

ALCOHOL

and

Highway Safety:

A Review of the State of Knowledge



U.S. Department
of Transportation

**National Highway
Traffic Safety
Administration**



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16. Abstract This sixth volume in NHTSA's series of reviews on the state of knowledge in alcohol and highway safety covers research reported after the 2001 publication up to 2006. Specifically, it includes articles published between 2000 and 2006, as well as additional reports published in early 2007. As has been the practice in previous issues of this report, articles from earlier periods are included to provide sufficient background for more recent findings. Thus, this volume is a compilation of information from a 5-year span of alcohol and highway safety reports and research findings.			
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List of Acronyms

Acronym	Meaning
AA.....	Alcoholics Anonymous
AAA.....	American Automobile Association
ABC.....	alcohol beverage control
ACS.....	Alcohol Countermeasures Systems
ACEM.....	Association of European Motorcycle Manufacturers
AF.....	attributable fraction
AHA.....	American Heart Association
ALT.....	alanine aminotransferase
AMOD.....	A Matter of Degree
AMS.....	Alcohol Monitoring Systems
AOA.....	U.S. Administration on Aging
ARIMA.....	Auto-Regressive Integrated Moving Average
ASI.....	Alcohol Severity Index
AST.....	aspartate aminotransferase
AUDIT.....	Alcohol Use Disorders Identification Test
AUDs.....	alcohol use disorders
AUI.....	Alcohol Use Inventory
BAIDs.....	breath alcohol ignition interlock devices
BALs.....	breath alcohol levels
BLS.....	Bureau of Labor Statistics
BrACs.....	breath alcohol concentrations
BRFSS.....	Behavioral Risk Factor Surveillance System
CASA.....	Center on Addiction and Substance Abuse
CDC.....	Centers for Disease Control
CHD.....	coronary heart disease
CI.....	confidence interval
DHHS.....	U.S. Department of Health and Human Services
DIP.....	driver intervention program
DMV.....	Department of Motor Vehicles
DOJ.....	Department of Justice
DOT.....	Department of Transportation
DRI.....	Driver Risk Inventory
DrInC.....	Drinker Inventory of Consequences
DUIB.....	drinking-and-driving behavior index
DWU.....	driving-while-unlicensed
EtG.....	ethyl glucuronide
FHWA.....	Federal Highway Administration
g/dL.....	grams per deciliter
GAO.....	General Accounting Office

GDL	graduated driver's licensing
GES	General Estimates System
GGT	gamma glutamyltransferase
HGN.....	horizontal gaze nystagmus
I/O	input/output
IBC.....	Injury Behavior Checklist
IPTs.....	Integrated Project Teams
LAI.....	Life Activities Inventory
LBD	liquor by the drink
MAC	MacAndrew Alcoholism Scale
MACH	Minnesota Assessment of Chemical Health
MADD	Mothers Against Drunk Driving
MAIDS	Motorcycle Accident In-Depth Study
MAST	Michigan Alcoholism Screening Test
MET	motivational enhancement therapy
MF.....	Mortimer-Filkins
MLDA.....	minimum legal drinking age
mph	miles per hour
MTF	Monitoring the Future
NAIC.....	National Association of Insurance Commissioners
NAMS.....	National Agenda for Motorcycle Safety
NAS	National Alcohol Survey
NASS	National Automotive Sampling System
NCADI.....	National Clearinghouse for Alcohol and Drug Information
NAIC.....	National Association of Insurance Commissioners
NCIPC.....	National Center for Injury Prevention and Control
NCSA.....	National Center for Statistics and Analysis
NESARC.....	National Epidemiologic Survey on Alcohol and Related Conditions
NHSDA.....	National Household Survey on Drug Abuse
NHTSA.....	National Highway Traffic Safety Administration
NPTS.....	National Personal Transportation Survey
NRS.....	National Roadside Survey
NSDUH.....	National Survey on Drug Use and Health
OLS.....	one-leg-stand
OR.....	odds ratio
OSG	Office of the Surgeon General
OWUI	operating while under the influence
PARs	police accident reports
PARC.....	Preventing Alcohol-Related Convictions
PAS	passive alcohol sensors
PBT	Problem Behavior Theory
PBTs	preliminary breath tests

PI&E	public information and education
PSAs	public service announcements
PY/PM	Protecting You/Protecting Me
RBT	random breath test
REA	Research and Evaluation Associates
RIASI	RIA Self-Inventory Screening Instrument
RID	Remove Intoxicated Drivers
RTS	Rating the States
SADD	Students Against Drunk Driving
SAIC	Science Applications International Corporation
SALCE.....	Substance Abuse Life Circumstance Evaluation
SASSI	Substance Abuse Subtle Screening Inventory
SBI	Screening and Brief Intervention
SBIR	Small Business Innovation Research
SBT	selective breath test
SCRAM™	Secure Continuous Remote Alcohol Monitoring
SEC	serum ethanol concentration
SEtG.....	serum EtG
SFSTs.....	Standardized Field Sobriety Tests
SIP.....	Support for Interlock Program
SOS	Secular Organization for Sobriety
STEPS	Selective Traffic Enforcement Programs
SVN	single-vehicle nighttime
SVRA.....	stipulated vehicle release agreement
TAC	transdermal alcohol concentration
TRB.....	Transportation Research Board
UEC	urinary ethanol
UEtG	urinary EtG
UPPL.....	Uniform Accident and Sickness Policy Provision Law
VIP	victim impact panels
VMT	vehicle miles traveled or vehicle miles of travel
WAT	walk-and-turn
WDOT	Wisconsin Department of Transportation
WHO.....	World Health Organization
WrisTAS™	Wrist Transdermal Alcohol Sensor

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Executive Summary

The year 2006 marked the 40th anniversary of the passage of the Highway Safety Act that provided the foundation for the Department of Transportation (DOT) and the National Highway Traffic Safety Administration (NHTSA). During those four decades, NHTSA sponsored research and supported demonstration programs that have provided much of the scientific background for the growth in traffic safety legislation and safety programs including alcohol-impaired driving. Between 1968 and 2005, the national highway fatality rate fell from 5.49 to 1.45 per hundred million vehicle miles of travel (VMT). An important element of NHTSA's support for alcohol safety research has been a series of reports on alcohol and highway safety. This is the sixth report that reviews the state of knowledge on alcohol and highway safety, dating back to 1968. Previous reviews in this series were published in 1968, 1978, 1984, 1989, and 2001.

This sixth volume in NHTSA's series of reviews on the state of knowledge in alcohol highway safety covers research reported after the 2001 publication up to 2006. Specifically, it includes articles published between 2000 and 2005, as well as additional reports published in early 2006. As has been the practice in previous issues of this report, articles from earlier periods are included to provide sufficient background for more recent findings. Thus, this volume is a compilation of information from previous alcohol and highway safety reports and current research findings, which provides a more comprehensive state-of-the-art report than can be provided by just including the last 5 years of published research literature.

Contents of This Volume

To maintain continuity with the previous *Alcohol and Highway Safety* reports, this volume is organized under the standard six headings used in previous reviews beginning with Chapter 1, "Introduction and Methods" ("Introduction," in previous reports), and continues with Chapter 2, "Overview of the Alcohol-Crash Problem." In this volume, Chapter 2 contains three sub-units. The first covers an overview of the epidemiology of alcohol-related crashes; the second examines alcohol-related crash data for the United States as of 2005; and the third covers trends in alcohol-related crashes since 1982, looking for explanations for the reduction in alcohol-related fatalities in the 1980s and 1990s. Chapter 3, "Alcohol Effects on People," describes recent research on the development of new techniques for measuring blood alcohol concentration (BAC), the drinking characteristics of the American public, recent studies on the influence of alcohol on human performance, and recent studies of the relative risk of crash involvement as a function of BAC.

Chapter 4, "Drinking Drivers, Pedestrians, and Pedalcyclists," covers nine special at-risk groups. Three groups of underage drinkers who are or eventually may become drinking drivers are covered, including early onset of drinking by teenagers age 14 and younger, transition teens (15- to 17-year-olds), and college students. Adults are considered in three groups: high-risk drinking drivers

ages 21 to 34, female drivers, and older drivers. Also considered as special high-risk groups are drinking pedestrians and motorcyclists. Finally, ethnic differences in drinking, drinking-and-driving, and alcohol crash involvement are considered in this chapter.

Chapter 5, “Dealing with the Alcohol-Crash Problem,” is divided into three sections: *Primary Prevention* (reduction in risky drinking), *Secondary Prevention* (separating drinking from driving), and *Tertiary Prevention* (preventing DWI offender recidivism). The *Primary Prevention* section addresses those laws and policies directed at increasing alcohol taxes, reducing the availability of alcohol by controlling the times and conditions of sales, responsible beverage service programs, and limits on underage drinking. The *Secondary Prevention* section deals with enforcement, prosecution, and adjudication of drinking-and-driving laws and penalties for impaired driving. It also includes public information programs, designated driver and safe ride programs, and community programs directed at reducing impaired driving. *Tertiary Prevention* is broken into two main components: the first focuses on the incapacitation of the convicted drinking driver to prevent further harm to the driving public, and the second on the treatment programs designed to help offenders overcome their drinking problems.

Chapter 6, “Summary and Conclusions,” lists the primary findings described earlier in the volume. Further, it focuses on future directions. Included is a description of research needs, laws, and policies that appear to be effective but have not yet been implemented by most States, and a section on new technological developments that provide promise for reducing impaired driving in the future.

Chapter 1

This chapter covers three areas: a review of the previous Alcohol and Highway Safety Reports (1.1*); a description of the scope and approach to the development of this volume (1.3); and a description of the literature search methodology (1.4).

Prior reviews (1.2). The first report in this series was issued in 1968 (U.S. DOT, 1968) in response to a Congressional requirement when the agency was founded. The DOT report summarized the relatively limited research in the traffic safety field and highlighted the role of “heavy drinkers” (alcoholics and problem drinkers) in the alcohol-related crash problem. Since then, there have been four additional reports. The current volume, covering the period from 2000 to 2006, is the sixth in the series.

Literature review procedures (1.4). A comprehensive review of the available literature was conducted. Major social psychological, psychological, and medical databases (e.g., CINAHL, PubMed, PsycINFO, and Sociological Abstracts) were consulted, as were transportation and safety databases. These initial database searches yielded more than 27,000 titles, nearly half of which were determined subsequently to be duplicates. Other reference sources (such as NHTSA, National Transportation Safety Board, National Institutes of Health, Mothers Against Drunk Driving, and the Insurance Institute for Highway Safety library) and databases from peer-reviewed journals were also searched. Meetings with NHTSA officials at their headquarters office provided relevant NHTSA reports on alcohol safety not listed in the peer-reviewed literature. Also examined were various sources of statistical data and information on impaired driving and crash data including NHTSA’s

* Numbers indicate paragraphs in the volume that cover the topic.

National Survey of Drinking and Driving Attitudes and NHTSA's *FARS*. These data were used for constructing the graphs and tables throughout the text.

Chapter 2

This chapter begins with a discussion of the types of crash data files available to traffic safety researchers and the measures that can be extracted from them. Potential questions surrounding their use in evaluation of alcohol-related safety issues are also discussed. Briefly covered are the basic characteristics of alcohol-related fatal crashes and the types of drivers involved in such crashes in 2005. This is followed by a discussion of the reduction in alcohol-related crashes over the last three decades and the factors that may have influenced that downward trend. Also covered are alcohol-related injury crashes and what is known about drinking drivers from roadside surveys and national telephone surveys.

Understanding traffic statistics (2.2.2). Traffic safety researchers have benefited from the extensive crash records maintained by NHTSA and the States. These data files have provided the basis for analyzing the characteristics of alcohol-related crashes and for the evaluation of impaired-driving laws and programs. Not fully appreciated by the public and some safety activists is the complexity of the data on alcohol-related crashes. In part, this complexity is derived from the richness of the information that allows the reporting of similar sounding but quite different variables, such as alcohol-related crashes, drinking drivers in crashes, and alcohol-related fatalities. Table 1 illustrates the differences between these three measures based on 2005 data from the Fatality Analysis Reporting System (FARS), a census of all fatal crashes occurring on U.S. highways. A crash is characterized as alcohol-related based on FARS data if one of the drivers, pedestrians, or pedalcyclists involved had, or was imputed to have had, a positive BAC at the time the crash occurred.

Table 1

Percentage of alcohol-related (i.e., BAC ≥ 0.01 g/dL) crashes in 2005 as a function of the crash measure

	Fatal crashes	Fatalities	All drivers in fatal crashes
Total	39,189	43,443	59,104
Alcohol-related	15,238	16,885	14,068
Percentage alcohol-related	39%	39%	24%

Source: NCSA (2005a)

Additional complexity arises from the limited availability of the best measure of the blood alcohol concentration (BAC) by impaired drivers involved in crashes. FARS provides a record of all fatal crashes occurring each year in the United States, but a BAC measure is only available for 64% of the drivers who die in such crashes and only 25% of surviving drivers. The absence of BAC data for most research studies requires researchers to impute (estimate) the BAC levels for those cases where this measure is lacking or to use surrogate measures based upon other information such as single-vehicle nighttime crashes.

Another area of complexity is the choice of a normalizing or exposure variable, such as the number of deaths per 100,000 in the population or deaths per billion VMT, which is the basis for comparing different groups, such as men versus women, youths age 20 and younger versus adults age 21 and older. This is illustrated in Table 2.

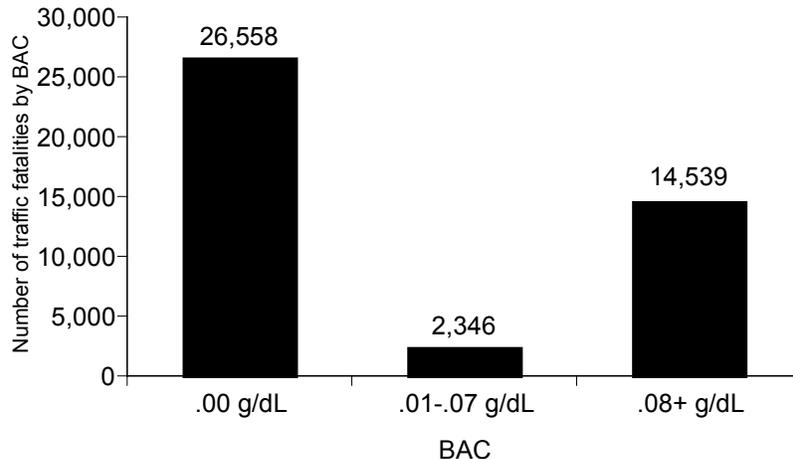
Table 2

Fatalities and injuries in 2005 as a function of vehicle miles or population measures

	Number/count	Fatalities per unit	Injuries per unit
Per 100 million VMT	2,989,807,000,000	1.45	90
Per 100 thousand resident population	296,410,404	14.66	911
Per 100 thousand registered vehicles	245,641,663	17.69	1,099
Per 100 thousand licensed drivers	200,665,267	21.65	1,345

Source: NCSA (2005a)

Impaired driving in 2005 (2.3). There were 43,443 traffic fatalities in 2005, and 16,885 (39%) of those deaths were considered alcohol-related because they occurred in crashes involving a drinking driver, motorcyclist, or pedestrian. Eighty-six percent of the drinking road users involved in those crashes had BAC levels higher than the .08 g/dL legal limit for driving (see Figure 1).



**Figure 1. Traffic fatalities in 2005 by highest BAC level in crash (Total N = 26,558 + 16,885 = 43,443)
Adapted from NCSA (2006a)**

Figure 2 (see below) shows the distribution of the 16,885 alcohol-related fatalities. Of that total, 14,539 (86%) died in crashes involving at least one driver or nonoccupant (pedestrian or pedalcyclist) with a BAC level of .08 g/dL or higher (NCSA, 2006b). As can be seen, 70% of the victims were the impaired drivers or the other driver in a two-car crash. Twenty percent were passengers riding with the impaired driver or in the other vehicle involved in the crash. Ten percent were other drivers or nonoccupant road users who were not impaired.

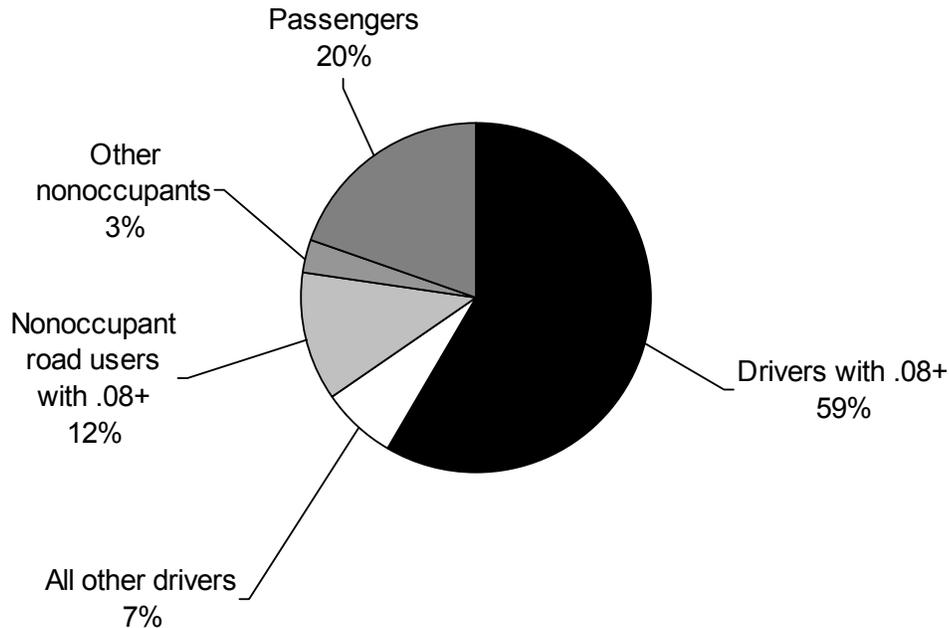


Figure 2. All alcohol-related traffic fatalities in 2005, (N= 16,885). Adapted from NCSA (2006b)

Trends in impaired driving in the United States (2.4). Alcohol has historically been involved in a substantial proportion of fatal crashes in the United States. Over the past 25 years, however, progress has clearly been made in reducing the problem. A qualitative estimate of the influence of various countermeasures on the impaired-driving problem can be deduced from the trend over the last quarter century in alcohol-related fatal crashes. Based on the NHTSA BAC imputation method where the BAC level of the active participant is estimated if it is not known (Subramanian, 2002), alcohol-related traffic fatalities (at least one active participant in crash with a BAC of .01 g/dL or greater) declined from 26,173 in 1982 to 16,885 in 2005, a 35% decrease; while non-alcohol-related traffic fatalities (no active participant with a BAC greater than .00 g/dL) gradually increased from 17,773 in 1982 to 25,558 in 2005, a 44% increase (Figure 3) (NCSA, 2006a). Fatalities in crashes involving a road user with a BAC of .08 g/dL (the current legal limit) declined by 37%, from 23,246 to 14,539.

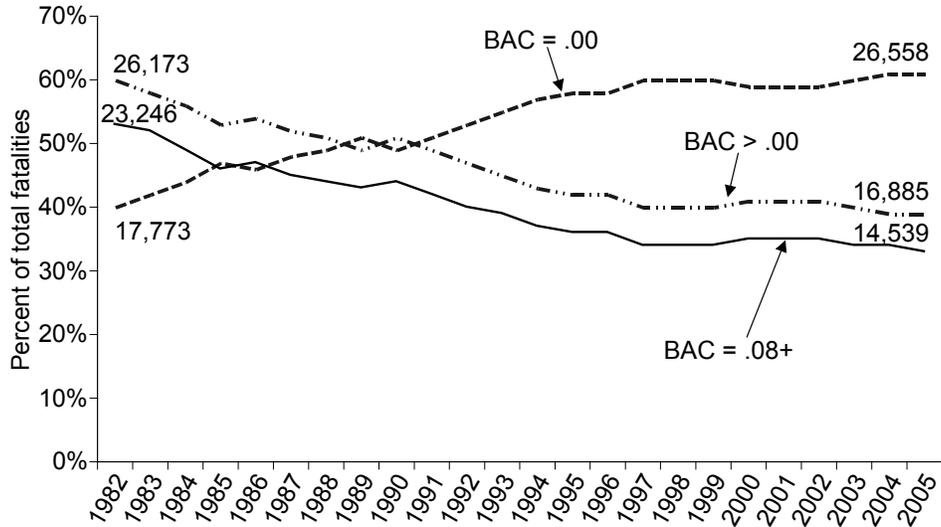


Figure 3. Traffic fatalities by percentage by highest BAC in crash, 1982-2005. Adapted from NCSA (2006a)

Although the decline in alcohol-related crashes since 1982 has been substantial, other safety measures have contributed to highway safety in the United States over those years. Table 3 shows the traffic deaths prevented due to changes in risk factors from 1982 to 2001 based on a 2006 study by Cummings and his coinvestigators (June 2006) using FARS data. In addition to the 53% reduction in alcohol-related deaths prevented by the decline in drinking drivers, Cummings et al. (2006) estimated that there was a 49% reduction in deaths due to increase seat belt wearing and a 74% reduction in motorcyclist deaths due to failure to wear a helmet.

Table 3

Traffic deaths attributable to one of five factors, with percentage of mortality decline and deaths prevented over 20 years, 1982-2001

Traffic safety risk factor	Attributable traffic deaths	% mortality decline (1982-2001)	Deaths prevented
Drinking and driving	366,606	53%	153,168
Not wearing seat belt	259,239	49%	129,297
No air bag	31,377	17%	4,305
No motorcycle helmet	12,075	74%	6,475
No bicycle helmet	10,552	39%	239

Source: Cummings et al. (2006)

The reduction in alcohol-related fatalities provides evidence that alcohol safety laws and programs implemented in the last three decades may have been responsible for at least some of the decline in alcohol-related traffic fatalities. However, this conclusion must be accepted with some caution because there was a general worldwide decline in alcohol-related crashes during the same period and other socioeconomic factors certainly played a role in the reduction in crashes involving alcohol (see 2.6).

Chapter 3

This chapter focuses on the emerging practical technologies for measuring BAC levels in the field (3.2). Also covered is the growing information on the role of drivers with alcohol use disorders (AUDs) in alcohol-related crashes and the emerging definitions of problem drinking and moderate drinking (3.6). Recent studies on the effect of low doses of alcohol on performance are also reviewed (3.7). These studies have been important in supporting legislation reducing the legal BAC limit to .08 g/dL for adults and .02 g/dL for drivers age 20 and younger. In addition, the new information on the relative risk of crash involvement provided by a recent case-control study funded by NHTSA is reviewed (3.7.3).

Measuring alcohol in the body (3.2). The general principles regarding the processing of alcohol by the body remain essentially unchanged from those established in the first half of the 20th century. Alcohol is absorbed by diffusion, metabolized mainly in the liver, and the small remaining amount is eliminated in urine and in expired air and through the skin. The most important developments over the last decade have been in the technology for the measurement of alcohol in the body, which is leading to practical methods for controlling the drinking and controlling the impaired driving of offenders convicted of DWI.

At the millennium, breath testing has become more precise, more reliable, and more convenient. This has led to two applications that show promise for application to impaired-driving programs. The development of small fuel-cell sensing systems that are specific to alcohol has allowed the development of standard police flashlights with an integrated passive alcohol-sensing capability that can detect breath alcohol at a distance of 6 inches in front of the face, and provides the officer with a means of determining whether a driver has been drinking (see Figure 4). The fuel cell has also provided a means of constructing vehicle interlocks that prevent the starting of a vehicle by a driver who has been drinking heavily.



Figure 4. Passive sensor flashlight



Figure 5. The SCRAM™ Ankle Unit

Other techniques that measure alcohol presence in alternative substances, such as in oral fluid and in sweat, are also evolving. The great interest in the development of a minimally intrusive method of detecting and measuring drug use has led to the development of methods for collecting oral fluids in the field (3.2.2). The most recent practical methods for monitoring BAC in the field have been based on sensing alcohol in sweat. Two electrochemical devices, the SCRAM™ and the WrisTAS™, that detect transdermal alcohol concentration (TAC) have been developed (3.2.3). The devices are adapted for long-term wear by the subject and transmit data to a remote data storage device. One of the devices, the SCRAM™ (Secure Continuous Remote Alcohol Monitoring), measures ethanol gas at the skin surface using a fuel-cell sensor attached to an ankle bracelet (Figure 5). The unit is worn 24

hours a day, 7 days a week, for several months. It was designed for security and remote reporting to minimize circumvention and to render data usable by courts or corrections. Several thousand of the units are being used in the field.

Characteristic of drinking in the United States (3.3). A national household survey of 43,093 adults age 18 and older, conducted in 2001 and 2002, provided information on drinking norms in the United States. The household survey procedure provides particularly strong data as the surveys were conducted face-to-face by Census Bureau employees and an 81% response rate was achieved. The data were adjusted to ensure that they were representative of the noninstitutionalized U.S. population by reference to the 2000 census data. Thirty-two percent of men age 18 and older and 40% of women age 18 and older, reported abstaining from alcohol over the last 12 months. The survey results showed that a man who consumes 4 to 5 standard drinks a week is consuming more alcohol than three-quarters of his peers in the same age group. A woman who consumes 1 or 2 drinks a week is drinking more than 85% of her peers in the United States.

Binge drinking (3.5). Based on recent research, on February 5, 2004, the National Advisory Council of the National Institute on Alcohol Abuse and Alcoholism (NIAAA) officially defined binge drinking as “... a pattern of drinking alcohol that brings blood alcohol concentration (BAC) to 0.08 gram percent or above. For the typical adult, this pattern corresponds to consuming 5 or more drinks (male), or 4 or more drinks (female), in about 2 hours.” A 2003 study based on data from the National 2001 Behavioral Risk Factor Surveillance System telephone survey of adults age 18 or older determined that there were approximately 1.5 billion episodes of binge drinking in the United States. Binge-drinking rates were highest among those ages 18 to 25; however, 70% of the binge-drinking episodes occurred among those age 26 years and older). Binge drinkers were 14 times more likely to report alcohol-impaired driving than nonbinge drinkers.

Alcohol use disorders (AUDs)(3.6). Alcohol abuse and dependence are generally accepted as two clinical alcohol use disorders with symptoms that are currently defined by the American Psychiatric Association DSM-IV standards. Dependence is based on evidence of tolerance to alcohol, symptoms of withdrawal, and reduced control over drinking. Abuse is generally defined by four criteria: (1) hazardous use, (2) failure to fulfill major role obligations, (3) continued use despite social or interpersonal problems, and (4) legal problems. Diagnosis as a dependent drinker takes precedence over the diagnosis of abuse and precludes such a diagnosis.

According to the the 2001-2002 National Epidemiological Survey on Alcohol and Related Conditions (NESARC; NIAAA, 2006), a household survey of 43,093 adults age 18 and older, 17.5 Americans are afflicted with AUDs. The prevalence of abuse and dependence was greater among males than females; younger age groups more than older age groups; and Whites more than African Americans, Asian Americans, or Hispanics. They reported an increase in abuse but a decline in dependence over the decade from 1991 to 2001. The approximate distribution of each type of AUD drinker, binge drinkers, and normative drinkers, based on the 2001-2002 national household survey, are shown in Table 4, along with those who reported no drinking in the last 12 months.

Table 4

Percentage of respondents (age 18+) who fall into one of the six nonoverlapping categories based on the 2000 NESARC Survey

	Dependent drinkers	Abusive drinkers	Dependent & abusive drinkers	Binge drinkers	Current normative drinkers	Current nondrinkers	Total
N (raw data)	553	1,843	931	3,297	20,332	16,147	43,093
N (weighted)	2,666,000	9,668,000	5,246,000	17,098,000	101,360,000	71,845,000	207,883,000
% Total	1.28%	4.65%	2.52%	8.22%	48.76%	34.56%	100.00%

Note: N (raw data) denotes sample size on the NESARC and N (weighted) the U.S. population size estimated from the NESARC. Source: NIAAA (2006).

Alcohol's effect on driving performance(3.7.2). Recent research regarding alcohol's effect on performance related to driving has focused on low BAC levels, as it has clearly been established in previous research that performance is substantially impaired in virtually everyone at BAC levels of .08 g/dL and higher. In 2000, Moskowitz and Florentino viewed 87 experimental studies of performance skills at low BAC levels. Their study identified 550 tests in 12 behavioral categories. Their focus was largely on the BAC threshold at which impairment was first measurable in each skill category, which varied from thresholds as low as .01 g/dL for some skills to as high as .06 g/dL for others.

In a second study published in 2000, Moskowitz and his associates conducted a study in which heavy and light drinkers were tested at BAC levels up to .10 g/dL. They recruited 168 participants equally divided between men and women in four age groups: under 21, 21-24, 25-50, and over 50; and three drinking levels: light, moderate, and heavy. Performance was measured on a simulator with an added task to measure ability to divide attention. They found that in 11 of the 14 subtest scores derived from their performance task, a majority of the subjects were impaired at a BAC level of .04 g/dL. At a BAC level of .08 g/dL, despite some indication of differences in the extent of impairment in performance between subjects, neither gender, age, nor surprisingly, the light, moderate, or heavy drinking levels of the participants predicted the extent of impairment.

In a later paper published in 2004, Ogden and Moskowitz, building on the earlier reviews by Moskowitz and his associates, made the following points: (1) there is no evidence that low BAC levels improve human skills; (2) there is no evidence of a threshold at which alcohol begins to have an effect because impairment occurs at the lowest levels at which BAC can be measured; (3) all individuals are impaired at any positive BAC level, and impairment increases with BAC level; and (4) many of the skills related to driving are significantly impaired at BAC levels lower than .05 g/dL.

Relative risk of involvement in a crash (3.7.3). Perhaps the strongest evidence for the role of drinking in crash involvement may come from case-controlled studies of drivers in crashes in which research teams collect the BAC levels of crash-involved drivers and compare them with BACs collected from a random sample of drivers not in crashes driving at the same location at the same time of day and day of week. Blomberg, Peck, Moskowitz, Burns, and Fiorentino conducted a case control study at two sites—Long Beach, California, and Fort Lauderdale, Florida—from June 1997 to April 1999. They collected breath tests from and conducted interviews with 4,316 crash-involved drivers and 10,066 control drivers. The study achieved a high level of participation with 88% of the crash-involved drivers and 93% of the comparison drivers providing a complete set of data.

The study was noteworthy in two aspects. First, passive alcohol sensors were used on both crash-involved and control drivers, thereby providing a basis for estimating the BAC levels of those

drivers for whom the survey team failed to obtain a regular preliminary breath test. Second, the police-researcher teams succeeded in locating, interviewing, and breath-testing 17% of the hit-and-run drivers who fled the scene of the crash. This provided information on a group never before included in a case-control study. The relative risk curve derived from Blomberg and associates' study is compared with the classic Borkenstein curve in Figure 6.

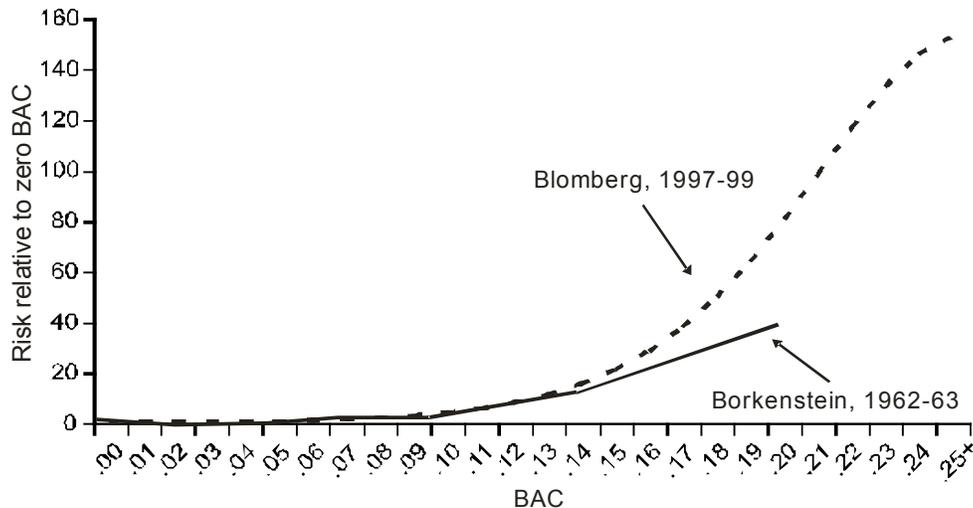


Figure 6. Comparison of two estimates the relative risk of crash involvement as a function of BAC. Adapted from Blomberg et al. (2005) and Borkenstein (1974)

Chapter 4

This chapter covers the risk of involvement in an alcohol-related crash faced by special groups of road users. Some, like motorcyclists (4.9), are at special risk because they operate a less-safe vehicle. Others, such as older drivers (4.8), are at risk because they are particularly prone to injury or their driving skills have deteriorated; and still others, such as teenagers (4.3), are at special risk because they are inexperienced and tend to take more chances. Finally, some (e.g., children and infants) are at risk because they are dependent on others who may drink and drive (4.7). Not all of the special groups of interest are at greater than normal risk: Asians and Cubans are less involved in impaired driving than the average citizen (4.6), and females (4.8.2) are less frequently involved in alcohol-related crashes than men.

Early onset of drinking (4.2). Initiating drinking of alcohol before age 21 has been associated with increased risk for subsequent drinking-and-driving and lifetime alcohol-related crash involvement. The earlier drinking begins, the greater the risk of crash involvement, even after adjustments for alcohol dependence and other individual variables. Delaying the onset of alcohol and other drug use holds promise for reducing alcohol-related crashes and associated injuries and deaths. Concern with the early onset of alcohol consumption is supported by recent studies indicating that the brain continues to mature until the mid-twenties, with the possibility that excessive consumption at an early age can affect brain structure as well as function. This supporting evidence growing out of brain research is leading to an increasing interest in the problem of early onset of drinking as a factor in a broad range of adult drinking problems.

Novice drivers ages 15-17(4.3). Among youth ages 15 to 20 in the United States, motor-vehicle crashes are the primary cause of death, and this age group is overrepresented in traffic fatalities and injuries, particularly in alcohol-related crashes and at lower BAC levels. Their relative risk of being in a crash at a given BAC is substantially higher than that of an adult as shown in Figure 7. Diminishing parental supervision and limited driving experience contribute to the problem of alcohol-related crashes for this population. The transition from being driven by parents to driving or riding with peers involves substantial risk to youths of licensing age. Particularly at risk is the novice teenage driver during the first few months of solo driving (Figure 8). Graduated licensing systems that are described in Chapter 5 (5.3.1) appear to hold promise for reducing the crash risk of 15- to 17-year-olds.

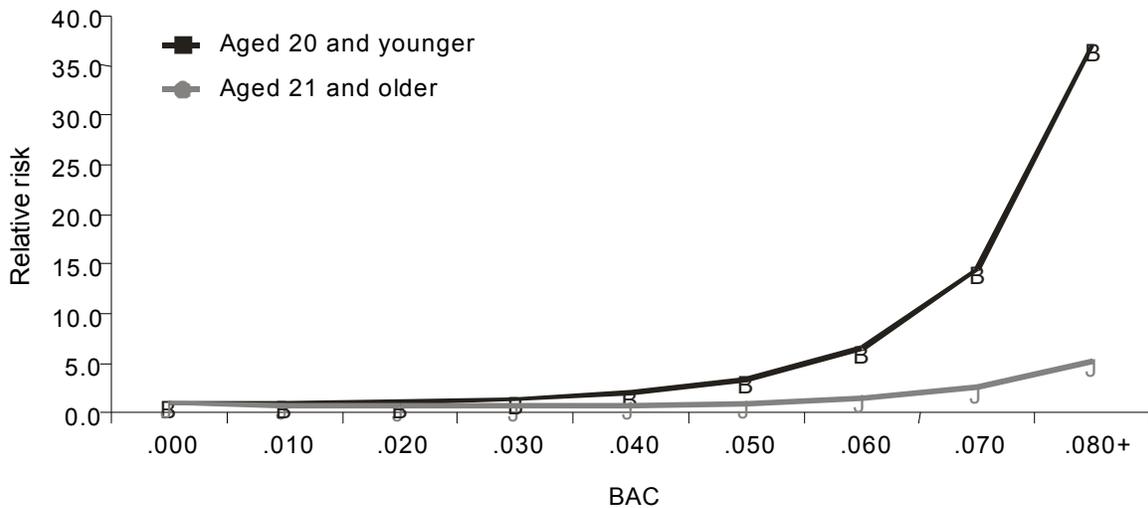


Figure 7. Relative risk for being involved in a crash. Comparison of drivers age 20 and younger and age 21 and older. Adapted from Peck (2007)

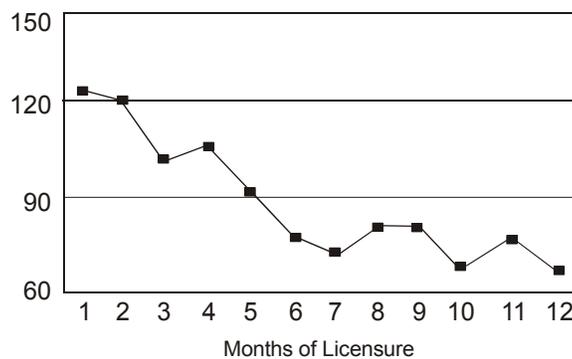


Figure 8. Novice drivers' risk versus experience Adapted from Mayhew & Simpson (1995)

College student drinking and impaired driving (4.4). College students, particularly those from ages 17 to 24 attending school full-time, are at increased risk for driving while impaired. College men are more involved in drinking and driving than are college women. For college students, their increased independence from parents often leads to increased or initiation of alcohol use, and the predominant population with whom they associate are other people their age who tend to be tolerant of increased risky drinking. Initiating drinking at a younger age; being male; drinking at bars, at home,

at a friend's residence, or at parties; and drinking at a location 1 to 5 miles from the driving destination have all been found to be associated with increased risk for drinking and driving.

In a 2005 study, using multiple national data sources to derive estimates of the prevalence of student injuries related to college drinking, Hingson and his associates estimated conservatively that there was an increase of 6% (from 1,600 to 1,700) in unintentional injury deaths among college students ages 18 to 24 between 1998 and 2001. In 1998, 2.3 million college students reported driving while under the influence of alcohol, and 2.8 million reported this behavior in 2001. Although not statistically significant, the percentage of college student alcohol-related traffic deaths increased approximately 5% from 1998 to 2001, from about 14.4 to 15.2 deaths per 100,000 college students.

Drivers in the age group from 21 to 34 (4.5). Drivers ages 21 to 34 account for approximately 45% of the drinking drivers with BAC levels at .08 g/dL or higher. Men are at particularly high risk for crashes related to drinking and driving. Motor-vehicle crashes are the most common cause of death among drivers younger than 35, and many of these deaths involve alcohol. One study in 1996 found that 70% of fatally injured male drinking drivers in FARS were ages 21 to 39, with 65% of those drivers having a BAC level of .15+ g/dL. Using data from the 1996 National Roadside Survey and FARS, Zador and his associates showed that males ages 21 to 34 with BAC levels of .08 to .09 g/dL are 13 times more likely to be killed in a single-vehicle crash than sober male drivers of the same age. Moreover, at BAC levels equal to or greater than .15+ g/dL, these 21- to 34-year-old males were 573 times more likely than a 21- to 34-year-old male driver with zero BAC to be killed in a single-vehicle crash. Women in this age group are generally at considerably lower risk of involvement in an alcohol-related crash.

Age and gender in relation to drinking and crash involvement (4.5.3). Men drink more than women and consumption levels decline with age. Crash involvements vary by age and gender, with alcohol-involved crashes showing a distinctly different pattern than non-alcohol-related crashes. Figure 9 shows the age and gender distribution of drivers in fatal crashes with zero BAC levels. The graph is U-shaped with the highest rates occurring among underage and older drivers. The rates for males and females are similar. In contrast, the graph for drivers with positive BAC levels (>.00 g/dL) (Figure 10) is L-shaped with the highest rates among underage and young adult drivers, with females having substantially lower rates than males.

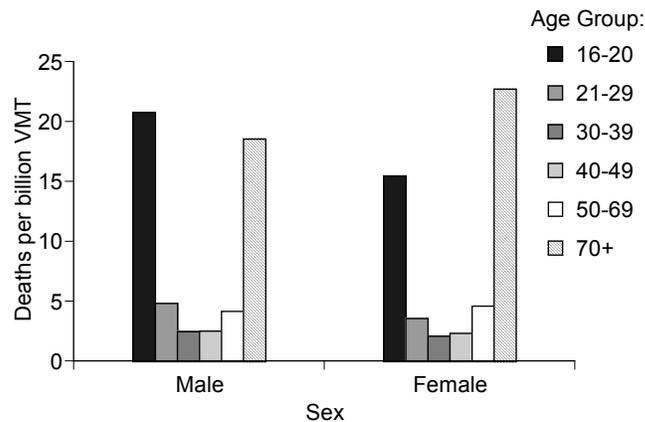


Figure 9. Mileage involvement rate for nondrinking male and female drivers in fatal crashes, FARS, 1990-1994

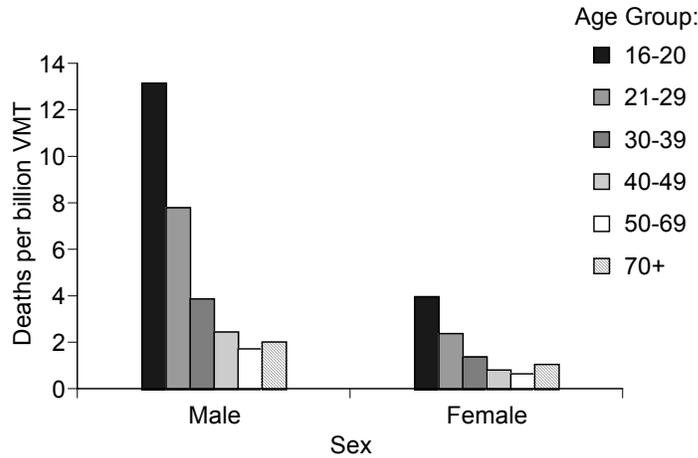


Figure 10. Mileage involvement rate for drinking male and female drivers in fatal crashes, FARS, 1990-1994

Ethnicity and crash involvement (4.6). There is strong evidence suggesting that racial and ethnic groups show dissimilar vulnerability to impaired driving. Such strong evidence has been acquired despite a lack of consensus about what constitutes a race or an ethnicity or how each group should be named. There is ambiguity regarding the criteria of group membership that results in “fuzzy group boundaries” rather than specific and mutually exclusive racial and ethnic categories. Research on traffic crashes has usually focused on the following five racial/ethnic groups: American Indians or Native Americans, African Americans or Blacks, Asians and Pacific Islanders, Hispanics or Latinos, and Whites (with all groups other than Hispanics being non-Hispanics). There is strong consensus that alcohol abstinence is high among Asians and low among Whites. Reports based on the 2000-2005 National Household Survey of Drug Use have consistently indicated that Whites show the highest prevalence of current (past year and past month) use of alcohol among adults (age 18 and older) from all racial/ethnic groups. Rates of past-month or past-year alcohol use are the lowest for Asians and African Americans, intermediate for Hispanics and Native Americans, and highest for Whites. Information on the role of race/ethnicity on impaired driving shows Native-American and White drivers are consistently among those most at risk of impaired driving, whereas Asians are among the least vulnerable. For Hispanics and African Americans, the picture is less clear, with arrest and crash data showing an overrepresentation of both groups in impaired-driving events, whereas data from national surveys show smaller rates of impaired driving for these groups.

Child passengers (4.7). Based on a 1999 national telephone survey, an estimated 46 to 102 million drinking-and-driving trips are made each year with children age 14 and younger in the vehicle. A study of alcohol-related passenger fatalities from 1985 to 1996 showed that there were 5,555 child passenger fatalities involving a drinking driver, and 64% of those fatally injured children were in a vehicle driven by a drinking driver. In two-thirds of these cases, the drinking driver was old enough to be the parent or caregiver of the child. Additionally, an estimated 149,000 child passengers age 14 and younger sustained nonfatal injuries in crashes involving a drinking driver, of which 38.9% were riding with a drinking driver when injured in the crash.

Older drivers (4.8). NHTSA has defined older drivers as people who drive vehicles and are age 70 or older. Because the baby boom generation is reaching retirement age, increasing attention is being devoted to older drivers. However, research on impaired driving by those age 70 and older has been very limited. Although older drivers are involved in fewer alcohol-related crashes, their

sometimes diminished physical health, cognitive changes (e.g., dementia for some), and greater likelihood of taking medications that might interact with alcohol can impair their driving abilities. All these factors play a role in the outcome of alcohol-related crashes. Pedestrians in this age group are also at increased risk for alcohol-related crashes, even when they are not drinking. More research is needed about this population, particularly since U.S. demographic shifts mean this group is growing.

Motorcycle riders (4.9). The rate of motorcyclists' involvement in alcohol-related crashes has been declining, but ironically, the total number of drinking motorcyclist in fatal crashes has increased due to an increase in the number of individuals seeking licenses and operating motorcycles. They are particularly vulnerable as road users (in part, because of their resistance to wearing helmets), which has led to their overinvolvement in alcohol-related crashes, including overrepresentation at BAC levels lower than .08 g/dL. Studies of motorcycle crashes in Hawaii and Florida in 2001 have shown that alcohol-related motorcycle crashes occur more frequently at night and on weekends. These crashes are associated with speeding and other risky driving behaviors, failure to wear a helmet, and riding without a proper motorcycle license. Further, they are more likely to be in single-vehicle crashes than non-alcohol-related motorcycle crashes. The mean age of fatally injured riders has been increasing in the past several years, as has the mean age of alcohol-involved riders. Sixty percent of alcohol-involved fatal crashes involved riders between the ages of 30 and 49.

Pedalcyclists (4.10). Experimental studies have shown that riding a bicycle requires a higher level of psychomotor skills than driving a motor vehicle. At the legal .08 g/dL BAC limit, the performance of pedalcyclists appears to be reduced by more than 80%. Researchers have found that the chance of injury for pedalcyclists with a BAC level of .10 g/dL or higher is more than 10 times greater than for pedalcyclists who have not been drinking. Based on trauma center data, drinking injured bicyclists are more likely than sober injured bicyclists to have a record of a conviction for DWI and to have had their license suspended.

Pedestrians (4.10). Of all road users, pedestrians are killed and injured at higher rates than expected given their proportional road use. A 2005 study showed that pedestrians were more likely than other road users to test positive for alcohol only, rather than alcohol and other drugs (e.g., marijuana) or other drugs only. Pedestrians who tested positive for alcohol were more likely to be killed in traffic crashes and comprised between 39 and 60% of all pedestrian fatalities.

Chapter 5

This chapter covers research on the laws, programs, and policies that have been implemented in an effort to reduce impaired driving and alcohol-related fatalities. It builds on the information presented in earlier chapters and uses a three-part model (Figure 11) to organize the presentation of actions varying from efforts to control risky drinking(5.2), to deterring drinking drivers (5.3.7), to controlling the driving of individuals arrested for driving while impaired. It attempts to cover research on government laws (5.3.6) and programs (5.3.11), as well as private and community (5.3.12) efforts prevent alcohol-related crashes. Although its primary focus is on research conducted from 2000 through 2006, strategies tested earlier are covered and, in some cases, provide a basis for understanding more recent interventions.

Chapter 5 covers interventions directed at reducing alcohol-related crashes. It is organized around the model shown in Figure 10, which reflects the results of a review of the literature on the factors that contribute to alcohol-related crashes and includes relevant research on public health and

traffic safety. It ties together extensive research on (1) the prevention of risky drinking and alcohol use disorders (AUDs), (2) the main area of alcohol safety research—preventing impaired driving; and (3) the clinical research on the treatment of alcohol abusers. The model is divided into three sections, running from left to right. The first section covers *Primary Prevention* that, in this context, is the control of high-risk drinking. The center section, *Secondary Prevention*, focuses on separating drinking from driving. Finally, the third section, *Tertiary Prevention*, covers actions that can prevent future impaired driving by individuals who are apprehended for DWI. The factors named represent those subjects that have been the focus of research interest, and the arrows, derived from research studies, link the various elements in the model. The model clearly reflects the complexity of the interrelationships of the factors that affect impaired driving. Some activities or constructs do not fit easily into the model. Screening and brief intervention (SBI) methodologies, for example, have been used in colleges and primary health care facilities to prevent risky drinking and, therefore, belong in the *Primary Prevention* element of the model. Alcohol screening and brief interventions are also used in emergency rooms with crash-involved drivers, and therefore could also be placed in the *Tertiary Prevention* area.

Primary Prevention: Strategies for Reducing Risky Drinking

The model in Figure 11 suggests that three major strategies influence heavy drinking: *Alcohol Price, Retail Availability, and Alcohol Serving and Sales Practices*. These strategies, in turn, are strongly influenced by *Alcohol Promotion, Community Norms About Drinking, Social Availability, and Drinking Context*.

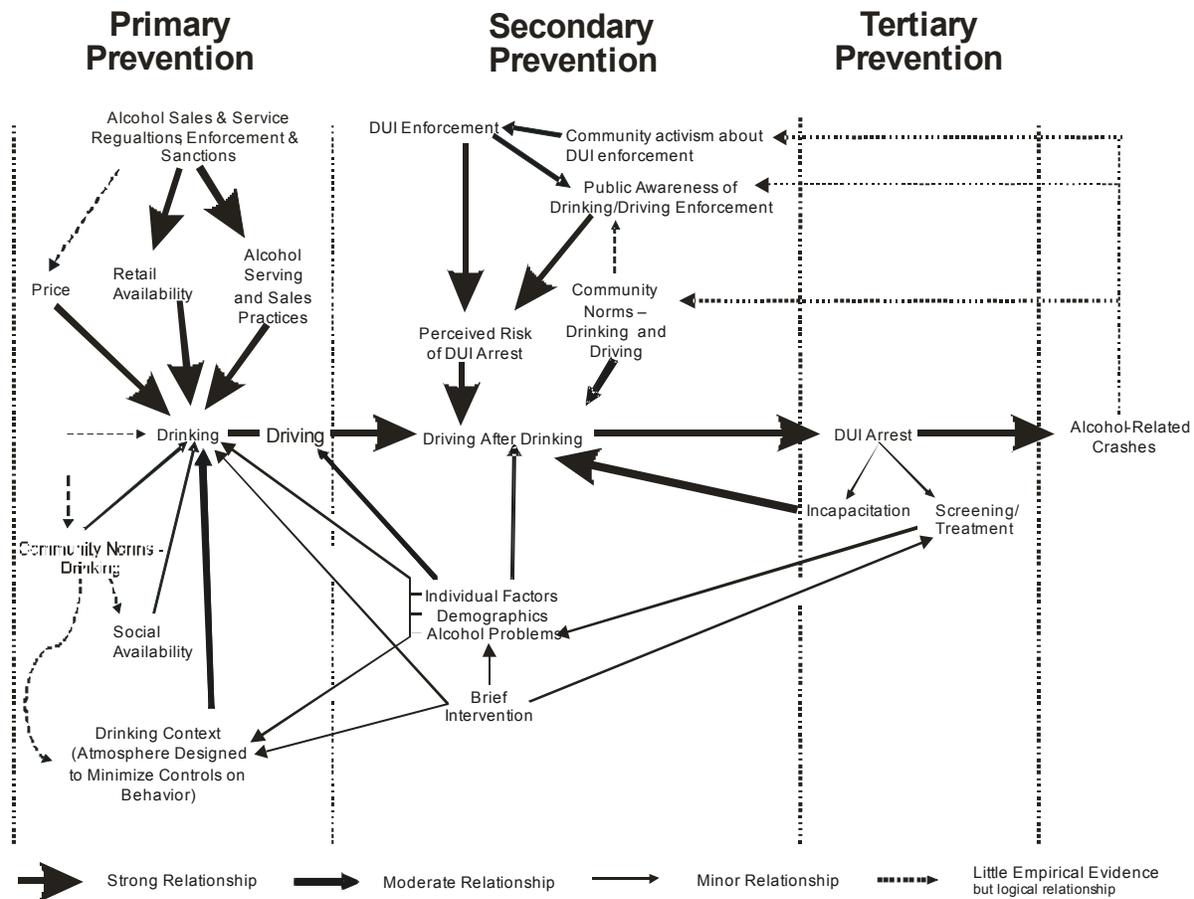


Figure 11. Alcohol-related motor-vehicle crash causal model Adapted from Birckmayer, Boothroyd, Friend, Holder, & Voas (2008)

Alcohol Price (5.2.3). The price of alcohol has been linked to heavy drinking and increased risk of alcohol-related harm. Evidence shows that higher taxes on alcohol reduce alcohol-associated public health problems including traffic crashes. A 2001 study in Canada used time-series analysis to study the relationship of alcohol consumption to alcohol-related crashes in the Province of Ontario from 1972 to 1990. The study found a strong positive relationship between consumption and alcohol-related crashes ($r=.82, p<.01$) and between consumption and alcohol-related offenses ($r=.89, p<.01$). After adjusting the price for changes in inflation and income, they confirmed the negative relationship between alcohol consumption and alcohol-related crashes but not to alcohol-related traffic offenses. Two recent studies in 1999 and 2001 supported earlier studies that price increases would reduce motor vehicle accident fatalities among those ages 18 to 20.

Alcohol Availability (5.2.4). Availability is how accessible or convenient it is for individuals to obtain alcohol (independent of the cost of alcohol). In general, when alcohol purchases are convenient and easily accessible in a given community, people drink more and the rates of alcohol problems are higher. Conversely, when alcohol is less convenient (e.g., fewer retail outlets and limited hours of sale) and less accessible (e.g., restrictions on drinking age), people generally drink less and problem rates are lower. Retail availability of alcohol can be affected by license restrictions, hours of sale, minimum age of purchaser, and alcohol outlet density (distance to a retail outlet). Research on restrictions or limits on retail availability of alcohol have generally demonstrated an overall effect on the level of consumption by the general population and on alcohol-related problems.

One strategy that reduces drinking by underage individuals, which should also reduce alcohol-related motor-vehicle crashes, is restricting retail access to alcohol through minimum purchase age laws. Raising the minimum purchase age to 21, which has been adopted by all 50 States plus the District of Columbia, has resulted in decreased alcohol consumption among the affected age group. A 2002 review found 57 published studies that assessed the effects of changes in the legal minimum drinking age on indicators of drunk driving and traffic crashes. The authors analyzed 102 crash outcome measures (e.g., fatal crashes, drink-driving crashes, self-reported driving-after-drinking), and in more than 50% of the 103 measures, they found that raising the drinking age reduced crashes, and lowering it raised the crash rate. However, enforcement of MLDA laws appears to be weak. Several studies have found that buyers who were age 21, but looked underage, could buy alcohol about 50% of the time. Purchases by such pseudo-patrons at off-premises establishments were more successful if the clerks were male and the store was located in a residential area or mall.

Responsible Alcohol Serving and Sales Practices (5.2.5). Responsible Beverage Service (RBS) Programs involve training bartenders and waiters to control the service of alcohol to patrons of drinking establishments. These programs generally involve three basic elements: (1) control of service to prevent intoxication, (2) refusal of service to visibly intoxicated individuals, and (3) actions to prevent intoxicated patrons from driving after leaving the premises. Actions that control service also include management policies that avoid reduced price or oversized alcoholic drinks and serving food with alcoholic drinks. Evaluations of server training programs have shown some significant shifts toward more responsible service on the part of both servers and managers of licensed establishments. Research suggests that server training alone appears to have limited effectiveness. A 2001 evaluation of RBS studies contended that responsible beverage service could be effective in reducing patron intoxication when it was accompanied by strong and active management support. That support may be dependent on strong enforcement of alcohol beverage control laws that motivate managers to adopt safe practices.

Laws directed at preventing high-risk sales (5.2.6). Dram shop laws allow individuals injured by an adult or a minor who is under the influence of alcohol to recover damages from the alcohol retailer who served or sold alcohol to the person causing the injury. In some jurisdictions, the retailer can also be liable for the damages the minor or drinker causes to himself or herself. Owners and licensees can be held liable for their employees' actions under most or all dram shop liability laws. Research suggests that implementation of dram shop liability may lead to significant increases in checking age identification and to greater care in service practices to intoxicated individuals. Early studies have indicated that dram-shop-liability laws can significantly reduce single-vehicle nighttime (SVN) crash deaths, alcohol-related traffic crash deaths, and total traffic crash deaths among minors. Overall, dram shop liability has been estimated to reduce alcohol-related traffic fatalities among underage drivers by 3 to 4% (Chaloupka, Saffer, & Grossman, 1993).

Currently, 47 States and the District of Columbia prohibit sales to obviously intoxicated people (Florida, Nevada, and Wyoming are the only exceptions). Nevertheless, research indicates that alcohol sales to obviously intoxicated patrons in on-premises establishments, such as bars, occur 58 to 85% of the time. These laws are often not enforced by the police and are ignored by bar and liquor store owners. One study, in 2004, used trained actors who tried to buy alcohol while appearing intoxicated. Over 10 months, these actors visited 372 bars and liquor stores in 11 communities. The research team found 79% of the establishments sold alcohol to these "pretend" drunks.

Secondary Prevention: Preventing Impaired Driving

Introduction to secondary prevention (5.3). The *Primary Prevention* section of Chapter 5 focused on programs that encourage abstinence from or avoidance of risky drinking. Although many of the laws and policies reviewed appeared to be effective in reducing heavy consumption, 68% of men and 60% of women reported drinking in the last year (see 3.3 and Chen, Neighbors, Gilson, Larimer, & Marlatt, 2007). It has been well established that drinking and driving is prevalent in the United States (see Chapter 2.3). As indicated by roadside surveys, about 1 in 10 motorists on weekend evenings have been drinking. As shown in the causal model in Figure 11, the focus of the central section on *Secondary Prevention* is on deterring drinkers from driving after they have consumed alcohol. Deterrence is produced predominantly through laws, law enforcement, and publicity that increase the public's perception of the risk of arrest if they drive while impaired by alcohol or other drugs.

Traffic safety education (5.3.1). The high crash rate of young novice drivers (16-year-old drivers have crash rates that are three times greater than 17-year-olds, five times greater than 18-year-olds, and even twice those of drivers age 85), including their involvement in alcohol-related crashes, has been recognized for the last 50 years. Research has shown that three factors—inexperience, immaturity and risk-taking, and greater exposure to risk—play a prominent role in crashes involving teenagers. Research around the world has shown that the first few months of licensure for young novice drivers entail the highest crash risk. To address this issue, many States have adopted graduated driver licensing (GDL) systems that require staged progression to full license privileges (NCSA, 2003). 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. The system consists of three stages: a learner's permit stage, an intermediate or provisional license stage, and a full licensure stage. Evaluations of State programs clearly show the benefits of adopting the GDL system. For example, the GDL law in Florida was associated with a 9% reduction in crashes for 16- and 17-year-old drivers.

