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Abstract

This is the third update of research on graduated driver licensing (GDL) and related teenage driver issues. It briefly summarizes research published since or not included in the 2005 update (Hedlund, J., & Compton, R. (2005). Graduated driver licensing research in 2004 and 2005. *Journal of Safety Research, 36*(2), 109–119.), describes research in progress of which the authors are aware, and announces plans for a symposium on teenage driving and GDL to be held in February 2007.

Keywords: Graduated driver licensing; Beginning drivers; Teenage drivers; Driver education

1. Introduction

The January 2003 special issue of the *Journal of Safety Research* was devoted entirely to graduated driver licensing (GDL). The first 12 papers, written for and presented at a GDL symposium in November 2002, provided a comprehensive review of research on teenage drivers with an emphasis on GDL. The final paper (Hedlund, Shults, & Compton, 2003) used information from these papers to summarize GDL knowledge, information gaps, and research needs as of the time of the symposium. All papers are available on the National Safety Council's website www.nsc.org/gdlsym/index.htm.

There has been substantial research on GDL and teenage drivers since the 2002 symposium. Hedlund and Compton (2004, 2005) provide annual summaries of newly-published results and work in progress. This paper is the third annual update. It briefly summarizes research published since or not included in the 2005 update and lists research in progress or planned. Published research was obtained from a keyword search of Medline, PsycInfo, ERIC, TRIS, NTIS, Wilson Applied Science and Technology Abstracts, and EMBASE, supplemented by information provided by the authors and several reviewers.

2. What is GDL and where has it been implemented?

GDL is a three-stage licensing system for beginning drivers consisting of a learner's permit, an intermediate license, and a full license. A learner's permit allows driving only while supervised by a fully licensed driver. An intermediate license allows unsupervised driving under certain restrictions. Both the learner's permit and the intermediate license have a minimum age requirement and must be held for a specified minimum period of time.

Other restrictions or requirements may apply during the learner's permit and intermediate license periods. The most common are that learner's permit drivers may be required to have a minimum amount of supervised driving before advancing to the intermediate phase, and intermediate license drivers may be prohibited from driving during specified nighttime hours or with young passengers. For a full discussion of GDL systems, requirements and restrictions, and recommended practices see Insurance Institute for Highway Safety (IIHS) and Traffic Injury Research Foun-

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dation (TIRF; 2004) or Mayhew, Simpson, and Singhal (2005).

Almost all jurisdictions in the United States and Canada have implemented GDL in some form. The GDL requirements in all jurisdictions as of October 2005 are summarized in IIHS (2005) for the United States and Mayhew et al. (2005) for Canada. The National Committee on Uniform Traffic Laws and Ordinances provides a model GDL law (NCUTLO, 2002).

3. Syntheses and overviews

3.1. Extensive syntheses

Mayhew et al. (2005) contains a detailed description of current GDL programs in Canada; a comparison with GDL programs in other countries, including tabular summaries of GDL provisions in Canadian provinces, states in the United States, Australian states, and New Zealand; a description of the safety benefits of GDL, including a tabular summary of effectiveness estimates from evaluations and a discussion of the features that have been shown to contribute to GDL effectiveness; and recommendations for best practices.

Senserrick and Haworth (2005) provide a comprehensive review of driver education and training, licensing, and GDL, with well over 300 references. They provide specific recommendations for Western Australia.

Simons-Morton, Mickalide, and Olsen (2005) summarize research on young driver crash and injury rates; risk factors, including age, inexperience, nighttime driving, passengers, safety belt use and alcohol; and prevention strategies, including GDL and parental management.

Simons-Morton and Winston (2006) discuss GDL and parental management of young drivers as examples of how research translates into action by informing and influencing policy.

The Organization for Economic Co-operation and Development (OECD) has established a working group on Young Driver Risks and Effective Counter-Measures. The working group is assessing the factors that contribute to young drivers' crash risks; reviewing countermeasures, including driver education, driver training, and GDL; and documenting current practices in the OECD countries. A final report is scheduled for release in 2006. For information, contact Colin Stacey at Colin.STACEY@oecd.org.

The Highway Safety Research Center (HSRC) at the University of North Carolina is drafting a guide for states to use in reducing crashes involving young drivers. The guide is part of the series of state guides for implementation of the American Association of State Highway and Transportation Officials (AASHTO) strategic plan. Each guide is a volume in the National Cooperative Highway Research Program (NCHRP) Report 500. The young driver guide should be completed in 2006. For information, contact Rob Foss at foss@hsrc.unc.edu.

The Centers for Disease Control and Prevention (CDC), the National Institutes of Health (NIH), and the National Highway Traffic Safety Administration (NHTSA) are co-funding a National Research Council scoping study to examine new insights from the behavioral, cognitive, health, social, and biological sciences, especially in the area of adolescent development and learning processes, that may guide prevention strategies to reduce motor-vehicle crash rates. The study will examine diverse scientific literatures, including research on adolescent health and development, decision making research, parental and family processes, education, risk communication, public health, human factors studies, highway safety, motor-vehicle injuries, public policy, and related fields. The scoping study should be completed by late 2006. For information, contact Ruth Shults at rshults@cdc.gov.

The United Kingdom Department for Transport is funding an extensive review of the judgment and decision making literature to investigate potential road safety applications to adolescents. Victor Strecher and Jean Shope expect their review of psychosocial factors and behavioral science theoretical frameworks to be available in 2006. For information, contact Deirdre.O'Reilly@dft.gsi.gov.uk.

3.2. Brief overviews and commentary

Williams (2005) observed that by 2005 the first phase of GDL implementation was essentially complete in the United States and Canada, with most jurisdictions having some form of GDL in place. In the next phase, jurisdictions with weak GDL systems should strengthen them. He noted that 15 states have improved their initial GDL systems but that as of 2005 no state had an "excellent" system consisting of a minimum learner age of 16, a 6-month learner's permit holding period, and intermediate license restrictions on nighttime driving (beginning at 9 p.m.) and carrying more than one young passenger, with intermediate restrictions in place until age 18.

Stevenson (2005) observed that Australian GDL systems have no nighttime or passenger restrictions for intermediate license holders. He recommends that they be added.

McKay (2005) briefly reviewed teenage driver crash risks and advocates GDL with nighttime and passenger restrictions as well as safety belt use, not drinking and driving, and safer vehicles.

