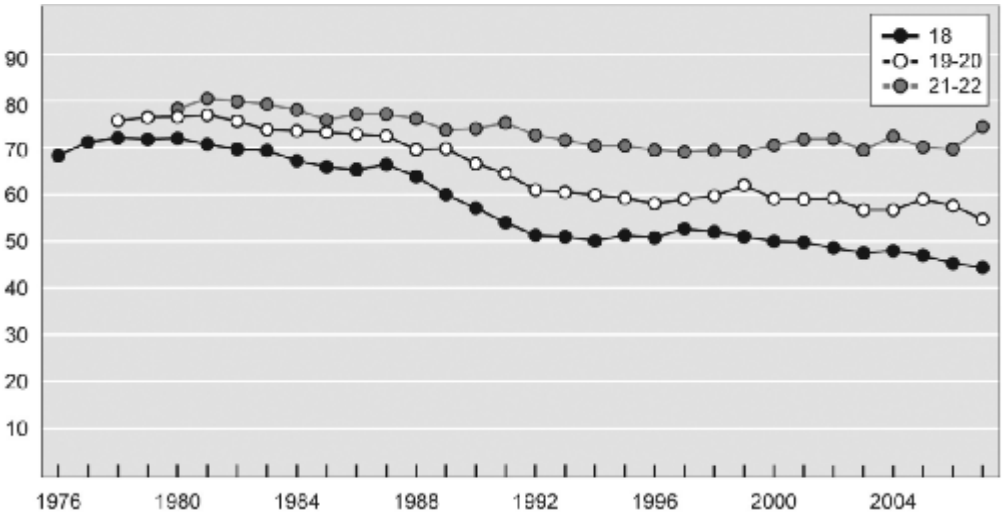
National roadside breath surveys of weekend nighttime drivers also show declines in drinking and driving among underage drivers as of the mid-1990s, declines that were larger than among older drivers (Voas et al., 1998). Among drivers younger than 21, the percentage with BACs of 0.05% or higher was 10.9% in 1973, 4.6% in 1986, and 2.8% in 1996 (Figure 3). The change during 1973-96 represented a 74% decline, larger than the percentage declines for other age groups (27% for ages 21-34, 57% for ages 24-44, and 57% for ages 45 and older).



Source: V oas et al. (1998)

FIGURE 3 Percent of drivers with BAC ≥ 0.05% in national roadside surveys by age, 1973, 1986, 1996.

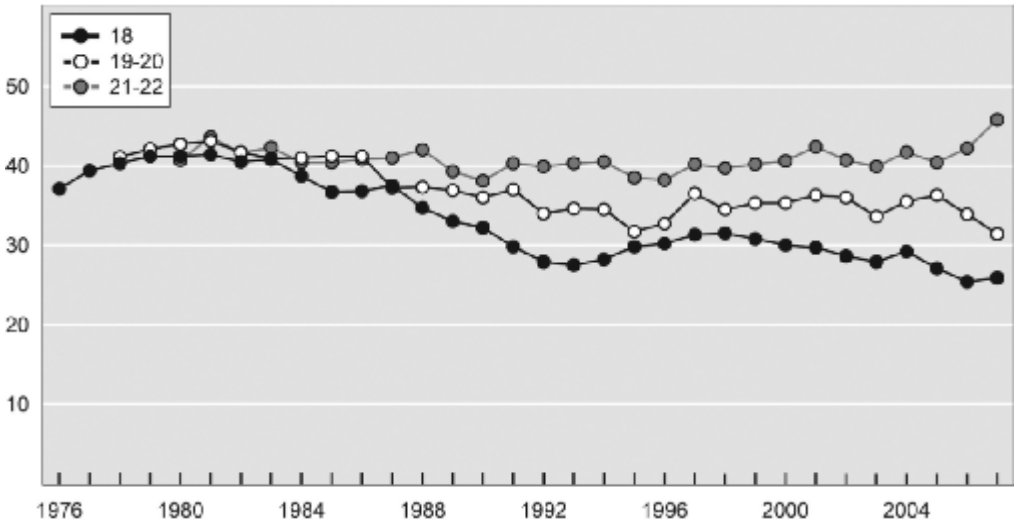
Drinking behaviors of high school students, college-age people, and young adults have been tracked since the 1970s by the Monitoring the Future survey, an annual large-scale national survey conducted by the University of Michigan. The survey indicates that drinking among people 21 and younger in the United States has declined since the late 1970s, but most of this decline occurred by the early 1990s (Johnston et al., 2008). As shown in Figure 4, the percentage of 18 year-olds reporting they used alcohol in the past 30 days declined from 68% in 1976 to 51% in 1992 and to 44% in 2007. Reported use among 19-20 year-olds also declined, although less steeply. The percentage reduction in reported use during 1980-2007 was 38% for 18 year-olds and 29% for 19-20 year-olds; in contrast, reported use declined by 5% among people ages 21-22.



Source: Johnston et al. (2008)

FIGURE 4 Percent consuming alcohol in past 30 days among ages 18-22, 1976-2007.

The Monitoring the Future survey indicates problem drinking also has trended downward among underage people (Johnston et al., 2008). The survey tracks various measures of problem drinking including "binge drinking," defined as consuming at least 5 drinks on one occasion. As shown in Figure 5, the proportion of underage people who reported "binge drinking" in the past 2 weeks peaked in the early 1980s. For 18 year-olds, the proportion declined from 41% in 1980 to 28% in 1992 and 26% in 2007. Among 19-20 year-olds the percentage was 43% in 1980, 34% in 1992, and 31% in 2007. Among 21-22 year-olds, the percentage was 41% in 1980, 40% in 1992, and 46% in 2007. Thus, although the prevalence of reported binge drinking was comparable among the age groups in 1980, the current reported prevalence is considerably lower among underage people than among those ages 21-22. Reported binge drinking among older adults has either increased or stayed about the same (data not shown).



Source: Johnston et al. (2008)

FIGURE 5 Percent having 5 or more drinks on at least one occasion in past 2 weeks among ages 18-22, 1976-2007.

Using data from the Behavioral Risk Factor Surveillance System survey, an annual random-digit dialing telephone survey of US adults 18 and older conducted by the Centers for Disease Control and Prevention, Naim et al. (2003) reported that per-person episodes of reported binge drinking in the past 30 days increased during 1993-2001 among US adults (from 6.3 to 7.4 episodes), including 18-20 year-olds (from 9.8 to 15.3 episodes). In discussing the limitations of the survey, the authors noted that college students were likely undersampled because many live in dormitories and are ineligible for inclusion in the survey. A third survey tracking alcohol use among young people is the National Survey of Drug Use and Health conducted by the Substance Abuse and Mental Health Services Administration (SAMHSA). The SAMHSA data indicate relatively stable rates of alcohol use, binge drinking, and heavy drinking among 18-22 year-olds during 2002-2007 (SAMHSA, 2008). Due to changes in the survey methodology in 2002, data after 2001 cannot be compared with data from earlier years.

HISTORY OF MLDAs IN THE UNITED STATES

Minimum drinking age laws underwent many changes in the 20th century, reflecting shifts in societal attitudes toward alcohol and alcohol-impaired driving, evolving views on the age at which the rights and responsibilities of adulthood should be conferred, and the influence of research on the effects of lowering or raising MLDAs. Key events in the history of MLDAs are highlighted in Table 2.

On January 16, 1919, the 18th Amendment to the US Constitution was ratified, prohibiting the manufacture, sale, or transportation of intoxicating beverages. Nearly 15 years later, on December 15, 1933, prohibition ended with ratification of the 21st Amendment. At that time, most states set MLDAs at 21. Notable exceptions were Louisiana and New York (age 18) and Hawaii (age 20). Other exceptions were states with different MLDAs for different classes of alcohol (21 for liquor and fortified wine and a lower age, typically 18, for beer and wine).

States made few changes in MLDAs until the Vietnam era when they began lowering them. Most states that lowered MLDAs did so for all alcohol; others lowered them just for beer and wine. The trend toward lowering MLDAs began in 1966 when Mississippi lowered its MLDA to 18 for beer and light wine; then, in 1969, Maine and Nebraska lowered from 21 to 20 their MLDAs for all alcoholic beverages. With the lowering of the voting age to 18 in 1971, many states decreased the minimum age for other privileges of adulthood including marriage, the legal age of consent, and drinking alcohol. During 1966-75, 30 states lowered their MLDAs, usually to 18. By the end of 1975, only 12 states had MLDAs of 21. Studies conducted during the 1970s reported significant increases in crashes among affected age groups in states that had lowered their MLDAs. For example, Williams et al. (1975) found that lowering MLDA to 18 was associated with a significant increase among drivers younger than 21 in fatal crashes that were most likely to involve alcohol (e.g., single-vehicle and nighttime crashes). Increases occurred among those directly affected by the law change (ages 18-20) and also among younger teenagers (ages 15-17) not affected.

Partly due to the research on the harmful effects of lower MLDAs, during 1976-79 MLDAs were raised from age 18 in eight states that had lowered them earlier in the decade. Seven of these states raised MLDAs incrementally, eventually reaching 21 in the 1980s. Michigan, however, made the jump from 18 to 21 in 1978, becoming the first state that had lowered an MLDA to raise it back to 21. As states restored MLDAs of 21, researchers found significant reductions in crashes among younger people affected by the law change (Hingson et al., 1983; Wagenaar, 1983; Williams et al., 1983) and some evidence of a positive spillover effect among younger drivers unaffected directly (Williams et al., 1983).

Fortified with this research, Mothers Against Drunk Driving (MADD) and other advocacy groups lobbied states to enact MLDAs of 21. Nine states raised their MLDAs to 21 during 1980-84. As some states enacted MLDAs of 21 and others kept their existing lower MLDAs, a patchwork of different MLDAs was created across the nation. This enabled minors who were too young to purchase alcohol in their own states to drive to nearby states where they could legally purchase or consume alcohol. In 1983, West Virginia dealt with this issue when it

raised its MLDA from 18 for everyone to 19 for West Virginia residents and 21 for everyone else. The border issue added pressure to create a uniform MLDA of 21.

Table 2 History of Minimum Legal Alcohol Drinking Age (MLDA) Laws in United States

1933	21st Amendment repealed prohibition; most states set MLDA at 21
1966-75	30 states lowered MLDA for some or all alcoholic beverages (Alabama, Alaska, Arizona, Connecticut, Delaware, Florida, Georgia, Hawaii, Idaho, Illinois, Iowa, Maine, Maryland, Massachusetts, Michigan, Minnesota, Mississippi, Montana, Nebraska, New Hampshire, New Jersey, Rhode Island, South Dakota, Tennessee, Texas, Vermont, Virginia, West Virginia, Wisconsin, and Wyoming) Only 12 states had 21 MLDA in 1975 (Arkansas, California, Indiana, Kentucky, Missouri, Nevada, New Mexico, North Dakota, Oregon, Pennsylvania, Utah, and Washington)
1971	26th Amendment lowers voting age to 18
1970s	Studies show teenage crashes (particularly nighttime and single-vehicle fatal crashes) increased in states that lowered MLDA (e.g., Whitehead et al., 1975; Williams et al., 1975)
Early 1980s	Advocacy groups lobby for 21 MLDA and 13 states started incrementally raising MLDAs (Connecticut, Florida, Georgia, Nebraska, New Jersey, New York, North Carolina, Ohio, Rhode Island, South Carolina, Texas, West Virginia, and Wisconsin)
1978	Michigan is first state to restore 21 MLDA
1980-84	9 states (Alaska, Arizona, Delaware, Illinois, Maryland, New Jersey, Oklahoma, Rhode Island, Tennessee) pass 21 MLDA; 22 states have 21 MLDA in effect by the end of 1984
1980-1985	Studies show decrease in teenage crashes when MLDA is raised (e.g., Hingson, 1983; Wagenaar, 1983; Williams et al., 1983)
1984	Federal Uniform Drinking Age Act enacted (1984)
1985-1986	21 states (Alabama, Connecticut, Florida, Georgia, Hawaii, Iowa, Kansas, Maine, Massachusetts, Minnesota, Mississippi, Nebraska, New Hampshire, New York, North Carolina, South Carolina, Texas, Vermont, Virginia, West Virginia, Wisconsin) and the District of Columbia pass 21 MLDA; total of 43 states and DC with 21 MLDA by the end of 1986
1987	5 states (Colorado, Idaho, Louisiana, Montana, Ohio) pass 21 MLDA
1985-current	Numerous studies confirm increasing 21 MLDA reduces teenage crashes (e.g., DuMouchel et al., 1987; General Accounting Office, 1987; O'Malley et al., 1991; Shults, 2001; Wagenaar and Toomey, 2002)
1988	South Dakota and Wyoming are last to pass MLDA of 21
1999	Zero tolerance laws had became effective in all states by 1999.
Current	Studies continue on effects and enforcement of MLDA of 21; Choose Responsibility spearheads initiatives to lower MLDA to 18; moves to lower MLDA in a few states fail to gain traction

(Presidential Commission on Drunk Driving, 1983), and safety groups lobbied Congress to enact legislation leading to a nationwide MLDA of 21.

The federal government could not enact a national MLDA of 21 because the US Constitution reserves to the states powers not specifically granted to the federal government and because the 21st Amendment gave states the right to regulate alcohol. Instead, Congress in 1984 enacted the Uniform Drinking Age Act. The act provided for a 5% reduction in federal highway

funding to states without MLDAs of 21 for all alcoholic beverages by October 1, 1986, and a 10% loss of funding to states without MLDAs of 21 by October 1, 1987. The US Supreme Court upheld the act when it was challenged as a violation of the 21st Amendment and the limitations of Congressional spending power under Art. I, 8, cl. 1 of the Constitution. The court noted that the act did not require any state to change its drinking age and reasoned that because Congress was not obligated to make funds for highways available to the states, it was permissible for Congress to condition the grant of such funds on state enactment of an MLDA of 21 (*South Dakota v. Dole*, 483 U.S. 203 (1987)).

Between January 1, 1985, and October 1, 1986, 21 states and the District of Columbia raised their MLDAs to 21. Five states followed suit by the end of 1987, and the last two states, South Dakota and Wyoming, enacted MLDAs of 21 by July 1, 1988. Numerous studies confirmed that raising MLDAs to 21 reduced teenage crashes (DuMouchel et al., 1987; General Accounting Office (GAO), 1987; O'Malley and Wagenaar, 1991; Shults et al., 2001; Wagenaar and Toomey, 2002), and researchers increasingly have focused on ways to increase compliance with 21 MLDA.

EVIDENCE OF EFFECTS OF MLDAs

Changes in states' MLDAs across timeprovided a fertile opportunity for researchers to assess the effects of raising or lowering MLDAs. This yielded a large body of evidence of the substantial highway safety benefits of 21 MLDA, including studies conducted in various jurisdictions and time periods and using different methods and measures of effectiveness.

Effect of MLDAs on Alcohol-Related Crashes

Several reviews of studies of the effects of MLDAs on crashes have been conducted (e.g., GAO, 1987; Shults et al., 2001; Wagenaar and Toomey, 2002). Wagenaar and Toomey (2002) examined 57 studies containing 102 separate analyses of the crash effects of MLDAs. Of the 66 analyses that reported significant effects, 98% found an association between higher MLDAs and lower crashes and 2% found the opposite. The Centers for Disease Control and Prevention conducted a systematic review of MLDA effects on crashes among drivers ages 18-20 (Shults et al., 2001). The 33 reviewed studies were published as journal articles and met specified standards for methodological rigor. Overall, MLDA modifications resulted in changes of about 10-16% in alcohol-related crash outcomes for the targeted ages, with crashes decreasing when MLDAs were raised and increasing when they were lowered. The effects were consistent across follow-up times, which ranged from 7 to 108 months. Shults et al. (2001) identified nine studies that examined the effect of raising MLDAs on crashes involving adolescent drivers who were younger than MLDAs both before and after they were raised. A median decline in crashes of 6% was associated with raising MLDAs, but the effect size was inconsistent, with some studies showing no effect. Several studies examined a so-called "drinking experience" effect — i.e., an increase in crash involvements resulting from lack of drinking experience when drivers reach an MLDA. Results were inconsistent because of difficulties in disentangling an experience effect from the MLDA effect.

A recent study by Fell et al. (2008) found that the enactment of laws raising MLDA to 21 was associated with an 11% reduction in the ratio of drinking (positive BAC) to non-drinking (non-positive BAC) underage drivers involved in fatal crashes during 1982-90, after controlling for other factors that could influence this ratio. The authors noted that the size of the effect may have been dampened by the use of states that already had 21 MLDA laws as a comparison to states enacting such laws and the constrained study period.

According to the National Highway Traffic Safety Administration, 21 MLDA laws have saved about 900 lives each year during 2003-07 and a total of 26,333 lives since 1975. These lives represent people of all ages who would have died in a crash involving 18-20 year-old drivers without 21 MLDA (Fell, 2008; Kindelberger, 2005). The derivation of the number of lives saved is based on studies that found an average reduction of 13% in fatal crash involvements of drivers 18-20 associated with an increase in the drinking age (Arnold, 1985; Womble, 1989).

Most research on the effects of MLDA laws has been conducted in the United States, but recent evidence on the adverse crash effects of lowering MLDA comes from New Zealand, where the minimum alcohol purchasing age was lowered from 20 to 18 in 1999. Kypri et al. (2006) found that the after-to-before ratio of the alcohol-involved crash injury rate per population was 12% larger for males ages 18-19 and 14% larger for males ages 15-17 than the after-to-before ratio for males ages 20-24. For females, this rate was 51% and 24% higher, respectively; the latter change was not significant.

Effects of MLDAs on Self-Reported Drinking

Several studies reported that higher MLDAs were associated with decreased alcohol consumption (e.g., Hingson et al., 1983; O'Malley and Wagenaar, 1991). O'Malley and Wagenaar (1991) examined the effects of 21 MLDAs on self-reported drinking during 1976-81 using data from the Monitoring the Future survey. The study found that high school seniors drank more (as measured by mean 30-day alcohol use) in states with 18 MLDAs than in states with 21 MLDAs, but throughout the 1980s alcohol use among high school seniors declined in states with 18 MLDAs and states with 21 MLDAs. After controlling for sociodemographic and other variables, an 21 MLDA was a significant predictor of lower alcohol consumption. The lower alcohol consumption associated with 21 MLDA led to declines in fatal nighttime single-vehicle crashes among drivers younger than 21. The analyses also suggested that even after reaching age 21, those who were unable to purchase alcohol at a younger age consumed less alcohol than those able to purchase it at age 18.

FULL COMPLIANCE WITH 21 MLDAs HAS NOT BEEN ACHIEVED

Despite the reductions in drinking associated with higher MLDAs, surveys suggest that many underage people drink and many drink heavily. According to the 2007 National Survey on Drug Use and Health, the proportion of people reporting drinking alcohol in the past month was 29% for ages 16-17 and 51% for ages 18-20 (SAMHSA, 2008). The proportion of people reporting binge drinking (having at least 5 drinks on one occasion) in the past month was 19% for ages 16-17 and 36% for ages 18-20. The most recent Monitoring the Future survey reported that 26% of

high school seniors reported binge drinking in the past 2 weeks (Johnston et al., 2008). Thirty-nine percent of eighth graders reported having tried alcohol, and 10% reported binge drinking in the past 2 weeks.

Surveys of young people indicate problem drinking is particularly acute among college students. In 2007, people ages 18-22 enrolled full-time in college were more likely than their peers not enrolled full-time in college to report drinking during the past month (64% vs. 54%), binge drinking (44% vs. 38%), and heavy alcohol use, defined as binge drinking on 5 or more days in the past 30 days (17% vs. 13%) (SAMHSA, 2008). During 1980-93, binge drinking declined among college students at a slower rate than among their non-college-age peers (Johnston et al., 2008). Since 1993, reported binge drinking has changed little among college students and increased among their non-college peers, but college students still stand out as having elevated rates of binge drinking.

A majority of underage drinkers interviewed in 2007 reported that their last use of alcohol had occurred in someone else's home (56%) or their own home (29%). Among those who did not pay for the alcohol, the sources of the alcohol were most often an unrelated person 21 or older (37%), another underage person (21%), or parents or other adult relatives (20%) (SAMHSA, 2008). A 1994-95 survey of underage college students and high school juniors and seniors in New York and Pennsylvania found that more than one-third of high school students and more than 60% of college students had tried to buy alcohol. About a third of college and high school students combined had used false identification to purchase alcohol (Preusser et al., 1997). Almost all (92%) high school seniors interviewed in the 2007 Monitoring the Future survey said it is fairly easy or very easy to get alcohol (Johnston et al., 2008).

ENFORCEMENT CAN INCREASE COMPLIANCE WITH 21 MLDAs

Most enforcement of 21 MLDA laws has been directed at retail or drinking establishments rather than private settings, and enforcement aimed at sellers and buyers can be effective in reducing underage access to alcohol. During 1990-91, researchers found that males ages 19-20 could easily purchase a six-pack of beer in Washington, DC, and a New York City suburb (Preusser and Williams, 1992). However, youths were less successful in two upstate New York counties where police recently had cracked down on underage alcohol purchases. Sting operations using underage police agents at licensed retail sellers of alcohol reduced agents' successful purchase of beer from 59% during baseline to 26% 4 months later after an extensive media campaign (Preusser et al., 1994). Community programs combining enforcement with other types of interventions (e.g., responsible beverage services training) have been effective in reducing sales to minors (Grube, 1997; Wagenaar et al., 2000; Wagenaar et al., 2005), reducing attempted alcohol purchases by underage people and self-reported underage drinking (Wagenaar et al., 2000), reducing single-vehicle nighttime crashes among underage people (Holder et al., 2000), and reducing self-reported underage drinking and driving fatal crashes among drivers ages 15-25 (Hingson et al., 1996).

Without special funds, there may be little enforcement of underage MLDA laws, and the level of enforcement varies widely among jurisdictions (McCartt et al., 1989; Wagenaar and Wolfson, 1994). Low funding for state alcohol beverage control agencies inhibits rigorous enforcement of MLDAs, inhibiting not only the identification of violators but also the timely

application of administrative penalties. Establishments do not always check teenagers' identification cards to establish age, and many teenagers obtain false identifications that are difficult to distinguish from official licenses. Home delivery services provide an avenue for sales of alcohol that are difficult to police. One study reported that 7-10% of underage people used home delivery services to get alcohol (Fletcher et al., 2000).

States' MLDAs are not all alike, and some are more easily enforced than others. For example, although all states prohibit the sale of alcohol to minors and possession of alcohol by minors is illegal, it is difficult to prove possession unless the minor is found in possession of alcohol in its original container. Also, the strength and enforceability of states' dram shop liability laws (allowing a person injured by someone under the influence of alcohol to recover damages from the retailer who served or sold the alcohol) vary widely. Deficiencies in laws pertaining to underage drinking may inhibit enforcement, but little research has addressed the extent to which specific components of MLDAs affect enforcement of underage drinking or drinking and driving (Fell et al., 2007).

Enforcement of alcohol-impaired driving (DUI) laws and zero tolerance laws and enforcement of MLDAs are mutually reinforcing. Preusser et al. (1992) found that young drivers were substantially underrepresented in the DUI arrest population relative to their contributions to the alcohol crash problem. Young drivers with high BACs were more likely than drivers of other ages to be missed by police at sobriety checkpoints (Wells et al., 1997). Zero tolerance laws are difficult to enforce independent of DUI because offenders with low BACs are not likely to display the erratic driving that results in drivers with high BACs being stopped. In addition, in seven states (Massachusetts, Nevada, New Jersey, New Mexico, North Dakota, Rhode Island, and Tennessee) police must arrest a suspect for DUI before administering an alcohol test. As a result, although it is illegal in these states for a person younger than 21 to drive with any measurable BAC, only those arrested for DUI may be tested (Ferguson et al., 2000). When zero tolerance laws are enforced they can be effective. Washington state's zero tolerance law was associated with an increased likelihood that an underage person would be sanctioned for drinking and driving, especially among drivers with BACs less than 0.08% (McCartt et al., 2007). Recent research evaluated the effects of a college community program of publicized stepped-up enforcement of 21 MLDA and the drinking and driving laws, including the zero tolerance law (McCartt et al., 2008). The percentage of underage agents who were able to purchase alcohol in licensed establishments declined, and reductions in driving at various BAC levels were achieved among drivers ages 16-20 and ages 21-24 — the ages targeted by the program.

Enforcing 21 MLDAs in private settings is problematic. So-called 'social host liability' may help. Generally people serving alcohol to guests in their homes are not liable for injuries caused to other people by intoxicated guests. However, there is liability if the guest is underage because it is illegal to provide a minor with alcohol and courts recognize a greater duty to protect minors than adults. Although not well researched, such laws may be a powerful tool against extra-establishment drinking among underage people, and these laws are being considered by an increasing number of states (Insurance Journal, 2006).

OTHER STRATEGIES TO REDUCE UNDERAGE DRINKING

Other strategies in addition to strengthening MLDA laws and tougher enforcement were suggested by the National Academy of Sciences' (2003) Committee on Developing a Strategy to Reduce and Prevent Underage Drinking. The committee recommended increasing the excise tax on alcohol, based on research that found an inverse relationship between the price of alcohol and consumption levels. Other recommendations included stronger controls on the advertising and promotion of alcoholic beverages and on the availability of alcohol in retail settings (e.g., outlet density and restrictions on hours of sale).

A 2003 national survey of drivers found that increased enforcement ranked higher as a strategy for reducing alcohol-impaired driving than measures to reduce the availability of alcohol or to raise taxes on alcoholic beverages (Royal, 2003). However, there is reasonable public support for a wide range of policies, as exemplified by another national survey that found at least half of adults supported 29 of 33 different policies. Among the top 10 policies (all with more than 80 percent support) were requiring server and bar owner training; restricting drinking at college campuses, concerts, and street fairs; tip lines to report illegal sale/use; punishment of adult providers; and tax increases (Harwood et al., 2002).

RECENT INITIATIVES TO LOWER MLDA TO 18

Despite the preponderance of evidence showing that 21 MLDA is an effective deterrent to underage drinking and driving, initiatives to lower MLDA to 18 have captured the attention of the local and national media (e.g., Crist, 2008; Dallas Morning News, 2008; Flores, 2008; Flynn, 2007; Greensboro News-Record, 2008; Huppke, 2008; Sack, 2008). Spearheading the initiatives is the organization Choose Responsibility (www.chooseresponsibility.org) which recommends that MLDA be lowered to 18 and that a "drinking license" be given to high school graduates ages 18-20 upon completion of education on responsible drinking. In July 2008, Choose Responsibility launched the Amethyst Initiative (http://www.amethystinitiative.org); about 120 college and university presidents signed a statement calling for a reconsideration of 21 MLDA in light of the "culture of dangerous binge drinking on many campuses."

Ignoring the large body of scientific evidence summarized above, Choose Responsibility states that factors other than 21 MLDA are responsible for the substantial declines in crashes among underage drivers (Chronicle of Higher Education, 2007; www.chooseresponsibility.org) For example, it is asserted that declines in the population of young people are responsible for the declines in alcohol-related crashes. However, as noted above, the rates of alcohol-related crashes per population fell during 1982-95 and 1995-2007. Similarly, it is claimed that safer vehicles, higher seat belt use, stricter alcohol-impaired driving laws, and other safety initiatives are responsible for the declines in alcohol-impaired crashes and not 21 MLDA. However, these factors have affected drivers of all ages, but the decline in crashes among underage drivers is substantially larger than the decline among older drivers.

According to Choose Responsibility, 21 MLDA has led to increases in underage binge drinking and other problem drinking behaviors; the rationale is that 21 MLDA leads to clandestine drinking, which fosters extreme drinking. However, the best evidence, summarized above, shows long-term declines in underage drinking and problem drinking and no up-tick in

recent years. It is sometimes claimed that heavy drinking and underage drinking are more common in the United States than in Europe, where MLDA is 16-18. However, surveys suggest that underage drinking also is prevalent in Europe, although it varies by country. A 1999 survey of European high school students found a higher proportion of 15-16 year-olds reported drinking alcohol in the past 30 days than was reported for 10th graders in the United States (National Academy of Sciences, 2003). A larger percentage of young people in a majority of European countries also reported binge drinking, compared to their US counterparts. In addition, US students were less likely than their European counterparts to report being intoxicated within the past year. Concern over underage drinking has prompted the Scottish Executive to propose raising MLDA from 18 to 21 for alcohol from off-licenses and supermarkets (Devlin and Porter, 2008).

According to Choose Responsibility, drinking education could effectively supplant and improve upon 21 MLDA laws in combating the problem of alcohol among 18-20 year-olds. There is no evidence about what effect drinking education might have on 18-20 year-olds, although alcohol education and public information programs rarely result in short-term behavior changes (Williams, 1994). However, there is evidence about the effects of driver education, which offers some insights about how drinking education and a drinking license might affect teenagers. Formal evaluations of US high school driver education programs, which usually cover education about drinking and driving, indicate little or no effect in reducing crashes per licensed driver (Mayhew et al., 1998; Vernick, 1999). Offering driver education in schools can have an unintended negative effect on crash involvement by encouraging early licensure among 16-17 year-olds (Christie, 2001). The net result is more crashes per capita among teenagers. A good education course, emphasizing on-the-road driving, can teach basic vehicle control skills and help drivers understand why traffic laws are what they are. Driver education, however, is not itself an effective public health strategy. Similarly, studies of the long-term effects of the Drug Abuse Resistance Education (DARE) program, the school-based substance abuse prevention program, found no significant difference in self-reported drug use or attitudes toward drugs (General Accounting Office, 2003). Drinking and drug use are lifestyle behaviors shaped by many ongoing social forces, and they are not amenable to change through one-time education efforts. By exposing students to drinking education, it is possible that driver education would even increase the number drinking. Receiving a license to drink could cause teenagers and some parents to conclude that a school thinks teenagers will drink safely.

Since January 2007, organized efforts in 9 states have been directed at some form of legislation to lower 21 MLDA, at least for some people. In two states (Missouri and South Dakota) signatures are being collected for a ballot initiative. The Missouri initiative would allow people 18 and older to legally purchase and consume alcohol. Petitioners were unable to collect the required 100,000 signatures needed to put the initiative on the November 2008 ballot, but the petition is still in circulation for 2010. The South Dakota initiative would allow 19 and 20 year-olds to purchase beer no stronger than 3.2% alcohol. In six states (Kentucky, Louisiana, Minnesota, New Hampshire, South Carolina, and Vermont) legislation has been introduced but has failed to progress. The Minnesota bill would have allowed people 18 and older to drink in bars; the Vermont legislation would have created a commission to study the implications of lowering the drinking age to 18; and New Hampshire's bill would have lowered the legal drinking age to 18. The bills in Kentucky, Louisiana, and South Carolina would have allowed military personnel who are younger than 21 to purchase and consume alcoholic beverages. In

Wisconsin a bill to lower MLDA for military personnel was drafted but not officially introduced. A few states have provisions that automatically restore the pre-MLDA drinking age if federal law ceases to penalize states for drinking ages younger than 21.