Low BAC limits for young drivers (5.3.2). Another law aimed at the high-level of crash involvement by young drivers—both the 16- and 17-year-old novice drivers and the 18- to 20-year-old drivers—is the zero tolerance law. By 1998, all States and the District of Columbia had passed laws making it illegal for any driver younger than 21 to have a positive BAC level. Zwerling and Jones (1999) conducted a systematic review of zero-tolerance laws and their effect on alcohol-related injuries and fatalities. The six studies that met their strict selection criteria showed reductions in injuries and fatalities associated with the implementation of zero-tolerance laws, and in three of those studies, the reductions were statistically significant. The total evidence is strengthened even more because similar results were found in two countries (Australia and the United States) using different methods and different outcome measures.

Key alcohol safety laws (5.3.6). Administrative license suspension or revocation (ALR) laws provide for the arresting officer to seize the driver's license when an offender is arrested for DWI. The license is then sent to the motor vehicle department, following which driving privileges of the offender will be suspended within a short period following apprehension. Based on deterrence theory (see below), this should have a general deterrent effect on impaired driving. This conclusion has been supported by numerous studies. A 2003 panel study by Voas and his coworkers of the 50 States and the District of Columbia from 1982 to 1997 found that ALR laws were associated with a 19% decline in alcohol-related fatal crashes. A meta-analysis of 46 studies of State laws, which included 12

evaluations of ALR laws by Zobeck and Williams (1994) found an average reduction of 5% in alcohol-related crashes and a reduction of 26% in fatal crashes associated with administrative licensing revocation. Miller, Galbraith, and Lawrence (1998) concluded that the benefit-to-cost ratio was \$11 per dollar invested when violators received a 6-month license suspension. As of 2005, 41 States had enacted ALR laws.

.08 per se laws. Between 1991 and 2000, nine evaluations of .08 g/dL laws involving 11 States were conducted in the United States. A scientific review by a committee of experts assembled in 2001 by the Centers for Disease Control and Prevention (CDC) concluded that the median treatment effect detected by the studies of the effects of .08 g/dL BAC laws was a 7% reduction in alcohol-related fatal crashes. A review by the U.S. General Accounting Office in 1999 found that the .08 g/dL law was effective, but generally only when combined with an administrative license revocation law. To test the significance of the combination of the two laws, Hingson and his coinvestigators (2000) compared States in which the two laws were implemented at about the same time with States where an ALR law had been in place for at least a few years before adoption of a .08 g/dL law. They found that the .08 g/dL law made a significant difference in States where the ALR law had been in place for some years.

Implied-consent laws, which have been adopted by all States, provide for license suspension for failure to submit to a chemical test. Although this provides a strong motivation for a DWI suspect to comply with the test, most defense attorneys advise their clients to refuse because an illegal BAC makes DWI conviction much more certain. This problem is likely to be exacerbated by the growth of high-BAC laws that result in more severe penalties based on the offender's BAC level. Zwicker, Hedlund, and Northrup in 2005 developed estimates for 40 of the 50 States of refusal frequency that varied considerably across the States. Simpson and Robertson's 2001 survey of 2,731 police officers found that officers experienced some type of refusal to cooperate in a DWI investigation about one-third of the time and that multiple offenders were more likely than first offenders to refuse the chemical test.

High BAC laws. As of July 2005, 32 States and the District of Columbia had enacted high-BAC laws, yet there has been only one study of their implementation. In 2004, McCartt and Northrup conducted a study of Minnesota's high-BAC law and detected a short-term increase in the severity of penalties for offenders with BAC levels of .20 g/dL or higher, the State's definition of a high-BAC offense. Despite the apparent increase in the severity of the penalties for a high BAC level, the test refusal rate for first offenders decreased; however, the refusal rate for multiple offenders remained unchanged. The authors attribute this to the relatively severe penalties for refusal in Minnesota. They also reported a decline in the recidivism rate for first offenders that was reduced over time. Despite the wide adoption of high-BAC statutes, no study has attempted to relate high-BAC sanctions to crashes.

DWI Enforcement (5.3.8)

Sobriety Checkpoints. Evaluations of the random breath test (RBT) enforcement procedure in which any driver can be stopped and required to provide a breath test, which is used in Australia and Sweden (among other countries), have demonstrated the effectiveness of random breath testing as a method of enforcing DWI laws. Because the U.S. Constitution limits the ability of police to require a BAC test unless they have reason to believe that the suspect driver has been drinking, American officers are limited to a brief interview at checkpoints. In 1997, Henstridge, Homel, and Mackay conducted a time-series analysis for four Australian states and found that RBT was twice as effective

as selective checkpoint systems used in the United States. Although not as effective as RBT, many studies conducted over the last two decades in the United States have found significant decreases in alcohol-related crashes associated with sobriety checkpoint programs in States such as Arizona, Florida, Virginia, New Jersey, North Carolina, Tennessee, and New York.

Enforcement Technology (5.3.9). In 1999, Moskowitz, Burns, and Ferguson conducted an experiment in which individuals were limited to detecting a drinking person only through their sense of smell. Under those conditions, they were unable to identify impaired drivers with any regularity. Thus, the validity for predicting impairment is limited when left purely to the sense of smell. Police officers, of course, have many other cues to use in detecting a drinking driver, dependent on their having the time to observe the potential offender. Although sobriety checkpoints have been shown to be effective in reducing alcohol-related crashes, police departments have resisted implementing this procedure, partially because few DWI arrests are made in checkpoint operations. As noted, this occurs in part because the officer cannot test every driver stopped. A device designed to aid the officer in detecting drinking is the PAS III, a standard police flashlight with a built-in passive alcohol sensor. It draws in a mix of expired and environmental air from in front of a person's face. These sensors can provide a good estimate of whether a driver has been drinking. The PAS appears to be particularly effective when observation time is short; therefore, it is a potentially helpful police aid at checkpoints. Furthermore, a series of studies have demonstrated that when officers use passive sensors at a checkpoint, more drinking drivers are detected and the arrest rate increases by approximately 50%.

Tertiary Prevention

Treatment programs(5.4.7). The proportion of first offenders who exhibit alcohol use disorders (AUDs) is not entirely clear as research studies have varied in the number identified as dependent or abusers with estimates varying from 10 to 80%. A significant problem for treatment providers working within the criminal justice system is that screening for AUDs may occur under what the offenders view as coercive conditions if they are aware that assessment is likely to influence the length and intensity of treatment. If this is the case, they are unlikely to be forthcoming in describing their alcohol problems. It is clear, however, that a substantial proportion of first offenders and essentially all multiple offenders can profit from a therapeutic program that goes beyond a short classroom educational effort. Despite this limitation, there is substantial evidence that treatment programs are effective in reducing offender recidivism and crash involvement in which alcohol plays a role.

In a 2002 paper by Wells-Parker and Williams commenting on their review of court-mandated treatment, they noted that “In general, research has consistently shown that treatment has a modest effect on reducing drinking-driving and alcohol-impaired crashes among offenders who are mandated to attend and *who actually receive the intervention*” [emphasis added]. Dill and Wells-Parker in their 2006 review of mandated treatment for DWI offenders, indicated that such programs have shown less effectiveness in reducing the severity of alcohol-related problems other than impaired driving. A notable exception, however, was the study by Mann and his coworkers in 1994. They found that offenders who received treatment had lower overall mortality rates compared to similar untreated offenders in a comparison group.

DWI/Drug Courts (5.4.8.2). Based on the effectiveness of drug courts for substance abusers, DWI courts have begun to emerge. Modeled after drug courts, DWI courts are designed to provide constant supervision of offenders by judges and other court officials who closely administer and

monitor compliance with court-ordered sanctions coupled with treatment. DWI courts generally involve frequent interaction of the offender with the DWI court judge, intensive supervision by probation officers, an appropriate level of treatment, random alcohol and other drug-testing, community service, lifestyle changes, positive reinforcement for successful performance in the program, and jail time for noncompliance. DWI courts reportedly have held offenders accountable for their actions, changed offenders' behavior to end recidivism, reduced alcohol abuse, treated the victims of DWI offenders in a fair and just way, and protected the public.

Methods for Controlling Impaired Driving by DWI Offenders (5.4.9)

Motorists convicted of DWI offenses are high-risk drivers, as shown in studies of the extent to which they delay reinstatement. They are at particularly high risk immediately after arrest and conviction, which is the time they should be receiving treatment. The public needs protection from these high-risk drivers. Conceptually, this can be accomplished in three ways: (1) by preventing driving (which is the intent of license suspension, but which is no longer fully effective), (2) by preventing drinking, or (3) by preventing the combination of the two. Impounding, immobilizing, or forfeiting the offender's vehicle (5.4.9.1), in addition to license suspension, prevents driving. Intensive court-monitored abstinence through surprise breath or urine test programs, remote electronically monitored in-home breath tests, or sensors worn on the body prevent drinking. Finally, vehicle alcohol interlocks provide a parsimonious method of preventing the combination of drinking with driving. The status of each of these preventive approaches is briefly discussed in the following paragraphs.

Vehicle sanction overview (5.4.9.1). Overall studies to date suggest that impoundment is an effective method of reducing the recidivism of DWI and DWS offenders. To be effective, the vehicle must be impounded at the time of the arrest, and a procedure must be devised to deal with nonoffender owners. In Ohio, impoundment legislation was strengthened by two additional pieces of legislation: one prevented an offender from registering another vehicle while the vehicle driven at the time of arrest was impounded, and the other allowed the police to hold the vehicle of a nonoffender unless the owner could demonstrate that it had been driven without permission. Because a substantial proportion of offenders do not retrieve their vehicles, some localities will be liable for storage and towing expenses if the sale of the offender's vehicle does not raise sufficient funds to cover these expenses. Of the various vehicle sanctions, impoundment appears to be the most clearly effective for reducing recidivism for both DWI and DWS offenders. License plate forfeiture appears to have considerable promise but has received limited evaluation.

The interlock record of all breath tests associated with driving can provide the treatment specialist with important information for use in evaluating the status of participating offenders, and the information can also be used in therapy sessions to help the offenders confront their drinking problem (Marques and Voas (1995; see also Beirness, Marques, Voas, & Tippetts, 2003). Timken and Marques (2001b, 2001a) developed a *Support for Interlock Program (SIP)* that uses the data from the interlock recorder in therapy sessions for DWI offenders. A preliminary test of the SIP program was conducted and evaluated in Texas (Marques, Voas, & Timken, 2004b; Marques, Voas, Timken, & Field, 2004a). Participants in the SIP program demonstrated large decreases in self-reported drinking and drinking problems.

Vehicle alcohol interlock devices (5.4.9.2). Perhaps the most direct and specific method for preventing impaired driving by DWI offenders is to require that they place on their vehicles a device that will not permit the engine to start if the prospective driver has been drinking. This interferes only

minimally with the offender's life while protecting the public from the risk of impaired driving by suspended drivers. As of 2004, 43 States have laws providing for interlock programs, but only a small proportion of DWI offenders have been motivated to install interlocks despite the strong evidence for their effectiveness when on the vehicle. The units have four basic elements: (1) A breath alcohol sensor that records the driver's BAC level and can be set to provide a warning if any alcohol is detected that prevents starting the vehicle if the BAC level is .03 g/dL or higher, (2) A rolling retest system that requires a new test every few minutes while driving to prevent an offender from starting the vehicle for a person who has been drinking, (3) A tamper-proof system for mounting the unit in the vehicle that is inspected every 30 to 60 days, and (4) A data-logging system that records both the BAC tests and engine operation, thus ensuring that the offender is actually using the vehicle and not simply parking it while driving another vehicle. In 1992, NHTSA issued "Model Specifications for Breath Alcohol Ignition Interlock Devices" that recommended standards for sensitivity and reliability and provided for the incorporation of rolling retests and data-recording systems on ignition interlocks to make circumvention difficult.

The interlock data recorder also provides important information for predicting future recidivism, particularly when combined with the prior record of the offender. This opens up the possibility that, rather than assigning interlock requirements for fixed periods, the time during which the offender would be required to have the interlock on the motor vehicle would be determined by the interlock breath-test record. Therapists can also use the status of the interlock BAC record to assist them in determining how long DWI offenders should remain in treatment. Although only about 10 percent of DWI offenders installed interlocks, if they do participate in an interlock program, there is strong evidence that their recidivism is substantially reduced since they have 36 to 90% lower DWI recidivism rates than similar DWI offenders who remain suspended.

Chapter 6

This chapter reviews the findings of the 2001 prior report and notes the principle studies that relate to the research that that earlier report indicated was needed. It also describes three other reviews of research and comments on the studies conducted since 2001 that relate to those reviews. The major research areas covered in this 2006 summary are highlighted along with those areas of research that appear most likely to be actively pursued in the future. Following are the summarized major findings of recent alcohol and highway safety research as described in this report.

Prevention of risky drinking (6.2.3). Section 5.2, which covers the research on primary prevention, deals mostly with programs directed at reducing heavy drinking, especially in situations that lead to impaired driving. There is substantial evidence that raising the price of alcohol through excise taxes or other means reduces consumption and alcohol-related crashes, particularly among underage drinkers. Laws that limit the number of alcohol outlets, such as State monopoly of sales, or restrict the times or locations where alcohol can be sold also reduce consumption and alcohol-related crashes. The evidence for the effectiveness of responsible beverage service programs is somewhat contradictory and limited to reductions in drinking by bar patrons and apparently requires strong enforcement to be effective. Strong enforcement of ABC laws against service to the obviously intoxicated appears to produce effective responsible beverage service programs. The designated-driver concept has received much public attention and some encouragement from research studies but a review in 2005 of the evidence for the effectiveness of the designated-driver concept found it to be insufficient.

One of the most active fields of investigation since the last update has been the study and evaluation of screening and brief intervention procedures that are being broadly implemented in emergency rooms and trauma facilities, and also in university health and safety programs and medical service facilities. There is substantial research evidence for the effectiveness of screening and brief interventions in reducing risky drinking. The evidence for their effectiveness in reducing impaired driving and alcohol-related crashes is more limited. (For more information on Alcohol Screening and Brief Interventions, see the *Special Report on Screening and Brief Intervention for Alcohol Problems: A Community Approach to Improving Traffic Safety*.)

Underage drinking and impaired driving (6.2.4). There is strong agreement that MLDA laws effectively reduce underage drinking and driving, but enforcing underage-drinking laws varies substantially among States. Police decoy operations using underage officers who try to buy alcohol can substantially reduce sales to minors, but deterrence produced by such operations fades after 3 months. The effects of other types of alcohol sales enforcement operations are not as well documented. There is substantial evidence for the effectiveness of zero-tolerance (ZT) laws; however, enforcement of ZT laws has been complicated by the weak laws that some States have enacted. As noted in 5.3.1, school programs have generally not resulted in behavioral changes.

Impaired-driving laws (6.2.5). Although .08 g/dL and zero-tolerance laws have proven effective and have been enacted by all the States and the District of Columbia, the current issue regarding those laws is the extent to which States and communities choose to enforce them. There have been a large number of research studies on DWI enforcement (5.3.8); however, more work on enforcement methods is needed to develop more effective low-cost, high-visibility programs that can be more readily carried out by local police agencies. Although ALR laws are effective (5.3.6), as of 2006, nine States still had not enacted these laws. Several laws that have been passed in a few States seem promising, but they have not yet been shown to reduce alcohol-related crashes. For example, there is evidence that increased penalties for refusal to take a BAC test reduces the number of DWI suspects who refuse the test; however, it has yet to be proved that this results in reduced alcohol-related crashes. Similarly, as noted in 5.3.6, both the laws providing for more severe penalties for offenders with high BAC levels and the laws banning open containers in vehicles have received little research attention. The extensive surveys of the DWI criminal justice system by Robertson and Simpson, reported in 2001 and 2002, suggest the laws in most States need to be simplified and better organized. Although this appears to be logical, research studies showing the effectiveness of such reorganizations are lacking.

Law enforcement (6.2.6). Substantial research effort has been applied to the implementation of high-visibility enforcement efforts at the State and regional levels. Evidence for the effectiveness of checkpoints (5.3.8.3) is extensive, but checkpoints are underused by the States and especially by the local police departments because of the concern that they require substantial staffing and resources but result in few arrests. There is strong evidence that passive alcohol sensors (5.3.9.3) increase the detection of impaired drivers at checkpoints, but unfortunately passive sensors have been used too rarely to determine their effect on alcohol-related crashes. Both preliminary breath tests (PBTs) and passive sensors assist officers in detecting impaired drivers, but PBTs (5.3.9.4) are much more widely used. Further, there is evidence that they increase the number of DWI arrests made by officers who are equipped with them. The evidence suggests that passive sensors are most effective when used at checkpoints where they can increase arrests by up to 50%.

Prosecution/Adjudication (6.2.7). Among the traditional penalties for the DWI offense—license suspension, fines, and jail—there is strong evidence for the effectiveness of license suspension in reducing recidivism and alcohol-related crashes of DWI offenders. The effectiveness of license suspension has been eroded by the limitations imposed on the police in their enforcement of laws against DWS. A 2007 study by Wagenaar and associates reviewed 39 research reports on fines and jail sanctions from 1992 to 2006. They reported that only 6 of the 19 studies that evaluated fines showed a relationship of such sanctions to drinking or impaired driving. Jail is a sanction that is much more difficult to evaluate because of the complex role it plays in both general deterrence (reducing impaired driving by the public) and special deterrence (reducing recidivism of DWI offenders) (5.3.7). Particularly complex is the role of jail in the sanctioning of DWI offenders because it is the threat behind every court sanction. Failure to follow the court’s probation requirements can be punished by imprisonment, so, independent of its direct effect on recidivism and or crashes through its incapacitating effect, it is important to keep jail as a sanction to reinforce other measures, such as treatment program requirements and house arrest or interlock programs. In the Wagenaar and associates review in 2007, they identified 20 studies of the jail sanction between 1991 and 2006. Only two of those reported decreases in traffic fatalities, whereas five similar studies failed to show a relationship to fatalities. Their own study of 18 States, which imposed minimum jail penalties between 1976 and 2002, found 5 States with decreases and two with significant increases in SVN crashes. They concluded the evidence for the effectiveness of mandatory jail penalties was weak.

Treatment, monitoring, and control of offenders’ driving (6.2.8). Treatment programs have been shown to reduce DWI offender recidivism and alcohol-related crashes, particularly when combined with other sanctions. As might be expected, however, treatment chiefly affects alcohol-related crashes rather than non-alcohol-related crashes that are primarily a function of the extent of driving exposure. Offender monitoring includes several types of programs (including intensive probation supervision) and is an element in DWI courts and interlock programs, which are receiving increased attention. DWI courts are just beginning to be fully evaluated. Among sanctions for repeat offenders, ignition interlock programs have received the greatest research attention, and the effectiveness of this device while on the offender’s vehicle is well established. So far, however, only about 10% of the eligible offenders have installed interlocks. The most widely used vehicle sanction is impoundment, but the most promising may be license plate confiscation as it avoids court hearings and the potential cost to the community of long-term storage of vehicles that offenders fail to retrieve.

Looking ahead (6.3). Although public attention to impaired driving has declined since its peak in the 1980s and 1990s, government support for traffic safety research and safety demonstration programs has continued to increase, but this support certainly is not commensurate with the magnitude of the problem. What we know about alcohol safety laws and programs suggests considerable room for revising and strengthening current State and community efforts to reduce impaired driving. Progress in understanding the drinking-and-driving problem, combined with development of new technologies, is offering opportunities to resume the decline of alcohol-related crashes nationwide, which stagnated in 1995.

Chapter 1.

Introduction and Method

This chapter covers three areas: a review of the previous Alcohol and Highway Safety Reports, a description of the scope and approach to the development of this volume, and a description of the literature search methodology.

1.1. The NHTSA Alcohol and Highway Safety Reports

The year 2006 marked the 40th anniversary of the passage of the Highway Safety Act that provided the foundation for the Department of Transportation (DOT) and the National Highway Traffic Safety Administration (NHTSA). During those four decades, NHTSA sponsored research and supported demonstration programs that have provided much of the scientific background for the growth in traffic safety legislation and safety programs including alcohol-impaired driving. Further, between 1968 and 2003, the national highway fatality rate fell from 5.49 to 1.48 per hundred million miles of travel. An important element of NHTSA's support for alcohol safety research has been a series of reports on alcohol and highway safety. This is the sixth report that reviews the state of knowledge on alcohol and highway safety, dating back to 1968.

The first report in this series was issued in 1968 (U.S. DOT, 1968) in response to a Congressional requirement when the agency was founded. The DOT report summarized the fairly limited research in the traffic safety field and highlighted the role of "heavy drinkers" (alcoholics and problem drinkers) in the alcohol-related crash problem. It had a substantial influence on the safety community and was an important factor in the decision by Congress to appropriate funds for the Alcohol Safety Action Program (ASAP), the first National demonstration program on drinking and driving (Levy, Voas, Johnson, & Klein, 1977). A followup to the 1968 report, *Alcohol and Highway Safety: A Review of the State of Knowledge*, was published a decade later (Jones & Joscelyn, 1978). This complete update of the alcohol safety field that had grown substantially resulted from the research and demonstration programs funded by NHTSA in its first decade. The report covered three main areas: (1) it defined the alcohol-crash problem, (2) it addressed the alcohol-crash problem, and (3) it provided future directions for the alcohol-crash problem. When this report was published, the national alcohol fatality record system did not exist; therefore, the publication contained an extensive review of individual studies in localities throughout the United States. An important addition to the 1968 report was its presentation of a "health approach" as a part of the criminal justice system. This approach, which focused on screening people convicted of DWI offenses and referring them to treatment, grew out of the ASAP program's health approach that had been implemented as a part of the total community program. Despite research conducted since the 1968 report, the 1978 publication concluded that the "the state of knowledge pertaining to fundamental hypotheses upon which most

alcohol safety programs have been based in the past is totally inadequate for designing and operating effective programs.”

States have used a number of terms for the impaired-driving offense, such as driving under the influence (DUI), driving while impaired (DWI), and operating while under the influence (OWUI). This document uses the term “DWI” to cover all such terms.

In 1984, an interim update of *Alcohol and Highway Safety* was published by NHTSA (1985). This report built on the 1978 report and included the “most clearly important studies and findings for the period from January 1978 to December 1982.” This update contained the first discussion of vehicle and roadway engineering programs as methods for reducing impaired-driving crashes. It provided the first mention of alcohol safety interlock systems. It also discussed under the topic of exposure reduction (e.g., reduction in alcohol availability) the emergence of underage drinking as a potential issue in traffic safety and the possible value of age 21 as the minimum legal drinking age (MLDA) limit. Finally, it was the first of the alcohol and highway safety reports to present data from the newly established Fatality Analysis Reporting System (FARS, originally titled Fatal Accident Reporting System). The report noted a 2% reduction in drivers in fatal crashes with BACs of .10 g/dL or higher from 1980 to 1982, which was the legal limit for driving at that time.

In 1989, NHTSA sponsored the fourth in its series of *Alcohol and Highway Safety* reports (Jones & Lacey, 1989) that established the style and format adopted by all the subsequent editions. Influenced in part by the *Surgeon General’s Workshop on Drunk Driving* (OSG, 1989) that was held the year before, this update gave considerable attention to controls on the availability of alcohol, reporting that 28% of the countermeasure documents reviewed related to availability. This increased focus on laws and policies related to drinking, as distinct from impaired driving, and reflected the movement to close the gap between research on traffic safety and research on public health issues surrounding alcohol abuse that was stimulated by the *Surgeon General’s Workshop*. This report gave more space to private sector programs such as “Designated Driver” and “Safe Ride” (outlet-funded free rides for intoxicated patrons) programs. It also provided the first reviews of the developing literature on the effectiveness of administrative license revocation (ALR) laws that provide for immediate suspension of a driver arrested for DWI.

The most recent publication in this series was *Alcohol and Safety 2001* (Jones & Lacey, 2002), the precursor to the current volume, covering the period from 1990 to 2000. It is the most comprehensive of the volumes to date (156 pages compared to 89 pages for the 1989 volume). The authors (p. 155) found evidence for the effectiveness of four types of legislation when enforced: ALR laws, reducing the legal BAC limit from .10 g/dL to .08 g/dL, raising the MLDA to 21, and zero-tolerance laws. With the FARS data system in place for over a decade, the report concluded that the “...hard data on the nature of the alcohol-crash problem are adequate for defining the gross prevalence of alcohol-impaired drivers in fatal crashes...” and that “...the alcohol-crash problem in general has declined significantly in recent years.”

1.2. Other Comprehensive Reviews

Several comprehensive treatments of the subject have been conducted since 1978. The first was the report of the Presidential Commission on Drunk Driving (1983). It incorporated commentary and opinions from the Commission’s sessions and reviewed some of the literature on impaired

driving, particularly countermeasures since the Commission's objective was to generate national and State legislative action.

Another early examination of the alcohol and safety literature was published in 1984 as a result of a conference sponsored jointly by the Johns Hopkins Medical Institutions and the Alcoholic Beverage Medical Research Foundation. DOT and the National Safety Council were cosponsors. The results of the conference were published in the conference proceedings (Turner, Borkenstein, Jones, & Santora, 1985).

Perhaps the most significant research update was published as a product of the *Surgeon General's Workshop on Drunk Driving* (Office of the Surgeon General [OSG], 1989). That publication consisted of a compendium of 15 papers provided by experts in traffic safety and in public health research. It covered a wide range of topics, including the pricing and availability of alcohol, alcohol advertising, and marketing, as well as traditional topics such as the epidemiology of impaired driving, law enforcement, and DWI offender treatment programs. The significance of the publication was based on the participation in the workshop by researchers in both traffic safety and public health. Bringing together leaders in these two fields served to integrate public health activities directed at reducing the health risks presented by alcohol. The early studies supported by NHTSA that were summarized in the series of *Alcohol and Highway Safety* reports tended to be limited to traditional highway safety programs such as enforcement, adjudication, and treatment of alcohol offenders. Following the *Surgeon General's Workshop*, however, traffic safety researchers had a greater appreciation of the relationships between programs and policies directed at moderating alcohol consumption and crash injury reduction. Similarly, public health research scientists had an increased appreciation of the value and importance of traffic safety data as indicated by their importance in the study of underage drinking.

In 2001, the Transportation Research Board (TRB) Committee on Alcohol, Other Drugs, and Transportation produced a report on research needs and priorities (TRB, 2001). That document, like the *Surgeon General's Workshop Report* (OSG, 1989), consisted of a compendium of individual papers. The presenters at the conference were required to respond to a set of evaluative questions; their responses were used to develop a list of alcohol research priorities. Among these priorities were the following: (1) determine the extent to which programs and policies have specific deterrent effects on repeat (DWI) offenders, (2) study the global trends in alcohol-related crashes and fatalities, and (3) determine and understand the differences in alcohol-related crash rates across ethnic groups. The list of priorities described in the report presents a fairly clear picture of the status of research on alcohol and highway safety at the beginning of the new millennium.

In October 1998, the National Institute on Alcohol Abuse and Alcoholism (NIAAA) convened an Extramural Scientific Advisory Board meeting on prevention. This advisory board assembled many experts who reviewed the state of knowledge and the research needs on a broad range of topics related to the prevention of alcohol problems, including drinking and driving. The review of underage alcohol problem prevention by Grube (NIAAA Extramural Scientific Advisory Board, 1998) suggested that education programs were generally ineffective and that efforts should be concentrated more directly on drinking and driving, and intoxication. This point was reflected by Larimer and Cronce (2002) in their NIAAA-commissioned paper for the Task Force on College Drinking. The authors found limited empirical evidence supporting education and awareness programs to reduce college drinking; they found better evidence that interventions targeted at the high-

risk population of problem drinkers or special risk groups (e.g., first-year students) may be effective. The full task force report provides a comprehensive review of the college drinking problem.

Several smaller, independent reviews of the alcohol safety area have appeared during the last 5 years, among which is the “Epidemiology and Consequences of Drinking and Driving” by Hingson and Winter (2003). They described the groups most at-risk for involvement in alcohol-related crashes, reporting that there are 80 million trips each year in which a driver exceeds the legal BAC limit (.08). Further, although alcohol-related fatal crashes decreased in the 1980s, there has been little reduction since the mid-1990s and even a slight increase between 2000 and 2003. A report funded in part by the World Health Organization (WHO), *Alcohol: No Ordinary Commodity Research and Public Policy* (Babor et al., 2003), provided a broad review of alcohol consumption, patterns of drinking, and policies directed at reducing high-risk drinking. The report also contains a chapter reviewing drinking-and-driving countermeasures.

1.3. Scope and Approach of This Volume

This sixth volume in NHTSA’s series of reviews on the state of knowledge in alcohol highway safety covers research reported after the 2001 publication up to 2006. Specifically, it includes articles published between 2000 and 2005, as well as additional reports published in early 2006. As has been the practice in previous issues of this report, articles from earlier periods are included to provide sufficient background for more recent findings. Thus, this volume is a compilation of information from previous alcohol and highway safety reports and current research findings, which provides a more comprehensive state-of-the-art report than can be provided by just including the last 5 years of published research literature.

To maintain continuity with the previous *Alcohol and Highway Safety* reports, this volume is organized under the standard six headings, beginning with Chapter 1, “Introduction and Methods” (Chapter 1, “Introduction,” in previous reports), and continues with Chapter 2, “Overview of the Alcohol-Crash Problem.” In this volume, Chapter 2 contains three subunits. The first is an overview of the epidemiology of alcohol-related crashes, and the second examines trends in alcohol-related crashes since 1982, looking for explanations of the reduction in alcohol-related fatalities in the 1980s and 1990s. Chapter 3, “Alcohol Effects on People,” describes recent research on the types of drinking patterns exhibited by the American public and compares American and European alcohol consumers. It also covers recent studies on the influence of alcohol on human performance and the effect of alcohol on brain injuries in crashes. The third subunit concludes the chapter with recent studies of the relative risk of crash involvement at various BAC levels.

Chapter 4, “Drinking Drivers, Pedestrians, and Pedalcyclists,” covers nine special at-risk groups. Three groups of underage drinkers who are or eventually may become drinking drivers are covered, including early onset of drinking by teenagers age 14 and younger, transition teens (15- to 17-year-olds), and college students. Adults are considered in three groups: high-risk drinking drivers ages 21 to 34, female drivers, and older drivers. Also considered as special high-risk groups are drinking pedestrians and motorcyclists. Finally, ethnic differences in drinking, drinking-and-driving, and alcohol-crash involvement are considered in this chapter.

Chapter 5, “Dealing With the Alcohol-Crash Problem,” is divided into three sections: *Primary Prevention* (reduction in risky drinking), *Secondary Prevention* (separating drinking from driving), and *Tertiary Prevention* (preventing DWI offender recidivism). The *Primary Prevention* section

addresses those laws and policies directed at increasing alcohol taxes, reducing the availability of alcohol by controlling the times and conditions of sales, responsible beverage service programs, and limits on underage drinking. The *Secondary Prevention* section deals with enforcement, prosecution, and adjudication of drinking-and-driving laws and penalties for impaired driving. It also includes public information programs, designated driver and safe ride programs, and community programs directed at reducing impaired driving. *Tertiary Prevention* is broken into two main components: the first focuses on the incapacitation of the convicted drinking driver to prevent further harm to the driving public, and the second focuses on treatment programs designed to help offenders overcome their drinking problems.

Chapter 6, “Summary and Conclusions,” lists the primary findings described earlier in the volume. Further, it focuses on future directions. Included here is a description of research needs, laws, and policies that appear to be effective but have not yet been implemented by most States, and a section on new technological developments that provide promise for reducing impaired driving in the future.

1.4. Methods

The preparation of this review required the development and implementation of a comprehensive strategy for searching the available literature about alcohol and highway safety. Once the strategy was in place, abstracts were obtained and reviewed to screen-out titles not relevant to the current topic. Next, the relevant titles were identified and copies of the articles were obtained for thorough review. These journal articles, technical reports, conference proceedings, and books were reviewed and summarized for potential inclusion in the final report. The final report contains both a synthesis of all the articles that were reviewed and sufficient material from previous reviews of the literature to provide a comprehensive picture of the state of knowledge regarding alcohol in relation to traffic safety.

1.4.1. Literature Search Plan

A formal literature review was conducted using the keywords listed in Table 1-1 in combinations that would return the most relevant results: Each term in the left column of the table was paired with each term from the right column of the table, using multiple Boolean-type connectors (such as “and” and “or” and specified grouping terms). For example, the term “alcohol*” (with the asterisk indicates a search for a truncated term in order to return all documents with that root word, including terms such as “alcoholic” or “alcoholism”) was paired with the term “driv*” for one search and with the term “highway” for the second search, and so on. Using the multiple Boolean connectors, however, many of the paired searches were conducted simultaneously.

Table 1-1. General search terms

Alcohol* (alcoholic, alcoholism)	Driv* (drive, driver, driving)
Drink* (drink, drinks, drinking)	Highway (highway safety)
Drunk* (drunken)	Traffic (traffic safety)
Intoxicat* (intoxicated, intoxication)	Accident* (accidents, accidental)
Impair* (impairment, impaired)	Vehicle (motor vehicle)
BAC	Crash* (crashes, crashed, crashing)
Inebriat* (inebriated, inebriation)	
Influence	

In addition to these paired terms, standalone terms like “DUI” and “DWI” were searched. All the terms were used in the search, not only of article titles, but also of all fields in the searchable databases, thus providing greater assurance of detecting relevant articles. These general searches cast a wide net. The paired search terms created a thorough search and returned most of the documents needed for the entire review; however, many of the results were redundant and required exclusion of duplicate titles. The searches were limited to documents published since 2000 (inclusive).

After searching with the general terms in Table 1-1, more specific searches were conducted for different sections of this report. The specific search terms relevant to each section of the 2006 review were determined by selecting potentially relevant terms from the reference section of the 2001 version of the *Alcohol and Highway Safety* review. This list was narrowed tremendously because most of the documents that would be returned for these specific search terms had already been detected by the general searches. Some of the specific terms were standalone terms, whereas others obviously had to be paired with relevant keywords to obtain relevant results. For example, the term “motorcycle” was paired with terms such as “alcohol” or “drinking” to limit the results to documents that were relevant to a specific report section.

1.4.2. Databases Consulted

A comprehensive review of the available literature was conducted. Major social psychological, psychological, and medical databases (e.g., CINAHL, PubMed, PsycINFO, and Sociological Abstracts) were consulted, as were transportation and safety databases. These initial database searches yielded more than 27,000 titles, nearly half of which were subsequently determined to be duplicates. Other reference sources (such as NHTSA, National Transportation Safety Board, National Institutes of Health, Mothers Against Drunk Driving, and the Insurance Institute for Highway Safety library) and databases from peer-reviewed journals were also searched. Meetings with NHTSA officials at their headquarters office provided relevant NHTSA reports on alcohol safety not listed in the peer-reviewed literature. Also examined were various sources of statistical data and information on impaired driving and crash data including NHTSA’s *National Survey of Drinking and Driving Attitudes* and NHTSA’s *FARS*. These data were used for constructing the graphs and tables shown throughout the text.

1.4.3. Document Screening Process

After the searches were conducted and most duplicates removed, more than 15,000 titles remained. A further screening procedure was undertaken based primarily on titles and abstracts to ensure that the articles identified through keyword searches addressed a relevant subject. Documents found to be wholly irrelevant for the report were eliminated from further review. (For example, the paired search terms “impairment” and “accident” retrieved articles on stroke.) The next screening yielded more than 1,100 titles that appeared to hold promise for this 2006 report and included documents referencing alcohol and driving, crashes, or highway safety. Further screening through the review of abstracts eliminated additional duplicates, items not in English, and studies that were not generally applicable to the United States. Once this screening was complete, more than 500 documents remained.

Full copies of these 500 documents were obtained and critically reviewed. Screened out were those documents that only expressed an author’s opinion instead of presenting evidence based on scientific data or for which the research results did not appear valid due to insufficient sample size,

confounding variables, inappropriate data analyses, and so on. These documents were excluded from the report but were retained in the working database records. The database, created specifically for this critical review, includes summary information, quantitative ratings, and free-format evaluations of each document. All documents reviewed for this report are included in the database. Each document was evaluated on several dimensions. The numerical ratings assigned to the documents were used only as guidelines for the extent to which the document should be reviewed further. These ratings did not act as firm exclusion criteria nor were they statistically analyzed or included in this report. Further, documents were not eliminated from additional review based solely on these quantitative ratings. Documents were reviewed on several mutually exclusive dimensions. For example, a document that scored high on one dimension, such as Informativeness, and low on another dimension, such as Scientific Quality, remained in the pool for inclusion in the review, but its limitations were noted.

Articles not originally identified have been added if they appeared in reference sections of the basic 500 documents identified. A few relevant articles appearing during the first 6 months of 2006 while the review was being prepared were included in the publication here as well.

1.4.4. References in the Review

The literature searches began in November and December of 2005 and continued through June of 2006. The extensive bibliography resulting from this effort contains more than 500 references. The materials used in this report were carefully selected, as in previous *Alcohol and Highway Safety* reports, with a concentration on the most scientifically reliable studies that are available to the general reader. The main focus of this volume, as in the past, is on studies relevant to the alcohol-crash problem in the United States, but some studies from other countries were included as appropriate. In addition to articles relating directly to highway safety, some reports from the public health field covering brief interventions and drinking patterns among ethnic groups have been included as a result of the production of two special studies on those topics. From those reports, databases maintained by the National Institute on Alcohol Abuse and Alcoholism (NIAAA) and the Centers for Disease Control and Prevention (CDC) were consulted. As noted, not all of the studies identified in our literature search are discussed in this review. As in earlier volumes, we sought those studies that best illustrated current thinking and looked for background material from earlier research that led to current thinking. Articles from such earlier periods were included in this update. For the most part, the treatment was from the perspective of the traffic safety generalist, with departures into more specialized technical subjects occurring only when they were central to this volume.

Chapter 2.

Overview of the Alcohol-Crash Problem

This chapter begins with a discussion of the types of crash data files available to traffic safety researchers and the measures that can be extracted from them. Potential questions surrounding their use in evaluation of alcohol-related safety issues are also discussed. Briefly covered are the basic characteristics of alcohol-related fatal crashes and the types of drivers involved in such crashes in 2005. This is followed by a discussion of the reduction in alcohol-related crashes over the last three decades and the factors that may have influenced that downward trend. Also covered are alcohol-related injury crashes and what is known about drinking drivers from roadside surveys and national telephone surveys.

2.1. Introduction

Motor-vehicle crashes became a public safety problem in this country at the beginning of the 20th century. Alcohol has been associated with traffic crashes for more than 100 years, as indicated by the publication of the first scientific report on the effect of drinking by operators of “motorized wagons” in 1904 (Editorial, 1904). The Federal Highway Administration (FHWA) estimated that 172 people died in motorized vehicle crashes in 1904 (NCSA, 2004). The number alcohol-related would be purely speculative, but it was probably substantial. In 2005, NHTSA estimated that 16,885 (39%) of the 43,443 traffic fatalities were alcohol-related (NCSA, 2006a). NHTSA also estimated that an additional 512,000 people are injured in alcohol-related crashes each year and that alcohol-related crashes cost the U.S. society \$51 billion annually (Blincoe et al., 2002). That estimate was corrected for the underreporting by police of alcohol involvement and includes reported and unreported injury crashes.

The traffic safety field has benefited from the availability of a strong statistical base. For the last half century, States have been maintaining relatively detailed information on highway crashes. This has provided information for scientists studying the factors that produce highway injuries. Perhaps more importantly, however, these data have provided legislators, local governments, police departments, and motor-vehicle agencies with key information that assists them in developing and evaluating policies. The value of traffic statistical records has been demonstrated by their widespread use, not only by those in safety research, but also by those in public health. These data have been particularly useful to researchers in the public health arena who deal with the problems surrounding unhealthy use of alcohol and drugs. Perhaps an outstanding example of the effect of traffic safety statistics on the public health issue is the adoption by Congress of 21 as the minimum legal drinking age (MLDA) in the United States. The primary evidence for the effectiveness of that law in reducing

alcohol problems was drawn from the records of alcohol-related crashes involving youth ages 15 to 20.

Despite the widespread use of these data, or perhaps because of that use in promoting programs and legislation, the public's appreciation of the complexity of the measures commonly presented to support various policy options is somewhat limited. Many types of measures are used to evaluate programs. Their significance varies, not only with what is measured (e.g., crashes, drivers in crashes, injuries, fatalities), but also with the method used to normalize or compare these measures (e.g., vehicle miles of travel, number of licensed drivers) over time or between jurisdictions.

2.2. Data Sources

Our information on alcohol-related crashes at the national level is derived from two principal sources: the Fatality Analysis Reporting System (FARS) and the General Estimates System (GES) of the National Automotive Sampling System (NASS), both of which are maintained by NHTSA's NCSA.

FARS is a census of all motor-vehicle 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. FARS analysts are stationed in each of the 50 States, the District of Columbia, and Puerto Rico. They collect data in more than 100 categories from several State data sources including State crash report records, driver records, death certificates, vehicle registration files, and other sources, which they enter into a local computer database. These data are quality-controlled and transferred to the national FARS file. The total annual number of fatal crashes since the establishment of the FARS file in 1975 is shown in Figure 2-1. Alcohol involvement is documented through BAC test results collected by police or coroners. Where such data are not available, the BAC levels 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). Data are entered daily into a file that is finalized at the end of the following year (end of 2006 for the 2005 file year). The data in this section currently reflect the initial summary analysis for 2005 in NHTSA's *Traffic Safety Facts* annual report (NCSA, 2006a).

NASS GES includes data from a nationally representative sample of 410 police jurisdictions at 60 sites. It is based on a sample of approximately 57,000 police accident reports (PARs) covering all the severities: fatal, injury, and property-damage-only crashes. NCSA estimates that approximately half of the vehicle collisions on U.S. highways are not reported to the police. Those unreported crashes tend to be minor fender benders that do not involve injury to passengers or extensive damage to vehicles. GES data analysts visit local sites weekly and randomly select PARs for entry into the GES file. Unlike FARS, no records other than PARs are used in constructing this file. Thus, any information on alcohol involvement comes from the police officer who filled out the report. Officers are often conservative when reporting a driver's drinking, so estimates based on the GES data are likely to underestimate the actual level of alcohol involvement (Terhune & Fell, 1982).

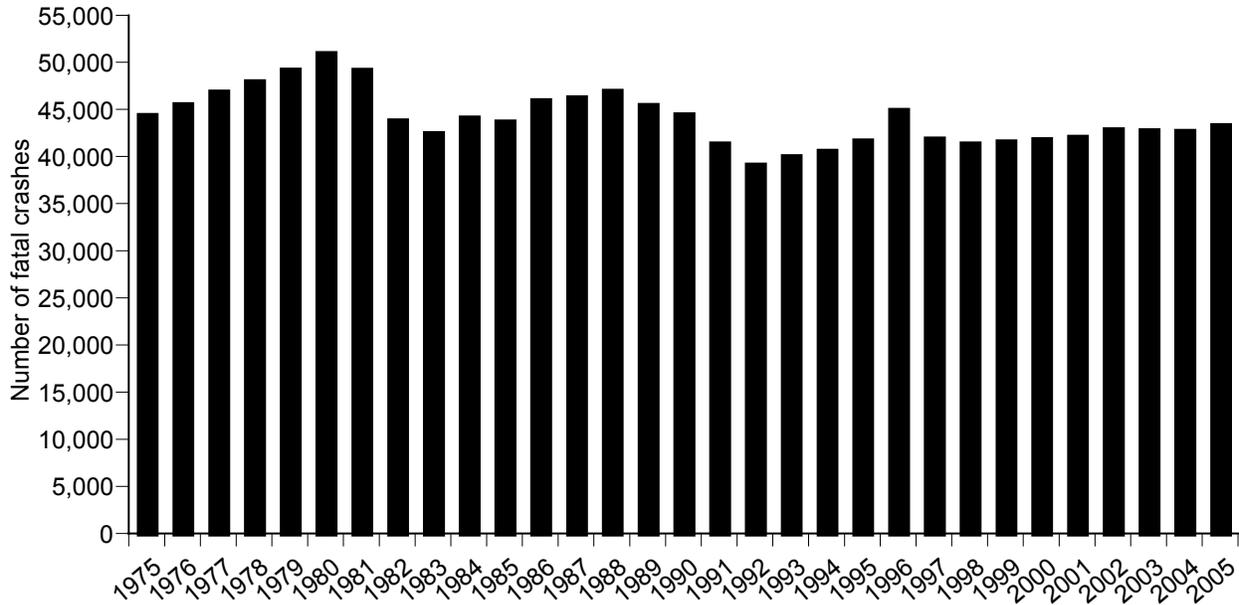


Figure 2-1. Total U.S. fatal crashes, 1975-2005. Adapted from NCSA (2006a)

In addition to these two federally maintained files, all States maintain files on vehicle crashes. As with the GES, minor crashes are unlikely to be reported, and alcohol-related crashes are likely to be underestimated. State laws generally require BAC testing of fatally injured drivers, but few surviving drivers or drivers in less serious crashes are tested. Thus, reliance for alcohol information must be placed on police reports or the characteristics of the crash such as single-vehicle nighttime (SVN) crashes. Except in the largest States, individual State crash files contain too few fatal crashes on an annual basis to permit the evaluation of programs based on fatalities alone. State crash files, which contain a relatively large number of injury and property-damage-only crashes, however, are useful for evaluations of State laws or programs and for measurement of alcohol crash trends in the State when a surrogate for alcohol involvement, such as police-reported drinking, can be used. When using State-level crash data in studies of alcohol involvement, it is important to note that alcohol is more of a factor in fatal crashes than in injury and property-damage-only crashes (39% for fatalities compared to 9% for injuries and 6% for property-damage-only crashes) (NCSA, 2006a).

2.2.1. Defining Alcohol Involvement

The FARS contains a separate file of the BAC levels of “active road users” defined as drivers, pedalcyclists, pedestrians, and individuals who are hypothesized to contribute to the occurrence of a fatal crash. BAC levels of passengers, who are viewed as not contributing to the occurrence of a crash, are not used to define “alcohol-related” crashes. The BAC file contains the actual measured value when that is available. In 2005, measured BAC levels were available on 17,581 (64%) of the 27,472 fatally injured drivers and 7,471 of the 31,632 (23%) of the surviving drivers in fatal crashes (NCSA, 2006c, p. 8). Because of the large number of road users in fatal crashes for which BAC levels are not available, an imputation system for estimating BAC levels for cases without measured values was developed by NHTSA (Subramanian, 2002) to provide a complete BAC file. The imputation process uses features of the crash and characteristics of the road users involved to estimate the BAC levels for cases without a measured BAC. This imputation has been included in FARS each year since 1982. It provides a BAC value for every driver, pedalcyclist, and pedestrian in the FARS file.

Historically, two BAC levels have been of special interest: (1) “alcohol-related” crashes involving an active road user with a BAC greater than zero ($BAC \geq .01$ g/dL) and (2) “alcohol-impaired” fatal crashes where one or more of the drivers, pedestrians, or pedalcyclists had a BAC at or higher than the legal limit. This alcohol-impaired criterion changed from a BAC level of $\geq .10$ g/dL to a BAC level of $\geq .08$ g/dL with the adoption by all States of a .08 g/dL illegal per se law. More States have been legislating additional sanctions for driving-while-impaired offenders with BAC levels of .15 g/dL or higher. This has increased interest in BAC levels of .16 g/dL and .20 g/dL.

The term “alcohol-related” implies that drinking played a role in the crash. Determining the cause of a crash, however, generally requires an investigation of the circumstances involved, and the results of these investigations are not generally available in crash record systems. Thus, responsibility is often inferred. It is generally assumed, for example, that drivers in single-vehicle crashes are responsible for such events, though in some cases, such as an unlighted vehicle blocking the road at night, this may not be the case. Determination of responsibility for multiple-vehicle crashes is more problematic because, in many cases, some level of responsibility can be attributed to both drivers. Thus, the presence of alcohol in a driver, pedalcyclist, or pedestrian does not demonstrate that they “caused” the crash. The fact that the relative risk of being in a crash is substantially increased at BAC levels of .08 (the legal limit) or higher (see Chapter 3) suggests that road users in crashes with high BAC levels were impaired and therefore likely to have contributed to the cause of the crash. Although the term “alcohol-related” is applied in this volume to crashes where an active road user had a nonzero BAC, summary statistics on legally impaired drivers is also provided.

2.2.2. Selection of the Measure of Interest

A potential source of confusion for the public in the reporting of fatal crash data is the unit of measure. Typically, three types of measures are used: the number of fatalities, the number of crashes, or the number of drivers (which generally includes motorcycle operators) involved in the fatal crashes. Table 2-1 illustrates the differences between these three measures based on 2005 FARS data. A crash is characterized as alcohol-related based on FARS data if one of the drivers, pedestrians, or pedalcyclists involved had, or was imputed to have had, a positive BAC at the time the crash occurred.

Table 2-1.

Percentage of alcohol-related (i.e., $BAC \geq .01$ g/dL) crashes in 2005 as a function of the crash measure

	Fatal crashes	Fatalities	All drivers in fatal crashes
Total	39,189	43,443	59,104
Alcohol-related	15,238	16,885	14,068
Percentage alcohol-related	39%	39%	24%

Source: NCSA (2006a)

2.2.3. Selection of Normalizing Measure

Another source of confusion can be the use or nonuse of a normalizing variable, such as vehicle miles of travel, to provide a basis for comparing groups of road users or trends across multiple years. A basic principle in safety research is that the occurrence of unintended injury events correlates with an individual’s exposure to such events. A person without access to a vehicle may be a pedestrian fatality but is not at risk of being a driver in a fatal crash. Thus, there is strong interest in data that

provide a measure of exposure to alcohol-related crash involvement. Three types of reporting can be distinguished: (1) reporting the raw numbers of alcohol-related fatalities without reference to a normalizing measure; (2) using a normalizing measure from the crash file itself, for example, by reporting alcohol-related fatalities as a percentage of all fatalities (alcohol-related/all fatalities) or as the Crash Incidence Ratio (CIR) (Voas, Tippetts, Romano, Fisher, & Kelley-Baker, 2007c), (alcohol-related/non-alcohol-related fatalities); and (3) reporting the number of alcohol-related fatalities as a function of a measure external to the crash file such as fatalities per 100 million vehicle miles of travel (VMT). Table 2-2 illustrates the reporting of 2005 crashes as a function of a traffic exposure or population measure outside the crash file.

Table 2-2.

Fatalities and injuries in 2005 as a function of vehicle miles or population measures

	Number/count	Fatalities per unit	Injuries per unit
Per 100 million VMT	2,989,807,000,000	1.45	90
Per 100 thousand resident population	296,410,404	14.66	911
Per 100 thousand registered vehicles	245.641,663	17.69	1,099
Per 100 thousand licensed drivers	200,665,267	21.65	1,345

Source: NCSA (2006a)

The most frequently used normalizing measure in *public health studies* is the incidence per population, which compensates for changes in basic demographic variables such as age, gender, and ethnicity over time. These population-based measures do not, however, account for variations in access to vehicles and the number of miles driven, which may be the result of resident location and the availability of public transport (e.g., the availability of a vehicle is less important in New York City than in the suburbs). Vehicle ownership may also be influenced by socioeconomic status. A more relevant normalizing measure for *traffic safety studies* is the number of VMT, which comes closer to measuring exposure to crash involvement. Historically, VMT has been the preferred measure when accounting for the growth in traffic over time on American roads. The influence of VMT is shown in Figure 2-1, which illustrates the trend from 1923 to 2003 in the number of traffic fatalities, the number of VMT, and the traffic fatalities per 100 million VMT rate in 10-year increments (NCSA, 2004). From 1923 to 2003, the number of fatalities rose from 17,870 to 42,884. This reflects the large increase in exposure measured in VMT. Although VMT increased 34-fold over the 80 years from 1923 to 2003, fatalities increased only 2.5-fold, resulting in a reduction in the mileage fatality rate from 24 per 100 million VMT to fewer than 1.5 fatalities per 100 million VMT.

Total traffic fatalities decreased during two periods between 1923 and 2003. As shown in Figure 2-2, the first decrease was associated with World War II, when automobile production was curtailed and gasoline rationed. The second period was associated with the gas crisis in 1974, when the maximum speed limit was set at 55 mph in response to that crisis. Some of the reduction may also reflect the entry of the Federal Government into the road safety arena via the establishment of the Department of Transportation (DOT) and NHTSA in 1967, and the subsequent establishment of vehicle and highway safety standards.

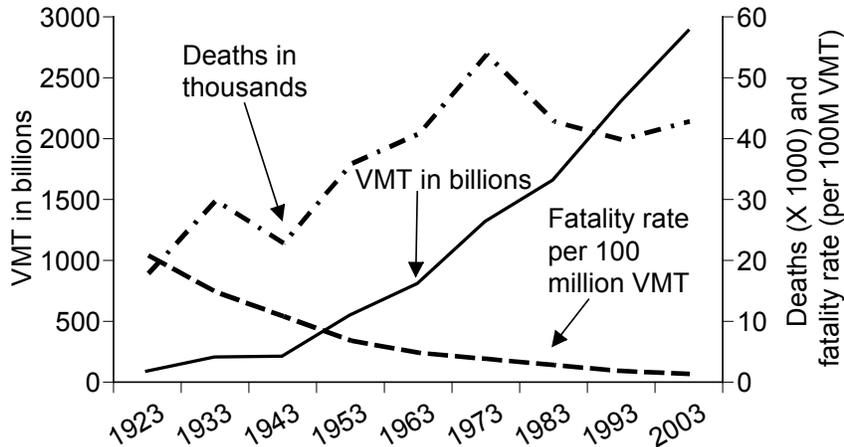


Figure 2-2. Vehicle miles of travel, fatalities and fatality rate per 100 million vehicle miles in the United States, 1923- 2003. Adapted from NCSA, 2004

Although the fatality/VMT rate has often been proposed as a measure of progress in traffic safety, this measure is affected by several factors not directly related to traffic safety. O’Neill and Kyrychenko (2006), for example, highlighted some of the factors that can potentially influence the number of vehicle miles of travel. They analyzed State-level data to determine the relationship of VMT to demographic and socioeconomic factors. Figure 2-3 shows the relationship they derived between traffic fatalities per billion miles of travel and three measures of urbanization. The three measures clearly indicate that rural States have higher mileage fatality rates than urban States. Figure 2-4 presents similar data on the relationship of State socioeconomic data and the crash fatality rate. Their study concluded that urbanization and demographics account for 59% of the variation among States in VMT fatality rates, suggesting that more than half of that measure is unrelated to vehicle, highway, and driver safety programs.

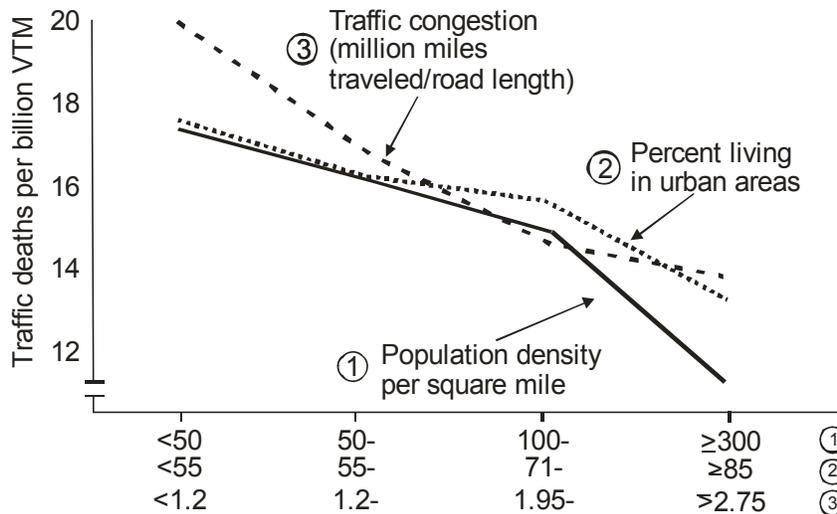


Figure 2-3. The relationship between the VMT traffic fatality rate and three measures of urbanization Adapted from O’Neill and Kyrychenko (2006)

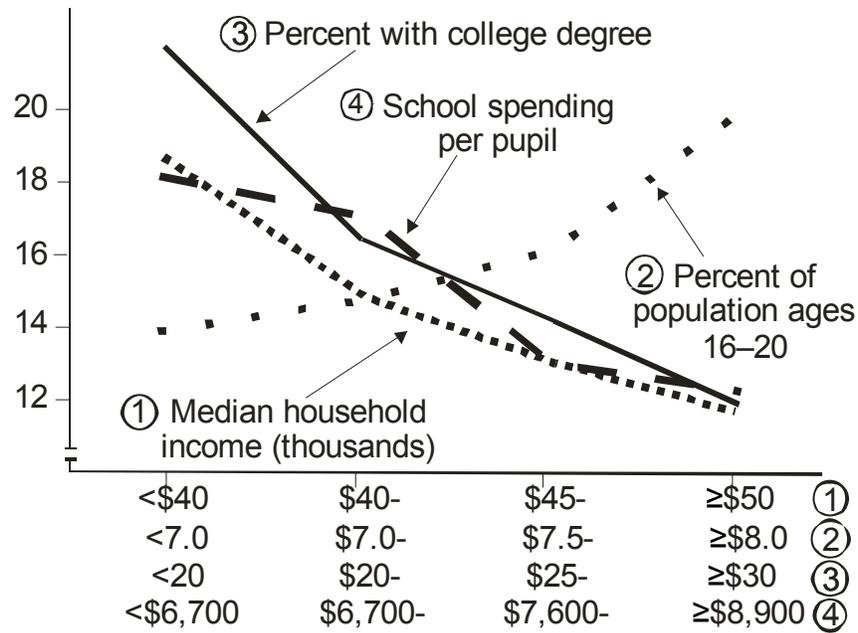


Figure 2-4. Relationship of State socioeconomic data and the VMT traffic crash fatality rate. Adapted from O'Neill and Kyrychenko (2006)

The alternative of presenting raw numbers rather than fatality rates neglects the fact that the number of vehicles and the miles traveled are increasing every year, potentially overwhelming safety efforts directed at reducing fatalities. An interesting illustration of this effect is provided in Figure 2-5, which contrasts the *number* of motorcycle crash fatalities that are alcohol-related with the *percentage* that are alcohol-related. The *percentage* of alcohol-related motorcycle operator fatal crashes has remained relatively constant or has slightly decreased, whereas the actual *number* of such crashes has increased in recent years. Thus, the impression of whether progress is being made in alcohol safety can vary significantly depending on the measure selected and the method of normalizing the data for presentation.