4. The need for GDL: teenage driver risk factors

Risk factor study methods include cohort studies, focus groups, telephone surveys, questionnaires, crash data analyses, and experimental studies. They provide additional detail on the influences of general lifestyle and of specific individual and environmental factors on teenage driver crash risk.

4.1. Teenage driver crash risks

Williams, Ferguson, and Wells (2005) used Fatality Analysis Reporting System (FARS) data to investigate fatal crashes involving 16-year-old drivers in the United States from 1993 to 2003. During this period 46 states and the District of Columbia introduced important GDL components. The per capita fatal crash rate for 16-year-old drivers decreased 26% from 1993 to 2003 compared to 11% for 17-year-old drivers, 6% for 1819 year-old-drivers, and 7% for 20–49 year-old drivers. Fatal crashes per licensed driver did not change for 16-, 17-, or 18-year-old drivers. There was a substantial decrease in fatal crashes in which 16-year-old drivers had teenage passengers but no change in late-night fatal crashes.

O'Malley and Johnston (2003) summarized data from the annual Monitoring the Future surveys from 1976–2001. In 2000–2001, 32% of high school seniors in the United States reported receiving a traffic ticket or warning in the past year and 22% were involved in a crash. Over the 25-year period, the annual proportion who received tickets increased slightly while the proportion involved in a crash remained relatively stable. When adjusted for miles of travel, both proportions decreased over time. Crashes after drinking decreased markedly from 1981 to 2001. Crashes after using marijuana peaked in 1979, decreased substantially over the next decade, and then rose again in the 1990s.

AAA (2006) studied fatal crashes involving drivers aged 15, 16, and 17 using FARS data from 1995–2004. Of the 30,917 persons who died in these crashes, about one-third were the teen drivers themselves (36%), one-third were passengers of these teen drivers (32%, almost all of whom were under 21 years old), and the remainder were other vehicle occupants (24%) and nonmotorists (8%).

Gonzales, Dickinson, DiGuiseppi, and Lowenstein (2005) studied fatal crashes involving 16-year-old drivers in Colorado, using FARS data from 1995 to 2001. Compared to drivers aged 25-49, 16-year-old drivers in fatal crashes were more likely to be reported as speeding or driving recklessly, more likely to be in a rollover, run-off-road, or single vehicle crash, and more likely to have two or more passengers, but less likely to have been drinking. Almost half the drivers in both groups were not wearing safety belts.

Aultman-Hall and Padlo (2004) studied crashes involving drivers aged 16–20 in Connecticut, using state crash data from 1997–2001. With the use of quasi induced exposure techniques, they concluded that the risk of causing a crash for these drivers increases at night, on freeways, and with passengers. The youngest drivers and male drivers also had substantially higher crash risks.

Adams (2005) compared overall crash rates and crash distributions by hour for intermediate-stage drivers and fully-licensed drivers aged 19–59 in Western Australia. She found that both fatal and hospitalization crash rates per population were about seven times higher for intermediate stage drivers, both overall and for male and female drivers separately. Intermediate-stage drivers had a higher proportion of crashes at night. Western Australia has no nighttime restriction for intermediate stage drivers.

Bellavance et al. (2005) reviewed the literature on psychological factors underlying teenage risk-taking, factors that predict risky behavior, and methods to evaluate the attitudes and driving behaviors of beginning drivers. The 525-page review is available at www.hec.ca/pages/francois.bellavance/Nouveaux-conducteurs.pdf. The authors are preparing shorter summaries in English for journal publication. For information, contact François Bellavance at francois.bellavance@hec.ca.

IIHS and TIRF have reviewed studies since 1990 on the relative effects of age and experience on crash risk, especially for young drivers. The report should be released in spring 2006. For information, contact Anne McCartt at AMcCartt@iihs.org.

The Preusser Research Group (PRG) is studying crashes during the first few months of driving. The study, sponsored by IIHS, should be released in 2006. For information, contact Susan Ferguson at sferguson@iihs.org.

Rhodes and colleagues at the University of Alabama Injury Control Research Center are conducting a five-year study to develop and test risk-taking countermeasures for drivers aged 16–20. Initial information on crash risks and teenage driver attitudes obtained from analyses of Alabama crash data and from a series of focus groups with young drivers are summarized in Rhodes, Brown, and Edison (2005).

In a study funded by CDC, The University of Michigan Transportation Research Institute (UMTRI) will use existing longitudinal data to identify risk and protective factors related to crashes involving teenage drivers. Information about the psychosocial and problem behavior development of a large cohort of public school students who were followed from the 5th through the 12th grade will be merged with their state drivers license history records and police crash report records. The study will identify types of crashes for which teens are at greater risk than adult drivers, and examine individual psychosocial risk and protective factors that predict the high-risk crash types among teen drivers. For information, contact Ruth Shults at rshults@cdc.gov.

CDC will convene an expert panel to identify and critically assess existing datasets that provide information on adolescent motor-vehicle related crashes, injuries, and fatalities. This panel will bring together experts in such areas as transportation, health outcomes, insurance costs, and health care utilization. A report will summarize the different existing datasets, critically assess their strengths and weaknesses, identify gaps, and propose linkages. The report should be available by late 2006. For information, contact Ruth Shults at rshults@cdc.gov.

The National Institute of Child Health and Human Development is beginning a multi-year naturalistic driving

study of teenagers during their first 18 months of licensure. The study, conducted by the Virginia Tech Transportation Institute, will equip the cars of 24 teenage drivers with cameras, motion sensors, global positioning instrumentation, and other devices to measure and record driving performance. Initial data will be available in 2007. For information, contact Bruce Simons-Morton at mortonb@exchange.nih.gov.

4.2. Sociodemographic characteristics

Paschall (2003) studied the relation between college attendance and two risky driving behaviors — safety belt use and drinking and driving — in a sample of 11,549 college-age youth from the National Household Survey on Drug Abuse (NHSDA). He found that college students were more likely to drink and drive but also more likely to wear safety belts than non-students, after controlling for other factors related to these behaviors.

Elliott, Shope, Raghunathan, and Waller (2006) investigated associations between gender, substance use, environmental factors that may affect substance use (peers, parents, and ease of access), and risky driving behavior in a longitudinal study of 4,022 high school students in Michigan. Overall, young women had lower levels of substance use and less risky driving (measured by serious traffic offenses and crashes) than young men. At every level of substance use, men had higher levels of risky driving than women. However, substance use and environmental factors were more closely associated with risky driving among young women than young men. For example, as substance use levels increased, risky driving increased more for women than for men.