Recent national surveys indicate little support for lowering MLDA from 21 to 18. Among all adults surveyed by Nationwide Insurance in April 2008, only 22% believed the legal drinking age should be lowered, and 75% supported tougher enforcement of existing underage drinking laws and increased penalties for adults who give alcohol to underage people. Seventy-two percent of people interviewed thought reducing the drinking age would make alcohol more accessible to underage people, and nearly half believe it would increase binge drinking among teenagers. A 2007 Gallup national survey had similar findings: only 22% supported a federal law that would lower the drinking age to 18 in all states, and 60% percent believed penalties for underage drinking should be stiffened (Carroll, 2007).

SUMMARY

The highway safety benefits of 21 MLDA have been proven, and the cause and effect relationship between MLDA and highway crashes is clear. Deaths go up when the drinking age is lowered, and they go down when it is raised. Research also has found that a higher drinking age results in lower alcohol consumption among young people. Most of the public supports 21 MLDA laws and stronger enforcement of the laws. Although underage drinking and underage drinking and driving remains a significant problem, the scientific evidence suggests that lowering MLDA would only worsen the problem. Initiatives to lower MLDA to 18 may be well-intentioned but ignore the fact that 21 MLDA is a proven countermeasure against underage drinking and driving.

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THE IMPACT OF UNDERAGE DRINKING AND RELATED LAWS ON YOUTH ALCOHOL-RELATED FATAL CRASHES

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Background

In an effort to reduce youth drinking and alcohol-related problems in the United States, the federal government adopted legislation in 1984 that provided a strong incentive for states to adopt a uniform minimum legal drinking age (MLDA) of 21. By 1988, every State had raised its minimum legal age for both the purchase and possession of alcohol to persons aged 21 or older or face a significant loss of federal highway construction funds. In addition, all the States and the District of Columbia enacted laws prohibiting the furnishing or selling of alcohol to those under age 21, many of them adopting this law at the same time as the two "core MLDA laws". These two core MLDA laws (prohibiting possession and purchase by youth) have been studied extensively and considerable evidence exists that such laws can influence underage drinking and driving fatalities (Arnold 1985; Womble 1989; O'Malley and Wagenaar 1991; Toomey, Rosenfeld, and Wagenaar 1996; Shults et al. 2001; Voas, Tippetts, and Fell 2003; Ponicki, Gruenewald, and LaScala 2007). Between 1988 and 1995, alcohol-related traffic fatalities for youth aged 15 to 20 declined from 4,187 to 2,212, a 47% decrease, with considerable variability in these declines between the States (National Center for Statistics and Analysis [NCSA], 2003).

In actions to support these two core MLDA laws and further enhance their underage alcohol prevention programs, States have enacted other legislation targeting access to alcohol by youth, adults who provide alcohol to youth, and the prevention of impaired driving by underage youth. For example, keg registration, the use of fake identification, and minimum server/seller age laws all seek to make it more difficult for youth to obtain alcohol from licensed alcohol outlets. Other laws such as zero tolerance (ZT), which makes it an offense for drivers aged 20 and younger to operate a vehicle with any amount of alcohol in their system (blood alcohol concentration [BAC] > .00), focus on preventing youth from drinking and driving. Some provisions of recent graduated driver licensing (GDL) laws have night restrictions on driving by youth in order to reduce the risk of drinking and driving, most of which occurs at night. Use and lose laws, which authorize the suspension of driving privileges for underage alcohol violations (i.e., purchase, possession, or consumption of alcohol) aim to provide meaningful sanctions for youth who violate the MLDA laws. Social host laws target those who host underage drinking parties. All of these additional laws were designed to strengthen the prior two core MLDA 21 laws and increase States' alcohol prevention efforts targeting youth.

However, it is evident that considerable public ambivalence has resulted in substantial variation between States in the comprehensiveness of such underage drinking legislation—despite the

promise of such laws. For example, although all States make it unlawful for an underage person to possess alcohol, it is not illegal in some States for an underage person to consume alcohol. Further, some States have ZT laws that are unenforceable because police officers cannot take a youth into custody or transport them to the police station for a breath test unless they can demonstrate that the youth has a BAC higher than the adult illegal limit of .08 BAC (Ferguson, Fields, and Voas 2000). Not all States have graduated driver licensing (GDL) laws and some States do not have provisions in them restricting unsupervised driving at night when alcohol is most likely to be a factor (Williams and Preusser 1997).

It is assumed that the variability in the States' MLDA-21 laws as well as their strengths and limitations work together to produce different levels of deterrence. Thus, the extent to which States should devote resources to controlling alcohol sales and consumption by young people remains an important policy question, at least at the State and local level. In an earlier study (Fell et al. 2008, in press), 16 underage drinking laws were documented and their existence and relative strengths were assessed in each State. Table 1 provides each state's weighted scores on each of the 16 key elements of state laws and regulations relating to underage drinking and underage drinking and driving. Scores of "0" indicate that a state does not have a particular law or regulation; higher scores represent stronger laws. Thus, aside from issues relating to the level of enforcement and the publicity given to underage laws, there is substantial variation in the completeness with which states have adopted all components of these laws and the strength of adopted provisions.

After controlling for various factors it was found that the existence and strength of one of these laws was associated with reductions in underage drinking drivers in fatal crashes. The law making it illegal to use a fake identification to purchase alcohol was associated with reductions in the percent of underage drivers in fatal crashes who were drinking (-7%;$p<.05$). In that same study, it was found that the core MLDA-21 laws (possession and purchase) were associated with a national 11% reduction in the ratio of drinking to non-drinking underage drivers in fatal crashes using analysis of variance (ANOVA) regression methods. In this current study, alternative approaches were used to determine if any of the laws had effects.

In addition to underage drinking laws, past research has shown that certain impaired driving and traffic safety laws also affect drinking drivers in fatal crashes. Back in the 1970s and early 1980s, States began adopting laws making it illegal per se to drive with a blood alcohol concentration (BAC) that was equal to or exceeded .10g/dl. Pre-post law studies in individual States showed that these per se laws were effective in reducing alcohol-related fatal crashes (Zador et al. 1988; Klein 1989; Voas, Tippetts, and Fell 2000). In the 1990s, many States lowered their illegal per se laws to .08 BAC and in 2000, the U.S. Congress passed a bill encouraging States to adopt the .08 BAC standard or lose federal highway construction funds. By 2003, all 50 States and DC adopted the .08 BAC as illegal per se for adult drivers aged 21 and over. Numerous studies have shown that lowering the illegal per law from .10 to .08 has been effective in reducing alcohol-related traffic fatalities (Johnson and Fell 1995; Hingson, Heeren, and Winter 1996, 2000; Voas, Tippetts, and Fell 2000; Dee 2001; Shults et al. 2001; Bernat, Dunsmuir, and Wagenaar 2004; Tippetts et al. 2005; Wagenaar et al. 2007).

Table 1: Status and Strength of Key Underage-Drinking Laws in the United States: 2006

	Core Laws: Apply to Youth		Expanded Laws: Apply to Youth			Apply to Youth Driving		Apply to Providers							Mfgrs/ False ID	Cntrl Alc Dist
	(1) Possession (APIS)	(2) Purchase (APIS)	(3) Consumption (APIS)	(4) Use and lose (APIS)	(5) Use of Fake ID (APIS)	(6) Zero tolerance (APIS)	night restrictions	Furnishing/sellin g	on-premises servers/seller	off-premises servers/sellers	Registration	(12) RBS Training (ABC)	support provisions for	host—underage	Transfer/Producti on of False ID	of
AL	7	2	7	7	2	7	2	8	5	1	0	7	0	5	0	1
AK	4	1	4	0	3	8	1	5	8	4	0	8	2	0	0	0
AZ	8	2	7	2	3	5	0	8	0	1	0	3	2	6	0	0
AR	7	1	0	0	2	3	0	8	5	1	0	6	2	0	2	0
CA	1	2	0	8	2	6	2	8	4	1	2	2	3	0	1	0
CO	4	1	4	6	2	8	2	5	2	4	0	2	3	0	0	0
CT	1	2	0	6	2	6	2	8	0	0	3	0	3	0	0	0
DE	5	0	5	4	1	8	3	6	4	4	0	8	0	0	0	0
DC	7	1	7	7	2	6	2	8	4	0	4	7	2	0	0	0
FL	7	1	0	5	2	8	2	8	0	0	0	7	2	3	0	0
GA	6	1	0	4	2	8	2	7	0	0	6	0	3	0	0	0
HI	4	2	0	0	1	7	2	8	2	1	0	0	1	5	0	0
ID	5	1	7	6	2	8	3	8	0	0	1	0	3	0	2	0
IL	5	2	5	3	3	8	2	8	0	0	0	3	2	4	2	0
IN	7	0	7	5	2	7	2	8	6	1	2	6	1	0	1	0
IA	5	1	0	3	3	6	1	6	0	0	0	0	2	0	0	0
KS	7	2	7	6	1	10	0	8	5	4	3	0	2	6	1	0
KY	7	1	0	0	2	2	0	8	0	1	0	0	2	0	0	0
LA	3	1	3	7	2	7	2	8	0	1	3	8	2	0	0	0
ME	5	1	5	0	2	7	2	6	2	1	3	2	3	7	1	0
MD	5	1	0	0	2	6	2	6	0	0	3	7	2	6	0	0
MA	7	1	0	6	2	7	2	8	0	0	3	0	2	6	2	0
MI	7	2	7	0	2	1	2	7	0	0	0	8	2	3	1	1
MN	5	1	6	0	2	6	0	7	0	0	3	0	3	0	1	0
MS	1	1	0	4	2	5	3	8	4	4	0	0	2	0	0	0
MO	8	1	0	0	2	7	1	8	4	1	3	0	2	0	1	0
MT	7	1	7	3	2	8	2	8	0	0	0	6	0	0	2	1
NE	5	2	5	0	1	7	2	8	0	0	3	0	2	0	1	0
NV	1	1	0	6	1	8	3	8	8	1	0	5	2	0	2	0
NH	8	1	0	4	2	10	1	8	0	1	5	8	1	4	1	0
NJ	1	1	1	6	2	2	2	8	0	0	0	5	2	4	1	0
NM	4	1	0	2	1	8	2	5	4	4	3	8	2	0	1	0
NY	7	0	0	0	2	10	3	8	0	1	6	4	3	0	0	0

NC	7	1	7	4	2	5	3	8	0	0	0	2	2	0	1	1
ND	7	1	7	0	1	7	0	8	5	4	1	0	2	0	0	0
OH	7	2	7	0	3	7	1	8	0	0	0	0	3	8	2	0
OK	1	2	0	7	2	9	2	8	4	4	3	0	2	0	0	0
OR	5	2	5	5	2	8	2	8	0	0	5	11	2	6	0	1
PA	7	2	7	7	2	3	2	8	0	0	0	6	1	6	2	2
RI	7	2	0	5	2	2	1	8	0	0	3	7	3	0	1	0
SC	5	1	0	5	2	8	3	6	4	0	0	0	2	4	0	0
SD	8	1	7	6	2	3	3	8	5	0	0	6	0	0	0	0
TN	7	2	7	6	2	3	2	8	0	0	0	6	2	0	0	0
TX	7	2	7	6	2	8	2	8	0	0	0	2	2	0	0	0
UT	8	2	7	3	2	8	2	8	8	4	8	7	3	0	1	2
VT	8	0	7	0	1	9	0	8	0	0	5	8	2	0	1	1
VA	8	1	0	2	2	7	2	8	4	0	6	0	2	0	0	0
WA	7	2	7	7	2	7	1	8	5	1	6	7	0	6	2	1
WV	7	2	7	0	3	8	2	8	2	0	0	0	2	0	0	0
WI	7	1	7	3	2	6	2	8	0	0	0	6	3	5	2	0
WY	1	2	0	2	1	8	2	8	4	4	0	3	2	0	0	0
Total # with law	51	47	30	37	51	51	44	51	24	24	26	33	46	18	25	18

Administrative license revocation (ALR) laws where the licenses of drivers were automatically and administratively suspended for drivers arrested and found to have BACs at or exceeding the illegal limit also became popular in the 1980s and 1990s. Most States have these laws and a number of studies have indicated they are effective (Zador et al. 1988; Klein 1989; Voas, Tippetts, and Fell 2000; Shults et al. 2001; Wagenaar 2007). Finally, recent research is showing that as States adopt seat belt usage laws, especially laws allowing primary enforcement, alcohol-related front seat occupant fatalities are deceasing significantly (Voas, Tippetts, and Fell 2000; Voas et al. 2007).

As a follow up to our previous study, we set out to: (1) determine if the enactment of six MLDA 21 laws are associated with reductions in the rate of underage drinking drivers involved in fatal crashes after the enactment date, and (2) determine if the adoption of other key drinking and driving laws and socioeconomic conditions in the States have an effect on underage drinking driver fatal crashes.

Methods

We selected six underage drinking laws for analysis because we were able to obtain their effective adoption dates in each State: possession, purchase, keg registration, zero tolerance for driving, GDL with night restrictions, and use and lose. We selected four general impaired driving and traffic safety laws because there is substantial evidence that they are effective, at least with drivers of all ages: ALR, .10 BAC per se, .08 BAC per se, and mandatory seat belt laws (secondary and upgrades to primary enforcement). Past research indicated that sobriety checkpoints, beer consumption per capita, unemployment rates, and vehicular miles traveled per licensed driver also

had an effect on the ratio of drinking drivers to nondrinking drivers in fatal crashes (Voas, Tippetts, and Fell 2000, Voas, Tippetts, and Fell 2003).

Data Sources for Underage Drinking Laws

The primary source of data for underage drinking laws in the States is the National Institute on Alcoholism and Alcohol Abuse (NIAAA) *Alcohol Policy Information System (APIS)* dataset (1998–2005). The National Highway Traffic Safety Administration's (NHTSA's) *Digest of Impaired Driving and Selected Beverage Control Laws* (NHTSA 2006) was also used to obtain information on the license sanctions for violating ZT laws. For the final law, GDL, information from the Insurance Institute for Highway Safety (IIHS 2006) was used. Adoption dates for six of the laws (possession, purchase, keg registration, use and lose, zero tolerance and GDL with night restrictions) were obtained from NHTSA Digests, APIS and IIHS. The possession and purchase laws are core MLDA laws and the adoption dates were the same so they were treated as one law.

Data Sources for Adult Drinking Driving Laws

The primary sources for key impaired driving laws in the States are NHTSA's *Digests of State Alcohol Highway Safety Related Legislation* (NHTSA 1983-2006). The adoption dates for seat belt laws were obtained from NHTSA (2006, 2007) and the frequency of sobriety checkpoints was taken from Fell, Lacey, and Voas (2004). Beer consumption rates in the States were obtained from the NIAAA's Alcohol Epidemiologic Data System (Lakins et al. 2004); unemployment rates were obtained from the U.S. Bureau of Labor Statistics' online area statistics public database (2008) and vehicle miles traveled and licensed driver data were obtained from the online public databases of the Federal Highway Administration (FHWA), U.S. Department of Transportation (Office of Highway Policy Information (OHPI) 2008).

Data Sources for Traffic Fatalities

Annual State-Level data from the NHTSA's Fatality Analysis Reporting System (FARS) from 1982-2004 were used to determine the numbers of drinking drivers in fatal crashes. The FARS is a census of all fatal crashes (defined as a death of a participant within 30 days of the crash event) occurring on U.S. public roadways and reported to the police. Alcohol involvement is documented through BAC test results collected by police or coroners. Where such data are not available, the BACs of drivers, pedestrians, and cyclists are statistically imputed using crash characteristics (such as a police report of driver impairment) to obtain more complete and accurate alcohol data (Subramanian 2002). The imputation system for producing estimated BACs for cases without measured values (Subramanian 2002) is used to complete the BAC file. This imputation is available in FARS for each year from 1982 through the current year. It provides a BAC value for every driver, pedalcyclist, and pedestrian in the FARS file.

The data were analyzed using Structural Equation Modeling (SEM) techniques, in AMOS (Analysis of Moment-Based Structures), which is a Statistical Package for the Social Sciences (SPSS) based method. A path diagram was developed which represents the SEM model hypothesized for the analysis of youth alcohol-related traffic fatalities. The model is comprised of the following measured variables:

- six laws targeting underage 21 drinkers/drivers (possession and purchase [the two core laws treated as one law in our analyses], keg registration, use and lose, graduated driver licensing [GDL] with nighttime restrictions, and zero tolerance [ZT]),
- four laws targeting all drivers (.08 BAC per se limit laws, .10 BAC per se limit, administrative license revocation [ALR], and primary and secondary seat belt usage laws),
- sobriety checkpoint enforcement (frequency)
- beer consumption (per capita gallons of ethanol),
- unemployment rates (%),
- vehicular miles (thousands) traveled (VMT) per licensed driver,
- the FARS ratio of under age 21 drinking drivers to non-drinking drivers in fatal crashes, and
- the FARS ratio of drinking to non-drinking drivers aged over 25 years.

Crash Incidence Ratio (CIR) Measure

Since alcohol-related crashes do not occur in controlled environments, it is important to control or adjust for external factors not related to alcohol legislation that affect the numbers of all crashes. Some examples of these are: population growth and demographic changes; driving exposure (reflected in VMT, and to a lesser extent in economic indicators); general changes in vehicle safety (construction, trends towards driving larger vehicles); weather and road conditions; etc. While it is theoretically possible to try to account/adjust for the effects of all such factors on alcohol-related crashes individually via covariate techniques, realistically it is impossible to obtain operational measures for all of the known extraneous influences. There are also many other general influences of which we may be unaware. However, because the majority of these risk factors should similarly affect the risk of non-alcohol-related crashes as they do alcohol-related crashes, employing non-alcohol-related crashes as a 'control' group should adjust for the vast majority of extraneous factors that cause deterministic variance within both groups of drivers (other exposure factors).

One way to account for these extraneous factors is to use the non-alcohol crashes as a covariate or regressor within the model. We chose to account for the 'control' group (non-alcohol-related fatal crashes) explicitly as part of the dependent measure, by combining the two figures into a single measure or rate, such as the percent of fatal crashes that are alcohol-related, or the odds of a driver in a fatal crash being alcohol-positive (i.e. the ratio of crash involved drinking drivers to crash involved nondrinking drivers, or the Crash Incidence Ratio (CIR) (Voas et al. 2007). These are the two most commonly used arithmetic methods of controlling for extraneous general factors.

For statistical analysis, the odds (usually log-transformed into log-odds) has several advantages over the proportion, so we chose the CIR for our dependent measure. The size of increases/decreases of an odds-ratio are simpler to interpret (e.g., "1.4 times as likely") than are the "relative percent of a percent" or "percent of a proportion" which can be confusing to the non-research public.

Structural Equation Modeling

"Structural Equation Modeling (SEM) is a process that allows for the testing of competing theories that are hypothesized *a priori* to explain the correlations (or variances and covariances) among measured variables." It is a confirmatory technique because the model, which is normally presented in the form of a path diagram, must be specified beforehand. SEM enables the exploration of the causal relationships between variables, both observed (measured) and unobserved or latent (which are linear combinations of observed variables) (Jöreskog 1966, 1967, 1969). As such, it has become more popular among researchers who are interested in more than the simple nature of relationships between variables that, say, regression analysis provides.
The data were analyzed using SEM techniques, in AMOS (Analysis of Moment-Based Structures), which is an SPSS-based package. We had previously used cross-sectional time series regression to model the data (Fell et al. 2007) but found that it would be more beneficial to use SEM.

The Hypothesized Model

The path diagram we developed represents the SEM model hypothesized for the MLDA analysis. The model is comprised of 13 measured variables: the 6 laws targeting youth drivers (GDL with nighttime restriction, use and lose, keg registration, possession and purchase (the two core laws treated as one law), and ZT), the 4 laws targeting all drivers (primary and secondary seatbelt laws (treated as one composite seat belt law), .08 BAC per se, .10 BAC per se, ALR), beer consumption per capita (gallons of ethanol), unemployment rates (%), vehicular miles (thousands) traveled per licensed driver, enforcement level through the frequency of sobriety checkpoints, the CIR or ratio of alcohol-positive to alcohol-negative drivers aged under 21 years, and the ratio of alcohol-positive to alcohol-negative drivers aged over 25 years (older cohort).

The model suggests that there are two outcomes which co-vary: the ratio of alcohol-positive to alcohol-negative drivers under 21 years old, and the ratio of alcohol-positive to alcohol-negative drivers aged over 25 years. In addition, the respective previous year's ratios are used as predictors of the outcomes and are allowed to co-vary. Furthermore, all 9 laws directly affect the under-21 ratio, but only the non-youth laws and the remaining variables affect the over-25 ratio. Also, beer consumption affects both ratios, but beer consumption is affected by the .08, .10 and ALR laws, and a latent economy variable represented by unemployment and VMT. Thus, beer consumption serves as both predictor and outcome in the model.

Also included in the model are components representing the autoregressive parameters for the two FARS outcome measures (these two being the previous year's alcohol-ratio for the under-21, and for the adult cohort). The autoregressive components help account for correlated errors within state over time, and are the best way to eliminate general "trend" influences that are separate from other measured factors that change over time (e.g., law changes, economic changes and beer consumption changes). Given that the outcomes are allowed to covary, logic dictates that we allow these to covary too.

Results

Table 2 presents the estimates, standard errors and significance levels of coefficients representing the direct relationships between the predictors and outcomes, and the associated effect sizes. Figure 1 presents a graphical display of the relationships. In both, only the significant relationships are presented. The results imply that the .08 law was associated with a 10% ($p < .001$) decrease in beer consumption while keg registration was associated with a 7% ($p < .001$) decrease in beer consumption. The .08 law was also associated with an 8% decrease in the underage FARS ratio and a 6% decrease in the FARS ratio for the older cohort. With respect to beer consumption, every additional gallon of ethanol (per capita) consumed was associated with a 0.44 increase in the underage FARS ratio and a 0.28 increase in the FARS ratio for the older cohort. In addition, significant decreases in the underage ratio were associated with the implementation of possession and purchase laws (-16%, $p < .001$), the ZT law (-5%, $p = .015$), a secondary seatbelt law or adding a primary law (-3%, $p = .041$), the ALR law (-5%, $p = .024$), and the use and lose law (-5%, $p = .026$). There was only a downward trend associated with the .10 law with respect to the underage group (7%, $p = .065$).

As shown, when the economy was good the unemployment rate decreased and VMT per licensed driver increased. This also had the effect of reducing the FARS ratios in both the underage and older age cohort. A closer look at the data revealed that the reduction in the FARS ratio for the underage drivers was driven by the number of alcohol-positive drivers, which sharply declined over time while the number of alcohol-negative drivers fluctuated around a median value. On the other hand, the reduction in the FARS ratio for the older age cohort was driven by the number of alcohol-negative drivers, which sharply increased over time while the number of alcohol-positive drivers declined only slightly.

The FARS ratio for the older age cohort also experienced decreases associated with the .10 law (-4%, $p = .042$), seatbelt laws (-2%, $p = .016$) and the ALR law (-4%, $p < .001$). The results presented in Table 1 also suggest that the covariances hypothesized are highly significant. No significant relationships were found between the underage FARS ratio and GDL with nighttime restriction (0.1%, $p = .98$), between the .10 law and beer consumption (2.7%, $p = .22$), and from economy to beer consumption (-0.7%, $p = .26$).

Table 2. Estimated Coefficient Values and Significance Levels for the Direct Effects

Outcome	Dir'n	Predictor	B (Estimate)	Effect Size (%)	S.E.(B)	*P*-value
Significant paths:						
Beer Consumption	<---	ALR law	0.061	6.29	0.013	< .001
Beer Consumption	<---	.08 law	-0.109	-10.33	0.015	< .001
Beer Consumption	<---	Keg Registration law	-0.077	-7.41	0.015	< .001
Unemployment	<---	Economy	-0.909	-59.71	0.215	< .001

Outcome	Dir'n	Predictor	B (Estimate)	Effect Size (%)	S.E.(B)	*P*-value
VMT/Licensed Dr	<---	Economy	Set to 1*			
LN(< 21 FARS ratio)	<---	.08 law	-0.079	-7.60	0.026	0.002
LN(< 21 FARS ratio)	<---	Keg Registration law	0.116	12.30	0.026	< .001
LN(< 21 FARS ratio)	<---	Possession & Purchase laws	-0.176	-16.14	0.036	< .001
LN(< 21 FARS ratio)	<---	ZT law	-0.052	-5.07	0.021	0.015
LN(< 21 FARS ratio)	<---	Economy	-0.030	-2.96	0.011	0.007
LN(< 21 FARS ratio)	<---	Beer Consumption	0.367	44.34	0.051	< .001
LN(< 21 FARS ratio)	<---	.10 law	-0.068	-6.57	0.037	0.065
LN(< 21 FARS ratio)	<---	Composite SB law	-0.032	-3.15	0.016	0.041
LN(< 21 FARS ratio)	<---	ALR law	-0.051	-4.97	0.023	0.024
LN(< 21 FARS ratio)	<---	Use & Lose law	-0.054	-5.26	0.024	0.026
LN(< 21 FARS ratio)	<---	Checkpoint enforcement	-0.009	-0.90	0.01	0.387
LN(< 21 FARS ratio)	<---	Lag 1 of LN(< 21 FARS ratio)	0.435		0.02	< .001
LN(> 25 FARS ratio)	<---	Composite SB law	-0.019	-1.88	0.008	0.016
LN(> 25 FARS ratio)	<---	.08 law	-0.065	-6.29	0.013	< .001
LN(> 25 FARS ratio)	<---	Beer Consumption	0.250	28.40	0.025	< .001
LN(> 25 FARS ratio)	<---	ALR law	-0.037	-3.63	0.011	< .001
LN(> 25 FARS ratio)	<---	.10 law	-0.037	-3.63	0.018	0.042
LN(> 25 FARS ratio)	<---	Economy	-0.031	-3.05	0.006	< .001
LN(> 25 FARS ratio)	<---	Keg Registration law	0.042	4.29	0.013	0.001

Outcome	Dir'n	Predictor	B (Estimate)	Effect Size (%)	S.E.(B)	*P*-value
LN(> 25 FARS ratio)	<---	Checkpoint enforcement	-0.014	-1.39	0.005	0.004
LN(> 25 FARS ratio)	<---	Lag 1 of LN(> 25 FARS ratio)	0.577		0.016	< .001
Covariances						
e13	<-->	e12	0.117		0.006	< 0.001
Res4	<-->	res3	0.017		0.002	< 0.001
Non-significant paths						
LN(< 21 FARS ratio)	<---	GDL with nighttime restriction		0.1		0.983
Beer Consumption	<---	.10 law		2.7		0.218
Beer Consumption	<---	Economy		-0.7		0.257

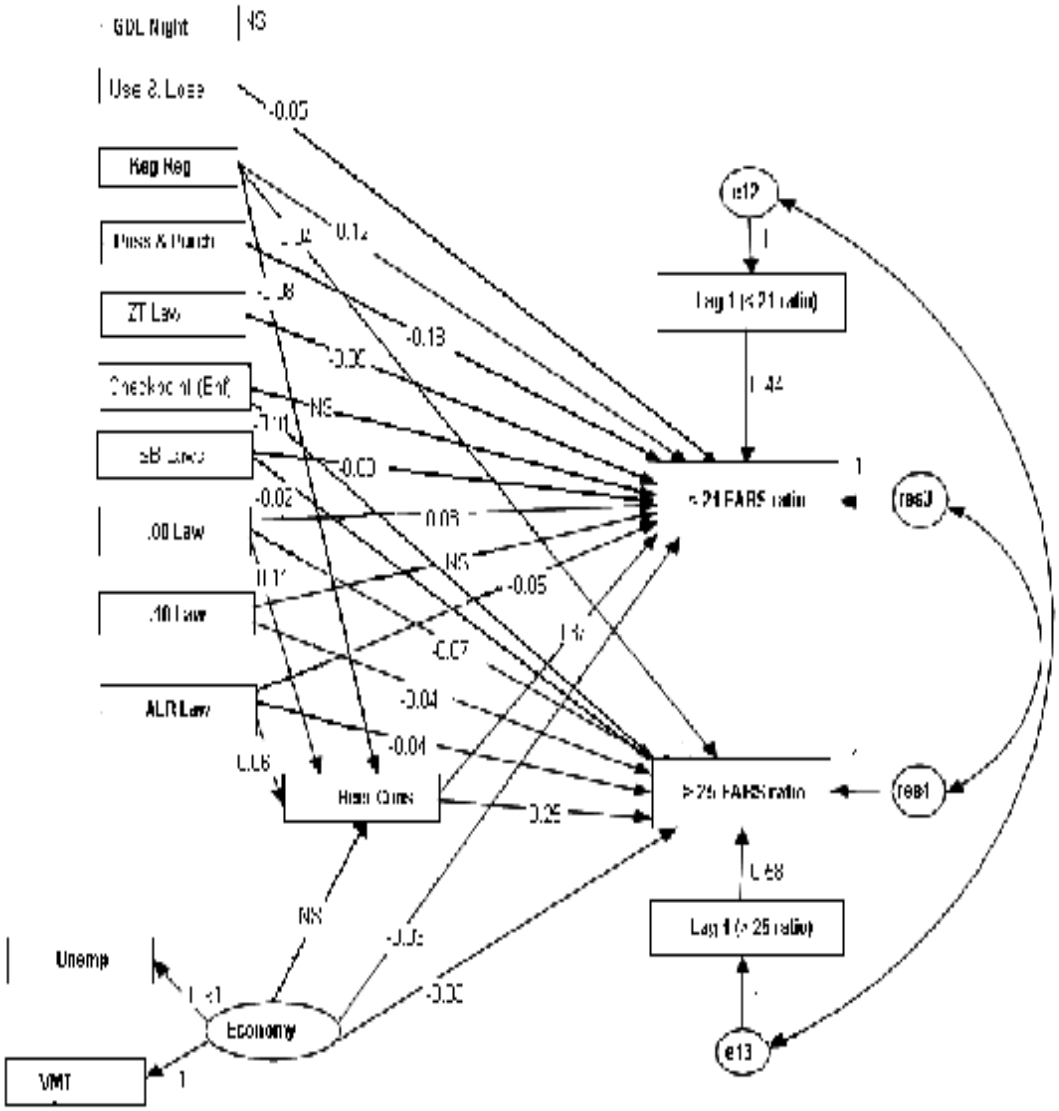

Figure 1. Model with Estimated Coefficients

The ALR law was associated with a 6% ($p < .001$) increase in beer consumption, and there are positive direct effects of keg registration on both the youth outcome (12%, $p < .001$) and adult outcome (4%, $p < .001$). One would expect these direct effects to be negative, given that the mean of the ratios is lower during the period after keg registration than in the period before. This reversal (called Simpson's paradox) was likely caused by the non-random assignment of the laws throughout the states and years, resulting in cells which are not representative of the majority of states when the data are broken out across the laws. This problem may be solved by stratifying by state but this is not feasible, given that there are only 23 cases per state and the SEM being fitted estimates many parameters. Thus, there is no option but to retain the current model.

Discussion

With respect to direct effects on underage drinking driver fatal crashes, significant decreases in the underage ratio measure were associated with four of the laws targeting underage drinking: possession and purchase laws [treated as one in the analysis(-16%, $p < .001$), the use and lose law (-5%, $p = .026$) and the ZT law (-5%, $p = .015$). Three laws targeting all drivers also had significant effects on youth: .08 BAC law (-8%, $p = .002$), a secondary enforcement seatbelt law [allowing a seatbelt citation only after stopping for some other traffic violation] or adding a primary enforcement law [allowing police to stop and cite drivers directly who are not wearing their seat belt] (-3%, $p = .041$), and the ALR law (-5%, $p = .024$); as well as the economy [expressed as the unemployment rate](-3%, $p = 007$). Alternatively, and as expected, beer consumption was associated with an increase in the underage CIR (.44 unit increase in the FARS CIR per unit increase in per capita gallons of ethanol consumed).