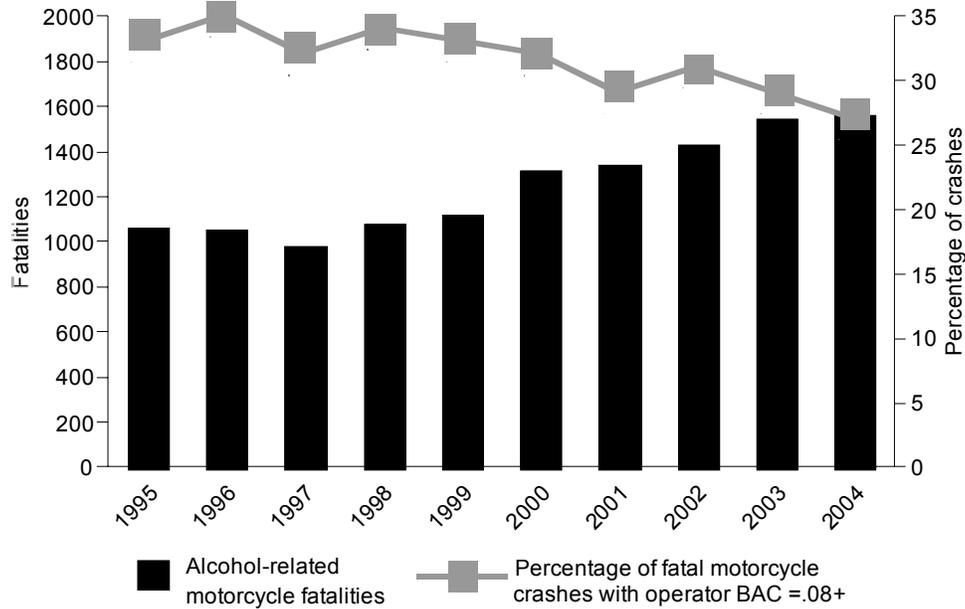


Figure 2-5. The number of motorcycle fatalities that are alcohol-related versus the percentage that are alcohol-related, FARS 1995-2004. Adapted from NHTSA (2004a)

As described later in this chapter in section 2.4 on crash trends, the number of alcohol-related fatalities fell between 1982 and 1995 and then leveled off. VMT, however, has increased steadily over that same period, resulting in an apparent reduction in alcohol-related fatalities per VMT, even in the later years when the number of such fatalities remained relatively constant. A limitation of the VMT measure, which is calculated using gas tax receipts, is that it does not distinguish between miles driven after drinking and miles driven with a zero BAC. The limitation in calculating an alcohol-related crash/VMT rate plus the strong relationship of VMT to urban location and driver demographics suggests that alcohol-related crashes are best measured using data from the crash record system. An example would be the number of alcohol-related crashes divided by total crashes (i.e., *percentage* that are alcohol-related) or the CIR (crash incidence ratio = alcohol-related crashes divided by non-alcohol-related crashes). These two measures assume that exposure can be measured indirectly through the number of non-alcohol-related crashes. Both the crash measure and the exposure measure come from the same source and therefore share a common set of data elements that can be used to help normalize comparisons between groups. Although the factors that may influence crash involvement are unlikely to be identical for drinking and nondrinking drivers in fatal crashes, when examining certain groups of interest (e.g., comparing fatality rates of drivers with different ethnic backgrounds) where VMT rates for specific subgroups may not be available, such relative measures may provide the best data for analysis (Voas et al., 2007c; Klein, 1989).

2.3. Alcohol-Related Crashes in the United States

FARS maintains four interrelated files (NCSA, 2006a): (1) a *crash-level file*, which includes data on the time, date, location, and other characteristics of the crash; (2) a *vehicle-level file*, which covers information on each vehicle involved in the crash (e.g., make, model, year); (3) a *driver-level file*, which includes data elements such as license status, previous DWI convictions, and drinking status; and (4) a *person-level file*, which contains items such as age, gender, injury severity, and role in

the crash. The characteristics of fatal crashes in these four files are summarized annually in NHTSA's *Traffic Safety Facts*. This section uses examples from that publication for the year 2005 of the types of alcohol-related crashes that are occurring in the United States and the relationships of driver, person, and vehicle characteristics to alcohol-related crashes. For a more detailed and comprehensive presentation of this information, the reader should consult the latest issue of NHTSA's *Traffic Safety Facts 2005* (NCSA, 2006a, pp. 189 & 190).

2.3.1. Alcohol-Related Traffic Fatalities, 2005

Overall, there were an estimated 16,885 alcohol-related traffic fatalities out of a total of 43,443 traffic fatalities in 2005 (NCSA, 2006a). Of the 16,885 fatalities, 14,539 (86%) died in crashes involving at least one driver or nonoccupant (pedestrian or pedalcyclist) with a BAC of .08 g/dL or higher (NCSA, 2006b). Figure 2-6 shows the distribution of those fatalities. As can be seen, 70% of the victims were the impaired drivers or the other driver in a two-vehicle crash. Twenty percent were passengers riding with the impaired driver or in the other vehicle involved in the crash. Ten percent were other drivers or nonoccupant road users who were not impaired.

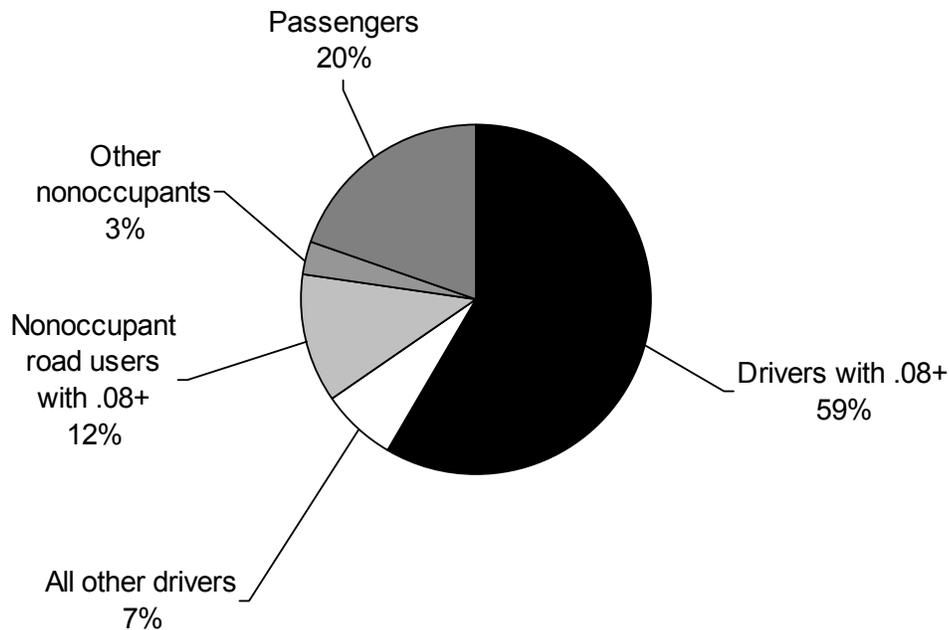


Figure 2-6. All alcohol-related traffic fatalities in 2005, (N= 16,885). Adapted from NCSA (2006b)

2.3.2. Characteristics of Alcohol-Related Crashes

Crash severity (fatal, injury, or property damage only), the number of vehicles involved, and the time of day are the principal crash characteristics related to the alcohol involvement of the driver. Figure 2-7 presents the percentages of crashes that were alcohol-related in 2005 as a function of the number of vehicles (one or two or more) in a crash and the crash severity. The strong relationship of

alcohol involvement to the occurrence of single-vehicle crashes is important because the lone driver in such events is viewed as being responsible for the crash. In multiple-vehicle crashes, several drivers may be involved and responsibility is less clear. Where responsibility for a crash involving more than one vehicle can be assigned by studying the specific characteristics of the event to a particular driver, such individuals tend to have the same probability of alcohol involvement as drivers in single-vehicle crashes (Terhune & Fell, 1982).

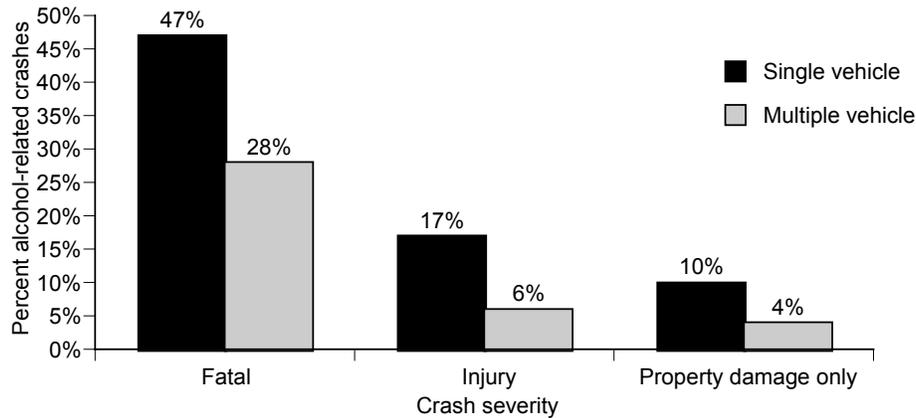


Figure 2-7. Percentage of crashes that were alcohol-related in 2005 as a function of the number of vehicles and crash severity. Adapted from NCSA (2006a)

There is also a strong relationship between the time of day and the occurrence of an alcohol-related fatal crash. Figure 2-8 shows the proportion of fatal crashes occurring in the United States between 9 p.m. and 3 a.m. in 2005 that were alcohol-related. As shown, close to 7 of 10 fatal crashes occurring during those hours were alcohol-related. Figure 2-9 displays data from the GES showing that 1 in 3 injury crashes during those hours was alcohol-related (NCSA, 2006a). Alcohol involvement in fatal crashes in 2005 was more than three times higher at night (6 p.m.–5:59 a.m.) than during the day (6 a.m.–5:59 p.m.). In addition, alcohol involvement was 30% during weekdays compared to 51% on weekends. This reflects the typical drinking pattern in Northern Europe and North America, where most drinking occurs during the evenings and particularly on weekends. The strong relationship of alcohol involvement to time of day and number of vehicles is frequently used as a proxy measure for alcohol-related crashes when BAC data are not available. First evaluated by Heeren, Smith, Morelock, and Hingson (1985), and later corroborated by Voas et al. (2007c), surrogate measures such as these have been employed in several other studies on impaired-driving laws. Shults et al. (2001) have shown that for fatal crashes, the SVN measure is closely related to alcohol-related crashes involving drivers with known BAC levels. Relative to other surrogates (all nighttime crashes, crashes involving injury), this measure is relatively conservative.

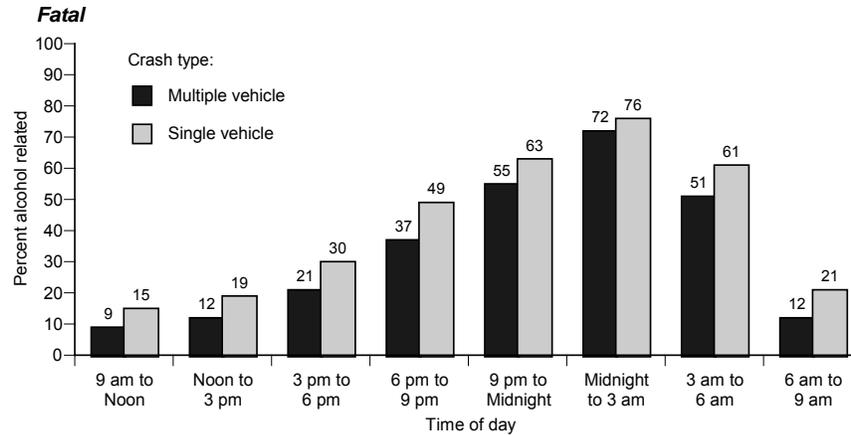


Figure 2-8. Percentage of fatal crashes alcohol-related by time of day and crash severity Adapted from NCSA (2006a)

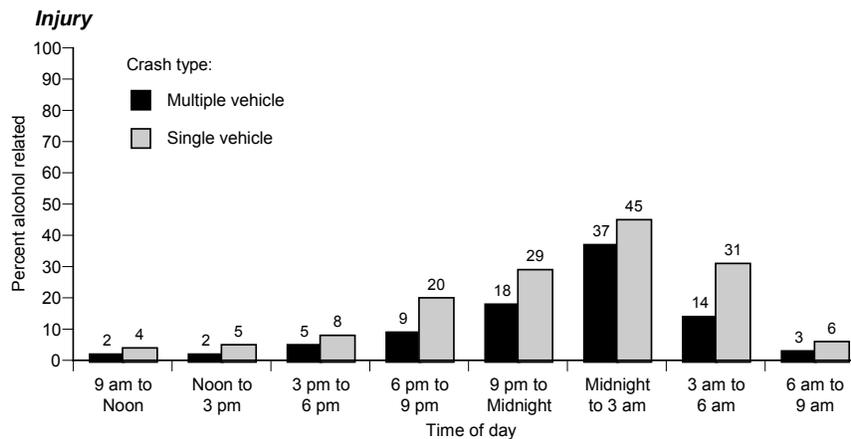


Figure 2-9. Percentage of injury crashes alcohol-related by time of day and crash severity. Adapted from NCSA (2006a)

2.3.3. Characteristics of Vehicles Involved in Alcohol-Related Crashes

Alcohol involvement of the driver varies substantially by vehicle type as shown in Table 2-3. In 2005, approximately one in four drivers of personal vehicles (e.g., passenger cars or light trucks) and one in three motorcyclists in fatal crashes had a positive BAC. In contrast, only 2% of the commercial drivers of heavy trucks had an illegal BAC. More information on the involvement of motorcyclists in alcohol-related crashes is provided in section 4.9.

Table 2-3.

Drivers in fatal crashes by vehicle type and BAC in 2005

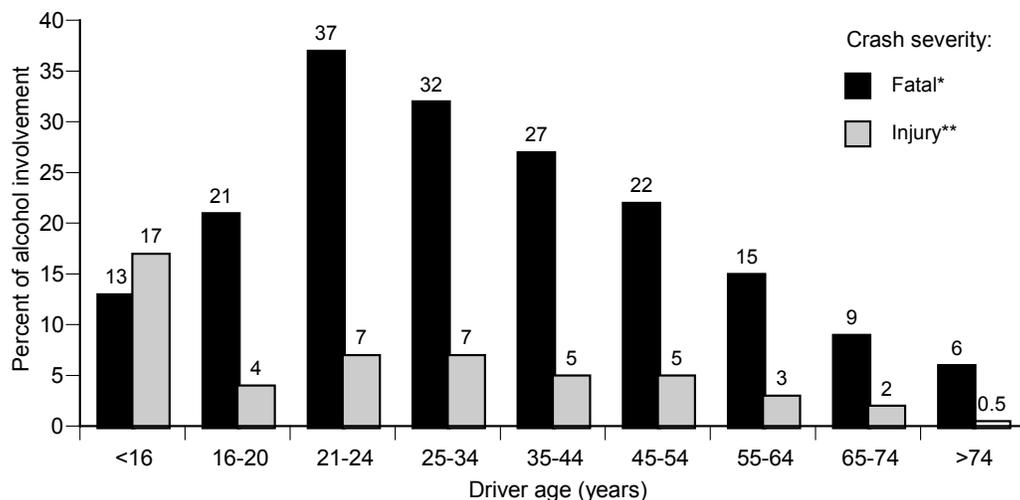
Vehicle type	Total number of drivers	Number of drivers with BAC \geq .01 g/dL	Percentage of drivers with BAC \geq .01 g/dL
Passenger cars	24,908	6,424	26%
Light trucks	22,757	5,595	25%
Large trucks	4,881	117	2%
Motorcycles	4,652	1,587	34%

Source: NCSA (2006a)

2.3.4. Characteristics of Drivers in Alcohol-Related Crashes

In 2005, as in previous years, drivers who died in fatal crashes were more likely to have been drinking (36%) than those who survived a fatal crash (13%) (NCSA, 2006a, Table 19, p.38). This suggests that drinking drivers are involved in more serious crashes where the acceleration loads are greater (e.g., wrong-way head-on collisions and single-vehicle rollovers). There is also evidence that given the same acceleration load, individuals with high BAC levels sustain greater injury severities than those who are not drinking in crashes (Committee on Trauma Research, 1985; Fabbri et al., 2001; Evans & Frick, 1993; McLeod, Stockwell, Stevens, & Phillips, 1999; House, Waller, & Stewart, 1982; Waller et al., 1986).

Age is clearly an important factor in alcohol-related crashes. Figure 2-10 provides an overview of the relationship of age to involvement in fatal and injury crashes in 2005 (NCSA, 2006a). As shown, the age variation is generally stronger for fatal than for injury crashes, but the 21 to 34 age group has the highest alcohol involvement in both types of crashes. Research related to impaired driving by specific age groups is discussed in Chapter 4.



*For fatal crashes, alcohol involvement is a BAC of .01 g/dL or greater.

**For injury crashes, alcohol involvement is police-reported alcohol involvement.

Figure 2-10. Percentage of drivers and motorcyclists involved by age in fatal and injury crashes in 2005. Adapted from NCSA (2006a)

There were 43,443 fatalities in 2005 and 16,885 (39%) of those fatalities were considered alcohol-related because they occurred in crashes involving a drinking driver, motorcyclist, or pedestrian. Eighty-six percent of the drinking road users involved in those crashes had BAC levels higher than the .08 g/dL legal limit for driving (see Figure 2-11).

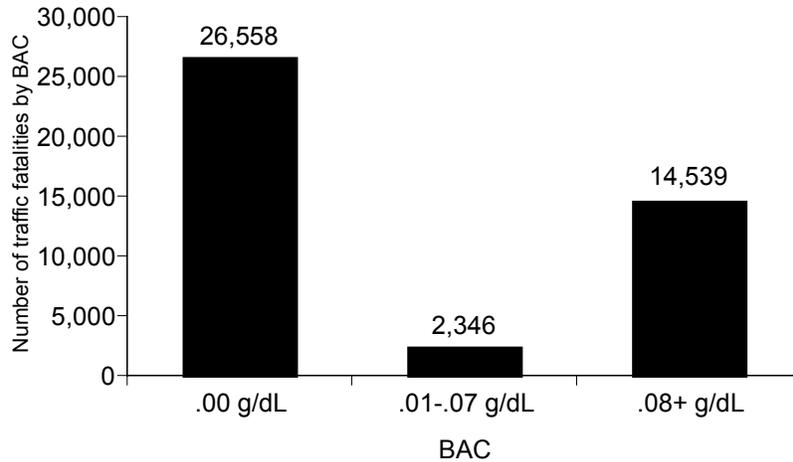


Figure 2-11. Traffic Fatalities in 2005 by highest BAC level in crash. (Total N = 26,558 + 16,885 = 43,443). Adapted from NCSA (2006b)

To better understand the role of alcohol, it is useful to compare drinking and nondrinking drivers in fatal crashes. This is illustrated in Figure 2-12, with FARS data from 1990 to 1994 (Tippetts & Voas, 2002). The first graph shows the age distribution of non-alcohol-related fatal crash involvements as a function of VMT for each age group as reported by the 1990 FHWA National Personal Transportation Survey (NPTS). That graph takes the traditional U-shape with underage and older drivers having the highest non-alcohol-related crash rates per mile driven. The common explanation for this relationship is the inexperience and risk-taking of youthful drivers (Williams, Preusser, Ulmer, & Weinstein, 1995) and the deterioration of driving skills and, perhaps more importantly, the greater fragility of older drivers as evidenced by their greater susceptibility to fatal injury particularly under certain crash conditions (Waller et al., 1986; House et al., 1982).

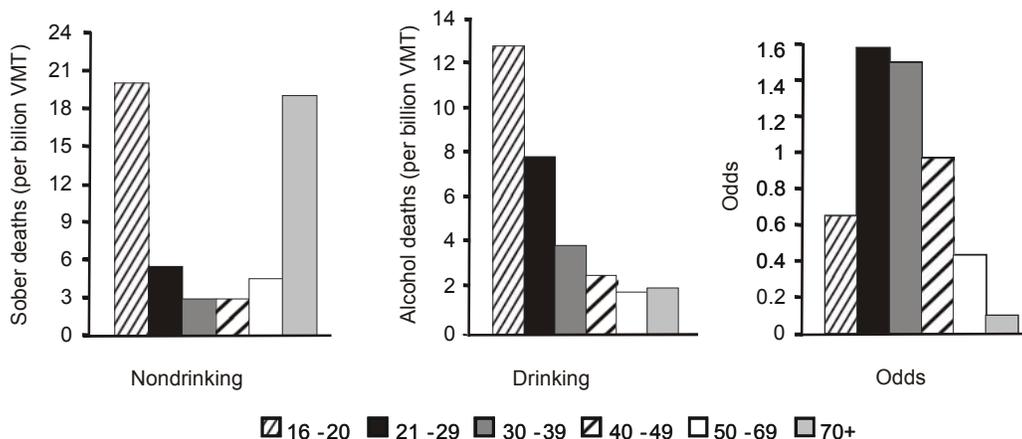


Figure 2-12. Drinking and nondrinking driver fatal crash rates for males by driver age and the odds of drinking to nondrinking driver rates, 1990-1994. Adapted from Tippetts & Voas (2002)

When, as in the second graph of Figure 2-13, alcohol-related rates per VMT are plotted, an L-shaped curve results with drinking driver rates per mile driven being the highest among youthful drivers and gradually dropping off with age, with older drivers being the least involved. The common explanation is that the driving skills of underage drivers are more vulnerable to alcohol, an explanation that is supported by some evidence for this (see section 4.3 on teenage novice drivers in section 4.3). A somewhat different impression is provided when alcohol-involvement rates are considered as a ratio (drinking driver rates/nondrinking driver rates) by age group (third graph in Figure 2-11). This takes the shape of an inverted “U.” Thus, when the involvement of underage drinking drivers in fatal crashes is related to mileage driven, their risk level is high. This is partly because their risk is higher when sober. When the effect of their high risk when sober is accounted for by using that measure to normalize the data to compare across age groups, drivers 21 to 49 have a higher relative risk compared to when driving sober than do underage drivers.

Figure 2-13 shows the percentage of fatally injured drivers at three BAC levels (.00 g/dL; .01-.07 g/dL; $\geq .08$ g/dL) by the race and ethnicity of the driver in crashes that occurred between 1999 and 2004 (Hilton, 2006). Although Whites and Blacks had similar percentages with BACs $\geq .08$ g/dL (30%), Native Americans and Hispanics had substantially higher rates at those illegal BAC levels (52 and 42%, respectively). Asian and Pacific Islanders had the lowest rates with BACs $\geq .08$ g/dL (20%). Studies of the epidemiology of the crash involvement of ethnic groups have been hampered by a number of factors including the absence of race/ethnicity information on crash records and the difficulty in determining the race/ethnicity of crash victims, particularly for those who are fatally injured. These issues and recent research on the factors contributing to differences between racial and ethnic groups are discussed in Chapter 4.

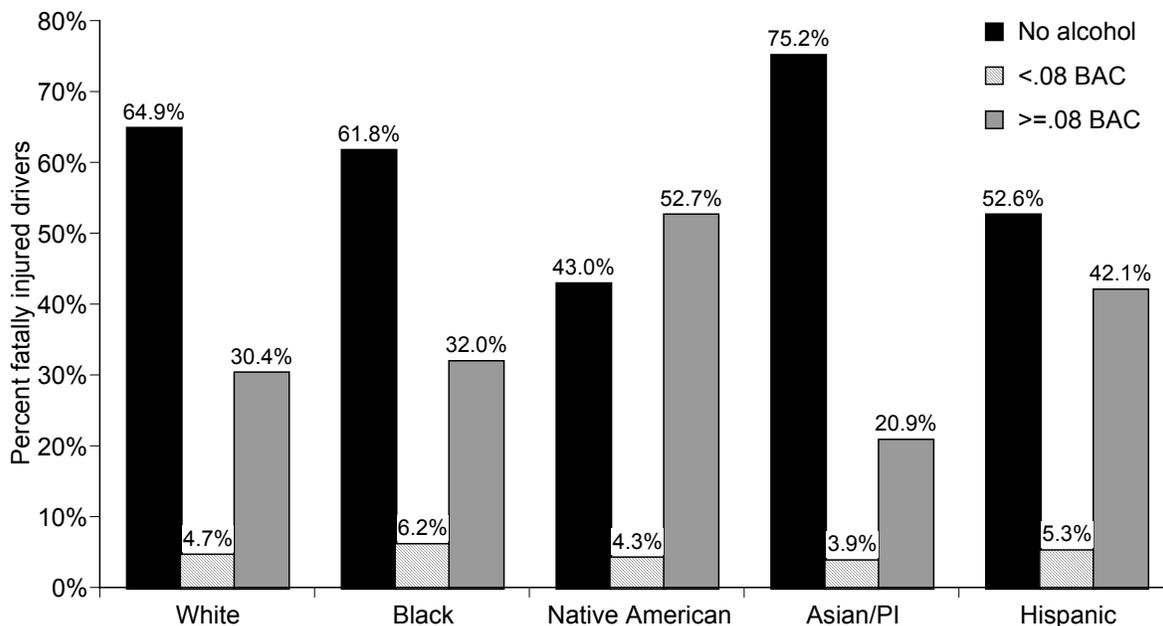


Figure 2-13. Fatally injured drivers by race and ethnicity and BAC. Adapted from FARS data 1999-2004 in Hilton (2006)

2.3.5. State Variation in Alcohol-Related Crashes

Figure 2-14 shows the substantial variation between States in the proportion of drivers with illegal BAC levels (.08 g/dL or greater) involved in fatal crashes in 2005. Utah with its large Mormon population had the lowest rate at 9%. Montana with 31% and North Dakota with 33% had the highest rates. Because States vary in the extent to which they collect the BAC levels of fatally injured and surviving drivers in fatal crashes, some of the variation may be due to greater or lesser reliance on the imputation of BAC. Most of the variation presumably comes from the characteristics of the States themselves. Among the factors that have been shown to be related to impaired driving are per capita alcohol consumption, employment level (a measure of the economy), and State alcohol safety laws, such as administrative license suspension and the .08 BAC legal limit.

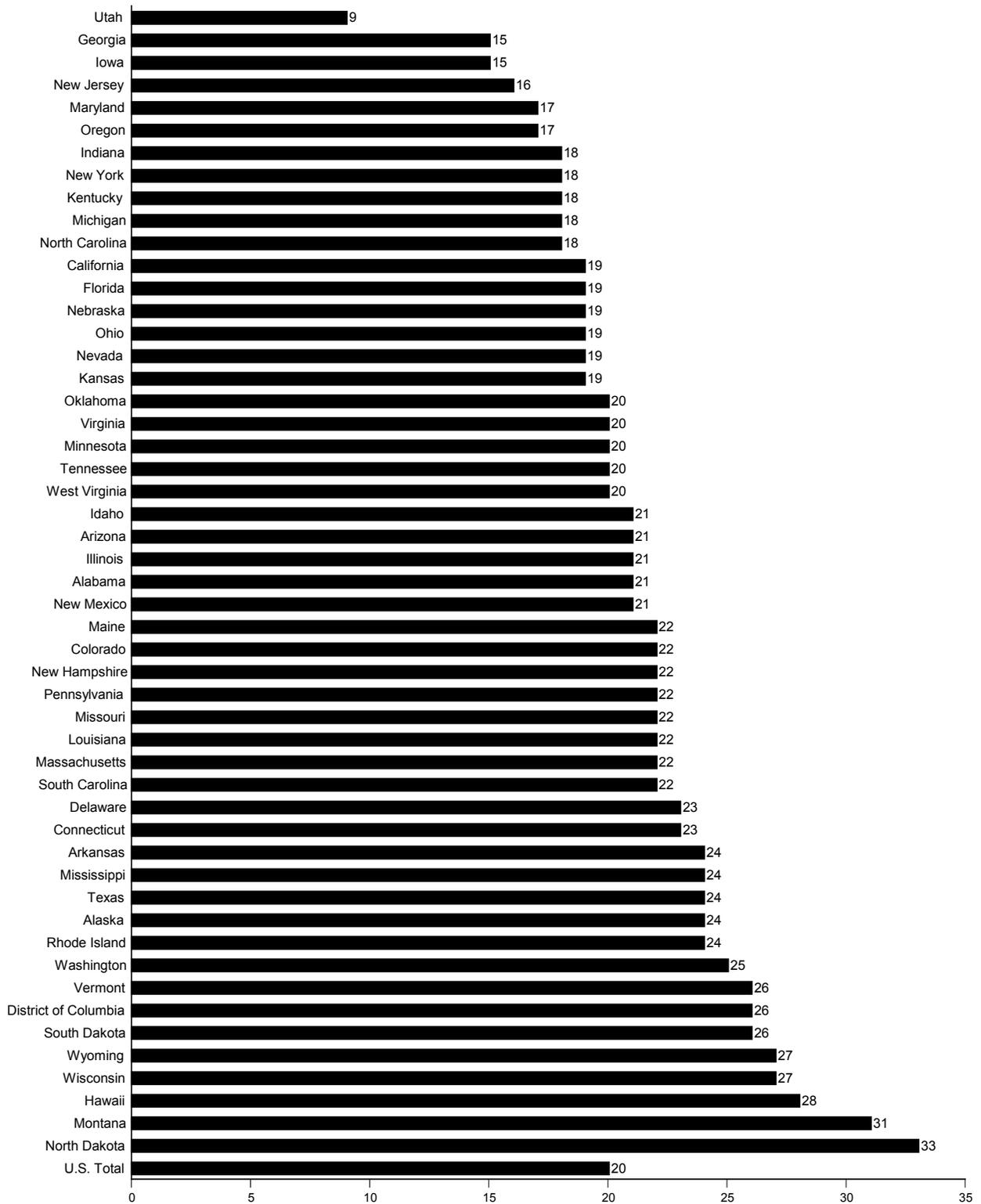


Figure 2-14. Percentage of drivers involved in fatal crashes with BACs ≥ 0.08 g/dL, 2005. Adapted from NCSA (2006a)

2.4. Trends in Alcohol-Related Crashes in the United States

2.4.1. Fatalities

Alcohol has historically been involved in a substantial proportion of fatal crashes in the United States. Over the past 25 years, however, progress has clearly been made in reducing the problem. A qualitative estimate of the influence of various countermeasures on the impaired-driving problem can be deduced from the trend over the last quarter century in alcohol-related fatal crashes. Based on the NHTSA BAC imputation method where the BAC of the active participant is estimated if it is not known (Subramanian, 2002), alcohol-related traffic fatalities (at least one active participant with a BAC level in crash = .01 g/dL or greater) have declined from 26,173 in 1982 to 16,885 in 2005, a 35% decrease; while non-alcohol-related traffic fatalities (no active participant with a BAC level greater than .00 g/dL) have gradually increased from 17,773 in 1982 to 25,558 in 2005, a 44% increase (Figure 2-15) (NCSA, 2006a). Fatalities in crashes involving a road user with a BAC level of .08 g/dL (the current legal limit) declined by 37%, from 23,246 to 14,539.

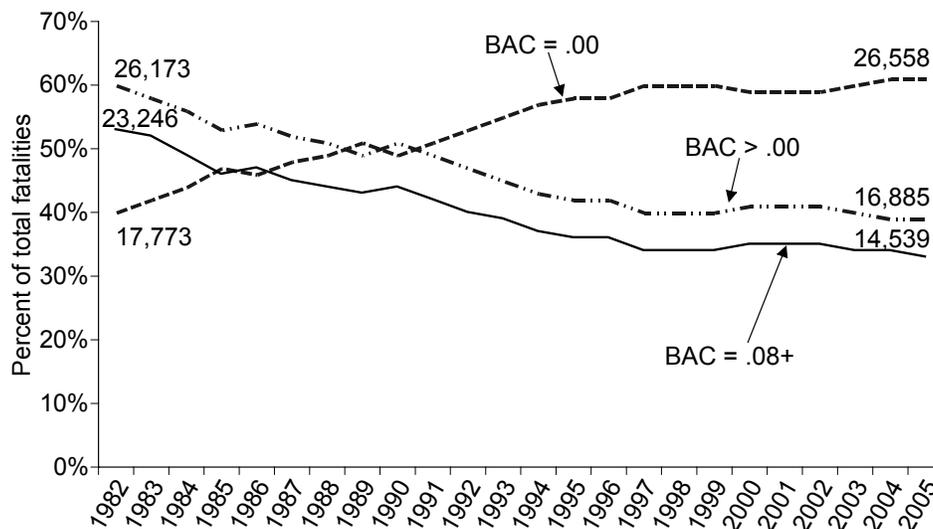


Figure 2-15. Traffic fatalities by percentage and by highest BAC in crash, 1982-2005. Adapted from NCSA(2006a)

When alcohol-related and non-alcohol-related fatalities are considered as a function of vehicle miles of travel, a slightly different picture emerges. Figure 2-16 provides the trend in VMT rates from 1982 to 2003. Although the number of non-alcohol-related fatalities rose between those years (Figure 2-15), VMT increased more, resulting in a fall in the nonalcohol-related fatality rate from 1.58 to .89, the 25% reduction shown in Figure-2-16. The alcohol-related (BAC = .01 or greater) fatality VMT rate fell 63% during the same period.

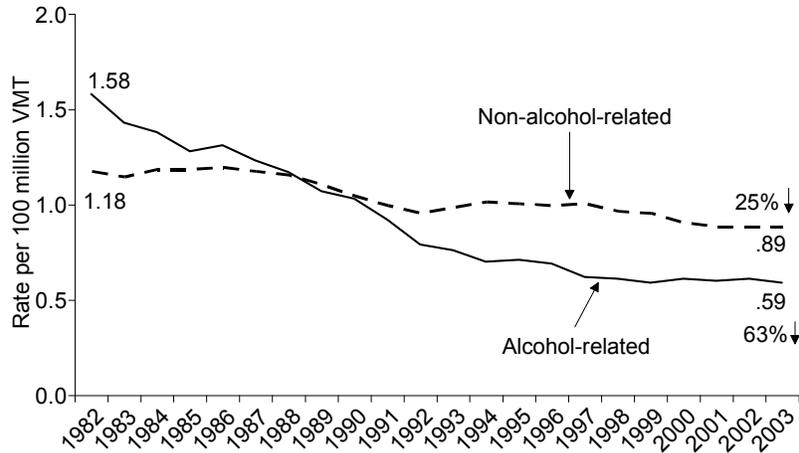


Figure 2-16. Trend in alcohol- and non-alcohol-related traffic fatalities per 100 million VMT, 1982-2003. Adapted from NHTSA (2004a; 2006c)

2.4.1.1. Drivers Fatally Injured in Crashes

Figure 2-17 shows the trend in the BAC levels of fatally injured drivers from 1982 to 2004. Two trends are displayed, drivers with BAC levels of .08 g/dL (the current legal limit) or higher and at very high BAC levels of .20 g/dL or higher. As can be seen, drivers at the current .08 g/dL legal limit have decreased by 37%, whereas those at very high BAC levels of .20 g/dL or higher have decreased by 41%.

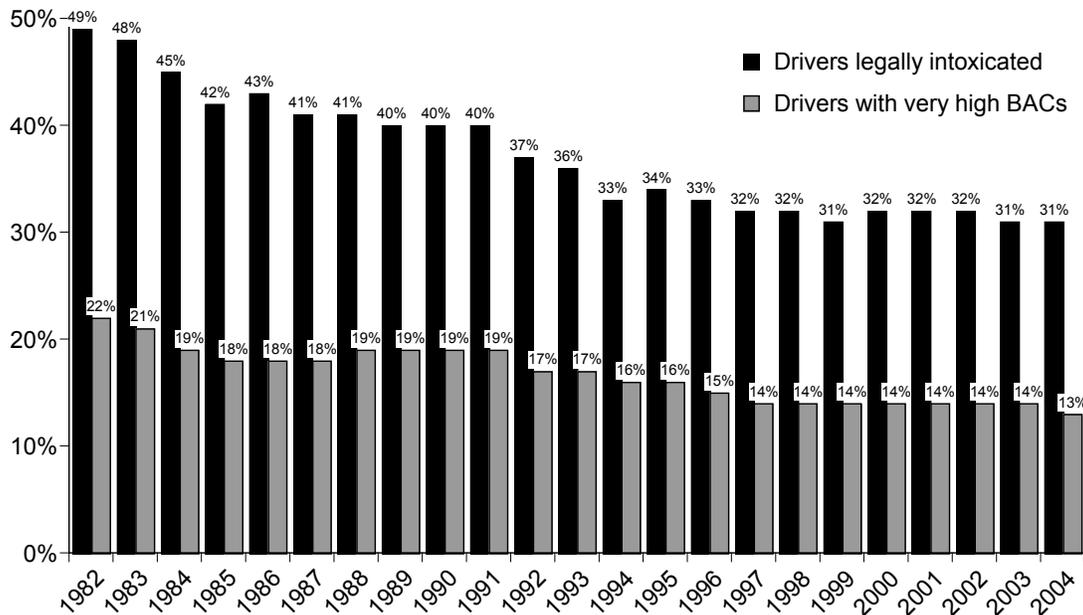


Figure 2-17. Trend from 1982 to 2004 in the proportion of all fatally injured drivers estimated to have had BACs = .08+ g/dL and the proportion with very high blood alcohol concentrations of .20 g/dL or higher (gray bars). Adapted from NHTSA (2004a)

The decrease in .08 drivers in fatal crashes occurred among all age groups as is shown in Figure 2-18. The largest reduction occurred in the first half of the 1980s, and since 1995, the

percentage of .08 g/dL drivers in fatal crashes has remained relatively constant. The largest overall reduction in .08 g/dL drivers in fatal crashes occurred in the 16 to 20 age group. Drivers 75 and older, who have the lowest percentage of .08 g/dL drivers in fatal crashes, dropped in the early 1980s, but there has been no significant reduction in that group since 1985.

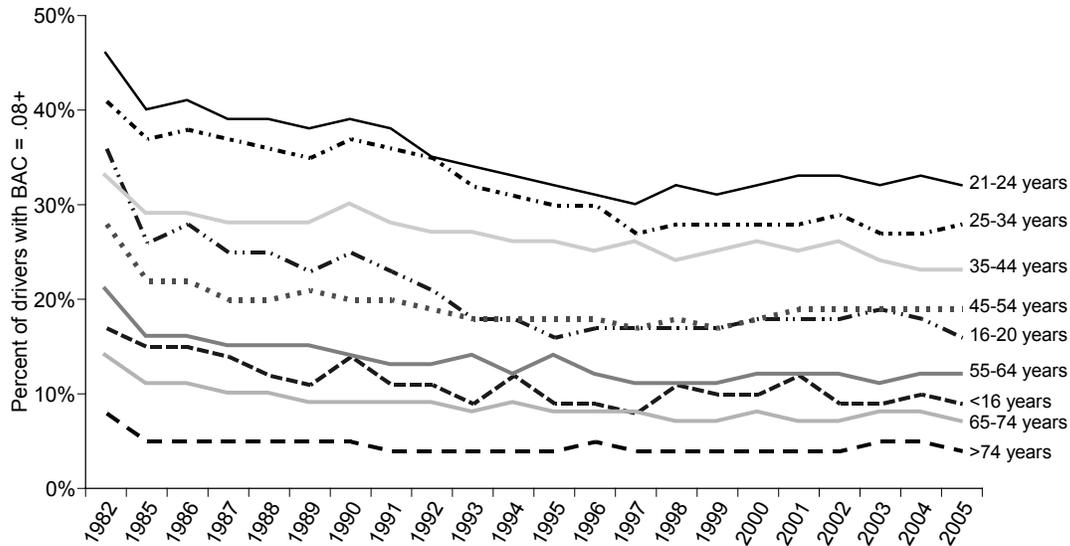


Figure 2-18. Trend from 1982 to 2005 for various age groups in the percentage of drivers with BAC levels of .08 or higher in fatal crashes Adapted from NHTSA (2004a; 2006a)

Another method for considering the decline over time in alcohol-related fatal crashes is the calculation of the ratio of drinking drivers to nondrinking drivers in fatal crashes. This is the CIR measure that has been used to evaluate the effectiveness of various impaired-driving countermeasures (Voas et al., 2007c). The CIR declined from .69% in 1982 to .32% in 2003, a 54% decline in that measure (Figure 2-19).



Figure 2-19. Ratio of drinking drivers to nondrinking drivers in fatal crashes, 1982-2003 (-54%). Adapted from NHTSA (2004a)

2.4.2. Trend in Impaired Drivers in Crashes by Vehicle Type

As shown in Figure 2-20, the downward trend from 1982 to 2005 in drivers in alcohol-impaired fatal crashes has occurred in all the major types of vehicles, despite different trends in the number of each type of vehicle on the roadways. Between 1982 and 2005, the number of passenger cars in fatal crashes declined by a third, the number of light trucks in such crashes nearly doubled, and the number of motorcycles was unchanged (NCSA, 2006a, Table 17, p. 35). Despite these variations in vehicle involvements, the relative decline in the percentage of impaired drivers (BAC level of .08 g/dL or greater) in each type of vehicle was relatively similar, 38%, 43%, and 39%, respectively. Only among the drivers of large trucks (which are generally commercial vehicles) was the decline greater (80%). This may be partially related to the establishment of a .04 g/dL BAC limit for commercial drivers in 1988 (Perrine, 1988; Voas, 1987).

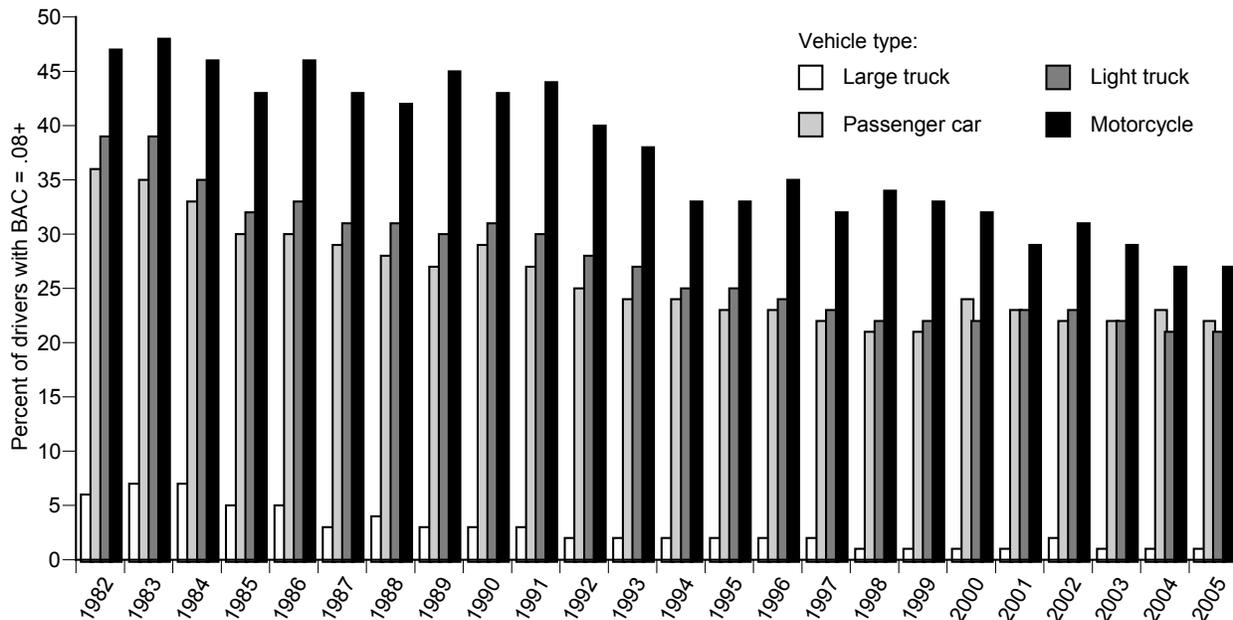


Figure 2-20. Traffic fatalities by percentage and by highest BAC level in crash, 1982-2005. Adapted from NCSA (2006a)

2.5. Deaths Prevented by the Downward Trend in Alcohol-Related Crashes

Based on FARS records of fatalities it is possible to estimate the deaths that have been prevented due to the downward trend in alcohol involvement in fatal crashes (Table 2-4). Alcohol-related crash fatalities declined from 60% of total crash fatalities in 1982 to 39% in 2005. Although demographic and per capita alcohol consumption changes may account for some of this reduction, there is substantial evidence that much of the decline is related to safety legislation and programs, such as administrative license revocation and lowering of the legal BAC limit (Zador, Lund, Fields, & Weinberg, 1988; Hingson, Heeren, & Winter, 1996a; Voas, Tippetts, & Fell, 2000b), minimum legal drinking age laws (Wagenaar & Toomey, 2002), increased enforcement (Ross, 1992b; Lacey, Jones, & Smith, 1999a; Shults et al., 2001), a change in attitude by the driving public (Fell, 2001; Williams, 2006), and the influence of Mothers Against Drunk Driving (Fell & Voas, 2006b). Support for these hypotheses is described in section 5.2.

Table 2-4.

Deaths prevented due to the downward trend of alcohol involvement in fatal traffic crashes from 1982 to 2004

Year	Total traffic fatalities	Alcohol-related fatalities		Non-alcohol-related fatalities		Estimated total fatalities if alcohol-related had remained at 1980 level	Lives saved due to reduction in alcohol in fatal crashes
		%	Number	%	Number		
1982	43,945	60%	26,173	40%	17,772	43,945	—
1983	42,589	58%	24,635	42%	17,954	44,395	1,806
1984	44,257	56%	24,762	44%	19,495	48,205	3,948
1985	43,825	53%	23,167	47%	20,658	51,081	7,256
1986	46,087	54%	25,017	46%	21,070	52,100	6,013
1987	46,390	52%	24,094	48%	22,296	55,132	8,742
1988	47,087	51%	23,833	49%	23,254	57,500	10,413
1989	45,582	49%	22,424	51%	23,158	57,263	11,681
1990	44,599	51%	22,587	49%	22,012	54,429	9,830
1991	41,508	49%	20,159	51%	21,349	52,790	11,282
1992	39,250	47%	18,290	53%	20,960	51,828	12,578
1993	40,150	45%	17,908	55%	22,242	54,998	14,848
1994	40,716	43%	17,308	57%	23,408	57,881	17,165
1995	41,817	42%	17,732	58%	24,085	59,555	17,738
1996	42,065	42%	17,749	58%	24,316	60,126	18,061
1997	42,013	40%	16,711	60%	25,302	62,564	20,551
1998	41,501	40%	16,673	60%	24,828	61,392	19,891
1999	41,717	40%	16,572	60%	25,145	62,176	20,459
2000	41,945	41%	17,380	59%	24,565	60,742	18,797
2001	42,196	41%	17,400	59%	24,796	61,313	18,881
2002	43,005	41%	17,524	59%	25,481	63,007	20,002
2003	42,884	40%	17,105	60%	25,779	63,744	20,860
2004	42,636	39%	16,694	61%	25,942	64,147	21,511
2005	43,443	39%	16,885	61%	26,558	65,666	22,223
TOTAL LIVES SAVED							334,772

Source: NHTSA (2004a)

Note: If the proportion of alcohol-related fatalities had stayed the same as 1982, lives saved per year could be calculated by converting the 40% non-alcohol-related to decimal .4044147 and dividing the non-alcohol-related fatalities each year by this decimal. In 1983, there were 17,954 non-alcohol-related fatalities. If divided by the decimal .4044147, the estimated total fatalities if the proportion had remained the same would be 44,395. Taking the 44,395 and deducting the actual 1983 fatalities of 42,589 would result in 1,806 lives saved. This same formula would be used for each year. Alcohol-related fatalities from 1982 to 2004 are from the new FARS imputation method (Subramanian, 2002).

Chou et al. (2005) studied the change in reported drinking and driving over the 11-year period from 1991 to 2002 using two national household surveys of adults older than 18: the 1991-92 National Longitudinal Epidemiologic Survey (NLAES) (N=42,862) and the 2001-02 National Epidemiological Survey on Alcohol and Related Conditions (NESARC) (N=43,093). They compared responses to the question in each survey regarding whether the respondent had driven after drinking too much in the past 12 months. They reported that the prevalence of driving after drinking too much was 3.7% in

1991-92, which fell to 2.9% in 2001-02, a 22% reduction over 11 years. The authors noted that this corresponds to about half the percentage reduction in alcohol-related fatal crashes in FARS from 1982 to 2002.

The large reductions in alcohol-related crash measures between 1982 and 2005 suggest that safety program interventions may have had some effect. Cummings, Rivara, Olson, and Smith (2006) have produced some evidence for this. They used FARS and relative-risk data to estimate the attributable fraction (see Chapter 3) of fatalities related to the five traffic risk factors shown in Table 2-5. They calculated the values for each of the 20 years from 1982 to 2001 to estimate the total numbers of fatalities prevented by the reduction in each of the five risk factors. As can be seen, their estimate of the drinking-and-driving fatalities prevented because of the decline in attributable deaths between 1982 and 2001 is 153,168, about half of that shown in Table 2-5. These results suggest that a substantial number of the deaths prevented in Table 2-5 can be attributed to reductions in other highway risk factors.

Table 2-5.

Traffic fatalities attributable to one of five factors, with percentage of mortality decline and deaths prevented over 20 years, 1982-2001

Traffic safety risk factor	Attributable traffic Fatalities	% mortality decline (1982-2001)	Fatalities prevented
Drinking and driving	366,606	53%	153,168
Not wearing seat belt	259,239	49%	129,297
No air bag	31,377	17%	4,305
No motorcyclist helmet	12,075	74%	6,475
No bicycle helmet	10,552	39%	239

Source: Cummings et al. (2006)

2.6. Four Alternative Explanations for the Decline in Alcohol-Related Crashes

Before accepting the conclusion that these reductions in reported drinking and driving and alcohol-related crashes result from safety program activity, it is necessary to evaluate alternative explanations for the observed reductions. Among the possible non-impaired-driving program explanations are: (1) a reduction in per capita alcohol consumption; (2) a reduction in the numbers of high-risk young males in the population; (3) a reduction in the number of drivers with alcohol use disorders who drive at high BAC levels and commit repeated DWI offenses; and (3) a general worldwide decline in alcohol-related crashes associated with roadway and vehicle improvements and an increase in traffic congestion.

2.6.1. Per Capita Alcohol Consumption

From 1982 to 1995, per capita alcohol consumption in the United States declined (Lakins, Williams, Yi, & Hilton, 2005). Figure 2-21 shows the annual decline in per capita consumption of alcohol along with the annual decline of fatally injured drinking drivers and fatally injured drinking pedestrians from 1982 through 2003. Substantial declines are seen in all three rates between 1982 and

1995, with a leveling off in the past decade. The reduction in the percentage of fatally injured drinking drivers was substantially greater than for fatally injured pedestrians. The percentage of reduction in fatally injured drinking drivers also was greater than the reduction in per capita alcohol consumption. This suggests that the change in national alcohol consumption that might have produced much of the reduction in fatally injured drinking pedestrians did not totally account for the larger reduction in fatalities among drinking drivers.

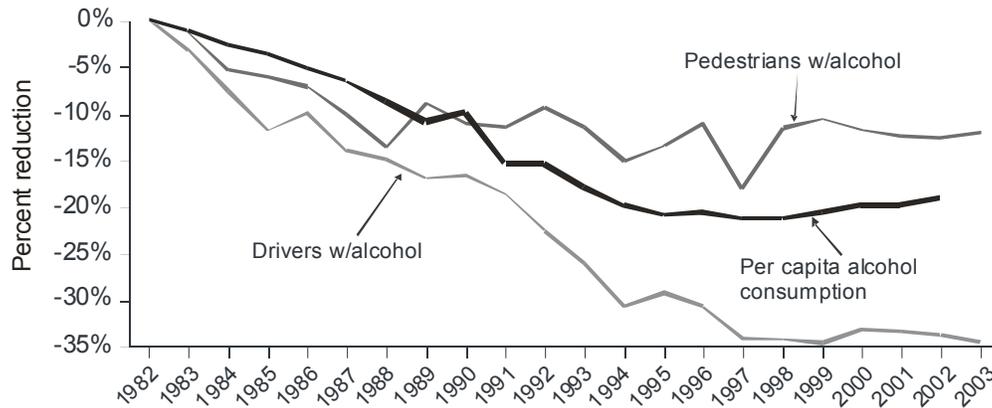


Figure 2-21. Percentage of reduction in fatally injured drinking drivers and pedestrians and per capita alcohol consumption in the United States, from the 1982 baseline year to 2003. Adapted from Fell & Voas, (2006b)

Because most countermeasure programs in the last 25 years have targeted drivers, not pedestrians or drinking in general, this difference supports the hypothesis that these programs had an effect on drinking-driver fatalities and injuries beyond that which might be accounted for by the observed reduction in alcohol consumption.

2.6.2. High-Risk Young Drivers

Figure 2-22 compares the reduction in underage drinking drivers and nondrinking drivers in fatal crashes along with the changes in the number of licensed drivers younger than 21 in the United States during that period. The number of licensed drivers younger than 21 declined by 14% between 1982 and 2004. During that same period, the number of underage drinking drivers in fatal crashes declined by 62%. Further, during that period, the number of nondrinking drivers age 20 and younger in fatal crashes actually increased by 10%. Thus, it appears that changes in the size of the underage driving population cannot account for the reduction in the involvement of underage drinking drivers in fatal crashes. So it appears that the MLDA 21 law and, to a lesser extent, the national zero-tolerance law had a substantial effect on underage drinking and driving (Hingson, Heeren, & Winter, 1994; Hingson, Heeren, & Morelock, 1986; Hingson et al., 1983; Voas, Tippetts, & Fell, 2003b) (see sections 5.2.4 and 5.3.2).

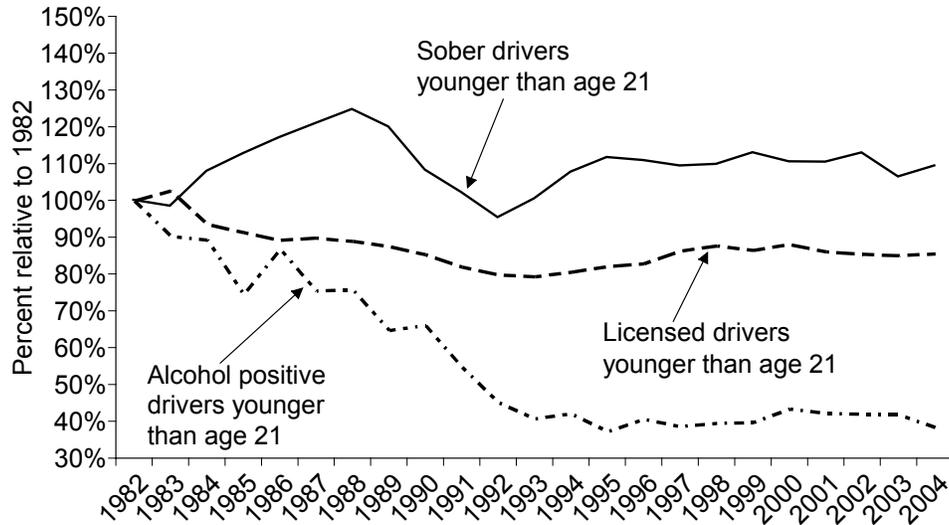


Figure 2-22. Drivers younger than age 21 relative to the 1982 baseline (which is 1.0). Adapted from Fell & Voas, (2006b)

Figure 2-23 shows the same data for drivers age 21 and older. The number of licensed drivers and nondrinking drivers involved in fatal crashes increased steadily from 1982 to 2004 (+38%). The number of drinking drivers age 21 and older involved in fatal crashes declined by 32% during that period. Fell and Voas (2006b) and McCartt and Williams (2004) suggested that impaired-driving laws, increased enforcement, and a change in the public attitude had a role in this reduction in alcohol-related fatal crashes among adult drivers age 21 and older. The evidence for this possibility is described in Chapter 5.

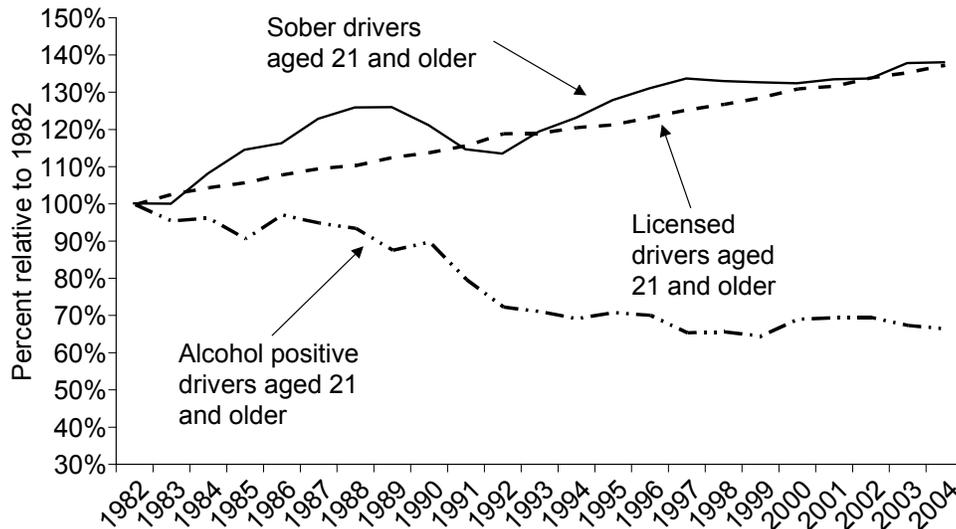


Figure 2-23. Drivers age 21 and older relative to the 1982 baseline (which is 1.0). Adapted from Fell & Voas, (2006b)

2.6.3. Drivers With Alcohol Use Disorders

Although alcohol-related fatal crashes were substantially reduced between 1982 and 1995, there has been little change over the past 10 years (Stewart, Fell, & Sweedler, 2004). A frequent argument for the current importance of offenders with very high BAC levels is that the decrease in alcohol-related crashes in the last 10 years resulted from a reduction in impaired driving by the “easy-to-deter” drinking drivers, whereas the “hardcore” drinking drivers remain to be controlled. Thus, this argument suggests that we “hit the wall” in the mid-1990s after most social drinkers changed their behavior. The evidence shown in Figure 2-17, however, does not indicate a large difference in the trend of very high (.20+ g/dL) BAC drivers from all drivers over the limit (.08 g/dL) during the last 20 years. McCartt and Williams (2004) pointed out that, as shown in Figure 2-24, the reduction in the percentage of fatally injured drivers with high BAC levels of .15 g/dL or greater from 1982 to 2003 was 37%, the same as for drivers at BAC levels of .08 g/dL or greater. In fact, the percentage of decline in drinking drivers at every BAC interval was approximately the same between 1987 and 1998 as shown by the graph in Figure 2-25. A fuller discussion of the role of individuals with alcohol use disorders in fatal crashes is provided in section 3.6.2.