In three related studies, Laflamme and colleagues investigated sociodemographic characteristics associated with young drivers' crashes in Sweden using crash records from 1988–2000 for all persons born in 1970–1972. Hasselberg and Laflamme (2005) found that young drivers who sustained more than one crash injury in an 8-year period did not differ from drivers who sustained only one injury with regard to gender, education, or socioeconomic group. Vaez and Laflamme (2005) found that among all drivers less than 30 years of age who were involved in crashes, the odds of severe injury were higher for the youngest drivers, for drivers who were impaired by alcohol, and for drivers with less education. Males and drivers with the least education were most likely to have been impaired by alcohol. Laflamme, Vaez, Hasselberg, and Kullgren (2005) examined how the interaction between a driver's socioeconomic status and the safety of the driver's car affects injury risk. For drivers of cars in each of five crash safety groups determined by Folksam insurance, injury risk was higher for males and for less-educated drivers. This suggests that safer vehicles reduce crash injuries for all socioeconomic groups and do not reduce injury risk differentials across groups.

4.3. Attitudes and personality

4.3.1. Attitudes and behavior regarding risk

Clarke, Ward, and Truman (2005) studied 3,437 crash reports from the United Kingdom involving drivers aged 17–25 from the years 1994–1996. Based on interpretation of the individual crash reports, crashes of all types were more frequently due to voluntary risky behaviors than to lack of driving skills such as failure to observe potential hazards.

Harré, Foster, and O'Neill (2005) studied "crash-risk optimism" — the view that while a behavior is risky for others, it's not risky for me — and how these beliefs are related to young drivers' reactions to traffic safety messages. In a survey, 314 New Zealand students aged 16–29 generally rated themselves better than their peer drivers on measures of both driving skill and driving caution. In a second study, 266 students viewed traffic safety television ads that were either highly graphic, with crashes and injuries resulting from drinking and driving, or positive, showing people taking measures to avoid driving after drinking. The students then took the crash-risk optimism survey. Students who watched the graphic ads rated themselves better on driving skill than the students who watched the other spots. This suggests that some young drivers may dissociate themselves from the types of driving behavior depicted in graphic traffic safety ads, so that graphic ads may have little effect on them. In both groups, men rated their driving skill higher than did women.

Victoir, Eertmans, Van den Bergh, and Van den Broucke (2005) studied how beginning drivers' attitudes, norms, and intentions predicted their driving performance in a 90-minute on-road driving session. Ninety-eight Flemish drivers, average age 22, participated in the study. A model based on the theory of planned behavior predicted performance as evaluated both by the participants themselves and by instructors. Driving confidence (or self-efficacy — a driver's belief that he or she is able to control the car, anticipate risks, and the like) was the most important single predictor of performance.

Tilleczek (2004) studied and described the youth driving culture in a northern Ontario community using a survey and direct observations of 88 novice drivers aged 15–34. The results suggest that youth are aware of the risks of driving and intend to drive safely. However, the "system" does not encourage safe driving when it characterizes youth as risk-takers and blames individuals for risky actions.

Sarkar and Andreas (2004) investigated risky driving behaviors in brief surveys of two groups of young California drivers: 1,430 beginning drivers in driver training programs and 880 licensed teenage drivers who were attending traffic school after receiving a moving violation. All drivers recognized that alcohol-impaired driving, sleepiness, speeding, and similar driving behaviors were risky. Drivers who had experienced these behaviors, either through their own

driving or in a car with another driver, rated them as less risky than those who had not.

Bina, Graziano, and Bonino (in press) studied risky driving and other risky behaviors in a survey of 645 Italian youth aged 14–17. Many of these teenagers drove cars and motorcycles without a proper license, frequently speeding or following too closely. Risky driving was associated with other risky activities, anti-social behavior, smoking, and drug use.

4.3.2. Personality traits

Dahlen, Martin, Ragan, and Kuhlman (2005) investigated how driving anger, sensation seeking, impulsiveness, and boredom proneness correlated with aggressive and risky driving in a survey of 224 college students in Mississippi. Driving anger was most predictive, followed by sensation seeking, with modest contributions from impulsiveness and boredom.

Ulleberg and Rundmo (2003) studied how personality affects driving behavior in a survey of 1,932 Norwegian adolescents whose average age was 18.5 years. They concluded that personality traits, such as sensation-seeking and normlessness, affect attitudes toward traffic rules and the enjoyment of driving, which in turn affect driving behavior and risk-taking.

Fernandes and Job (2003) studied how various demographic, personality, and attitudinal factors predict different risky driving behaviors in a survey of 109 Australian university students under 22 years old. They found that different factors predicted different behaviors: for example, authority rebellion predicted speeding while sensation seeking and crash-risk optimism predicted driving after drinking. A survey of 115 older drivers found different predictors.

Sánchez Martín and Estévez (2005) studied 144 young drivers in Spain when they first enrolled in a driving course, at average age 22.5, and again five years later, at which time 40% reported at least one crash. Cluster analyses produced two quite different cognitive profiles related to crash involvement: one with relatively high practical intelligence, good hand-eye coordination, and good perceptual-motor performance; the other with lower practical intelligence, poor hand-eye coordination, and poor perceptual-motor performance.

4.3.3. Developmental factors

In a series of four papers, Bingham and Shope (2004a, 2004b, 2005, in press) investigated the relationships between various personal and social characteristics of teenagers in their high school years and their subsequent driving behavior. Data for all four studies came from a longitudinal survey of approximately 2,000 Michigan young adults who were contacted in 10th grade, 12th grade, and at average age of 24. The first study (2004a) found that self-reported driving under the influence of alcohol or drugs at age 24 was predicted during high school years by alcohol and drug use and by tolerance of social deviance. Self-reported risky driving at age 24 was predicted in high school by alcohol use, tolerance of deviance, less cigarette smoking, and better high school grades. The second paper (2004b) investigated risky driving predictors in more detail. High school students with lower levels of parental monitoring and greater permissiveness, weaker social development, and higher levels of alcohol, drug, and cigarette use were more likely to become risky drivers as young adults.