Generally, effects were in the expected direction. However, no significant relationship was found between the underage drinking driver FARS ratio and GDL with nighttime restrictions (0.1%, $p = .98$). Nighttime restrictions for novice (age 15-17) drivers have been found to be effective in reducing underage driver fatal crash involvement (Williams and Preusser, 1997), but it is not apparent whether the restriction reduces all *drinking* drivers under age 21 in fatal crashes. In this analysis, we only considered the fact that the State had a GDL law with *some* nighttime restriction. The specific hours of restriction were not considered. Further analyses may show that the specific hours of restriction have an effect—such as one that begins at 10:00 pm as opposed to one that begins at 1:00 am.

Contrary to logic, keg registration was associated with an increase in the underage CIR (12%, $p < .001$). An analysis of indirect effects, however, showed that keg registration has a significant *negative* indirect effect on the underage CIR (-3%) through beer consumption, yielding a total effect size of an increase of 9%. It is not apparent why this increase occurred. Perhaps States that tend to enact keg registration laws have greater underage drinking problems to begin with. We are not aware of any studies of keg registration laws that have shown any impact of the law as the provisions of these laws are very complex (see Wagenaar et al. 2005).

The direct effects of laws on alcohol-related fatal crashes of drivers over age 25 were similar to the effects on underage drivers but of a lesser magnitude. There were significant decreases in the drinking to non-drinking over age 25 driver CIR associated with four of the laws targeting all drivers: the .08 BAC law (-6%, $p <.001$), the .10 BAC law (-4%, $p = .042$), the composite seat belt law (-2%, $p = .016$), and the ALR law (-4%, $p < .001$) as well as the economy (-4%, $p < .001$). Also consistent with the underage results and as expected, beer consumption was associated with an increase in the CIR (.28 unit increase in the CIR per unit increase in per capita gallons of ethanol consumed). Keg registration was again positively and significantly associated with the CIR of drinking to non-drinking drivers 25 and older r (4% $p = .001$); however, it also demonstrated a significant negative indirect effect through beer consumption (-2%), resulting in a total effect size of 2%.

In conclusion, four of the six underage drinking laws were significantly associated with reductions in underage drinking and driving fatal crashes. Only GDL with night restrictions and keg registration laws failed to show associations with CIR reductions. This does not mean these laws are not effective, it just means effects could not be detected in this study using these measures. GDL with night restrictions may very well reduce the risk of fatal crashes for young drivers—drinking and non-drinking drivers equally. Keg registration laws may very well reduce the number of underage drinking parties where kegs of beer are usually purchased. If changes like that occurred, they did not translate (in this study during this period) to a reduction in drinking driver involvement in fatal crashes.

Three of the general impaired driving and traffic safety laws examined were significantly associated with reductions in underage drinking-driving fatalities (lowering the illegal BAC limit to .08; ALR; safety belt usage laws) which was expected. However, the four underage drinking laws had a greater effect.

The reduction in the underage drinking to non-drinking driver ratio over time was primarily due to reductions in the number of drinking underage drivers while the number of non-drinking drivers fluctuated around a median value. On the other hand, the reduction in the CIR for the older age cohort was influenced by the number of alcohol-negative older cohort drivers, which sharply increased over time while the number of alcohol-positive older cohort drivers declined only slightly. These findings point to the importance of underage drinking, alcohol policy and traffic safety laws in States' efforts to prevent drinking and driving among young people.

There are at least 16 underage drinking laws that have been adopted by some of the States that could have an impact on underage impaired driving. Documented in detail the previous study (Fell et al. 2008, in press), these were as follows (see Table 1):

- The two core laws applying to youth: (1) possession, (2) purchase
- Three expanded laws applying to youth: (3) consumption, (4) use & lose, (5) use of a fake ID
- Two expanded laws applying to youth driving: (6) zero tolerance, (7) GDL with night restrictions
- Seven laws applying to providers of alcohol to youth: (8) furnishing or selling, (9) age for on-premise servers, (10) age for off-premise servers, (11) keg registration, (12) responsible beverage service training, (13) retailer support provisions for false ID, and (14) social host liability for underage parties
- One law applying to manufacturers of fake IDs: (15) illegal to produce or transfer fake IDs
- One law applying to State control of alcohol: (16) licensed or state control of alcohol distribution

We were able to obtain adoption dates in the states for 6 of the 16 laws. It will be difficult obtaining adoption dates for the remaining 10 underage laws as comprehensive in-depth legal analysis likely will be required. However, these dates should be accessed so that additional analyses of the kind described in this study can be conducted. This will help States decide what

their legislative agenda should be when it comes to reducing underage drinking and the consequences that result from it in their State.

Public policy officials need to be cognizant of the fact that the MLDA 21 in the States is not just one law. The MLDA 21 consists of two core laws (purchase and possession) and at least 14 expanded laws (e.g. consumption; use and lose; zero tolerance for driving; furnishing). Recently there has been a movement in several states to lower the drinking age to 18 and provide for "drinking licenses" for youth who successfully complete an alcohol education course (Wasley 2007). If the drinking age is lowered in any State, it will affect not just one law (or the two core laws), but several related laws. Given that at least four of these laws are associated with significant reductions in underage drinking driver rates in fatal crashes, controlling for many other factors, it is the opinion of the authors that the MLDA remain at 21 in the United States.

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SECTION IV .PREVENTION/INTERVENTION STRATEGIES: STRATEGIES ON COLLEGE CAMPUSES AND IN THE MILITARY

EFFECTS OF A COLLEGE COMMUNITY CAMPAIGN ON DRINKING AND DRIVING WITH A STRONG ENFORCEMENT COMPONENT

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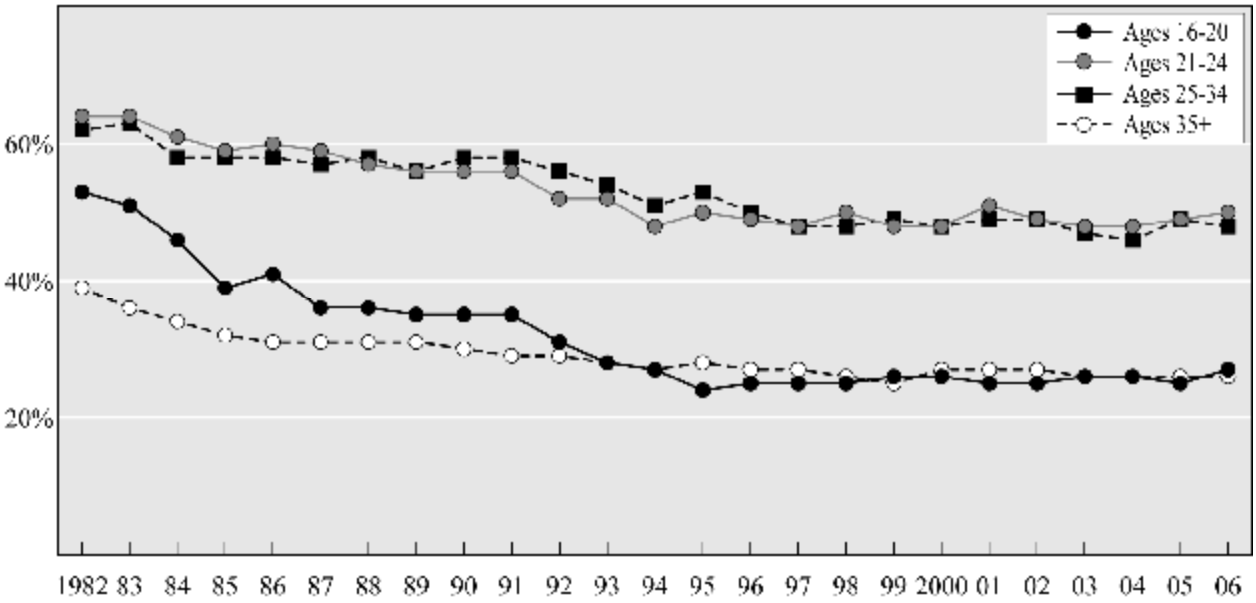
ABSTRACT

A program of publicized intensive enforcement of minimum drinking age law and drinking and driving laws was implemented in a college community. The effects on driving at various blood alcohol concentrations (BACs) were evaluated, particularly for drivers ages 16-24 targeted by the program. Objective measures of driver BACs were collected through nighttime roadside surveys before and during the program in the experimental college community and a comparison college community. Logistic regression models estimated the program's effects on the likelihood of driving at various BAC thresholds in the program community, after accounting for BAC patterns in the comparison community. Relative to the comparison community, consistent reductions in driving at various BAC levels (positive BAC and BAC at least 0.02%, 0.05%, or 0.08%) were achieved in the experimental community. Reductions were greatest for 16-20 year-olds (from 66% for positive BAC to 94% for BAC≥0.05%), followed by 21-24 year-olds (from 32% for positive BAC to 71% for BAC≥0.08%) and drivers 25 and older (from 23% for positive BAC to 53% for BAC≥0.08%). All reductions for 16-20 year-olds were significant ($p<0.05$), and all except the reduction for BAC≥0.08% were significantly greater than the corresponding reductions for drivers 25 and older. Reductions for 21-24 year-olds were significant for BACs at least 0.02%, 0.05%, and 0.08%, but they were not significantly greater than the corresponding reductions for drivers 25 and older. Although large, reductions for drivers 25 and older were not significant, based on 95% confidence intervals. A college community program with a strong enforcement component produced substantial reductions in drinking and driving among teenagers and young adults and smaller reductions among older adults. It is hoped this will encourage colleges and communities to incorporate enforcement into interventions directed at alcohol use among young people.

INTRODUCTION

From 1982 to the mid-1990s highway crashes involving alcohol-impaired driving in the United States declined substantially among drivers of all ages (Figure 1). From 1982 to 2006, the percentage of fatally injured passenger vehicle drivers with blood alcohol concentrations (BACs) at least 0.08% (0.08 grams of alcohol per deciliter of blood) declined by 49% for ages 16-20, 22% for ages 21-24, 22% for ages 25-34, and 33% for drivers 35 and older. However, almost all of these declines occurred by 1995. Progress stalled during the subsequent years, and alcohol impairment remains a major crash factor. Among passenger vehicle driver crash deaths in 2006, drivers ages 21-24 had the highest percentage of BACs at least 0.08% (50%). This compares with 27% of drivers ages 16-20, 48% of drivers ages 25-34, and 26% of drivers 35 and older. These percentages were up slightly from 2005 for all age groups.

All US states set 21 as the minimum age for legally consuming alcohol, and all states have zero tolerance laws that prohibit people younger than 21 from driving with any measurable alcohol in their systems. Still, one-third of fatally injured drivers ages 16-20 had positive BACs in 2006. Research has shown that raising the minimum legal drinking age to 21 and implementing zero tolerance laws has reduced crashes among drivers younger than 21 (DuMouchel et al., 1987; Hingson et al., 1994; McCartt and Kirley, 2007; Shults et al., 2001), but compliance with these laws remains far from universal (Jones and Lacey, 2001).



Source: Fatality Analysis Reporting System (FARS), 1982-2006 (Insurance Institute for Highway Safety, 2008)

FIGURE 1 Fatally injured passenger vehicle drivers with BACs>0.08% by age, 1982-2006.

Many 16-24 year-olds reside in college communities. Nearly 11 million 18-24 year-olds were enrolled in college in the United States in 2006, representing about 40% of all 18-24 year-olds and almost half of 18-21 year-olds (US Census Bureau, 2007). Results from the 2006 National Survey on Drug Use and Health indicate that 18-22 year-olds enrolled full-time in college are more likely than their peers not enrolled full-time in college to report using alcohol during the past month (66% vs. 54%), binge drinking (46% vs. 19%), and drinking heavily (38% vs. 13%) (Substance Abuse and Mental Health Services Administration, 2007). Alcohol-related deaths of college students occur primarily in highway crashes. Hingson et al. (2005) estimated that in 2001, 1,349 college students ages 18-24 died in highway crashes in which at least one involved driver had a positive BAC. An estimated 368 college students died in 2001 from alcohol-related nontraffic unintentional injuries. These estimates assume that college students are involved in alcohol-related crashes and noncrash injuries at the same rate as the entire 18-24-year-old population, although college students reported more frequent heavy drinking and more frequent driving under the influence than people in the same age group who were not in college.
Many if not most colleges have programs aimed at reducing on-campus drinking, especially high-risk drinking, but few have targeted drinking and driving. Mass media campaigns aimed at drinking among college students have used various strategies, but they have emphasized education about high-risk drinking rather than enforcement of laws on underage drinking or drinking and driving (DeJong, 2002). The Task Force on College Drinking (2002) recommended the use of comprehensive, integrated programs targeting individuals, student

populations as a whole, and colleges and surrounding communities. The task force found that effective or promising strategies applied campus or community wide, including increased enforcement of drinking and driving laws, had been insufficiently tested. In their overview of environmental strategies that may reduce college drinking, Toomey et al. (2007) concluded that combined strategies may be most effective in reducing alcohol-related problems among college populations. Recent evaluations of efforts to reduce drinking and driving among college students generally have relied on students' self-reports rather than objective measures of drinking or impairment (Clapp et al., 2005; Nelson et al., 2005). An exception was a study by Foss et al. (2001) that found reductions in students' BACs following an education program using social norming approaches. However, the study focused on pedestrians and did not evaluate the program's effects on drinking and driving in the college community.

The importance of publicized enforcement in deterring alcohol-impaired driving and alcohol-impaired driving crashes is well established (Levy et al., 1990; Shultz et al., 2001; Wells et al., 1992). Sobriety checkpoints are one of the most effective enforcement approaches (Lacey et al., 1999; Stuster and Blowers, 1995) at the community level (Wells et al., 1992) and the state level (Lacey et al., 1999). The effects of an intensive publicized enforcement program directed at drinking and driving among young people in a college community have not been examined using objectively measured BACs.

The current study summarizes results of a college community program of publicized intensive enforcement focusing on violations of the 21 minimum legal drinking age and violations of drinking and driving laws. The focus was college students and other young people ages 16-24. Effects of the program on drinking and driving were measured and contrasted with the patterns of drinking and driving in a comparison college community with no special program. The experimental and comparison communities were located in West Virginia, a state with a history of publicized intensive enforcement of alcohol-impaired driving laws directed at the general population, including sobriety checkpoints (Lacey et al., 2006, Zwicker et al., 2007).

METHOD

West Virginia's minimum drinking age law and drinking and driving laws are typical of other states. Driving under the influence (DUI) is a misdemeanor. The illegal BAC threshold, 0.08%, is prima facie evidence that a driver is under the influence of alcohol, and a BAC higher than 0.05% and less than 0.08% is relevant evidence of impairment. West Virginia's zero tolerance law prohibits people younger than 21 from driving with BACs at or above 0.02%. It is illegal for people younger than 21 to possess, consume, or purchase alcohol and for anyone to buy, give, or furnish alcohol to anyone younger than 21.

Program Components and Timeline

A comprehensive community program focusing on underage drinking and drinking and driving among 16-24 year-olds was implemented in the City of Huntington, located in Cabell and Wayne counties in the southwest corner of West Virginia. Huntington is home to Marshall University, with an enrollment of approximately 18,000 students. The comparison community was the City of Morgantown, located in Monongalia County in northern West Virginia. West Virginia

University, with an enrollment of approximately 40,000 students, is located in Morgantown. Huntington and Morgantown are located approximately 200 miles apart and are served by different media markets. This minimized the possibility that residents of Morgantown would be affected by the program in Huntington. Officials in Morgantown indicated they would not substantially change enforcement of the drinking and driving laws or the minimum drinking age law throughout the study period.

The program in Huntington was implemented during late winter 2006 and early spring 2007 and continued through fall 2007, with efforts intensified during the university's spring and fall terms. Local, university, and state enforcement agencies increased enforcement of drinking and driving laws, including the zero tolerance law, through low-manpower sobriety checkpoints, saturation patrols, and stepped-up DUI directed patrols. The state Alcohol Beverage Control Administration, with assistance from local and state law enforcement agencies, increased enforcement of the minimum drinking age law. This included enforcement of laws directed at servers/sellers and laws directed at underage people, including the use of false identifications. Enforcement occurred not only within the City of Huntington but also throughout the surrounding areas and was publicized through a multimedia campaign that included paid and earned print and broadcast media. Two slogans, one addressing the minimum legal drinking age and the other addressing drinking and driving laws, were used in the media campaigns (Figure 2).

In addition to publicity within the community, the program was publicized on the Marshall University campus. This included posters in dormitories and classroom buildings, articles in the student newspaper, additional alcohol education programs in dormitories and sorority and fraternity houses, and

FIGURE 2 Program slogans.

additional individual and group counseling sessions for students cited for underage drinking or other alcohol-related problems.

Evaluation

The primary measure of program effect was the BACs of nighttime drivers, gathered in roadside surveys during fall 2006, spring 2007, and fall 2007. During all three periods, surveys were

conducted on Thursday-Saturday evenings from 10 pm to 2 am. Surveys also were conducted on a few Wednesday evenings in fall 2006, but the Wednesday surveys were discontinued due to small sample sizes.

The survey protocol provided that a uniformed officer directed passing noncommercial vehicles into the research bay. If all bays were occupied, the officer let all vehicles pass by until one was available. All drivers ages 16-24 were asked to participate. One-quarter of drivers 25 and older were systematically sampled and asked to participate. Participants were interviewed about their patterns of alcohol consumption and drinking and driving and their perceptions of DUI enforcement, and then were asked to take a breath test. Drivers younger than 21 with measurable alcohol and drivers 21 and older with BACs above 0.05 were given alternative transportation home.

In the spring 2007 roadside surveys, some components of the program began only shortly before the first data were collected in late March. In addition, inclement weather precluded conducting some of the scheduled surveys. This resulted in smaller sample sizes relative to the other survey periods. Therefore, analyses focused on comparisons of results in fall 2006 with results in fall 2007, when the program had been fully underway for at least 8 months. In addition to simple before-after comparisons of BAC results, logistic regression models were used to examine changes in the odds of driving with a positive BAC, a BAC at least 0.02%, a BAC at least 0.05%, and a BAC at least 0.08%. Predictor variables in the models were city (program (Huntington) vs. comparison (Morgantown)), school term (fall 2007 vs. fall 2006), age group (16-20 and 21-24 vs. 25 and older), and presence of the drinking and driving program (yes vs. no). In the models, the effect of the program was estimated separately for each age group, and the statistical significance of the differences in program effects for 16-20 and 21-24 year-olds relative to drivers 25 and older was tested. Similarly, logistic regression also was used to model changes in drivers' self-reported drinking and driving and drivers' perceptions of stronger enforcement of drinking and driving laws, using data from interviews with drivers participating in the roadside surveys.

To gather additional information about program awareness among the target driver group of 16-24 year-olds, handout surveys were conducted of a convenience sample of young drivers in each community in fall 2006 and in spring and fall 2007. Sidewalk surveys were conducted on the college campus and at a local shopping mall, and surveys were distributed to high school and university classes.

RESULTS

Enforcement Activities

Enforcement activities increased substantially during the program period in the program community (Huntington) (Table 1). The number of special DUI enforcement activities per month quadrupled from 15 per month in fall 2006 to 60 per month in fall 2007. The majority of special enforcement activities were saturation DUI patrols, but low-manpower checkpoints also were conducted. Minimum drinking age compliance checks at drinking establishments more

than tripled in the program community, from 7 per month prior to the program to 24 per month after. In contrast, enforcement levels were stable in the comparison community (Morgantown).

TABLE 1 Counts of Monthly Alcohol Enforcement Activities in Program and Comparison Communities before (Fall 2006) and during (Fall 2007) Program

		Underage compliance checks per month	Sobriety checkpoints and special DUI patrols per month
Program site	Before program	7	15
	During program	24	60
Comparison site	Before program	12	10
	During program	10	9

A variety of approaches were employed to enforce compliance with the minimum drinking age law, including the use of underage "agents" to attempt to purchase alcohol or to observe alcohol being served to other minors, and the use of enforcement personnel at establishment entrances to check identifications. The increased enforcement appeared to reduce the ability of underage people to obtain alcohol. In fall 2006 in the program community, prior to inception of the stepped-up enforcement, 43% of underage agents attempting to purchase alcohol were successful. In fall 2007, during the heightened enforcement, the percentage declined to 18%. In contrast, the successful buy rate in the comparison community increased from 19% in fall 2006 to 23% in fall 2007.

Roadside Survey

Rates of participation in the roadside surveys were high in both communities and in both survey periods (Table 2). Except for the fall 2007 survey period in the comparison community, breath test results were obtained from more than 90% of the drivers approached. It is not clear why participation was somewhat lower in the fall 2007 survey in the comparison community (84%).

TABLE 2 Roadside Survey Samples in Program and Comparison Communities before (Fall 2006) and during (Fall 2007) Program

		Drivers approached (N)	Drivers who refused interview N (%)	Drivers who refused breath test N (%)	Breath test results N (% of approached)
Program community	Fall 2006	1,571	2 (<1%)	134 (9%)	1,435 (91%)
	Fall 2007	2,490	4 (<1%)	138 (6%)	2,348 (94%)
Comparison community	Fall 2006	2,531	40 (2%)	112 (4%)	2,379 (94%)
	Fall 2007	2,862	355 (12%)	116 (4%)	2,391 (84%)

The gender distribution of drivers with breath test results did not differ significantly between the fall 2006 and fall 2007 surveys in the program community or the comparison community overall or within each age group; for all surveys combined, 58% of drivers in the program community and 61% of participants in the comparison community were male. In the program community, the age distribution of drivers with breath test results also did not vary significantly; for both surveys combined, 35% of drivers were ages 16-20, 38% were ages 21-24, and 27% were 25 and

older. In the comparison community, the percentage of drivers tested who were ages 16-20 increased from 38% in fall 2006 to 42% in fall 2007, the percentage who were ages 21-24 declined from 48% to 43%, and the percentage of older drivers increased slightly (from 14% to 15%). The distribution varied significantly between survey periods (χ^2=9.8, p=0.007).

In the program community, the BACs of the age groups targeted by the program and the BACs of older drivers declined substantially from fall 2006 to fall 2007 (Table 3). Prior to the program, 1.8% of drivers ages 16-20 had BACs at least 0.02%; during the program, this percentage was 0.7%. There also were declines in the percentage of 16-20 year-olds with positive BACs, BACs at least 0.05%, and BACs at least 0.08%. In the comparison community, the percentage of 16-20 year-olds with BACs at least 0.02% was unchanged from fall 2006 to fall 2007, and the percentage with positive BACs or with higher BACs increased. The percentage of 21-24-year-old drivers with BACs in each category declined in both communities, but the declines were larger in the program community. Although drivers 25 and older were not specifically targeted by the program, the BACs of these drivers declined as well in the program community. In the comparison community, the percentage of drivers 25 and older with positive BACs or BACs at least 0.02% increased; the percentage with higher BACs changed negligibly.

TABLE 3 Percent of Drivers in Program and Comparison Communities before (Fall 2006) and during (Fall 2007) Program with Various BACs by Age Group

Age			BAC >0%	BAC ≥0.02%	BAC ≥0.05%	BAC ≥0.08%
16-20	Program community	Fall 2006 (N=507)	2.0	1.8	1.4	1.0
		Fall 2007 (N=813)	1.4	0.7	0.1	0.1
	Comparison community	Fall 2006 (N=907)	4.9	3.9	2.0	0.9
		Fall 2007 (N=1,006)	6.4	3.9	2.4	1.4
21-24	Program community	Fall 2006 (N=548)	7.1	5.5	3.1	1.6
		Fall 2007 (N=878)	4.9	3.0	1.0	0.7
	Comparison community	Fall 2006 (N=1,136)	9.8	6.4	3.9	2.1
		Fall 2007 (N=1.037)	8.3	5.5	2.8	1.5
25+	Program community	Fall 2006 (N=380)	11.3	8.7	7.1	5.8
		Fall 2007 (N=657)	7.6	5.0	3.0	1.8
	Comparison community	Fall 2006 (N=336)	10.4	6.5	3.9	1.8
		Fall 2007 (N=348)	12.4	8.9	4.0	1.7

Logistic regression models estimated the odds of drivers in each age group exceeding a given BAC in the program community in fall 2007 compared with fall 2006, after accounting for changes in the BACs in the comparison community. Table 4 summarizes the estimates of the odds of drivers exceeding a BAC at least 0.08%. Driving with a high BAC was 64% and 41% less likely for drivers ages 16-20 and 21-24, respectively, than for drivers 25 and older, and these differences were significant. The effect of the program on driving with a high BAC was positive for all age groups and was significant for the two younger groups. The program reduced the odds of a high BAC by 91% for 16-20-year-old drivers and by 71% for 21-24-year-old drivers. The differences in program effects for the three age groups were not statistically significant.

TABLE 4 Logistic Regression on Odds of Driver BAC≥0.08%

Effect	Odds ratio	95% confidence limits	
		Lower	Upper
Program vs. comparison community	1.44	0.90	2.30
Fall 2007 vs. fall 2006	0.95	0.60	1.51
Age 16-20 vs. age 25+	0.36	0.22	0.61
Age 21-24 vs. age 25+	0.59	0.38	0.93
Age 16-20, program vs. none	0.09	0.01	0.67
Age 21-24, program vs. none	0.29	0.11	0.81
Age 25+, program vs. none	0.47	0.20	1.08

Table 5 summarizes the estimated effects of the program on driving at different BAC thresholds (positive and at least 0.02%, 0.05%, and 0.08%). Results were fairly consistent. The greatest reductions in drinking and driving were for 16-20 year-olds (from 66% for positive BAC to 94% for BAC≥0.05%), followed by 21-24 year-olds (from 32% for positive BAC to 71% for BAC≥0.08%). There also were reductions for drivers 25 and older (from 23% for positive BAC to 53% for BAC≥0.08%), but these reductions were not significant. Drivers younger than 21 were 66% less likely to drive with a positive BAC after the program, about 76% less likely to drive with a BAC at least 0.02%, about 94% less likely to drive with a BAC at least 0.05%, and 91% less likely to drive with a BAC at least 0.08%. All of these reductions were significant, and all except the reduction for BAC≥0.08% were significantly greater than the corresponding reductions for drivers 25 and older (all p values<0.03). For drivers ages 21-24, the reductions in drinking and driving were significant for BACs at least 0.02%, 0.05%, and 0.08%; these reductions were not significantly greater than the corresponding reductions for drivers 25 and older.

TABLE 5 Estimated Changes in Odds of Various Driver BACs Attributable to Program

BAC threshold	Age	Odds	95% confidence limits	
			Lower	Upper
>0%	16-20	0.34	0.17	0.67
	21-24	0.68	0.44	1.07
	25+	0.77	0.50	1.20
≥0.02%	16-20	0.24	0.10	0.59
	21-24	0.56	0.33	0.96
	25+	0.67	0.40	1.13
≥0.05%	16-20	0.06	0.01	0.46
	21-24	0.31	0.14	0.70
	25+	0.61	0.32	1.18
≥0.08%	16-20	0.09	0.01	0.67
	21-24	0.29	0.11	0.81
	25+	0.47	0.20	1.08

Interviews at Roadside Surveys

Interviews with drivers at the roadside surveys in the program community reflected reductions in self-reported drinking and driving after the program was underway (table not shown). In the comparison community, there were either smaller reductions or increases. Logistic regression models found that almost all of the reductions in the program community were not statistically different, relative to changes in the comparison community. During the program, self-reported drinking and driving during the past 3 months was about 17% less likely for 16-20 year-olds, 12% less likely for young adults, and 22% less likely for drivers 25 and older, relative to changes in the comparison community. None of these estimates was statistically significant. During the program, self-reported driving after drinking enough to be considered DUI during the past 3 months was about 72% less likely for 16-20 year-olds, 33% less likely for young drivers, and 30% less likely for drivers 25 and older, relative to changes in the comparison community. Only the estimate for teenagers was significant. Relative to drivers surveyed in the comparison community, 16-20 year-olds in the program community were about 3% less likely to perceive increased enforcement (much or little stronger enforcement) compared with a year ago, young adults were about 19% more likely, and drivers 25 and older were about 5% less likely. The changes in the program community were not significant, relative to changes in the comparison community. In the comparison community, there were either smaller reductions or increases.

Community Surveys

The number of people ages 16-24 who completed community surveys ranged from 328 in fall 2007 in the program community to 505 in fall 2006 in the comparison community. For the fall 2006 and fall 2007 samples combined, about three-quarters of respondents in both communities were 16-20 year-olds and slightly more than half were male.

The community surveys documented a perception in the program community, but not in the comparison community, that enforcement of drinking and driving laws and the minimum drinking age law had increased (tables not shown). In the program community, there were significant increases in the percentage of respondents who reported they recently had read, seen, or heard anything about alcohol-impaired driving enforcement (from 42% in fall 2006 to 60% in fall 2007; χ^2=25.9, p<0.0001); recently had read, seen, or heard anything about enforcement of the 21 minimum drinking age law (from 33% to 52%;χ^2=29.1, p<0.0001); believed they were somewhat or very likely/almost certain to be stopped by an officer if driving after drinking enough to be DUI (from 37% to 54%; χ^2=19.4, p<0.0001); and had gone through a DUI checkpoint during the past 30 days (from 17% to 38%; χ^2=40.7, p<0.0001). In the comparison community, there were reductions or smaller increases in these percentages. When asked to provide the name of an alcohol-impaired driving enforcement program in fall 2007, 38% of respondents in the program community said “Drink and Drive, Get Busted” and 20% said “Drink before You’re Legal, Get Busted,” the program slogans. The percentages in the comparison community were 2% and 1%, respectively.

DISCUSSION

Using objective measures of drinking and driving, the current study evaluated the effects of a college community program of publicized stepped-up enforcement of the 21 minimum legal drinking age law and the drinking and driving laws. The program was implemented in a community where strong enforcement of DUI laws had occurred during the past few years, and the prevalence of drinking and driving among all ages prior to the program was relatively low. This makes it even more remarkable that objectively measured drinking and driving was further reduced such that it was nearly eliminated. The program's target audience was drivers ages 16-24, and reductions in drinking and driving were greatest among teenagers and second largest among drivers ages 21-24. Drinking and driving among older drivers also was reduced. This is not surprising. Although publicity focused on young drivers and enforcement included a crackdown on violators of the minimum drinking age law, the stepped-up enforcement of drinking and driving laws would have affected drivers of all ages.

The roadside surveys were conducted to collect data to support evaluation of the program, and enforcement of drinking and driving laws did not occur during the surveys. However, it is likely the surveys added to perceptions of an increased police presence and a greater awareness of drinking and driving laws. This may explain why BACs declined in the comparison community for some age groups and led to somewhat higher perceptions of tougher enforcement among drivers in the comparison community.

It is well established that publicized intensified enforcement reduces alcohol-impaired driving among the general population of drivers. Results of the current study point to the importance of publicized enforcement in reducing drinking and driving among young people and reducing underage drinking. It is hoped this will encourage colleges and communities to incorporate enforcement into interventions directed at alcohol use among young people and to include enforcement messages in publicity and education directed at youth.