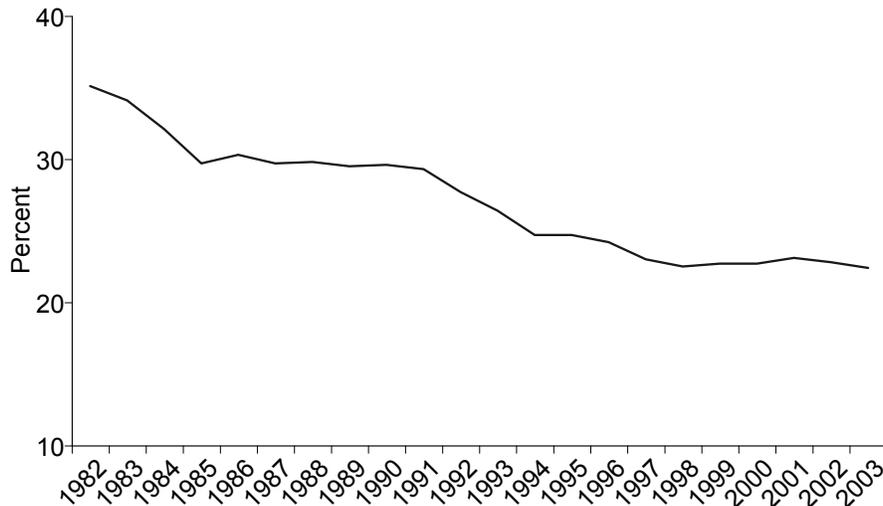


Figure 2-24. Percentage of fatally injured drivers with BACs \geq .15 g/dL (1982-2003). Adapted from McCartt & Williams (2004)

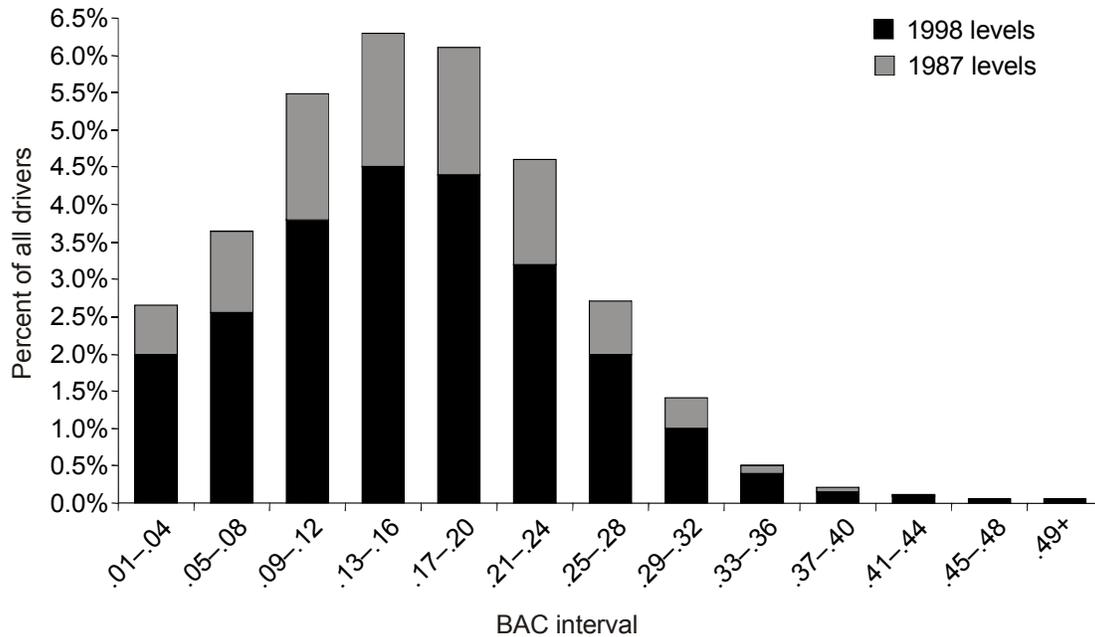


Figure 2-25. Reduction from 1987 to 1998 in the percentage of all drivers who were drinking in fatal crashes, FARS 1987-1998 (produced for this report). Adapted from NHTSA (2004a)

A more plausible explanation for the slowing decline since the late 1990s is the apparent reduction in public awareness and media attention to the impaired-driving problem (Williams, 2006). Newspaper and other media reports on the issue gradually declined, legislation slowed, enforcement decreased, and other social issues dominated the news (McCarthy & Harvey, 1988; Williams, 1994).

2.6.4. *Worldwide Changes in Drinking and Driving*

Several other nations reported substantial reductions in alcohol-related crashes during the 1980s and early 1990s, which were generally attributed to national safety programs (see next section). That most industrialized nations experienced a reduction in impaired-driving crashes during the 1980s and 1990 suggests that some broader factors (such as the general increase in the number of four-wheeled vehicles on the road and improved safety features of these vehicles) may have had an influence. Some safety programs may have differentially protected highly impaired drivers who more easily lose control of their vehicles and are less likely to buckle their seat belts than sober drivers. In any case, the reduction in alcohol-related crashes, particularly for drivers younger than 21, was generally greater in the United States than elsewhere. Canada experienced reductions in young drinking drivers ages 16 to 19 in fatal crashes from 1982 through 1998 that were similar to the U.S. reductions of drinking drivers age 20 and younger, so other mechanisms apparently affected young drinking drivers (Hedlund, Ulmer, & Preusser, 2001).

2.6.5. *Worldwide Trends*

As mentioned in the previous section, the United States is not unique in experiencing substantial declines in impaired driving over the last 25 years. Other countries have experienced similar declines (Sweedler et al., 2004).

Research in Canada indicates that during the 1980s there was a consistent and substantial decline in the percentage of fatally injured drivers with positive BAC levels (Mayhew, Simpson, & Beirness, 2002). Then from 1992 through 1999, there was a decrease in the proportion of fatally injured drivers with positive BAC levels from 48 to 33%, a 31% relative decrease in that proportion. Since 1999, however, the proportion of fatally injured drivers with positive BAC levels increased to 38% in 2001 (Mayhew, Beirness, & Simpson, 2004).

In France, the number of alcohol-related traffic fatalities declined from 11,946 in 1983 to 10,289 in 1990, and again to 7,242 in 2002. Some researchers attribute the decrease to the massive increase in random breath testing of drivers on the roads and the lowering of the legal BAC limit to .05 g/dL (Observatoire National Interministeriel de Securite Routiere, 2002; Beiecheler-Fretel & Peytavin, 2004).

The Netherlands also reported declines of traffic fatalities that were alcohol-related, from more than 50% in the 1970s to about 35% in 2000 (Mathijssen, 2004). Increased enforcement was the main reason given for the progress.

In Sweden, the proportion of driver fatalities that were alcohol-related decreased sharply from 31% in 1989 to 18% in 1997. Increased enforcement and lowering the legal BAC limit from .05 to .02 g/dL were the reasons cited. Since Sweden joined the European Union in 1996, however, they have gradually lost their restrictive alcohol policies. Consequently, alcohol consumption has increased, and the proportion of fatally injured drinking drivers has increased from 18% in 1997 to 28% in 2002 (Sweedler et al., 2004).

In Great Britain, the proportion of fatally injured drivers with BAC levels higher than the .08 g/dL limit decreased from 30% in 1982 to 20% in 1998 (Tunbridge, Keigan, & James, 2001; Keigan & Tunbridge, 2003).

It appears that most industrialized countries experienced declines in alcohol-related crashes and fatalities throughout the 1980s and into the early 1990s. Recently, though, the progress has stalled in some countries. In others, progress has continued but at a slower rate. There appears to be a strong link in most countries between levels of enforcement and alcohol-related fatalities. When random breath testing and other enforcement measures increased, alcohol-related fatalities decreased (Sweedler et al., 2004).

2.7. Nonfatal Alcohol-Related Crashes

NHTSA estimates that alcohol is involved in about 17% of nonfatal injury crashes and about 7% of all police-reported crashes (NCSA, 2006b). Approximately 248,000 people were injured in alcohol-related crashes that were reported to the police in 2004. It is very difficult to determine a trend in the injury data because of the large standard error in the GES estimates, but Table 2-6 shows the estimates of injured people in alcohol-related crashes from 1993 to 2004. The number of people injured in alcohol-related crashes appeared to peak in 1997 at 327,000 and appeared to be at a low of 248,000 in 2004. These estimates are from police-reported crashes and do not include unreported crash injuries. NHTSA estimated that, if a correction is made for the underreporting of alcohol in crashes reported by the police and for the number of injuries in alcohol-related crashes that are not reported to the police, 512,000 people were injured in alcohol-related crashes in 2000 (Blincoe et al., 2002) rather than the 310,000 as reported by the GES.

Table 2-6.

Estimates of injured people in alcohol-related crashes, 1993-2004

Year	Number injured
1993	289,000
1994	297,000
1995	300,000
1996	321,000
1997	327,000
1998	305,000
1999	308,000
2000	310,000
2001	275,000
2002	258,000
2003	275,000
2004	248,000
2005	254,000

Source: NCSA (2006a)

2.8. Drivers on the Roads

The National Roadside Survey of more than 6,000 drivers on Friday and Saturday nights in 1996 indicated that 2.8% had BAC levels of .10 g/dL or higher (Voas, Wells, Lestina, Williams, & Greene, 1998b). This included 3.5% of the male drivers on the roads, 1.5% of the female drivers; .3% of the drivers age 20 and younger, 3.8% of the drivers ages 21 to 34, 3.7% of the drivers ages 35 to 44, and 1.7% of the drivers age 45 or older. Previous National Roadside Surveys in 1986 and 1973 provide some trend data. Figure 2-26 shows that more than one-third (36%) of the drivers on our roads in 1973 had some alcohol (BAC \geq .01 g/dL) in their systems on weekend nights. That proportion of drinking drivers on the roads was reduced 28%, to slightly more than a quarter (26%) of the drivers who were drinking on weekend nights in 1986. The decrease in that proportion (26%) in 1986 to 1 in 6 drivers (17%) in 1996 was 35%. So there is strong evidence that drinking and driving was significantly reduced between 1973 and 1996. Figure 2-26 also shows the proportion of drivers with BACs \geq .05 g/dL and BACs \geq .10 g/dL in each of the three surveys. Substantial decreases also occurred at those BAC levels.

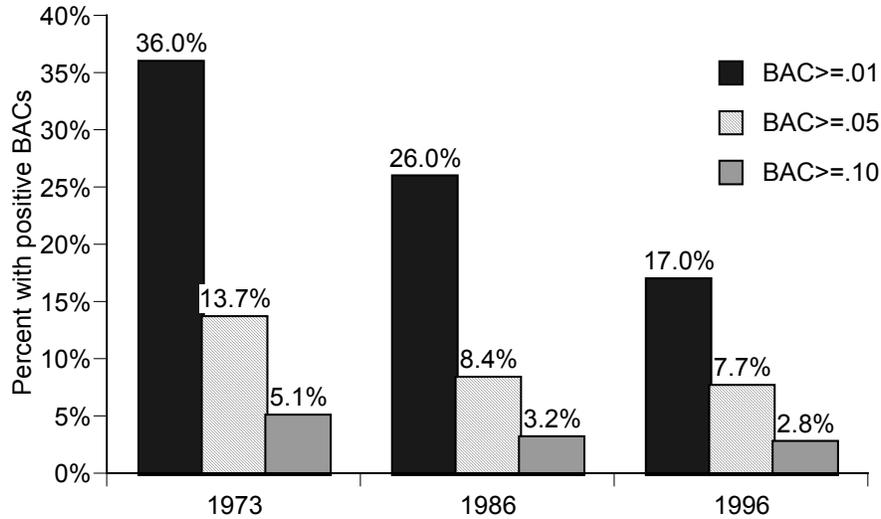


Figure 2-26. Percentage of drivers with positive BAC levels on the road weekend evenings, 1973 versus 1986 versus 1996. Adapted from Voas et al. (1998b)

2.9. Telephone Surveys of Drinking and Driving

NHTSA has sponsored six national telephone surveys of more than 6,000 people age 16 and older in the United States between 1991 and 2001. In 2001, 23% of the respondents reported driving within 2 hours of drinking alcohol in the past year (Royal, 2003). That suggested that there were 906 million drinking-driving trips in that year. Based on the national telephone sample, the prevalence of drinking and driving has declined. Figure 2-27 shows that the proportion of respondents who reported driving within 2 hours of drinking at least once in the past month declined steadily from 26% in 1991 to 19% in 2001.

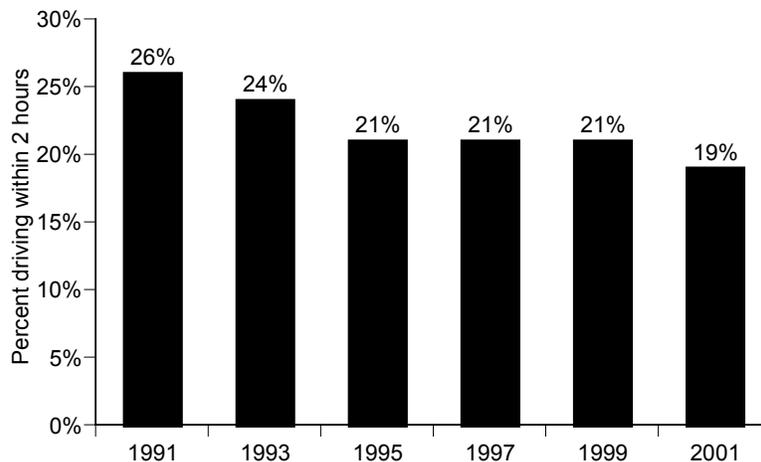


Figure 2-27. Percent of those who drove within 2 hours of drinking 1 or more times in the past month. Adapted from Royal (2003)

In that same survey, problem drinkers were estimated to be 29% of the past year's drinking drivers and to have accounted for about 46% of all drinking-and-driving trips reported in that survey –

or somewhere between 343 and 491 million drinking-driving trips in 2001. “Problem drinkers” were defined in that survey as having two or more positive responses to the CAGE instrument (Ewing, 1984), or as having consumed five or more drinks on 4 or more days in the past month, or as having consumed nine or more drinks (eight for females) on at least one occasion in the last month. A fuller discussion of problem drinking among drivers in alcohol-related crashes is provided in section 3.6.2.

2.10. Household Surveys of Drinking and Driving

Chou et al. (2006) analyzed data from the 2001-2002 NESARC household survey in which data collectors visited the homes of the 43,093 participants to conduct face-to-face surveys on alcohol and drug use. Participants were selected on the basis of a national stratified random sampling procedure described by Grant and Dawson (2006). Based on their analysis of the NESARC survey, Chou and her associates found that 4.53% of Americans older than 18 reported “driving *while* drinking” more than once in the last year. This equates to 9 million individuals who report consuming alcohol while driving a vehicle. In contrast, the percentage of respondents that reported driving after having too much to drink more than once in the last year was only 2.87%. Their analysis indicated that 6.63% of their respondents (corresponding to 13.8 million adult Americans) reported riding with a drinking driver more than once in the last year. Interestingly, 7.63% of the respondents reported drinking while they were riding as a passenger. This evidence of the large number of individuals drinking in vehicles, particularly drinking while driving, indicates the potential safety benefits of open-container laws that prohibit open bottles or cans in the passenger compartment of the vehicle as well as laws against drinking while driving. Data from the NESARC on special groups of drivers (male/female, young/older) of interest to traffic safety specialists is provided in Chapter 4.

2.11. Summary

Traffic safety researchers have benefited from the extensive records of crashes maintained by NHTSA and the States. These data files have provided the basis for analyzing the characteristics of alcohol-related crashes and for the evaluation of impaired-driving laws and programs. Not fully appreciated by the public and some safety activists is the complexity of the data on alcohol-related crashes. In part, this complexity is derived from the richness of the data that allows the reporting of similar sounding but quite different variables, such as alcohol-related crashes, drinking drivers in crashes, and alcohol-related fatalities. Additional complexity arises from the limited availability of BAC measures of road users involved in crashes. Only 64% of fatally injured and only 25% of surviving drivers in fatal crashes are tested for alcohol. This requires imputing BAC levels for those cases where this measure is lacking or using surrogate measures based upon other information such as single-vehicle nighttime crashes. Another area of complexity is the choice of a normalizing or exposure variable, such as population or vehicle miles of travel, upon which to properly compare different groups.

Alcohol involvement in fatal and injury crashes is strongly patterned. Crashes involving only one vehicle, occurring at night and on weekends, are much more likely to involve a drinking driver. The type of vehicle also plays a role: drivers of commercial vehicles are much less likely to be involved in an alcohol-related crash than private-vehicle drivers or motorcyclists. Men are more involved as drinking drivers than women and young men more than older drivers, but these simple differences conceal much more complex relationships. Many are based primarily on the extent of exposure, where men, for example, may drive more than women during high-risk evening hours.

The United States enjoyed a remarkable downward trend in alcohol-related crashes between 1982 and 1995, which has since leveled off. That trend coincided with a period during which per capita national alcohol consumption declined and the number of young drivers decreased, but those factors alone did not appear to account for the overall reduction. This provides evidence that safety program activity may have been responsible for at least some of the decline. However, this conclusion must be accepted with some caution because there was a general worldwide decline in alcohol-related crashes during the same period and other socioeconomic factors certainly played a role in the reduction in crashes involving alcohol. The evidence that there are safety laws and programs that can reduce alcohol-related crashes and may have contributed to the reductions that occurred between 1982 and 1995 is covered in Chapter 5.

Chapter 3.

Alcohol Effects on People

The biomechanics of alcohol consumption and elimination was first described by Widmark in Sweden in the 1930s (Widmark, 1932). Knowledge in this area has increased little in the last 30 years; however, significant progress has been made in methods for measuring alcohol in the body, opening the way for new technological methods for monitoring drinking and preventing impaired driving. This chapter focuses on the emerging practical technologies for measuring BAC in the field. Recent studies on the effect of low doses of alcohol on performance are reviewed. These studies have been important in supporting legislation reducing the legal BAC limit to .08 g/dL for adults and .02 g/dL for drivers age 20 and younger. Also covered is the growing information on the role of drivers with alcohol use disorders (AUDs) in alcohol-related crashes and the emerging definitions of problem drinking and moderate drinking. In addition, the new information on the relative risk of crash involvement provided by a recent case control study funded by the NHTSA is reviewed.

3.1. Background

As described in previous State of Knowledge reports, the processing of alcohol by the body is generally well understood. It begins with absorption by the stomach and the small intestines, a process that requires 1 to 3 hours, depending on the type and quantity of the alcoholic beverage and the presence of food in the stomach. Alcohol enters the bloodstream by simple diffusion and does not have to be digested. The presence of food in the stomach slows the rate of alcohol absorption, but absorption is also influenced by other factors including the type of alcoholic beverage, the drinker's gender and body temperature, the presence of certain medications in the body, and the types of spices in the food. Body fat and skeletal mass absorb very little alcohol. Thus, an identical quantity of alcohol per unit of body weight will induce a higher BAC in women than in men because of differences in body constitution (Bode & Bode, 1997). Some recent research suggests that, in a social drinking setting, a shorter time to peak BAC and a faster absorption rate may occur when alcohol is consumed over an extended period. In contrast, earlier studies found longer absorption times (Winek, Wahba, & Dowdell, 1996). The extent of the variability in absorption time is illustrated in a study by Friel, Baer, and Logan (1995), who found that the time to peak BAC measured by breath test varied from 10 to 91 minutes after the start of drinking and that the mean BAC levels were significantly lower in females than in males.

Alcohol is metabolized primarily in the liver, but metabolism occurs also in the stomach and small intestine. Gastric alcohol metabolism, which is significant only at low alcohol concentrations, is more efficient in men than in women, which helps explain why the same amount of alcohol produces higher BAC levels in women than in men. There is also evidence that alcohol can be metabolized by bacteria in the large intestine. Bode and Bode (1997) noted that alcohol is not only degraded, but also is *produced* in the gastrointestinal tract as a byproduct of bacterial breakdown of ingested carbohydrates. Finally, of the alcohol absorbed, 90 to 98% is oxidized, 1 to 5% is excreted in an unaltered state in urine, 1 to 5% is expired via the lung (Vrij-Standhardt, 1991), and about 1% is

eliminated through the skin (Swift, 2003). The total time to eliminate alcohol from the body depends upon the variables that influence absorption (already described).

Alcohol consumption is normally defined for public programs in terms of “standard drinks.” A standard drink equates to .54 ounces of ethanol, generally described as a 12-ounce glass of (4.5%) beer; a 5-ounce glass of (12%) wine, or 1.2 ounces of 80 proof liquor (NHTSA, 2005a). Although the wording of this definition varies slightly from study to study, it is generally included in the instructions provided in drinking surveys involving the measurement of drinking quantity and frequency. It is also generally used in public media, but needs to be accompanied by a warning regarding ad lib pouring of drinks at parties or ordering doubles at bars and restraints where the alcohol content of the drink may be considerably higher than a “standard” drink.

Counting standard drinks is one method that individuals use to estimate their own BAC levels. Other methods for estimating BAC levels have been published in various forms—formulas, procedures, tables, computer programs, and monograms. South (1992) summarized factors affecting the BAC level and presented a formula for calculating it. He concluded, however, that the formula was too complex to use and not very accurate. This assessment holds true for self-determination methods in general, which give only a rough idea of an individual’s BAC level after drinking. South, a resident of Australia, recommended that those wanting to know how much they can drink and then drive legally should combine counting drinks and using a coin-operated breath-testing device. The application of alcohol measurement techniques in safety programs is discussed in more detail in Chapter 5.

3.2. Measurement of Alcohol Presence

The acute effects of alcohol, which are most directly related to impaired driving, flow from its effect on the brain. The best measure for predicting performance following drinking is the measure that most directly reflects brain alcohol concentration. Although chemical tests of blood drawn from a vein or capillary are the preferred indirect way of estimating alcohol concentration in the brain in live humans, breath measurement may be a more accurate estimate during the 20- to 30-minute absorption period, because the alcohol absorbed from the intestines flows directly to the heart and is pumped directly to the brain. It takes some time for the blood alcohol concentration to equilibrate throughout the body so that blood collected in a vein on its way back to the heart generally has a lower alcohol concentration than the blood in the alveoli of the lungs, which are in contact with the expired air measured by a breath test during the first 20 to 30 minutes following ingestion (Jones, 2000). A variety of bodily substances have been used to measure alcohol presence elsewhere in the body to alcohol presence in the blood. Jones (2000) provides an excellent review of the development of measurement techniques during the 20th century.

Breath alcohol measurement has become more precise and reliable over the last 30 years with the development of infrared and fuel cell measurement techniques. It is also more convenient and easy to perform, especially in field research and enforcement settings. When breath tests were first developed, the relationship of the concentration of alcohol in the breath to the concentration in blood was set at 2,100 in breath to 1 in blood. More recent studies using improved technology indicate that the conversion factor may be closer to 2,400 than 2,100 (Jones & Anderson, 1996). This means that, on average, using a conversion factor of 2,100 would underestimate the BAC level by about 10%. Jones and Anderson noted the fairly high variability of the conversion factor and discussed some of the factors that may influence the variability. This was recognized by experts at the time, but the

standard was not changed, thereby providing the offender with an additional margin of protection. Legal challenges to the 2,100 relationship eventually led the National Safety Council's Committee on Alcohol and Other Drugs to recommend legislation establishing legal limits for the concentration in breath without reference to blood. Jones and Pounder (1998) discussed current practices for measuring alcohol concentration in clinical and forensic laboratories and recommended methods for assuring quality in laboratory procedures.

The major advances in BAC measurement technology during the last decade have been in the development of practical devices that give promise of providing methods for increasing the efficiency of DWI enforcement, the monitoring of DWI offenders, and monitoring the recovery of patients being treated for alcohol problems. Interest has centered on three biological samples: breath, oral fluid, and sweat and blood.

3.2.1. Breath Measurements

3.2.1.1. PBTs

The development of the fuel cell, which reacts specifically to alcohol, provided the basis for the production of small handheld units, called "preliminary breath testers" (PBTs), that could be used by police at the roadside (see Figure 3-1). Based on NHTSA's qualified products list, the fuel cell provided a level of accuracy that was equal to that of the larger evidential testers used to collect evidence for the courts. Equipping police with PBTs appears to have substantially increased the number of DWI arrests they make (Cleary & Rodgers, 1986; Saffer & Chaloupka, 1989; see Chapter 5). The PBT technology has also been adapted for use in home confinement programs where video technology may be used to confirm that the confined offender is the individual providing the test (Voas & Marques, 2003b).



Figure 3-1. SD-4 preliminary breath-test device

3.2.1.2. PAS Units

The small size of the fuel cell also could be integrated into a police officer's flashlight to be used as a nonintrusive method for detecting alcohol in the expired air of a suspected impaired driver. A passive alcohol sensor (PAS) collects mixed expired and environmental air from 6 inches in front of the face and produces a relatively accurate estimate of the individual's BAC level. Farmer et al. (1999) analyzed passive sensor data which were collected by the research staff during the 1996 National Roadside Survey on more than 6,000 drivers, and found a .70 correlation between the PAS and BAC

as measured on a PBT. Voas et al. (2006b) also found a .79 correlation between the PAS and BAC as measured by a PBT in their analysis of 12,587 PAS tests conducted by the police. A series of studies (Ferguson, Wells, & Lund, 1995; Lund & Jones, 1987; Lund, Kiger, Lestina, & Blackwell, 1991) have demonstrated that when officers use passive sensors at a checkpoint, more drinking drivers are detected and the arrest rate increases by approximately 50% (see section 5.3.9).

3.2.1.3. Self-Testers

Coin-operated breath-test devices for bars and restaurants have also been developed and tested. These units provide a straw through which the user blows into the unit, and they use a fuel cell or semiconductor to analyze the sample and display the BAC level. These units depend on the users to follow the instructions – wait for 15 to 20 minutes after the last drink, blow correctly, and interpret the information appropriately – when they may be impaired. Safety advocates have been concerned that the machines would lead to drinking contests to see who could reach the highest BAC level, but so far there is only limited anecdotal evidence that this has occurred. These units have failed commercially in the United States; however, in Australia where the police use large-scale random testing and the illegal BAC level is lower (.05 g/dL), evidence indicates these devices are more widely used. In 1986, Breakspear (1986) reported 17,000 tests per day in Australia, which appear to have a limited effectiveness in that high-enforcement environment.

3.2.1.4. Vehicle Alcohol Interlocks

The fuel cell was also used in the development of vehicle alcohol interlock systems designed to prevent driving by suspended DWI offenders. Based on a 2006 national survey of interlock providers conducted by Richard Roth, approximately 100,000 DWI offenders in the United States had installed interlocks on their vehicles (paper presented at MADD Technology Symposium, Albuquerque, New Mexico, June 19-20, 2006, by Richard Roth). Vehicle alcohol interlocks require the driver to blow into a sensor that disables the vehicle's ignition if the breath sample provided has a .03 g/dL BAC or higher. NHTSA has provided a model standard for the performance of such devices, and the units appear to work effectively and are difficult to circumvent. The current standard, which is in the process of being updated, covers areas such as the BAC lockout point and the precision with which the BAC is measured. These devices are also able to avoid contamination, to perform under a wide range of temperatures, and to prevent circumvention by the use of balloons or other methods for delivering an artificial air sample to the interlock sensor. One drawback is that the device reacts to some nonalcoholic substances (e.g., acetone, which can occur in the breath of diabetics). Most of the States with interlock programs have adopted the NHTSA standard, and the widespread use of these devices suggests that most suppliers meet the specifications. Many evaluation studies have demonstrated that alcohol interlocks are effective while on the offenders' vehicles (Coben & Larkin, 1999; Willis, Lybrand, & Bellamy, 2004). These systems have encountered considerable resistance and only a small proportion of the eligible offenders have actually been required to install them. For a review of the effectiveness of interlocks as a method of controlling impaired driving by DWI offenders, see section 5.4.9.

3.2.2. Oral Fluid Measurement

Saliva comes in contact with the blood across the tissues of the mouth. Through this contact, oral fluid can reflect alcohol and, to a varying extent, drug constituents in the blood. The greatest interest in this biological medium has been as a minimally intrusive method of detecting and

measuring drug use (Flores, Spicer, & Frank, 1992; Hold, de Boer, Zuidema, & Maes, 1995). To date, saliva measurement devices have been used more often outside the United States and have been found to perform favorably for rapid estimation of BAC level (Keim, Bartfield, & Raccio-Robak, 1996; Kiesow, Simons, & Long, 1993). Considerable progress has been made for easily and accurately drug screening tests at the roadside. For the first time, the 2007 National Roadside Survey, funded by NHTSA, will include the collection of oral fluid samples using a quantitative collection device, and the sample will be sent to a laboratory for analysis. A preliminary study of the collection of oral fluid at the roadside was conducted in preparation for the 2007 National Roadside Survey (Lacey, Kelley-Baker, Furr-Holden, Brainard, & Moore, 2007). This type of oral fluid collection and analysis can provide a highly accurate specification of some of the drugs commonly abused.

Less accurate is an inexpensive oral fluid self-testing system developed for personal use. This system consists of litmus-type test strips that can be detached and placed in the mouth for 10 to 15 seconds; these strips change color in the presence of alcohol. This system, however, is not highly reliable, is subject to misuse and misinterpretation (Johnson, 2003; Johnson & Voas, 2004), and is not commercially successful.

3.2.3. *Transdermal Alcohol Measurement*

A recent addition to the BAC monitoring options is transdermal alcohol detection. Approximately 1% of ingested alcohol is lost through the skin (Swift, 2003). Efforts to measure alcohol from the surface of the skin have been underway for some time. Deveaux and Gosset (2000) evaluated “sweat patches” for estimating BAC levels in 2000. More recently, two electrochemical devices, the SCRAM™ and the WrisTAS™, that detect transdermal alcohol concentration (TAC) have been developed. The devices are adapted for long-term wear by the subject and transmit data to a remote data storage device. A limitation on any transdermal device is that error can derive both from the measuring device and from the alcohol signal. In an effort to characterize the variation in the transdermal alcohol signal from the kinetics of a model system, Anderson and Hlastala (2006) reported that ethanol transport through the skin is substantially affected by the stratum corneum, the externalmost layer of the skin surface. They determined that detectable transdermal ethanol gas concentration is particularly affected by the thickness, temperature, and hydration state of the stratum corneum, and because of these variables, they concluded that TAC cannot be considered a quantitative estimate of the BAC level as TAC can vary by as much as 2:1 depending on local skin factors.



Figure 3-2. The SCRAM™ Ankle Unit

The Alcohol Monitoring Systems (AMS) device, the SCRAM™ (Secure Continuous Remote Alcohol Monitoring), measures ethanol gas at the skin surface using a fuel-cell sensor. The system consists of three components: (1) a SCRAM™ “bracelet” that is locked onto the ankle (Figure 3-2), (2) a SCRAM™ modem for uploading data, and (3) a remote server for aggregating data from offenders and for reporting these data to monitoring staff. Based on current practice, the unit is worn 24 hours a day, 7 days a week, for several months. Typically, it is set to sample air at 60-minute intervals in the supradermal space enclosed by a rubber muff; it switches to 30-minute samples if alcohol is detected. It was designed for security and remote reporting to minimize circumvention and to render data usable by courts or corrections. In most applications, the SCRAM™ modem is scheduled to read the bracelet log during normal sleeping

hours and transfer data by autodial to the SCRAM™ server. An error-free operation with no alcohol detected means an uploading of 24 samples daily. Within minutes after upload, the data are available for a monitoring authority to review. The ankle bracelet weighs about 8 ounces; it has a sample measuring side and a signal processing digital side linked by a data cable embedded in straps. In addition to the alcohol sensor, other sensors detect changes in the infrared characteristics and temperature near the alcohol sensor. The two nonalcohol sensors are parts of the circumvention detection protocols. Battery life is approximately 30 to 45 days. According to AMS, several thousand of these devices were in use by 542 courts in 35 States as of early 2006.

University of Colorado investigators Sakai, Mikulich-Gilbertson, Long, and Crowley (2006) completed a two-part evaluation of SCRAM™. Part 1 included a one-day laboratory analysis in which subjects arrived, were hooked up, drank, and then had the bracelet removed. The devices were found to discriminate lower- and higher-dosed subjects. Part 2 was a 7-day wear study in which subjects (alcohol dependent and nondependent) logged drinking while wearing their SCRAM™ bracelets. The investigators reported no episodes of false-positive TAC results and qualitative parity between reported drinking and SCRAM™ results. They also found the devices readily discriminated the consumption patterns of alcohol dependent and social drinkers.

The Giner WrisTAS™ (Wrist Transdermal Alcohol Sensor) is a research prototype of a sensor that is not commercially available. Nonetheless, due to support from NIAAA's SBIR funds, it has a documented research history and was developed with treatment applications in mind. This device affixes to the wrist with a Velcro strap and is about the size of a wristwatch; it is based on Giner's patented proton exchange membrane technology. In the WrisTAS™, an electrode oxidizes the ethanol to form acetic acid that diffuses into a reservoir. Alcohol concentration is reflected by the level of oxidation current and is continuously monitored. The device writes a file entry, typically every 5 minutes, by averaging a near-continuous signal that reflects TAC over that time. Data logged in the device can be periodically downloaded to a computer via a serial port interface. The data storage capacity of WrisTAS version 5 is approximately 21 days.

Giner devices, selected for good performance characteristics, have been reported to be linear within normal pharmacologic ranges of ethanol dosing. Swift, Martin, Swette, LaConti, and Kackley (1992) reported that the WrisTAS™ linearity extends from 5 to 500 mg/dL (.005 to .50 g/dL). This transdermal device outputs a TAC that parallels the more familiar BAC curves but is shifted to the right with a 1- to 2-hour delay. The alcohol sensor in the Giner device can respond to changes in alcohol more promptly than can a fuel-cell sensor. The device also has nonalcohol sensors that monitor for proximity and removal.

In an effort to estimate the accuracy and precision of these wearable electrochemical alcohol-monitoring devices, NHTSA funded an evaluation study in 2005 (Marques & McKnight, 2007). The study required extended wear of the devices (up to 4 weeks) by both men and women in the high-risk age range of 21 to 35. The study evaluated two types of drinking: laboratory-dosed and free-form self-directed drinking. The laboratory drinking was done with one 30-minute dose of alcohol calculated to bring the BAC level to .08 g/dL. Twenty-two subjects participated in 60 dosing episodes during which subjects attained BAC levels ranging from .04 to .12 g/dL with a mean of .83 g/dL. In addition, the same subjects used personal breath testers (fuel-cell devices) to measure their BAC levels when drinking on their own. A total of 211 episodes of self-drinking were studied during which BAC levels attained were between .02 to .23 g/dL with a mean of .77 g/dL.

Results demonstrated that each device had technical weaknesses to overcome but both had a basic ability to detect alcohol gas from the skin surface. The SCRAM™ devices attained more than 90% detection with BAC levels in the .08+ g/dL range. Further, its ability to detect lower BAC levels was in the 60% range for .04 to .06 g/dL. It may be that SCRAM™ holds excess moisture from the skin or other sources that can dilute the alcohol that is drawn into the sensor housing. The study determined that SCRAM's™ accuracy declines over time as water accumulates. A possible explanation, however, is related to drinking levels. In the evaluation study, subjects were expected to drink, and the devices were probably exposed to higher levels of alcohol than would be expected in normal court-ordered use to enforce abstinence.

These results serve to emphasize that the transdermal alcohol signal, the vapor or gaseous state of alcohol that leaves the skin surface, is related to BAC but is not the same thing. As noted, a theoretical paper by Anderson and Hlastala (2006) raises the possibility that individual variation in the hydration state and the thickness of the stratum corneum, the outermost layer of the skin, could have important influences on the levels of alcohol gas that are detectable. However, the detection of alcohol by both devices leaves little doubt that, conceptually, the transdermal alcohol detection is a valid way to estimate alcohol consumption, even if it does not yield a precise BAC equivalent. The evaluation study demonstrated that the technical challenges for routinely and reliably detecting alcohol levels have not yet been overcome. Both companies have newer products that reportedly solve some or all of the peculiarities and reliability issues that were uncovered during this evaluation. For a brief discussion of the application of the SCRAM™ to the monitoring of DWI offenders, see Chapter 5.

3.2.4. Biomedical Measures of Drinking

Other measures of alcohol use can include the standard blood test for ethanol that typically provides a 6- to 12-hour window for detection of drinking; however, recent interest has centered on blood constituents that provide longer lasting markers of alcohol use, such as gamma-glutamyl transpeptidase (GGT). Also attracting interest is urinary ethyl glucuronide (EtG) that offers 36 or more hours of detection (Wurst et al., 2003b; Helander & Beck, 2005; Borucki et al., 2005). All of these biological measures have strengths and weaknesses based on their sensitivity to drinking and their cost. All require periodic specimen collection to monitor drinking.

Biological markers of alcohol consumption differ in sensitivity, specificity, and timeframe of detection after drinking has ceased. These markers can be roughly divided into two groups based on whether they directly reflect ethanol consumption or whether they reflect an indirect consequence of ethanol exposure. Liver enzymes—such as GGT, aspartate aminotransferase (AST), and alanine aminotransferase (ALT)—are indirect markers because they become elevated with extended drinking, alcoholic liver disease, and other liver disorders. These are not very sensitive indicators of recent drinking. By the time these become elevated (if they do elevate), their rise will have been preceded by other markers.

3.2.4.1. Ethyl Glucuronide

The primary bodily fluids for finding both direct and indirect markers are blood serum or urine. EtG is a nonvolatile, water-soluble, stable, direct metabolite of ethanol that can be detected in various body fluids, tissues, and hair. Shortly after the beginning of drinking that produces even small amounts of ethanol, EtG becomes positive and brings the possibility of detecting ethanol intake up to 80 hours after the complete elimination of alcohol from the body (Wurst, Skipper, & Weinmann,

2003a). EtG covers a unique and important time spectrum for recent alcohol use. It meets the need for a sensitive and specific marker to detect past alcohol use that cannot be detected by standard testing. Unlike other biological markers that only increase after extended drinking episodes, EtG can detect alcohol consumption occurring from 1 day to 1 week.

In drivers suspected of DWI, serum ethanol concentration (SEC) of .01-.39 g/L, serum EtG (SEtG) 3.2-13.7 mg/L, urinary ethanol (UEC) .01-.20g/L, and urinary EtG (UEtG) 3.0-130 mg/L have been found (Schmitt, Aderjan, Keller, & Wu, 1995). A second study showed 37 of 50 drivers arrested for DWI had positive SEtG (Schmitt, Droenner, Skopp, & Aderjan, 1997). Wurst et al. (2003b) reported EtG concentrations between 0 and 1,038 mg/L in urine samples from 304 patients. A significant ($p<0.001$) Spearman rank correlation was found between EtG and days of sobriety (-0.600). The correlation between EtG and total grams of ethanol consumed in the past month was 0.467 ($p<0.001$), indicating that EtG should be an adequate tool for detecting significant illicit drinking that is not picked up by surprise breath tests or those drinking episodes that might be missed by SCRAM™.

3.2.5. *Advanced Sensing Devices*

Since the first vehicle alcohol interlock was developed by the Borg Warner company in 1969 (Voas, 1969), there has been an interest in an engineering solution applicable to all vehicles that would prevent impaired driving. Because up to 40 percent of American drivers do not drink, such a safety device would have to be completely passive, coming into action only by exception when a drinking driver attempts to operate the vehicle. As noted, MADD sponsored a conference on advanced technology in Albuquerque, New Mexico, on June 19-20, 2006, that highlighted several sensing technologies that potentially can lead to devices that might meet such a requirement (Hedlund, 2007). Among the advanced devices displayed at the conference was a highly sensitive passive alcohol detection device that can detect small amounts of alcohol in a vehicle (Lambert et al., 2006). Such devices using an infrared detection system based on a heated metal oxide film can detect alcohol down to 50 parts per million.

Nonetheless, these passive devices cannot distinguish between ethanol from the driver and that from passengers. These systems may have value as a method for activating a vehicle interlock system only when there is evidence of a drinking driver in the vehicle. Preventing the vehicle from starting only when a possible drinking driver has already been detected would greatly reduce the intrusiveness of the interlock device. Several practical problems remain to be solved (e.g., how to prevent vehicle owners from blocking the sensor intakes or driving with all the windows open or both).

Of the several technologies presented at that conference, a noninvasive alcohol sensing system using diffuse reflectance, near-infrared spectroscopy (McNally, 2006), appeared to be particularly promising because it measures the BAC level in the tissue beneath the skin. It therefore provides a “true” BAC similar to a blood test, rather than measuring alcohol in sweat that has been delayed by about 90 minutes because of the time required to pass through the skin. A “bonus” provided by the system is that the characteristics of each individual’s skin is sufficiently specific to provide a means of identifying the driver. Currently, the demonstration units described by McNally require placing the lower arm on an armrest for the measure. Presumably, advanced applications could use smaller sensors, possibly a finger. A somewhat similar approach, developed from a system for identifying fingerprints, was presented at the same MADD conference by Ennis (2006). Such systems open the

possibility of steering-wheel sensors that both identify the driver and measure BAC passively. However, a practical working unit that is sufficiently sensitive and reliable, easy to maintain, and resistant to circumvention remains to be demonstrated.

3.2.6. Self-Estimation Devices

The Widmark (Andréasson & Widmark, 1985) formulae for estimating BAC levels based on the number of drinks consumed and the weight and gender of the drinker have provided a means for individuals to estimate their BAC levels. To assist the public in such estimates, “Know Your Limit” wallet-size cards are available that provide a table showing the BAC level produced by a given number of drinks based on the weight of the drinker. Such aids have been problematic because they assume that the user has consumed drinks with a standard amount of alcohol, and they generally do not provide for differences between men and women, differences related to an empty versus a full stomach, and differences in the time over which the alcohol was consumed. The advent of the computer has allowed for more refined estimation systems. NHTSA developed a BAC estimator (NHTSA, 1994, November) that is distributed on a computer disk for use on personal computers. This software provides for the entry of a greater number of factors influencing the BAC level obtained by various amounts of drinking. A credit-card-size computerized system for estimating BAC levels was marketed in the United States in the early 1990s but was not commercially successful (Williams & Voas, 1990).

3.2.7. Detection of Impairment by Observation of Driver Behavior

Subjective estimates of BAC levels by untrained people, even those with considerable contact with heavy drinkers, such as physicians and bartenders, are generally inaccurate (Hansen, Popkin, Campbell, Burton, & Waller, 1991). Although well-trained officers with sufficient observation time to use specially developed behavioral tests are usually successful in identifying individuals impaired by alcohol, operational conditions sometimes limit their ability to detect impaired drivers. Wells, Greene, Foss, Ferguson, and Williams (1997) studied drivers missed at sobriety checkpoints (where interviews with the motorists are generally limited to less than a minute) and found that 62 to 64% of the drivers with BAC levels higher than .08 g/dL were not detained by the police. In another study of police officers’ ability to detect alcohol at various BAC levels up to .13 g/dL, through their sense of smell alone, researchers found that the officers’ estimates were unrelated to the BAC levels. (Moskowitz, Burns, & Ferguson, 1999).

NHTSA supported the development and the training of police offices in the use of a Standardized Field Sobriety Test (SFST). The three subtests of the SFST battery have been used for more than two decades in the United States. Currently, police in all 50 States use it to apprehend impaired drivers (Burns, 2003). The subtests are horizontal gaze nystagmus (HGN), walk-and-turn (WAT), and one-leg-stand (OLS). HGN requires the subject to visually follow a moving object, and the angle of onset and degree of nystagmus (an involuntary jerking of the eye) is observed. Alcohol-impairment causes an earlier onset and a greater degree of nystagmus. HGN has been found to be the best index of alcohol of the three tests. An excellent discussion of HGN and its use by police officers can be found in a recent NHTSA report prepared by the National Traffic Law Center (Dietrich & Frost, 1999). Moskowitz (2006) noted that nystagmus, a key element in the SFST, is the only behavioral test with a high degree of reliability that has been shown to be sensitive to the low BAC levels used as the maximum legal level for drivers. Its sensitivity to BAC levels as low as .05 g/dL has

been demonstrated in several studies (Stuster, 1997; McKnight, Langston, McKnight, & Lange, 2002; Burns, 2003).

3.3. Characterizing Alcohol Consumption Levels

A variety of terms have evolved over time to characterize the levels of drinking, particularly those levels that constitute a problem for the consumer. A list of the terms most frequently encountered in the research literature is provided in Table 3-1. Most of these terms are poorly defined and, as used in scientific reports, highly dependent upon the context in which they are used. There is, however, an important continuing international effort to define psychiatric terms such as “dependence” and “abuse” with sufficient precision to allow comparison of studies across national borders. The terms listed in Table 3-1 are discussed briefly in the following paragraphs.

Table 3-1.

List of terms used to define drinking characteristics

Dependent drinker
Abusive drinker
Alcohol use disorder
Binge drinker/heavy episodic drinker
Alcoholic
Hardcore drinker
High-risk or risky drinker
Moderate drinker
Social drinker
Abstainer

3.4. Normative Drinking in the United States

Although the definition of abstainers (individuals who report no drinking in the last year) is clear, the definition of what constitutes “normal” or nonsymptomatic drinking is much more poorly defined than are the characteristics of the deviant drinkers described hereinbefore. Terms frequently encountered in the literature for which there are no well-defined criteria are “moderate drinker” and “social drinker.” These terms tend to be applied to the drinkers who do not meet the criteria for having an alcohol use disorder (AUD) like dependence or abuse. Because the average level of alcohol consumption is skewed by the heavy consumption of AUD drinkers, the use of any mean or average number of drinks to classify normal drinking may be inappropriate. One alternative is to provide population percentile information to allow individuals not diagnosed with an AUD to be provided with an indication of where they stand in relation to other drinkers. An alternative approach is to attempt to identify the level of consumption that is consistent with good health (i.e., drinking levels that are not associated with physiological or psychological problems).

A national household survey of 43,093 adults age 18 and older (the National Epidemiological Survey on Alcohol and Related Conditions; NIAAA, 2006; Grant & Dawson, 2006), conducted from 2001-2002, has provided information on drinking norms in the United States. The household survey procedure provides particularly strong data as the surveys were conducted face-to-face by Census

Bureau employees and an 81% response rate was achieved. U.S. Census data for the year 2000 were used to adjust the NESARC data to ensure that they were representative of the noninstitutionalized U.S. population. Chan et al. (2007) used these data to construct the drinking norms tables for males and females of varying ages (shown in Table 3-2 taken from p. 972 of their report). The table shows the percentage of respondents that report consuming one or more drinks (recall the definition of a standard drink already defined) in the last year. As can be seen, 32% of men age 18 and older and 40% of women age 18 and older report abstaining from alcohol over the last 12 months. For most age groups, a man who drinks 4 to 5 standard drinks a week is consuming more alcohol than three-quarters of his peers in the same age group. Note that the percentiles for both men and women in the underage (18 to 20) group are lower at each drink interval up to 9 to 12 drinks than the percentiles for older age groups, indicating that they are consuming more alcohol than adults age 21 and older.

Table 3-2.

Percentage of U.S. males and females drinking at various levels during the last year

Ages	Cumulative percentile of drinks per week by age									
	0	1	2-3	4-5	6-8	9-12	13-19	20-29	30-39	40+
Men										
Total	32%	65%	71%	76%	80%	84%	87%	90%	93%	100%
18-20	20%	49%	59%	65%	73%	79%	85%	90%	93%	100%
21-25	19%	53%	63%	71%	78%	84%	91%	94%	97%	100%
26-29	21%	57%	68%	76%	82%	88%	93%	96%	97%	100%
30-34	25%	57%	67%	73%	80%	86%	91%	95%	97%	100%
35-39	26%	60%	68%	74%	80%	86%	91%	94%	95%	100%
40-44	27%	59%	69%	75%	81%	86%	91%	94%	96%	100%
45-49	28%	61%	70%	75%	81%	86%	92%	95%	96%	100%
50-54	32%	65%	72%	78%	84%	89%	94%	97%	98%	100%
55-59	36%	68%	74%	77%	83%	88%	93%	96%	97%	100%
60-64	45%	73%	78%	82%	87%	91%	95%	98%	99%	100%
65+	29%	61%	69%	75%	81%	86%	91%	95%	96%	100%
Women										
Total	40%	81%	86%	90%	92%	94%	96%	97%	98%	100%
18-20	27%	72%	81%	85%	90%	93%	96%	98%	99%	100%
21-25	30%	80%	88%	91%	94%	97%	98%	99%	99%	100%
26-29	32%	80%	87%	92%	94%	97%	98%	99%	99%	100%
30-34	32%	78%	86%	90%	93%	96%	98%	99%	99%	100%
35-39	35%	80%	86%	91%	94%	96%	98%	99%	100%	100%
40-44	36%	79%	86%	89%	93%	95%	97%	99%	99%	100%
45-49	42%	82%	87%	90%	94%	96%	98%	99%	99%	100%
50-54	43%	82%	88%	91%	93%	96%	98%	99%	99%	100%
55-59	50%	85%	90%	93%	95%	98%	99%	100%	100%	100%
60-64	63%	89%	92%	94%	96%	98%	99%	100%	100%	100%
65+	41%	81%	87%	91%	94%	96%	98%	99%	99%	100%

Source: Chan et al. (2007)

The American Heart Association (AHA) issued an advisory in 1997, stating that:

“More than a dozen prospective studies have demonstrated a consistent, strong, dose-response relation between increasing alcohol consumption and decreasing incidence of coronary heart disease (CHD). The data are similar in men and women in a number of different geographic and ethnic groups. Consumption of one or two drinks a day is associated with a reduction in risk of approximately 30-50 percent. Studies of coronary narrowings defined by cardiac catheterization or autopsy show a

reduction in atherosclerosis in people who consume moderate amounts of alcohol. In general, the inverse association is independent of potential confounders such as diet and cigarette smoking. Concerns that the association could be an artifact due to cessation of alcohol consumption in people who already have CHD have largely been disproved. No clinical trials have been performed to test the alcohol-CHD relation. However, the large numbers of observational studies support a true protective effect of moderate consumption of alcohol. While 100,000 excess deaths have been attributed to alcohol-related diseases each year, approximately 80,000 excess deaths would occur if all current consumers of alcohol abstained from drinking.” (Pearson, 1997).

Based in part on evidence that moderate amounts of alcohol are protective for coronary heart disease, reducing risk by 30 to 60%, one drink a day for females and two for males has generally become accepted as consistent with good health in individuals without other medical problems (Pearson, 1997). An editorial by Criqui (1997), however, has offered contradictory advice, concluding that, “. . .while it is clear that a modest intake of alcoholic beverages affords some protection against CHD, a general public health recommendation endorsing drinking is contraindicated.” Thus, although there controversy on what level of drinking is consistent with good health, the potentially positive effects of one or two drinks has led to defining heavy drinking as consuming alcohol in excess of 7 drinks a week for females and 14 drinks a week for males, or an equivalent to one drink per day on average for women and more than two drinks per day on average for men (NIAAA, 2004). Dawson, Grant, and Li (2005) reported that in the 2001-2002 NESARC, 8.8% of U.S. adults exceeded the weekly drinking limits (14 for men, 7 for women) once or twice in the past year (12.9% of the females and 9.6% of the males).

3.5. Binge Drinking

An important deviant group of alcohol consumers who fall outside the traditional AUD categories are binge or heavy episodic drinkers who are defined by the number of drinks consumed at a single drinking session. For some years, binge drinking has been defined as five or more drinks at a session for males and four or more for females. Questions specifying that criterion were used in national surveys of drinking behavior (Naimi et al., 2003; Royal, 2003). That definition, principally derived from the work of Weschler in surveys of college students, had no time span for drinking. Thus, an individual drinking over an afternoon and evening might remain at a relatively low BAC level, despite consuming five drinks. Lange and Voas (2001) breath-tested youths returning from a night of drinking in Mexico and found that those with .08 g/dL BAC levels reported, on average, consuming six to seven drinks. Thus, the number of drinks that defines a binge event has varied across research studies with the most popular criterion being five or more drinks. That original definition has been modified in two ways: first by providing a lower criterion for females (four or more drinks), and second, by defining the period during which the criterion drinks are consumed. Time is an important factor because any drinking occasion could stretch over several hours during which case four drinks for females and five drinks for males might not lead to a high (.08 g/dL) BAC level. As defined by the National Advisory Council of the NIAAA in 2004, the definition of binge drinking is “. . . a pattern of drinking alcohol that brings blood alcohol concentration (BAC) to 0.08 gram percent or above. For the typical adult, this pattern corresponds to consuming 5 or more drinks (male), or 4 or more drinks (female), in about 2 hours.” This definition was selected in part because it was the theoretical consumption level that would result in a BAC of .08 g/dL (see definition of a “drink”).

Naimi et al. (2003) analyzed data from the 2001 Behavioral Risk Factor Surveillance System telephone survey of adults age 18 or older and determined that binge drinking was increasing: by 2001, there were approximately 1.5 billion episodes of binge drinking in the United States. Binge-drinking rates were highest among those ages 18 to 25; however, 70% of the binge-drinking episodes occurred among those age 26 and older). Binge drinkers were 14 times more likely to report alcohol-impaired driving than nonbinge drinkers (Naimi et al., 2003).

Dawson, Grant, and Li (2005) used the 2001-2002 NESARC to study the relationship of the frequency of binge drinking ($\Rightarrow 5$ for males/ $\Rightarrow 4$ for females) to alcohol dependence and abuse. The number of days that drinking exceeded the daily limit based on 7 drinks a week for females and 14 for males was calculated for each respondent and related to the individual's responses to the questions defining abuse and dependence. Figure 3-3, taken from that study, shows the relationship established between exceeding such daily limits and dependence and abuse. As can be seen, they found that the relationship between exceeding the daily limit ($\Rightarrow 5$ / $\Rightarrow 4$) rose most rapidly among drinkers exceeding those limits once a week (52 days a year). The prevalence of drinkers meeting the criteria for abuse reached 20% for those who binge drank on an average of once a week. More frequent bingeing did not increase that prevalence. For those meeting the criterion for dependence and abuse, however, the number of days of drinking over the limit ($\Rightarrow 5$ / $\Rightarrow 4$) was almost linearly related to the percentage meeting the criteria. They suggested that their results indicated the risk associated with drinking more than the recommended daily limits ("risk drinking") and supported the weekly drinking "caps" for defining drinking that is not threatening to the health of healthy adults.

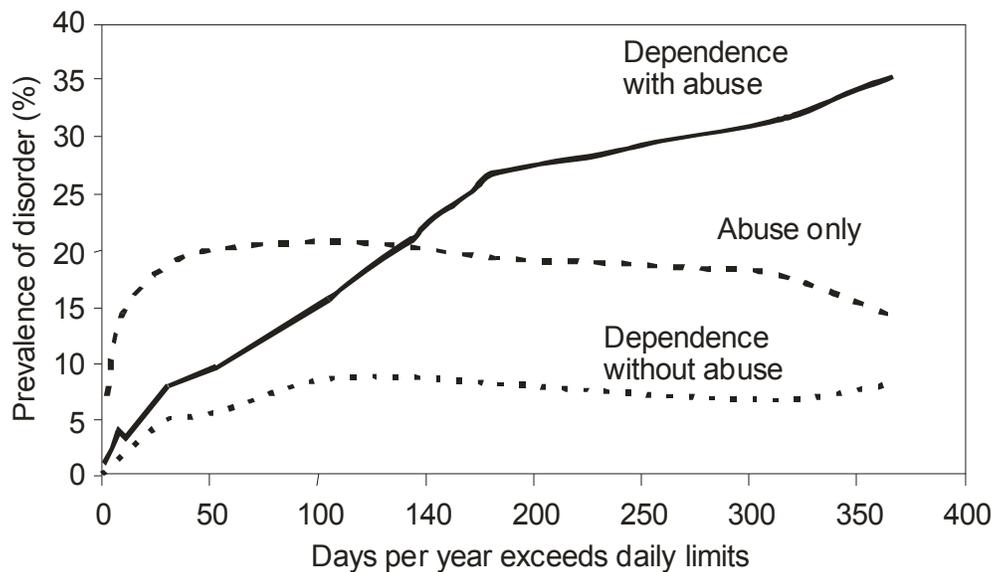


Figure 3-3. Prevalence of DSM-IV AUDs according to frequency of exceeding daily drinking limits: U.S. past-year drinkers age 18 and older. Adapted from Dawson et al. (2005)

3.6. Alcohol Use Disorders

There are two basic systems for categorizing AUDs (Maisto & Saitz, 2003). The first is dimensional systems that specify levels of symptoms that lend themselves to quantification so that more or less of a problem can be scaled. An example might be BAC levels reached at a drinking

session or the number of drinks consumed at a session with the assumption that those who obtain higher BAC levels or consume a larger number of drinks have a greater problem. The second is categorical systems that identify AUDs by discrete clusters of signs or symptoms. The best known and most widely used cluster approach is that described in the *Diagnostic and Statistical Manual of Mental Disorders*, fourth edition (DSM-IV), published by the APA (1994). The DSM-IV diagnostic criteria establish two categories of AUDs: alcohol dependence and alcohol abuse.

3.6.1. Alcohol Abuse and Dependence

Alcohol abuse and alcohol dependence are generally accepted as two clinical alcohol use disorders with symptoms that are currently defined by the American Psychiatric Association DSM-IV. A complex set of factors distinguish each entity, with abuse being defined by four criteria: (1) hazardous use, (2) failure to fulfill major role obligations, (3) continued use despite social or interpersonal problems, and (4) legal problems (Table 3-3). Diagnosis as a dependent drinker takes precedence over the diagnosis of abuse and precludes such a diagnosis (Hasin, 2003). A limitation with this definition of abuse is that a report of any one of the four criteria results in an abuse designation; thus, a report of an instance of driving after drinking too much in the last year will result in a diagnosis of alcohol abuse. Because most Americans drive and the definition of “too much” is subjective, overdiagnosing abuse in the United States is highly probable. Ting-Kai Li, the NIAAA administrator, noted this possibility in commenting on the lower level of abuse in the Australian population where vehicle ownership is lower (Kettle Brun Society meeting, Sydney, Australia, 2006). Hasin, Paykin, Endicott, and Grant (1999) noted that, in one study, driving after drinking too much accounted for 47% of all abuse classifications. Consequently, urban residents who find a vehicle uneconomical and individuals who cannot afford an automobile are “protected” against an abuse diagnosis. Hasin et al. (1999) compared individuals with an abuse diagnosis based on factors other than driving with those given that classification based on reported drinking and driving and those who did not have an abuse diagnosis, and noted that both abuse groups were different from nonabusers and that there were some similarities but also some differences between the two abuse groups.

Table 3-3.