The third and fourth papers (Bingham and Shope, 2005, in press) investigated how these characteristics in high school predicted crash patterns in the teenage and young adult years as recorded in Michigan driver history records. After adjusting for driving exposure, higher or increasing crash rates were predicted in high school by less parental monitoring, more tolerance for deviance, lower grades, and more substance use.

Taubman-Ben-Ari, Mikulincer, and Gillath (2005) studied associations between driving behaviors of parents and their adult children through a survey of 174 Israeli families. They found significant associations between the driving styles (anxious, reckless, angry, or careful) of parents and children, especially between fathers and sons and between mothers and daughters.

Sagberg and Bjørnskau (2006) investigated whether beginning drivers improve their hazard perception skills during the first few months of driving. There were no significant differences in performance on a video-based hazard perception and reaction test among four groups of drivers who had been licensed for one, five, and nine months and for several years, respectively.

4.4. Alcohol and drugs

4.4.1. Prevalence and trends

In the 2002 and 2003 U.S. National Surveys on Drug Use and Health (NSDUH) of over 32,000 persons aged 16–20, 21% reported that they had driven in the past year while under the influence of alcohol (17%) or drugs (14%) (SAMHSA, 2004b). The proportion reporting they had driven under the influence of alcohol or drugs rose steadily with age from 10% of respondents aged 16 to 28% of those aged 20.

In the 1999–2001 NSDUH surveys, 10% of drivers aged 15–17 reported that they had driven in the past year under the influence of alcohol (SAMHSA, 2004a).

In the 2001 Ontario Student Drug Use Survey, 15% of young drivers in grades 10–13 reported driving within an hour after consuming two or more drinks and 20% reported driving within an hour after using cannabis (Adlaf, Mann, and Paglia, 2003). The corresponding rates for young drivers in grades 10–12 from the 2002–2003 Student Drug Use Survey in the Atlantic Provinces were 12% for alcohol and 15% for cannabis (Asbridge, Poulin, & Donato, 2005). Both driving after drinking and after using cannabis were correlated with higher crash rates.

4.4.2. Attitudes and behavior

In a 2002 survey of 400 drivers aged 19–25 in California, 88% believed it was easy for underage persons to obtain alcohol, 34% reported that they had driven after drinking, and 17% after drinking too much to drive safely. More than half believed it was likely they would be stopped by police if they were driving after drinking (University of California Traffic Safety Center, 2003).

McCarthy and Brown (2004) surveyed 2,865 students in four California high schools to investigate how obtaining a drivers license affected drinking behavior. Teens increased their drinking frequency, but not the amount consumed on each drinking occasion, after they received their license, compared to similar-aged teens who were not licensed. Newly licensed drivers also had a higher perception of the dangers of drinking and driving.

Davey, Davey, and Obst (2005) surveyed alcohol and drug attitudes and behavior among 275 university students in Queensland, Australia, of average age 25. Fourteen percent reported that they had driven "under the influence of alcohol" in the past month and 15% had driven within six hours of drug use in the past year. Attitudes regarding driving after drinking and after using drugs were very similar and generally unfavorable. Peers had a strong influence on attitudes.

Van Beurden, Zask, Brooks, and Dight (2005) studied the relation between binge drinking (defined as six or more drinks at one occasion) and alcohol-impaired driving by surveying students in 40 high schools in New South Wales, Australia. Frequent binge drinkers were more likely to report driving after drinking.

Pinsky, Labouvie, and Laranjeira (2004) surveyed the attitudes regarding drinking and driving of 2,166 young Brazilians aged 18–25 who were about to receive their drivers licenses. Respondents generally did not hold firm attitudes and appeared open both to driving after drinking and to finding other transportation options to avoid driving after drinking.

Sabel, Bensley, and Van Eenwyk (2004) examined associations between self-reported drinking and driving or riding with a drinking driver and other health risk factors in a survey of 2,955 high school students in the state of Washington. Both drinking and driving and riding with a drinking driver were associated with low levels of support from parents and schools and with other risky behaviors such as drinking frequency and quantity, drug use, cigarette smoking, and low safety belt use.

Leung and Starmer (2005) investigated how age and alcohol affect performance on a driving simulator. Sixteen young (19–21) and older (25–35) Australian drivers each were tested at a target blood alcohol content (BAC) of 0.08 and with a no-alcohol placebo. Alcohol at 0.08 BAC affected all drivers' abilities to divide attention but had little effect on their ability to make decisions. In general, the younger drivers drove in a more risky manner and older drivers took longer to detect potential hazards.

Jennifer Zakrajsek and Jean Shope are conducting a longitudinal examination of underage drinking and subsequent risky driving. Young people who begin drinking by middle school subsequently have worse records for driving overall and driving after drinking than those who do not. Results should be available in 2006. For information, contact Jean Shope at jshope@mail.umich.edu.

4.4.3. Drinking locations

Walker, Waiters, Grube, and Chen (2005) studied how drinking location affected drinking and driving and riding with a drinking driver through a telephone survey of 1,534 persons aged 15–20 in California. The strongest predictors of both behaviors were heavy drinking and drinking in cars. Drinking in restaurants also predicted drinking and driving. Gender, age, and ethnicity had little effect after controlling for alcohol consumption.

Usdan, Moore, Schumacher, and Talbott (2005) studied drinking locations in a survey of 91 college students identified as being at high risk for drinking and driving. These students had a higher blood alcohol content when driving after drinking at a party than when driving after drinking at other locations.

4.4.4. Prevention, education, and enforcement programs

Elder et al. (2005) synthesized studies of high school programs to prevent alcohol-impaired driving. They found evidence of small and inconsistent effects on driving after drinking, small and consistent effects on riding with a drinking driver, and insufficient evidence of effects of either peer organization programs (such as Students Against Destructive Decisions, SADD) or social norming programs.

Carcaillon, Salmi, and Atout-Route Evaluation Group (2005) found a positive but not statistically significant effect for "Atout-Route," an educational program including a contract through which young drivers promise not to drive after drinking, using drugs, or while fatigued. Nelson, Weitzman, and Wechsler (2005) found significant reductions in driving after drinking, driving after five or more drinks, and riding with a drinking driver resulting from "A Matter of Degree," a program directed at a college campus environment that encourages heavy drinking.

Clapp et al. (2005) report the results of a publicized enforcement program to reduce driving after drinking among college students. The program included increased law enforcement through checkpoints and roving patrols coupled with media and social marketing campaigns to increase student perceptions of the risk of arrest. Self-reported driving after drinking decreased significantly after the program among students in the experimental site and remained stable at the comparison site, both of which were large public universities in southwestern United States.