Communities may find it difficult to sustain high-intensity enforcement programs. This points to the importance of efforts to go beyond traditional enforcement and deter potential DUI offenders. In almost all states some alcohol-impaired driving offenders are permitted to drive only if their vehicles have been equipped with alcohol ignition interlocks. These devices analyze a driver's breath and disable the ignition if the driver has been drinking. The federal government, automobile manufacturers, and other highway safety organizations are cooperating in the exploration of advanced in-vehicle alcohol detection technologies that would be suitable for all drivers. The Insurance Institute for Highway Safety has estimated that almost 9,000 deaths would have been prevented in 2005 if all driver BACs had been reduced to less than 0.08% (Lund et al., 2007). Absent advanced technologies, the most effective way to reduce alcohol-impaired driving among people of all ages is publicized intensive enforcement.

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THE PERSPECTIVE ON CAMPUS

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Introduction

The college campus remains one of the most difficult areas to reach in underage drinking prevention. The environment is one steeped in a tradition of alcohol, and little regard to rules and regulation. Those wishing to perform underage drinking prevention on the college campus find unique challenges not present in other settings. I attempt to provide here both the perspective of a college student living in an urban campus as well as those of respected leaders in college drinking prevention. This is not intended as an all-encompassing view of the world of college drinking. It is rather my particular experiences as a student, and a selection of practices recommended by those who are highly respected in the field.

Background

My involvement in underage drinking prevention began in early high school, where I volunteered with MADD Massachusetts's Youth in Action program. I worked with our youth coordinator to conduct compliance checks, shoulder tap surveys, sticker shocks, legislative briefings, press conferences, and media interviews. It was through this program that I gained my experience in environmental prevention. As I graduated, I arrived at the Massachusetts Institute of Technology to find very different approaches to underage drinking prevention. While at MIT, I have been serving on the MADD National Board of Directors, and, when available, visiting Cambridge Prevention Coalition meetings to work with their Environmental Strategies Subcommittee. At these meetings, representatives from the community, local liquor stores, the Cambridge License commission, Harvard, and MIT, as well as others come together to work on environmental strategies for issues usually relating to alcohol. The partnership between the Prevention Coalition and MIT is strong, as I will elaborate upon later.

Enforcement on Campus

The independence of the college campus from its surrounding city or state dates back at least as far as Medieval Europe. These first universities were considered their own entities, inside which the laws of the city and state did not apply. It is fair to say that in some ways, this status has remained today. Most modern campuses have their own full-fledged police forces. This has enabled some colleges to selectively enforce laws regarding the minimum drinking age, including consumption, possession, and provision of alcohol to minors. On paper, it is clear that this practice is not only improper, but potentially unlawful if the enforcement is intentionally suppressed. I will admit that I continue to have difficulty understanding how colleges can justify their suppressed enforcement of these laws, but I will expand upon this point further. The issue of enforcement on campuses varies widely, with some attempting to "crack down" and some attempting to "ease up."

Those campuses choosing to "ease up," are often looking instead to treatment programs for their students found to be having issues with alcohol use. One of the particularly concerning trends in college drinking is the increasing number of females who binge drink. Unlike males, whose behavior often attracts attention and signals the need for enforcement and treatment, females who binge drink are less likely to get themselves into such situations. It is of large concern today that females with alcohol problems are going untreated, their behavior is less likely to attract the attention of those enforcing campus policies, meaning they are less likely to receive the proper treatment.

Many campuses focusing on treatment rather than enforcement have adopted a "Good Samaritan Policy." Such policies are designed to ensure that alcohol related incidents be reported, rather than covered-up. It is an unfortunate truth that some students would rather risk the life of a friend than to risk being caught regarding underage alcohol use. These policies range from broad forms of amnesty to limited situation-based exclusion. The University of Missouri has no official policy and leaves the discretion to the officers at the scene how to best handle situations. In practice, arrests for MIP are rarely made on campus at MU. MIT does have an official Good Samaritan Policy on record, which it has recently revised. The MIT policy features particular restrictions, including any occurrences of serious misconduct, violence, or repeat infractions. When asked for details about how a Good Samaritan Policy is consistent with enforcing the laws of the state, the answers I have gotten have been cloudy at best. The issue relates back to the independence of college campuses, which, oftentimes, take the liberty to (create) and enforce their own rules.

The Issue of Availability

One of the most troubling issues that I encountered coming to a college campus was the sheer availability of alcohol. Coming from a high school perspective, where sources are limited to retail availability, and to social availability through friends and parents, the college campus is much more open in terms of access. The social availability of alcohol on a college campus cannot be underestimated. It is not difficult for any college student to find a student of-age who is willing to purchase, either from a pouring or non-pouring establishment. The threat of the law in these situations is virtually insignificant. Students do not fear being caught for providing alcohol to a minor.

Unfortunately, due to this availability, another issue arises. Whenever an attempt is made to restrict or limit drinking in one location, students make their best efforts to migrate elsewhere for their alcohol consumption. I spoke with Ryan Travia M.ED., the director of Alcohol and Other Drug Services at Harvard University last year regarding one of their most difficult events of the year, their Harvard-Yale football game. As he pointed out, if Harvard chose to ban all consumption of alcohol from the tailgate party before the game, the major issue would not be solved. Students would initiate their drinking before the event, a behavior known as "pre-gaming." In the case of Harvard, the environmental approach the school took involved many programs. These included responsible serving of limited quantities to of-age spectators during the tailgate, strict enforcement of underage drinking during the tailgate, and other environmental factors like plentiful food and activities to keep students busy earlier in the day. These earlier activities were designed specifically to help prevent the *pre-gaming* that would be expected

knowing the event would be regulated. In addition, Harvard initiated a mini-grant program to supplement budgets for parties and gatherings to be used for non-alcoholic drink and food purchases. These mini-grants, while only totaling a few thousand dollars, managed to supplement the budgets of over 100 events. By structuring the entire weekend in such a way that students were constantly busy, well fed, and well entertained, Harvard was able to reduce their hospitalizations due to alcohol poisoning from over 50 in previous years to less than 5 at their last Harvard-Yale home game weekend.

Common Practices in College Prevention

It is clear that in their current state, college campuses are not prepared to realistically limit availability in any considerable way to minors. Although this situation is unfortunate, as we can see, many colleges have made the decision to focus their efforts in programs and services towards reducing the harms associated with student drinking. In talking with both Danny Trujillo Ph.D. from MIT, and Kim Dude from the University of Missouri, I have collected information about the programs at both schools, which I will attempt here to summarize. Danny Trujillo indicated that MIT bases its policies on the NIAA recommended Tier 1 programs. Strategies in this tier have been shown in two or more favorable studies to have measurably targeted individual problem, at-risk, or alcohol-dependent drinkers (NIAA, 2007). These strategies serve as a guideline when creating programs. One prominent program in both MIT and MU is BASICS, Brief Alcohol Screening and Intervention of College Students. BASICS is a SAMHSA model program designed for the brief treatment of students exhibiting problems with alcohol. This program has been shown effective at reducing the negative consequences of alcohol use among college students (BASICS, 2003). Both MIT and MU offer the BASICS program as a voluntary consult, as well as through their enforcement and treatment programs for students. Both campuses have reported to me that their evaluations of the programs have shown success in reducing the negative consequences associated with alcohol use after the program.

In addition to treatment programs, both campuses rely heavily on social norming campaigns to change campus perceptions of alcohol use. These social norming campaigns seek to reduce the perceived consumption of alcohol by students, to inform more accurately how the student body as a whole behaves on average. At MIT, student surveys reported the perception that more students were binge drinking than were in actuality. Social norming campaigns at MIT are designed to inform students that most of their peers are indeed *responsible drinkers* (a loosely defined term). At MU, their social norming campaign focuses on protective factors, encouraging the use of designated drivers, eating before drinking, and other methods to help reduce the harms associated with alcohol use. Social norming is often based on surveys taken by students via the web. Using these surveys from students, conducted at varying points through each year, both schools also track progress and measure the effectiveness of their programs at reducing consumption and the negative consequences resulting from it. All programs at MIT and MU are evaluated, and feedback from the evaluations is used to improve the programs in focus, scope, and method.

MIT utilizes a rather unique system of event registration to help monitor and track large parties on campus. All events sponsored by student resident halls must be registered through the event registration system. This registration requires a host, over age 21, to monitor the event,

and to remain sober throughout the event. Registration approval passes through a number of offices including Resident Life Programs, the Housemasters of the dorm, and the Campus Police. This system helps to encourage responsibility in event hosting. Guidelines regarding alcohol service at events are clearly laid out in the event registration process, ensuring that hosts are well informed of MIT policies and procedures. The partnership MIT has formed with the Cambridge Prevention Coalition has helped to produce a server training program sponsored by the coalition that is now used in MIT fraternities. This program, developed and customized to the issues and policies of MIT, has been in practice for the past few years. Such a comprehensive training program would not have been possible without the help and support of the Cambridge Prevention Coalition.

The University of Missouri has built an extensive portfolio of environmental prevention strategies, based in coalitions and task forces targeting the creation of an environment that supports students making responsible decisions. The University of Missouri has also engaged in programs that some consider more controversial. For years, it supported a program of free cab rides home from local bars. When this program was eliminated, students picked up where it left off. Student-driven rides from local establishments are available Thursday, Friday, and Saturday evenings, free of charge. Since its inception, over 70,000 rides have been given by students for students. The University of Missouri also provides alcohol education, including pouring demonstrations, to help educate incoming freshmen about *responsible* alcohol usage, going so far as to define the term on-campus officially as a .05 BAC or lower. This program strikes me as very controversial, as it not only appears to condone and support underage drinking, but also establishes a quantitative bar of acceptability that applies to those both over and under the legal drinking age. The University, however, has found this program effective at reducing consumption across the board, and the negative effects thereof on its campuses.

Key Ingredients for a Successful College Program

I asked both Danny and Kim to comment on what they believed was most necessary in order for a college to reduce the effects of alcohol use on its campus. The most important *key ingredients* that I received were the following. The support of senior leadership cannot be underestimated. The mission of community health and wellness must be of prime concern to the college administration. In addition, those charged with building a community wellness program must be given the authority and the responsibility necessary to bring about such changes. Danny Trujillo, for instance, is an Associate Dean of Student Life at MIT. Student support is also necessary, and Kim Dude strongly recommends the BACCHUS Network as a great resource to build a student coalition for health and safety on campus. Lastly, both Danny and Kim cite the many evaluation processes they perform each year to help steer and direct their programming. These evaluations are made in part by grant funding. These grants, according to Danny, are critical to the work his office performs at MIT.

Final Thoughts

The programs selected for presentation here are fairly representative of what the *most effective* college programs are doing. I thought it might be helpful to supplement these brief summaries with the reflections of a college student living in the midst of one of these programs. My

perspective on college programs has certainly changed over the past three years. Coming from an environment where the messaging was strictly no-use, it was difficult to wrap my head around programs that endorsed or allowed for drinking by minors. Adding to this an enforcement model that skirts the laws in favor of treatment, rather than enforcing the laws with the addition of treatment, was concerning. Having now lived on a campus for three years, I can see, however, that the programs I have discussed here have been effective (in my mind) at assisting and treating those with the most severe issues with alcohol. I have watched friends come to MIT with alcohol issues, get referred to our medical center for a brief screening and intervention, complete the BASICS program, and be better for it. I can testify that the common stereotype of college students, out-of-control, and drinking to excess, is mostly myth on my campus. There are certainly exceptions that have yet to be dealt with, but as the evidence collected by MU and MIT demonstrates, their programs have been effective at reducing the quantity consumed by their students, as well as the harmful effects relating to student drinking. It is my opinion that these efforts have been effective at achieving their reduction goals.

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YOUNG IMPAIRED DRIVERS: THE NATURE OF THE PROBLEM AND THE STRATEGIES BEING USED IN THE MILITARY

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Introduction

This paper offers a summary of the limited English language literature on the prevalence of driving under the influence (DUI) in the military, and a recounting of some of the distinctive measures the military has taken to combat the problem of DUI. The paper concludes with an overview of a variety of DUI prevention approaches mentioned by U.S. Navy personnel in ethnographic interviews conducted in the course of two five year studies on alcohol and the military workplace among young sailors as well as careerists within the Navy. This paper's literature review, as well as the DUI-focused analysis of interviews with Navy personnel, primarily concern the Department of Defense (DoD) in the United States, but they include deployment overseas as well as the DUI prevention efforts of the military in several other countries. A noteworthy limitation of the literature is the paucity of peer-reviewed studies focusing explicitly on drinking and driving in the military; even fewer offer suggestions on military-specific DUI prevention approaches. Clearly, there is room for much more evaluation research in this area.

Methods

To locate published material on DUI in military populations, we conducted literature searches in MEDLINE, PsycINFO and other online databases for various combinations of the search terms military, navy, marine, army, alcohol, and driving. These searches yielded a small number of citations, which were then reviewed for relevance. In snowball fashion, the references in these works included other appropriate citations, which were in turn examined for their utility. A number of these citations are in the gray literature or in military news publications rather than in the peer-reviewed scientific literature. For the final portion of the paper, the methods by which we sought recurring mentions of DUI incidence and prevention approaches include a review of recurring themes concerning driving under the influence on and around bases from semi-structured interviews with 110 U.S. Navy personnel.

As part of two larger studies on the influence of the military workplace on drinking beliefs, behaviors and problems among new officers and enlisted personnel as well as careerists with over 7 years of U.S. Navy service (Ames et al. 2007; Moore, Cunradi, and Ames 2007), we collected 110 tape-recorded, semi-structured open-ended interviews with a sample of line officers, enlisted personnel, medical personnel, alcohol counselors, and chaplains. The officers and enlisted personnel were stratified by gender, occupational categories and geographical location. At each of these bases, we asked medical officers to help us identify knowledgeable key informants as well as pools from which we randomly selected young adult respondents representing a variety of occupational specialties. We then asked the individuals we selected if they were willing to take part in an interview. The voluntary and confidential interviews were

conducted out of earshot of other naval personnel in shore offices as well as in private work and recreational areas on board ships.

We obtained full authorization and support from the U.S. Navy to conduct the ethnographic field work on Navy bases, work sites, including sites on board submarines, carriers and various other types of military vessels in the Atlantic and Pacific Fleets that are located within and outside of the continental U.S. Approval of the study's human subjects protocol was obtained from the Institutional Review Boards of the Pacific Institute for Research and Evaluation and the San Diego Naval Health Research Center. Informed consent was obtained from all study participants. The hour-long face-to-face interviews were carried out on five large military bases in the United States: two in the East Coast (Norfolk, VA and Jacksonville, FL), one on the Gulf Coast (Pensacola, FL), one on the West Coast (San Diego, CA), and one in the South Pacific (Pearl Harbor, HI); Another dozen interviews were conducted at a U.S. base in Southern Europe (Naples, Italy). The drinking age in and around each of these bases was 21 except in Naples, where the DoD-specified limit of 18 applied on base and the local age limit of 16 applied off-base.

Interviews were transcribed, coded for relevant themes and categories of behavior, and entered into a database using ATLAS.ti (Muhr 2006), a computerized program for deriving thematic analysis. A theme is defined as a specific category or subcategory of information that appears throughout the interview data in similar or varying contexts and with interconnectedness to other themes (Ryan and Bernard 2003). The ATLAS.ti program assists analyses of data as it allows for organization of lengthy interview narratives into thematic categories that describe and conceptualize beliefs, attitudes and behaviors.

The Extent of the Problem and Identified Risk Factors

Precise statistics on DUI prevalence and consequences in the military are characteristically difficult to come by. In a major epidemiological effort, the U.S. Department of Defense Injury Surveillance and Prevention Work Group produced an Atlas of Injuries in the U.S. Armed Forces (1999), which included 1980-1994 statistics on mortality and morbidity by branch and type of injury. Although alcohol involvement was not broken out specifically, it is worth noting that of all military personnel deaths during those 15 years, vehicle accidents accounted for between 31% for most branches and 41% for the U.S. Marine Corps; the extent to which DUI played a decisive factor was not noted (1999). Online resources from the Naval Safety Center provide more detailed data on DUI incidence and consequences for the Navy and Marine Corps branches, at least.

The prevalence of driving under the influence (DUI) in any population varies by a number of attributes, including gender and age (Abdel-Aty and Abdelwahab 2000; Caetano and Clark 2000). Relative to the civilian population, the U.S. military workforce consists predominantly of younger men. Even if other factors such as sensation-seeking (Bell, Amoroso, Yore et al. 2000; Jonah 1997) are not included, the demographic profile of the military workforce suggests that it is at elevated risk for problems with driving under the influence. Relevant demographics from the Defense Manpower Data Center are summarized by the Department of Defense annual "Population Representation in the Military Services" reports (U.S.

Department of Defense 2007): In Fiscal Year 2006 in the U.S., women comprised 14% of active enlisted and 16% of active officer corps. Although the mean age of enlisted and officers was 27 and 34, nearly half of the active duty enlisted personnel was between 17 and 24 years old. New active duty recruits in the military, including the Coast Guard, had a mean age of 20. Reserve forces are somewhat older but still much younger than the civilian workforce, on average (U.S. Department of Defense 2007).

The influential large-scale DoD Survey of Health Related Behaviors Among Active Duty Military Personnel reported a variety of risky behaviors by level of drinking (Bray et al. 2006). For heavy drinkers, the percentage of respondents reporting that they drove a vehicle after too much to drink was 33.2% (vs. 7.1% of infrequent/light drinkers), and 38.3% reported riding in a car driven by someone else who had too much to drink (vs. 8.3% of infrequent/light drinkers). The overall totals were not provided but could be extrapolated from the percentages of respondents corresponding to the different drinking levels. Bray and colleagues (2006) also measured risk-taking through questions concerning impulsiveness, sensation seeking, and venturesomeness. Unsurprisingly, 23.5% of servicemembers classified as high risk takers reported drinking and driving vs. 4.6% of low risk takers. A 2002 study of high-risk drinkers in the U.S. Army found that they were less likely to use seatbelts and were more likely to drive more than 15 mph over the speed limit (Williams, Bell, and Amoroso 2002). Additional risk factors for drinking and driving include soldiers who have returned from deployment to the Persian Gulf (Bell, Amoroso, Williams et al. 2000). Soldiers with multiple DUI arrests are more likely than their non-DUI arrested counterparts to be arrested for many kinds of antisocial behaviors (Lucker et al. 1991).

It is worth noting that alcohol is not the only cause of vehicle crashes; a study of fatal crashes among Finnish military conscripts identified fatigue as a greater contributor to crashes than drunk driving (Radun et al. 2007). Moreover, even drivers under the legal BAC admitted that they felt unfit to drive in a study of Swiss soldiers (Wicki, Gache, and Rutschmann 2000) This latter finding reinforces evidence for a gradient of driving impairment rather than a simple binary state of being intoxicated or not, as suggested by the BAC-based code. Even incomplete statistics on DUI by military personnel suggest that comparisons of risk factors with new drivers and college drivers would be productive in terms of commonalities and differences across these populations of young adults.

Legal Frameworks and Military Responses to DUI

Three primary legal documents serve as guideposts for how the armed forces are to treat driving while intoxicated or impaired: the Uniform Code of Military Justice (UCMJ) the Manual for Courts Martial (MCM) (United States 2008), and a guide to motor vehicle traffic supervision for military police (U.S. Department of the Army 2006). All of these documents have been revised over the past three decades and the sections pertaining to DUI include strengthened definitions of intoxicated driving reflecting lower BAC levels as well as increasingly stringent prescriptions for punishment.

A critique of the strengthened military approach to DUI (Masterson 1995) questions the UCMJ's reliance on *per se* prohibitions of BAC levels based on potentially inaccurate

breathalyzer tests. At the time of the article was published, the UCMJ's specified BAC was .10 and has since been lowered to .08. Masterson's article is useful for its historical analysis of drunk driving statues in the U.S. military. Amusingly, it points out that a technical problem with Article 111 of the UCMJ had to be corrected in 1993: the original wording of a 1992 amendment prohibiting operation at .10 had to be corrected: "The 1993 amendment made it clear that operating a vehicle, aircraft, or vessel with a blood or breath alcohol concentration*above* these levels was also prohibited" (Masterson 1995). Drunk driving convictions under the UCMJ affect a servicemember's career (Masterson 1995) but tend to be pursued only if a civilian court prosecution has not taken place. Masterson notes that overseas DUI incidents are more likely to trigger military trials (1995).

As a 2005 memo from the Secretary of the Navy (SECNA VINST 5300.28D) indicates, detection and deterrence include strict enforcement of traffic control regulations. However, the memo states that "Breath analyzers are not to be used for random spot checks other than in vehicles or where probable cause is established." The memo places responsibility for the military response to alcohol-related conduct squarely in the hands of commanders, who are in turn obliged to transmit this imperative to the entire chain of command that answers to them. In response to some of the concerns raised by Masterson (1995), this memo notes that substantiated DUI incidents must be duly noted on fitness reports and promotion reviews, but that they should not obviate the review of the rest of a servicemember's duty.

Although a 2006 article on hair sample testing for drugs does not directly concern DUI detection and prevention efforts, it offers particularly incisive review of the constitutional limits on unlawful search and seizure interacting with military discipline requirements (Kercher 2006). Illustrating this tension between servicemember rights and the collective good of the military, another *Military Law Review* article on off-duty appearance standards for military personnel cites legal precedents by observing that "The essence of military service 'is the subordination of the desires and interests of the individual to the needs of the service'" (Jurden 2005).

As framed by the legal documents mentioned above, discipline for DUI may include reductions in pay, fines, suspension or curtailment of driving privileges, imprisonment or restriction to base, extra duty, and delays in promotion (Garrison 1995; McMichael 2006; Morales 2005). How on- and off-base DUI arrests are treated by military leaders may differ, because enforcement details tend to be left to individual commanders. Between 2001 and 2007, on-base DUI arrests for USMC personnel were between 1000 and 1300 per year, based on cited data from Law Enforcement Branch, PP&0, USMC Headquarters (U.S. Marine Corps 2008). In general, mirroring trends in the wider population, the matter is addressed by commanding officers with greater seriousness and severity than in past decades. Moreover, when a service member is caught driving under the influence, the event serves as a warning sign to military leaders of problem drinking (Kruzich et al. 1986), and may trigger referral to assessment and inpatient or outpatient treatment within the framework of one of the military's many substance use treatment program options (Fertig, Allen, and Gross 1993; Lucker and Gold 1995).

Military DUI Prevention Programs

Of course DUI in military populations transpires in the wider context of drinking patterns in the military (Ames, Cunradi, and Moore 2002; Ames et al. 2007; Ames and Cunradi 2004/2005; Bray et al. 2006; Cosper 1976; Hitz 1973; Pack 1983; Polich 1981). Random drug screens and zero tolerance for illegal drug use in the post-Vietnam era have also served to elevate alcohol as the key remaining intoxicant effectively available to US military personnel (Bray et al. 1990). It is worth noting that another distinctive feature of military service is the centralized command structure that permits interventions to be implemented and widely deployed. Although there is an extensive historical association between military service and high levels of intoxication, military leaders in all branches have made strong efforts to reduce the normative centrality of alcohol at command functions by emphasizing activities over consumption and requiring nonalcoholic beverages to be served as well (Ames et al. 2007; Cosper 1976; Hitz 1973; Moore, Cunradi, and Ames 2007). Such norm- and availability- oriented measures are one piece of the DUI prevention toolkit for bases but by themselves are not sufficient.

Educational efforts about DUI take multiple forms: in periodic briefings as well as multi-day workshops (e.g. PIRE's PREVENT program for the U.S. Navy) and awareness campaigns such as the Right Spirit deglamorization effort in the Navy. Evaluation of these programs is rare, however. Another unevaluated awareness program involves distributing Don't Drink and Drive stickers customized to include the name of a squadron (U.S. Navy 2008).

Taxi cards for free rides for intoxicated personnel (called "Arrive Alive" or "Tipsy-Taxi" on different bases), promotion of taxi availability outside base clubs during prime drinking hours and designated driver programs are among the suggestions offered by the Naval Safety Center website (U.S. Navy 2008). Distribution of keychain breath alcohol detectors is another tactic used on some Army bases (Schafer 2008). None of these efforts have been evaluated rigorously.

A recent awareness program attracting news attention but little published evaluation is the U.S. Air Force's 0-0-1-3 program (Sixbey 2006). These numbers stand for zero tolerance for underage drinking and for DUI, one drink per hour and three drinks maximum per drinking occasion (Pomeroy 2006). Following the rules of this simple mnemonic guarantees that one's BAC will not surpass .08.

A particular risk factor for DUI by young military personnel is proximity to a border with a jurisdiction with low minimum legal drinking ages (Moore, Cunradi, and Ames 2007; Voas, Romano, and Kelley-Baker 2007). Voas and colleagues have described and evaluated a chit system initiated by Marine commanders who require permission to be granted before their charges could venture across the border (Lange, Voas, and Johnson 2002; Voas, Johnson, and Lange 2002).

A noteworthy intervention study deserves attention and should be replicated: A Responsible Beverage Service (RBS) experiment in a Navy bar emphasizing slowing the pace of serving drinks, reducing drink specials and promoting food items all contributed to lower rates of intoxication and DUI (Saltz 1987).

One online resource is worth mentioning for its creativity: The U.S. Navy Naval Safety Center (U.S. Navy 2008) highlighted a concerted effort of synergistic DUI prevention efforts at a Patuxent River naval base, sharply reducing DUI incidents through community mobilization and deployment of multiple efforts. A central feature of their efforts was the use of communal meals and alcohol-free events as rewards for ever-increasing numbers of consecutive days without a DUI incident in the base population. This approach is not new, however; the extra holiday reward for DUI-free stretches of time was mentioned as a component of a DUI crackdown in the mid-1970s at the Army's Fort Campbell, complementing a policy of strict penalties for drunk driving (Fraker 2004).

Although treatment (Harvey 1974) does not constitute prevention per se, it has a role to play in reducing DUI recidivism. Brief interventions in the form of motivational interviewing offer a promising practice for treating military DUI offenders (Fernandez, Hartman, and Olshaker 2006).

Overcoming Barriers to Conducting Evaluations of DUI Prevention in the Military

It is not due to chance that the evaluation literature is scanty when it comes to rigorous assessments of DUI prevention programs in the military. In addition to the usual complaint that there is insufficient funding for evaluations when prevention programs are put into place, there are multiple gatekeepers who make conducting research on military populations more challenging (Russ and Ames 2006). In our research, we found reasons for this resistance. Commanders do not want to risk the reputations of their units, multiple IRBs need to be included in the loop in part because military personnel are classified as vulnerable populations due to the fact that their voluntary participation in research needs extra scrutiny, and security concerns (particularly in a post-9/11 world) appropriately restrict outsider access to bases without thorough checks. These barriers are not insurmountable but must be considered while formulating sound research projects on DUI prevention methods. Following principles of Community-Based Participatory Research, increasingly recognized as a productive way for scientists to work with communities wary of research (Minkler and Wallerstein 2002), early involvement of relevant military leaders and medical personnel in the setup phase of DUI prevention efforts is essential to gain both access and meaningful results.

Prevention Approaches Mentioned in Interviews with US Navy Personnel

To augment the review of the sparse literature on military DUI prevention, the following quotes from our interviews about alcohol use in the Navy offer some additional insight into the prevention of DUI in the military. For example, a female E-6 highlighted the awareness and reward campaigns supported by her command: "The base does a lot of promotions against drinking and driving. They set those cards out there at the gate. They also get that 90 days no DUI, everybody gets a day off." A number of other quotes reiterated command messages to look after drinking buddies, to offer nonalcoholic beverages at squadron functions, and advertising for designated driver programs and safe ride taxi programs.

Illustrating changing DUI norms and policies in the military, a male non-commissioned officer said, "Oh, when I came in, to make chief you have to have at least one DUI. And

nowadays, if you get DUI, they want to process you out. So it's a change of philosophy and attitude." That change of philosophy is reflected in concrete policy changes, as a male E-6 in Pearl Harbor stated: "I racked up more DUIs than you probably shake a stick at in the early '80s. Well, the thing was nobody knew back then, because it wasn't required. See, if you get a DUI out here, the Honolulu police department is required to notify the base. The base automatically knows if you get a DUI now. The command knows. And two, out here nowadays when you get picked up for DUI, they automatically call your command. So you're screwed. The old days, they didn't do that. You know, they arrested me, and basically I just call somebody to come pick me up and I was good to go and appear in court on a set date. So basically my command never knew that I had a DUI. I was able to get leave or take time off without nobody knowing."

We heard two contrasting stories about the repercussions of DUI depending on the offender's rank. Some interviewees, mainly officers but also higher-ranking enlisted, said that the higher the rank, the more likely the incident would end the career. A male O-4 said, "If you get a DUI, you will not advance as an officer in the United States Navy, or a chief petty officer. It will go into your record and that will be the end of it."

A female E-8 said, "Once you get a DUI... If you get a DUI in the Navy, especially in your senior, your officers and your senior enlisted rank, they're going to mark that on your fit-rep, on your evaluation, and you'll never get promoted beyond where you are at." Sharing this view, a male Officer said: "I know when my wife and I go out, I don't drink at all because the effect that a DUI has on your career is just staggering compared to out in town if somebody in corporate America in middle management goes out and gets a DUI, you know, that's probably a civilian matter and it wouldn't harm his work. For us, that's a tie-breaker for advancement, for promotion, for…you know, it shows a lack of judgment on your part, and when you go up a selection board and you've got a spotless record, and a DUI, and there's a spotless record without a DUI-guess which one gets selected?"

However, enlisted personnel cited multiple occasions where they perceived that officers or high ranking enlisted received relatively mild punishment for DUI incidents relative to their junior enlisted counterparts. For example, a female E-4 said, "I knew a chief at my last command who got a DUI but nothing happened to him, whereas an E-2 got a DUI and dropped down to E-1, pay taken away. So it depends on the person in charge of the command." A male E-7 stated, "I know I had a friend who got two DUIs in his career and still make chief. On the other hand, I have another friend that got two DUIs and stayed in E-6 for 7 years.

Similarly, a male E-5 said, "One night on watch, there's an enlisted friend of mine-he got in trouble for DUI. So he got pulled in and then at captain's mast, he was busted down low one rank, 45 days with certain restrictions. And a couple of days later, Captain sees the same situation with an officer. DUI, pulled in by Seal, and basically, he got left onboard the ship for 5 days and nothing ever happened. No rank dropped or writing a letter of reprimand. I'm not sure what happened. But pretty much he got off in the short time he was given."

In response to a question about the short-term and long-term repercussions of a sailor being charged with a DUI, a male E-5 said, "The short-term is the financial struggle. The Navy will not represent you on a criminal charge trial, so if you want a lawyer, around the average is

about $5000. And your insurance premium will skyrocket. And of course a lawsuit if there's a person killed or something like that…I would say that probably the more senior you are, the worse your punishment is going to be. But on top of that, it can also hurt your choices of advancement too. So your chances of advancement to chief petty officer or above lieutenant if you got a DUI are probably none."