DSM-IV criteria for diagnosis of alcohol dependence or abuse

Symptoms	DSM-IV Criteria for Alcohol Dependence
	A maladaptive pattern of alcohol use, leading to clinically significant impairment or distress as manifested by three or more of the following occurring at any time during a 12-month period:
Tolerance	Need for markedly increased amounts of alcohol to achieve intoxication, or reduced effect with continued use of the same amount of alcohol.
Withdrawal	The characteristic withdrawal syndrome for alcohol, or alcohol or a closely related substance is taken to relieve or avoid withdrawal symptoms.
Impaired control	Persistent desire or at least one unsuccessful effort to cut down or control drinking. Drinking in larger amounts or over a longer period than the person intended.
Neglect of activities	Important social, occupational, or recreational activities given up or reduced because of drinking.
Time spent drinking	A great deal of time spent in activities necessary to obtain alcohol to drink or to recover from its effects.
Drinking despite problems	Continued drinking despite knowledge of having a persistent or recurrent physical or psychological problem that is likely to be caused by or exacerbated by alcohol use.
Duration criterion	None specified. Three or more dependence criteria must be met within the same year and must occur repeatedly as specified by duration qualifiers associated with criteria, such as “often,” “persistent,” and “continued.”

DSM IV Criteria for Alcohol Abuse

A. A maladaptive pattern of alcohol use leading to clinically significant impairment or distress, as manifested by one or more of the following, occurring within a 12-month period:

- Recurrent drinking results in a failure to fulfill major role obligations at work, school, or home.
- Recurrent drinking in situations in which it is physically hazardous.
- Recurrent alcohol-related legal problems.
- Continued alcohol use despite having persistent or recurrent social or interpersonal problems caused or exacerbated by the effects of alcohol.
- Continued alcohol use despite having persistent or recurrent social or interpersonal problems caused or exacerbated by the effects of alcohol.

B. The symptoms have never met the criteria for alcohol dependence.

Adapted from the National Institute on Alcohol Abuse and Alcoholism (1995)

Based on the 2001-2002 NESARC household survey of 43,093 adults age 18 and older, Grant et al. (2004a) noted that 17.5 Americans are afflicted with AUDs. The prevalence of abuse and dependence was greater among males than females; younger age groups more than older age groups; and Whites more than Blacks, Asians, or Hispanics. They reported an increase in abuse but a decline in dependence over the decade from 1991 to 2001.

3.6.2. Relationship of Drinking Category to Alcohol-Related Crashes

Voas, Romano, Tippetts, and Furr-Holden (2006e), using the 2000 NESARC, determined the percentage of State residents falling into six nonoverlapping alcohol user categories—dependent

drinkers, abusive drinkers, dependent and abusive drinkers, heavy episodic drinkers, current nominative drinkers, and current nondrinkers. The number and percentage in each of those groups is shown in Table 3-4, taken from that publication. The relationships of the percentage of residents in each State in each of these user categories to the number of drinking drivers involved in fatal crashes in that State was determined through regression analysis using data from the FARS.

Table 3-4.

Percentage of respondents (age 18+) who fall into one of the six nonoverlapping categories based on the 2000 NESARC Survey

	Dependent drinkers	Abusive drinkers	Dependent & abusive drinkers	Heavy episodic drinkers	Current normative drinkers	Current nondrinkers	Total
N (raw data)	553	1,843	931	3,297	20,332	16,147	43,093
N (weighted)	2,666,000	9,668,000	5,246,000	17,098,000	101,360,000	71,845,000	207,883,000
% Total	1.28%	4.65%	2.52%	8.22%	48.76%	34.56%	100.00%

N (raw data) denotes sample size on the NESARC and N (weighted) the U.S. population size estimated from the NESARC. Source: NESARC (2001-2002); adapted from NIAAA (2006).

Based on 2001-2002 NESARC State-by-State data of self-reported drinking in the last 12 months, Voas et al. (2006e) determined the percentage of the population in each State that fell into each of the six nonoverlapping consumption categories shown for the Nation as a whole in Table 3-4. They then related the State distributions of drinker types to the ratio of drinking to nondrinking drivers in fatal crashes in each State using 1999 through 2001 data from FARS. This provided an N of 51 for a regression analysis to calculate national estimates of the number of drinking drivers in fatal crashes attributable to each category of drinker shown in Table 3-5. Although there are several limitations to this study, the results appear to provide a reasonable picture of the general relationship between the different drinking categories and their relationship to impaired driving.

The data in Table 3-5 suggest that abusive drinkers and heavy episodic drinkers have the highest rates of involvement in alcohol-related fatal crashes. Dependent drinkers (which include individuals who may have qualified for the abusive designation but are in the dependent category as they also qualify for that designation) exhibit lower rates per 10 million drivers. This is probably because many who are dependent on alcohol are no longer driving, either because they can no longer afford vehicles or are hospitalized. Current normative drinkers demonstrate substantially lower crash-involvement rates but still account for more than half of the drinking drivers in fatal crashes. This is another example of the frequently observed “prevention paradox” where lower risk individuals contribute more to the overall total of harmful events because they are far more numerous than the high-risk group (Rehm et al., 2001; Skog, 1999; Spurling & Vinson, 2005; Williams, McCartt, & Ferguson, 2007). These results support the emphasis in brief interventions on the screening of offenders so that the focus is on the highest risk drivers for the greatest effect, but it also calls attention to the fact that intervention programs are needed for drinkers who do not meet criteria for AUD classifications.

Table 3-5.

Number and percentage of U.S. drinkers in four consumption categories and their relationship to drinking drivers in fatal crashes expressed in rate per million drinkers

Drinker classifications	U.S. drinking population based on the NESARC (71,845,000 nondrinkers not included)		Number of drivers in fatal crashes with BACs =.01+ g/dL 3-year average, 99-01			Number of drivers in fatal crashes with BACs =.15+ g/dL 3-year average 99-01		
			Total=12,500			Total=8,000		
	N	%	N	%	Rate	N	%	Rate
Dependent including dependent & abusive	14,914,000	11.0%	1,680	13.4%	113	1,120	14.1%	75
Abusive drinkers	2,666,000	2.0%	560	4.5%	210	470	5.9%	176
Binge drinkers	17,098,000	12.6%	3,170	25.3%	185	2,340	29.4%	137
Current normative drinkers	101,360,000	74.5%	7,110	56.8%	70	4,040	50.7%	40

Rate expressed per 10⁶. Drivers in each fatal crash category were estimated from our regression models. (Note: For dependent drinkers and dependent and abusive drinkers, add the columns for rates and the rows for the combination of both. Current nondrinker category not shown.) Source: Voas et al.(2006e).

Based on the results of their study, they suggested that the programs that deal with binge (heavy episodic) drinkers and abusive drinkers in Table 3-5 are likely to be the most efficient because drinkers in those categories have the highest potential to become drinking drivers in fatal crashes. As noted above, additional study of the abusive drinker class is needed because, as currently defined in the NESARC, it is not possible to distinguish between the roles being played by the questions on driving after drinking compared to the other elements of the abusive behavior syndrome. They indicate that their results also suggest that 5+/4+ binge drinking should be given more prominence in diagnostic measures to identify DWI offenders who should receive special treatment and monitoring as part of their probation requirements. Finally, they found that (based on the NESARC) a substantial number of current normative drivers will be involved as high-level BAC drivers in highway crashes. There is a need to determine whether this is underreporting of alcohol consumption by the respondent or whether otherwise apparently normative drinkers may become involved in crashes at high BAC levels.

3.6.3. Other Terms for Drinking Problems

Several other less well-defined terms are used in connection with describing drinking status. “Alcoholic” and “problem drinker” are popular terms, but they have very inexact meanings. In general, they cover the clinical AUD criteria and are avoided in this paper. Two other terms—“hardcore drinker” and “high-risk drinker”—are context-dependent. The term “hardcore drinker” (Simpson, Mayhew, & Beirness, 1996) has primarily been used in the context of impaired driving to identify individuals who are repeat DWI offenders or high-level BAC (.15 g/dL) offenders. Such high-risk drinkers may or may not have AUDs, although the majority may qualify for such a

designation. The term “high-risk drinker” denotes individuals whose consumption places them at risk for experiencing the negative consequences of heavy drinking with the meaning dependent upon the context, such as the risk of becoming alcohol dependent or the risk of being involved in an alcohol-related crash. Finally, the term “problem drinker” is widely used to define the person whose alcohol consumption affects his or her daily life. As generally used, it appears to overlap with the concept of alcohol abuse.

The term “hardcore” has been used extensively to identify people who regularly drink and drive, typically at high BAC levels (Simpson, Beirness, Robertson, Mayhew, & Hedlund, 2004). More specifically, the usual operational definition of a hardcore drinking driver is one who either has repeated convictions for alcohol impaired driving or has a BAC level of .15 g/dL or greater upon arrest (Baker, Braver, Chen, Li, & Williams, 2002). “Hardcore” also generally refers to individuals who seem resistant to changing their behavior, and the definition assumes that this group is largely comprised of individuals with drinking problems (Baker et al., 2002).

Simpson et al. (2004) conducted a review of studies on crash-involved drivers, which resulted in a description of the characteristics of hardcore drivers. They indicate that this group constitutes <2% of all driver trips; ≤5% of drinking-driver trips; >50% of DWI arrests and convictions; >12% of drivers in fatal crashes; ~25% of all driver fatalities; >66% of drinking-driver fatalities; and >75% of legally impaired driver fatalities. The authors suggested there are several fundamental questions regarding hardcore drinking drivers that need to be answered: To what extent can their behavior be modified or controlled? Are methods directed at social drinkers effective for hardcore drinkers, or are separate activities needed? How best should scarce resources be allocated between hardcore drinking drivers and other drinking drivers?

Simpson et al. (2004) recommended two general approaches to addressing the hardcore drinking-driver problem: first, assure that DWI control systems function efficiently and well (law enforcement, prosecutors, judges, probation, and treatment); and second, use specific strategies to detect, arrest, prosecute, convict, sanction, and monitor hardcore drinking drivers to keep them off the roads until they change their behavior. They have pursued this issue in a series of studies of the criminal justice system and its limitations as they relate to the apprehension, prosecution, and sentencing of hardcore offenders *** (Robertson & Simpson, 2002a; 2002b; 2002c; Simpson & Robertson, 2001). This work, which covers countermeasures to impaired driving, is discussed in Chapter 5.

Extensive field research supports the belief that high-level BAC drivers are at greater relative risk for crash involvement (Blomberg et al., 2005; Borkenstein et al., 1974; Zador, Krawchuk, & Voas, 2000a; see discussion of relative risk hereinafter). Research has also shown that arrested impaired drivers with higher BAC levels are more likely to be recidivist (Peck & Helander, 2001b). Thus, they would be expected to be overrepresented in alcohol-related crashes. Fell (1992) calculated the relative risk of a repeat offender being involved in a fatal crash in 2004. Using the FARS file, he compared crash-involved drivers who had a prior DWI offense within the last 3 years with an estimate of the number of drivers in the general population who had an alcohol-related offense during the last 3 years. He estimated the relative risk for three conditions: involvement in any fatal crash (RR= 1.98), involvement in an alcohol-related (BAC>.00 g/dL) fatal crash (RR= 5.45), and involvement in a high-level BAC (=>.10 g/dL) fatal crash (RR=1.16). Based on his estimates, repeat offenders are substantially more likely to be involved in an alcohol-related crash than the average driver. Together, a high BAC level and a prior DWI offense provide an operational definition of the term “hardcore.”

These two factors have become the basis for applying increased penalties to first offenders with high BAC levels (generally $>.15$ g/dL) and repeat offenders.

3.6.4. Issues With the Hardcore Drinking-Driver Concept

The widespread application of this term has generated controversy, and some researchers disagree over the utility of the hardcore distinction. There are essentially two positions in the debate. One camp suggests that great attention should be paid to this group of drinking drivers as they pose the most threat to the safety of the driving public. The other camp suggests that this runs into the “prevention paradox,” (Spurling & Vinson, 2005), which notes that although less deviant drinking drivers have a lower risk of crash involvement, the much larger number in that more normative group results in their accounting for the majority of the alcohol-related crashes. Baker et al. (2002) note that the dichotomy between “hardcore drinkers” and “social drinkers” ignores the people who usually drink moderately but occasionally drink to excess (i.e., heavy episodic or binge drinkers). The argument against focusing on the hardcore drinkers is that drinking and driving is not just a problem of individuals with diagnosable alcohol problems. Thus, occasional light drinking (social drinking) and driving should not be socially acceptable.

The concept that drinking drivers involved in crashes are a deviant group is not new. The original Alcohol and Highway Safety Report to Congress, published by the Department of Transportation in 1968, focused on the problem drinker. This focus provided the foundation for the development of the federally funded ASAP program from 1969 to 1975. Past studies and surveys have indicated that about 11% of the drinking-and-driving public can be classified as problem drinkers (NIAAA, 2004; Naimi et al., 2003; Midanik et al., 2004; Mokdad, Marks, Stroup, & Gerberding, 2004). In contrast, problem drinkers were estimated to be 27% of the past year’s drinking drivers, accounting for about 46% of all drinking-and-driving trips (Royal, 2003). A recent study of drivers killed in traffic crashes reported that anywhere from 21 to 61% of these fatally injured drivers who had very high BAC levels of $.15+$ g/dL were considered problem drinkers, depending on the criterion used (Baker et al., 2002).

Hedlund and Fell (1995) and Jones and Lacey (1998a; 1998b), although noting the overrepresentation of repeat offenders in fatal crashes, pointed out that they still accounted for only a small proportion of the total crashes (see also Brewer et al., 1994, and Jones & Thomas, 1994). The use of a high BAC level at the time of arrest as a signal that the individual is a hardcore offender or dependent on alcohol is questionable based on Marowitz, DeYoung, and Yu’s (1996) finding that only a relatively modest relationship exists between BAC and recidivism among California DWI offenders.

Chamberlain and Solomon (2001) cited a 1999 NHTSA survey showing that 24% of Americans age 16 and older admitted driving within 2 hours of drinking. They estimated that 811 million to 1.1 billion impaired-driving trips occurred in the United States in 1997, with “problem drinkers” accounting for roughly 40% of the total (with a subset of those being “hardcore drinking drivers”). This indicated that more stereotypical “social drinkers” made the majority (60%) of impaired-driving trips. The authors suggested that it is misleading to attribute the impaired-driving problem to the very small percentage of hardcore drinking drivers. Chamberlain and Solomon (2001) concisely stated their argument against relying on the term “hardcore drinking driver” as follows:

“The alcohol industry, governments, and some traffic safety experts continue to claim that there is little more we can do to address impaired driving other than target hardcore drinking drivers and toughen sanctions. Although we support improved prosecutorial and sentencing practices, we wholly disagree with the narrow focus on hardcore drinking drivers. The “hardcore” stereotype mischaracterizes the impaired-driving problem, and ignores a major segment of the population that occasionally drinks immoderately and is responsible for a substantial percentage of impaired driving crashes, injuries, and fatalities. In particular, it ignores the problem of episodic heavy drinking among young males, who continue to be dramatically overrepresented in crash statistics. Not surprisingly, this same constituency is the prime target of almost all alcohol-marketing initiatives. In summary, the myth of the hardcore drinking driver detracts attention from more comprehensive approaches that are essential to reducing impaired driving among all segments of the population.” (Chamberlain & Solomon, 2001, p. 274)

Baker et al. (2002) investigated problem-drinking indicators using FARS data and interviews of relatives of individuals killed in alcohol-related traffic crashes. Their research shed light on the question about the extent to which drivers who meet the operational definition of hardcore drinking drivers (those with a BAC level of .15+ g/dL or repeated offenses for alcohol impaired driving) have characteristics indicative of problem drinking. They found that drivers with very high BAC levels (.15+ g/dL) were more likely than were other fatally injured drivers to be described as having histories suggestive of problem drinking. Yet many fatally injured drivers with illegally high BAC levels of .10+ g/dL (and even many at .15+ g/dL) were not described as problem drinkers or as typically driving after having five or more drinks. They suggest that the distinction often made by researchers and public health practitioners between drinking drivers with BAC levels of .10 to .14 g/dL and those with BAC levels of .15 g/dL or higher appear to be arbitrary for the purpose of identifying people who chronically drive while impaired by alcohol. The authors concluded that tough sanctions to deter repeat offenders are important, but other measures directed at the general population of drinking drivers also are needed.

McCartt and Williams (2004) studied FARS data from 1982 to 2002 and found that driver characteristics did differ with increasing BAC levels, but differences in characteristics of those at or higher than the legal BAC limit of .08 g/dL were not large. Furthermore, trends in the BAC level of drivers in fatal crashes from 1982 to 2002 showed similar reductions across all BAC categories (roughly a 4 to 5% decrease). These results do not indicate that drivers with BAC levels of .15 g/dL or higher have been more resistant to changing behavior than other drinking drivers. All categories of BAC levels, even BAC levels of .25 g/dL or higher declined substantially from 1982 to 2002. As shown in Figure 2-17 of this report (see page 26), the reduction in the percentage of fatally injured drivers with high BAC levels of .15 g/dL or greater from 1982 to 2003 was 37%, the same as for drivers at BAC levels of .08 g/dL or greater (McCartt & Williams, 2004). Thus, the findings did not support the claim that hardcore drinking drivers have become a large part of the problem and have been unaffected by general deterrent approaches.

3.7. Behavioral Effects of Alcohol

3.7.1. Acute Effects of Alcohol

The short-term or *acute effects of alcohol* of interest here are those related to alcohol's depressant effect on the brain. The exact nature of the mechanisms involved is not known. Fromme and D'Amico (1999) discussed basic knowledge of the neural systems that are implicated in alcohol's acute and chronic effects and suggested two relatively distinct neuroanatomical and neurochemical response systems to account for the subjective and behavioral effects of alcohol: (1) a simple reinforcement/motivation system, and (2) a complex neurochemical system that mediates higher order cognitive functions and conditioned effects of alcohol. The U.S. Department of Health and Human Services' Ninth Special Report to Congress on Alcohol and Health (1997) provides an extensive discussion of the neuromolecular actions of alcohol on the brain and the ability of alcohol to influence many cellular functions.

3.7.2. Driving-Related Performance

Historically, there has been little controversy over the impairing effects of heavy drinking. They have generally been easy to observe and have been the subject of humor in the theater and in mass communications. Nevertheless, examples of heavy drinkers who appear to perform well at high BAC levels are not uncommon. Extreme amounts of alcohol (e.g., BAC \approx .40 g/dL) can paralyze the respiratory system and cause death, but some people can survive and even drive at these and still higher concentrations. Jones (1999) examined 81 drinking drivers in Sweden who had unusually high BAC levels (.40+ g/dL) when apprehended. Jones concluded that attempting to drive a motor vehicle after consuming sufficient alcohol to reach a BAC level of .40 or more indicates an exceptionally high tolerance to the impairment. Jones noted that the alcohol burn-off rate (mean = .023 per hour) was relatively high in these heavy drinkers, which probably reflected the extent of their development of tolerance to alcohol. The 2001 State of Knowledge reported that studies indicate that experienced drinkers can, if motivated, overcome these impairing tendencies at BAC levels as high as .20 g/dL. Vision per se and visual functions, such as flicker fusion and glare recovery, are not greatly affected by alcohol at BAC levels of much less than .10 g/dL (Moskowitz & Robinson, 1988), but higher than that level, these functions become impaired in most people. "Simple" reaction time does not appear to be seriously degraded for most people at BAC levels of less than .10 g/dL (Moskowitz & Fiorentino, 2000).

This ability of some individuals to perform in some areas despite heavy intoxication is more than balanced by the extensive deterioration in performance at lower BAC levels (.01-.05 g/dL) for most individuals on important skills related to driving (Moskowitz and Fiorentino, 2000). Nevertheless, the evidence that some individuals develop a high tolerance for alcohol raises the issue of the legitimacy of legislating per se BAC limits for impaired driving rather than relying on observations of impaired performance by the police. As long as BAC limits were set at very high levels (e.g., .15 and .10 g/dL), it was likely that most drivers would definitely be impaired. However, studies of the effect of low doses of alcohol on heavy drinkers, who would be expected to have developed a tolerance to alcohol, were needed to demonstrate that the driving performance of drinkers with high tolerance is affected at BAC levels of less than .10 g/dL.

Thus, reviews of recent experimental research on the behavioral effects of alcohol have focused on impairment at low BAC levels (Moskowitz & Robinson, 1988; Moskowitz & Fiorentino,

2000). Moskowitz and Florintino reviewed 87 experimental studies of skills performance at low BAC levels. The authors restricted the behaviors of concern to cognitive factors clearly related to driving; they therefore excluded factors such as motivation, aggression, and emotion their review. The results of 550 tests in 12 behavioral categories were compiled. The review was concerned with behaviors at BAC levels of .08 g/dL and lower, but some of the studies also contained the results of tests at higher BAC levels. Their focus was largely on the BAC threshold at which impairment was first measurable in each skill category, which varied from thresholds as low as .01 g/dL for some skills to as high as .06 g/dL for others. Figure 3-4, taken from the 2001 State of Knowledge report, summarizes their results. It indicates that 4 of the 12 behaviors were impaired at a BAC level of .05 g/dL or lower in more than half of the tests for a given behavior. The four impaired behaviors were, in descending order of percentage of impairment, drowsiness (as the authors note, not a behavior, but a condition), vigilance, divided attention, and visual functions (contrast sensitivity and neuromuscular control). All of these are clearly related to driving, whereas others showing a lesser percentage of impairment have a less obvious relationship.

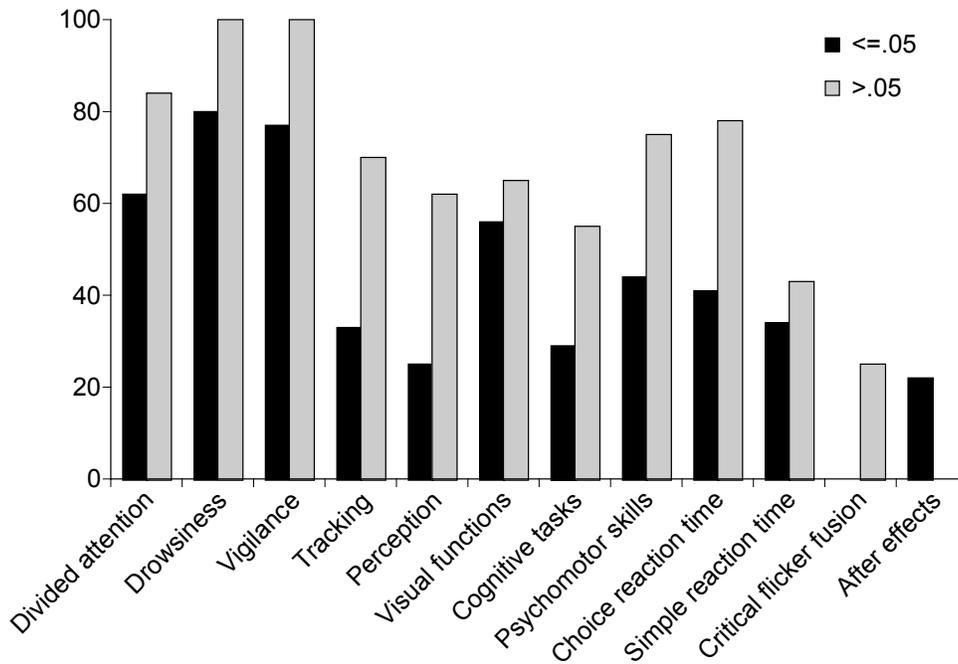


Figure 3-4. Percentage of tests showing impairment by BAC group and type of test. Adapted from Jones & Lacey (2002)

Other reviews of experimental studies have concluded that alcohol can cause significant impairment at low BAC levels. For example, Ferrara, Zancaner, and Georgetti (1994) reviewed the international literature of the effects of low levels of alcohol on driving ability and found that most authors had concluded that low levels of alcohol (in the .025 to .08 g/dL BAC range) can cause significant impairment in psychomotor performance, comprising driving safety. A review by Mitchell in 1985 concluded that alcohol impairment of driving-related behavioral skills is greatest for those tasks that require cognitive functioning and that simple perception alone is least affected. He found that impairment of tasks requiring cognitive functioning begins to be evident at BAC levels higher than .05 g/dL and that there was no evidence that BAC levels lower than .05 g/dL impair any behavior in most individuals. His review is one of the few that addressed the *amount* of impairment, finding

that, for most behavioral skills, the impairment at low BAC levels is slight, between 8 and 10% in many studies. He concluded that tolerance to central nervous system impairment may develop in regular drinkers, with sensorimotor coordination showing the greatest degree of tolerance, and that divided attention shows relatively little impairment.

Because many of the studies of impairment have been aimed at the first evidence of impairment and the amount of impairment has received less attention, it was not clear at what point all drivers would be significantly affected. This was partially because most subjects in the experiments were not heavy drinkers likely to have developed a strong tolerance to alcohol. To determine more directly the potential role of tolerance in mediating the affect of alcohol on performance impairment, Moskowitz et al. (2000) conducted a study in which heavy and light drinkers were tested at BAC levels up to .10 g/dL. They recruited 168 participants equally divided between men and women and four age groups—>21, 21-24, 25-50, and >50—and three drinking levels—light, moderate, and heavy. Performance was measured on a simulator with an added task to measure ability to divide attention. A test session at a zero BAC level (using a placebo drink) was compared with a separate test in which the participants were brought to a BAC level of .10 g/dL and then tested at several BAC levels on a descending BAC curve.

They found that in 11 of the 14 subtest scores derived from their performance task, a majority of the subjects were impaired at a BAC level of .04 g/dL. At a BAC level of .08 g/dL, between 58 and 92% of the subjects were impaired on each of the 14 measures. There was a clear relationship between the extent of impairment and BAC level, but a few individuals showed no significant performance deterioration in their performance either in the placebo condition or at BAC levels as high as .10 g/dL. Despite this indication of differences in the extent of impairment in performance between subjects, however, neither gender; age; nor, surprisingly, the light, moderate, or heavy drinking levels of the participant predicted the extent of impairment. Moskowitz et al. (2000) concluded that their results showed that BAC levels as low as .02 g/dL produced impairment on some measure for most subjects and that the percentage of subjects showing impairment rose consistently with higher BAC levels. Within the diverse group of drinkers studied, there were only random variations in performance impairment that were not related to age, gender, or drinking status of the subjects. This is contrary to the data from epidemiological relative risk studies described hereinafter, which have generally found differences based on age and drinking status (Borkenstein et al., 1974; Hurst, 1973). The difference between the laboratory data and the epidemiologic data is influenced by many factors that are controlled or not important in the laboratory, such as risk-taking, that play a role in highway crashes.

Ogden and Moskowitz (2004) published an “overview of the field” of the effects of alcohol and drugs on driving. Building on the earlier reviews by Moskowitz and Robinson (1988) and Moskowitz and Fiorentino (2000), they have brought the knowledge of the impairing effects of alcohol on driving up-to-date. Their paper makes the following key points: (1) there is no evidence that low BAC levels improve human skills (Moskowitz, Burns, & Williams, 1985); (2) there is no evidence of a threshold at which alcohol begins to have an effect because impairment occurs at the lowest levels at which BAC can be measured; (3) all individuals are impaired at any positive BAC level, and impairment increases with BAC level; and (4) many of the skills related to driving are significantly impaired at BAC levels lower than .05 g/dL. They go on to express the opinion that “The legislature is free to prohibit driving at any BAC level, since such a limit would not contradict the scientific data demonstrating no lower limit to impairment” (p. 186).

The Ogden and Moskowitz paper (2004) also provides a brief overview of two alcohol impairment issues frequently overlooked: its effect through hangover effects and its potentiating effects on recovery from crash injuries. They note that there have been several studies indicating that a hangover, which usually lasts about 3 hours after an individual's BAC level has returned to zero, depresses brain activity, affects judgment, and reduces concentration. Hangover effects have been demonstrated on driving and aircraft simulators. Although it is well understood that the presence of alcohol in the body increases the probability that a driver will become crash-involved, it is less well recognized that, given crashes of equal severity, drinking drivers are likely to sustain more serious injuries and less likely to recover from those injuries (Waller et al., 1986; Evans & Frick, 1993).

Of particular interest to this review is a study by Waller, Stewart, and Hansen (1986) who used data from North Carolina's crash reports, driver records, and medical examiner reports to estimate the effects of alcohol on increasing the severity of injuries suffered in traffic crashes. They concluded that alcohol increases vulnerability to injury in *any* given crash. A more recent case-control study examined the risk of injury of any cause after the recent consumption of alcohol (McLeod et al., 1999). The 797 cases were injured patients from a hospital emergency unit. The 797 controls were matched on residence location and were interviewed at home regarding activities leading up to the time of their matched case's injury. Cases and controls were breath-tested and questioned about the injury event and alcohol and other drug use consumed in the 6 hours before the injury. Analysis of the data produced an odds ratio of 3.4 of sustaining an injury from any cause after consuming more than 60 grams of alcohol in a 6-hour period, after controlling for demographic variables.

3.8. Relative Risk of an Alcohol-Related Crash

The laboratory and simulator studies reviewed by Moskowitz and others demonstrate the acute impairment produced by even small amounts of alcohol and provide a strong basis for policies and programs directed at preventing impaired driving. But actual crashes are produced by a complex set of events, and the presence of alcohol in the body of the driver is not necessarily a demonstration that acute intoxication produced the event. Men drive more than women; men have more crashes than women; men drink more than women. Thus, crash-involved male drivers are more likely to have been drinking. The mere association of alcohol with crash involvement does not demonstrate a causal influence unless all other relevant factors can be eliminated.

3.8.1. Background

More direct evidence of a causal relationship is provided by demonstrating that crash probability is directly related to the amount of alcohol in the driver's body. *Relative risk* studies attempt to refine the influence of alcohol on crashes by comparing drivers in crashes with similar drivers using the road at the times and places where crashes have occurred. Such studies are often titled "case-control" investigations because, for each crash-involved (case) driver, one or more non-crash-involved (control) drivers are selected for comparison. The key to such studies is to ensure that the control driver is selected so that the only distinction between that driver and the case driver is the involvement in a crash. In concept, this is achieved by going to the same location where the crash occurred at the same time of day on the same day of the week and randomly selecting control drivers (non-crash-involved drivers) operating vehicles in the same direction on the road as the crash-involved driver. Although eight studies of this type have been conducted over the last 70 years, in practice this level of control has rarely been achieved.

The first attempt to conduct a case-control study dates back to 1938. Conducted by Holcomb (1938) in Evanston, Illinois, that study involved collecting data at the roadside to compare with 270 hospitalized drivers from crashes—46% of whom had been drinking based on urine alcohol tests. Holcomb obtained breath tests on 1,750 non-crash-involved drivers during the evening hours. The study, though not adjusting for differences in day of the week or the exact hour of the crash in selection of the roadside cases, nevertheless showed that only 12% of the roadside drivers, compared to 46% of the hospitalized drivers, had a positive BAC level. In 1951, a study in Toronto, Canada, by Lucas, Kalow, McColl, Griffith, and Smith (1955) compared 433 crash-involved and 2,015 non-crash-involved control drivers. Breath-test data were available for both crash and comparison drivers and selection of non-crash-involved drivers was carefully controlled to account for day of the week and time of the crash. The results were reported in BAC intervals so that crash risk could not be determined at each BAC level.

In 1962, McCarroll and Haddon (1962) conducted a case-control study in New York City that compared 43 fatally injured passenger car drivers with 258 control drivers, six for each crash case. The controls were selected on the same day and same time of day as the crash occurred within a few weeks of the event. They found that drivers with BAC levels from .10 to .25 g/dL had relative risk rates of 2.6, whereas drivers with BAC levels higher than .25 g/dL had relative risk rates of 176.8. Perrine and colleagues (Perrine, Waller, & Harris, 1971) conducted a study of 75 drivers in fatal crashes who were judged to have been responsible for those crashes and obtained somewhat similar results. Other case-control studies have been conducted in Huntsville, Alabama, by Farris, Malone, and Lilliefors (1977) involving 650 drivers in injury crashes and in Adelaide, Australia, by McLean, Holubowycz, Sandow, and the Road Accident Research Unit (1980) involving 299 drivers in injury crashes. Both of those studies, like the earlier ones just described, developed relative risk curves that showed rapid rises at BAC levels higher than .05 g/dL.

The most influential of the case-control studies was conducted by Borkenstein and his associates (1964, 1974) in Grand Rapids, Michigan, in which 5,985 crash-involved drivers were compared with 7,590 control drivers. Between July 1952 and July 1953, research staff traveled to the sites of crashes occurring between 6:30 p.m. and 10:30 p.m., Monday through Saturday, to collect breath samples from crash-involved drivers. Later, they collected data on four comparison drivers at each site where crashes had occurred in the previous 3 years, but not at the same sites at which they collected the crash cases. Thus, the study was not strictly a case-control study because the comparison cases were not matched to the drivers in the crash cases. Rather, comparison drivers were matched to drivers in crashes randomly sampled from police accident reports occurring during the previous 3 years. Further, no correction was made for drivers who refused to provide breath tests. Finally, the group of crash-involved drivers who were compared to the control group was modified to represent drivers judged to be “at fault” by a process of combining those in single-vehicle crashes with half of those in two-car crashes. Despite these limitations, the Grand Rapids study became the gold standard for estimating the relative risk of involvement in an alcohol-related crash based on the driver’s BAC level.

Hurst, Harte, and Frith (1994) reviewed these classic studies and contrasted the relative risk curves for each of the case-control studies up to that time (Figure 3-5). As shown, the risk curves all have the same general form with a small increase up to a BAC level of .08 g/dL and an accelerating rise beyond that point; however, there are substantial differences between the studies at BAC levels of .08 g/dL or higher. Several factors account for these differences. The crash-involved drivers vary in

severity from fatal to injury to property-damage-only events. Because high BAC levels are far more prevalent in fatal than in injury or property-damage-only crashes, this variation influences the relative risk curves. These summary curves lump together all types of drivers so they do not highlight the different risks related to gender, age, and ethnicity; level of alcohol consumption; and the many other factors that can affect crash risk. Drinking experience appears to be particularly important as demonstrated Hurst et al.'s (1994) reanalysis of the Grand Rapids data shown in Figure 3-6.

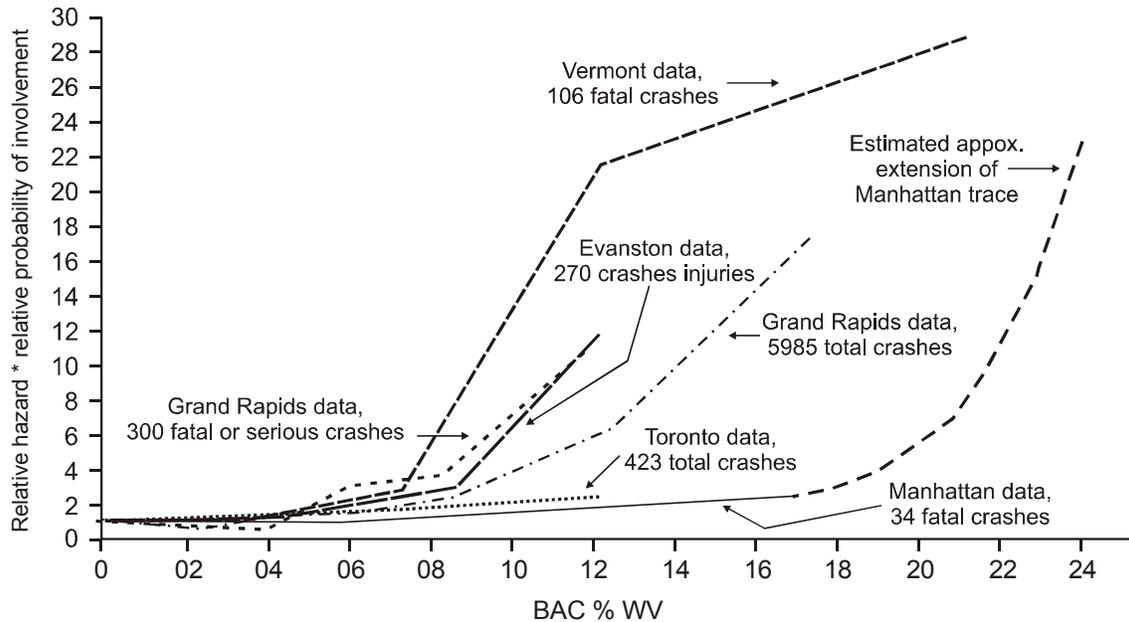


Figure 3-5. Summary of relative crash risk as a function of BAC from six case-control studies. Adapted from Hurst et al.(1994).

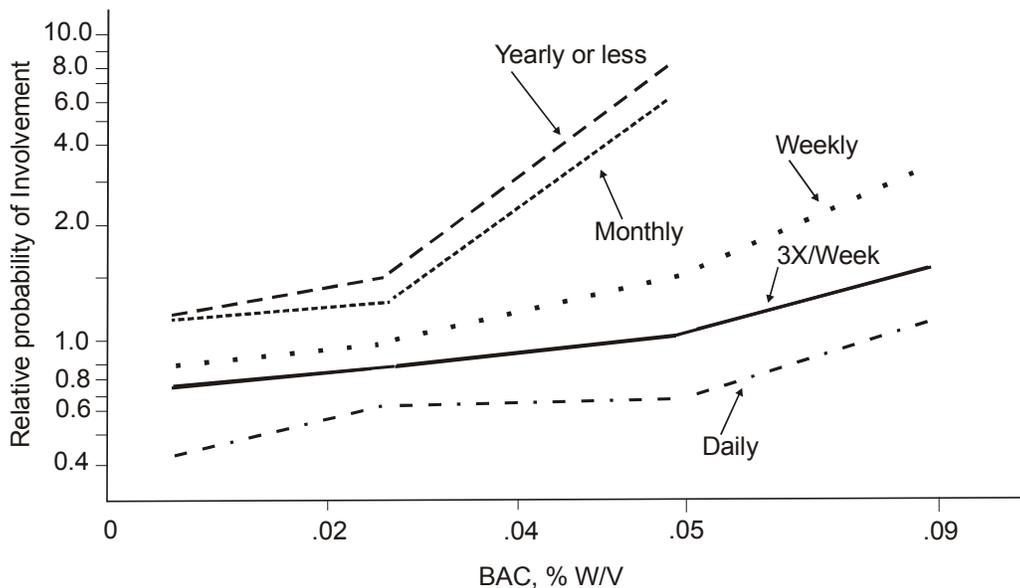


Figure 3-6. Relative risk of crash involvement by BAC level and drinking frequency. Adapted from Hurst et al., (1994)

3.8.2. *The New Classic Case-Control Study*

The classic Borkenstein study has been superseded by the most complete, detailed case-control study to date. This latest study was conducted with NHTSA funding by Blomberg, Peck, Moskowitz, Burns, and Fiorentino (2005) at two sites—Long Beach, California, and Fort Lauderdale, Florida—from June 1997 to April 1999. Five two-person research teams at each site consisting of a police officer and a research assistant operating from a police vehicle traveled to crash sites and interviewed and breath-tested the drivers involved in those crashes between 4 p.m. and 2 a.m. in Long Beach and 5 p.m. and 3 a.m. in Fort Lauderdale. One week following the crash, the research team returned to the crash site on the same day and at the time as the crash occurred and stopped and interviewed two drivers heading in the same direction as the crash-involved driver. A breath test and a brief interview were obtained from two comparison drivers for each crash-involved driver. At the two sites, 4,316 crash-involved drivers were contacted and compared with 10,066 control drivers. The study achieved a high level of participation with 88% of the crash-involved drivers and 93% of the comparison drivers providing a complete set of data.

The study was noteworthy in two aspects. First, the research teams conducting the initial portion of the interviews used passive alcohol sensors (PASs), which can detect expired breath alcohol and provide a rough indication of the BAC level at a distance of about 6 inches from the driver's face (Farmer et al., 1999; Voas, Romano, & Peck, 2006c). The PAS was used on both crash-involved and control drivers, thereby providing a basis for estimating the BAC level of those drivers for whom the survey team failed to obtain a regular preliminary breath test. Second, the police-researcher teams succeeded in locating, interviewing, and breath-testing 17% of the hit-and-run drivers who fled the scene of the crash. This provided information on a group never before included in a case-control study. More than 12% of the 4,919 crash-involved drivers fled the scene before the research team arrived. The significance of these two unique sets of data is shown in Figures 3-7 and 3-8. The PAS data, which had a correlation of .65 with the BAC levels collected using the evidential handheld breath-testers, were used to impute the BAC levels of crash-involved drivers and comparison drivers who were not tested with the evidential units. Drivers who refused to provide a breath sample tended to have higher BAC levels than those who provided a breath sample. Consequently, the inclusion of the drivers with PAS BAC estimates increased the BAC risk relationship, particularly at higher BAC levels, as shown in Figure 3-7. At BAC levels higher than .20 g/dL, the PAS adjusted curve has lower risk values. That is believed to be an artifact due to the maximum reading of the PAS at a .12 g/dL BAC level and the relatively few cases in the study with BAC levels higher than .20 g/dL (Blomberg et al., 2005).

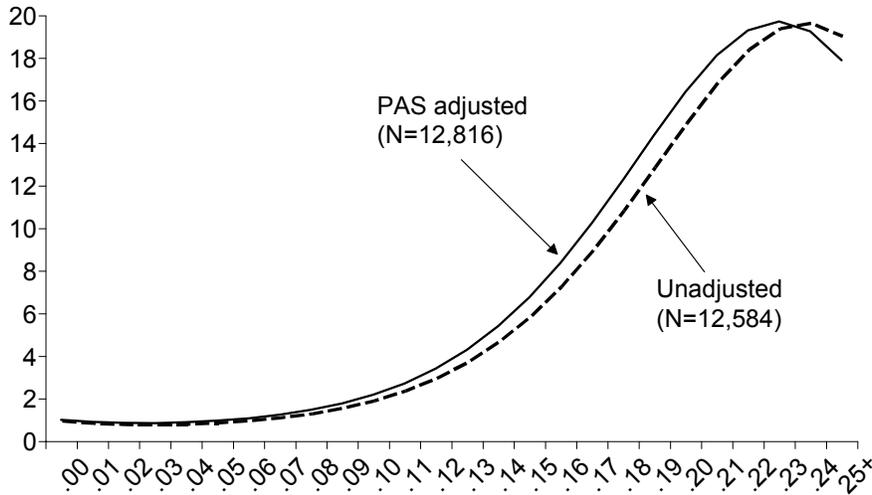


Figure 3-7. Effect of adding imputed BAC levels based on PAS readings Adapted from Blomberg et al., 2005

Second, the BAC levels obtained from 17% of the hit-and-run drivers were used to impute the BAC levels of the 83% of hit-and-run drivers from whom a BAC was not obtained. The BAC levels of the hit-and-run drivers were substantially higher than for crash-involved drivers who were contacted and interviewed at the crash site. When hit-and-run drivers were included in the calculation of the BAC risk curve, they also substantially raised the relative risk levels at high BAC levels, as shown in Figure 3-8 (Blomberg et al., 2005).

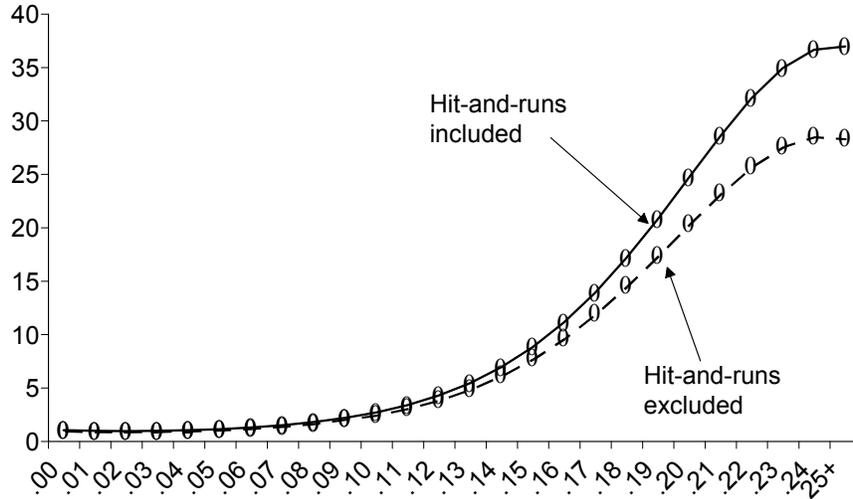


Figure 3-8. Effect of adding hit-and-run cases. Adapted from Blomberg et al. (2005).

Other factors also influence the shape of the risk curve. Young drivers ages 16 to 20 display risk rates that rise more rapidly than older drivers, as shown in Figure 3-9 from the Blomberg study.

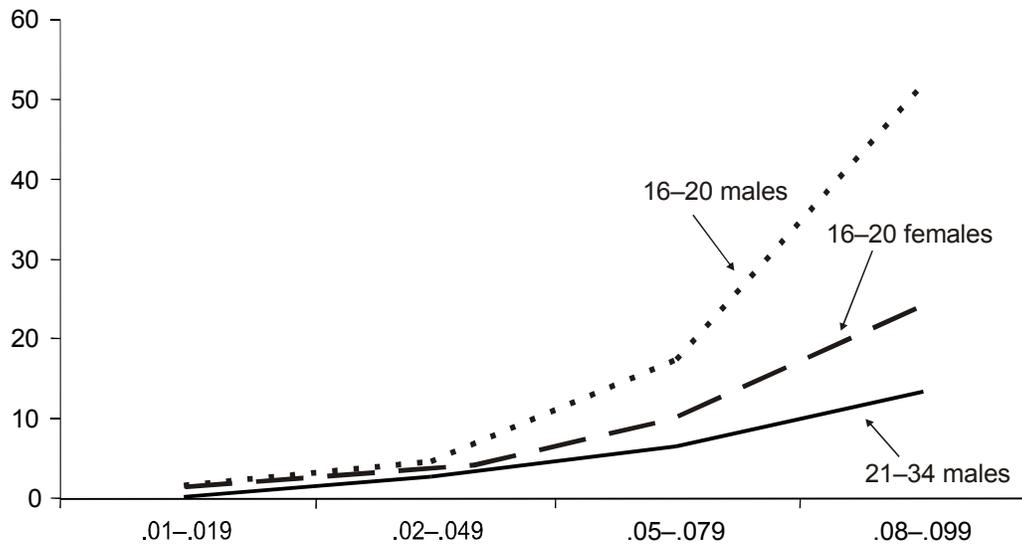


Figure 3-9. Relative crash risk by BAC level and driver age. Adapted from Blomberg et al.(2005)

Because other variables such as age, gender, and quantity and frequency of drinking can vary between the drivers in crashes and the comparison drivers, it is necessary to compensate for these differences by the use of covariates in computing the risk curves. Blomberg et al. (2005) collected information on a substantial set of demographic variables including items such as marital status, education, ethnicity, employment status, and vehicle type, as well as age and gender, for use in correcting the differences between the crash and the comparison drivers. Regression analysis was used to determine which variables were most important in distinguishing crash and control drivers, and those that proved to be significant were used as covariates in adjusting the risk curves. The significance of adjusting for those differences in calculating the risk curve is shown Figure 3-10.

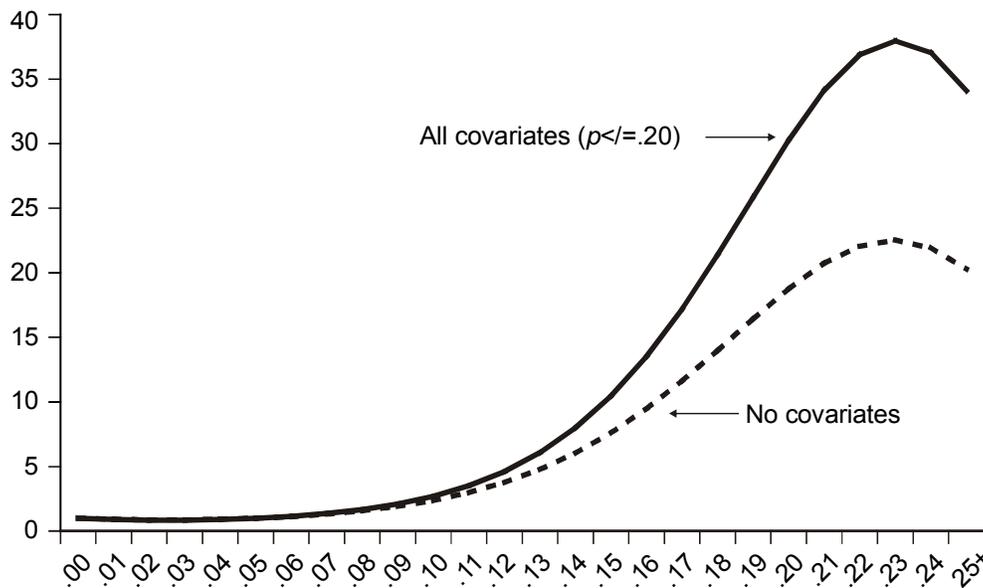


Figure 3-10. Relative risk of a crash by BAC level with covariates and without covariates. Adapted from Blomberg et al.(2005)

The final relationship derived from the Blomberg et al. (2005) analysis is contrasted with the classical Borkenstein et al. (1974) Grand Rapids relative risk curve in Figure 3-11. Blomberg et al. (2005) found a statistically significant relative risk of a crash at BAC $\geq .04$ g/dL and increasing exponentially at BACs of .10 g/dL and higher. The Blomberg et al. (2005) final relative risk curve (pp. 88 and 89) does not show the infamous “Grand Rapids Dip” at BAC levels in the .02-.03 g/dL range because it corrects for the differences in drinking levels as Hurst (Figure 3-6) did. As noted, this “dip” has been shown by Allsop (1966) and Hurst et al. (1994) to be an artifact of the data due to the lack of inclusion of covariates for drinking frequency. Blomberg et al. showed that when “reactive” covariates for drinking quantity and frequency are omitted, their curve dipped between .01 and .03 g/dL BAC. As noted earlier in this chapter, Ogden and Moskowitz (2004) reported that there is no evidence that low BAC levels improve performance and similarly there is no evidence a small amount of alcohol will actually reduce crash risk.

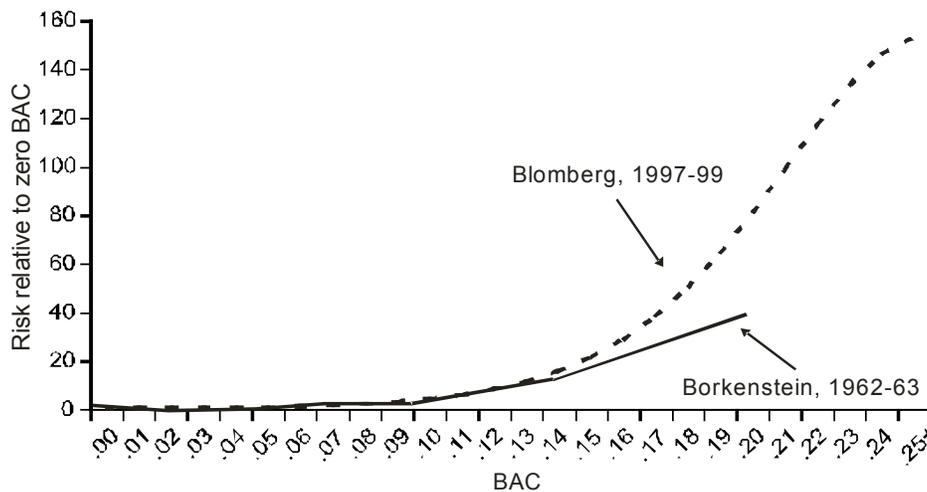


Figure 3-11. Relative crash risk by BAC levels. Adapted from Blomberg et al. (2005) and Borkenstein (1974)

3.8.3. *Attributable Risk Estimation Based on Case-Control Studies*

Case-control studies that provide relative risk estimates can also provide the basis for estimating the influence of reducing the number of drivers at or higher than specific BAC levels on our highways. This may be useful in considering at what point the per se BAC limit should ultimately be established. For example, based on the Blomberg et al. (2005) data in Figure 3-12, a driver at .08 g/dL BAC is 2.69 times more likely to be in a crash than if that driver was at a zero BAC level. Along with other evidence, this provides a solid basis for making driving at or higher than that level illegal. But it does not indicate how many crashes would be avoided if, in fact, there were no drivers at a higher level than .08 g/dL BAC on the roads. That estimate is commonly called “attributable risk” or “attributable fraction” (AF) in the public health field and can be derived from two sets of data: (1) the relative risk from the case-control studies and (2) the frequency of crashes in the population for which the risk curve was developed (Coughlin, Benichou, & Weed, 1994). AF can be estimated from the following equation, where *RR* = relative risk and *P* = proportion of the at-risk population that has the characteristic (i.e., BAC level).

$$AF = \frac{P(RR-1)}{P(RR-1) + 1} \times 100\%$$

This can be derived from the cases measured in the case-control study, or it can be based on an external data set such as FARS or GES. The distribution of BAC levels in the control sample can be used to estimate P , thereby providing an estimate of AF for driving at the time.

An example of applying this calculation of the attributable risk is shown in Figures 3-12 and 3-13. Figure 3-12 shows a comparison of the relative risk of crash as a function of BAC levels for males compared to females from the analysis of the Blomberg data by Voas, Romano, and Peck (2007b). As can be seen, there appears to be little difference between males and females in the relative risk of involvement in a crash given a similar BAC level. Women, however, generally drink less than men and are less likely to be on the road at high BAC levels. This shows up when the attributable fraction of crashes that involve women is compared with that of men in Figure 3-13. In that figure, the prevalence of crashes is estimated from GES data. As can be seen, women and men are involved in about the same number of injury and property-damage-only crashes at BAC levels of .08 g/dL or less, but women are involved in far fewer crashes at higher BAC levels because so few females relative to men are driving at those high BAC levels. Thus, an effective intervention aimed at male drivers should be expected to prevent more crashes than an equally effective one targeting females, even though their relative risk of crash involvement is the same.

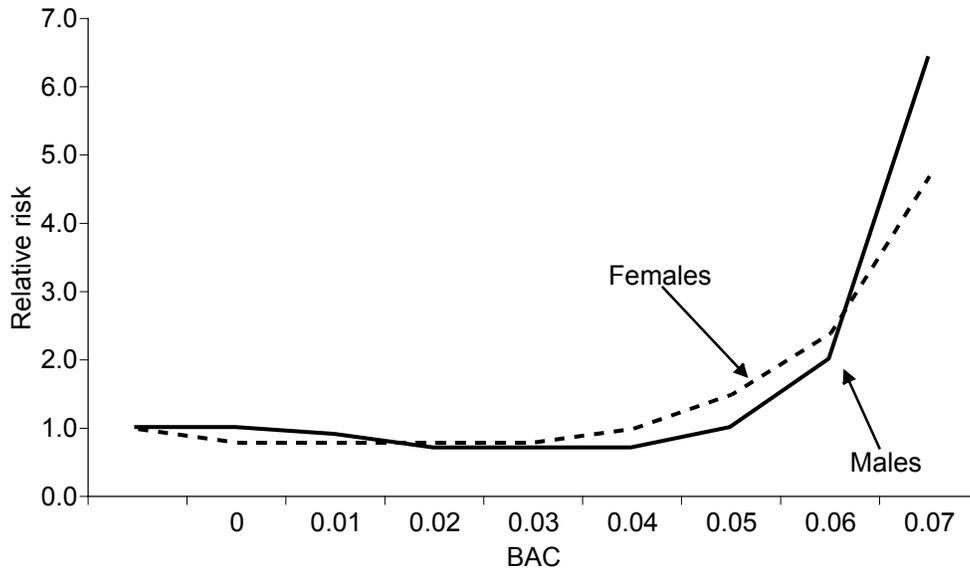


Figure 3-12. Comparison of the relative risk for males compared to females of a crash. Adapted from Voas et al. (2007b)

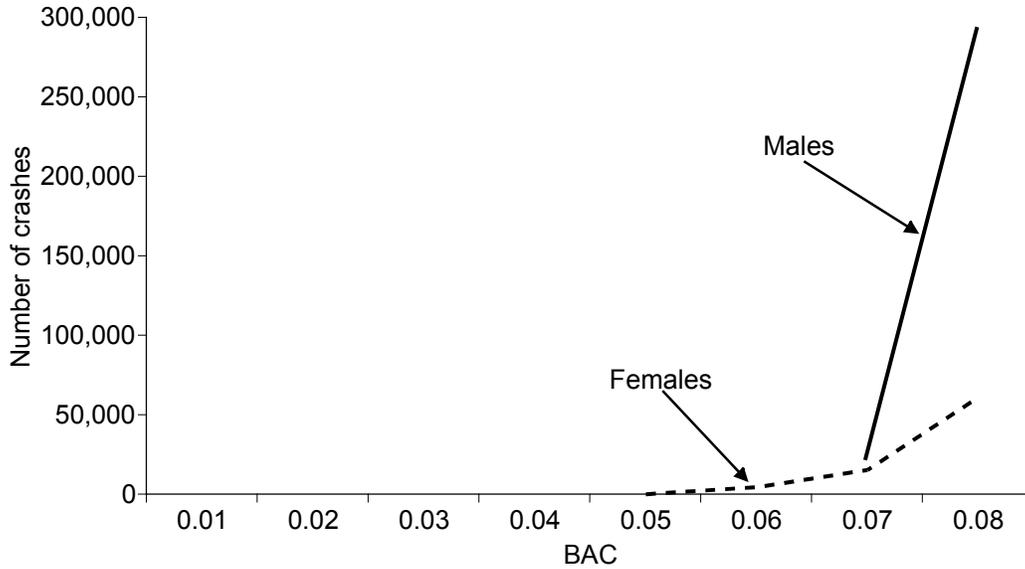


Figure 3-13. Comparison of males and females in attributable risk of crash involvement. Adapted from Voas et al. (2007b)

Another illustration of the potential significance of attributable risk is provided by comparing drivers age 20 and younger with drivers age 21 and older. In this case, the relative risk of the underage driver is seven times greater than that of adults age 21 and older at BAC levels higher than .08 g/dL (Figure 3-14), but the number of fatal crashes in which they are involved (estimated from FARS) is only twice that of older drivers (Figure 3-15).