4.4.5. Drinking and driving laws

In 1999, New Zealand reduced the minimum alcohol purchase age from 20 to 18. Kypri et al. (2006) compared

crash data for four years before and two years after the law change. The alcohol-involved crash rate per population increased by 12% for men aged 18–19, by 14% for men aged 16–17, by 51% for women aged 18–19, and by 24% for women aged 16–17.

U.S. GDL laws typically do not address driving after drinking because every state has a zero tolerance law that prohibits persons under the age of 21 from driving with a blood alcohol content exceeding 0.02. Carpenter (2004) studied the effects of zero tolerance laws using 1984–2001 Behavioral Risk Factor Surveillance System (BRFSS) data. He found that these laws reduced binge drinking (five or more drinks at one sitting within the past month) among males age 18–20 by 13% compared to males age 22–24. He also found a corresponding increase in moderate drinking among males, suggesting that zero tolerance laws may moderate heavy drinking rather than eliminate drinking altogether. Results for females were ambiguous.

4.5. Speed and other driving behavior

Whissell and Bigelow (2003) created and validated a 14-item speeding attitude scale that had a significant but low correlation with speeding tickets in a sample of 257 undergraduate students in Ontario. Redshaw (2004) reported the views on speeding of young drivers in New South Wales who participated in focus groups. Participants were comfortable with speeding and valued it as a way to save time. They expressed impatience with slow drivers and considered driving at 10 to 20 km above the speed limit to be normal. They characterized speeding as driving 40 km or more above the limit.

Two studies compared driving behaviors of 18 newly-licensed teens and 18 experienced adult drivers on a test track. Lee, Olsen, and Simons-Morton (2006) found that the teens had significantly fewer glances to the rearview mirror than the adults during both baseline driving and while performing in-vehicle tasks such as operating a radio or cell phone. Olsen, Simons-Morton, Lee, and Neale (in press) studied behavior when approaching a signalized intersection. The adults were more likely to stop when the traffic light switched from green to amber at each of three distances from the intersection. When approaching the intersection while performing a cell phone task, one-quarter of the teens failed to stop even after the traffic light turned red, while all the adult drivers stopped.

4.6. In-vehicle distractions

Simons-Morton, Lerner, and Singer (2005) documented the effects of teenage passengers on young drivers. They observed vehicles leaving parking lots at 10 high schools, recorded the gender and age (teen or adult) of drivers and any passengers, and recorded the vehicle's speed and headway at a nearby site. Teenage drivers drove faster and with shorter headways than general traffic. Drivers with male teenage passengers drove even faster and with shorter headways.

IIHS is reviewing and summarizing the international research literature on the effects of passengers on teenage drivers, especially the effects of teenage passengers. The study should be completed in 2006. For information, contact Susan Ferguson at sferguson@iihs.org.

Driver distraction resulting from cell phone use has been documented extensively. As of 2005, two states, the District of Columbia, and several communities prohibit hand-held cell phone use while driving. Ten states and the District of Columbia prohibit all cell phone use by drivers with a GDL or all drivers under the age of 18 (Governors Highway Safety Association [GHSA], 2005). Strayer and Drews (2004) studied the distracting effects of cell phone conversations in simulated driving. They found similar effects for both younger (age 18–25) and older (age 65–74) drivers. Lerner and Boyd (2005) studied the willingness of 88 drivers to engage in various distracting tasks involving cell phones, personal communication devices, vehicle navigation systems, passengers, and food. The 22 teenagers perceived the tasks as less risky and were more willing to engage in them than older drivers.

4.7. Drowsy driving

It is well-documented that drowsy driving (driving while sleepy or fatigued) causes crashes and also that many young persons do not get enough sleep. Two studies explored the role of sleep for young drivers. Carskadon (2002) reported on two surveys of several hundred high school and college students. Two-thirds of the drivers in one survey reported having driven while sleepy, and one-fifth in the other reported they had fallen asleep while driving. The students believed that driving while sleepy is less risky than driving while impaired by alcohol. Smith, Carrington, and Trinder (2005) investigated the relationship between predicted and perceived sleepiness while driving in 47 young persons aged 18–25 over four weeks. Participants often drove when they perceived themselves to be sleepy. Many of these trips were at times when sleepiness could be predicted because the driver had been awake for a long period.

4.8. Medical conditions

Barkley (2004) provides an overview of the how attention-deficit or hyperactivity disorder (ADHD) can affect driving, among younger and older drivers alike, and suggests potential strategies to control its effects.

4.9. Vehicles driven

Kindelberger and Eigen (2003) documented crash characteristics for young drivers of sport utility vehicles (SUVs). From 1992 through 2001, about one-quarter of all SUVs in crashes had drivers aged 16–24. These young drivers were substantially more likely to roll their SUV

over in a crash than older drivers, especially if the young drivers were in older SUVs.

Williams, Leaf, Simons-Morton, and Hartos (2006) studied vehicle access and ownership of 3,743 Connecticut teenagers in their first year of licensure. More than half of both male and female teens owned a vehicle when they were first licensed and almost all had regular access to a vehicle. A year later, 74% owned a vehicle. About half of the teens drove small passenger cars and about one-quarter drove SUVs, pickups, or sports cars. At licensure, teens who owned vehicles reported that they averaged 90 miles of weekly driving and teens who did not own vehicles reported an average of 51 miles. Leaf, Simons-Morton, Hartos, and Northrup (2005) investigated the accuracy of these mileage estimates using a subsample of 118 teens. The teens' simple report of their total mileage for the week was 20–30% lower than estimates obtained by asking about each trip throughout the week or from trip logs.

Yannis, Golias, and Papadimitriou (2005) investigated the combined effects of driver age and engine size on motorcycle crashes in Greece. Once the interaction of driver age on accident fault was taken into account, engine size had no effect.

4.10. High school policies

McCartt, Geary, and Solomon (2005) studied the effects of a high school policy requiring safety belt use for everyone in the cars of student drivers with parking permits. Few of the 38 schools contacted for the study were interested in adopting such a policy. Driver belt use, measured at the school, increased from 42% to 67% after the policy was implemented in one school in Mississippi, a state with a secondary belt use law and generally low rates. Passenger belt use increased from 16% to 61%. The policy had no effect in one school in Connecticut, where 86% of drivers and 79% of passengers were belted before the policy.