A male E-7 suggested that for DUI, "Tolerance is going down, way down. Still happens, people still get covered. But since there is no double jeopardy in the military, a person will get arrested for DUI out on town and if they're convicted, they come here and they go to non-judicial punishment;" A male E-9 elaborated about the the risk of dual civilian and military penalties for military personnel: "Results, if it's a civilian (arrest), it's double jeopardy. We're calling it Catch-22. You're gonna pay the civilian community, and then we have to deal with military side of it. For me, if it's a khaki, the admiral sees us. His policy, he sees us. He takes no mercy on us. We're not supposed to be stupid. Junior crews, it's handled at squadron level. Here you are as a leader, you're suppose to be setting examples."

We conclude this section with a provocative quote from a male officer who identified two factors that determine DUI prevention at the local level: Leadership and community norms. He said, "This command has a pretty good program that has been run effectively -- The Right Spirit campaign. The XO and the captain of the community also have been big proponents of the program. I was stationed at Pearl Harbor in a submarine base before and the ship's superintendent back then had adopted zero alcohol at all of our parties that we had and it was widely accepted. When I was in Florida, I saw a lot of alcohol use in Florida. And I think a lot of that stems from what they saw in the community. A lot of people were drinking and driving in the community. If it seems to be prevalent in the local community, I think the bases then have a lot more tendency to do that. I don't know why that is, because we all have one standard set of rules. Like I said, in that station in Florida, at least in the northeast section of Florida, there's a lot of drinking and driving. They had stores you can drive through to get the alcohol, which to me is a definite incentive for a lot of weak individuals to drink and drive."

Conclusions and Next Steps for Reducing Drinking and Driving in the Military

It is important to consider the conflicting pressures on military leaders as they look out for the safety of their troops without constraining their off-duty liberty (echoing the*in loco parentis* dilemmas of universities). Parallels in the workplace literature include supervisor minimization of alcohol problems identified by Ames and colleagues; if managers penalize workers for alcohol infractions by temporarily removing them from the workforce then they have fewer hands to get the work done (Ames and Delaney 1992). Within the military, though, there are also traditions incorporating alcohol that are difficult to eliminate entirely in the interest of safety. As we found in our interviews with Naval careerists, some military personnel are nostalgic for a less restrictive approach to alcohol that characterized their initial experience with military culture. Safer substitutions, including alternatives to alcohol, are part of a norm change that will result in lower incidence of DUI, but such changes require continual efforts on the part of military leaders.

A variety of approaches to deterring drinking and driving among military personnel have been attempted. Yet many continue to drink and drive, and the prevention efforts are often limited to localized bases, squadrons, or vessels. A current challenge is that in the context of the global war on terror, political demands to reduce the drinking age for anyone willing to sacrifice her or his life are increasing. Such a move to lower the military drinking age would likely increase alcohol-related traffic fatalities (DuMouchel, Williams, and Zador 1987; Wagenaar 1986).

In conclusion, our review of transcripts of interviews with Naval careerists as well as fairly young entrants to the Navy indicate that the military is mirroring the wider society in terms of norm shifts around DUI: The prevention and disciplinary approaches are currently far more strict than they used to be. This is not to say that individuals serving in the military have entirely given up drinking and driving; Bray et al.'s world wide surveys as well as online data from DoD safety centers offer evidence that the issue continues to pose a threat to military personnel well being as well as force readiness.

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SECTION V. ENFORCEMENT STRATEGIES

THE POTENTIAL FOR NIGHTTIME ENFORCEMENT AND SEAT BELT LAW UPGRADES TO IMPACT ALCOHOL-RELATED DEATHS AMONG HIGH RISK OCCUPANTS

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Introduction

In spite of reductions in alcohol-related deaths among young vehicle occupants from 1982 through the mid 1990s, little progress has been made since that time. Laws, enforcement, and sanctions were key factors associated with early declines and such efforts likely provide the foundation for further progress. However, another aspect of alcohol-related fatalities affects all age groups and that is low seat belt use. Most persons who die in alcohol-related crashes are not buckled up and this is particularly the case late at night, when younger drivers and their passengers are more prevalent on the roadway. This paper suggests that there is considerable overlap between occupants (of all ages) who are killed in alcohol-related crashes and those victims who are unbuckled. It suggests that, along with efforts to deter impaired drivers, more emphasis should be placed on increasing seat belt usage among potential alcohol-related crash victims. At least a portion of such emphasis should be shifted to nighttime hours when impaired driving and seat belt non-use are at their highest levels and when the majority of unbuckled, alcohol-related fatal crashes occur. In the 24 states with secondary seat belt laws, upgrades that allow for primary enforcement, combined with intensified and combined HVE efforts, provide the greatest potential for reducing alcohol-related deaths. Combined nighttime enforcement programs and primary law upgrades have considerable potential to further reduce alcohol-related deaths among all age groups.

The Problem

Alcohol-impaired driving and safety belt non-use are serious problems that affect young motorists (ages 16-24). Among the youngest group of ***drivers involved in fatal crashes*** (ages 16-20), 22% had a positive BAC in 2006 and 31% of those ***killed*** had been drinking (BAC≥ 0.01 g/dl). There were large decreases from 1982 through 1995, when the percentage of those killed who had a positive BAC declined by about 50% (from 61% to 31%). However, there have been only slight declines since 1995. Thus, the problem of ***alcohol-related deaths*** continues to be substantial among these drivers who cannot legally possess or consume alcohol. Amplifying the dangers involved with the use of alcohol, there is a high rate of seat belt non-use among these drivers and their passengers. Sixty-five percent of young drinking-and-crash-involved drivers were not buckled up in 2006 and 77% of those killed were unbuckled (NHTSA, 2008a).

The 21-24 age group contributes even more substantially to alcohol-related fatal crashes. In 2006, this four-year age-group accounted for 33% of all fatal-crash-involved drivers with an *illegal* BAC (about 8% for each age-year in this group). By comparison, younger drivers, ages

16-20 accounted for 19% (about 3.8% per age-year) and drivers aged 25-34, constituted 29% (about 2.9% per age-year). Again, while there were major reductions in alcohol related crashed among these groups from 1982 through 1995, there has been little change since that time (NHTSA, 2008b).

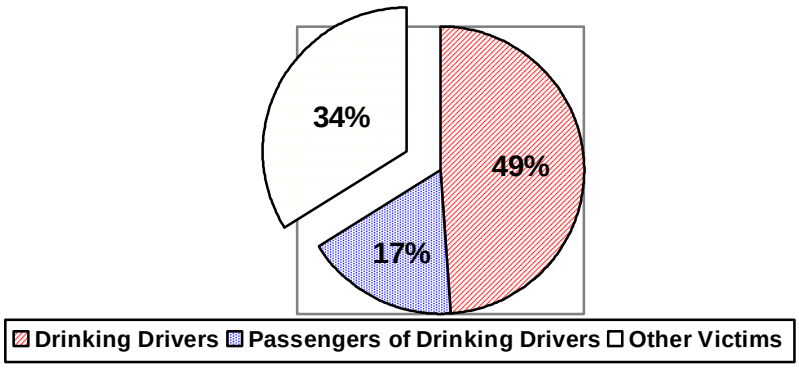
Impaired Driving and Seat Belt Non-Use

While the problems of impaired driving and failure to buckle up have been treated as separate issues over much of the past three decades, there are similarities and overlaps between these two issues. Both, for example, involve over-representation of high risk groups that include: young drivers, males, drivers with previous crashes and violations, and persons driving or riding during late-night hours, particularly on weekends. Each of these overlapping groups contributes heavily to alcohol-related crashes and each is among the least likely of all vehicle occupants to buckle up.

Victims of Alcohol-Related Crashes by Role in Crash

Figure 1 shows that, in 2003, the majority of persons killed in an alcohol-related crash (66%) were in a passenger vehicle driven by a drinking driver (Subramanian, 2005)[3].Nearly half (49%) were the drinking drivers themselves and an additional 17% were passengers riding with drinking drivers. One implication of these data is that many deaths could be prevented if something were done within the drinking driver's vehicle to prevent deaths and serious injuries. Unfortunately, seat belt usage among such occupants is among the lowest of any group, particularly among youthful occupants.

Figure 1. Fatally Injured Victims of Alcohol-Related Crashes by Role in Crash
Source: Subramanian, 2005; 2003 FARS data



The Relationship between Alcohol Involvement and Seat Belt Use

There is a strong (negative) relationship between alcohol and seat belt use. Unrestrained drivers and operators who were killed in 2003 were about twice as likely to have a positive BAC as

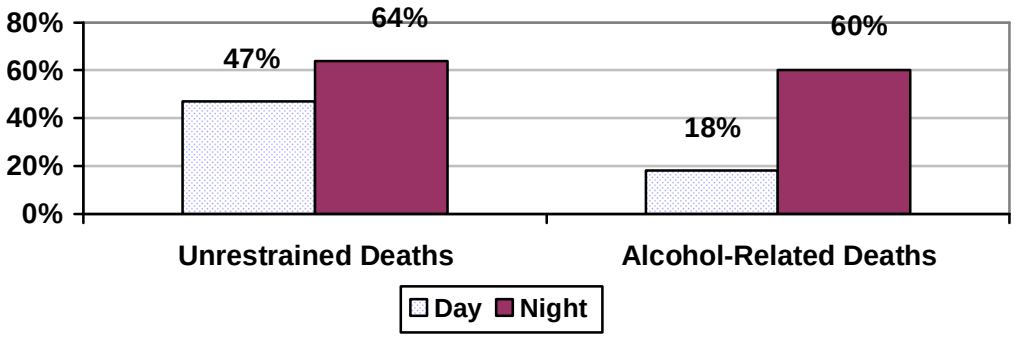
[3] Constituting the remaining victims were motorcycle operators or their passengers (9%); non-drinking drivers or their passengers (10%); and non-occupants or other (15%).

restrained drivers and operators. Conversely, those drivers and operators who had a positive BAC were about half as likely to be restrained as those who had not been drinking (Subramanian (2005).[4]

Time of Day as a Factor in Alcohol-Related and Unrestrained Deaths

Time of day is a key factor in the overlap of alcohol-related and unbuckled fatalities and it has important implications for program efforts. FARS data for 2005 show that*non-use* of safety belts is considerably higher at night than during the day (64% vs. 47%) and that the proportion of occupants killed in an alcohol-related crash is more than three times as high at night as during the day (60% vs. 18%). Both problems peak between midnight and 3 a.m. and peaks are greatest on weekends.

Figure 2: Unrestrained and Alcohol-Related Occupant Fatalities: Daytime (6 a.m. to 6 p.m.) versus Nighttime (6 p.m. to 6 a.m.)
Source: Varghese and Shankar (2007); FARS, 2005 data.



Looking only at *usage among occupants killed*, Figure 3 shows that such usage is substantially lower at night than during the day, bottoming out between midnight and 3 a.m. among younger occupants.

Figure 4 shows that the decline in nighttime usage among young occupants is not quite as extreme as it is for all ages, in part because peak daytime seat belt use is lower among youth. Usage ranges from a low of about 26% to a high of 46% among young crash victims, whereas it ranges from about 29% to 58% among all victims.

[4] "Restrained" included helmet use among motorcycle operators or riders who constituted about 13% of the drivers and operators involved in this analysis.

Figure 3. Seat Belt Use among Fatally Injured Occupants, by Time of Day, All Ages: Source: FARS, 2005 data

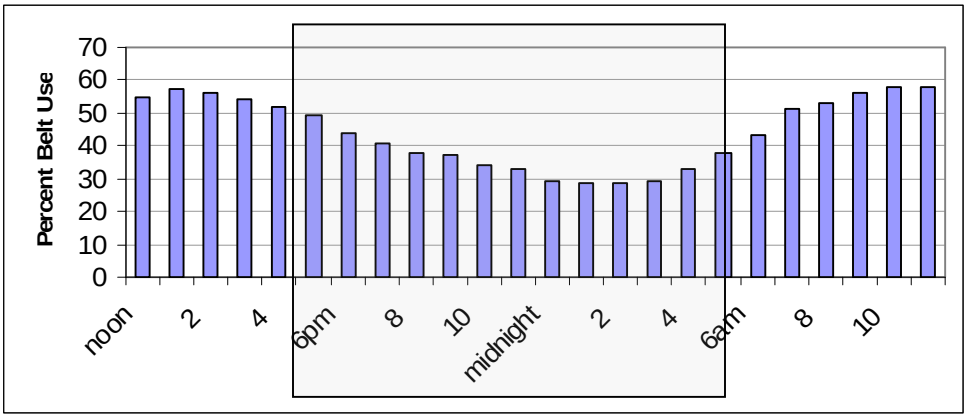
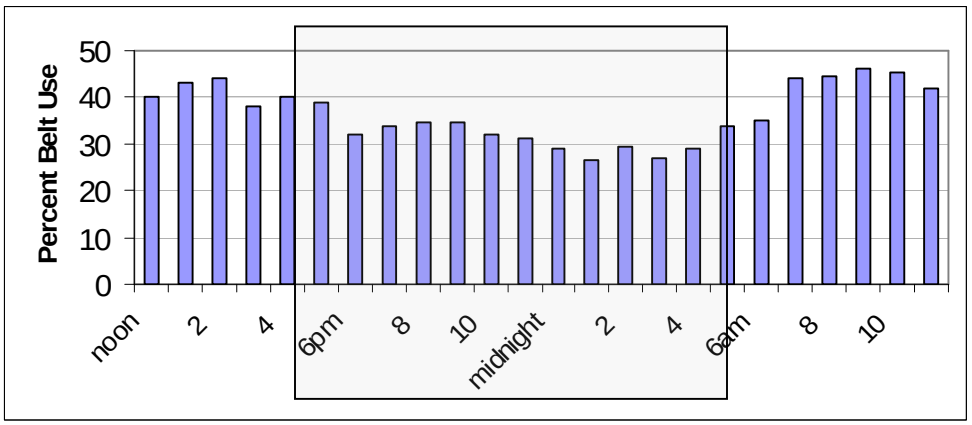


Figure 4. Seat Belt Use among Fatally Injured Occupants, by Time of Day, Ages 16-24: Source: FARS, 2006 data



Perhaps the most powerful illustrations of the relationship between seat belt *non-use*, *alcohol involvement*, and *time of day* are provided by Figure 5 (for all ages) and Figure 6 (for ages 16-24). These figures show that *unbuckled, alcohol-related deaths* peak after midnight in both groups, while *unbuckled, non-alcohol-related deaths* peak at about 3:00 p.m. in the afternoon and at 7:00 a.m. in the morning, for both groups.

Figure 5. Number of Unbuckled Fatalities, by Time of Day, and by Presence or Absence of Alcohol: All Ages
(Source: FARS, 2003 data)

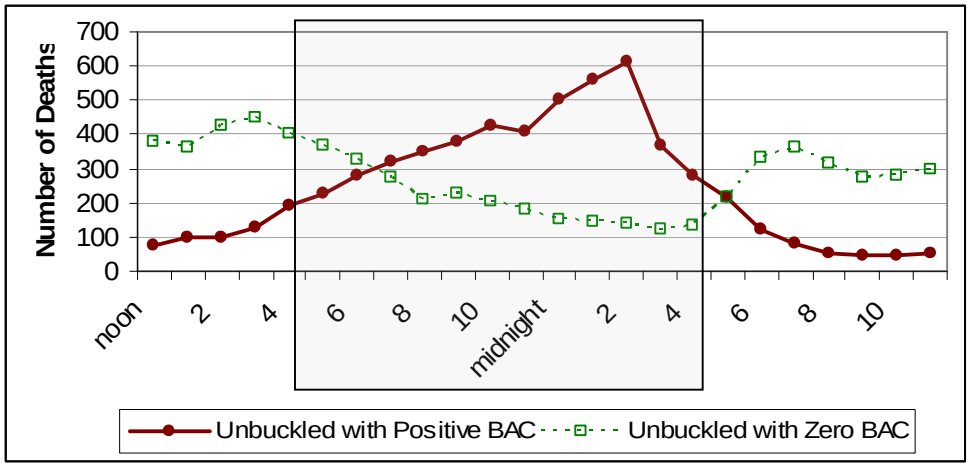
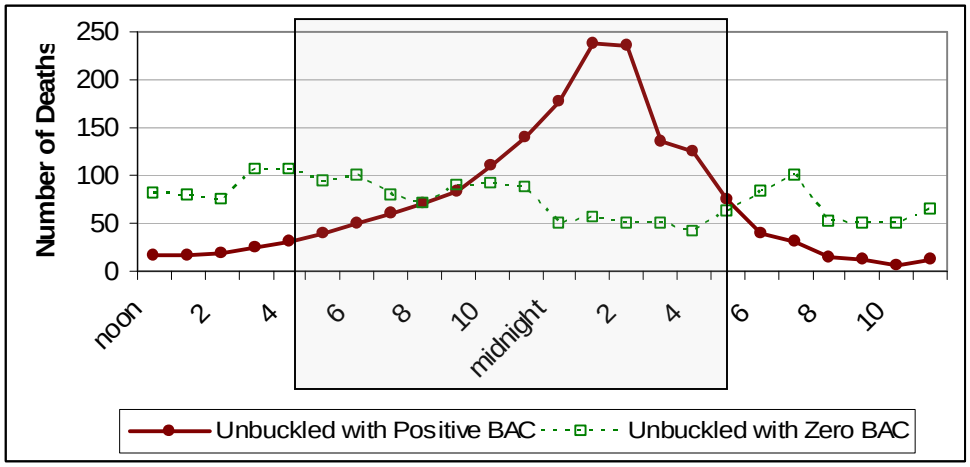


Figure 6. Number of Unbuckled Fatalities, by Time of Day, and by Presence or Absence of AlcoholAmong Drivers, Ages 16-24
(Source: FARS, 2006 data)



In summary, these data suggest that considerable potential exists for an approach that focuses on increasing seat belt use among vehicle occupants who are most likely to be involved in an alcohol-related crash, particularly at night. While such an approach would not necessarily be specific to youth, young drivers and their passengers would be prime targets and prime beneficiaries of such an effort.*High visibility enforcement (HVE)* of seat belt laws, conducted at night and in conjunction with enforcement of impaired driving laws, provides such potential as do *primary law upgrades* in the 24 states that currently allow only secondary enforcement of their seat belt laws.

Past Increases in Seat Belt Usage and Reductions in Alcohol-Related Deaths

Before examining the potential for nighttime enforcement of seat belt laws and additional primary law upgrades, it is useful to review past progress in terms of increasing seat belt use and reducing alcohol-related fatalities. Much progress has been made in terms of *increasing seat belt use* among occupants of passenger vehicles. Observed usage has increased from about 11% in 1979 to 82% in 2007. These increases have been associated with (1) initial safety belt laws implemented in 49 states from 1984 through 1995; (2) primary law upgrades enacted in 18 states from 1993 through 2007; and (3) increased emphasis on highly visible enforcement (HVE), which began in 1990 and has since been enhanced by national enforcement mobilizations. Together, these actions have resulted in the substantial increases in observed usage (and more modest increases in usage among fatally injured occupants) shown in Figure 7.

In a recent review of this area, Nichols and Ledingham (2008) pointed out that the impact of early seat belt laws was greatest among less risky occupants (e.g. females, adults, occupants of passenger cars, and occupants in non-alcohol-related crashes). However, they also pointed out that more recent *law upgrades* have affected proportionately more high risk occupants (e.g. males, young drivers and passengers, occupants of pickup trucks, and those involved in alcohol-related crashes). This is an important point with regard to future programs. It suggests that, as usage rates increase, proportionately more high risk occupants are affected by upgrades and HVE.

Figure 7: Safety Belt Use Rates (Observed and Among Fatalities) and the Alcohol-Related Percent of Total Deaths in the United States:
Sources: 19 cities surveys (1979-90); weighted aggregate of State Surveys (1991-93), National Occupant Protection Use Survey, NOPUS (1994-2007); FARS (1982-2006).[5]

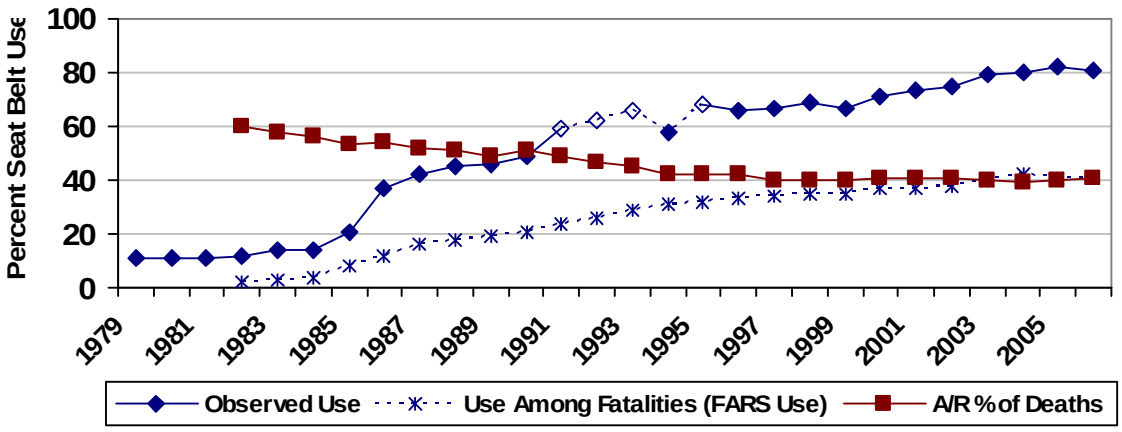


Figure 7 shows that significant progress has also been made in terms of reducing alcohol-related fatalities over the past 2½ decades. Since 1982, there has been a 33% reduction in the *number* of alcohol-related deaths, declining from 26,173 in 1982 to 17,602 in 2006, and resulting in about 8,571 fewer deaths per year. Similarly, the alcohol-related *percentage* of total deaths declined by

[5] Except for 1994, usage during the period from 1991 through 1995 (dotted lines) was measured by an aggregate of state survey results. Following that period (and for 1994), results are from NOPUS.

32%, from about 60% in 1982 to 41% in 2006, with the largest reductions occurring from 1982 through 1995. As indicated, declines in alcohol-related deaths among youth were even greater but, as with the overall problem, there has been little change for more than a decade.

Factors Likely Associated Past Successes

Highly visible enforcement (HVE) has played a key role in the progress made in both occupant protection and impaired driving. With regard to increasing seat belt use, activity has consisted primarily of daytime campaigns conducted at state and local levels, often in conjunction with national *mobilizations* which have included extensive publicity generated via a combination of news stories and paid media. Messaging has frequently been focused on young male drivers, particularly in recent years. Over the past decade, *some* of these campaigns have involved the use of *enforcement zones (EZs)* where vehicles pass through an observation *zone* and are stopped if occupants are observed to be unbuckled. Some HVE efforts have been effective in reaching higher risk groups, particularly when they have been paired with primary law upgrades.

With regard to alcohol-related fatalities, it is generally accepted that the declines in alcohol-related deaths in the 1980s were associated with a combination of legislation, high visibility enforcement, publicity, and public activism (i.e., deterrence). The factors associated with reductions from 1990 through 1997 are less clear, although large increases in seat belt usage, a series of public policy workshops with the states, and a favorable Supreme Court decision regarding the constitutionality of checkpoints may have played some role in these reductions.[6] More recently, impaired driving *crackdowns* have been implemented at least annually and some states conduct additional HVE efforts during the year. Similar to seat belt mobilizations, recent impaired driving crackdowns have made extensive use of paid media, frequently with messages aimed at the18-34 year-old males, who are considered to be of highest risk of being involved in an alcohol-related crash.

A Key Difference between Seat Belt and Impaired Driving Enforcement Efforts

Impaired driving *crackdowns* have differed from seat belt *mobilizations* in at least two important ways. As would be expected, they have focused on impaired driving rather than on seat belt use. In addition, however, they have frequently been implemented at night, while seat belt mobilizations have been implemented nearly exclusively during daytime hours. In fact, it has sometimes been suggested that seat belt use is a daytime issue and impaired driving is a nighttime issue. Fortunately, as a result of a recent focus on nighttime seat belt usage, that view is becoming much less common than it was a decade ago. Another key difference involves the fact that crackdowns and other HVE efforts focused on impaired driving frequently include the use of *roadside sobriety checkpoints*, but mobilizations and related seat belt enforcement efforts seldom include such highly visible techniques. This may limit the potential of such campaigns to reach higher risk drivers.

Stalled Progress: A Need to Explore New Approaches and Measures of Impact

[6] In checkpoint operations, vehicles pass through the checkpoint area (similar to an *enforcement zone*) and are stopped according to a pre-determined selection process (e.g., all vehicles; every third vehicle, etc.) and drivers are asked to take a breath test. If the driver refuses or fails the breath test, he or she is arrested.

Unfortunately, progress in both areas has leveled off. As indicated, there have been few reductions in impaired driving over the past 15 years and there have been only modest increases in seat belt usage over the past 3 years. While national seat belt usage stands at about 82% and some states have achieved observed rates of 90% or greater, usage among high risk occupants, such as young males, late-night motorists, alcohol-impaired drivers, and fatal crash victims remains much lower. In 2006, usage among occupants killed (i.e., *FARS use*) was 41% and usage among victims ages 16-24 was only about 33%.[7]

Based on the *number of restrained occupants killed* and on the *effectiveness of seat belts against deaths,* which is about 52% across all vehicle types and seating positions[8], a 41% use rate among crash victims translates to about 63% usage among *occupants involved in potentially fatal crashes.*[9] This relatively modest level of usage among those persons who are actually involved in serious crashes limits the potential of seat belts to prevent deaths and injuries.

Alternative Indices of Seat Belt Usage. Related to the discrepancy between observed seat belt use and usage among crash victims is the fact that exclusive reliance on observed usage as a measure of progress may be hindering efforts to aggressively enforce existing seat belt laws and to pursue primary law upgrades in secondary law states. These high daytime rates, unless balanced with consideration of the more modest rates among high-risk motorists and those killed or involved in fatal crashes, suggest that all that can be done to increase seat belt usage has been done. This inhibits a jurisdiction's ability to mount more intense programs that could further reduce fatalities among high risk groups. Ironically, it is at the currently higher rates of usage, that any additional gains will be more likely to affect higher risk occupants.

Moving Beyond Plateaus. Another potential obstacle to future efforts to reach higher-risk occupants is that HVE programs tend to be associated with diminishing returns after repeated implementations. When they reach such a plateau, they appear to require some change in *approach,* in the *environment,* or both to "*break through"* to higher levels of usage. This situation occurred in the late 1980s in Canada; it occurred in the late 1990s in 20 or more OP-sTEP demonstration states; and it appears to be occurring nationwide at this time with regard to national *Click It or Ticket* mobilizations. In Canada, *reinvigorated enforcement* efforts, combined with *penalty points,* may have been the factors associated with *breaking through* and increasing national usage to above 90%. In the OP-sTEP states, the emergence of a national series of *mobilizations* and the use of *paid media* were likely the key factors associated with 10-15 point increases in usage in most of these states (from relatively stagnant rates at or below 70%). Finally, in several secondary law states, *recently enacted upgrades* have facilitated greater impact associated with *HVE* programs, in terms of increases in both observed use and usage

[7] These estimates include victims with unknown belt use; excluding unknowns from the calculation results in slightly higher usage estimate (e.g., 45% among all occupants of passenger cars, light trucks, and vans).

[8] This estimate was based upon the distribution of deaths among passenger cars, light trucks, and vans in front and rear seating positions in 2005.

[9] *Occupants involved in potentially fatal crashes* constitute a hypothetical group which includes all occupants killed in crashes plus an estimate of the number not killed because they were buckled up. This estimate (of occupants not killed) is based on the total number of restrained occupants killed and the estimated effectiveness of seat belts against deaths. The formula for estimating the number not killed is (number retrained victims x the effectiveness of seat belts) divided by (1 – the effectiveness of seat belts).

among crash victims. The 2002 upgrade in the State of Washington provides a reasonably clear example of this enhanced impact as does the 2003 upgrade in Illinois.

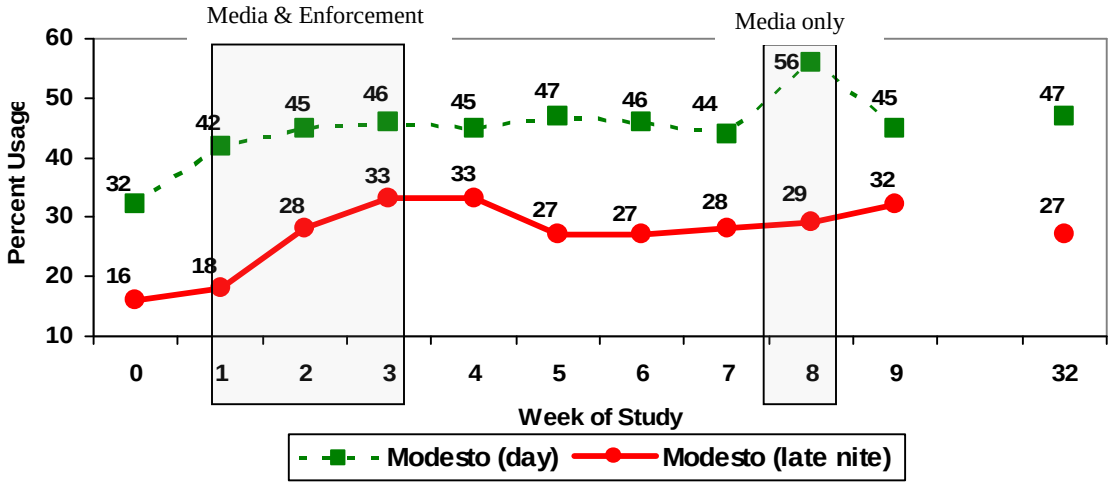
Protecting High Risk Occupants? With regard to *alcohol impaired driving*, it has been increasingly difficult to generate sufficient visibility for enforcement and sanctions to create HVE of sufficient intensity to increase the perceived likelihood of being stopped and arrested. In spite of substantial focus and resources placed on crackdowns and on targeted state programs in recent years, there has been very change in this perception in recent years. It may be a time for a novel approach involving HVE and accompanying publicity that focuses on both deterrence *and* efforts to protect high risk drivers and their passengers. Such an approach could result in greater deterrence due to the more visible offense of not buckling up and it could result in increased protection for youthful and other high-risk occupants who choose to buckle up, thus impacting both of these major traffic safety issues.

In summary, enforcement and legislation have played prominent roles in past efforts to increase seat belt use and reduce alcohol-related deaths. However, these approaches, in their current forms, have been met with diminishing returns in recent years. Based on the high proportion of fatally injured occupants who are unbuckled at the time of the crash and on the relatively untouched potential of nighttime seat belt usage, it may be time to examine ways to incorporate nighttime seat belt enforcement with ongoing impaired driving crackdowns and to integrate impaired driving enforcement with seat belt mobilizations. While both crackdowns and mobilizations are still being promoted as annual events, they provide opportunities to experiment with different combinations of such integrated efforts. In the next section, we explore the rather sparse evidence of impact on nighttime usage (and impaired driving) associated with daytime seat belt enforcement programs and the few programs implemented during nighttime hours.

The Impact of Daytime Seat Belt Enforcement on Nighttime Usage.

Modesto, California (1988). Lund, Stuster, and Fleming (1989) studied the impact of an eight-week program HVE program in Modesto, California. Publicity, in the form of paid and public service advertising, was designed to increase public awareness of efforts to enforce the California's secondary seat belt law. This was a reasonably intensive effort that included a warning phase, a ticketing phase, and a publicity-only phase. Baseline usage was very low (only 32% during the day and 16% at night).