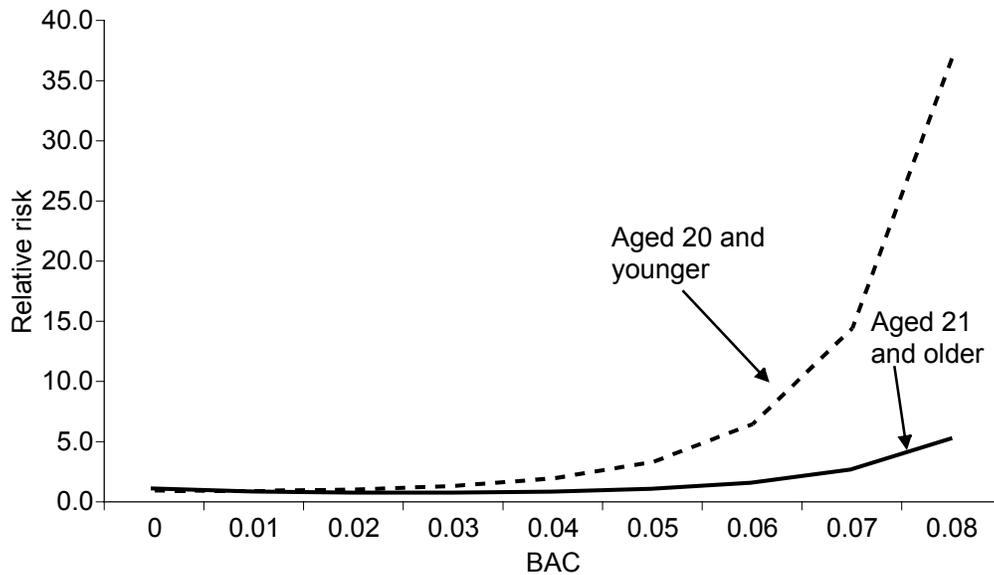


Figure 3-14. Comparison of the relative risk of fatal crash involvement of drivers age 20 and younger and age 21 and older. Adapted from Voas et al. (2007b)

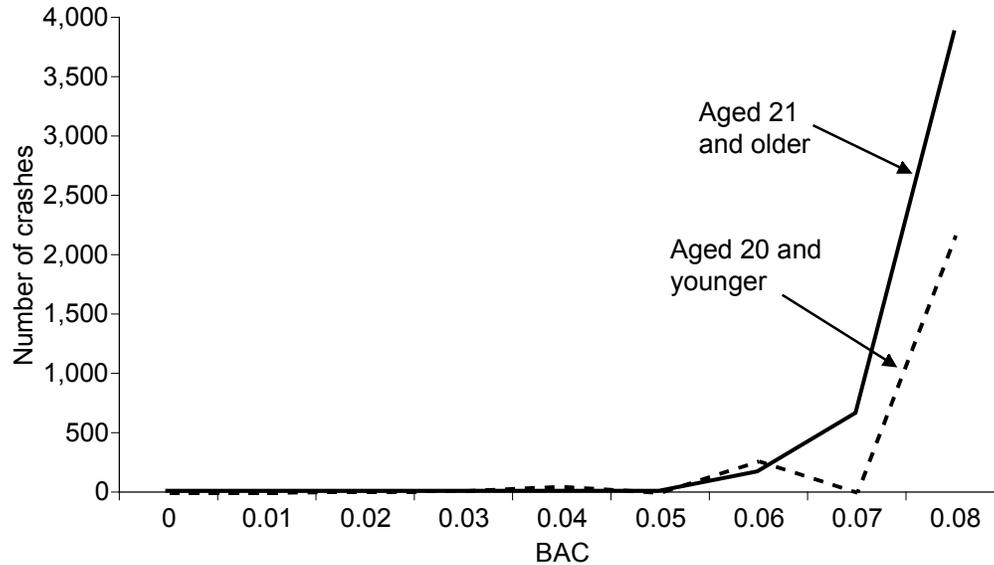


Figure 3-15. Comparison of drivers age 20 and younger and age 21 and older on the attributable risk of crash involvement Adapted from Voas et al. (2007b)

These examples are intended merely to illustrate the potential usefulness of the attributable risk concept in traffic safety. Attributable risk assists in assigning the level of priority to competing programs and policies. That calculation can also provide an important piece of information (not shown in the simple calculation described hereinbefore); how many people would have to be “treated” (i.e., denied licenses, put in jail, or subjected to some other control measure to ensure that no driver would be on the road with a BAC higher than a specific limit). Although keeping all drivers off the road at BAC levels higher than a specified limit is clearly impractical, the calculation of the number of drivers who would require “treatment” permits an estimate of how many would need to be treated to reduce the over-the-limit drivers in crashes by a more realistic 10 to 20%. That number would provide safety advocates and legislators with an indication of the cost of implementing programs such as enhanced enforcement of the .08 g/dL or any other BAC limit.

To make a more refined calculation of attributable risk, it is necessary to consider the exposure of the group concerned along with their prevalence in crashes. Unfortunately, this requires data that are less readily available on the typical amount of driving of the group of interest and also requires driver survey data on the amount of driving done by individuals in each group of interest. These data are not generally available, though they might be estimated from the Federal Highway Administration’s (FHWA) Personal Transportation Survey. Even without that refinement, taking the step beyond the simple reporting of relative risk and estimating attributable risk increases the utility of case-control studies of alcohol in crashes.

3.9. Summary

The general principles regarding the processing of alcohol by the body remain essentially unchanged from those established many years earlier. Alcohol is absorbed by diffusion, metabolized mainly in the liver, and the small remaining amount is eliminated in urine and expired air.

Alcohol's immediate effects are due to its depressant effect on the brain, and chemical tests of blood drawn from a vein or capillary are the preferred indirect way of estimating alcohol concentration in the brain in live humans. The most common way of estimating the concentration of alcohol in the blood is testing air expired from the lungs.

At the millennium, breath-testing became more precise, more reliable, and more convenient. Other techniques also are evolving that measure alcohol presence in alternative substances such as saliva (Flores et al., 1992) and sweat. Practical self-testing devices have also been developed and are being used in some countries. Improved behavioral tests also are being widely used to assist police officers in determining alcohol impairment among drivers suspected of a drinking-and-driving law violations. Subjective estimates of BAC levels by people, such as police officers and physicians, and the use of methods for self-calculation of the BAC level are not accurate enough to use either in research or in operations.

The acute depressant effect of alcohol increases with the BAC level and has been measured in terms of its effects on human performance at BAC levels as low as .02 g/dL. Alcohol also has been shown to increase vulnerability to injury. Recent research regarding alcohol's effect on performance related to driving has focused on low BAC levels, as it has clearly been established in previous research that performance is substantially impaired in virtually everyone at BAC levels of .08 g/dL and higher. Techniques for testing for alcohol and measurement of human performance have improved markedly in recent years, resulting in an overall increased sensitivity to the impairment of behavior by alcohol as determined both in laboratory experiments and in tests of actual driving performance. Consequently, behaviors related to driving are known to be impaired at lower BAC levels than was previously believed, with increased impairment of many behaviors clearly occurring at BAC levels in excess of .05 g/dL. The amount of impairment of these behaviors at lower BAC levels (less than .05 g/dL) and its association with increased crash risk has been confirmed in a recent large case-control study by Blomberg et al. (2005).

Chapter 4.

Risks Associated With Special Groups of Road Users

This chapter covers the risk of involvement in an alcohol-related crash faced by special groups of road users. Some, like motorcyclists, are at special risk because they operate a less-safe vehicle. Others, such as the older drivers, are at risk because they are particularly prone to injury or their driving skills have deteriorated; and still others, such as teenagers, are at special risk because they are inexperienced and tend to take more chances. Finally, some (e.g., children and infants) are at risk because they are dependent on others who may drink and drive. Not all of the special groups of interest are at greater than normal risk: Asians and Cubans are less involved in impaired driving than the average citizen, and females are less frequently involved in alcohol-related crashes than men.

4.1. Introduction

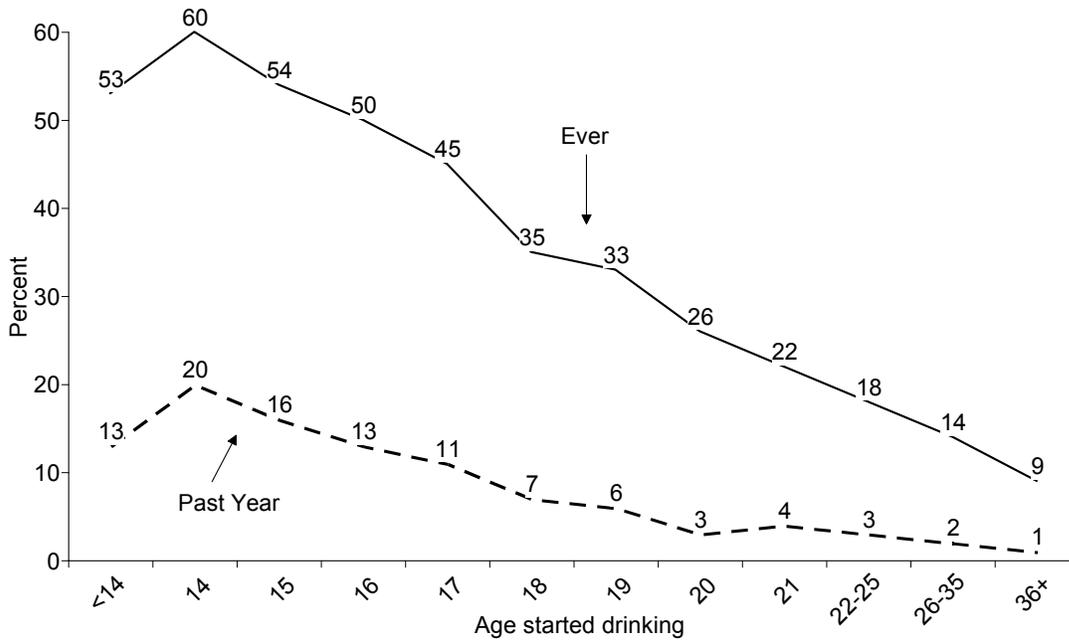
The interest in these special groups stems from the ability to identify them and study their drinking and driving with a view toward creating specialized programs to reduce their involvement in alcohol-related crashes. For some groups, the most significant protective programs do not involve alcohol. Seat belts may be the most important issue for passengers. For children, the most important factor is securing them in a safety seat in the rear of the vehicle. For pedestrians, on the other hand, the emphasis is on providing a safe environment through the engineering of street lighting, sidewalks, pedestrian crossings, and traffic lights. For these special groups, drinking, although secondary, may still be an important safety issue. This chapter discusses what is known about the impaired-driving risk of 10 special groups that have attracted the interest of safety researchers and briefly discusses recent studies of countermeasures designed to reduce their exposure to alcohol-related crashes. As noted, the groups included in this section are not necessarily those at highest risk, but rather those that can be identified because of their characteristics and offer the possibility for developing programs that will reduce their risk of alcohol-related crash involvement. The primary research on drinking-and-driving countermeasures is covered in Chapter 5.

4.2. Early-Onset AOD Users

4.2.1. Effect of Early Drinking on Adult Driving

There is evidence that age of drinking onset (the beginning of regular drinking, not just an occasional sip on a holiday) may be associated with drinking problems later in life (Grant & Dawson, 1997). Hingson, Heeran, Levenson, Jamanka, and Voas (2002) analyzed data from the National Longitudinal Epidemiology Survey to see whether people who begin drinking at younger ages are

more likely to report impaired-driving and alcohol-related crash involvement over their lifetimes. They found that the earlier respondents started drinking, the more likely they were to report driving after drinking too much and being in a motor-vehicle crash because of their drinking. This was the case even after adjusting for a current or past diagnosis of alcohol dependence and other personal characteristics and behaviors associated with the age respondents started drinking. Even among people who were never alcohol dependent, those who began drinking before age 21, relative to those starting at age 21 or older, were more likely to report “ever” and “in the past year” after having been in a crash after drinking too much. Another study of the same data set revealed that early onset of drinking was also associated with unintentional injuries of any kind (Hingson, Heeren, Jamanka, & Howland, 2001).



N = 1131 844 1507 3161 2866 5699 2213 2082 2975 2573 1377 454 $p < .001$

Figure 4-1. Drinking drivers in a fatal crash according to the age of drinking onset. Adapted from Hingson et al. (2002)

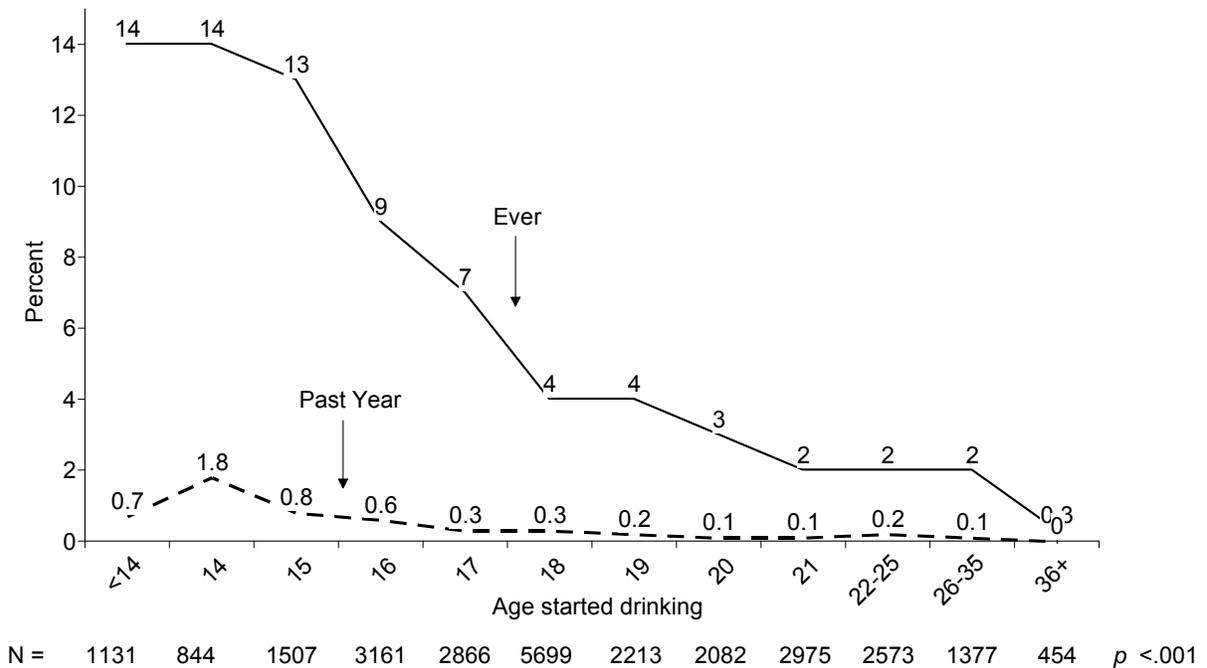


Figure 4-2. Motor-vehicle occupants in an alcohol-related fatal crash according to the age of drinking onset. Adapted from Hingson et al. (2002)

Hingson, Heeren, Zakocs, Winter, and Wechsler (2003) analyzed data from 14,138 college students from 119 schools and found that those who began drinking before age 19 were significantly more likely to experience alcohol-related problems than those who began later. Such early-onset drinkers were more likely to be alcohol dependent and heavy episodic (binge) drinkers and to report driving after any drinking, driving after five or more drinks, riding with a driver who was high or drunk, and sustaining injuries that required medical attention. Individuals first intoxicated at younger ages also believed they could consume more drinks and still drive safely and legally, which contributed to their greater likelihood of driving after drinking and riding with drivers who were high or drunk (Hingson et al., 2003).

Two other recent studies have related driving behavior to early onset of drinking. Oesterle et al. (2004) investigated trajectories of heavy episodic drinking during adolescence and found that young adults who did not engage in heavy drinking during adolescence had the lowest occurrence of health problems and were most likely to engage in safe health behaviors at age 24, including safe-driving behaviors. Individuals who began heavy drinking in late adolescence were less likely to engage in safe-driving practices. Shope, Waller, Raghunathan, and Patil (2001c) found that substance use (cigarettes, marijuana, and alcohol) reported at age 15, and negative parental influences (lenient attitudes toward young people's drinking; low monitoring, nurturance, family connectedness) increased the risk of serious driving offenses and serious crashes for both men and women.

Although not specifically investigating onset of alcohol use, Gulliver and Begg (2004) found that adult or peer modeling of impaired-driving behaviors in the mid to late adolescence of young people was related to DWI behaviors at a later age. Specifically, the modeling was related to differences between perceived safe and estimated illegal alcohol consumption limits for both males and females and was related to DWI for males.

4.2.2. Early Drinking Related to Other Alcohol Problems

Midanik and Clark (1995) highlighted general alcohol-related problems associated with drinking at a young age. Their analysis involved separate statistical studies of dependence symptoms and social consequences in which demographic variables were used as controls. After all of the demographic variables (11 in all) were taken into account, only younger ages (18-29 years) were associated with alcohol problems. Yu and Perrine (1997) highlighted the influence of parental alcohol consumption on the onset of consumption by adolescents. They found that parent-child alcohol use transmission was gender-specific: fathers' drinking tended to affect sons' drinking onset and mothers' drinking tended to affect daughters' drinking onset.

Sargent et al. (2006) examined another antecedent to early-onset alcohol use: viewing depictions of drinking in the entertainment media. They investigated the association of exposure to drinking in the movies to the early-onset drinking in adolescents. They found a significant association between higher exposure to alcohol use in the cinema and increased risk of alcohol consumption by adolescents, independent of several potentially confounding factors.

4.2.3. Alcohol and Brain Development

Concern with the early onset of alcohol consumption is supported by recent studies indicating that the brain continues to mature until the mid-twenties, with the possibility that excessive consumption at an early age can affect brain structure as well as function (National Institute of Mental Health, Teenage Brain: A Work in Progress). As described in Chapter 3, some evidence of this has been produced by Brown, Tapert, Granholm, and Delis (2000) and Tapert et al. (2004). This supporting evidence growing out of brain research is leading to an increasing interest in the problem of early onset of drinking as a factor in a broad range of adult-drinking problems. Further, this research suggests that interventions directed at reducing consumption by youths in middle school, high school, and college can have value for reducing impaired driving by adults. Based on the growing evidence that early onset of drinking is a problem, Hingson and colleagues suggested that minimum legal drinking age (MLDA) laws not only protect individuals younger than the legal drinking age from alcohol-related traffic injuries, but also reduce crash involvement among adults. The risk appears particularly high for youths age 14 and younger who start regular drinking as early as junior high school, which emphasizes the need to develop effective interventions for that age group (Hingson et al., 2002).

4.3. Teenage Novice Drivers

4.3.1. Crashes Are a Leading Source of Death for Teenagers

Motor-vehicle crashes are the leading cause of death for young people ages 15 to 20 in the United States, accounting for approximately 36% of their deaths (Subramanian, 2005b). Although young people ages 15 to 20 make up between 8 and 9% of the U.S. population and only about 6 to 7% of the licensed drivers, they are involved in between 13 and 14% of the fatal traffic crashes each year (NHTSA, 2006a). In recent years, between 6,000 and 7,000 young drivers and passengers ages 15 to 20 have been fatally injured in motor-vehicle crashes, accounting for more than one-third of their total fatalities (NHTSA, 2006a). Crashes involving young drivers ages 15 to 20 are costing the U.S. economy an estimated \$42.3 billion each year (Blincoe et al., 2002). About 23 to 24% of young drivers (ages 15-20) involved in fatal crashes are estimated to be drinking before their crash

(Subramanian, 2005b). Sixteen-year-old drivers have crash rates that are three times greater than 17-year-olds, five times greater than 18-year-olds, and even twice those of drivers age 85 (McCartt, Shabanova, & Leaf, 2003).

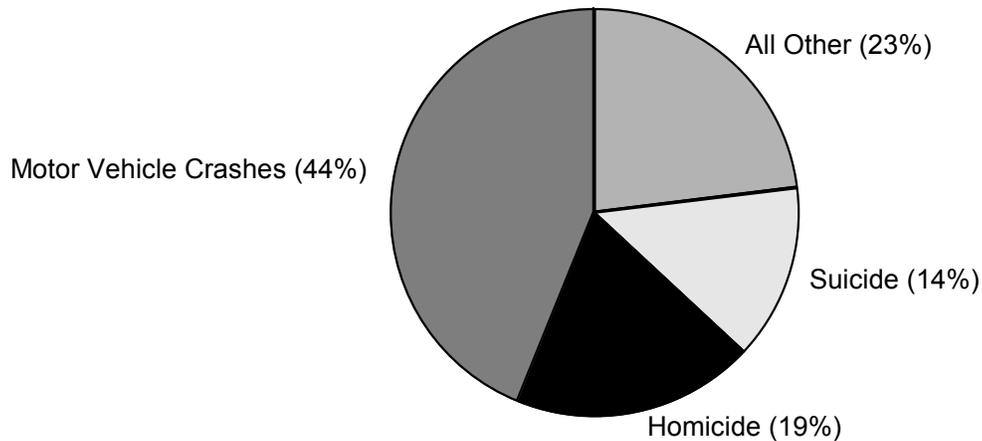


Figure 4-3. Leading causes of fatalities for teens. Adapted from NHTSA 2003 DATA NSC Family Safety & Health, Summer 2004

The 2005 FARS data (see Figure 2-10 in Chapter 2) shows that 13% of the drivers age 15 and younger in fatal crashes had been drinking. These youths were younger than the normal age at which a teenager can get a learner's permit and had been drinking. This group also has the highest percentage (17%) of drinking drivers in injury crashes of all age groups. Twenty-one percent of the 16- to 20-year-olds involved in fatal crashes had been drinking despite being younger than the legal drinking age.

Figure 2-18 in Chapter 2 shows that the number of underage drinking drivers in fatal crashes declined somewhat more than that of other age groups between 1982 and 2005. The analysis of that reduction, shown in Figure 2-22, indicates that, although the number of licensed drivers younger than 21 also declined by 14% during that period, it did not account for the much larger relative reduction in underage drinking drivers in fatal crashes. Further, during the same period, the number of nondrinking drivers age 20 and younger in fatal crashes actually increased by 10%. Figure 2-22 traces the number of licensed drivers younger than 21, the number of drinking and nondrinking drivers in fatal crashes between 1982 and 2004, as a function of the level in the base year 1982. From the figure, it appears that the small reduction in the number of licensed drivers younger than 21 does not account for the large reduction in underage drinking drivers in fatal crashes. Further, the increase in nondrinking underage drivers in fatal crashes suggests that the reduction in alcohol-related crashes cannot be accounted for by other safety programs, such as seat belts, better roadways, and safer vehicles, that would benefit the sober drivers as much as the drinking drivers. This supports the belief that programs related to underage drinking and underage impaired driving effected impaired driving of youths age 20 and younger during that period, at least up to 1995 when all three trends in Figure 2-22 leveled off.

4.3.2. *The Relative Risk of Crash Involvement is Higher for Underage Drivers (see also Chapter 3)*

Drivers younger than 21 have less experience driving, less experience drinking, and less experience driving after drinking than older drivers. Research has indicated that young drivers are

more vulnerable to the impairing effects of alcohol than older drivers (Mayhew et al., 1986; Zador et al., 2000a; Keall, Frith, & Patterson, 2004). Peck et al. (2007) reanalyzed the case-control data collected by Blomberg et al. (2005) (see Chapter 3). Their research, consisting of 3,792 crash drivers and 7,582 matched controls collected in Long Beach, California, and Fort Lauderdale, Florida, from 1997 to 1999, indicated that drivers younger than 21 with a BAC level of .04 g/dL are at twice their normal risk for crash involvement; adult drivers showed no increase in risk at that BAC level. At a BAC level of .08 g/dL drivers age 20 and younger were at 37 times their normal risk compared to those age 21 and older who were at only 5.14 times their normal risk (see Figure 4-4).

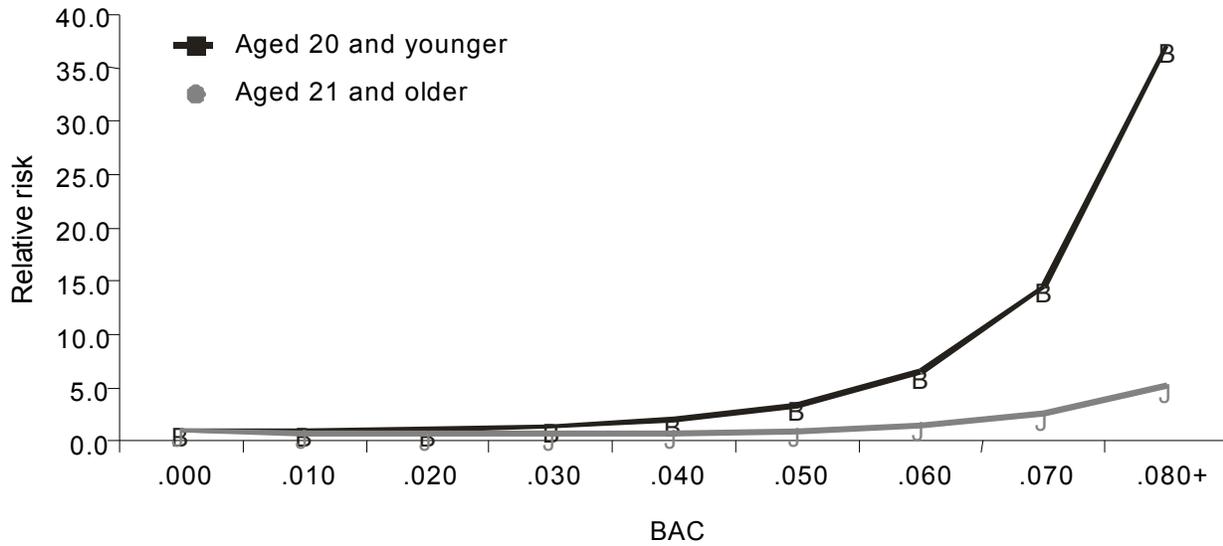


Figure 4-4. Relative risk for being involved in a crash. Comparison of drivers age 20 and younger and age 21 and older. Adapted from Peck (2007)

4.3.3. Factors Related to Teen Impaired Driving

4.3.3.1. “Transition Teens” Developmental Stage

In a recent publication presenting the development sources of crash risk in young drivers, Arnett et al. (2002) argued that “the difference between 16- to 17-year-olds and 18- to 19-year-olds is so stark that they should be considered to be in two separate periods of life ... for most young Americans, life changes in such important ways at age 18.” This suggestion—that the initiation of teen driving, which occurs between ages 15 and 17, may be the most important developmental stage between puberty and emerging adulthood—led McCarthy and Brown (2004) to propose that the period from age 15 through age 17 is critical in the lives of teenagers. They suggested that this period marks a very important transition for teens, the point at which they can drive on their own or with peers with the result that parental control over social behavior is greatly reduced and opportunities for risk-taking are greatly increased. They further noted that before this age, parents control travel decisions and the vehicle-dependent activities of the teenager. When a teen is licensed to drive, a substantial amount of control over his or her personal activities passes to the teen. Positively, this provides an important opportunity for growth in maturity that will be required when the individual leaves home 2 to 3 years later. Negatively, however, it also exposes the teenager to two new health risks. The first is the substantial risk of crash injury associated with being a novice driver or riding with one. The second is the potential for increased access to alcohol and drugs, for sexual risk-taking,

and for violence associated with the ability to travel to high-risk environments without parental supervision.

When McCarthy and Brown (2004) conducted a survey of 4,275 students in 9th through 12th grades in San Diego, they found support for their concept that the age of driver licensing is an important transition period and that obtaining a driver's license was associated with an increase in the frequency of both alcohol and substance abuse. This was not accounted for by a tendency for heavy drinkers to be more likely to seek a license. In fact, the study found that an increased perception of the dangerousness of alcohol was found among new drivers. Drinking-and-driving behavior increased as driving experience increased. The authors found some support for the hypothesis that the increases in usage frequency resulted from more opportunities for use and less parental monitoring.

Beck, Hartos, and Simons-Morton (2005) found that the degree of disagreement between a parent and a teenager about parental restrictions on driving and parent-imposed consequences for violations of driving rules were significantly associated with teen risky driving. Greater agreement regarding restricted driving conditions and consequences were associated with decreased driving risk (using a measure that included drinking and driving). As might be expected, they found that male teens were more likely to report risky driving; however, they also found that novice drivers with female parents had lower levels of risky driving, but the discordance between parent and teen was the most important predictor of risky driving. Sabel, Bensley, and Van Eenwyk (2004) found that parent, school, and community support were each significantly associated with *less* driving after drinking and that higher quantity and frequency of drinking, more smoking cigarettes and drug use, and less seat belt use were each associated with more drinking and driving.

4.3.3.2. Antecedents to Impaired Driving

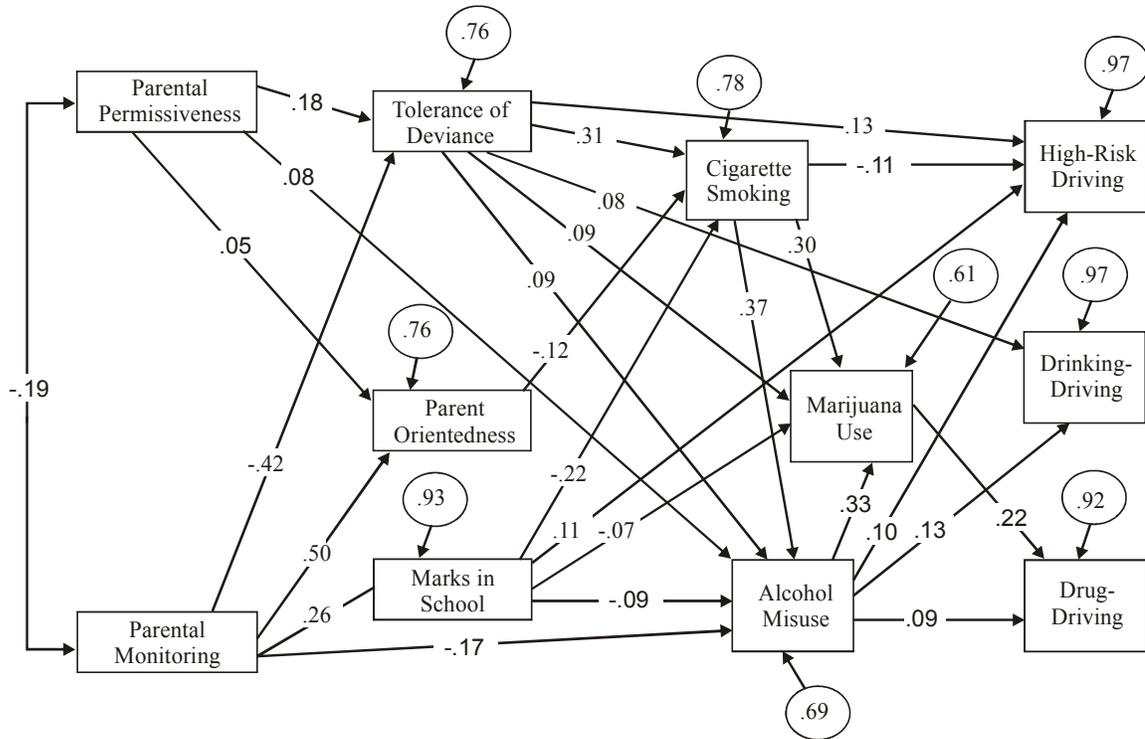
Using a sample from which data were collected in the early 1990s from school-age adolescents, researchers (Shope & Bingham, 2002) collected subsequent data from these same participants within 5 or 6 years beyond high school. These combined data were used to prepare a series of three published studies (Bingham & Shope, 2004a, 2004b; Shope & Bingham, 2002) on young adult drinking and driving. The first of the studies (Shope & Bingham, 2002) applied Problem Behavior Theory to models of problem driving and problem behavior to determine if the model applied to young adult men and women from the general population. The second study (Bingham & Shope, 2004a) identified some of the developmental, contextual, and behavioral aspects of antecedents to risky driving behavior and suggested that adolescents likely to engage in risky driving as young adults could be identified during adolescence based on these traits and could receive intervention for preventing such behavior. Finally, the third study in the series (Bingham & Shope, 2004b) examined a theoretical model to predict young adult problem driving, demonstrating differences in predictors of substance-related driving and risky driving.

Shope and Bingham (2002) conducted a study of problem driving and associated problem behavior in a sample (N=4,230) of young adults ages 21 to 28 (M=23.5, SD=.79). Although their sample did not include people to age 34, who were also included in the high-risk group, their study still informs research for the high-risk group. The authors applied Problem Behavior Theory (Donovan, 1993, in Shope & Bingham, 2002) to the study of drinking-and-driving and problem driving more broadly in a general sample of young men and women. As they described it, Problem Behavior Theory posits that people may demonstrate problem behaviors as they are “‘trying on’ alternative behaviors, roles, and attitudes, or in testing the limits of social norms” (p. 25). Using

structural equation modeling, a strong statistical method of both modeling and analyzing explanations of behavior, they found that drinking-and-driving behavior for both men and women was associated with other risky driving behaviors and with problem behaviors more generally. The authors suggested that knowing associations among such behaviors and their contributing variables can help predict drinking and driving in this population, as well as for both men and women. They further suggested that research is needed to heighten understanding of the developmental, contextual, and behavioral elements that may lead to drinking and driving.

In a followup study classifying participants from this same 2002 study into five groups related to type and level of risky driving, Bingham and Shope (2004a) extended this earlier research to examine antecedents of risky driving behavior among young adults (age $M=23.8$ years). They hoped further understanding of the antecedents to risky driving behavior would aid the understanding of developmental, contextual, and behavioral elements leading to drinking and driving and related risky driving. Findings from their longitudinal sample of more than 2,000 participants suggested that high-risk driving behavior in young adulthood, including alcohol-impaired driving, is preceded by illustrations of differences in developmental trajectories of the drivers in adolescence. For some participants, the trajectories demonstrating psychosocial adjustment patterns and substance use behaviors had diverged from those of age peers—illustrating poor adjustment and higher substance use—as early as the 10th grade and had peaked by the 12th grade, suggesting a need for targeted intervention in high school. People whose outcomes categorized them as drinking drivers, as high-risk drinking drivers, or as drugged drivers were most likely to have demonstrated these peer-divergent trajectories during adolescence; the lowest risk drivers at followup demonstrated the least psychosocial risk (e.g., better adjustment) and least substance use behavior. Clearly, problem behaviors, including risk for impaired-driving involvement, start early and need to be addressed by adolescence. The authors suggested a focus on early intervention, targeting driving and substance use behaviors, as well as a sense of belonging among teens, adherence to healthy social norms, and effective parenting to reduce subsequent risky driving.

The pattern of decreasing risk with increasing age established by the Zador et al. (2000a) study is reflected in the third study in the series (Bingham & Shope, 2004b). This study used the high school to young adult longitudinal dataset described previously and demonstrated a similar pattern to that found by Zador et al. Bingham and Shope concluded that the continued pattern of problem behavior, some of which included risky and alcohol-impaired driving, resulted from a continuity of behavior from adolescence, which was still being displayed in young adulthood. This was explained, in part, by an extended developmental period focused on adult role acquisitions (e.g., delayed by education, training) often seen in industrialized nations. Another key finding was that earlier parental influences (e.g., permissiveness, monitoring) played an important role in subsequent problem-driving behavior, including impaired driving. Overall, Bingham and Shope (2004b) found that less parental monitoring, less socialization against problem behavior in high school, and weaker bonds to conventional values and institutions predicted more substance-related problem behavior, including drinking and driving, suggesting the need for early intervention and prevention. Based on their data, they developed the model shown in Figure 4-5, which illustrates the role of parental permissiveness and monitoring in influencing impaired driving in novice drivers. The authors suggested that impaired-driving interventions should be initiated early, should target both risky driving and substance abuse in combination, should target family and social context infrastructures; and that specially designed interventions should be created for drugged driving, which was characterized as a unique and serious problem.



$\chi^2 = 61.67, df = 23, p < .000, RMSEA = 0.030, GFI = .99, CFI = .99$

Figure 4-5. Model of antecedents to drinking and driving. Adapted from Bingham & Shope (2004b)

Lewis, Thombs, and Olds (2005) reported that boyfriend-girlfriend alcohol use was the strongest predictor of alcohol-impaired driving. Gibbons et al. (2002) found that for teens, engaging in risky behavior (such as drinking and driving) is associated with a lowering of the perceived risk of that behavior. They also found that, for adolescents who tended to engage in social comparison, the more common they thought drinking and driving was among their peers, the less risk they attributed to the behavior (both personal and general). Perceptions of risk, in turn, were prospectively related to risk behavior (for all participants). Specifically, low-perceived risk, especially personal risk, was associated with an increase in drinking-and-driving behavior.

4.3.3.3. Driving Experience

Ballesteros and Dischinger (2002) conducted a study in Maryland and found that, *within* the age category of 16 to 21 years, younger drivers (i.e., 16-year-olds) have the highest rate of crashes per licensed driver and per annual miles driven. Inexperience, however, rather than intentional risky driving may account for the differing rates, as drivers closer to age 16 were involved in crashes under the safest conditions (during the day in clear weather while drinking *less*). Gonzales, Dickinson, DiGuseppi, and Lowenstein (2005) found that, when compared to older drivers, novice drivers (16-year-olds) are less likely to be involved in crashes caused by alcohol although they are at elevated risk due to recklessness. Mayhew and Simpson (1995) calculated the monthly crash rates of young novice Canadian drivers from the date at which they were first licensed. The results of his study are shown in Figure 4-6. As can be seen, the rate of crash involvement fell by 50% during the first 12 months of driving. Although inexperience reveals itself as a major contributing factor for crashes among this

young population, inexperience combined with alcohol use exacerbates the problem even further. Although not specifically investigating teenage drivers, Harrison and Fillmore (2005) used a driving simulator to experimentally demonstrate that alcohol use reduced driving precision among participants and that individuals with poorer baseline skill levels (e.g., less experienced drivers) showed greater impairments in response to alcohol.

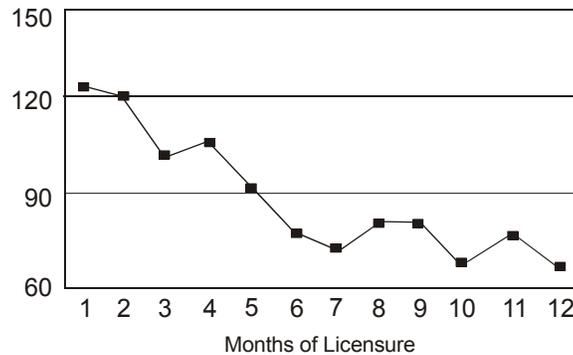


Figure 4-6. Novice drivers' risk versus experience. Adapted from Mayhew & Simpson (1995)

4.3.3.4. Drinking and Drug Use

Substance use and alcohol use are clearly associated with a risk of impaired driving. As mentioned earlier, Shope et al. (2001c) found that substance use (cigarettes, marijuana, and alcohol) reported at age 15 and negative parental influences (lenient attitudes toward young people's drinking; low monitoring, nurturance, family connectedness) increased the risk of serious driving offenses (including alcohol-related offenses) and serious crashes (including alcohol-related crashes) for both young men and women. Jelalian et al. (2000) found that self-reported alcohol use was associated with increased motor-vehicle crash risk among a sample of teenagers. Van Beurden, Zask, Brooks, and Dight (2005) found that heavy episodic (i.e., binge) drinking is a predictor of dangerous drinking-and-driving behavior beyond the sensation-seeking personality, although that personality type is related as well.

Bingham and Shope (2004b) found that higher levels of alcohol misuse among adolescents, as well as marijuana use and tolerance of deviance, predicted drinking-and-driving and drugged-driving at followup. Greater alcohol misuse, less cigarette smoking, greater tolerance of deviance, and better school performance predicted risky driving. The authors emphasized the qualitative difference between (1) substance-related driving behavior (which is strongly socially prohibited, and this prohibition is reinforced by general agreement regarding the grave nature of these behaviors), and (2) risky-driving behavior (which is less strongly prohibited by social norms, occurs more frequently, and is seen among a much larger proportion of drivers than substance-related driving behaviors).

Stoduto and Adlaf (2001) developed a typology of adolescent drinking drivers and identified correlates for each type. "Marginal drinkers" were characterized as having the lowest proportion of males, and the lowest delinquency, alcohol use, crash involvement, drinking-and-driving frequency, and consequence experience. "Heavy drinkers" consisted of the greatest proportion of males, heaviest alcohol use, greatest driving exposure, highest drinking-and-driving frequency, few drinking-and-driving convictions, and no drinking-and-driving crashes. "Delinquents," less common than the other two types, consisted of the highest delinquency, crash involvement, drinking-and-driving crashes and

convictions, and the least driving exposure. The authors suggested tailoring prevention efforts to better fit each subtype; however, it seems that replication of their results is necessary before adopting their typology for future purposes.

4.3.4. *Legal Countermeasures for Teen Drinking* *(more details are presented in Chapter 5)*

4.3.4.1. Minimum Legal Drinking Age Laws

The primary countermeasure for teen drinking has been the State MLDA laws that consist of some 20 measures prohibiting sales of alcohol to youths age 20 and younger and laws prohibiting youths from purchasing or attempting to purchase alcohol and other measures, such as those banning the production of fake IDs (Fell, Voas, & Fisher, 2006). Despite lax enforcement (Wolfson, Wagenaar, & Hornseth, 1995; Wolfson et al., 1995; Wagenaar & Wolfson, 1994), these laws have effectively reducing teen drinking and teen impaired driving (Grube & Nygaard, 2005; Shults et al., 2001; Voas et al., 2003b). The use of underage sting operations effectively reduces sales to underage-appearing pseudopatrons, but the deterrent effect of enforcement is transitory and must be reinforced periodically (Wagenaar, Toomey, & Erickson, 2005b).

4.3.4.2. Zero-Tolerance Laws

Laws that ban driving by youths age 20 and younger with any amount of alcohol in their bodies have effectively reduced alcohol-related fatal crashes in that age group (Grube & Nygaard, 2005; Shults et al., 2001; Voas et al., 2003b). Evidence for the effectiveness of these laws is more fully presented in sections 5.3.5 and 5.3.6.

4.3.4.3. Graduated Driver Licensing

The rationale for GDL is based on reducing the high crash rate of novice drivers shown in Figure 4-6 by extending the period when the newly licensed driver must drive with an adult in the vehicle and by controlling the driving environment by delaying nighttime driving until the individual has accumulated substantial experience under safer daytime conditions. The GDL laws also provide for limiting driving with teen passengers who can be a source of distraction and who may possibly encourage risk-taking (Ferguson, 2003).

GDL systems in the United States vary widely, but typically they delay initial learners' permits until age 16. There is a required supervised learning stage of 6 months or more, followed by a provisional license period when the novice drivers begin to drive solo. During this time, they are restricted from carrying teenage passengers and from driving at night, typically between 11 p.m. and 3 a.m. There is strong evidence for the effectiveness of GDL laws (Baker, Chen, & Li, 2006), which is more fully discussed in section 5.3.1. Other potential countermeasure programs reviewed in previous SOK reports are describe in the following paragraphs.

4.3.5. *Driver Education Programs*

Newman, Anderson, and Farrell (1992) reported promising behavioral effects of an educational program targeted at 9th graders. Shope and associates (Shope, Copeland, Maharg, & Dielman, 1996) implemented and evaluated a program for high-school students. The Shope et al. (1996) paper is of special interest here, as it contains specific material on drinking and driving. The

program it addresses is a curriculum for prevention of alcohol misuse for 10th grade students that was developed, implemented, and evaluated through the 12th grade with 1,041 students from four school districts in southeastern Michigan. The students had participated in the prior Alcohol Misuse Prevention Study (AMPS) program for elementary school students previously described. As with the prior program, the curriculum emphasized social pressures resistance training, immediate effects of alcohol, risks of alcohol misuse, and social pressures to misuse alcohol. The curriculum involved five sessions of 45 minutes each.

The evaluation used self-reported data—knowledge, alcohol refusal skills, alcohol use, and alcohol misuse—obtained from surveys of the students. Shope and colleagues found significant positive program effects on alcohol misuse prevention knowledge ($p < .001$), alcohol misuse ($p < .02$), and refusal skills ($p < .09$). Gender differences over time were found on alcohol use, alcohol misuse, and driving after drinking, with boys' rates increasing more than girls'. The authors concluded that, despite high levels of alcohol use among high-school students, a 10th grade curriculum can result in some desirable effects, but they cautioned that “creative approaches are needed . . . especially for boys who tend to use and misuse alcohol at rates that increase more steeply than those of girls.” Interestingly, exposure to the 6th grade program, as well as the 10th grade program, did not result in better outcomes.

Shope et al. (2001c) examined the effects on subsequent driving of the AMPS 10th grade program. The study reported the findings of a randomized test on the effectiveness of the program among 4,635 tenth-grade students, 1,820 of whom were assigned to the intervention group and 2,815 to the control group. Both groups were followed for an average of 7.6 years after licensure, which typically occurred during or shortly after the 10th grade. Outcomes examined included alcohol-related and other serious offenses and at-fault, single-vehicle, and alcohol-related crashes. The authors found that only serious offenses (which included alcohol-related offenses) had a significant treatment effect (statistically marginal) after adjustment for sex, age, race, alcohol use/misuse, family structure, presence of pre-license offenses, age of driver licensure, and parental attitudes toward teen drinking. The effect was found only during the first year of licensure. Also, two first-year serious offense interactions were found. The positive effect was strongest among the largest subgroup of students, those who were drinking less than one drink per week on average before the curriculum compared with those who drank more than one drink per week ($p = .009$). The effect was also stronger for the small subgroup of students whose parents had not expressed disapproval of teen drinking, compared with those whose parents had disapproved ($p = .004$). The authors concluded that their findings suggested that a high-school-based alcohol prevention program can positively affect subsequent driving, particularly for students who do not use alcohol regularly.

4.3.6. Alcohol Availability

Jones-Webb et al. (1997b) examined relationships among perceived alcohol availability, drinking location, alcohol consumption, and drinking problems. Their subjects were 3,372 adolescent drinkers, ages 16 to 18, who participated in the authors' Communities Mobilizing for Change on Alcohol Project baseline survey (p. 134). The authors found that perceived alcohol availability was significantly associated with higher levels of alcohol consumption for males. Drinking in a public location (such as a bar, restaurant, or party) was marginally associated with higher levels of alcohol consumption for females.

The *Cops in Shops* program for restricting alcohol availability for those age 20 and younger has been incorporated into several countermeasures programs in recent years. In the *Cops in Shops* program, officers in civilian clothes are stationed in retail outlets. If they observe underage people attempting to purchase alcohol, they issue appropriate citations. One evaluation of this countermeasure is of a youth-alcohol program in Salt Lake City, Utah (Lacey, Wiliszowski, & Jones, 2003). *Cops in Shops* was a major component of the Salt Lake City program, which also included working with Peer Leadership Teams engaged in anti-drinking activities (e.g., graduation, ribbon week, December anti-drunk-driving month activities, and Teen Courts for adjudicating drinking violations). A time-series evaluation of the program suggested a possible positive effect, gradually increasing to a 14% reduction in youth nighttime crashes after 3 years.

4.4. College Students

4.4.1. Student Drinking and Driving: Problem and Prevalence

Drinking among college students is a serious public health problem resulting in heightened risk of unintentional injury to self and others. Estimated alcohol-related deaths among college students ages 18 to 24 increased 5% from 1998 to 2001, a conservative estimate according to researchers, even after accounting for shifts in the population (Hingson, Heeren, Winter, & Wechsler, 2005a). First-year adolescent college students are particularly vulnerable to the exacerbation or “uptake” of high-risk drinking in particular, including drinking and driving, as they transition from high school to college and the increased independence from parents and home environments generally associated with that transition (Weitzman, Nelson, & Wechsler, 2003). College campuses, many of which are wholly or partly residential, offer a unique environment of underage and young adult peers who are learning adult roles and responsibilities. Some students see drinking alcohol as an expected part of college, a rite of passage, thus increasing the acceptance of risky drinking.

In recognition of the magnitude of the problem, NIAAA convened the Task Force of the National Advisory Council on Alcohol Abuse and Alcoholism. The work of this task force resulted in *A Call to Action: Changing the Culture of Drinking at U.S. Colleges* (NIAAA, 2002), a collection of the papers produced by the Task Force. These papers were published in a special issue of the *Journal of Alcohol Studies* (Supplement 14, March 2002) that focused specifically on the state of the science surrounding college drinking. Together, these publications provided both an overview and considerable detail regarding the extent, nature, and correlates of drinking and drinking problems among college students.

Much of the literature deals with heavy episodic or “binge” drinking. Binge drinking has now been officially defined by NIAAA (2004) as five drinks for male students and four for females within 2 hours (an amount that generally results in a .08 g/dL BAC level; see section 3.5). Wechsler et al. (Wechsler, Davenport, Dowdall, Moeykens, & Castillo, 1994; Wechsler, Molnar, Davenport, & Baer, 1999) used data from the 1993 Harvard School of Public Health College Alcohol Study to describe weekly alcohol consumption and its associated problems among a representative national sample of 17,592 students at 140 colleges. This study relied on self-reports by participants as does most literature related to college student drinking. In this study, as is standard practice in many alcohol-related studies, a drink was defined as either a 12-ounce can/bottle of beer, a 4-ounce glass of wine, a 12-ounce bottle or can of wine cooler, or a drink containing 1.25 ounces of liquor. Three categories of drinkers were analyzed: nonbinge drinkers, infrequent binge drinkers, and frequent binge drinkers. They found that the median number of drinks consumed per week by all students was .7 for those who

did not binge drink and 3.7 for those who did so infrequently. Frequent binge drinkers imbibed a median 14.5 drinks a week. By these researchers' definitions, nationally, 1 in 5 college students was a frequent binge drinker, and binge drinkers consumed 68% of all the alcohol that students reported drinking. Further, binge drinkers accounted for the majority of reported alcohol-related problems.

Data from the 1997 Harvard School of Public Health College Alcohol Study survey revealed a number of correlates of underage alcohol consumption and related problems (Wechsler, Kuo, Lee, & Dowdall, 2000). Compared to students age 21 or older, underage students (< 21 years) engaged in drinking less frequently but consumed more drinks per occasion and had a greater likelihood of drinking in private settings, which is not surprising as they cannot drink legally. Correlates of binge drinking overall included residence in a fraternity or sorority, easy access to alcohol, ability to obtain drinks at lower or set prices, and consumption of beer. Being male, White, Hispanic, or having parents with an annual income of more than \$60,000 have also been correlated with heavy episodic drinking (Kerber & Wallisch, 1999).

In their 2005 study, Hingson et al. (2005a) used multiple national data sources—including CDC, FARS, the College Alcohol Study, National Household Survey on Drug Abuse (NHSDA), national coroner studies, U.S. Census data, and college enrollment data—to derive estimates of the prevalence of student injuries related to college drinking. Hingson et al. estimated conservatively that there was an increase of 6% (from 1,600 to 1,700) in unintentional injury deaths among college students ages 18 to 24 between 1998 and 2001. In 1998, 2.3 million college students reported driving while under the influence of alcohol, and 2.8 million reported this behavior in 2001, a significant increase from 26.5 to 31.4% of college students reporting drinking and driving (Hingson et al., 2005a). Further, there was a “highly significant” (Hingson et al., 2005a, p. 266) increase of 18% in the number of students who reportedly drove under the influence of alcohol in the previous year. Although not statistically significant, the percentage of college student alcohol-related traffic fatalities increased approximately 5% from 1998 to 2001, from about 14.4 to 15.2 fatalities per 100,000 college students.

In an international study of drinking and driving reported by college students, Steptoe et al. (2004) found that driving-after-drinking rates were highest for both male and female students in the United States and for men in South American and Mediterranean countries. Their study had limitations related to the representativeness of their within-country samples. Still, their investigation points to the substantial problem with drinking and driving for students within the United States, particularly for college women in this country compared with college women in other countries.

4.4.2. Relationships of Impaired Driving to Student Characteristics and Behaviors

Studies have shown a number of variables covary with or predict drinking and driving among college students. Recent studies, reported over the past 5 years, are highlighted here. They demonstrate the relationships of impaired driving to student characteristics and behaviors.

4.4.2.1. Characteristics of College Students Who Drink

Paschall (2003) used data from the 1999 NHSDA to examine a sample (N=11549) of 18- to 25-year-old students (full-time and part-time) and similarly aged nonstudents who reported drinking in the past year. The study focused particularly on the differences and similarities between groups based on student status related to drinking and driving and seat belt use. Analyses demonstrated that all three

groups (full-time, part-time, and nonstudents) reported a similar age for initiation of alcohol use and a similar level of disapproval of drinking and driving (Paschall, 2003). They differed, however, in some important respects. Full-time students were more likely (34.2%) than part-time students (32.8%) to report drinking and driving in the past year. Further, full-time students were also more likely (54.4%) than nonstudents (50.4%) to report heavy drinking in the past month, and they were more likely to perceive higher levels of drinking among friends and a greater tendency to take risks than were nonstudents. Full-time students were more likely than part-time students or nonstudents to be female and non-Hispanic White. Students were more likely to be single than married. Full-time students were more likely to be unemployed than were nonstudents, but part-time students were more likely to be employed than were nonstudents. Full-time students tended to report lower personal income than nonstudents and were more likely (13.9%) than part-time students (< 1%) to live in group housing, such as college residence halls.

Perhaps surprisingly, when regression analyses were conducted rather than the simple examination of frequency, several key variables (place of residence, past month heavy drinking, friends' heavy drinking, risk-taking propensity, and disapproval of drinking and driving) that were expected to be related to impaired driving explained little of the differences in drinking and driving between the full-time and part-time student groups (Paschall, 2003). Further, living in residence halls and other group housing was unrelated to drinking and driving. Paschall (2003) found that students were more likely than were nonstudents to drink and drive, a high-risk behavior, and to report wearing a seat belt while traveling in a motor vehicle, a protective behavior. Understanding both the increased risk for impaired driving and the increased use of seat belts is important to the development of prevention and intervention of impaired driving and harm from impaired driving among college students (Paschall, 2003).

4.4.2.2. Age and Age of First Intoxication

Clapp, Shillington, Lange, and Voas (2003b) used a random sample (N=803) of students slightly older than the traditional age of college students at two Southwestern universities and self-report data to study of the modes of drinking and the modes of driving among college students. They found that age correlated with drinking-and-driving variables but was not predictive of the past 28 days of drinking and driving when examined using multiple regression. No interactions between age and other variables (i.e., alcohol consumption patterns or marijuana use) were found in post-hoc analyses. Their findings may have been specific to the slightly older (mean age = 25) sample of students in their study. Possibly, their findings might have been different with a younger, adolescent sample.

Usdan, Moore, Schumacher, and Talbott (2005) studied college students (N=91) from a single university who reported two or more drinking-and-driving episodes in the past month. Despite limitations of sample size and demographics (predominantly White and male), the researchers found that age was predictive of drinking location before a drinking-and-driving episode. Students age 20 and younger were more likely to drive after drinking at a friend's house, whereas those 21 and older were more likely to drive after drinking at a restaurant or bar.

Hingson et al. (2003) used data collected from 4-year accredited colleges by the 1999 College Alcohol Study (Wechsler, 1998) to examine the correlates of drinking and driving. Their sample included participants who were age 19 and older from 119 colleges. Although the response rate for the survey was only 60%, a followup shorter survey detected no significant differences between

participants and nonparticipants on relevant variables. They found that experiencing intoxication (i.e., being drunk) at a younger age was positively correlated with a number of subsequent experiences that increased the risks of alcohol use for this group. Compared to students who reported their first experience of being drunk at age 19 or older, those students who were first drunk at a younger age were significantly more likely to be alcohol dependent and frequent heavy drinkers as adults. Those who started drinking at the younger age were also more likely as adults to report driving after any drinking, driving after five or more drinks, riding with a driver who was impaired, and sustaining injuries in an alcohol-related crash that required medical attention (Hingson et al., 2003, p. 23). Contributing to their drinking and driving and their riding with drivers who were high or drunk was the belief held by participants first drunk at a younger age that “they could consume more drinks and still drive safely and legally” (Hingson et al., 2003, p. 23). This study highlighted the substantial vulnerabilities among college students who have experienced a first intoxication at a younger age. This study also found differences of college student drinking and driving that were related to age-of-drinking initiation that were similar to those found by Paschall (2003) who, as already noted, demonstrated older ages of drinking initiation across groups by student status (full-time, part-time, and nonstudent) predicted lower levels of drinking and driving.

4.4.2.3. Location of Drinking

Interestingly, Usdan et al. (2005) found that drinking before driving impaired occurred most often at a bar or at a friend’s house, whereas the highest BAC levels and the greatest number of drinks consumed before drinking and driving occurred when drinking at parties. As noted previously, some differences were evident based on gender and on age. Kulick and Rosenberg (2000) conducted a study of student drinking in which they found that the most common locations reported for drinking before driving were friends’ residences, bars or clubs, and the participants’ own residences. The same locations were also the most common destinations for travel after drinking. These authors found that nondriving destinations after drinking were most common (42%) at locations less than a mile from the drinking location. Driving after drinking was most common (40%) at destinations located between 1 and 5 miles from the drinking location. This last finding in particular suggests, for instance, that sobriety checkpoints might be most useful if located somewhere in the 1- to 5-mile range from these locations (e.g., student residences, bars, clubs, and restaurants). The Kulick and Rosenberg (2000) findings suggest that students sometimes drink before they depart from their residences and that impaired driving may occur on the way to other drinking destinations. Anecdotal stories from student affairs administrators, campus peer leaders (e.g., resident assistants), and students certainly reaffirm this. Students sometimes call this “pre-gaming” when they drink, sometimes heavily, before going places, particularly to places where they may have less access to alcohol (especially if they are underage) or where alcohol may cost more.

4.4.2.4. Motivations to Engage in or Avoid Drinking and Driving

Kulick and Rosenberg (2000) recruited 116 college students (age $M=25$ years, $SD=8.1$, somewhat older than the adolescent student) who drank at least four times monthly, had access to a motor vehicle on or near campus, and had a valid driver’s license. These students participated in a study of motivations for choosing to drink and drive or choosing not to drink and drive. The authors also included in the study the alternatives to drinking and driving and strategies for avoiding detection or arrest when driving after drinking as reported by participants. Most commonly cited by participants as reasons for not driving after drinking was the availability of alternate transportation (including use

of a designated driver) and the perception of self or the other driver as too intoxicated to drive, so they chose to walk. On the other hand, reasons participants most commonly cited for driving after drinking were the perceived need to get to their destinations, the perception of being minimally intoxicated, and the perception of being less intoxicated as compared to other potential drivers in the group. As the authors pointed out, these judgments about one's own perceived intoxication level can be risky and lead to impaired driving. Walking was most commonly cited alternative to driving after a drinking episode, with calling someone for a ride, riding with another driver from the drinking location, and calling a taxi also being commonly reported. Finally, driving more slowly or staying within the speed limit and using caution were the most commonly cited strategies for avoiding detection or arrest by police when driving after drinking; using back roads or side streets or doing nothing differently were also noted with some frequency. Participants reporting more intoxicated driving listed a larger number of strategies.