Stone and Runyan (2005) studied the effect on crash rates of high school policies allowing students to drive off campus during lunchtime. They found significantly higher crash rates for teenagers during lunch hours in two North Carolina counties with these open-lunch policies compared to one county in which students remained on campus.

HSRC is completing a study of the effect of high school starting times on teenage driver crash rates. Preliminary results suggest that moving very early morning (7:30 a.m. or earlier) starting times later by an hour or more may reduce weekday crashes during the school year by 10%. HSRC plans more extensive work on this issue. For information, contact Rob Foss at foss@hsrc.unc.edu.

5. Effectiveness of GDL as implemented

Two new state-level evaluations and two multi-jurisdictional studies add to the evidence that GDL reduces teenage crashes and injuries. Several other evaluations should be released in 2006.

5.1. Wisconsin

In September 2000, Wisconsin implemented a GDL law that extended the minimum learner's permit holding period to six months from seven days, required at least 30 hours of supervised practice driving, and added a 9-month intermediate stage with nighttime and passenger restrictions. Fohr, Layde, and Guse (2005) evaluated the law's effects. The per-population crash rate for 16-year-old drivers decreased 14% from 1999 to 2003 compared to the crash rate for drivers aged 25–59, and the injury crash rate decreased 16%. For 17-year-old drivers, both the overall and the injury crash rates decreased 6%; for 18-year-old drivers there was a small but not statistically significant decrease in both crash rates. There were substantially fewer crash-involved 16-year-old drivers carrying two or more teenage passengers in 2002 compared to 1999. There were very few crashes during the restricted hours of midnight to 5 a.m. in both years. There was no statistically significant change in the odds of a 16-or 17-year-old driver being at fault in a crash. From this latter result, the authors concluded that GDL's effect was due to reduced teenage driving through delayed licensure and reduced driving in risky situations through the intermediate license restrictions rather than to safer driving by teens.

McIntosh (2005) reported on knowledge and attitude surveys administered to 26 parent-teen pairs in the Madison, Wisconsin area in 2002 and 2003. Both parents and teens knew the GDL requirements very well. While 76% of parents supported the law, 70% of teens opposed it.

5.2. Texas

On January 1, 2002, Texas implemented a GDL law with a 6-month learner's permit holding period and a 6-month intermediate stage with nighttime (midnight to 5 a.m.) and passenger (no more than one under the age of 21) restrictions. Willis (2005) used FARS data to compare fatal crashes involving at least one 16-year-old driver during two-year periods before and after the law. The number of 16-year-olds who held a drivers license dropped from 43% in 2000 to 28% in 2003, a decrease of 34%. Fatal crashes involving 16-year-old drivers dropped 29%, from 103 in 2000 to 76 in 2003. The fatal crash involvement rate per licensed driver rose slightly. Crash circumstances, including time of day and number of passengers, were quite similar for the pre-and post-GDL fatal crashes. FARS data do not contain the date of licensure so cannot determine which of the post-GDL 16-year-old drivers were subject to the nighttime and passenger restrictions. Henk and Fette (2006) provide some evidence that these restrictions may not be well understood. In surveys of about 2,000 students

in two Texas high schools in both October 2002 and April 2003, one-third of the students were "not at all familiar" with GDL requirements and only one-sixth were "very familiar" with them.

5.3. Multi-jurisdiction studies and summaries

Dee, Grabowski, and Morrisey (2005) studied GDL effects on fatalities in a cross-section analysis using 1992–2002 FARS data from 48 states (excluding Alaska, Hawaii, and the District of Columbia) and controlling for other influences on teen drivers. They concluded that GDL, defined as any system with an intermediate licensing phase, reduced traffic fatalities among teenagers aged 15–17 by at least 5.6% and did not increase fatalities among older teens.

Morrisey, Grabowski, Dee, and Campbell (2006) carried these methods further and compared the effects of GDL programs of different strengths, as defined by IIHS and TIRF (2004). They concluded that "good" programs reduced traffic fatalities among drivers aged 15–17 by 19%. "Fair" programs reduced nighttime fatalities by 13% but had no effect on daytime fatalities. "Marginal" programs had no effect.

Mayhew et al. (2005) summarized five GDL evaluations in Canada and 13 in the United States, including tables comparing the crash reductions achieved in different jurisdictions.

McKnight (2006) summarized the history and previous evaluations of Maryland's GDL, from its initial implementation in 1978 through revisions in 1985, 1998, and 2005.

Hartling and colleagues plan to update their Cochrane GDL review in late 2006 or 2007. For information, contact Lisa Hartling at lisa.hartling@ualberta.ca.

5.4. GDL evaluations in progress

California: PRG is re-analyzing California data to understand and reconcile the conflicting results of three recent California evaluations summarized in Hedlund and Compton (2005). The study, sponsored by IIHS, should be released in early 2006. For information, contact Susan Ferguson at sferguson@iihs.org.

Georgia: Emory University's study, funded by the National Highway Traffic Safety Administration (NHTSA), should be released in early 2006. For information, contact Paul Tremont at Paul.Tremont@nhtsa.dot.gov.

North Carolina: The University of North Carolina School of Public Health and HSRC studied the effect of North Carolina's GDL system on hospitalization rates and hospital charges for 16-year-old drivers. Preliminary results suggest that hospitalization rates and charges have decreased similarly to the previously-reported decrease in crash rates. Funded by CDC and State Farm Insurance, the study should be released in early 2006. For information, contact Lewis Margolis at lmargoli@email.unc.edu. HSRC is examining three other GDL questions using North Carolina data: long-term effects of GDL, the effects of a passenger restriction, and whether GDL has produced crash reductions beyond those attributable to reduced or delayed licensure. For information, contact Rob Foss at foss@hsrc.unc.edu.

Ontario: TIRF's evaluation is under final review by the sponsor, the Ontario Ministry of Transportation. For information, contact Dean Morin at deanm@trafficinjuryresearch.com.

Oregon: The NHTSA-sponsored study by the Center for Applied Research should be released in 2006. For information, contact Patricia Ellison-Potter at Patricia.Ellison-Potter@nhtsa.dot.gov.

Quebec: The Société de l'Assurance Automobile's evaluation should be released in 2006. For information contact Robert Simard at Robert.Simard@saaq.gouv.qc.ca.