Figure 8. Daytime and Nighttime Seat Belt Use in Modesto, California



Daytime usage increased by 10 points following initial publicity; by an additional four points during the warning and citation phases; and by 12 points (briefly) during a second publicity period. Late night usage, measured from 10:00 p.m. to 12:00 a.m., increased by about 15 points during the two weeks of enforcement; declined slightly after enforcement was discontinued; and increased slightly during and after the final week of publicity. Peak nighttime usage occurred during the enforcement phase.

This study suggested that, nighttime usage (at a very low baseline level) was affected by an intensive daytime enforcement and publicity effort in a secondary law state. It also suggested that, while daytime usage was affected by follow-up publicity, nighttime usage was less affected by publicity without enforcement.

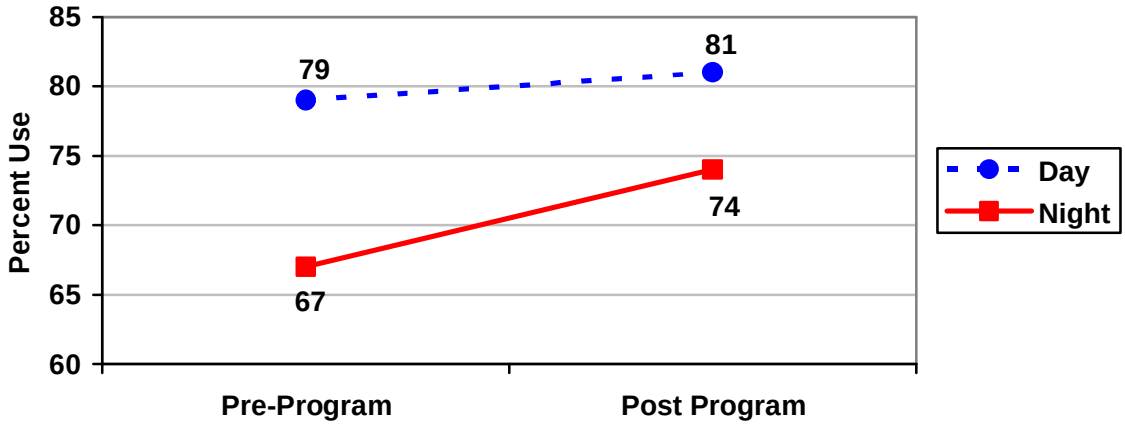
Connecticut (2004). The impact of a more recent daytime enforcement effort on nighttime usage was reported by Chaudhary and Preusser (2006). In this program, intensified enforcement and publicity efforts were implemented in conjunction with Connecticut's 2004 *Click It or Ticket* mobilization. Daytime usage was measured by means of typical daytime observational surveys and nighttime belt use was observed using night vision equipment.

At baseline, nighttime use was 12 points lower than daytime use (67% and 79%, respectively). Associated with the mobilization, daytime usage increased by two points (from 79% to 81%) and nighttime use increased by seven points (67% to 74%). Thus, this daytime campaign appears to have had a larger impact at night than during the day.

Indiana (2006). The most recently published study of the impact of a daytime mobilization on daytime and nighttime usage found very different results. Vivoda, Eby, St. Louis, and Kostyniuk (2007) evaluated the impact of the May 2006 *Click It or Ticket* mobilization in Indiana, another primary law state with a 5-6 year history of participation in HVE efforts. Baseline usage was relatively high during the day and at night. Associated with the mobilization, daytime usage increased by four points (from 80% to 84%) while nighttime usage *decreased* by five points (from 79% to 74%). No reason for the decline in nighttime usage was apparent to these researchers but it was clear that this daytime effort had not increased nighttime usage from its high baseline level.

Figure 9. Changes in Daytime and Nighttime Seat Belt Use in Connecticut Following a Daytime *Click It or Ticket* Mobilization.

Source: Chaudhary and Preusser (2006)



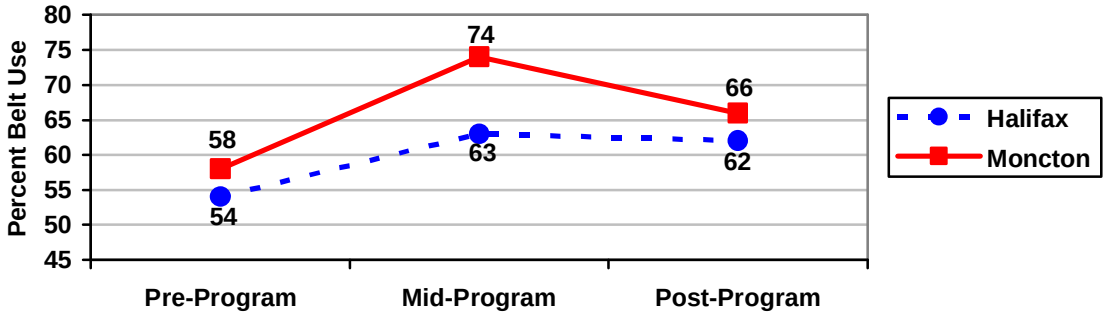
The results of these three studies suggest that the impact of daytime campaigns on nighttime seat belt use is variable. Such efforts resulted in increases in Modesto and in Connecticut and a decrease in Indiana. The Modesto study is of questionable relevance today because it was conducted when usage was very low. While the Connecticut and Indiana studies were more recent and involved higher usage rates, they found very different results.

The Impact of Nighttime Seat Belt Enforcement on Nighttime Usage

Three published studies were found that specifically examined the impact of nighttime seat belt enforcement efforts on nighttime usage. They included a 1988 study of a program in two cities in eastern Canada; a 1992 study of a combined alcohol and seat belt program in Binghamton, New York; and a 2004 study of a nighttime effort in Reading Pennsylvania.

Eastern Canada (circa 1987). Malenfant and Van Houten (1988) examined the impact of a combined daytime and nighttime enforcement program to increase seat belt use in Halifax, Nova Scotia and Moncton, New Brunswick. The nighttime effort was aimed primarily at late-night bar patrons. Publicity was modest, consisting of a press release, signs, and posters, with the slogan: *Safety Belt Use Enforced Day and Night*. These posters were placed at or near selected tavern parking lots and in shopping malls. The daytime enforcement program did not appear to be intensive as officers were instructed to enforce the seat belt use law *whenever they were not busy with other work*. However, a special team of two officers in a marked vehicle conducted nighttime checkpoints over four successive weekends (in each city). They stopped only those motorists who were not buckled up. Although some citations were issued, most violations resulted in warnings.

Figure 10. Nighttime Safety Belt Use in Halifax and Moncton.
Source: Malenfant and Van Houten, 1988



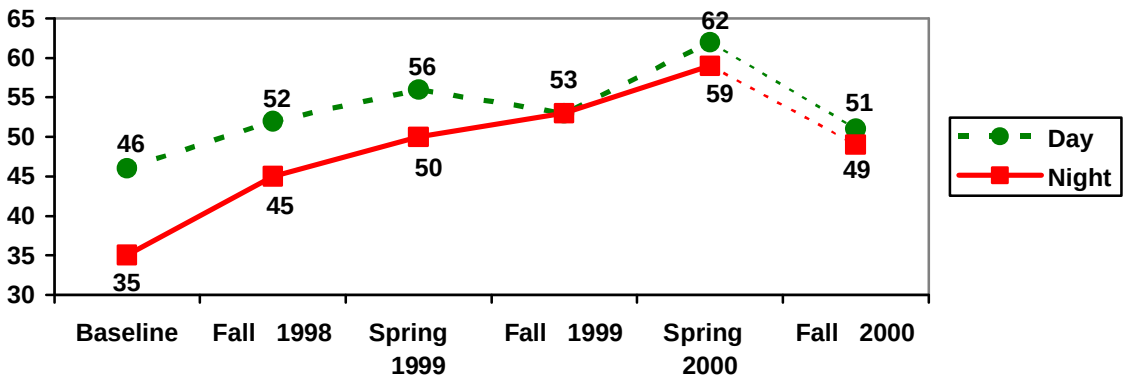
Daytime surveys were conducted between 10:00 a.m. and 4:00 p.m. Nighttime surveys were conducted on Thursday and Friday evenings between 10:00 p.m. and 2:00 a.m. near the parking lots of ten selected drinking establishments. Results showed no change in daytime usage in Halifax (the larger city with a relatively high baseline rate of 86%) but there was an 11-point increase in Moncton (a smaller city with a lower baseline rate of 63%). Prior to the program, nighttime usage was substantially lower than daytime usage in both cities (58% vs. 86% in Halifax and 54% vs. 63% in Moncton). In conjunction with the nighttime enforcement effort, however, nighttime usage increased in both cities (by nine points in Halifax and by 16 points in Moncton) and usage remained about eight points over baseline after one month of follow-up.

In summary, this nighttime enforcement effort, which consisted primarily of warnings issued during checkpoints and modest publicity, increased nighttime usage among late-night bar patrons and much of this increase was maintained for at least one-month after enforcement was discontinued. Daytime usage in the larger city was not affected by the program but daytime usage in the smaller city was affected, at least temporarily.

Binghamton, New York (1988-1990). Results from a combined alcohol/seat belt enforcement program in Binghamton, NY were reported by Wells, Preusser, and Williams (1992). This program, called "*Buckle Up and Drive Sober*," entailed a two-year enforcement and publicity effort. Publicity initially included a press conferences and substantial television, radio, and newspaper coverage. Paid and public service advertising were added later in the program. In addition, drivers stopped at checkpoints were given pamphlets that described the enforcement effort and its purpose.

Emphasis of seat belt and impaired driving laws was phased, rather than simultaneous. Seventy-two checkpoints were conducted over two years. Seventy-five percent of these operations were conducted at night to apprehend and deter impaired drivers but warnings were issued to unbelted occupants as well. Eight daytime checkpoints were conducted to enforce the seat belt law. Emphasis in these seat belt efforts shifted from warnings during the first year to citations during the second year. There was substantial increase in the annual number of DWI arrests made during the program period (about 33%) but only a small increase in the number of citations issued for seat belt violations (about 7%).

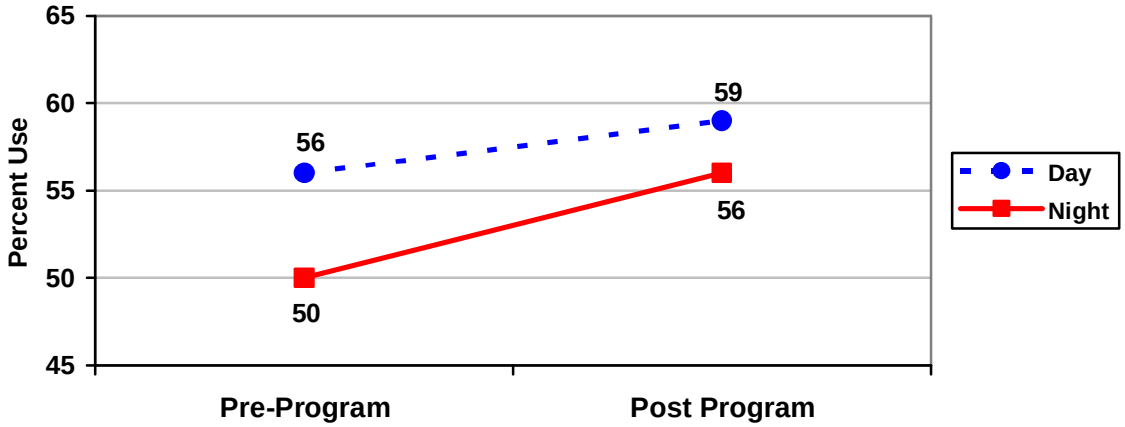
Figure 11. Daytime and Nighttime Safety Belt Use in Binghamton, NY
Source: Wells, Preusser, and Williams, 1992



Night time roadside surveys were used to measure the proportion of drivers who had been drinking and observational surveys were conducted from 2:00 p.m. to 4:00 p.m. and from 9:00 p.m. to 2:30 a.m. to measure daytime and nighttime seat belt usage. Results showed a reduced number of drinking drivers; fewer late-night and injury-producing crashes; and increased seat belt use, *particularly at night*. The nighttime increase in safety belt use was greater than the daytime increase (+24 points and +16 points, respectively).

Reading, Pennsylvania (2004). Results of a nighttime seat belt enforcement program in Reading, Pennsylvania were reported by Chaudhary, Alonge, and Preusser (2005). The enforcement effort in this secondary-law state involved a combination of safety checkpoints, roving patrols and "mini-cades." In the checkpoint operations, vehicles were inspected for safety violations but an officer equipped with night vision goggles observed the vehicles prior to being stopped to determine if seat belts were being used by front seat occupants. If a safety violation was observed (e.g., a headlight out) and seat belts were not worn, a ticket was issued for the seat belt violation. Roving patrols involved 3-4 police vehicles assigned to specific area to observe all traffic safety violations, including seat belt non-use. With the "mini-cades," a police car was parked, with emergency lights flashing, near a sign encouraging seat belt use. More warnings that tickets were issues (225 and 42, respectively) but approximately 5,500 motorists were contacted via the various enforcement approaches. Publicity included earned media only, primarily in the form of press events that called attention to the nighttime enforcement effort and the use of the night-vision equipment. These events generated considerable media attention. Associated with this program, daytime usage increased by three points (from 56% to 59%) and nighttime usage increased by seven points (from about 50% to 56%). Usage in Bethlehem, a control city, did not change appreciably.

Figure 12. Change in Daytime and Nighttime Seat Belt Use in Reading, PA following A Nighttime Enforcement Campaign. Source: Chaudhary, Alonge, and Preusser, 2005



In summary, there is evidence that these nighttime enforcement efforts increased nighttime seat belt usage. In addition, the single program that included both seat belt and impaired driving enforcement was associated with an increase in nighttime belt usage, a decrease in impaired driving, and a decrease in late night crashes. None of these results were specific to youth but, based on the fact that young drivers are disproportionately involved in alcohol-related crashes, it is highly likely that youth were affected at least as much as other drivers and passengers. Nighttime seat belt usage in the four jurisdictions studied increased by an average of about 14 percentage points and daytime usage increased by an average of about 6 points. In one city, daytime usage did not increase at all. Thus, nighttime enforcement appeared to impact nighttime usage to a greater extent than daytime usage. As with other HVE efforts, a portion of the observed increases was lost after cessation of the enforcement activity. Experience with traditional HVE programs suggests that such losses can be overcome by follow-up efforts.

The Potential Impact of Primary Seat Belt Law Upgrades

Another option for increasing seat belt use among young drivers, drinking drivers, and their passengers is to upgrade the seat belt laws in the 24 states that currently allow only for secondary enforcement. HVE programs that target high risk occupants require strong laws in order to be effective. The most powerful enforcement techniques, such as checkpoints and enforcement zones are not as effective under secondary laws as they are under primary laws. Thus, it is not surprising that some of the most powerful examples of impact on both safety belt usage and alcohol-related deaths have occurred when HVE was combined with law upgrades. Following are but a few of such examples.

California (1993). Based on the State's annual seat belt surveys, California's primary law upgrade resulted in a 13-point increase in observed usage, from 70% in 1992 to 83% in 1993 (Bentacourt, 1992 and 1993). This law change also affected usage at night and among drinking drivers. More importantly, it was associated with a reduction in alcohol-related fatalities. Evidence of the increase in nighttime safety belt usage comes from a study by Lange and Voas (1998), who were conducting roadside alcohol surveys at the time of the upgrade. They reported a 23-point increase in nighttime safety belt usage (from 73% to 96%) and increases were greatest

among drivers whose BAC was 0.10 or above (from 53% to 92%; +39 points). There were indications that some of the drivers passing through the roadside surveys they were part of nighttime enforcement efforts.

Voas, Fell, Tippets, Blackman, and Nichols (2007) examined fatality trends in California before and after the upgrade. Using ARIMA time series analysis of data from 1987 through 2004, they reported a significant 28% reduction in alcohol-related fatalities among front seat occupants associated with the 1993 law change.

Michigan (2000). Michigan upgraded its law in 2000, about the same time as the State began participating in annual seat belt mobilizations. Eby, Vivoda, and Fordyce (2002) reported that usage rates had been stable at about 70% for several years prior to the upgrade. Following the law change, usage increased by 14 percentage points (from 70% to 84%). These researchers also reported that usage increased most among males, younger occupants (ages 16-29), and occupants of pickup trucks.

Voas et al. also examined the impact of Michigan's law change on fatalities and found a 13% reduction in ***alcohol-related deaths*** among front seat occupants, compared with national trends. They also reported a 37% relative increase in ***safety belt usage among alcohol-positive victims***, substantially larger than the increase found among victims with no alcohol in their system at the time of the crash.

Chaudhary and Solomon (under review) also examined the impact of the Michigan upgrade on observed seat belt use; usage among crash victims; and front-seat deaths among occupants of passenger vehicles. Based on the results of time series analyses, they reported significant increases in belt use among crash victims and a significant reduction in fatalities that translated to about 380 fewer deaths over a 45-month follow-up period.

The results of these studies of the Michigan upgrade provide consistent evidence that usage among high-risk, crash-involved occupants, including drinking drivers and their passengers, was affected by the law change and accompanying HVE efforts.

Washington State (2002). Another example of the impact of a primary law upgrade is relevant, not only because it resulted in a significant 12-point increase in observed usage but because the increase was from a very high baseline rate of 83%. Further, it is notable that the at least part of the increase associated with this 2002 upgrade in Washington State occurred immediately ***prior to*** the effective date of the law and in conjunction with intensified HVE efforts. In addition, Salzberg and Moffat (2004) reported that there was a 13.4% reduction in occupant deaths during a 12-month post-upgrade period, translating to approximately 72 fewer deaths over that period.

Voas et al. also examined the impact of the Washington experience and reported a large increase in safety belt usage among front-seat victims in alcohol-related crashes, about twice the size of the increase of victims in non-alcohol-related crashes. In addition, these researchers reported a 24% decline in front-seat, alcohol-related deaths and a 13% decline in front-seat, non-alcohol-related deaths.

A Five-State Case Study. Some of the results of a five-state case study conducted by Voas et al. (2007) have already been mentioned. These researchers examined the impact of primary law upgrades in California, Illinois, Maryland, Michigan, and Washington. Associated with these upgrades, four of the five states (all except Maryland) experienced increases in seat belt use among front-seat occupants of passenger cars involved in *alcohol-related fatal crashes* and three states (California, Michigan, and Washington) experienced significant reductions in *the number of front-seat occupant fatalities* resulting from *alcohol-related crashes*. Clearly, a range of high risk occupants had been affected by the law upgrades in four of the five states.[10]

The Impact of Upgrades on Usage in Nighttime Fatal Crashes. Finally, Masten (2007) examined the impact of primary law upgrades on usage among fatally-injured, front-seat occupants of passenger vehicles involved in fatal crashes. This study examined crashes occurring during the day (5:00 a.m. to 8:59 p.m.) and at night (9:00 p.m. to 4:59 a.m.). The states examined (and the year of upgrade) were Alabama (1999), Indiana (1998), Maryland (1997), Michigan (2000), New Jersey (2000), and Oklahoma (1997). ARIMA time series analyses showed that daytime *and* nighttime usage increased significantly in all states except Maryland. In Michigan and New Jersey, nighttime increases were greater than daytime increases. In Oklahoma, very similar increases were found for daytime and nighttime hours. Masten concluded that the upgrades in five of the six states were associated with significant increases in seat belt usage among occupants involved in fatal crashes during both daytime and nighttime hours.

In summary of the impact of primary laws on high-risk groups, there is strong and consistent evidence that primary law upgrades (often in combination with HVE) have impacted high-risk groups including young males, occupants of pickup trucks, occupants in alcohol related fatal crashes and those killed in both daytime and nighttime crashes. In several cases, primary law upgrades have enhanced the impact associated with HVE efforts. Even with these apparent successes, however, seat belt usage among the highest risk individuals, remains unacceptably low and a more direct approach may be needed to reach such motorists. Such an approach would expand enforcement and publicity efforts (in conjunction with primary law upgrades wherever possible) to nighttime hours when high risk drivers are more prevalent on the roadways.

Overall Summary and Implications

The data provided in this review provide reasonable clear evidence that increasing seat belt usage among high risk groups, including young drivers and their passengers, offers significant potential for further gains in reducing alcohol-related deaths and injuries. The evidence of impact associated with nighttime HVE programs and with primary law upgrades suggests that they will be effective if they are implemented with sufficient intensity and if they can be combined with impaired driving enforcement efforts.

[10] Several researchers have noted the lack of change in usage among crash victims in Maryland associated with its primary law upgrade (e.g., Nichols and Ledingham, 2008; and Masten, 2007). Each has pointed out that, at the time of the law change, Maryland already had one of the highest usage rates among crash victims in the nation. It is not known why this pre-upgrade rate was so high but the implication is that this high rate limited the potential for immediate change associated with the upgrade.

The combination of nighttime HVE and primary law upgrades provides the greatest potential for impact in secondary law states. In primary law states, nighttime seat belt enforcement, combined with impaired driving enforcement, likely offers the greatest potential. At this point there are not a sufficiently large number of studies to accurately estimate the potential impact of such efforts in terms of increasing in seat belt usage or in terms of reducing alcohol-related deaths and injuries among high-risk groups (including young drivers and their passengers). However, additional studies are currently underway in Washington State, North Carolina, and West Virginia and several additional states are experimenting with different combinations of nighttime alcohol and seat belt enforcement (e.g., Michigan, Iowa, and Missouri). Results from these studies and additional state efforts will increase the available research evidence regarding this proposed approach.

Several obstacles to combining seat belt and impaired driving enforcement efforts at night have been suggested. They include: problems with nighttime staffing in most enforcement agencies; difficulties in observing seat belt use at night; inability to conduct checkpoints or enforcement zones in secondary law states; and problems associated with combined messages. Each of these issues needs to be addressed in future program efforts.

In addition, there is the problem of sustaining impact. It is not likely that periodic HVE efforts alone (e.g. annual mobilizations or crackdowns) will result in sustained increases in nighttime seat belt usage or sustained reductions in alcohol-related deaths among youth or any other high-risk group. Unless such efforts are supplemented by sustained enforcement and publicity throughout the year, impact will likely be modest and temporary. Periodic HVE has provided a very effective means for gaining the public's attention and, to some extent, increasing the perceived risk of being stopped for either a seat belt or an impaired driving violation. However, unless there is some visible deterrent activity in place throughout the year, the gains associated with annual crackdowns or mobilizations are likely to be temporary.

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DRINK DRIVING AND DRUG DRIVING ENFORCEMENT STRATEGIES IN AUSTRALIA

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In Australia, strategies to tackle drivers impaired by alcohol or other drugs are based on general deterrence and targeted operations. Random breath testing is widely used across the Australian jurisdictions to combat alcohol impaired driving (drink driving), and most jurisdictions have adopted, or are to adopt, roadside drug testing of drivers. Roadside drug testing supports and extends the previous random breath test (RBT) powers for impaired driving. Australian police now have powers to stop drivers at random to test for alcohol and for specified drugs: THC (cannabis); methylamphetamine ('speed/ice'); or methylenedioxymethylamphetamine (MDMA or 'ecstasy'). The penalties provided for drink driving and for drug driving include a substantial fine and loss of drivers license.

This paper provides an overview of enforcement actions targeting drink driving and drug driving in Australia, using policies and programs in New South Wales as a representative example. Particular attention will be paid to issues affecting the likelihood of impaired driving by young people, that is, by novice drivers. In Australia, the States or Territories are the primary level of jurisdiction responsible to for the delivery of services to the community, including services such as health, education, corrective services, and public transport. Police forces are organised at State or Territory level, rather than at city, town or county jurisdictions, and most criminal law is administered through State or Territory legislation. There is a national police force – the Australian Federal Police – which is responsible for enforcement of commonwealth laws, but it also conducts community-level policing within the Australian Capital Territory. Police carry out many local traffic enforcement operations each year, focusing on traffic black spots and also coordinating with local crime prevention initiatives. As well, the State or Territory jurisdictions conduct statewide traffic enforcement operations during the year, usually over long weekends and peak holiday periods to encourage safe driver behaviour. More occasionally, State and Territories may combined to conduct co-ordinated traffic policing activities along major interstate transport routes (Faulks & Irwin, 2007).

The strategies to tackle drivers impaired by alcohol or other drugs are primarily based on general deterrence and targeted operations by police in Australia (Taxman & Piquero, 1998; Freeman, Liossis & David, 2006; see Leggett, 1997, for an account of a area-wide application of traffic policing based upon deterrence). That is, enforcement programs are based on the equation:

Deterrence = Perceived risk x Perceived consequence

Perceived risk of encountering enforcement action is generally manipulated, in part, by advertising and public relations activities in the community, through school-based education, and through education of apprehended traffic offenders (where available). For identified at-risk driving populations, targeted operations are conducted. The consequences arising from being detected are designed to be quick, certain, and severe, and typically involve arrest and court appearances and penalties involving removal of drivers licence, monetary fines, and custodial sentences.

Australian approaches to tackle road safety issues—the most fundamental are speeding, impaired driving (alcohol, other drugs, fatigue, distraction)—are achieved through several related processes involving interventions to reduce the risk of illegal road behaviour, enforcement actions to detect illegal road behaviour, and the prosecution and imposition of punitive action against offenders (NSW Road User Behaviour Study, 2001; Faulks & Irwin, 2007).

First, there are proactive programs to minimise road trauma and improve the behaviour of all road users. The programs work to an agreed road safety strategy, which typically includes:

- legislation;
- deterrence through visible community based policing;
- education/awareness initiatives, both through public advertising and through school-based education;
- provision of improved road engineering; and
- promotion of vehicle safety.

Road safety strategies have been developed at national, State and Territory, and local government levels (Faulks, 2002). Road safety strategies are typically linked into strategies developed by police, justice, health and education agencies, and may (as is the case in New South Wales) be co-ordinated within a general State Plan.

Second, detection of illegal and unsafe actions is achieved through:

- detection of illegal road use by targeted enforcement operations, particularly focusing on speed and alcohol/drug use;
- detection of illegal behaviour through enforcement operations prior to possible road use, including enforcement of liquor licensing laws, chain of responsibility lawsin the transport and logistics sector, etc..; and
- adoption of new technologies to support enforcement, as appropriate (e.g., new alcohol and drug screening technologies, automated number plate recognition technology, ANPR).

Third, prosecution and punitive action against offenders, including:

- monetary penalties;
- action against drivers licenses;
- custodial sentences;
- interventions within the judicial process, including guideline judgments prescribing penalties to be imposed;

- presentencing education, such as attendance at counselling, and attendance at traffic offender programs;
- specific sentencing conditions, including, for repeat drink driving offenders, requirements to undergo medical assessment, alcohol counselling, and installation of vehicle ignition alcohol interlock as a condition of resumption of driving.

BAC limits are well established across the Australian jurisdictions, with a BAC limit of 0.05 g/100mL for general light vehicle licence holders. Special limits typically apply to drivers of heavy vehicles, buses and taxis (usually a BAC of 0.02 g/100mL), and to provisional/learner drivers under 25 years old (e.g., a BAC of 0.00 g/100mL in states such as New South, Victoria and Queensland) (Faulks & Irwin, 2007).

While inappropriate and excessive speed and alcohol are major contributing factors to traffic crashes, police community surveys typically show that most people never drive while over the alcohol limit and rarely drive more than 10 km/h over the speed limit. While the non-use of safety devices, such as seat belts and crash helmets, also contributes significantly to fatal crashes, again police community surveys show people almost always wear seat belts when driving. The relatively high compliance with road rules is evinced in that less than one per cent of drivers are involved in traffic crashes, and also less than one per cent of drivers tested in stationary random breath testing operations exceed the alcohol limit relevant to their licence class.

Random breath testing is widely used across the Australian jurisdictions to combat alcohol impaired driving (drink driving) (Homel, Carseldine & Kearns, 1988), and most jurisdictions have adopted, or are to adopt, roadside drug testing of drivers (Faulks & Irwin, 2007). However, enforcement actions go beyond these high profile activities, and include interventions prior to the commencement of driving (e.g., availability of breath testing in hotels/clubs as a method of community education about drinking and driving, Dimitriadis & Faulks, 1999) and interventions within the judicial and correctional systems (such as traffic offender programs, requirements to drive vehicles fitted with alcohol ignition interlocks, etc.).

In New South Wales, which has a single police force of more than 13,300 members, traffic enforcement operations are co-ordinated through a State-wide strategic plan. In the New South Wales Police Force Corporate Plan 2004-2007, for example, traffic management and road safety policing activities were recognised as a core activity for police, involving:

- high visibility traffic patrolling;
- enforcement of traffic laws;
- crash attendance and investigation;
- liaison with other government and non-government bodies (Roads and Traffic Authority, local councils, community groups) involved in road safety, traffic control, street lighting, road design, car design and public education;
- Speed related operations;
- alcohol and drug detection (random breath testing, etc.);
- traffic research; and,
- traffic information management.

While traffic enforcement operations are primarily the province of the New South Wales Police Force, other agencies are involved to a limited extent. The Roads and Traffic Authority operates automated enforcement (fixed speed cameras, the Safe-T-Cam system for monitoring heavy vehicle transport, and assessments of vehicular roadworthiness), the Environment Protection Authority conducts vehicle emission and vehicle noise enforcement, and parking enforcement is the responsibility of local councils.

Police traffic enforcement activities in New South Wales are organised under an operational order, known as the Fundamental Response to Traffic, which establishes mandatory and measurable requirements for the provision and conduct of traffic policing that every Local Area Command across New South Wales must satisfy. Compliance and control is ensured through ongoing evaluations, including Operational Crime Reviews, Region Audits, and monitoring actions by Traffic Services Branch. Seven areas are required to be addressed in the delivery of traffic policing: intelligence, investigation, tasking and deployment, supervision, prosecution, review, and crime prevention. A computer-based tasking and reporting system, the Computerised Operational Policing System (COPS), enables police to quickly upload information about traffic offenders and offences and provides police with a download facility that can, for example, identify disqualified drivers within their operational areas.

Random breath testing as a drink driving countermeasure

Random breath testing is a robust, comprehensive set of drink-drive countermeasures, including specific drink-driving laws, use of breathalyser technologies at the roadside and as evidentiary instruments, specific operational traffic policing methods (random breath testing and the highly visible 'booze buses'), integrated with public advertising that alerts the community to the risks associated with drink driving and emphasises the high probability of detection for driving while impaired by alcohol, and school-based education targeting young people in the immediate pre-driving phase and providing for a discussion of driving while impaired (Homel, 1988; STAYSAFE 19, 1992; Homel, 1994; Harrison, 2001, Harrison, Newman, Baldock & McLean, 2003).