Kulick and Rosenberg (2000) found few significant correlations between impaired driving and the participant's background characteristics. Similarly, the characteristics of the drinking episode were generally not significantly related to the reasons for drinking and driving, the use of alternatives to driving, or the use of strategies to avoid detection. An important limitation of the study was that the 116 students in the study represented only 17% of the students the authors originally solicited. However, authors indicated that the participants were representative of the student body at the institution and of college students in national study samples. The authors noted that campuses present differing contexts, elements of which might offer different motivations and choices by students.

4.4.2.5 Motivations to Change Risky Drinking

Barnett et al. (2006) found that among college students, motivation to change drinking and heavy drinking habits following an alcohol-related incident was, as might be expected related to both the characteristics of the individual and the nature of the incident. They conducted a study (N=227) of college students required to attend an alcohol education program after an alcohol-related medical treatment and/or a disciplinary violation. They found that the greater the consumption of alcohol by the student, the greater the students' sense of responsibility for incident-related consequences whether harm to self or others. This in turn produced a greater sense of aversion toward the incident. They reported that that greater aversion toward an alcohol-related incident predicted a stronger motivation to change drinking behavior. They also found that students with a shorter history of heavy drinking and fewer associated problems were more likely to be motivated to change their drinking patterns than were students with longer heavy drinking histories and more associated problems. Thus they concluded that students with higher alcohol consumption who experience consequences of their drinking were less likely to find them aversive than were students with lower levels of alcohol consumption. Thus, the threshold for describing an incident as aversive was higher for students with higher consumption. This finding may be related to an increased acceptance and management of the immediate effect of consequences by students who drink more. As noted previously, the research demonstrated a significantly greater motivation to change for women in the study than it did for men.

4.4.2.6 Modes of Drinking

McCarthy et al. (2005) found, as might be expected, that college students who reported no consequences related to drinking and driving or to riding with a drinking driver also reported the lowest levels of alcohol use and the lowest levels of drinking and driving or riding with a drinking driver. This group significantly differed from those students reporting personal consequences (crash or

police involvement) who reported the highest levels of alcohol use, and with students who reported experiencing consequences vicariously through a friend who was drinking and driving. Their findings suggest that prevention targeted generally to highest risk drinkers and at students who report riding with friends who drink and drive should have the most potential to prevent drinking-and-driving consequences.

Kypri and Stephenson (2005) examined scores from the AUDIT (Alcohol Use Disorders Identification Test; see Saunders, Aasland, Babor, & De la Fuente, 1993) administered to 1,564 college students in New Zealand. They found that “hazardous drinkers, as defined by an AUDIT score of 8-14” (p. 220), were more than three times as likely to drink and drive as more moderate drinkers (AUDIT score of 1-7), whereas “harmful” drinkers with AUDIT scores of 15 or higher were more than five times as likely to drink and drive as moderate drinkers (p. 220). In addition, “harmful” drinkers were more than three times as likely to ride with a drinking driver as those who did not drink. Their findings point to the expected association between higher risk drinking and the extent of drinking and driving among college students. The AUDIT, which is widely used in the United States, makes this study more relevant to American college students. See section 3.6.1 for a fuller description of the AUDIT.

Clapp et al. (2003b) randomly selected 803 college students (age $M=25$ years, somewhat older than traditional college students) for participation in a cross-sectional telephone survey. They found alcohol consumption is significantly, though not strongly, related to their drinking-and-driving behavior index (DUIB), a sum of the scores for drinking and driving and for riding with a drinking driver. Clapp et al. found that past-year driving after drinking and regular access to a motor vehicle predicted 51% of the DWI behaviors. When predicting drinking and driving from alcohol consumption measures, drinks per occasion were less strongly related to reported driving after drinking than frequency of consumption, heavy episodic drinking, or variance in the amount of drinking at a session. However, once past-year drinking and driving and availability of a vehicle were accounted for, drinking variables were not significantly related to driving after drinking and marijuana use.

In this same study, Clapp et al. (2003b) found that past-month marijuana use significantly predicted drinking and driving and was a stronger predictor of the drinking-and-driving index used in the study than were age, gender, and vehicle access. The authors also found that more marijuana use was positively associated with higher alcohol use (i.e., frequency, drinks per occasion, heavy episodic drinking, and variance of drinking). Riding with a drinking driver was also predicted by frequency of marijuana use and was less strongly predicted by alcohol consumption in their study.

4.4.2.7 Consequences and Cognitions of Drinking and Driving

Research in which college students ($N=938$) completed surveys in introductory psychology classes found that risky attitudes toward drinking and driving, perceptions of the drinking and driving of other students, and potential alternatives to drinking and driving were not substantially modified by the experiencing of negative consequences of drinking and driving or riding with a drinking driver (McCarthy et al., 2005). Even though experiencing the consequences of drinking and driving (one’s own or as a rider) did not contribute to reduction in risky cognitions about drinking and driving, the authors did find that experiencing a personal consequence such as crash or arrest might increase appreciation of the potential for such consequences. In their study of perceptions of legally permissible levels of alcohol use, Kypri and Stephenson (2005) reported that New Zealand college student

participants (N=1564; age $M=20.5$) “dramatically” (p. 219) underestimated how much they could drink in one hour and still be lower than the legal limit, which is .08 g/dL for those 20 and older and .03 g/dL for those younger than 20. Further, only 5.8% overestimated the amount of alcohol they had consumed. The authors suggest the underestimated misperception is actually a benefit to public health. Of importance, most of the participants who overestimated how much they could legally drink were younger than 20, so that the .03 g/dL limit applied to their legal limit. The authors suggest that this indicates the need for an educational awareness intervention for this age group. However, overestimates of legally permissible drinking in an hour’s time were not related to drinking and driving or riding with a drinking driver as reported by participants. Kypri and Stephenson (2005) pointed out that their study demonstrated high rates of underestimates for the number of drinks needed to produce a legally impaired BAC level, whereas Johnson and Voas (2004) demonstrated high rates of overestimates for the number of drinks needed to produce a given BAC level (self-report estimates were gathered before breathalyzer data collection). “Together, the studies reveal a poor ability of drinkers to estimate their intoxication levels” (p. 223).

4.4.2.8 *Countermeasures*

A number of intervention programs have been implemented by universities to reduce the drinking and the drinking-and-driving risks of college students. These include brief interventions, educational programs, social marketing, impaired-driving enforcement, and designated-driving programs. These are described in Chapter 5.

4.4.3. *Summary*

An unfortunate part of the history of U.S. colleges has been the development of an environment that fosters a high level of alcohol consumption, as evidenced by the “Monitoring the Future” study (O’Malley & Johnston, 2002) that found high-school students who attend college drink more than those who go into the workforce. This problem has received considerable attention since the last State of Knowledge report and a number of promising programs have been tested (NIAAA, 2002). Clearly, however, the college-drinking problem is a pervasive environmental issue that requires a campus community effort to control. The current attention being given to the problem provides hope that the substantial human loss in alcohol-related injuries and deaths of college students described by Hingson et al. (2002) can be reduced in the years ahead.

4.5. **High-Risk Drivers (Ages 21 to 34)**

4.5.1. *Problem and Prevalence*

Young adult drivers ages 21 to 34 are a particularly high-risk group for involvement in impaired-driving crashes. The National Center for Injury Prevention and Control (CDC, 2000, in Bingham & Shope, 2004b) has rated motor-vehicle crashes as the most common cause of fatalities among drivers younger than 35, and many of these fatalities involve alcohol. Kennedy et al. (1996) found that 70% of fatally injured male drinking drivers in FARS were 21 to 39, with 65% of them having a BAC level of .15+ g/dL. Using data from the 1996 NRS and FARS, Zador et al. (2000a) have shown that males ages 21 to 34 with BAC levels of .08 to .09 g/dL are 13 times more likely to be killed in a single-vehicle crash than sober male drivers of the same age. Moreover, at BAC levels equal to or greater than .15 g/dL, these 21- to 34-year-old males were 573 times more likely than a 21- to 34-year-old male driver with a BAC = .00 g/dL to be killed in a single-vehicle crash. There was

generally a lesser risk for women than for men. Abdel-Aty and Abdelwahab (2000), in their study of 1994-1995 crash data from the Florida Department of Highway Safety and Motor Vehicles, found that out-of-State drivers age 34 and younger consistently demonstrated higher alcohol/drug traffic crash involvement than other groups and that the 25-to-34 age group experienced the highest crash rate in general.

In a review by Liu et al. (1997) of the BRFSS, alcohol-impaired driving was found to be most frequent among males ages 21 to 34 (1,739 episodes per 1,000 adults) compared to the average of 655 episodes per 1,000 adults for all ages. In a survey of 750 men ages 21 to 34, 230 were found to be binge drinkers by Nelson, Kennedy, Isaac, and Graham (1998). Those binge-drinking males were three times more likely than non-binge-drinking males to feel safe driving after consuming six or more drinks. Based on their survey, Kennedy, Isaac, Nelson, and Graham (1997) found that 55% of the 21- to 34-year-old males reported having been the target of an intervention to prevent them from drinking and driving.

4.5.2. Factors Influencing 21- to 34-Year-Old Drinking Drivers

In a recent study in New Zealand, Morrison, Begg, and Langley (2002) compared drinking-driving incidents (N=87) and sober-driving incidents (N=663) among 750 young adults (age 26 years). They examined personal and situational influences on each type of incident. The data demonstrated that drinking-and-driving incidents were more likely associated with driving alone, not making advanced plans for travel, drinking after work, driving to a drinking event, and drinking in bars. Further, about 25% of those people reporting drinking-and-driving incidents had also used marijuana and/or LSD at the drinking event. In fact, marijuana dependence at age 21 was significantly predictive of drinking-and-driving at age 26, as were being male or unmarried, having a lower socioeconomic status, having a lower educational level, and being alcohol-dependent. Morrison et al. (2002) suggested that interventions might focus on discouraging driving to drinking events and enforcement near bars.

In another study (Fabbri et al., 2005) in Italy, risk factors for predicting the recurrence of motor-vehicle crashes were examined. They found that being age 32 or younger, male, driving at night, and having a BAC level greater than .05 g/dL each predicted crash recurrence. They found that when other variables were controlled, BAC level was the most significant predictor being treated in an emergency room for a crash-related injury.

4.5.3. Gender

Men drink more than women as shown by data from the 2001 NESARC provided in Figure 4-7 by Chen et al. (2007). Consumption levels decline with age, consistent with the lower alcohol-related crash rates, also shown in Figure 4-7.

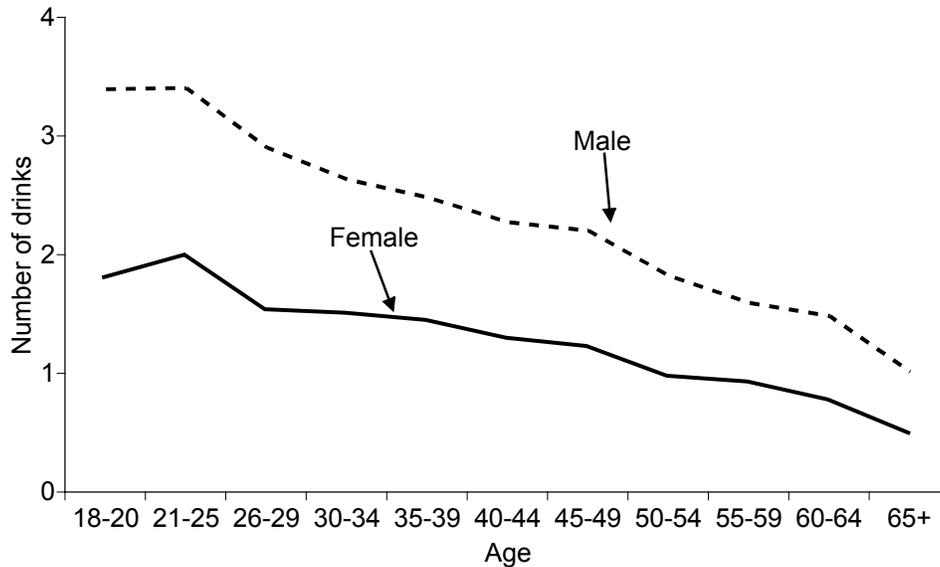


Figure 4-7. Number of drinks per typical occasion by gender and age. Adapted from 2001-2002 NESARC, Chen et al (2007)

Kypri and Stephenson (2005), in a study of 1,564 university students in New Zealand, found that men (8.4%) were more likely to drink and drive than women (3.4%) and to ride with a drinking driver (men, 11.5% versus women, 7.0%). Compared to men, women in their study were also more likely to overestimate the amount of alcohol they could consume in an hour and still drive legally. Contrary to Paschall's (2003) results, they found that drinking and driving by part-time and full-time students did not differ by gender.

In a study of college students at high risk for drinking and driving (i.e., reporting two or more episodes in the past month), Usdan et al. (2005) found that men were more likely to drink at a friend's house before driving, whereas women were more likely to drink at a bar or restaurant before driving. Men also drank more than women before driving, averaging 5.62 drinks versus women's 4.08 drinks per drinking-and-driving episode. The estimated BAC levels across locations did not differ significantly by gender, which was likely due to metabolic and body mass differences between men and women (Usdan et al., 2005).

Barnett et al. (2006), in their study of students experiencing recent alcohol-related incidents, found that women were more motivated to change heavy drinking behavior than men and that both men and women were more motivated to change drinking habits when consequences were perceived as aversive. Timmerman, Geller, Glindermann, and Fournier (2003) found in their study of designated drivers that women were more likely to serve as designated drivers and to have a lower BAC level than men who were designated drivers. They suggested that having a male designated driver might not prevent drinking and driving. McCarthy, Pedersen, and Leuty (2005), in a study of college students' cognitions about drinking and driving, found men were significantly more likely to report being a driver in an alcohol-related crash, but they found no gender differences in reported experiences with police or in riding with a friend who was in a crash or was stopped by police.

Because FARS provides a BAC measure on every driver in a fatal crash, it is possible to contrast drinking and nondrinking drivers in fatal crashes by age, as was shown in Figure 2-12 in

Chapter 2. This is done for males and females separately in Figures 4-8 and 4-9. The number of crash involvements per billion miles of travel determined from the Nationwide Personal Transportation Survey (FHWA & BTS, 1990), which represents U.S. drivers and was conducted by the Federal Highway Administration, is shown for males and females in age groups from 16 to 20 to 70+ for zero and for positive BAC-level drivers in fatal crashes from 1990 to 1994 Voas, Tippetts, and Fisher (2000c, 2001). The mileage fatality rates for both male and female nondrinking drivers (Figure 4-10) forms a U-shaped across age groups reflecting inexperience and risk taking among the underage drivers and deteriorating driving skills and increased vulnerability in the older driver age group. Of particular interest is that the crash rates per vehicle mile for males and females are basically similar. In contrast, the age distribution for male and female drinking drivers in fatal crashes is L shaped, with the highest rates occurring at the youngest ages. For drinking drivers in crashes the mileage crash rates for females is substantially lower than that for men. When the drinking crash involvements are presented as a ratio to the non-drinking involvements (Figure 4-3c) the age distribution results in an inverted U form with female ratios substantially below those of males.

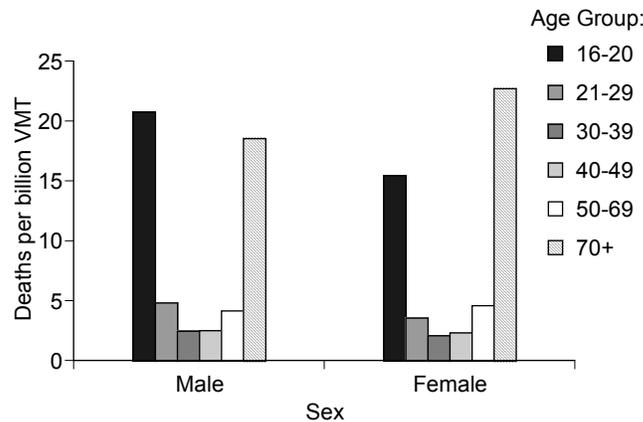


Figure 4-8. Mileage involvement rate for nondrinking male and female drivers in fatal crashes, FARS, 1990-1994

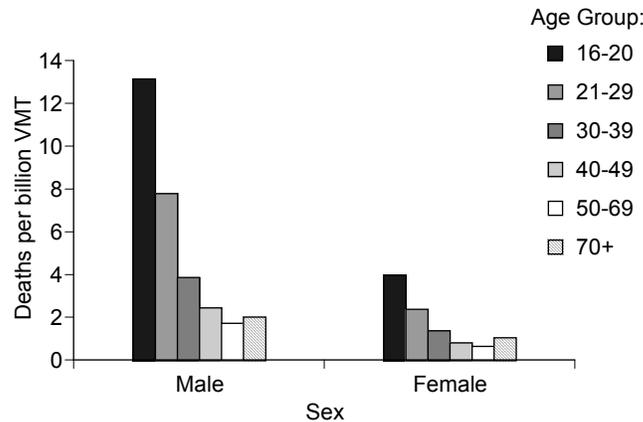


Figure 4-9. Mileage involvement rate for drinking male and female drivers in fatal crashes, FARS, 1990-1994

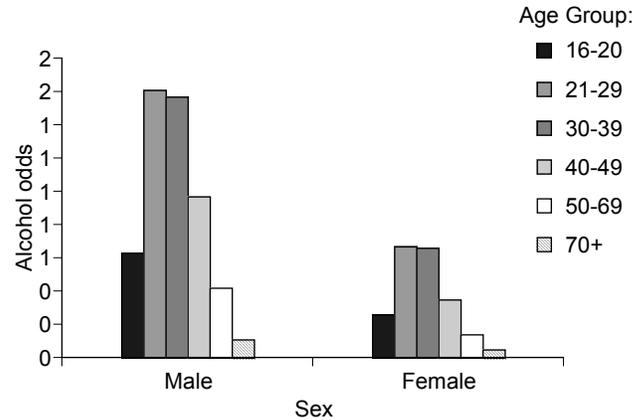


Figure 4-10. Odds of being in an alcohol-related crash for male and female drivers, FARS, 1990-1994

Midarik and Clark (1994) showed that the differences in the percentages between men and women increased with drinking frequency and quantity of drinking. A survey reported by Balmforth (1998) found that 74% of problem drinkers were male, and a Canadian survey reported by Cochrane, Goering, and Lancee (1992) found that problem-drinking rates for men are approximately six times greater than for women. Other recent research corroborates findings that females are generally at lower risk for alcohol impaired driving than males: Abdel-Aty and Abdelwahab (2000) investigated crash rates in Florida and found that male drivers experienced higher alcohol and drug-related crash rates than females for all age groups. The male crash rates were consistently about four times that of females. Furthermore, male drivers tend to have higher proportion of crashes while driving under the influence (especially alcohol). Fabbri et al. (2005) found that alcohol use and gender were among the strongest predictors in multiple crash involvement among more than 2,000 crash victims treated at emergency departments, with males being associated with higher rates of a recurrent crash.

Chou et al. (2005) analyzed national survey data and found that males were significantly more likely to operate a motor vehicle after drinking too much than were females (4.4% versus 1.5%), a ratio of about 2.93. However, they investigated changes in prevalence of driving after drinking between 1992 and 2002 and found that declines in driving after drinking were observed among males (5.8% versus 4.4%), but there were no significant changes in the rate of driving after drinking observed among females. Thus, generally, the male-female differentials in the rate of driving after drinking decreased over the past decade.

Several studies have investigated which correlates of impaired driving differ among men and women. For example, Elliott, Shope, Raghunathan, and Waller (2006) found that the associations between high-risk driving and substance use were generally stronger among women than among men. When matched by substance-use profiles, women had fewer risky-driving incidents than men. The results indicated that young women who exhibited high-risk driving behavior deviated more from the general population of young women regarding alcohol use, alcohol misuse, and marijuana use than high-risk driving behavior of young men differed from other young men in general. The authors further suggested that even if young men and women were to eventually have equal levels of substance use, women would likely retain their lower-risk driving profiles.

Lapham, Skipper, Hunt, and Chang (2000) found that female DWI offenders had disproportionately lower recidivism rates than males (especially young males). Male and female DWI offenders, however, had many similar characteristics, such as ethnicity, education, arrest BAC level,

lifetime use of several drugs, and physical abuse before age 18. There were also some important gender differences: more than twice as many males as females had a prior DWI arrest; females had a higher number of risk factors than males; a higher proportion of females had more than 5 risk factors than males; females were more likely to have had a parent who had a problem with alcohol; and a smaller proportion of female drivers were referred to court-mandated treatment programs. Despite differences in the offender sample, risk factors for DWI *re-arrest* were similar for males and females, except that young age predicted higher recidivism among males but not females. The authors concluded that young males are at particular risk for DWI re-arrest, but differences in risk factors do not account for gender differences found in re-arrest rates.

Dowdall, Crawford, and Wechsler (1998) studied data from a survey of 508 students at women's colleges and 9,624 students at coeducational colleges. They found that women at women's colleges binged less frequently, had fewer alcohol-related problems, experienced fewer negative effects of others' drinking, and were less likely to drink and drive. The researchers hypothesized that self-selection factors at women's colleges may contribute to a healthier environment for women. Jones-Webb et al. (1997b) found that drinking in a public location, such as a bar, restaurant, or party, was marginally associated with higher levels of alcohol consumption for females.

Robinson (1998) analyzed 1992 and 1993 United States Department of Education CORE Survey data and concluded that, despite their predominately occasional and moderate drinking, female students were still similar to men in suffering several negative consequences, such as memory loss, thoughts of suicide, arrest for drinking and driving, or missing classes. The authors concluded that females use less alcohol than males but suffer similar negative consequences, and therefore, male and female undergraduates need similar alcohol intervention and prevention programs.

Marelich, Berger, and McKenna (2000) surveyed California drivers and found that self-reported drinking-and-driving violations showed a substantial decline for both men and women across the survey periods (1986-1994), although violations remained much higher for men, paralleling the well-documented drop in alcohol-related traffic crashes during that time span. Men and women responded equally to the threat of punishment from the legal system (threat of arrest, jail, loss of license, fine, increased insurance), but women were much more responsive to social and internal controls, such as perceived disapproval from friends, feelings of guilt, and violation of a moral standard.

4.6. Drivers of Diverse Ethnicity

There is strong evidence suggesting that race and ethnic groups show dissimilar vulnerability to impaired driving. Such strong evidence has been acquired despite a lack of consensus about what constitutes a race or an ethnicity or on how each group should be named. According to Hahn and Stroup (1994), there is ambiguity regarding the criteria of group membership that results in "fuzzy group boundaries" rather than specific and mutually exclusive racial and ethnic categories. Many individuals also have trouble identifying themselves with the concepts of race and ethnicity as understood by health researchers (Moscou, Anderson, Kaplan, & Valencia, 2003; Beal et al., 2006). Perhaps due in part to sample size restrictions, research on traffic crashes has usually focused on the following five racial/ethnic groups: American Indians or Native Americans, African Americans or Blacks, Asians and Pacific Islanders, Hispanics or Latinos, and Whites (with all groups other than Hispanics being non-Hispanics). In this report, we also focus on these five groups, with the understanding (1) that any group other than Hispanics or Latinos are non-Hispanic, and (2) that use of

labels—such as African Americans and Blacks, Hispanic and Latinos, or Native Americans and American Indians—are interchangeable.

Measuring the role of race/ethnicity on traffic safety requires not only an operational separation between groups, but also within groups. Racial/ethnic groups are not homogeneous. Important variation in rates of alcohol-consumption and alcohol-related problems occurs within racial/ethnic group by country of origin, gender, acculturation level, or country of origin. For instance, there is consensus that Vietnamese Americans and Cambodian Americans tend to drink much more than Chinese, Japanese, Korean, and Filipino Americans (e.g., Dawson, 1998; Makimoto, 1998); Navajos more than Hopis (e.g., May, 1982; Mail & Johnson, 1993); and Mexican-American men more than Puerto Rican or Cuban men (e.g., Aguirre-Molina & Caetano, 1994). As Caetano, Clark, and Tam (1998) warned: “studies often do not take into consideration the variability that exists within each ethnic group, resulting in inaccurate generalizations.”

4.6.1. Health-Related Disparities Affecting Racial/Ethnic Groups in the United States

The 2005 *National Healthcare Disparities Report* (DHHS, 2005) shows that disparities related to race and ethnicity “still pervade the American health care system.” Members of racial and ethnic minorities in the United States, particularly African Americans, Hispanics, and Native Americans have poorer health than their White counterparts (Schultz et al., 2000; Hummer, 1996; Krieger et al., 1993). Some of the disparities affecting these groups include the prevalence of diseases, such as cancer, cardio-vascular diseases, obesity, diabetes, HIV/AIDS, infant mortality, and alcohol-related injuries (e.g., DHHS, 2000; Leigh & Jimenez, 2002; Jones-Saunty et al., 2003; CDC, 2005; DHHS, 2005). Asians, however, are usually viewed as a “model minority.” Such stereotyping ignores the variation existent between Asian subgroups and the vulnerability some of these subgroups are facing (Varma, 2001).

It is broadly agreed that inequalities in socioeconomic status, such as income and education, explain many health disparities in the United States. Population groups with poor health status tend to be those with the lowest SES (e.g., Feinstein, 1993; House et al., 1996). SES alone, however, cannot explain some of the observed health disparities (e.g., Herd, 1994; Buka, 2002). Cultural-based values and perceptions also play a role in shaping health-related disparities. For instance, African Americans and Hispanics, more than Whites, believe that their health is dependent upon fate and destiny (e.g., Lewis & Green, 2000). Such fatalism (or external locus of control) contributes to disparities in seat belt use. Although fatalism might also be partially responsible for perceived differences in drinking and driving between African Americans, Hispanics, and other racial/ethnic groups, it has not yet been clearly proven.

4.6.2. Race/Ethnicity and Alcohol Consumption

There is strong consensus that alcohol abstinence is high among Asians and low among Whites. Reports based on the 2000-2005 SAMHSA’s NHSDU have consistently indicated that Whites show the highest prevalence of current (past year and past month) use of alcohol among adults (age 18 and older) from all racial/ethnic groups. Rates of past-month or past-year alcohol use are the lowest for Asians and African Americans, intermediate for Hispanics and Native Americans, and highest for Whites. For multiracial groups, their rates of current alcohol use were consistently high, close to that of Whites. Asian/Pacific Islanders and African Americans also report the lowest prevalence of current (past-month or past-year) alcohol consumption among individuals ages 12 to 17.

Among those who drink, some studies report that rates of binge and heavy drinking are highest among Native Americans, followed closely by Hispanics and Whites, with African Americans and Asians showing the lowest rates of binge and heavy drinking. A similar picture was reported by other researchers (e.g., French, Finkbiner, & Duhamel, 2002; Herd, 1990). Many other researchers, however, question the relatively low involvement of African Americans in heavy drinking and binge-drinking events (e.g., Dawson, Grant, Chou, & Pickering, 1995; Caetano & Kaskutas, 1995; Dawson, 1998). In his review of the literature, Wallace (1999) agrees with the characterization of African Americans as showing a high frequency of heavy drinking occasions. The author suggested the apparent paradox of African Americans and Hispanics showing alcohol prevalence rates comparable (or lower) than those of Whites, yet simultaneously being overrepresented in alcohol-related problems. The author subsequently postulated the notion that there are “two worlds” of alcohol use among African Americans and Hispanics: the largest group is relatively light drinkers and a much smaller group of heavy drinkers.

4.6.3. Race/Ethnicity and Impaired Driving

Information on the role of race/ethnicity on impaired driving shows Native-American and White drivers are consistently among those most at risk of impaired driving, whereas Asians are among the least vulnerable. For Hispanics and African Americans, the picture is less clear, with arrest and crash data showing an overrepresentation of both groups in impaired-driving events, whereas data from national surveys show smaller rates of impaired driving for these groups.

Table 4-1.

Motor-vehicle crash fatalities and alcohol-related fatalities by year and race/ethnicity

Year	Fatalities											
	Total		African Americans		Asian/Pis		Hispanics		Native Americans		Whites	
	N	% A/R	N	% A/R	N	% A/R	N	% A/R	N	% A/R	N	% A/R
1999	41,717	33.2%	4,478	28.3%	744	13.8%	3,964	32.6%	645	44.2%	25,504	27.7%
2000	41,945	35.1%	4,202	32.3%	744	16.6%	3,459	33.9%	609	42.9%	24,596	29.0%
2001	42,196	35.0%	4,552	29.9%	869	15.8%	4,602	34.6%	580	47.2%	26,242	29.6%
2002	43,005	35.0%	4,654	30.9%	817	14.7%	4,928	34.3%	653	48.2%	27,586	29.6%
2003	42,884	34.5%	4,736	28.4%	856	13.7%	5,145	34.0%	650	45.3%	27,914	29.3%
2004	42,636	34.0%	3,951	30.1%	431	16.9%	3,227	31.0%	582	43.8%	22,894	28.2%
2005	43,443	34.6%	3,678	29.3%	395	19.1%	2,838	31.0%	534	49.6%	21,337	29.2%

Source: PIRE computations based on FARS data. Fatalities include all types of road users (i.e., all records showing variable inj_sev = 4 are included). Variables “Race” and “Hispanic” in FARS were used to define race/ethnicity. Information on race and ethnicity was absent from FARS before 1999. Racial/ethnic groups other than Hispanic are considered non-Hispanic. Because information on race/ethnicity was not provided to all fatally injured victims, adding fatalities for separate racial/ethnic groups does not match the total number of fatalities (i.e., column “N” for “Total” also includes records with missing race/ethnic information). BAC information was provided by FARS, either through a direct measurement or through multiple imputation. A motor-vehicle crash is considered to be *alcohol-related* if at least one driver or nonoccupant (such as a pedestrian or pedalcyclist) involved in the crash is determined to have had a BAC level of .01 g/dL or higher. Records with missing BAC information (neither directly measured nor imputed) were not included in computing percentages of alcohol-related crashes (%A/R).

There is clear evidence of the existence of disparities in the involvement of racial and ethnic groups in fatal alcohol-related crashes. Table 4-1 illustrates the disparities associated with fatal crashes. The publicly available FARS files with ethnicity information date only from 1999. Table 4-2 provides estimates of the prevalence of impaired driving obtained from 11 selected studies from

varying sources (telephone surveys, roadside surveys, and crash data); this table also shows measures of impaired driving, years, age, and gender. Table 4-2 provides a snapshot of impaired driving coming from self-reported surveys (the five top sources in Table 4-2 differ somewhat from that obtained from roadside surveys and crash data). Studies based on self-report data show impaired driving to be most prevalent among Whites and Native Americans, the least prevalent among Asians, and intermediate (or low) prevalence among African Americans and Hispanics.

Studies based on roadside surveys or crash data differ from self-report surveys in that they show a much larger prevalence of impaired driving among African Americans and Hispanics relative to that for Whites. Table 4-2 shows that, according to the 1996 roadside survey, there was a large overrepresentation of Hispanics and African Americans among drivers with BAC levels of .05 g/dL or higher. The roadside surveys also show that although the prevalence of drivers with BAC levels of .05 g/dL or higher have declined over time, such a decline has been steeper for Whites. This finding subsequently suggests an increasing relative overrepresentation of African Americans and Hispanic drivers in impaired-driving situations over time. The analysis by Voas, Wells, Lestina, Williams, and Greene (1998b) of this data set showed that, in 1996, the odds for an African-American driver to have a BAC level of .05 g/dL or higher were about the same as the odds for Whites, but the odds for Hispanics were 1.7 times the odds for Whites.

Using more recent and comprehensive datasets, Voas, Tippetts, and Fisher (2000c) used the 1990-1994 FARS, and Hilton (2006), the 1999-2004 FARS, to investigate the role of drinking and driving on fatal crashes across racial/ethnic groups. As shown in Table 4-2, Native Americans have the highest percentage of alcohol-involved driver fatalities of any ethnic group. Hilton (2006) reported that Hispanics and Native Americans are overrepresented in fatal crashes in which the driver had a BAC level of .08 g/dL or higher. Although not shown in Table 4-2, Voas et al. (2000c) investigated the prevalence of alcohol-related fatal crashes among Hispanics from different countries of origin. The authors found that among Hispanics, Cuban Americans stood out for their low percentage of alcohol-related fatalities. Next to Native Americans, Mexican Americans had the highest alcohol-related fatality rates among all four types of road users: drivers, passengers, pedestrians, and cyclists. This was true for both men and women. African-American drivers had the same rate of alcohol involvement as Whites, even higher for those older than age 40. Asians/Pacific Islanders had distinctly lower rates of alcohol-related fatalities. This review shows that the rate of impaired driving for Hispanics and African Americans relative to that for Whites is smaller when the estimate is based on self-reported surveys rather than when collected by archival data. These findings are coincidental to the findings reported by Ross, Howard, Ganikos, and Taylor (1991).

Table 4-2.

Prevalence of impaired driving by race/ethnicity as estimated by 11 studies

Source	Age	Measure	Years	Gender	Racial/Ethnic Group					Ref.
					Afr. Am.	Asian	Hisp.	Nat. Am.	White	
BRFSS	18+	Drink and drive in past month	1993	both	1.5%	*	1.9%	*	2.6%	Quinlan et al. (2005)
			1995	both	1.5%	*	2.3%	*	2.4%	
			1997	both	1.3%	*	2.3%	*	2.2%	
NAS	18+	Drunk enough to be stopped by police in past year	1995	males	14.0%	*	21.0%	*	22.0%	Caetano & Clark (2000)
				females	3.0%	*	6.0%	*	7.0%	
		Arrested for DWI in past year	1995	males	1%	*	4%	*	1%	
				females	0%	*	0%	*	0%	
		Ever in a car when driver drank too much in past year	1995	males	14%	*	15%	*	10%	
				females	13%	*	11%	*	10%	
NSDDAB	16-64	Drove within 2 hrs of drinking in past year	1993-1997	both	16%	13%	17%	21%	28%	Royal (2000b)
		Drove within 2 hrs of drinking in past month	1993-1997	both	8%	6%	9%	10%	18%	
NESARC	18+	More than once drove after too much alcohol in past year	2001-2002	males	3%	2%	3%	6%	5%	Chou et al. (2005)
				females	1%	1%	1%	2%	2%	
		Driving while drinking in past year	2001-2002	males	5%	4%	6%	9%	8%	Chou et al. (2006)
				females	2%	1%	1%	5%	3%	
NSDUH	16+	Drove within 2 hrs of drinking in past year	1996	both	13%	*	17%	*	25%	Townsend et al. (1998)
	18+	Drove after too much alcohol in past year	2000	males	17%	14%	17%	21%	22%	Caetano & McGrath (2005)
				females	9%	7%	7%	15%	12%	
	21+	Driving under the influence (alc & drugs) in past year	2002-2003	both	13%	8%	13%	19%	18%	OAS (2005)
	16-20	Driving under the influence (alc & drugs) in past year	2002-2003	both	10%	13%	14%	28%	26%	OAS (2004)
Roadside surveys	16+	BAC ≥ .05	1973	both	17%	*	22%	*	13%	Voas et al. (1998b)
			1986	both	14%	*	13%	*	7%	
			1996	both	9%	*	15%	*	7%	
		BAC ≥ .10	1973	both	6%	*	3%	*	5%	
			1986	both	6%	*	4%	*	3%	
			1996	both	4%	*	8%	*	2%	
FARS	16+	BAC > .00	1990-1994	both	37%	28%	41%	63%	38%	Voas et al. (2000c)
		.00 < BAC ≤ .08	1999-2004	both	7%	3%	5%	4%	4%	Hilton (2006) (**)
		BAC > .08	1999-2004	both	31%	23%	42%	54%	29%	

* not available; ** number in table estimated from graph; BRFSS = Behavioral Risk Factor Surveillance System; NAS = National Alcohol Survey; NHSDA = National Household Survey on Drug Abuse.

It has been suggested that differences in the rates of impaired driving are related to differences in the way members of different racial/ethnic groups perceive the associated risk, with Hispanics less likely to consider impaired driving a safety problem (Caetano & Clark, 1998) or less likely to believe they will be arrested or punished for impaired driving (Cherpitel & Tam, 2000). Fatalism (the perception by the driver that she/he has no control over the likelihood of a crash) has been reported as higher among Hispanics and African Americans and, therefore, another possible contributor to the impaired-driving problem. The Motor Vehicle Occupant Safety Survey revealed that African

Americans (39%) and Hispanics (37%) were more likely to agree with the fatalistic statement that “if it was your time to die, you’ll die” (Boyle & Vanderwolf, 2004). It has also been suggested that machismo is the reason for the much larger prevalence of impaired driving among Hispanic males (than among Hispanic females) (SAIC, 2005). There is no clear evidence, however, to support this hypothesis. In any case, there is evidence suggesting that overall, racial/ethnic groups differ in the way they perceive the risks associated with drinking and driving. Ferguson, Burns, Fiorentino, William, and Garcia (2002) surveyed a small sample of male drivers in Long Beach, California, and found evidence suggesting that Mexican-American drivers convicted of DWI vastly overestimated the number of drinks required to make them unsafe drivers.

Misinterpretation of current traffic laws and regulations is another possible contributor to impaired-driving disparities. Royal (2000b) compared the knowledge that drivers from different racial/ethnic groups have about their State’s BAC levels and found that, compared to Whites, African Americans were least likely to think they knew the BAC limit in their State and were the least knowledgeable about this limit among all racial/ethnic groups. In their 2002 study of Hispanic male drivers in Long Beach (California), Ferguson et al. (2002) reported that less than half of the Mexican Americans in the study were aware of the BAC threshold in California (.08 g/dL) compared with between 60 and 78% of Whites.

It has also been argued that the impaired-driving problem may be especially severe among recent immigrants (mainly Hispanics), who may have a lack of understanding of impaired-driving laws (Caetano & Clark, 2000; Cherpitel & Tam, 2000; Caetano & McGrath, 2005). Conversely, evidence also suggests that acculturation may serve as a risk factor for repeat DWI convictions (Hunter, Wong, Beighley, & Morral, 2006). Further, there is evidence showing that foreign-born Hispanics drink less often (Caetano & Raspberry, 2001), drive less frequently, and report less impaired-driving behavior than the most acculturated ones (Caetano & McGrath, 2005). Therefore, the role of acculturation on the impaired-driving problem is not clear yet.

4.7. Child Passengers

4.7.1. Child Passengers of Drinking Drivers

A 1999 national telephone survey (Royal, 2000a) produced an estimate that between 46 and 102 million drinking-and-driving trips are made each year with children younger than age 15 in the motor vehicle. Brewer et al. (1994) reported that from 1985 to 1996 there were 5,555 child passenger fatalities involving a drinking driver and 64% of those fatally injured children were in the vehicle driven by the drinking driver. As noted in the 2001 review, rates of alcohol involvement in child passenger fatalities range from about 22 to 28%, depending on the age group (CDC, 1997; Margolis, Foss, & Tolbert, 2000; Quinlan, Brewer, Sleet, & Dellinger, 2000). Passengers injured in crashes are generally identified as children if they are age 14 or younger. The injury will be labeled as alcohol-related if the driver of the vehicle in which the child was riding or the driver that struck the motor vehicle in which the child was riding had been drinking. Based on that definition, four recent studies have indicated that in two-thirds of the alcohol-related crashes involving someone age 14 and younger, the child was riding with a drinking driver.

In a study of alcohol-related traffic fatalities from 1985 through 1996, Quinlan et al. (2000) found one in four crash-related child passenger fatalities involved alcohol. They also reported that, of the 5,555 child passenger fatalities involving a drinking driver (i.e., with a BAC > .00 g/dL) during

that 12-year period, 64% of the fatalities occurred while the child was riding with a drinking driver. In two-thirds of these cases, the drinking driver was old enough to be the parent or caregiver of the child. Additionally, an estimated 149,000 child passengers sustained nonfatal injuries in crashes involving a drinking driver, of which 38.9% were riding with a drinking driver when injured in the crash. Notably, this study analyzed FARS data both with and without the standard (and sometimes criticized) BAC imputation methodology and found no differences.

The findings of Quinlan et al. (2000) based on drivers with any drinking are consistent with the findings of the Centers for Disease Control and Prevention (CDC, 1997). Using the same dataset 3 years earlier, CDC found that 60% of the child fatalities in crashes involving an impaired driver with a BAC level of .10 g/dL or higher occurred with the child riding in the same vehicle with the impaired driver. The findings are also consistent with those reported by Margolis et al. (2000), which also revealed that, among crashes involving alcohol, the child's own driver had been drinking in 66.3% of the cases (with child passengers defined as age 15 or younger). Margolis et al. also highlighted the role of drivers younger than 21 in a substantial number of child fatalities, with drivers under the legal drinking age accounting for 30.5% of all alcohol-related child passenger fatalities.

A more recent analyses by the CDC (2004) showed that among the 2,335 children who died in alcohol-related crashes from 1997 to 2002, 1,588 (68%) were riding with drinking drivers, and the majority of these children were not restrained (child passengers were again defined as passengers age 14 or younger). Of the 2,061 alcohol-related crashes involving drinking drivers in which children were killed, 1,624 (79%) involved at least one driver with a BAC level of .08 g/dL or higher. The median BAC level of the 1,409 drinking drivers who were transporting children was .13 g/dL. For all child passenger fatalities (including those not involving drinking drivers), child passenger restraint use decreased as both the child's age and the BAC level of the child's driver increased. Of 1,451 child passengers with known restraint information who died while riding with drinking drivers, 466 (32%) were restrained at the time of the crash.

4.7.2. Factors Related to Impaired-Driving Crashes Involving Child Passengers

Several studies (Anderson, Agran, & Winn, 2001; Margolis et al., 2000; Quinlan et al., 2000) have explored characteristics of alcohol- and motor-vehicle-related child passenger fatalities (e.g., use of child restraints and driver characteristics such as age, gender, and previous license suspensions or convictions for DWI). Baker, Braver, Chen, Pantula, and Massie (1998) reported that children and teenagers from some minority groups in the United States are at higher risk of dying in motor-vehicle crashes after controlling for exposure. These investigators found that among 5- to 12-year-olds, Black Americans had the highest exposure-based motor-vehicle occupant fatality rates, whereas among adolescents ages 13 to 19 years, fatality rates per billion vehicle miles of travel were highest among Hispanic Americans. One possible explanation for these cross-group differences in child occupant fatality rates is the disparities among groups in family and community-level social and economic resources. In fact, one report (Braver, 2001) found that, after adjustment for socioeconomic status, the elevated risk for adult occupant fatality disappeared among some minority groups.

Voas, Fisher, and Tippetts (2002b) analyzed FARS data and found that, compared to men, women were more likely to be accompanied by children at the time of a crash, but those children were more likely to be restrained than if traveling with men. Drivers who had been drinking at the time of their crash were less likely to have their child passengers properly restrained. Although alcohol was associated with a reduced likelihood of having a child riding in the vehicle, this reduction was less for

female drivers. Analyses of children killed in traffic crashes indicated that drivers in some ethnic groups were more likely to have a positive BAC level than White drivers, and their children were less likely to be restrained (see Figure 4-11). The authors suggest that greater alcohol use by drivers and lower rates of child restraint may place children in some groups at higher risk.

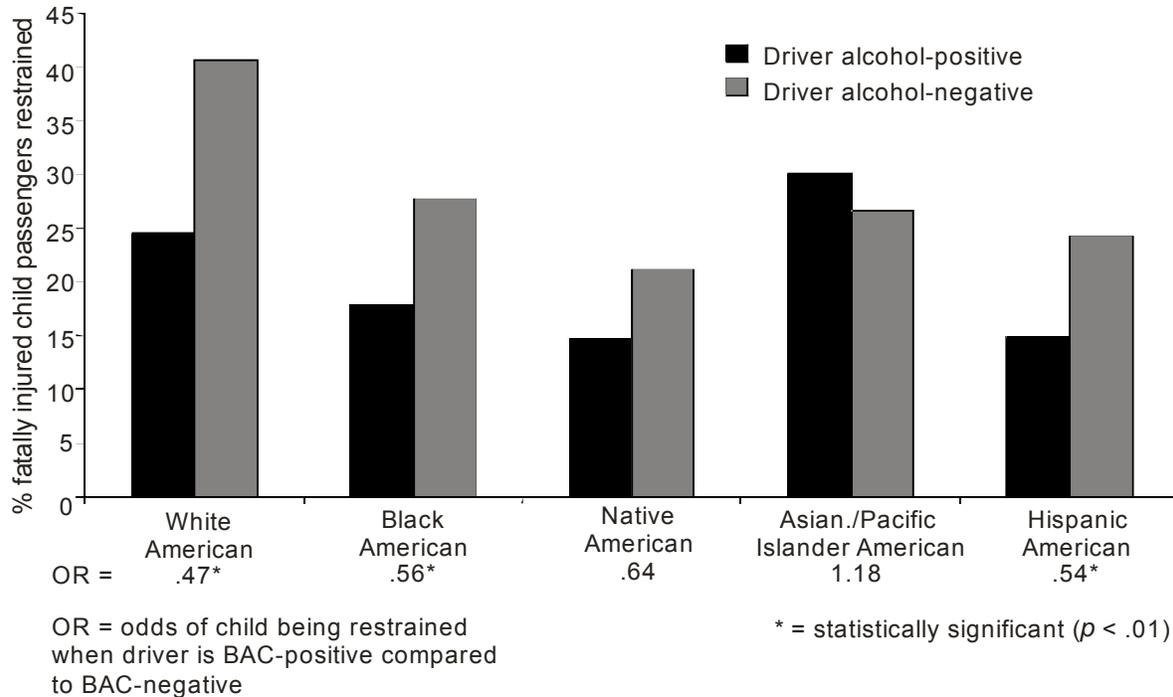


Figure 4-11. Use of occupant protection devices (fatally injured children). Adapted from Voas, Fisher, & Tippetts (2002b)

Jelalian, Alday, Spirito, Rasile, and Nobile (2000) found that younger adolescents reported that they rode less often with drivers who were dangerous or using substances. These authors speculated that younger adolescents, more than older adolescents, likely have fewer opportunities to ride with teenage drivers, thereby reducing their frequency of riding with risky drivers. Li (2000) commented that the Margolis et al. (2000) and Quinlan et al. (2000) studies, taken together, point out three specific types of offenders in alcohol-related child passenger fatalities: (1) adults with AUDs, often with prior DWI convictions, driving their own children; (2) underage drivers with child victims as passengers, pedestrians, or pedalcyclists; and (3) impaired drivers who may not be alcohol dependent, but who occasionally drink to a point that puts them at high risk of being involved in a fatal crash with children involved.

4.7.3. Countermeasures

American drinking-and-driving legislation has been increasingly oriented toward protecting youth from alcohol-related and motor-vehicle-related injury and fatalities. Some laws, such as those raising the national legal drinking age to 21 years and establishing zero tolerance and graduated driver licensing, primarily affect youthful drivers. Other legislation, such as the passage of child restraint laws, targets the parents of young child passengers to reduce their risk from injury should a crash occur. Child restraint laws, which have been passed by all 50 States and the District of Columbia,

require children (usually up to the age of 3 or 4) to travel in approved child restraint devices (i.e., child safety seats) (IIHS, 1999).

4.7.3.1. Child Endangerment Laws

More directly related to the problem of alcohol-related injuries are the child endangerment laws, enacted in 36 States (as of January 2004) that protect underage vehicle occupants (Mothers Against Drunk Driving, 2006, Child Endangerment Report). These laws create a separate offense or enhance existing DWI penalties for offenders who drive while intoxicated with a minor child in the vehicle. The effectiveness of these laws, however, has not been evaluated (CDC, 2004). Typical impaired-driving countermeasures can help reduce child passenger fatalities by reducing impaired driving in general. Specific measures targeted toward these offenders are recommended by many researchers in the field. Quinlan et al. (2000), for example, proposed lower BAC limits for drivers carrying children, and Margolis et al. (2000) suggested raising the price of alcohol to make it less affordable for adolescent offenders.

4.7.3.2. School Educational Programs

In addition to legislative measures created to protect child passengers, educational approaches have also been developed. Bell and colleagues (Bell, Kelley-Baker, & Ringwalt, 2005; Bell, Kelley Baker, Falb, & Roberts-Gray, 2005; Bohman et al., 2004) evaluated an educational curriculum (Protecting You/Protecting Me) aimed at elementary school-age children, designed to teach them the dangers of drinking and driving and, more specifically, riding with an impaired driver. Results showed positive changes in alcohol-relevant knowledge and self-reported behaviors, attitudes, and intentions. Specifically, students learned how to protect themselves if they ever have to ride in a motor vehicle with someone who has been drinking (e.g., sit in the backseat, buckle up tight, put everything on the floor, be quiet and do not bother the driver, and tell a trusted adult immediately). The studies showed effectiveness in both teacher-led and student-led formats of the curriculum (with the student-led format involving high-school students who were trained to teach the program). Investigations of behavioral outcomes were not performed.

Despite the continued problem of child passengers falling victim to impaired-driving fatal crashes, specific investigations of other countermeasures aimed at reducing child passenger fatalities were scarce for the period of this review. Further research on the problem and relevant interventions, particularly the child endangerment law, could prove valuable in enhancing the safety of young passengers.

4.8. Older Drivers

NHTSA (2004b) has defined older drivers as those people age 70 and older who drive vehicles. Because the baby boom generation is reaching retirement age, increasing attention is being devoted to older drivers. However, research on impaired driving of drivers age 70 and older has been very limited. The *Alcohol and Highway Safety 2001* report did not specifically address this population: neither their prevalence of alcohol-impaired driving nor any related research. Five years later, there is still limited empirical research to inform this discussion. Most of the research on older drivers does not focus directly on alcohol-impaired driving.

Medically at-risk drivers are defined as people having one or more functional impairments in vision, mobility/physicality, and cognition. Although individuals of any age may suffer from impairments that can affect driving skills, considerable literature demonstrates that such deficits are a part of the normal aging process and therefore more prevalent in the older drivers. A recent report published by NHTSA (Dobbs, 2005) provides an extensive review of the contributions of 14 classes of medical conditions and functional limitations to motor-vehicle crashes. Evidence from studies conducted by the Departments of Motor Vehicles (DMVs) suggests that unrestricted drivers with certain medical conditions have significantly higher crash and citation rates than control groups without impairments (Diller et al., 1999).

4.8.1. Problem and Prevalence

Although medical impairments increase the risk of crash involvement, many older drivers in response to age-related deficits stop driving or change their driving habits to reduce their crash risk (e.g., not driving at night, limiting driving to familiar locations, avoiding driving during peak traffic times). Despite these efforts, safety measures that account for driving exposure indicate that older drivers are at increased crash risk as well as more vulnerable to injury when in a crash (NCHRP, 2004). In fact, the fastest growing segment of the driving population is oldest group of drivers—those age 85 and older. They have the highest driver fatality rate per 100 million VMT, followed by novice drivers (i.e., those age 16), with 80- to 84-year-olds having the third highest driver fatality rates (NHTSA, 1997). As the U.S. population continues to age—the number of older drivers is estimated to double in the next 30 years, representing as much as 25% of the licensed drivers—increasing the safety of older drivers and other road users will be a growing concern. Evidence suggests that given current practices and demographic trends, sharp increases can be expected in the number and proportion of traffic fatalities related to declining abilities and frailties, including alcohol impairment among our aging population. The population of people 65 and older is expected to double in the next 25 years, reaching 70 million people by 2030 (U. S. Census Bureau, 2000 in Snyder & Bloom, 2004).

Recent data indicate that the age-70-and-older population grew at a 4% rate between 1994 and 2004, which is faster than the growth rate of the total U.S. population; this group now comprises about 9% of the total U.S. population (NHTSA, 2004b). In 2003, there were nearly 20 million licensed older drivers, a 27% increase since 1993 compared to only a 13% increase in all licensed drivers during that period. In 2004, despite comprising 9% of the U.S. population, drivers age 70 and older were involved in only 5% of the estimated 141,000 injury crashes in that year (NHTSA, 2004b). Older people, however, comprised 12% of all traffic fatalities, 11% of all vehicle occupant fatalities, and 16% of all pedestrian fatalities. Spanning 25 years and ending in 1999, MacDonald's (2003) study in Ontario, Canada, of older drivers in traffic crashes attributed the substantial reduction in alcohol-impaired crashes during that period, at least in part, to the increasing age of the population along with the increasing proportion of women drivers.

The 70-and-older age group has a lower exposure to crashes because they drive fewer miles. As shown in Figure 4-12, if only nondrinking drivers (BAC = .00 g/dL) in fatal crashes are considered, drivers age 70 and older have a high rate of involvement presumably resulting from their deteriorated driving capabilities and their sensitivity to injury. Conversely, if only drinking drivers in fatal crashes are considered (BAC > .00 g/dL), their rate of involvement is low, suggesting that alcohol is not as great a problem for older drivers as for younger drivers. An important protective factor for this age group is that they have a high rate of seat belt use. About three-quarters of older

occupants of passenger vehicles involved in traffic crashes were wearing seat belts, compared with less than two-thirds of younger adult occupants (ages 18 to 69) (NHTSA, 2004b).

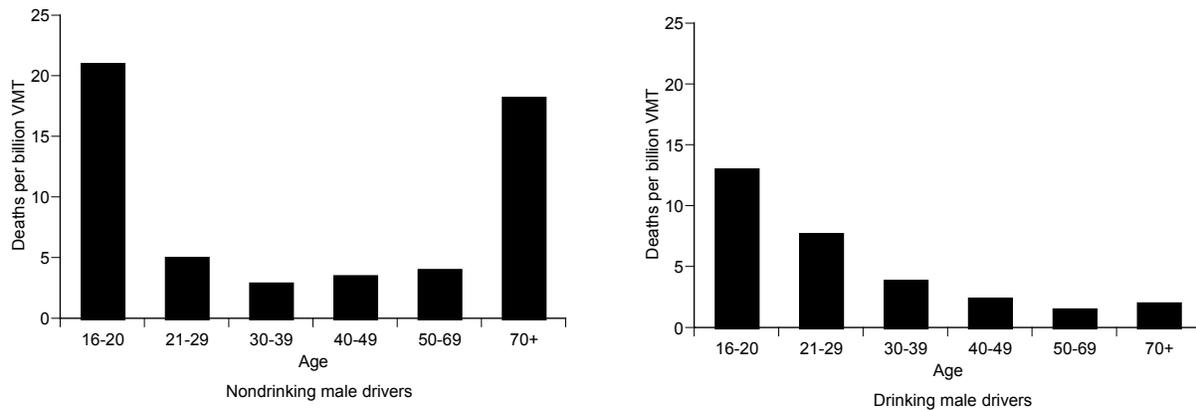


Figure 4-12. Mileage involvement rate for male drinking and nondrinking drivers in fatal crashes, FARS 1990-1994

4.8.2. Gender Differences

Reports from a recent study conducted by Voas and Tippetts (2002) revealed that, considering only nondrinking females in fatal crashes, the mileage involvement rates for youth and older people are significantly higher than for other age groups. These authors note that this elevated rate for older people is generally attributed to age-related decrements in cognitive and motor functions and increased risk of fatal injury given that a crash occurs. However, specific factors related to older female drivers involved in crashes has recently been investigated (Stutts, Martell, & Staplin, 2009).

Examining crash prediction models for older drivers, Hu and associates (1998) found that factors that place older female drivers at greater crash risk were different from those influencing male drivers. After controlling for the amount of driving, results indicated that women who live alone or who experience back pain have a higher crash risk. Interestingly, compared with men, older women are three times more likely to be living alone and spend a larger percentage of their lifetime disabled (AOA, 2001). According to Margolis (2002), increased risk factors associated with older women drivers include a fall within the previous year, greater orthostatic systolic blood pressure drop, and slower foot reaction.

When assessing crash risk, driving location is a strong factor to consider. As indicated by NHTSA (2002), older drivers are more likely to be involved in urban crashes at intersections and at slower speeds (though older drivers had a higher proportion of crash involvement in urban areas, the highest proportion of hospitalization or deaths were in crashes in rural areas). Some research suggests that females are especially at risk in intersection maneuvers (Staplin et al., 1998; Guerrier, Manivannan, & Nair, 1999; Finison & Dubrow, 2002). Goggin and Keller (1996) found that older women drive in different locations and at slightly different times than older men. These researchers discovered that 46% of older men reported that their driving occurred primarily on the highway as compared to only 17% of older women. Further, 83% of the older women indicated that their driving was primarily local, versus 54% of the men. In this same study, older adults' driving performance was examined in a simulated driving experiment. They found that men and women differed in overall

driving habits and abilities. Although the researchers found no differences between men and women in age, educational level, visual acuity, and years driving, men performed better than women during the driver simulation and drove more miles per year.

When asked about reasons to continue or to stop driving, researchers (Hakamies-Blomquist & Wahlstroem, 1998) found that both older male and female ex-drivers reported feelings of stress in traffic and more frequent avoidance of certain traffic situations than those who were currently driving. As both drivers and ex-drivers, women reported more traffic-related stress and avoidance than men.

4.8.3. Vulnerability

Perhaps the greatest risk for older people is their increased sensitivity to injury. Their bones are more brittle and subject to fractures and age-related deterioration. Further, their health makes them less able to recover from injuries. In a study comparing crashes involving older drivers in the State of Maine (Finison & Dubrow, 2002), researchers found that older drivers were more likely to be hospitalized or die if they were in a crash; their risk of hospitalization or being fatally injured per licensed driver was 1.7 times that of middle-age drivers. Of this group, older female drivers were 1.6 times more likely to be hospitalized or die during a crash than were older male drivers.

Despite the lower likelihood of older people driving while impaired by alcohol than younger adults, several age-related issues are associated with an increased risk for older drivers. These include dementia and other cognitive deteriorations, diminished physical capacity, risk for serious illnesses (e.g., diabetes) that could play a role in driving ability, and more likely use of medications that may impair driving (e.g., drowsiness or disorientation) and interact with alcohol (Knapp & VandeCreek, 2005). Each of these issues can potentially diminish driving skill or capacity, and together, they may represent even greater risks for older drivers. The decision to continue driving, to limit driving, or to find alternate transportation is one that an older driver is sometimes unable to make for himself or herself (e.g., in cases where cognitive function limits the capacity to appreciate physical and mental limitations).

4.8.4. Countermeasures

In the last few years, increased attention has been given to the issue of involvement by physicians in the process of deciding whether an older person can continue driving (e.g., State of Oregon legislation mandating physician reporting under specific conditions; Snyder & Bloom, 2004). This is related, in part, to two tragedies. One occurred in California in 2003 when an older driver became confused and lost control of his vehicle and then crashed into a farmer's market killing 10 people (Bowles, 2003 in Knapp & VandeCreek, 2005; Snyder & Bloom, 2004); the other was a fatal and injury crash involving an older driver in Oregon (Snyder & Bloom, 2004). The American Medical Association (AMA) and the American Psychiatric Association (APA) have recommended that their physicians discuss driving with their older patients, and the AMA has also recommended assessment of impairments that might diminish driving capacities along with consideration of possible patient interventions. The AMA, in collaboration with NHTSA, has also developed a physician handbook for office use in evaluating driving capacity (Wang, Kosinski, Schwartzberg, & Shanklin, 2003).