United States: Johns Hopkins University, in a NHTSA-sponsored study, is evaluating GDL and its components nationwide using national crash databases. The study should be released in 2006. For information, contact Paul Tremont at Paul.Tremont@nhtsa.dot.gov.

United States: Johns Hopkins is conducting a second national study for the AAA Foundation for Traffic Safety (AAAFTS). The study will examine licensing rates and mileage driven to separate GDL's effects on driving behavior and driving exposure. The study also will provide more information on the effects of individual GDL components. The study should be completed in 2006. For information, contact Scott Osberg at sosberg@aaafoundation.org.

Mayhew and colleagues at TIRF are comparing young drivers' crash characteristics, conditions, and circumstances in two jurisdictions with substantially different GDL programs. A second study examines how a wide range of young drivers' attitudes, motivations, and lifestyle variables relate to crash involvement, again in two jurisdictions with quite different GDL programs. A report on both studies, funded by AAAFTS, should be released in 2006. For information, contact Scott Osberg at sosberg@aaafoundation.org.

6. Operational features of GDL for parents and teens

Begg and colleagues in New Zealand will begin a large prospective cohort study in 2006. The study, described in last year's update (Hedlund and Compton, 2005), will follow beginning drivers as they progress through the learner's permit, intermediate, and full licensure stages. For information, contact Dorothy Begg at dorothy.begg@ipru.otago.ac.nz.

6.1. GDL acceptance

In 1998, California extended the learner's permit holding period from one to six months, required at least 50 hours of

supervised practice, and introduced nighttime and passenger restrictions during the intermediate phase. Williams, Nelson, and Leaf (2002) surveyed parents and teens on their reactions to and compliance with the new requirements. Parents whose children were subject to the new GDL requirements supported them, with 79% strongly in favor and only 4% neutral or opposed. Over 80% of teenagers supported the extended learner's permit period and the 50-hour practice requirement and over 60% supported the nighttime driving restriction, but fewer than half supported the passenger restriction. Teens reported that they generally obeyed the nighttime restriction: 58% said they never drove after midnight in their first six months with an intermediate license, and another 27% drove 1–9 times. Compliance with the prohibition on passengers under the age of 20 was lower: only 20% reported complete compliance, while 60% violated the restriction at least 10 times (and 36% violated it at least weekly).

Blows, Ivers, and Chapman (2005) analyzed Australian print media coverage of proposals for nighttime and passenger restrictions. Fifty-two articles were published in a 12-week period, including news stories, opinion articles, editorials, and letters. The authors identified about 15 common arguments each from proponents and opponents and described how these arguments are positioned, or framed, into broader contexts such as individual values, problem significance, research evidence, and practicality.

6.2. GDL enforcement

Goodwin, Wells, Foss, and Williams (2005) studied the effects of well-publicized enforcement of GDL provisions, including nighttime and passenger restrictions and a safety belt use requirement, in one North Carolina county (400,000 population), with another county used as a comparison site. In addition to regular patrols, enforcement activities included checkpoints near high schools when students were dismissed and nighttime saturation patrols in locations popular among teenage drivers. Teenagers were aware of the increased enforcement. But both self-reported data and direct observations of young drivers showed only modest changes in compliance with GDL provisions.

A CDC-funded follow-up study is underway to test similar enforcement and publicity activities in other settings. For information, contact Arthur Goodwin at arthur_goodwin@unc.edu.

6.3. Parental roles and programs to assist parents and teens

Hartos, Simons-Morton, Beck, and Leaf (2005) studied whether GDL helps parents manage their beginning drivers by comparing survey results from Maryland, a GDL state, and Connecticut, a state without GDL. Maryland parents imposed stricter restrictions than Connecticut parents regarding teenage passengers, nighttime driving, and high-speed road driving.

Simons-Morton and colleagues provided additional evidence that the Checkpoints program helps parents manage their teens' driving (Simons-Morton, Hartos, Leaf, & Preusser, 2005, 2006a, 2006b). They surveyed parents and teens before licensure and at 3, 6, and 12 months post-licensure. Checkpoints program parents and teens reported substantially stricter limits than comparison parents and teens through 3 months, and some effects through 12 months. A follow-up study is comparing the effectiveness of the Checkpoints program when delivered at the time of issuing the learner's permit or the intermediate license, assessing the effectiveness of communications on risk factors for parents and teens, and assessing the effectiveness of the Checkpoints parent-teen driving agreement. For information, contact Bruce Simons-Morton at mortonb@exchange.nih.gov.

In a series of papers, Beck, Hartos, and Simons-Morton (2005, in press-a, in press-b) are reporting the results of their studies of how agreement between parents and teens on parent-imposed driving restrictions affects teens' driving behavior.

Shope and colleagues at UMTRI, with funding from the National Institute of Child Health and Human Development and CDC, are implementing and evaluating an adapted version of the Checkpoints program in driver education classes in Michigan. Results should be available in 2006. For information, contact Jean Shope at jshope@umich.edu.

Hartos is studying the transition from parent-imposed to self-regulated safe driving practices among undergraduates at the University of North Carolina, Charlotte. For information, contact Jessica Hartos at jhartos@email.uncc.edu.

Three programs to assist parents and beginning drivers have been released recently.

- *Driving Skills for Life,* developed by Ford and GHSA, emphasizes four skills: hazard recognition, vehicle handling, space management, and speed management (Ford and GHSA, 2003). The program's educational kit includes a video, teacher's guide, and brochure and the Web site contains on-line learning materials and parental tips and coaching guide. It has been sent to every public high school in the United States and the materials have reached an estimated 4 million teenagers and their parents.
- *Road Ready Teens*, developed by DaimlerChrysler together with AAA, MADD, and the National Safety Council, provides a parent's guide, a parent-teen contract, and a video game and Road Ready Reality Check quiz for teens (DaimlerChrysler, 2003). Bingham and Shope (2003) conducted a pilot evaluation of the video game using 19 teens, most of whom held learners permits. The teens played the game for 50 minutes and then participated in a focus group. The teens enjoyed the game and reported that it helped them understand driving risks but the game did not produce significant changes in their intentions to avoid risks.