Police enforcement of drink-driving through random breath testing is a key element of road safety programs in all Australian jurisdictions, and operates as an enforcement tool both to apprehend offenders and to deter potential offenders (Faulks & Irwin, 2007). In the main, random breath testing is conducted in similar ways across all of the Australian jurisdictions, but there are still possibilities for developing further drink driving enforcement programs in a way that enhances their effectiveness. The level of enforcement of random breath testing is typically determined to be that to establish a perceived risk of one chance in two or three of being breath tested at any time or place during a calendar year. The consequences arising from being detected drink-driving were determined to be quick, certain, and severe. A drink-driver detected at the preliminary roadside screening test is automatically arrested, and a graduated series of penalties of increasing severity are in place to deal with progressively higher detected blood alcohol concentrations or with repeated offences. To ensure consistency in sentencing, some jurisdictions, such as New South Wales, have introduced mandatory sentencing guidelines to alert and direct judicial officers towards imposing penalties that reflect legislative intent. The perceptions of risk and consequence are usually emphasised through community-wide

advertising and public relations activities, school-based education, and in traffic offender programs. As a result, unlike their parents, today's young people have grown up in a society where drink-driving is socially unacceptable.

Random breath testing has been credited as the reason for a marked drop in road crash fatalities. The decrease in fatalities to be mostly in alcohol-related crashes. Evaluations of random breath testing operations have confirmed random breath testing as a very cost effective road safety measure

Interventions targeting drinkers prior to driving

There are a number of well established interventions targeting drinkers prior to driving, primarily through enforcement actions in licensed premises, including requirements for staff in premises licensed to sell alcohol to have completed responsible service of alcohol training, and legislation requiring the provision self testing breath analysis instruments in licensed premises (STAYSAFE 19, 1992).

Supporting these are actions such as the promotion of non-alcoholic beverages at licensed venues, promotion of designated driver programs, where a person look after mates by not drinking alcohol and driving them safely home, community buses (enabling patrons who have been drinking to be taken home), and programs such as Operation EN-LITE-EN conducted by NSW Police Force where police conduct community education about breath testing by visiting hotels, clubs and other licensed premises to educate drivers on the dangers of drink driving and conduct free breath testing to patrons.

Drink driving countermeasures are also supported by community wide actions to limit the availability of alcohol and alcohol products. This is down through such measures as taxes on alcohol, changes to hours and places of alcohol sales, and the banning or restrictions on sale of certain alcoholic products, for example, the tax on alcopop products such as cruisers and breezers has been increased recently in an attempt to reduce consumption by young people, and products such as Moo Joose (a line of alcohol-laced flavoured milk drinks) have been prohibited from sale.

There is active enforcement of the law banning alcohol sales to people under 18 years of age (under-age drinking).

Driver licence interventions for drink drivers

Administrative, or driver licence, interventions for drink drivers include removal of the drivers licence upon conviction (and in some cases, such as high range drink driving, immediate removal of drivers licence), requirements for assessments of fitness to drive for people convicted of drink driving, and the imposition of restrictions on the drivers licence such as a requirement to only drive vehicles fitted with an ignition interlock devices to disable vehicles if drivers were unable to blow air free of illegal concentrations of alcohol (STAYSAFE 20, 1993). In some Australian jurisdictions demerit points are placed against a driver licence for drink driving offences.

Interventions for drink driving offenders through judicial or correctional action

Interventions through judicial or correctional action include traffic offender programs and specific programs for repeat drink drive offenders, as well as specific requirements placed on judicial officers in deciding sentences for proven drink driving offences (guideline judgements).

Traffic offender programs are a pre-sentencing option available to judicial officers after a person has been found guilty of an offence (see, e.g., Bamford, Syme, Tynan, & Faulks, 2007). In New South Wales, the Traffic Offender Intervention Program enables judicial officers to refer unsentenced offenders who have either pleaded guilty to, or been found guilty of, a traffic offence to an approved traffic course. Approved traffic courses are intended to provide offenders with the information and skills necessary to develop positive attitudes towards driving and develop safer driving behaviours.

The majority of first drink drive offenders do not re-offend, but a second offence is a predictor of serial serious offending. For repeat offenders research indicates they may benefit from a specialist education program. In New South Wales, the Sober Driver Program is such an educational intervention targeting repeat drink drive offenders (Roads and Traffic Authority, 2003). Further modules, which target high range speeding, negligent and disqualified driving offenders may be developed in the future. The program targets adult offenders (18+) convicted of a drink driving offence who have been convicted of a previous drink driving offence within the past five years. The program is conducted over nine weeks by corrections staff (the Probation and Parole Service), and addresses issues such as consequences of drink driving, effects of alcohol on driving, managing drinking situations, alternatives to drinking and driving and relapse prevention and stress management (for a discussion of recidivist drink driving offenders, see Freeman & Watson, 2006).

To ensure consistency in sentencing, some jurisdictions, such as New South Wales, have introduced sentencing guidelines to alert and direct judicial officers towards imposing penalties that reflect legislative intent.

Judicial and correctional actions associated with traffic offences such as drink driving may be different for juvenile offenders or indigenous offenders, with requirements to engage in court-based diversion programs, non-custodial sentencing, etc..

Drug driving

Roadside drug testing supports and extends the previous random breath test (RBT) powers for impaired driving (Faulks & Irwin, 2007; for a recent comprehensive review of drug driving issues, see Stewart, 2006). Australian police now have powers to stop drivers at random, and to test for alcohol and for the following drugs:

- THC (cannabis);
- methylamphetamine ('speed/ice'); or
- methylenedioxymethylamphetamine (MDMA or 'ecstasy').

These specified drugs are not available as medical drugs in Australia.

Motorists who test positive for drugs are issued with prohibition notices preventing them from driving for 24 hours. Their tests are sent to a forensics laboratory for verification before the driver is charged with drug driving and required to attend court. The penalties provided for drink driving and for drug driving include a substantial fine and loss of drivers license.

In New South Wales, police force began roadside drug testing in January 2007 and 11,000 motorists Statewide have been tested, with an average of one in 40 of those drug tested showing a positive reading. Some recent roadside drug testing operations have yielded the following:

- In the last week of May 2008, drug testing of motorists was undertaken near Dubbo, in the central west region of New South Wales, with more than 600 motorists using the Newell Highway pulled over. From those motorists, 200 were drug tested and two motorists produced positive readings.
- Eleven truck drivers returned positive drug tests during a traffic operation in the Southern Highways of New South Wales, in mid-May 2008. Police conducted the random drug testing operation at a heavy vehicle checking station on the Hume Highway at Marulan. During the two-day operation, police drug-tested a total of 630 heavy vehicle drivers. Eleven drivers returned positive roadside readings for cannabis and methylamphetamine.

The procedure for roadside drug testing does vary across the Australian jurisdictions. In Victoria, motorists who return positive laboratory results for cannabis, methamphetamines or ecstasy are issued with a traffic infringement notice or are prosecuted in court. The penalties are a monetary fine and drivers licence cancellation. Drivers who lose their licence as a result of a drug driving offence must undertake a drug education and assessment course before being eligible to get their licence back.

Interestingly, despite a detection rate of between 1-3% for targeted enforcement operations involving roadside drug testing, there has not been a significant public education campaign in New South Wales, unlike those seen in other Australian jurisdictions.

Concluding comments

To conclude, strategies to tackle drivers impaired by alcohol or other drugs in Australia are based on general deterrence and targeted operations (NSW Road User Behaviour Study, 2001; see also Zaal, 1994; Lane & Faulks, 1997; Harrison et al., 2003; Delaney, Diamantopolous & Cameron, 2006; Shuey, 2007). Random breath testing is widely used across the Australian jurisdictions to combat alcohol impaired driving (drink driving), and most jurisdictions have adopted, or are to adopt, roadside drug testing of drivers (Faulks & Irwin, 2007). Roadside drug testing supports and extends the previous random breath test (RBT) powers for impaired driving. This said, both alcohol involvement in fatal road crashes and drug involvement in fatal road crashes remain sources of significant concern in Australia, as in other countries (Sweedler, 2007).

It is noteworthy that the recent Australia 2020 summit identified nationwide harmonisation and standardisation are an urgent priority, requiring reform to introduce uniform regulation,

licensing, standards and enforcement for road transport. But uniform regulation, licensing, standards and enforcement must take place within a wider debate. The summit report proposed the following ambition for alcohol use: 'In the year 2020 we want to live in a society that does not accept "intoxication" as acceptable', and noted:

> It was felt that this calls for an integrated approach, including marketing and government action. The view was expressed that to do this Australians need to change what they see as 'normal', just as the perception has changed about smoking. To achieve this, it was suggested that perhaps 'flavoured' alcohol could be banned as it currently attracts young people to consume large amounts of alcohol. It was felt that the community is not bothered by the problem of overindulgence but is bothered by the issue of drinking and 'safety': this is the community's main concern. It was reiterated that there is a need to change social perception of what is acceptable, just as has occurred with drink–driving. It was said the government can assist by implementing strong policies.
>
> It was suggested that there is a need to involve the education system to achieve this, starting with healthy lifestyle choices such as beginning the day with breakfast and doing some physical activity. It was suggested that education needs to start at younger ages, including at schools: the education system is an important partner in health; it is an intersectoral responsibility. The view was also put forward that schools cannot be the be-all and end-all as there are competing priorities there in terms of numeracy and literacy. To this end, it was felt that there is also a community and parental responsibility.
>
> . . . there was a need to redefine the unacceptable—similar to the issues of smoking and road deaths bring the impact of the problem of alcohol to the public's attention move away from a focus on individuals to the structures behind this: what makes the unhealthy choices the easy choices? How do we change these structures to make the healthy choices the easy choices?
>
> A view was put forward that this type of approach to policy and program implementation would risk the notion of a 'nanny state' and over-restriction of behaviour—in particular, where the view exists that health behaviour is a personal responsibility. It was felt that there needs to be an understanding that this response will occur and that health promotion must not succumb to these pressures. It was also considered that the program would require good intervention outcome measures, something more meaningful in the evaluation of programs, with a link to evidence and a resolution of the contradiction in existing policies—for example, alcohol availability and the abuse of alcohol.

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SECTION VI. TECHNOLOGICAL APPROACHES

The full paper can be found in *Journal of Safety Research* 38 (2007) 413–422

THE USE OF TECHNOLOGY TO ADDRESS PATTERNS OF RISK AMONG TEENAGE DRIVERS

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Abstract

Introduction: The crash risk of teens is high, with fatal crash rates of teen drivers higher than any other age group. New approaches to reduce teen traffic fatalities are clearly needed. Method: A possible approach to reduce the incidence of teen driver crashes and fatalities is through the use of vehicle-based intelligent driver support systems. To be most effective, the system should address the behaviors associated with an overwhelming number of teen fatal crashes: speed, low seatbelt use, and alcohol impairment. In-vehicle technology also offers an opportunity to address the issue of inexperience through enforcement of certain Graduated Driver's License provisions. Results: To fully understand the capability of such technologies, there should be a concerted effort to further their development, and human factors testing should take place to understand their effects on the driver. Impact: If successfully implemented, a Teen Driver Support System (TDSS), such as the one described here, could significantly decrease the number of teens killed in traffic crashes.

ALCOHOL MONITORING TECHNOLOGIES: APPLICATIONS FOR YOUTH AND YOUNG IMPAIRED DRIVERS

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Introduction

In the past two decades, a multitude of programs, policies and legislation designed to reduce the crash risk of young drivers have been implemented in jurisdictions throughout North America. In spite of these efforts, road crashes remain a leading cause of death among youth, outstripping suicide and other accidents (Emery et al. 2008).

Alcohol-related crashes among youth in particular continue to be a pressing concern because research has clearly demonstrated that, although young drivers account for a lower proportion of alcohol-related crashes than adult drivers (Mayhew et al. 2008), they have a much greater crash risk due to the combined effects of age, inexperience, and alcohol (Mayhew and Simpson 1999; Mayhew et al. 2006). In fact, the crash risk for young drivers who have not consumed any alcohol at all is roughly comparable to the risk posed by drivers in their mid-thirties with a BAC level of 80mg% (Preusser & Tison 2008). For this reason, drinking among youth and the separation of drinking from driving among youth are of paramount importance.

Of greater concern, there is evidence that, in spite of ongoing education and prevention initiatives combined with high levels of enforcement in the past two decades, a not insignificant number of youth continue to engage in drinking and also drinking and driving behaviour, as illustrated below.

University and college campuses have long been concerned with the consumption of alcohol by students, and with good reason. In March 2007, the U.S. National Center of Addiction and Substance Abuse published "Wasting the Best and the Brightest: Substance Abuse at America's College Campuses and Universities". Key findings from its 1993-2005 study included:

1) 1,700 U.S. college students die each year from alcohol-related injuries;
2) each month, 49% of full-time students aged 18-22 binge drink and/or abuse prescription drugs/illegal drugs;
3) drinking to "get drunk" has increased 21% since 1993 and getting drunk 3 or more times in the past month increased 26%;
4) 65% of college students who drink alcohol began drinking in high school;
5) 47% of college students drink to fit in socially;
6) acquiring alcohol from parents/relatives increased 34.5% since 1993; and,
7) 43% of college administrators think that alcohol abuse rates have not changed in the past 10 years.

Drinking and driving behaviour among youth is also not uncommon. Although the zero-BAC restriction is a key feature of almost all graduated or probationary licensing schemes, there is evidence that this restriction is frequently ignored by significant numbers of young drivers, and all too often with tragic results. For example, in Canada in 2005, more than 1/3 of all fatally injured legally impaired drivers involved youth under age 25 (Mayhew et al. 2008); in the U.S. youth accounted for ¼ of all legally impaired fatally injured drivers (NHTSA 2006).

National arrest data further illustrate the magnitude of the problem. In Canada, in 2003/2004, 1,528 criminal charges for impaired driving were laid against youth under age 18 (Thomas 2005)**;** in the United States in 2006, 14,292 impaired driving charges were laid against youth under age 18, and a total of 311,164 youth aged 16-24 were charged with impaired driving (UCR 2007). These data demonstrate that the problem of impaired driving among youth warrants concern and effective strategies to prevent and reduce continued offending.

Technologies to reduce impaired driving may provide one opportunity to reduce offending among youth impaired drivers. Technologies designed to reduce and prevent alcohol-impaired driving have long been used to incapacitate, deter, and control alcohol consumption and drinking and driving among adult offenders. Two important examples of such technologies that are widely used are continuous alcohol monitoring, based on transdermal measures of alcohol consumption, and alcohol ignition interlocks, based on breath alcohol measures. The former involves a bracelet that is attached to offenders and monitors drinking behaviour. It was introduced in 2003 and today is in use in more than 43 states in the U.S. The latter is a breath testing device linked to a vehicle's ignition or other on-board system so as to require a zero or low BAC test before the vehicle can be started or operated. Alcohol interlocks are designed to separate drinking and driving as well as to monitor alcohol consumption. Interlocks have been in use for more than two decades and are applied in almost all jurisdictions in North America to drunk driving offenders as well as to a range of drivers in other jurisdictions around the world. What follows is a brief discussion regarding ways in which these two important yet distinct technologies are beginning to be applied to youth.

Continuous Alcohol Monitoring

Although continuous alcohol monitoring is frequently used as a sanction and a mechanism to monitor drinking behaviour among adults; it is less often applied to youth. However, some jurisdictions are beginning to explore the application of this technology to young offenders who consume alcohol. Of interest, this method of monitoring alcohol consumption is being delivered to youth through community-based initiatives, and formal criminal justice-based initiatives in the form of diversion.

Community-based initiatives. Universities and colleges in Colorado and North Carolina have begun to apply and/or consider using continuous alcohol monitoring technology in the form of Secure Continuous Remote Alcohol Monitoring (SCRAM) to students in an effort to control and monitor drinking behaviour and reduce drinking on campus.

In Colorado, the City of Greeley was disturbed by increasing levels of alcohol abuse and its impact on community and personal safety; minors in possession (MIP) were of particular

concern. It was estimated that up to 85% of the 12,300 undergraduates at the University of Northern Colorado (UNCG) were at-risk for drinking. Campus police arrested approximately 200 MIPs annually, in conjunction with some 500 MIPs arrested by Greeley Municipal Police (some of which included UNCG arrests). In addition, there was some reason to believe that jail and house arrest were not having the desired effect with this population.

These concerns led to the development of a MIP deferred prosecution program in cooperation with the University. Parental notification of student participation was required for the deferred prosecution program and records of students were cleansed following one year of compliance with conditions imposed. In the event that parents declined to have their child participate in the program, the student would then be subject to a regular criminal prosecution. Key personnel involved in this initiative include a municipal court judge, a municipal attorney, a legal assistant, the Dean of Students, the Chief of Police, and the University Drug, Alcohol and Tobacco Education Coordinator.

The program itself consisted of assessment/education/treatment, as appropriate, community service, fines ($250.00 USD) and SCRAM. The program also incorporated graduated sanctions for multiple offences:

1) 1st MIP offence results in 6 hours of alcohol classes in conjunction with a fine;
2) 2nd MIP offence and/or a BAC>.05%, or student is combative or requires transport to hospital results in intensive alcohol classes, fines, 15 hours of community service and SCRAM;
3) 3rd MIP offence results in formal addiction assessment, 30 hours of community service and SCRAM;
4) 4+ MIPs or any drinking on SCRAM results in a referral to alcohol treatment by a private provider, fine, 1-year probation and SCRAM.

Generally speaking, SCRAM was employed in more extreme cases that involved aggravating factors (e.g., high-BAC, combative students, and multiple MIP offences).

Since January 2005, approximately 1,200 students have participated in the University-based program. Overall, results of this program have been positive. There has been a significant overall reduction in MIP citations and a 70% reduction in hospital/detox visits. Of these cases, several hundred have involved SCRAM and a 97% success rate is reported in cases in which SCRAM was used. Also of importance, personnel involved in the program along with student leaders and newspapers have voiced support for this initiative. According to the municipal attorney, with the use of SCRAM "we are having an impact…the numbers are coming down". More importantly, the university coordinator reports that "having to wear SCRAM is teaching students that irresponsible drinking is not a game anymore".

Based on this success, a similar initiative was proposed to universities and colleges in North Carolina, including the University of North Carolina at Chapel Hill and Orange County, NC, in October 2007. Although the initial response of these schools was positive, concerns have been raised by the universities regarding civil liberties and some alumni have also expressed concerns. Consequently at this time, universities have preferred that the program be administered

through the local district attorney. Following a meeting between the district attorney and service provider to discuss the possibility of such a program, it was determined that the district attorney was receptive to this initiative and discussions regarding the development of a program are underway.

In point of fact, it was discovered during discussions with the district attorney that SCRAM is already being employed to monitor underage offenders (those under 21 years) who had been charged with driving while consuming (an offence at 20mg% or greater). A total of 47 of the 650 offenders monitored using SCRAM are under 21. The majority of underage offenders are sentenced to 60 days on the device and additional sanctions applied to this group include assessment/treatment as appropriate, and community service.

Results for underage offenders sentenced to date to SCRAM through the district attorney reveal an 83% compliance rate with regard to drinking and that only 8 offenders have engaged in tampering (of which 3 involved multiple attempts). Compliance rates among youth offenders are comparable to those reported among adult offenders.

Criminal justice-based initiatives. In Akron, Ohio, SCRAM is also applied to youth who are formally processed through the youth criminal justice system in ways that are typically designed as diversion programs. Youth may be subject to SCRAM through the Summit County Juvenile Court diversion program called Crossroads developed in 2003, or as part of a Drug Court initiative developed in 1999 that includes youth. The Summit County program involves intensive supervision probation targeted towards youth with mental health and/or substance abuse dependence (often co-occurring), whereas the Drug Court program targets youth who have been charged with impaired driving, drug-related offences or alcohol-related offences.

To be eligible for the Summit County program, participants must be at least 12 years of age and diagnosed with some qualifying mental health and/or substance abuse issue. Other conditions imposed upon youth participating in the program include attendance in school, mental health treatment, the maintenance of any prescribed medications, and participation in any other programs as determined by an assessment. Of interest, many young offenders who are old enough to drive and who participate in this program have also already had their driving privileges suspended.

The youth's family is also required to participate in this program. They must attend Court proceedings and be involved in case planning. The case plan includes all requirements imposed by the Court, and issues identified by the family and the youth. While there is no fee for youth to participate in this program, parents must provide assurance that the youth will comply with imposed conditions and any recommendations made by drug, alcohol or mental health providers.

The Summit County program consists of four phases and primarily involves repeat offenders. In the first phase, youth must meet with their probation officer once a week and this phase lasts a minimum of 30 days. The second phase involves bi-weekly meetings, the 3rd phase involves meetings every three weeks, and the 4th phase involves monthly meetings. How rapidly an offender completes these phases is a function of their progress. The minimum duration of the program is one year and the average stay is approximately 18 months. To date, the use of

SCRAM as part of the Summit Court program is relatively new and the device has been used only on 6 occasions.

With regard to the Drug Court initiative, the program is very comparable to other drug court initiatives and treatment is typically a key component. Approximately 20 juvenile offenders are monitored each year using SCRAM and the majority of these are repeat offenders. The SCRAM device is Court-ordered and the service provider requires parental consent as well as consent from the juvenile. There is no restriction regarding where the youth resides. The period of monitoring using SCRAM varies from 30-180 days with the average being about 60 days. The service provider reports no complaints from parents regarding the use of the technology and there have been no challenges of the technology in Court, although youth appear to have slightly more tamper alerts than adult offenders. It is noted that the success of the program with youth is difficult to gauge because the court officer/judge solely determines which offenders are on the program and whether the offender remains on the program or not. However, almost all youth offenders are given a successful release or are ordered to remain on the bracelet until successfully released by the Court.

Given that continuous alcohol monitoring is relatively new, it is encouraging that this technology is already beginning to be applied to youth as a tool to monitor and control drinking behaviour and hopefully prevent future inappropriate drinking among this population. These applications should be closely tracked and monitored to determine what impact they are having on youth and whether such initiatives can reduce problem drinking and recidivism rates among youth. More importantly, this information can be used to identify optimal program strategies and guide the development of initiatives that are based on sound research

Ignition Interlocks

For drivers in general who violate 80mg% or other *per se* limits, alcohol interlocks have proven to be effective, and are becoming increasingly popular as a means of controlling drinking and driving behaviour and making responsible decisions for individuals who have demonstrated by their conduct that they will not or cannot make them on their own.

The successful use of alcohol interlocks to reduce recidivism by adult repeat drink driving offenders prompted the State of Victoria, Australia not only to extend the scope of its interlock program from repeat offenders to high BAC (≥ 150mg%) first offenders, but also to make interlocks mandatory for all new drivers on a probationary license or under 26 years of age convicted of a drink driving offence involving a BAC level of 70mg% or higher. Currently the number of young driver participants in Victoria's Alcohol Interlock Program is approaching 900 (approximately 25% of the total number of participants).

Measured against the yardstick of a growing consensus on best practices/desirable elements for interlock programs, Victoria's approach insofar as it applies to young drink driving offenders includes positive features such as performance-based removal, jurisdiction-wide application and department of motor vehicle (DMV) administration. However, on the less desirable side:

1) Participation is limited to young drivers with a BAC level of 70mg% or higher whereas the *per se* limit in Australia is 50mg% and, beyond that, drivers with a probationary license are subject to a zero BAC restriction;
2) drivers must complete a long period of hard suspension (6-14 months for BAC levels between .70mg% and 150mg%) before becoming eligible to participate in the interlock program.

Of interest, some may also raise concerns regarding the discretionary authority of magistrates to decide if it is appropriate for a drink driving offender to be relicensed and if so, to participate in the interlock program. In this event, it is imperative that magistrates develop a good understanding of the importance of interlocks in sentencing offenders and are supportive of the use of this technology to ensure that offenders will be subject to this scheme.

Victoria's initiative, launched in January of 2007, marks the first and to date the only example of a jurisdiction that has introduced special countermeasures against young impaired drivers involving the use of alcohol interlocks. This is a significant step, and its impact will undoubtedly be of interest to many in the research community and beyond. Hopefully measures to evaluate its effectiveness will soon be in place. On the other hand, it is questionable whether the young driver component of Victoria's Alcohol Interlock Program represents the precise model that other jurisdictions would want to emulate depending on the situation that exists in other jurisdictions.

Interlock programs for impaired driving offenders are all based to a certain extent on a model first introduced more than 20 years ago as a criminal justice sanction. Although today's programs in many jurisdictions include key elements suggesting more of a traffic safety than criminal justice perspective, the fact remains that offender interlock programs are by definition reactive in nature—responding to drink driving problems only after they have become manifested in criminal or quasi-criminal behaviour that has resulted in an arrest. Since the probability of detection per drinking driving episode is known to be low, it virtually guarantees that interlock programs for drink driving offenders, whether or not they are young drivers, will severely limit the potential of interlock technology to prevent driving after drinking.

The outlook might be more encouraging if alcohol interlocks were used proactively at an earlier stage, in an effort to reinforce the message that drinking and driving are activities which need to be separated. As it happens, an experiment along these lines is currently taking place in Sweden, where driving school cars are being equipped with simple "blow-and-go" interlock devices. A recent survey of its 400 member schools by the National Association of Swedish Driving Schools (*Sveriges Trafikskolors Riksförbund*) elicited responses from 82% of schools, and 92% of those were favourable toward interlocks. According to responses received, 38% have already installed alcohol interlocks in cars used to train students, 16% plan to do so in 2008, 9% in 2009, and a further 29% at a future date (Bjerver, 2008). The Swedish driver's license has been described as one of the most difficult and expensive in the world to acquire. According to one informed source, "[w]hile most American teens save their money to buy their first car, Swedish teens and young adults save their money for their first driver's license" (AWC Gothenberg, 2008). Driving school instruction is not mandatory; however because of the expense and difficulty of obtaining a driver's license, the great majority of student drivers in Sweden see

value in the added expense of having at least some professional instruction and therefore in practical terms they are increasingly being exposed to alcohol interlocks at an early stage in their driving career.

If alcohol interlock technology can achieve widespread acceptance in non-offender applications such as driving school cars, one is tempted to speculate about the possibility of interlocks used proactively for all new drivers. Under the scenario envisaged, a simple, low maintenance, and relatively inexpensive interlock device would be installed in vehicles operated by newly licensed drivers. This device would be linked biometrically to the new driver and would include a timer to log the number of hours of instructional or solo driving required in order to qualify to progress to the next stage of graduated licensing. In order to activate the device and enable the vehicle interlocking function an identification check would be required. The driver would then need to supply an alcohol free breath sample before starting the vehicle and activating the driving timer. A test at the end of the trip would not only confirm the driver's BAC level; it would also stop the driving timer and deactivate the interlocking function in order to permit the vehicle to be operated normally by another driver. Logged data would be used to generate a report for driver license authorities as proof of completion of the prescribed number of hours of driving. In the event that the log report included positive BAC test results or evidence of tampering, the driver would be denied the opportunity to progress to the next stage of graduated licensing and in some cases could be required to participate in a more conventional, offender-style interlock program as a condition of licensing. Conversely, a "clean" log report could enable the driver not only to progress to the next GDL level, but also to have the interlock system removed.

Clearly we are not going to see alcohol interlocks installed in all young drivers' vehicles in the immediate future. However there are some exciting developments in interlock technology taking place which are likely to make it feasible to be able to pilot test devices such as the one described above within the next year or so. That said, the issue of acceptance will be an important one to address. This is illustrated by two related research projects undertaken in Australia by the Monash University Accident Research Centre to examine the acceptability of various in-vehicle intelligent transport systems, including alcohol interlocks, to potential users. Focus groups which included young male drivers in Victoria (Regan et al, 2002) and were comprised entirely of young male and female drivers in New South Wales (NSW) (Young et al, 2003) were shown brief video clips demonstrating the technologies being studied, then a series of open-ended questions was used to guide discussion and obtain information on participants' perceptions of the usefulness, effectiveness, usability, affordability and social acceptability of each technology. In Victoria, interlocks were found to be among the least acceptable technologies although, along with electronic licenses and intelligent speed adaptation, they were also seen as conferring the greatest safety benefit. Concerns expressed included perceived ease of circumvention, potential false positives, the possibility that the system might fail, and the inconvenience of having to blow into a breathalyzer unit every time they wanted to start their car. In NSW, participants expressed similar concerns but were more likely to feel that these were outweighed by the safety benefits of the system. In fact, although they voiced some reservations about interlocks being too expensive for many young drivers, NSW participants were willing to purchase the interlock system and were comfortable for it to be made compulsory.

The overall positive reaction of young novice drivers in NSW to interlock technology is encouraging, and it may be that differences in attitudes and opinions between the NSW and Victoria focus groups are attributable to demographic characteristics (i.e. the Victoria focus groups were comprised entirely of males and included older drivers). Nevertheless, the work undertaken to date points to the desirability of further research in this area.

Conclusions

Impaired driving technologies such as continuous alcohol monitoring and ignition interlocks can play an important role in preventing and reducing alcohol consumption among youth and drinking and driving behaviour. The variety of applications that are currently being pursued in various jurisdictions demonstrates the flexibility and value of these devices in a range of settings. More efforts are needed to promote the development of these initiatives such that they can be adequately evaluated to determine ways to achieve optimal outcomes with youth.

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THE CONSEQUENCES OF PROVIDING DRINKERS WITH BAC INFORMATION ON ASSESSMENTS OF ALCOHOL IMPAIRMENT AND DRUNK-DRIVING RISK

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Introduction

Ever since illegal impaired driving could be defined in terms of a specific blood alcohol concentration (BAC), safety specialists have expressed concern about the absence of a method for a driver to measure his or her own BAC (Borkenstein et al., 1974). Those who oppose lower BAC limits argue that it is practically impossible for a drinker to determine his or her status with respect to the law. When both the driver's BAC and the legal driving limit are known, however, drivers presumably will make more rational choices when weighing the risks associated with driving after drinking.

Several studies have been conducted of drinkers' ability to estimate their own BACs (e.g. Beirness, 1984; Beirness, 1987; Vogel-Sprott, 1974). These studies suggest that individuals rely on internal sensations or on counting drinks to make their estimates, which often are different from their actual BAC levels. There is a reasonable argument that the drinking public could make more rational decisions about driving after drinking if they could accurately measure their BACs. Nevertheless, few studies have examined the effect of BAC estimation tools on impaired driving, and to our knowledge, no research has investigated how BAC feedback affects drinkers' perceptions of their impairment and their risk of DUI arrest.

Tools for Estimating BACs

Many attempts have been made to provide the public with informational materials and test devices to calculate or measure their own BAC levels. These have included "Know Your Limit" cards with matrixes with which drinkers can cross-index their weight and drink count to obtain an estimated BAC, and public use, coin-operated breath-test machines placed in drinking establishments. Small, handheld, electronic breath testers using semiconductors (earlier models) or fuel cells (such as modern police handheld breathalyzers) are available and can be accurate; however, they are expensive and require regular calibration to yield reliable results.

Recently, research on the use of saliva as a sample medium for detecting alcohol has yielded a variety of inexpensive, disposable, and portable personal alcohol testers. These tests, in general, include a paper test strip treated with a chemical that reacts with ethanol. Test-takers expose the test strip to saliva (often by holding the test strip on the tongue for several seconds), after which the strip changes color according to the level of ethanol in the saliva. Saliva-based alcohol test strips typically have three or four different color-coded BAC categories, usually with meaningful category thresholds (e.g., such as .05–.08). After exposing the test strip to saliva, the test-taker then is required to "interpret" the results by matching the color of the test-strip against a standard key (provided on the test package) that associates different test-strip colors with different BAC ranges.