- *Teen Driver: A Family Guide to Teen Driver Safety*, developed by the National Safety Council, provides information and advice to parents and teens on crash risks, how to develop a family plan and written agreement for beginning drivers, and GDL components and restrictions (National Safety Council [NSC], 2004). The University of North Carolina at Charlotte will evaluate the content and use of the Guide, strategies to implement it into new and existing driver safety programs, and how it helps families manage their teens' driving. For information on the CDC-funded project, contact Jessica Hartos at jhartos@email.uncc.edu.

The Allstate Foundation is developing a teenage driver safety program featuring teen participation and grassroots empowerment. The report announcing the program (Allstate Foundation, 2005) contains results from a national electronic survey of 1,000 teens on their driving attitudes and behavior and also discusses the implications on teenage driving of recent research on adolescent brain development.

Votta and MacKay (2005) studied an experimental family program, *I Promise*, consisting of a contract between parents and teen drivers and a window decal. Focus groups of young drivers, parents, and community members revealed substantial difficulties with the program's message, content, and language. Most families chose not to continue with the program after a pilot phase.

Henk and Fette (2006) studied the effects of a pilot program in high schools using a peer-to-peer approach to increase awareness among teenage drivers of common risk factors such as speeding, teenage passengers, and driving at night. Student awareness of several risk factors increased in the pilot high school, while there was no consistent change in the comparison school. The program is being refined and expanded to other Texas high schools. For information, contact Russell Henk at r-henk@tamu.edu.

7. Driver education and GDL

Research continues on the relationship between driver education and GDL and how to integrate them effectively.

7.1. Overviews

Bishop, Quinlan, Roeber, and Van Etten (2005) summarized the proceedings of the 2003 National Transportation Safety Board (NTSB) public forum on driver education and training. They provided brief histories of driver education and GDL in the United States. They summarized the views of forum participants from federal and state governments, driver education teachers, students, associations, and private companies. In August 2005, NTSB recommended that NHTSA and the United States Department of Education determine the best driver education curricula, training methods, and instructional tools; incorporate these into a model curriculum; and determine how driver education should best be integrated with GDL (NTSB, 2005).

"Driver Education: The Path Ahead" was the subject of the 2005 midyear meeting of the Transportation Research Board (TRB) Operator Education and Regulation committee (ANB30). Papers written for the meeting discuss driver education content, instructional methods, student competency measures, and course evaluation. The papers will be published in 2006 as a TRB Circular, edited by Daniel Mayhew and James McKnight.

Lonero and Clinton (submitted for publication) of Northport Associates are completing a thorough review of the driver education evaluation literature that identifies and assesses evaluation methods and data sources and provides recommendations. The report, funded by AAAFTS, is scheduled for release in 2006. For information, contact Scott Osberg at sosberg@aaafounation.org.

7.2. Driver education and crash risk

Zhao et al. (2006) investigated the impact of driver education on crash risk in the context of Ontario's GDL system. In Ontario, the minimum learner's permit holding period is reduced from 12 to 8 months for driver education graduates. Using self-report survey data from beginning drivers, and controlling for both months of licensure and kilometers of travel, the authors found that driver education reduced crash risk during the learner's permit phase and did not affect crash risk during the intermediate phase.

Maag and colleagues at the Université de Montréal have completed their comparison of crash rates for intermediate license drivers who have and have not taken driver education. The study may be obtained from Robert Simard at Robert.Simard@saaq.gouv.qc.ca.

8. Other related research

8.1. GDL for motorcyclists

A few jurisdictions use some form of GDL for beginning motorcyclists. Several other states place some restrictions on motorcyclists with a learner's permit or those younger than a specified age. Mayhew and Simpson (2001) described GDL programs in Canada, California, Maryland, and South Dakota and summarized the effectiveness evidence from motorcycle GDL programs in Quebec and New Zealand. Baer, Cook, and Baldi (2005) reported that seven states had some form of GDL for motorcyclists in 2001. See Motorcycle Safety Foundation [MSF] (2002) for state motorcycle operator requirements and restrictions.

8.2. In-vehicle technology

Several in-vehicle technology systems that may reduce the frequency or severity of young drivers' crashes are being

tested or are currently available. Young, Regan, and Mitsopoulos (2004) used focus groups of young drivers aged 17–25 to evaluate the acceptability of these systems. The systems studied were warnings for driver fatigue, lane departure, following distance, and collision; speed monitoring that either warns of or limits excessive speed; alcohol interlocks and alcohol performance tests; safety belt reminders or interlocks; and electronic licensing. Acceptability was evaluated by considering each system's usefulness, effectiveness, usability, cost, and social acceptability. The only well-accepted systems were alcohol interlocks and safety belt reminders, and focus group drivers believed belt use reminders were unnecessary. The paper provides references to a few other studies of vehicle technology acceptability.

8.3. Simulator studies

TraumaLink Injury Research Center at The Children's Hospital of Philadelphia, in cooperation with the University of Iowa, is studying the usefulness of the National Advanced Driving Simulator for teen driver research. The NSF-funded project will examine on-road and simulated driving for teens and compare their performance to other age groups. The performance of high and low sensation seeking teens will also be explored while controlling for driving experience. Other TraumaLink projects are investigating the driving exposure of young drivers with teenage passengers and with child passengers, unlicensed and underage driving, and teen perceptions of driving risks, other health risk behaviors, and associated interventions. For information, contact Suzanne Hill at hillsu@email.chop.edu.

8.4. Teen driving newsletter

Erik Olsen at the National Institute of Child Health and Human Development, in cooperation with the TRB Operator Education and Regulation Committee, has started a teen driving email newsletter to report on ongoing and published research, conferences, and resources regarding teen drivers. The first issue may be found at http://www.teendrivinginfo.com/teen_driving_newsletter.htm.

9. Conclusions and next steps

Research on teenage driving issues in general and GDL in particular continues to grow. The 2004 and 2005 updates cited 37 and 52 new papers, respectively; this update cites 107. To assess what has been learned from this research and from recent experience with young driver programs, a symposium on teenage driving is planned for February 2007. The 2007 symposium and background papers will summarize the current state of knowledge on key GDL and teenage driver issues, including the role of parents, driver education, and new technology, and will discuss research needs and action steps. For information on the symposium, contact Deborah Trombley of the National Safety Council at trombled@nsc.org. Readers are invited to send new and recent studies not included in any of the updates to Jim Hedlund at jhedlund@sprynet.com, who will pass them on to the 2007 symposium's organizers and background paper authors.

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