Risks of Providing BAC Estimates in Real-World Settings

At face value, the benefits of providing drinkers with tools for estimating BACs (such as saliva-based alcohol tests) seem obvious. There are, however, potential risks associated with BAC estimates that are not immediately clear (see Johnson & Voas, 2004, for a detailed discussion). For example, even if a BAC test device has demonstrated accuracy in lab settings, human error may lead to less accurate results when these devices are used in the field. Inaccurate test results might lead a drinker to assume that he or she can drive legally when he or she cannot. Furthermore, personal alcohol tests may encourage drinkers to drive at BACs that are lower than the legal limit, yet they are unsafe. There is substantial evidence that impairment of many skills crucial to driving occurs at BACs much lower than the .08 limit (e.g., Moskowitz & Robinson, 1988; Moskowitz & Fiorentino, 2000). Without access to BAC information, drinkers wary about the .08 limit may choose to err on side of caution and moderate their drinking considerably. Conversely, by using a personal alcohol test, drinkers may maximize their alcohol consumption while still staying under a .08 BAC, thus becoming dangerous, yet legal, drivers.

However, before attempting to weigh the disadvantages of providing BAC information to drinkers as a strategy for reducing drunk driving, it first is necessary to demonstrate that there is some advantage – that providing this information in fact changes drinkers' perceptions of risk for crash or arrest, and that it positively affects behavior. To date, there has been no research examining whether and to what extent receiving BAC information influences drinkers' subjective beliefs about impairment and driving risk. The research described herein tested experimentally whether providing drinkers with BAC information in real-world drinking environments affected their subjective perceptions of alcohol impairment and driving risk and whether it encourages drivers to moderate their drinking.

Study 1: BAC Feedback and Perceptions of Risk for Crash and Arrest

METHODS

Procedure

Data were collected over 18 weekend nights, between April 2005 and February 2006, from a convenience sample of men and women recruited from the "Gaslamp" district of bars and restaurants in San Diego, California. On survey nights, typically between 8 p.m. and 3 a.m., teams of two to four survey staff approached individuals walking on the streets and sidewalks of the Gaslamp district and attempted to recruit them for participation.

Survey staff approached potential participants and asked them whether they would be interested in participating in a brief, voluntary, and anonymous study on drinking and safety. Potential participants were offered a small incentive for taking part in the research. Only persons age 18 and older who indicate that they did not plan to drive later in the evening were allowed to participate.

After obtaining informed consent, participants in all conditions were interviewed regarding their demographics. Next, participants were asked three questions on a five-point scale concerning (1) how drunk they currently feel, (2) how impaired they feel their driving would be if they were to drive, and (3) their perceived likelihood of being stopped if they were to drive. The three Likert-

scale questions would be combined to form a measure of "subjective assessment of impairment". Additionally, participants then were asked a fourth, dichotomous (Yes or No) question regarding whether they believe it would be legal for them to drive at their current level of intoxication.

Following these questions, all participants were given a saliva-based personal alcohol test kit. Each participant was asked to examine the test package and to note that the test could be used to indicate whether his or her BAC was in the .000–.049, .050–.079, or .080 + category. Participants were asked to read the test instructions and self-administer the saliva-based personal alcohol test. Because we wanted all the alcohol test strips to produce valid results, survey staff corrected any test administration mistakes that participants might have made in the process.

Participants then were asked to provide a breath sample into a calibrated personal breath test unit. However, no participants received information about their BAC at this time. Next, participants were assigned at random to one of four experimental conditions; the procedures administered to participants per condition were as follows:

Control Condition

After self-administering the saliva test but *before* receiving or interpreting any test results, participants were asked again to respond to the same set of four questions regarding perceived driving impairment and the legality of driving in their current state. The three Likert-scale items would be combined to form a "Time 2 subjective assessment of impairment". This would serve as the primary dependent measure in the study. After answering the questions, participants examined the saliva test strip, interpreted the test results, and reported which BAC category they believed that the test indicated. Note that this condition was considered the "control" condition because participants made their time 2 ratings on the dependent measures before receiving and interpreting the personal alcohol-test results. Thus, BAC feedback could not play any role in differences between pre- and post-ratings.

Saliva Alcohol Test Condition

After participants assigned to the *saliva alcohol-test condition* finished self-administering the saliva test, they were asked to read and interpret the results indicated by the test strip. Then, *after* learning their BAC category from the test strip, they were asked to provide their time-2 responses to the four dependent measure items. Thus, in the saliva alcohol-test condition, unlike in the control condition, participants' subjective ratings of impairment might be influenced by the results of the personal alcohol test.

Categorical BAC Condition

In this condition, after participants administered and interpreted the personal saliva-alcohol test, but before they responded to the dependent measures, the research interviewer told each participant his or her actual and accurate BAC category (.000 - .049, .050 - .079, etc) based on the PBT test results. Thus, regardless of the validity of the saliva-alcohol test, participants in the categorical BAC condition received accurate BAC categorical information (using the same categories as indicated by the saliva test), but not their exact (precise) BAC reading. Finally, after receiving categorical BAC information based on the PBT test, participants were asked to respond to the time 2 dependent measure items.

Precise BAC Condition

Participants assigned to the *precise BAC condition* received identical instructions and were exposed to the same procedures as in the categorical BAC condition. However, after providing a breath sample to be analyzed using the calibrated PBT, participants were told their precise BACs (a three-digit reading), as opposed to their BAC categories. After receiving this precise BAC information, participants gave their time 2 ratings on the four dependent measures.

Participant Characteristics

The sample included 959 individuals. The majority of the sample was male (73.3%), non-Hispanic (87.0%), and White (78.0%). Only 5.1 percent were younger than age 21, and the median age was 23. The mean BAC was .080 (SD = .046), with roughly comparable values for men and women (M = .081 and .078, SD = .045 and .048, respectively).

RESULTS

The Effect of BAC Feedback Information on Subjective Ratings of Impairment

Although BAC and alcohol impairment are separate, independent constructs, research suggests that the relationship between the two is linear (Moskowitz, 1974; Landauer, 1983; Laurell, 1977). People with higher BACs, on average, are relatively more impaired (on driving-related skills) than those with lower BACs. If people accurately assessed their own alcohol impairment, we would expect a strong positive linear relationship between participants' BACs and their subjective impairment ratings. To the extent that BAC and impairment are linearly related, such a strong, positive correlation could be construed as evidence that people are relatively accurate in judging their alcohol impairment. Furthermore, to the extent that drinkers are affected by "objective" BAC feedback (e.g., from a BAC estimation device), we would expect the correlation between BAC and subjective impairment ratings to be stronger than when no BAC information is provided (i.e., the control condition). If different types of BAC feedback (e.g., categorical information vs. precise information) affect drinkers differently, then we would expect the magnitude of correlations between actual BACs and subjective impairment ratings to vary as well. Thus, in this study, we anticipate an interaction between participants' actual BACs and the experimental condition on time-2 subjective impairment ratings.

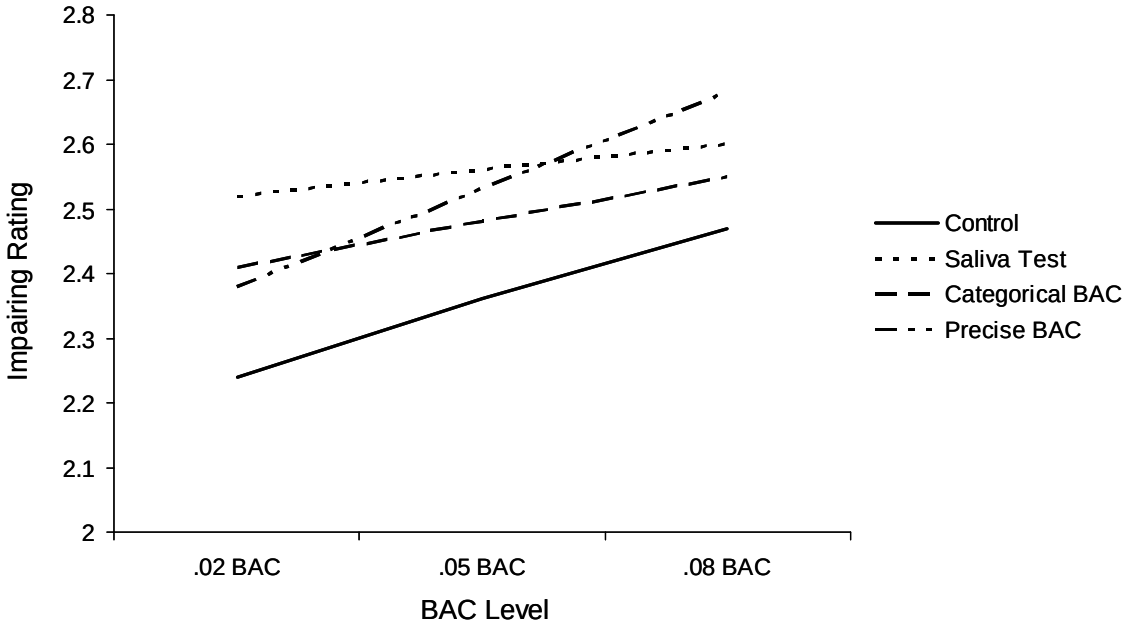
Our statistical model included time-1 subjective-impairment (the average of three time-1 dependent measure items) as a statistical covariate, along with the main effects of experimental condition and participants' BAC (as measured by the calibrated PBT), and the Condition x BAC interaction as the primary effects of interest. Subjective-impairment at time-2 was the dependent measure. An initial analysis also included gender, race, ethnicity, and age as control variables (main effects only), but none of these related significantly to the outcome variable (all p-values > .26) and were excluded from further analyses.

This analysis treated BAC and time-1 ratings of impairment as continuous (score) variables and the experimental conditions as a 4-level categorical variable. The analysis revealed statistically

significant main effects of time-1 ratings of impairment and for BAC, as well as a statistically significant Condition x BAC interaction, F (3, 950) = 3.9, $p < .01$.

As anticipated, both initial subjective ratings of impairment and BAC were positively related to post-ratings of impairment. The statistically significant Condition x BAC interaction indicates that the slopes (predicting time-2 subjective impairment ratings from BACs) differed among the four conditions. The unstandardized regression coefficients are depicted in Figure 1.

Figure 2. The relationship between BAC and subjective impairment ratings by experimental condition



Comparisons of the regression slopes between pairs of conditions (using the error term derived from the total model as the denominator) revealed that the relationship between actual BAC and time-2 subjective impairment ratings (controlling for time-1 impairment ratings) differed significantly only between the precise BAC and the saliva test conditions, F (1, 519) = 9.34 $p < .01$, partial $\eta^2 = .010$, and between the precise BAC and categorical BAC conditions, F (1, 579) = 6.13, $p < .01$, partial $\eta^2 = .018$. The difference between the precise BAC and the control conditions was not statistically significant.

Table 1 contains several descriptive indicators of the relationship between BAC and subjective impairment rating as a function of experimental condition. First, it contains the *standardized* regression coefficients (betas) for each group; these within-condition standardized regression coefficients were derived using the error term from the full model and computed using the method outlined by Aiken and West (1991). Second, the table contains the partial correlations between BAC and time-2 subjective impairment ratings (controlling for time-1 impairment ratings). Third, the table contains the zero-order correlations between BAC and time-1 subjective impairment ratings and between BAC and time-2 subjective impairment ratings. Only in the precise BAC condition was the correlation between BAC and time-2 ratings significantly greater than the correlation between BAC and time-1 ratings. It is worth noting, however, that despite

random assignment, baseline (time-1) correlations varied significantly across conditions, and were higher in the two categorical conditions.

Table 1. The relationship between BAC as subjective impairment ratings as a function of condition

	Standardized coefficients (betas)	**Partial correlations**	**Zero-order time 1 correlations**	**Zero-order time 2 correlations**	**Test of difference between time-2 and time-1 correlations**
Control	.165	.21	.334	.428	Z = 1.62, p = .11
Saliva Test	.079	.11 (*NS*)	.430	.401	Z = -.47, p = .64
Categorical	.121	.17	.511	.493	Z = -.41, p = .68
Precise	.217	.34	.384	.495	Z = 2.76, p < .01

Perception of Whether Participants are Legal to Drive

In addition to indicating their subjective impairment, participants also indicated whether they believed that they could drive legally at their current level of intoxication. This dichotomous item is distinct from the subjective-impairment items in that it pertains solely to legal risk, and not to risk of crash. It does not assume that participants feel impaired. We used logistic regression to predict the likelihood that participants felt they were legally able to drive from condition, BAC and the Condition x BAC interaction. We included time-1 responses to the "legality" question as a control variable. Guided by the previous results indicating little difference between the saliva-test condition and the categorical confirmation condition, we combined those conditions in the current analysis, leaving control, categorical BAC, and precise BAC as the three experimental conditions.

The results revealed statistically significant effects for time-1 perceptions of "driving legality," BAC, Condition, and the Condition x BAC interaction, Wald (2) = 7.0, p < .05. Overall, as BACs increased, the likelihood that a participant perceived that he or she was safe to drive decreased. To help interpret the Condition x BAC interaction, we conducted separate logistic regressions for each condition. The results for the control condition revealed no relationship between BAC and perception of being legal to drive (p = .28), whereas the relationship was statistically significant in both the categorical and the precise BAC feedback conditions (both p-values < .01). When including only the categorical and precise BAC feedback conditions in the analysis, the Condition x BAC interaction only approached statistical significance (p = .07).

Analysis of the Accuracy of Saliva Alcohol Test Strips

All participants self-administered the salvia-based test and interpreted the test results, identifying (according to the test) their BAC category. When compared with actual BAC categories (based on the PBT reading), only 43.8 percent of the time did a participant's interpreted BAC category correctly match his or her actual category. The mean BACs of the lower (.000–.049), higher (.050–.079), and highest (.080+) risk categories (based on participants' interpretations of the saliva alcohol test) were .061 (± .004), .086 (± .004), and .110 (± .008), respectively (95% confidence intervals in parentheses)—all significantly higher than the category as defined by the alcohol test.

Study 2: BAC Feedback and Drinking Behavior of Drivers

METHODS

Data for this study were collected using the portal survey method (Voas et al., 2006) at the San Ysidro border-crossing between San Diego County, California, and Tijuana, Mexico. The portal survey method involves a pseudorandom process of selecting and attempting to recruit naturally occurring peer groups as they approach the U.S.-Mexican border (from the U.S. side). In this study, two teams of three survey staff each worked at the border crossing. Whenever a survey team was not actively interviewing participants, one team member would approach the first individual to cross a pre-selected mark on the sidewalk as he or she headed south towards the border. This individual, along with each person in his or her peer group—was invited to take part in a research study on drinking and safety at the border. Potential participants were each offered $10 for taking part in the research, although in some conditions, participants could earn up to $20. Entire groups were solicited because our experience indicated that if group members were not invited to participate, they were unlikely to wait around for their friend. The recruited individual was therefore less likely to participate in the research. Not all persons in a group, however, were required to participate for some group members to take part in the study. Entire participant-groups were assigned to one of six experimental conditions.

Entry Procedure

After agreeing to participate in the research, all participants were given a clipboard containing the survey instrument and a pen. The survey instrument contained questions related to (1) demographics (e.g., sex, age, race and ethnicity, student status); (2) recent drinking history (e.g., on how many days in the past 4 weeks did they drink, number of times consuming 5+ drinks in the past 2 weeks); (3) transportation to the border (e.g., were they a driver or passenger); and (4) their drinking plans for the evening (e.g., did they plan to not drink, to get buzzed, to get drunk, or to get very drunk, and how important was it for them to reach their drinking goal).

After answering these survey questions, participants received additional information and instruction according to which of the six experimental conditions.

(1) Control Condition. Participants in groups assigned to the control condition did not receive any intervention, but were given the entry and exit surveys.

(2) BAC Warning Condition Except for those assigned to the control condition, all participants received information cards about drunk-driving enforcement operations being conducting in the San Diego area. The information cards warned participants that they could be arrested if they

drove with BACs of .08 or higher, and that consumption of any amount of alcohol would increase their impairment and risk of crash while driving. The basic purpose for providing this information was to persuade potential drivers to moderate their drinking and to provide a baseline level of knowledge about the .08 legal limit so participants had a threshold against which to compare their own BACs when estimated from the KYL matrices.

(3) KYL Condition. Participants in three of the treatment conditions, including the KYL condition, were given warning information cards (see above) with the "Know Your Limit" matrix printed on the back of the card (there were different KYL matrices for men and women).

(4) KYL + Instruction Condition. Participants in groups assigned to the KYL + Instruction condition received information cards with KYL matrix per the KYL condition but, in addition, were given explicit motivation to use the KYL matrix. These participants were told that part of the research involved using the KYL card to estimate their BAC levels at least twice during the evening: once during the middle of the evening and once again before returning to the United States. Furthermore, survey staff instructed participants on how to use the KYL matrix by providing a hypothetical example of estimating BAC levels for a given weight and the number of drinks per hour.

(5) Motivation Condition. Participants in groups assigned to the Motivation condition received the information card without the KYL matrix (as in the BAC warning condition). These participants also were told that if they could limit their drinking while in Tijuana and return to the United States with a BAC less than .05 (to be determined with a followup breath test upon their return), they would receive an additional $10 ($20 total). The purpose of this additional monetary incentive was to motivate drinkers to moderate their behavior and, conceptually, to mirror the experience of drivers who for legal or crash-risk reasons may be motivated to moderate their drinking. We anticipated that participants who were given this additional incentive would consume less alcohol that those who did not receive such motivation.

(6) KYL + Motivation Condition. In the 6th experimental condition, participants were given the additional $10 incentive (as in the Motivation condition) to limit their drinking and return with a BAC less than .05. Unlike the Motivation condition, however, these participants were given a KYL matrix with their information card. Thus, not only were they given a motive to control their drinking, but they were also given a tool (the KYL matrix) to help them estimate their BACs. To the extent that KYL matrices are beneficial for persons who are motivated to moderate their BACs (such as drivers) to achieve their goal, we would expect particularly low BACs (or a particularly high proportion of BACs less than .05) in this experimental condition.

After the survey, all participants were given hospital-style ID bracelets so the research team could identify them upon return and their entry data and exit data could be later be linked. Finally, all participants were asked to provide an anonymous BAC breath sample.

Exit Procedure

Participants returning from bars and clubs in Tijuana were re-sampled and given an oral interview; their responses were recorded (by the interviewer) directly into a handheld computer. The exit data-collection procedure (interview) differed from the entry data-collection procedure (pencil and paper) because returning participants often are too inebriated to complete the written survey. Further, the list of entry survey questions typically is longer than the exit survey, and it

would take too long to administer the entry survey as an interview separately (via interview) to each participant.

The exit interview contained questions related to (1) demographics, (2) drinking behavior (e.g., number of drinks consumed and number of bars visited), (3) transportation home (e.g., whether the participant would be a driver), and (4) each participants' estimate of his or her BAC. After completing the interview, participants were asked to provide an exit BAC sample.

Participant Characteristics

Data from a total of 1,215 participants (matching entry and exit surveys) were used in the analysis for this research. Of these participants, 51.8% were male and the median age was 20, with 79.2% being younger than aged 21. The sample was 27.4% White (non-Hispanic), 9.3% Asian, 14.5% Black (non-Hispanic), 40.8% Hispanic, and 8.0% Other (non-Hispanic). The majority of students (57.9%) indicated being students, and 6.6% indicated being in the military. Slightly more than one quarter (29.2%) indicated that they were a driver.

RESULTS

Our analyses used generalized linear mixed modeling, where participant group (we sampled whole groups of participants crossing the US-Mexican border) was treated as a random variable. Our analyses consisted of contrasting exit BACs from self-reported drivers and passengers across experimental conditions.

We first were interested in examining the impact of the warning on the drinking behavior of drivers and passengers. Contrasting only control participants v. those in the BAC warning condition, and including gender, race and entry BAC as covariates, we modeled a Condition x Driver Status interaction. This interaction contrast was statistical significant, $F(1, 695) = 11.0$, $p < .01$. Accordingly, in the control condition, the BACs for drivers and non-drivers (.050 and .044) did not differ significantly ($p = .36$), however BACs did differ significantly ($p < .01$) between drivers and non-drivers in the BAC warning condition (.032 vs. .059). We find that BACs for drivers significantly decreased in the BAC warning condition ($p < .05$) but significantly increased ($p < .05$) for nondrivers. Thus, the warning alone appeared to reduce BACs of drivers.

Next we examined the impact of providing participants with KYL matrices to estimate their BACs. We predicted that the KYL information combined the BAC warning would produce lower BACs among drivers than the BAC warning alone. However, the interaction contrast (Condition 2 v 3 x Driver Status) was not statistically significant ($p = .08$), neither was the main effect contrast between the BAC warning and KYL conditions ($p = .60$). Thus, providing participants with KYL matrices in addition to the BAC warning information did not affect BACs. We further examined whether providing drinkers with KYL matrices along with instructions to use the cards during the evening would affect BACs. However, contrasts of the KYL + instruction condition to both the KYL condition and the BAC Warning condition failed to produce any statistically significant effects on BACs (whether or not interactions with Driver Status were included). Thus, providing drinkers with KYL matrices appeared to have no influence on the drinking behavior of either drivers or passengers.

We then conducted contrasts comparing conditions five and six; specifically, we wanted to test whether among participants who were given incentive to maintain a relatively low BAC, would providing a KYL matrix for estimating BAC would help accomplish that goal. Lower BACs in the KYL + motivation condition, relative to the motivation condition, would suggest that the KYL matrices were useful to motivated participants in helping them regulate their drinking. However, the interaction contrast (Conditions 5 v 6 x Driver Status) was not statistically significant ($p = .40$), nor was the main effect comparing Conditions 5 and 6 ($p = .38$). Because the experimental instructions asked participants specifically to maintain BACs below .05, it made sense to conduct an analysis using a dichotomous BAC category variable (below .05 v. .05+) was the dependent measure. However, the results were not statistically significant ($p = .07$). In fact, the non-significant trends suggested that the proportion of participants with BACs at or above .05 was higher among those who reported using a KYL matrix relative to those who did not receive one (.44 v .32). Thus, even when participants are provided a motivation to regulate their BAC, there is little evidence that KYL matrices are useful in accomplishing this goal.

Discussion

Several theoretical perspectives predict that people will be less likely to engage in a behavior to the extent they believe that behavior increases the risk of negative consequences. Drinkers who intend to drive are at risk both for crash and for arrest or citation, yet it is not clear how well drinkers accurately assess this risk. Because the legal risk for drinking and driving is defined in terms of BAC and because BAC is related to driving impairment, it is theoretically consistent that high-BAC (.08+) drinking drivers will become more aware of the risks they face if they learn their actual BAC levels. Although research has examined drinkers' ability to estimate their own BAC and to monitor their alcohol consumption (e.g., Lansky et al., 1978; Martin, Rose, & Obemski, 1991; Vogel-Sprott, 1974; Vogel-Sprott, 1975), to our knowledge no research has demonstrated the effect of receiving BAC information on subjective perceptions of driving impairment and risk.

In the first study we interpreted the magnitude of the correlation between BAC and subjective impairment ratings as an indicator of *sensitivity to driving impairment.* Our research demonstrated statistically significant, moderate correlations between actual BACs and subjective-impairment ratings. The results also indicated that drinkers who were given precise BAC feedback rated their impairment more closely in line with their actual BAC than did participants who were given categorical feedback, and that the presumed sensitivity increased significantly beyond baseline only for participants who received precise BAC feedback. However, no strong evidence indicated that providing precise BAC feedback increased sensitivity relative to control participants (who received no BAC feedback). These patterns suggest that the saliva-based alcohol tests might actually have hindered participants' subjective estimates of presumed impairment. Overall, we cannot conclude with confidence that BAC feedback helps drinkers accurately assess their driving impairment; rather, under some conditions, categorical BAC feedback attenuated drinkers' natural ability to assess their driving impairment.

On the other hand, BAC feedback did predict participants' estimates regarding whether it was legal for them to drive. For control participants (who did not received BAC feedback), BAC did not significantly predict the perception of their legal status. For those who received BAC

feedback before completing the dependent measure, BAC did significantly predict perceptions of legality, but in this case no significant differences were found in the efficacy of categorical versus precise BAC feedback.

The second study took place in a real world drinking environment and examined whether providing BAC estimation tools (KYL matrices) would have any effect on alcohol consumption of drivers and passengers. Whereas providing drivers with a warning about drinking and driving was associated with a significant decrease in BAC, there is no evidence to suggest that giving them KYL matrices as a tool to estimate BACs did anything to moderate drinking. In fact, there was weak evidence to suggest that drinkers who were given incentive to maintain a BAC under .05 were less likely to achieve that goal when they were provided a KYL matrix. One might hypothesize that drinkers used the KYL cards to drink as closely to the .05 level as possible.

In summary, there does not appear strong evidence to support to distribution of personal BAC estimation tools as a strategy for reducing harm associated with alcohol-impaired driving.

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APPENDIX A: WORKSHOP SCHEDULE

Young Impaired Drivers:
The Nature of the Problem and Possible Solutions

Transportation Research Board
Committee on Alcohol, Other Drugs and Transportation

National Academy of Sciences Jonsson Conference Center
Woods Hole, Massachusetts USA
June 3-4, 2008

TUESDAY, JUNE 3

9:00 – 9:15 **Welcome, Introductions and Overview of the Workshop**
Kathryn Stewart, Safety and Policy Analysis International

Moderator: Susan Ferguson, Ferguson International

The Nature of the Problem

9:15 – 9:45 **The Relationship between Blood Alcohol Concentration (BAC), Age And Crash Risk**
Presenter: Bob Voas and Jim Fell, Pacific Institute for Research and Evaluation

9:45 – 10:00 **Female Involvement in Fatal Crashes: Increasingly Riskier or Increasingly Exposed?**
Presenter: Eduardo Romano, Pacific Institute for Research and Evaluation

10:00 – 10:30 **The Nature of the Young Impaired Driver Problem in Europe**
Presenter: Wolf Nickel, German Society for Traffic Psychology

10:30 -11:00 Break

11:00 – 11:30 **The Nature of the Young Impaired Driver Problem in Australia**
Presenter: Ian Faulks, Department of Psychology, Macquarie University, Sydney, New South Wales, Australia

11:30 – 11:45 Discussion

Characteristics of Young Drinkers, Drivers, and Crashes

11:45 – 12:00 **Developmental issues with respect to impairment by alcohol: Youth-alcohol interaction or what?**
Presenter: Herb Moskowitz, University of California at Los Angeles

12:00 – 12:15 **Characteristics of Young Offenders in Treatment**
Presenter: Jane Maxwell, University of Texas Addiction Research Institute

12:15 – 12:30 Discussion

12:30 – 1:30 LUNCH

Moderator: Ruth Shults, Centers for Disease Control and Prevention

1:30 – 1:50 **Psychosocial/Behavioral Factors That Predict Impaired and Other High-Risk Driving: Findings from a Longitudinal Study**
Presenter: Jean Shope, University of Michigan Transportation Research Institute

1:50 – 2:10 **Teen vs. Adult Impaired Driving Crash Risk**
Presenter: Ray Bingham, University of Michigan Transportation Research Institute

2:10 – 2:30 **Lack of Information from National Surveys: What We Still Need to Learn about Transition Teens**
Presenter: Tara Kelley-Baker, Pacific Institute for Research and Evaluation

2:30 – 3:00 Discussion

3:00 – 3:30 Break

3:30 – 4:00 **Most Common Impairing Substances Used by Young Drivers in the U.S.**
Presenter: Richard Compton, National Highway Traffic Safety Administration

4:00 – 4:15 Discussion

4:15 – 4:30 **History and Effects of Graduated Licensing and Zero Tolerance**
Presenter: Barry Sweedler, Safety and Policy Analysis International

4:30 – 4:45 **Single Vehicle Crashes: Trends and the Role of Graduated Licensing Laws – Preliminary Results**
Presenters: Jim Fell and Bob Voas, Pacific Institute for Research and Evaluation

4:45 – 5:00 Discussion

5:15 – 6:00 RECEPTION AT THE JONSSON CENTER WITH CLAM BAKE DINNER TO FOLLOW AT 6:00

WEDNESDAY, JUNE 4

Moderator: Paul Boase, Transport Canada

Prevention/intervention strategies: Laws and Regulations Affecting Traffic Safety among Young Drivers

8:30 – 8:45 **Sanctioning of Young Impaired Drivers**
Presenter: Robyn Robertson, Traffic Injury Research Foundation

8:45 – 9:00 **Latest Evidence on Effects of Minimum Purchase Age Laws on Alcohol-Impaired Driving: Wish Thinking versus Science**
Presenter: Anne McCartt, Insurance Institute for Highway Safety

9:00 – 9:15 **The Impact of Underage Drinking and Related Laws on Youth Alcohol-Related Fatal Crashes**
Presenter: Jim Fell, Pacific Institute for Research and Evaluation

9:15 – 9:45 **Impact of Primary Safety Belt Laws on Alcohol-Related Front-Seat Occupant Fatalities: Five Case Studies**
Presenter: Bob Voas, Pacific Institute for Research and Evaluation

9:45 – 10:00 Discussion

10:00 – 10:30 BREAK

Prevention/intervention strategies: Strategies on College Campuses and in the Military

10:30 – 10:50 **Effects of a College Community Campaign to Reduce Drinking and Driving with a Strong Enforcement Component**
Presenter: Anne McCartt, Insurance Institute for Highway Safety

10:50 – 11:10 **The Perspective on Campus**
Presenter: Brian Demers, student at MIT and member MADD National Board

11:10 – 11:30 **The Nature of the Problem and the Strategies being Used in the Military**
Presenter: Roland Moore, Prevention Research Center

11:30 – 12:00 Discussion

12:00 – 1:00 Lunch

Moderator: Paul Marques, Pacific Institute for Research and Evaluation

Enforcement Strategies

1:00 – 1:30 **How can enforcement be made more effective in deterring young impaired drivers?**
Presenters: Jim Nichols, Nichols and Associates, and Neil Chaudhary, Preusser Research Group

1:30 – 2:00 **Enforcement strategies in Australia, including random breath testing and random testing for drugs**
Presenter: Ian Faulks, Department of Psychology, Macquarie University, Sydney, New South Wales, Australia

2:00 – 2:15 Discussion

Technological approaches

2:15 – 2:45 **In-vehicle Technology for Improving Teen Driver Behavior**
Presenter: Max Donath, University of Minnesota

2:45 – 3:15 **Technological Approaches to Young Impaired Drivers: Alcohol Interlocks and Continuous Alcohol Monitoring**
Presenters: Robyn Robertson, Traffic Injury Research Foundation and Ian Marples, Alcohol Countermeasure Systems

3:15 – 3:30 **The Effects of BAC Estimation Tools on Drinking Behavior and Perceptions of Impairment and Driving Risk**
Presenter: Mark Johnson, Pacific Institute for Research and Evaluation

3:30 – 3:45 Discussion

3:45– 4:00 Concluding discussion

WORKSHOP COSPONSORS

National Highway Traffic Safety Administration
Transport Canada
Pacific Institute for Research and Evaluation
International Council on Alcohol, Drugs and Traffic Safety
Insurance Institute for Highway Safety
Centers for Disease Control and Prevention

APPENDIX B: WORKSHOP PARTICIPANTS

Midyear Meeting & Workshop of the TRB Alcohol, Other Drugs and Transportation Committee/Young Impaired Drivers: The Nature of the Problem and Possible Solutions
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June 03-June 04, 2008 - J. Erik Jonsson Woods Hole Center - Woods Hole, MA

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