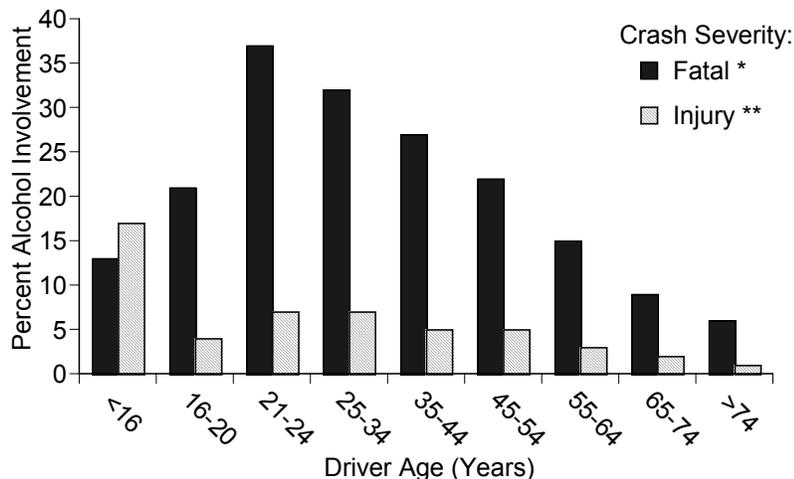
4.8.5. Future Needs

Research on impaired driving in the older population has been limited. More study is needed given the anticipated increases in the number of older drivers in the next 30 years. Even though this

group is less likely to drive under the influence of alcohol, it may be at greater risk per mile driven at an elevated BAC level than drivers in younger age groups because of the potentially greater effect of intoxication on the driving performance of older individuals. Further, alcohol can potentially exacerbate the increased fragility of older people because alcohol has the tendency to increase the severity of injuries (Waller et al., 1986; Evans & Frick, 1993).

4.9. Motorcyclists

Unlike for other motor vehicles, the effects of alcohol impairment on motorcycle operation are not well understood. Over the past several years, increasing motorcycle fatal crashes have led to an increased interest in the significant role that alcohol plays. Figure 4-13 shows the distribution of motorcyclist alcohol involvement in fatal and injury crashes as a function of age. It is clear that alcohol plays a far larger role in fatal than in injury crashes involving motorcyclists. An interesting feature of the phenomena is the high involvement of alcohol in injury crashes involving underage riders. In 2000, the National Agenda for Motorcycle Safety (NAMS) declared that there was an “urgent” need to discourage motorcyclists from mixing alcohol and other drugs with motorcycling and that there was an “essential” need to study patterns of use of alcohol and other drugs by motorcyclists and to better understand the effects of alcohol and other drugs on motorcycle operation. NHTSA motorcycle research priorities since 2000 have reflected these recommendations.



*For fatal crashes, alcohol involvement is a BAC level of .01 g/dl or greater.
 **For injury crashes, alcohol involvement is police-reported alcohol involvement.
 Source: NHTSA, 2005b; NHTSA Safety Facts, 2005

Figure 4-13. Percentage of driver and motorcycle operator involvement for fatal and injury crashes

Statistics frequently pointed to when discussing the issue of drinking and riding are the significant increase in motorcycling fatalities in recent years, along with the high proportion of fatal crashes that involve alcohol.

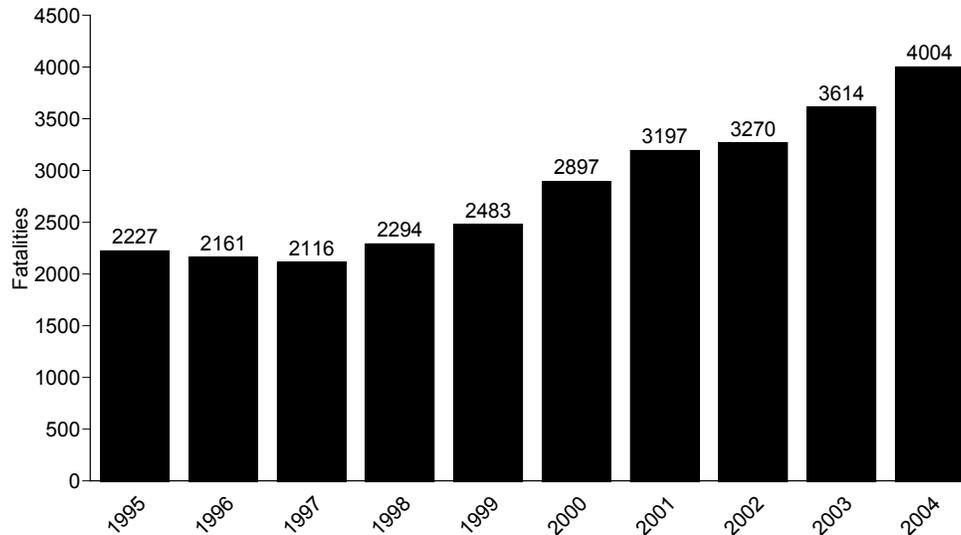


Figure 4-14. Motorcycle fatalities, 1995-2004. Source: Shankar and Varghese (2006)

After an extended downward trend through the 1990s, the number of fatal motorcycle crashes began to climb, starting in 1998, and have risen each year since (Figure 4-14). Fatal motorcycle crashes have increased 89%, from a low of 2,116 fatalities in 1997 to 4,008 fatalities in 2004, the last year for which data are available. Because FHWA's VMT for motorcycles have remained essentially the same since 1997, the upward trend remains when fatalities are divided by VMT as an exposure measure. However, the number of registered motorcycles increased by 51% (from 3,826,373 to 5,780,870) between 1997 and 2004, and the number of new motorcycles sold yearly increased by 268% from 1997 to 2003 (the last year for which there are data). Consequently, the assumption has been that the increase in motorcyclist fatalities has been due, at least in part, to an increase in exposure and that this increase is not being reflected in the VMT (for cited statistics, see Shankar & Varghese, 2006).

The traditional measures of exposure (VMT, registrations, and licensed operators) are not providing an accurate measure of exposure for motorcyclists. Given that VMT has not increased along with registrations and sales, there is a strong suspicion that the method of calculating VMT for other vehicle types does not capture accurate statistics for motorcycles. Registrations may not accurately reflect exposure because many riders purchase more than one motorcycle and may use motorcycles relatively infrequently, primarily for recreation. Changes in the number of motorcycle licenses or endorsements may overstate exposure as some motorcyclists ride only rarely compared to drivers of other vehicles. Conversely, the changes may be understated as the number of licenses does not reflect exposure for a significant proportion of riders who fail to obtain a motorcycle license. Because it is difficult to determine exposure rates for motorcyclists, it is difficult to discuss motorcycle crashes in anything other than raw numbers.

Figure 4-14 shows that the percentage of fatal motorcycle crashes where the rider had been drinking has fallen slightly in recent years, both for crashes with higher BAC levels ($\geq .08$ g/dL) and for lower BAC levels (.01 to .08 g/dL). The percentage of fatally injured motorcycle operators who had been drinking declined by 8 percentage points from 42% in 1995 to 34%

in 2004. During the same period, the percentages of crashes involving alcohol for other vehicle types have remained relatively stable. Passenger cars are shown here as an example. The proportion of crashes involving alcohol, however, is significantly higher for motorcycles than for any other vehicles (e.g., 34% for motorcycles compared to 26% for passenger cars in 2004). The number of alcohol-involved fatal crashes where the operator had a BAC level lower than .08 g/dL is also significantly higher for motorcycles (7%) than for other vehicle types (e.g., 4% for passenger cars). Sun, Kahn, and Swan (1998), in a comparison of injury crashes of motorcycles and other motor vehicles, had similar findings: that mean BAC levels were lower for motorcyclists (.12 g/dL) than for drivers (.18 g/dL). This might suggest that operation of a motorcycle is sufficiently complex, compared to operation of passenger cars, that riders' skills become impaired at lower BAC levels than do drivers. Another possible explanation is that the increased likelihood of a rider being killed or injured in a crash, compared to a passenger car driver, results in BAC levels for crash-involved riders that look more like the BAC levels for the non-crash-involved population at risk. Nonetheless, the large difference between alcohol involvement for fatal motorcycle crashes and for other vehicles suggests that there is room for improvement in drinking and riding.

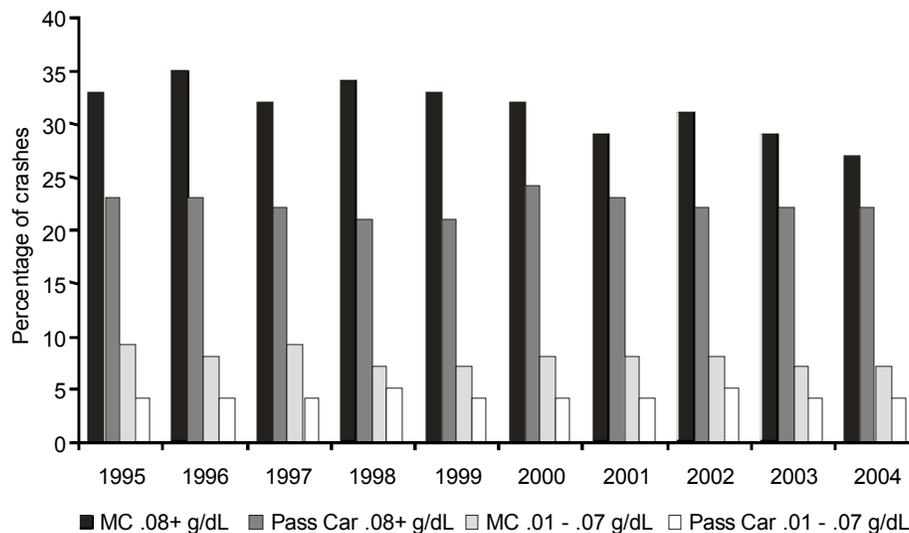


Figure 4-15. Driver BAC levels in motorcycle and passenger car fatal crashes, FARS, 1995-2004. Adapted from Shankar & Varghese (2006)

Although it is apparent that alcohol is involved in a higher proportion of motorcycle crashes than in other types of vehicles, the extent to which drinking riders are overrepresented in motorcycle crashes at various BAC levels is not entirely clear. This is primarily due to the lack of exposure data for the population at risk, though BAC data for riders involved in crashes has also been limited in past studies.

The prevalence of passenger car operators at varying BAC levels in the population at risk has been studied through roadside surveys. These surveys, however, have not included collection of data from motorcyclists, primarily due to difficulties in transporting the rider and the motorcycle if an obviously impaired rider is stopped.

Case-control studies have been used to understand the effects of alcohol on crashes in various types of motor vehicles, but few studies have collected sufficient data on motorcyclists to generate

relative risk data for drinking-and-riding crashes. Further, studies showing differences in crash likelihood between crash-involved and non-crash-involved riders are limited to comparisons of riders who had and had not been drinking, rather than providing relative risks for a range of BAC levels.

The Hurt, Ouellet, and Thom (1981) study was a case-control study involving 900 in-depth motorcycle crash investigations, analysis of an additional 3,600 crash records, and collection of comparison data for 505 crash sites. For injury crashes, alcohol data were limited to analyst and/or law enforcement opinions as to whether the rider had been drinking or was impaired. BAC data were available for fatal crashes only. Alcohol data in crash records suggest that police only recorded alcohol involvement when impairment was severe. Alcohol- and drug-impairment data for comparison cases was based on interviews with the 25% of riders willing to discuss their alcohol and drug use before riding. Of these riders, 88% reported no alcohol or drug involvement, 8% reported some drinking but no impairment, and the remainder reported some level of drug or alcohol impairment. Hurt et al. (1981) also attempted to estimate BAC data for comparison riders based on reported alcohol quantity consumed over time and rider weight. BAC levels were calculated for approximately 25% of the sample. Of these, 93.8% were at a .00 g/dL BAC level. Based on these somewhat limited alcohol data, these researchers also found an identical level of 11.7% drug and alcohol involvement for nonfatal crash cases and for comparison cases but a 43.1% involvement for fatal crash cases. The authors suspected that alcohol and drug use in nonfatal crashes was reported to be lower than it actually was due to underreporting by riders.

In the European Motorcycle Accident In-Depth Study (MAIDS; ACEM, 2004) of 921 crashes and 923 comparison cases, alcohol information for crashes was based on reports from police officers or impressions of crash investigators of whether riders were under the influence (as opposed to measuring BAC levels of all riders encountered) (ACEM, 2004). This study showed that riders were under the influence of alcohol in 3.9% of the cases, and drug use was identified in .5% of the cases. Alcohol data for the exposure population came from a subset of riders interviewed at fueling stations. Riders under the influence of alcohol were identified in 1.5% of comparison cases and riders under the influence of drugs in .2% of cases. The MAIDS study found that riders were 2.7 times as likely to be involved in a crash when under the influence of alcohol (chi-square, $p < .002$).

Haworth's (2000) motorcycle case-control study in Australia compared 222 crash cases to data from 1,200 comparison riders. BAC data were collected for 66% of crash cases and 90% of comparison cases. Less than 1% of control cases had BAC levels greater than .05 g/dL; therefore, statistical comparisons of crash and comparison cases had to be limited to comparisons of drivers with BAC levels of zero and riders with any alcohol. They found that crash-involved riders were more likely to have positive BAC levels and that their BAC levels tended to be higher than the comparison riders' BAC levels. Riders with any BAC level were found to have five times higher odds of crashing compared to riders with a zero BAC level. Riders with BAC levels greater than .05 g/dL were 40 times more likely to be in a crash compared to riders with zero BAC levels.

As part of a study of 1,082 crashes in Thailand, 372 motorcyclists were tested for BAC shortly after being involved in a crash. The authors compared nondrinking riders to riders at a range of BAC levels for crash characteristics, but they did not collect comparison data (Ouellet & Kasantikul, 2006).

4.9.1. Characteristics of Drinking Riders

Females account for 10% of motorcycle fatalities. We did not find a published breakdown of alcohol involvement for fatally injured female motorcyclists compared to fatally injured male motorcyclists. An in-house analysis of 2004 FARS data, however, resulted in odds ratios of 1.31 of female riders having positive BAC levels compared to female drivers of other vehicles, and an odds ratio of 1.43 of male riders having a positive BAC level compared to male drivers. This indicates that fatally injured female riders are more likely to have been drinking than female drivers, but less likely to have been the motorcycle operator than male riders.

The mean age of fatally injured riders has been increasing in the past several years, as has the mean age of alcohol-involved riders. Sixty percent of alcohol-involved fatal crashes involved riders between the ages of 30 and 49 (Shankar & Varghese, 2006).

Similarly, the engine sizes of motorcycles have increased over the years, resulting in larger mean engine sizes for all fatal motorcycle crashes and for alcohol-related fatal crashes. Of four categories of engine size, the one with the highest percentage of alcohol involvement was the 1000 – 1500 cc category, with 34% of those crashes involving BAC levels of .08 g/dL or higher and another 7% with BAC levels of .01 to .07 g/dL (Shankar & Varghese, 2006).

4.9.2. Characteristics of Alcohol-Involved Motorcycle Crashes

Studies of motorcycle crashes in Hawaii (Kim & Boski, 2001) and Florida (Turner & Georggi, 2001) have shown that alcohol-related motorcycle crashes occur more frequently at night and on weekends. These crashes are associated with speeding and other risky driving behaviors, failure to wear a helmet, and riding without a proper motorcycle license. Further, they are more likely to be single-vehicle crashes than non-alcohol-related motorcycle crashes.

4.9.3. Potential Countermeasures

To an extent, any countermeasure aimed at drinking drivers can potentially reduce drinking and riding. Villaveces et al. (2003) found that laws reducing the per se BAC levels and laws introducing administrative license suspension for DWI had similar effects on fatal crash rates for motorcycles and for other motor vehicles. Becker, McKnight, Nelkin, and Piper (2003) found that motorcyclists were likely to be concerned about costs and legal issues surrounding DWI offenses and that these concerns might guide drinking-and-riding behavior. Motorcyclist focus groups also expressed the opinion that anti-drinking-and-riding messages would be most effective coming from other motorcyclists (e.g., in the form of PSAs using motorcycling celebrities as spokespeople) or as advice coming from motorcycling peers (Syner & Vegega, 2001; Becker et al., 2003).

4.9.4. Barriers

Focus groups of motorcyclists indicate that certain commonly held beliefs among motorcyclists make it difficult to convince some riders of the importance of separating drinking from riding. Focus group research (Becker et al., 2003) revealed the following beliefs:

- Many riders tend to distrust authority and messages that come from those in authority, including, if not *especially*, the safety community.

- Many riders view their decision to ride as being part of having a risk-taking personality, and drinking and riding is a part of that.
- Riders point out that motorcyclists are the ones most often injured in motorcycle crashes. Therefore, unlike those who drink and then drive passenger vehicles, drinking riders are not likely to injure innocent parties due to their decision to drink and ride. They, therefore, should be free to make that decision.
- A large segment of the motorcycling population has become politicized over some issues, such as helmet legislation, and are prepared to work against any legislation they perceive as being aimed specifically at or discriminatory toward motorcycles.
- Most crashes involving motorcyclists and drivers of other types of vehicles are the fault of other vehicle drivers, leading some riders to believe that riders and their choices cannot be faulted for crashes.

4.9.5. Research Needed

As mentioned, there is a need for quality exposure data for motorcyclists. To determine risks of motorcycle operation at various BAC levels, this should include not only alcohol data for the population-at-risk, but also the most basic exposure data (e.g., reliable VMT data) for interpreting crash trends.

4.10. Pedestrians and Pedalcyclists

4.10.1. Problem and Prevalence

The scientific literature on the characteristics of *alcohol-impaired pedestrians and pedalcyclists* is far less extensive than that for drivers. What does exist indicates that the alcohol-crash problem for pedestrians is, as it is for drivers, predominately a male problem. Very high BAC levels are common for pedestrians in alcohol-related fatal crashes, especially for those in the 35-to-44 age group (for whom it is estimated that 41% have BAC levels at .10+ g/dL and 18% at .20+ g/dL). Alcohol-impaired pedalcyclists in fatal crashes are also more likely to be male, with the highest percentage of pedalcyclists at .10+ g/dL occurring for those in the 45-to-54 age group, an older peak age group than that for either drivers or pedestrians.

Outlined earlier in this report in the section regarding children as passengers, a research study (Margolis et al., 2000) using FARS data from 1991 to 1996 also illustrated the relationship between alcohol-related and motor-vehicle-related fatalities of children as pedestrians and pedalcyclists. These researchers' data included more than 16,000 children younger than 16 who died due to a motor-vehicle crash, of which 3,300 were alcohol-related. Of these 3,300, Margolis et al. (2000) found that over a fifth (20.5%) were child pedestrians or pedalcyclists killed by an alcohol-impaired driver, a substantial proportion. On a positive note, among child pedestrians and pedalcyclists, the percentage of alcohol-related fatalities declined between 1991 and 1996 from nearly 15% to just over 8%.

4.10.2. Pedalcyclists and Pedalcyclists

Experimental studies have shown that riding a bicycle requires a higher level of psychomotor skills than driving a motor vehicle; further, the legal .08 g/dL BAC limit reduces performance of pedalcyclists by more than 80% (Schewe, Knoss, Ludwig, Schaufele, & Schuster, 1984 in Li, Shahpar, Soderstrom, & Baker, 2000). Researchers have also found that chances of injury for pedalcyclists with a BAC level of .10 g/dL or higher is more than 10 times greater than for pedalcyclists who have not been drinking (Olkkonen & Honkanen, 1990 in Li et al., 2000). These researchers studied 3 years of driving records (May 6, 1995, to May 5, 1998) for 120 pedalcyclists injured while riding a bike between 1990 and 1997. They found significant relationships between a positive BAC level following a bicycling injury and record of license suspension/revocation and between positive BAC levels and DWI convictions. Pedalcyclists with a positive BAC level at admission to a trauma center following injury were more likely than negative BAC-injured pedalcyclists (52% versus 14%, $p < .01$) to have a record of license suspension/revocation. According to the authors, the positive BAC-injured pedalcyclists were also more likely than negative BAC-injured cyclists (30% versus 3%, $p < .01$) to have DWI driving convictions. Although a small sample size was used in the study, Li et al. (2000) suggested that these findings point to the “pervasive nature of drinking between bicycling and driving activities” (p. 583), including that bicycle injury associated with a positive BAC was predictive of alcohol-impaired driving. These authors concluded that the findings do not demonstrate a causal relationship but rather a relationship of alcohol use across activity domains.

4.10.3. Pedestrians

Of all road users, pedestrians were killed and injured at higher rates than expected given their proportional road use (Fell & Hazzard, 1985, in Öström & Eriksson, 2001). In a study of 168 road users, Walsh et al. (2005) found that pedestrians were more likely than other road users to test positive for alcohol only rather than alcohol and other drugs (e.g., marijuana) or other drugs only. Pedestrians who tested positive for alcohol were more likely to be killed in traffic crashes and comprised between 39% and 60% of pedestrian fatalities (Clayton, Booth, & McCarthy, 1977, Copeland, 1991; CDC, 1993, in Öström & Eriksson, 2001).

Locations of pedestrian alcohol-related crashes as a whole are most likely to be near the victim’s home or a short distance from the starting point of the trip. Recent research on race and ethnicity indicates that Native Americans have the highest prevalence of alcohol-related pedestrian crashes, roughly three times that of Caucasians at .20+ g/dL. Blacks and non-Black Hispanics fall somewhere between these two extremes.

Öström and Eriksson (2001) conducted a study in Sweden examining pedestrian fatalities and their relationship to alcohol, in part because such fatalities did not diminish between 1977 and 1995 as had other motor-vehicle crashes. They found that most alcohol-positive ($\geq .01$ g/dL) pedestrians who were fatally injured were men, with a minor peak for the 10- to 19-year-old group and a major peak for the 70- to 79-year-old group. In addition, they found that fatalities were somewhat less common in spring and summer, that fatalities were generally evenly distributed across days of the week and in daylight and darkness, and that most fatalities were on roads, with some on streets and at intersections. Younger pedestrians (ages 15 to 24) were more likely to test positive for alcohol use. Most pedestrians were struck by male drivers, whose mean age was 36 years. Few of these drivers were intoxicated, and most were driving passenger vehicles. This study was not conducted in the

United States, and thus it presents a different context for drinking and for drinking and driving; nevertheless, the risk elements (e.g., age, locations, and gender) may still be informative for future research in this country.

4.11. Summary and Conclusions

When investigating alcohol-related crashes, researchers have increasingly focused on special groups of road users, including various groups of drivers, child passengers, motorcyclists, pedestrians, and pedalcyclists. Research points to the sometimes-unique risk elements and group and crash characteristics presented by each of these groups. Most age groups have been studied, including child passengers, early-onset alcohol and other drug users, teenage drivers, college students, high-risk drivers (ages 21 to 34), and older drivers (age 70 and older).

About a quarter of the child-passenger (i.e., passengers age 14 and younger) fatalities are alcohol-related, with two-thirds of those fatalities resulting from children riding with a drinking driver old enough to be the parent or caregiver. More than one-third of child passengers injured in alcohol-related crashes were riding with a drinking driver when injured. Child restraint laws, which have been adopted by all States and the District of Columbia, and educational programs targeting children and parents are important elements of prevention. Child endangerment laws have also been enacted, creating a separate offense for driving under the influence when a child is in the vehicle.

Initiating drinking of alcohol before age 21 has been associated with increased risk for subsequent drinking-and-driving and lifetime alcohol-related crash involvement. The earlier drinking begins, the greater the risk of crash involvement, even after adjustments for alcohol dependence and other individual variables. Delaying the onset of alcohol and other drug use holds promise for reducing alcohol-related crashes and associated injuries and fatalities.

Among youth ages 15 to 20 in the United States, motor-vehicle crashes are the primary cause of death, and this age group is overrepresented in traffic fatalities and injuries, particularly in alcohol-related crashes and at lower BAC levels. Diminishing parental supervision and limited driving experience contribute to the problem of alcohol-related crashes for this population. The transition from being driven by parents to driving or riding with peers involves substantial risk to youths of licensing age. For the first few months of solo driving, the novice driver is at considerably increased risk of crash involvement compared to the adult or the experienced teen driver. Graduated driver licensing systems that are discussed in the next chapter appear to hold promise for reducing the crash risk of 15- to 17-year-olds.

College students, particularly full-time and at traditional ages (17-24), are at increased risk for drinking and driving. College men are more involved in drinking and driving than are college women. For college students, their increased independence from parents often leads to increased or initiation of alcohol use, and the predominant population with whom they associate is other people their age who tend to be tolerant of increased risky drinking. Initiating drinking at a younger age; being male; drinking at bars, at home, at a friend's residence, or at parties; and drinking at a location 1 to 5 miles from the driving destination have all been associated with increased risk for drinking and driving. Prevention and intervention for this group relate to both individual and environmental measures, which are discussed in Chapter 5.

Drivers ages 21 to 34 account for approximately 45% (NHTSA, 2006b) of the drinking drivers with BAC levels at .08 g/dL or higher. Men are at particularly high-risk for crashes related to drinking and driving. Aside from early onset of drinking, researchers have demonstrated that psychosocial development and parental monitoring during adolescence predict alcohol impaired driving in young adulthood. This group is a primary target for DWI deterrence programs, but additional research is needed to develop methods for motivating this age group to reduce their impaired driving by moderating their drinking and using designated drivers or other methods to avoid driving after drinking.

Although older drivers (≥ 70 years) are involved in fewer alcohol-related crashes, their sometimes diminished physical health, cognitive changes (e.g., dementia for some), and greater likelihood of taking medications that might interact with alcohol can impair their driving abilities, and all play a role in the outcome of alcohol-related crashes. Pedestrians in this age group are also at increased risk for alcohol-related crashes, even when they are not drinking. More research is needed about this population, particularly since U.S. demographic shifts mean this group is growing.

Women are less likely than men to be involved in both non-alcohol-related and alcohol-related crashes. The one exception to this rule is that women age 70 and older have a higher non-alcohol-related crash rate than men. Despite this, females age 70 and older have a lower involvement in alcohol-related crashes. When impaired-driving offender groups are compared by gender, male and female offenders have similar characteristics and most of the factors that contribute to re-arrest are similar. In contrast, women are more responsive to social and internal controls than are men; however, men's involvement was predicted in part by younger age whereas women's involvement was not.

The rate of motorcyclists' involvement in alcohol-related crashes has been declining, but ironically, the total number of drinking motorcyclist in fatal crashes has increased due to an increase in the number of individuals seeking licenses and operating motorcycles. They are particularly vulnerable as road users (in part, because of their resistance to wearing helmets), which has led to their overinvolvement in alcohol-related crashes, including overrepresentation at BAC levels lower than .08 g/dL.

Chapter 5.

Strategies for Dealing With the Alcohol-Crash Problem

This chapter covers research on the laws, programs, and policies that have been implemented in an effort to reduce impaired driving and alcohol-related fatalities. It builds on the information presented in previous chapters and uses a three-part model (Figure 5-1) to organize the presentation of actions varying from efforts to control risky drinking to deterring drinking drivers to controlling the driving of individuals arrested for driving while impaired. It covers research on government laws and programs, as well as private and community efforts, directed at preventing alcohol-related crashes. Although its primary focus is on research conducted from 2000 through 2006, strategies tested earlier are covered in some cases to provide a basis for understanding more recent interventions.

5.1. Model of the Drinking Driving Problem

A first step in understanding the methods that can be used to reduce alcohol-related crashes requires an understanding of the many factors that play a role in such crashes. One approach to this understanding is to create a model that describes these factors and their interrelationships. Figure 5-1 developed by Birckmayer, Boothroyd, Friend, Holder, & Voas (2008) is an example of such a model. It reflects the results of a review of the literature on the factors that contribute to alcohol-related crashes. The model is divided into three sections, running from left to right. The first section covers *Primary Prevention* that, in this context, is the control of high-risk drinking. The center section, *Secondary Prevention*, focuses on separating drinking from driving. Finally, the third section, *Tertiary Prevention*, covers actions that can prevent future impaired driving by individuals who are apprehended for DWI.

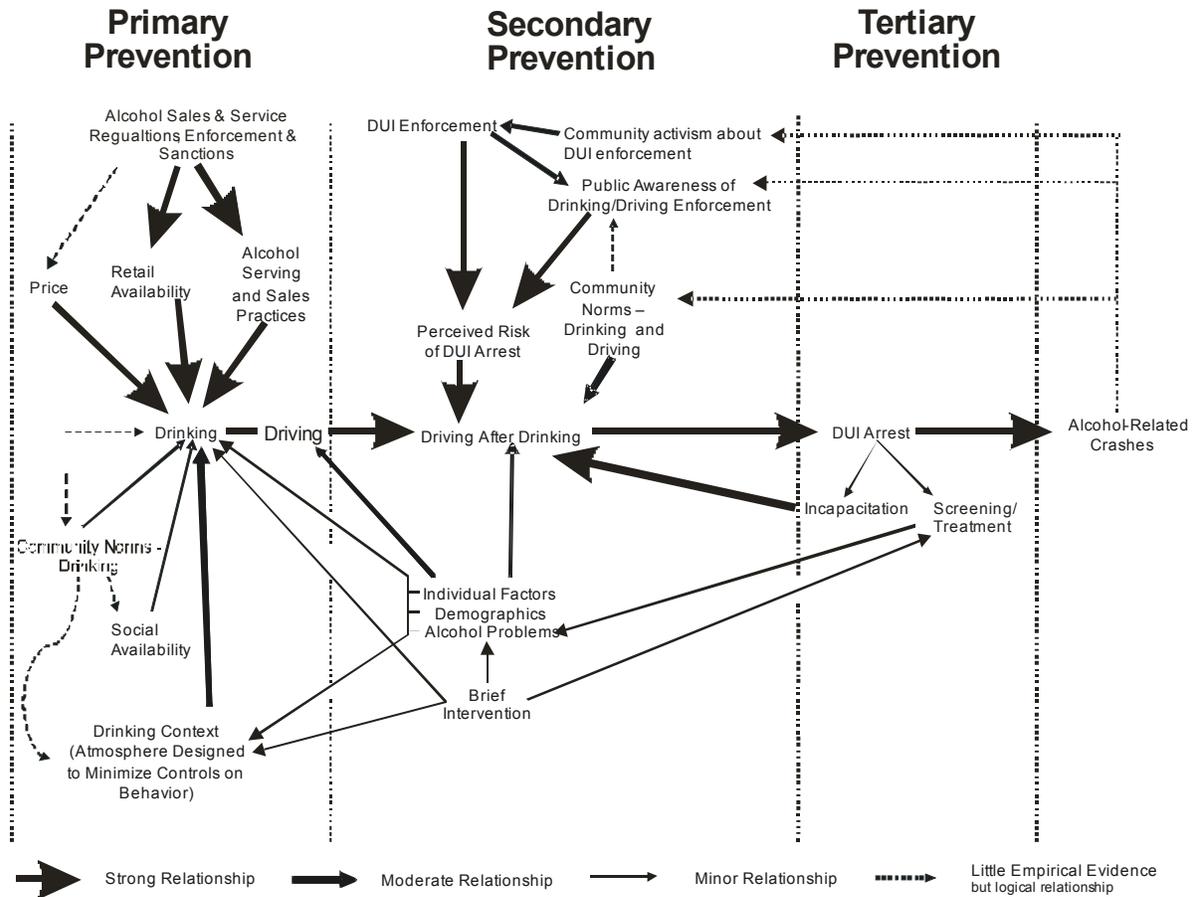


Figure 5-1. Alcohol-related motor-vehicle crash causal model. Adapted from Birckmayer, Boothroyd, Friend, Holder, & Voas (2008)

The central core of the model, moving from left to right, deals with three key elements that lead to involvement in alcohol-related crashes: drinking, driving, and the two combined. Historically, traffic safety specialists have been primarily concerned with impaired driving, so the principal countermeasures have been directed at deterring individuals from driving after drinking. Conversely, public health researchers have been primarily concerned with the factors that lead to heavy drinking, and drinking problems. After passage of the Federal MLDA law in 1984 and the Surgeon General's Workshop on Drunk Driving in 1988 (McCarthy & Harvey, 1989), the two fields have come together. Traffic safety researchers became much more involved with programs directed at reducing risky drinking such as responsible beverage service programs, keg registration, and the enforcement of underage drinking laws, whereas public health researchers became more interested in evaluating the consequences of traffic safety policies on drinking behavior. Thus, the model in Figure 5-1 expands the typical drinking-and-driving causal model to include strategies found to reduce the heavy drinking most associated with impaired driving.

The *Primary Prevention* portion of the model shows those programs that help reduce driving after drinking. Ross (1992b) highlighted the potential significance of transportation systems that could provide alternative transportation to and from locations where drinking occurs. Obviously, drinkers who do not drive or who have no access to a vehicle are not likely to become impaired drivers. Ross pointed to the greater availability of public transport in European countries as a protective factor reducing what might otherwise be a very high rate of alcohol-related crashes based on their heavy

alcohol consumption rate. In the United States, the use of *Designated Driver* and *Safe Ride Programs* (Apsler, 1989) has been encouraged by safety officials who recognize that the availability of alcohol and the opportunity to drive are necessary components of the impaired-driving problem.

The central section of the model in Figure 5-1 covers the traditional impaired-driving programs directed at those who both drink and have access to a motor vehicle. The central issue in *Secondary Prevention* is the separation of drinking from driving, generally by creating deterrence through the threat of legal sanctions (Ross, 1984). This area covers the development of effective drinking-and-driving laws, enforcement of these laws, and publicizing these laws, the objective of which is deterrence. For deterrence to be effective, drivers must have the perception that, if they drive while impaired, (1) apprehension is probable, (2) sanctions will follow swiftly, and (3) sanctions will be severe (Ross, 1984). Much of the focus in this area falls on obtaining highly publicized enforcement (Fell & Lacey, 2004) and ensuring that significant consequences will follow rapidly through administrative sanctions.

When deterrence fails, arrest and conviction for DWI offers a third level of program activity designed to prevent future impaired driving. *Tertiary Prevention* (the third section of Figure 5-1) covers interventions in two broad categories: (1) incapacitation through limiting future driving and (2) promotion of recovery from the alcohol problem that led to the impaired-driving conviction. DWI sanction programs that for the greater part of the 20th century focused primarily on punitive measures (such as jail or fines) have been modified to include screening for alcohol problems and treatment programs.

5.2. Primary Prevention: Reducing Risky Drinking

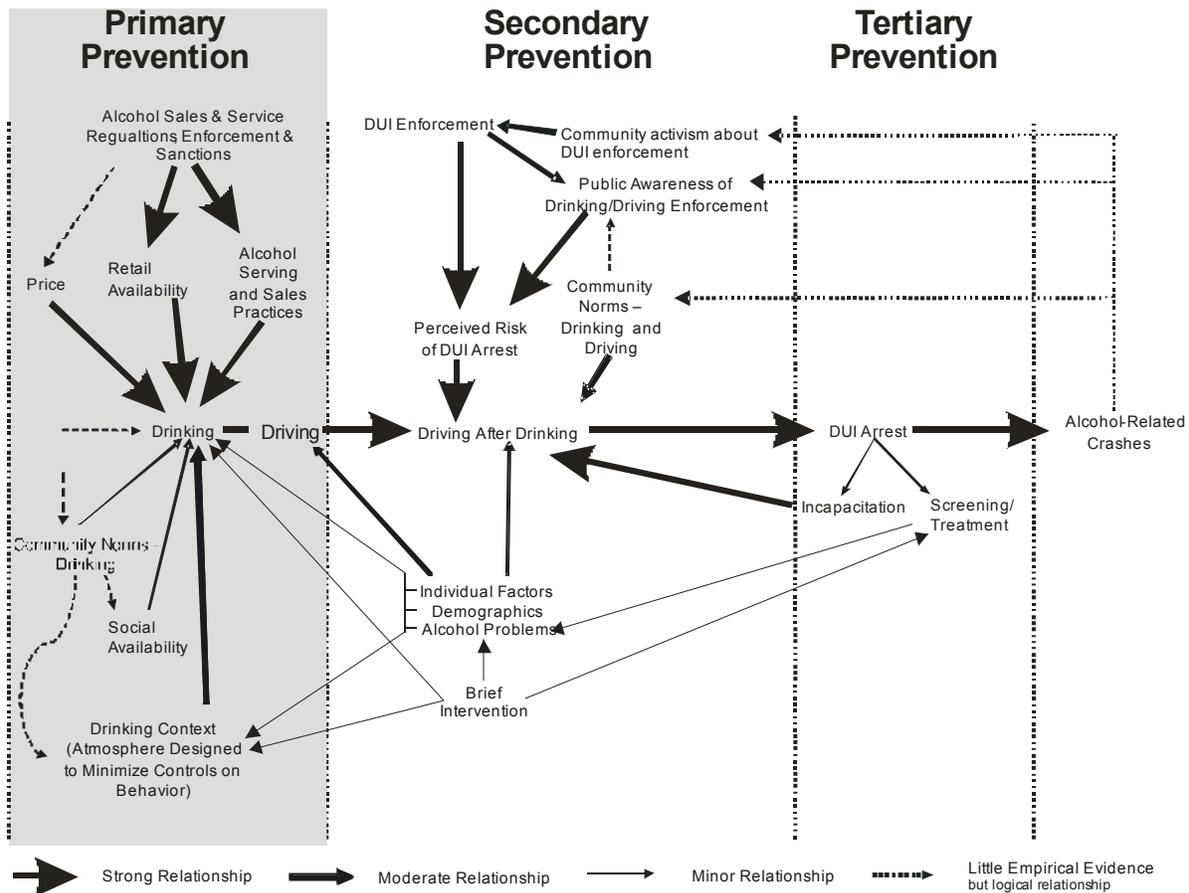


Figure 5-2. Alcohol-related motor-vehicle crash causal model—Primary Prevention. Adapted from Birckmayer et al. (2008)

This section reviews recent research on intervention programs in *Primary Prevention*. We begin by noting the role of individual factors in the effectiveness of intervention programs but point out that the burden of this section is to cover the policies and programs that can be applied to communities and environments rather than to individuals. The three principal strategies that can help reduce risky drinking (*Alcohol Price*, *Retail Availability*, and *Alcohol Serving and Sales Practices*) are covered first, followed by the factors that influence the effectiveness of those strategies (*Alcohol Promotion*, *Community Norms About Drinking*, *Social Availability*, and *Drinking Context*). Next is a review of programs for avoiding driving after drinking (*Designated Driver* and *Safe Ride Programs*), and the review concludes with a summary of the evidence for the major primary prevention programs.

The first major element in the model (Figure 5-1) is the reduction of high-risk drinking that, if combined with driving, leads to alcohol-related crashes. Because alcohol is a legal drug, the traffic safety interest is not in preventing its use, but rather in minimizing its high-risk use. High-risk consumption involves two elements: (1) the influence of alcohol on human physiology related to the chronic effects of alcohol on the body, and (2) the situation in which alcohol is consumed, which determines the extent of risk associated with acute impairment. “Safe” situations (e.g., at home where the alcohol consumed is usually eliminated overnight before the drinker undertakes activities that may

be risky, such as driving) may not involve high risk if the level and frequency of the drinking events is not so high that it produces chronic effects, such as alcohol dependence or physical symptoms. Within the limited scope of highway safety, the risk is minimized if drinking is not followed by driving. Some programs that are intended to minimize driving after drinking, however, may have unintended consequences. For example, programs such as *Safe Ride* or *Designated Driver* may encourage heavy drinking by passengers, a potential problem that cannot be ignored (Harding, Caudill, Moore, & Fressell, 2001).

5.2.1. Individual Factors

Several factors associated with the characteristics of the individual drinker (such as age, gender, health status, personality, and genetic background) are determinants of risky consumption, as suggested in Figure 5-1 by the path from “individual factors” to “drinking.”

The research on some of these individual characteristics, such as age and ethnicity, was reviewed in Chapter 4. In this section, we focus on programs and manipulating environments to reduce exposure to unhealthy drinking, rather than dealing with individuals. The model, however, must include several factors that increase a person’s likelihood of heavy drinking and/or developing alcohol use disorders. Evidence of genetic influences on heavy drinking includes studies of animals (McKinzie et al., 1996), twins, adoptees (Cloninger, Bohman, & Sigvardsson, 1981; Hrubec & Omenn, 1981), and children of alcoholics (Chassin, Rogosch, & Barrera, 1991). Age and gender are also linked with problem use. In 2001, there were approximately 1.5 billion episodes of binge drinking in the United States. Binge-drinking rates were highest among those ages 18 to 25; however, 70% of the binge-drinking episodes occurred among those age 26 and older (Naimi et al., 2003). Binge drinkers were 14 times more likely to report alcohol-impaired driving than were nonbinge drinkers (Naimi et al., 2003). “Heavy drinking” has been defined as consuming alcohol in excess of one drink per day on average for women and in excess of two drinks per day on average for men (National Institute on Alcohol Abuse and Alcoholism, 2004). In 2002, 5.9% of U.S. adults reported heavy drinking in the past 30 days; the prevalence of heavy drinking was greater for men (7.1%) than for women (4.5%). Information on normative and heavy drinking was covered in Chapter 3. In this section, we note the particular implications of programs for individuals with specific characteristics, such as females or young drivers.

5.2.2. Strategies for Reducing Risky Drinking

The model in Figure 5-1 suggests that three major strategies influence heavy drinking: *Alcohol Price, Retail Availability, and Alcohol Serving and Sales Practices*. These strategies are strongly influenced by *Alcohol Promotion, Community Norms About Drinking, Social Availability, and Drinking Context*, which are discussed in later sections.

5.2.3. Increasing Price

Economic theory holds that the demand for alcohol, as for many other products, responds both to price and to available income. Responses to price changes may differ from one group to another. For example, young people (who tend to have less disposable income) are more responsive to price than older people are (Pacula, 1998). The construct “price elasticity” provides a metric of responsiveness to price that can be compared across studies. It is measured as the percentage of change in per capita quantity of alcohol consumed divided by the percentage of change in price. This

measure provides an index (price elasticity) of the estimated percentage of change in alcohol use associated with a certain percentage of change in price.

Most research indicates that alcohol price and consumption or other alcohol-related outcomes are inversely related; that is, as the prices of beer, wine, and liquor increase, alcohol consumption and associated problems decrease. Likewise, as prices drop, use and related problems rise. Although the government can raise the price of alcohol by increasing excise taxes, tax hikes have not been widely used to influence drinking in the United States. Chaloupka, Grossman, and Saffer (2002) reported that alcohol prices remained stable during the last quarter of the 20th century; this price stability, combined with inflation, has produced real price reductions over time. Between 1975 and 1990, the real price of distilled spirits dropped by 32%, wine by 28%, and beer by 20% (Chaloupka et al., 2002).

The price of alcohol has been linked to heavy drinking and increased risk of alcohol-related harm. Evidence shows that higher taxes on alcohol reduce alcohol-associated public health problems including traffic crashes (Chaloupka et al., 1993; Cook & Tauchen, 1982). Cook (1981) studied the effect of 39 changes in State taxes on distilled spirits between 1960 and 1975. In 30 of the 39 instances, sales of distilled spirits and traffic fatalities fell after the tax increase. The reduction in total fatalities was attributed to the high proportion of fatalities that were related to alcohol. The total number of fatalities was inversely related to alcohol prices as measured by State alcohol excise taxes. Adrian, Ferguson, and Her (2001) used time-series analysis to study the relationship of alcohol consumption to alcohol-related crashes in the Province of Ontario from 1972 to 1990. They found a strong positive relationship between consumption and alcohol-related crashes ($r=.82, p<.01$) and between consumption and alcohol-related offenses ($r=.89, p<.01$). Adjusting the price for changes in inflation and income, they found a negative relationship to alcohol-related crashes but not to alcohol-related traffic offenses.

Chaloupka et al. (1993) and Mast, Benson, and Rasmussen (1999) found that increased price was associated with decreased drinking and driving among all ages, and Cook (1981) reported that increased taxes were related to fewer driving fatalities. Kenkel (1993) estimated that a 10% increase in alcohol price would result in 7% less drinking and driving among men and 8% less drinking and driving among women. Price effects were even greater among young men and women (13 and 21%, respectively). Dee (1999) and Dee and Evans (2001) reported that price increases would reduce motor-vehicle crash fatalities among those ages 18 to 20. Saffer and Grossman (1987a), after adjusting for inflation, found that increased beer taxes, combined with raising the MLDA, would reduce fatal crashes by 15% among 18- to 20-year-olds. In addition, many studies have shown that increased alcohol costs are associated with reductions in both violent and nonviolent crime (Cook & Moore, 1993; Grossman & Markowitz, 2001; Markowitz, 2000; Markowitz & Grossman, 1998; Markowitz & Grossman, 2000; Saffer, 2001).

Researchers who study the influence of price on youth typically also consider effective enforcement of MLDA laws, as the two are highly associated with youth access to alcohol. Based on the 1982 and 1989 Monitoring the Future surveys, Laixuthai and Chaloupka (1993) reported that raising the MDLA to 21 across all States, combined with higher beer taxes, decreased youth drinking, particularly among heavy users. Researchers consistently report that young drinkers are more sensitive to the price of alcohol than are adults, particularly young, heavy drinkers. Studies of the effects of price on youthful drinking have also reported gender effects. Chaloupka and Wechsler (1996) estimated that a tax increase would reduce the number of female college students who drank by 15% and who binge drank by 20%, but they found no effect for men. They suggested that these results

could be attributable to the “cost” of alcohol on college campuses, which includes both the retail price and the ready availability of alcohol at parties and other social situations.

There is considerable debate in the literature regarding whether abusive drinkers are less price-sensitive than nonabusive ones. Becker and Murphy (1988), in their Rational Model of Addiction, hypothesized that addicts consider the future consequences of the decision to consume their chosen substance of abuse so that price increases will decrease use likelihood among them, just as it might for nondependent individuals. Empirical studies support the Becker and Murphy (1988) model. Grossman (1993) found that a 10% increase in alcohol price would reduce cirrhosis mortality, which typically occurs in heavy drinkers, by an estimated 8.3 to 12.8% (Adrian et al., 2001). One strategy that some communities have undertaken is to regulate the sale of alcohol (e.g., restrict “happy hours” and other price promotions of alcohol, especially in on-premises outlets, such as bars and restaurants). Although this is a reasonable approach, there is no research on the effects of these regulations on prices.

5.2.4. *Limiting Availability*

Although the price indirectly limits the availability of alcohol to youth and possibly to other high-risk drivers, there is clearer evidence for the influence of governmental restrictions on sales and on the conditions under which alcohol is sold. Regulation of alcohol sales and the enforcement of government regulations is a State function. Following the period of Federal prohibition, States were free to enact alcohol control legislation; some States continued to ban sales, whereas other States liberalized their regulations or essentially eliminated controls on sales, except for prohibitions against sales to the obviously intoxicated or to underage youth. The age limit for youths to purchase alcohol was standardized across the 50 States by the passage of the Federal minimum legal drinking age law in 1984.

5.2.4.1. Minimum Legal Drinking Age Laws

One strategy that reduces drinking by underage individuals, which should also reduce alcohol-related motor-vehicle crashes, is restricting retail access to alcohol through minimum purchase age laws. Raising the minimum purchase age to 21, which has been adopted by all 50 States plus the District of Columbia, has resulted in decreased alcohol consumption among the affected age group (O'Malley & Wagenaar, 1991; Wagenaar, 1982; Williams & Lillis, 1986; Wagenaar & Toomey, 2002). Strategies to limit youth access to alcohol have generally involved some combination of merchant education, community participation and mobilization, and enforcement in the form of compliance checks and penalties for violators (OJJCP, 1999). Multiple component policies that include community participation and enforcement, as well as media publicity, may reduce access by as much as 35 to 40% (Grube, 1997; Wagenaar et al., 2000b).

The staff at U.S. General Accounting Office (GAO, 1987) reviewed 32 published research studies, both before and after the law changed. They concluded that there was solid scientific evidence that increasing the minimum age for purchasing alcohol reduced the number of alcohol-involved traffic crashes for those age 21 and younger. These and more recent studies uniformly show that increasing the minimum drinking age significantly decreases self-reported drinking by young people, the number of fatal traffic crashes, and the number of arrests for DWI.

Yu, Varone, and Shackel (1997) found a 70% decrease in self-reported alcohol purchase by 19- to 20-year-olds after implementation of a minimum drinking age of 21 in New York State.

O'Malley and Wagenaar (1991) found that the minimum age affected self-reported alcohol use among young people and reduced traffic crashes. Indeed, the effect on motor-vehicle crashes continued well after young people reached the legal drinking age. Klepp, Schmid, and Murray (1996) found that implementation of the uniform minimum legal drinking age of 21 in the United States reduced the overall prevalence of drinking and driving. Saffer and Grossman (1987a; 1987b) and Wagenaar (1981, 1986) indicated that raising the minimum legal drinking age from 18 to 21 decreased single-vehicle nighttime crashes involving young drivers by 11 to 16% at all levels of crash severity. Voas, Tippetts, and Fell (1999b) studied the uniform age 21 MLDA law using data from all 50 States and the District of Columbia for the years 1982 through 1997. They concluded that the enactment of this law was responsible for a 19% net decrease in fatal crashes involving young drinking drivers after controlling for driving exposure, beer consumption, enactment of zero-tolerance laws, and other relevant changes in the laws during that period.

In the most comprehensive review to date, Wagenaar and Toomey (2002) analyzed all identified studies (132 documents) published between 1960 and 1999 on the drinking age. They coded eight key variables for each study. These variables included the jurisdiction (i.e., State or province) studied, specific outcome measures analyzed (e.g., self-reported drinking, motor-vehicle crash fatalities), and whether the study was specific to college student populations. In addition, each study was rated on three indicators of methodological quality. In 48 of the studies, the effects of changes in the drinking age on alcohol consumption were examined, using 78 alcohol consumption measures (e.g., sales figures, self-reported drinking). Of the 78 measures, 45% showed that a higher legal drinking age was associated with reduced alcohol consumption among youth, whereas five of the measures showed that a higher drinking age was associated with greater adolescent consumption.

Wagenaar and Toomey (2002) found 57 published studies that assessed the effects of changes in the legal minimum drinking age on indicators of impaired driving and traffic crashes. They analyzed 102 crash outcome measures (e.g., fatal crashes, drink-driving crashes, self-reported driving-after-drinking), and in more than 50%, they found that raising the drinking age reduced crashes and lowering the drinking age raised the crash rate. Only two found a positive relationship between the legal drinking age and traffic crashes. Of the 95 analyses that included comparison groups, 50 (53%) showed a statistically significant effect of changing the drinking age on motor-vehicle crashes.

5.2.4.2. Enforcement of Minimum Legal Drinking Age Laws

The effectiveness of laws restricting youth's access to alcohol is strongly affected by the extent to which they are enforced. Enforcement generally takes the form of "stings" employing underage decoys. For example, in an undercover buying operation conducted by the Michigan State Police, underage purchases of alcohol were reduced by 73%, or from 75% at baseline to 20% at the program's conclusion (Michigan State Police, 1989). Another example of a sting operation was conducted in Denver, where underage police cadets purchased alcohol 59% of the time at baseline, which dropped to 32 and 26% with increased enforcement (Preusser, Williams, & Weinstein, 1994).

Nationally, however, weak enforcement appears to be the norm; consequently, youth can easily access alcohol (Jones-Webb et al., 1997a; Radecki & Strohl, 1991; Wagenaar, 1993). Forster, Murray, Wolfson, and Wagenaar (1995) reported the results of an enforcement program conducted in 24 communities in Minnesota and Wisconsin. They found that buyers who were age 21, but looked underage, could buy alcohol about 50% of the time. Purchases by such pseudopatrons at off-premises establishments were more successful if the clerks were male and the store was located in a residential

area or mall. On-premises buys by pseudopatrons were more successful if the server looked younger than 30; if the establishment was a restaurant/bar combination, as opposed to bar alone; and if warning signs were posted. The authors suggest that this might be because the signs may have substituted for more substantive merchant educational programs. Wagenaar and Wolfson (1994) found that, without adequate penalties, attempts to reduce underage retail sales were likely to be ineffective. They reported that only 2 of every 1,000 occurrences of underage drinking resulted in an arrest.

The enforcement of laws against sales of alcohol to youth varies considerably across States. States that take youth drinking less seriously have much lower arrest rates for violations of the laws on sales to youth; other States that apparently take sales of alcohol to youth seriously have much higher arrest rates for violations of the law (Wagenaar & Wolfson, 1994). These authors concluded that, where penalties were lenient, there was inadequate threat to deter providers of alcohol from selling alcohol or providing alcohol to underage people. Consequently, they concluded that the enforcement and penalties against providing alcohol to youth were inadequate to serve as an effective deterrent. Further, because few commercial establishments were cited for serving/selling alcohol to youth, there was no real practical level of deterrence for retail establishments (Wagenaar & Wolfson, 1994). More recently, Wagenaar, Toomey, and Erickson (2005b) have reported on a community trial featuring the enforcement of the MLDA law through police checks of outlets. They found that the enforcement effort was primarily effective against the locations checked by law enforcement officers and that the effect of that enforcement wore off after 3 months, suggesting that a long-term intermittent effort is required to produce lasting results.

5.2.4.3. Limiting Retail Availability

Availability is how accessible or convenient it is for individuals to obtain alcohol (independent of the cost of alcohol). In general, when alcohol purchases are convenient and easily accessible in a given community, people drink more and the rates of alcohol problems are higher. Conversely, when alcohol is less convenient (e.g., fewer retail outlets with limited hours of sale) and less accessible (e.g., restrictions on drinking age), people generally drink less and problem rates are lower. Retail availability of alcohol can be affected by license restrictions, hours of sale, minimum age of purchaser, and alcohol outlet density (distance to a retail outlet). Research on restrictions or limits on retail availability of alcohol have generally demonstrated an overall effect on the level of consumption by the general population and on alcohol-related problems (Gruenewald & Treno, 2000).

Some researchers have suggested that a variety of alcohol problems related to drinking establishments are more likely to occur when these places are clustered. These studies have included motor-vehicle crashes (Watts & Rabow, 1983; Rush, Gliksman, & Brook, 1986; Scribner, MacKinnon, & Dwyer, 1994; Jewell & Brown, 1995; Gruenewald et al., 1996a) and pedestrian injury collisions (Lascala, Gerber, & Gruenewald, 2000; LaScala, Johnson, & Gruenewald, 2001). Findings have shown that other alcohol-related problems, such as measures of abuse, respond to alterations in the availability of alcohol (Chiu, Perez, & Parker, 1997).

Gruenewald (1997) analyzed geographically based data from four communities to evaluate the relationships between measures of the physical availability of alcohol and rates of driving after drinking. From his review of the literature, they expected that rates of driving after drinking would be directly related to the availability of alcohol at on-premises establishments. Further, based on theoretical arguments regarding the life activities that underlie drinking and driving, the author expected that the effects of availability upon these outcomes would extend significantly beyond the

local area of outlets. Taking into account the geographic variations in environmental characteristics (road network density, traffic flow, and population density), socioeconomic factors (age, gender, race, marital status, income, and employment), and drinking characteristics (rates of abstention, and frequency and quantity of use) of resident populations, they conducted a spatial analysis of drinking and driving and alcohol-related crashes. The results of their analysis showed that physical availability was unrelated to self-reports of driving after drinking or the more problematic driving while intoxicated, but was significantly related to the rates of recorded single-vehicle nighttime crashes. In the latter case, physical availability affected both local and adjacent area rates of crashes.

5.2.4.4. Hours and Days of Sale

Several studies have shown that changing either the hours or the days of alcohol sales can redistribute the times at which many alcohol-related crashes and alcohol-related violence occurs (e.g., Smith, 1988b; Ligon & Thyer, 1993; Nordlund, 1984, Nordlund, 1985; Hauge & Nordlie, 1984; Österberg E & Säilä S-L, 1991; Vingilis et al., 2006; Voas, Tippetts, Johnson, Lange, & Baker, 2002d; Voas, Romano, Kelley Baker, & Tippetts, 2006d). Smith (1988b), for example, found that the introduction of Sunday alcohol sales in the city of Brisbane, Australia, was related to casualty and reported property damage caused by traffic crashes. Another study in Australia showed an increase in traffic crashes and assaults following extensions of alcohol outlet trading hours. Chikritzhs and Stockwell (2002; 2006) examined the effect of longer hours of sales for licensed hotels in Perth, Western Australia, on levels of associated impaired driver road crashes and driver BAC levels. They applied time-series analyses using multiple linear regressions to determine whether an association existed between the introduction of extended trading (longer hours) and (1) monthly levels of impaired driver road crashes associated with Extended Trading Plan (ETP) hotels, and (2) driver BAC levels associated with ETP hotels. Trends associated with non-ETP hotels were included as controls and possible confounders were considered. After controlling for the trend in crash rates associated with non-ETP hotels and the introduction of mobile police breath-testing stations to Perth freeways, a significant increase in monthly crash rates for ETP hotels was found. This relationship was largely accounted for by the higher levels of alcohol content in beer, wine, and spirits purchased by ETP hotels. No relation was found between the driver BAC levels and the introduction of ETPs. Late trading was associated with increased levels of impaired-driver road crashes and alcohol consumption, particularly of high-risk alcoholic beverages.

Voas et al. (2002d; 2006d) took advantage of a natural experiment that occurred when on January 1, 1999, in Juárez, Mexico, across the border from El Paso, Texas, when the Mexican government implemented a requirement that bars, previously open all night, close at 2 a.m. For their study, they conducted quarterly breath-test surveys of drinkers returning to El Paso from a night of drinking in Juárez and found that the number returning after 3 a.m. dropped to almost to zero. Further, for 2 years following the 2 a.m. closing policy, the number of drinkers crossing into Mexico was reduced by 50% overall; however, there was no change in the average BAC level of the reduced number who continued to drink in Juarez. During the next 5 years, the number of drinkers crossing into Juárez gradually increased to the original level, but they returned early since the 2 a.m. closing hour in Juarez was maintained throughout the 7-year period.

Vingilis et al. (2006) found that when the bars in Ontario, Canada, were allowed to remain open for an extra hour (closing at 2 a.m. instead of 1 a.m.), there was no significant increase in alcohol-related crashes in Ontario. There was, however, an increase in alcohol-related fatal crashes in

U.S. communities bordering on the crossing into Windsor, Ontario, which regularly receives a large number of young Americans patronizing its bars on weekends.

5.2.4.5. Types of Retail Outlets

Whether in a formal or an informal market, alcoholic beverages are sold to the retail customer in two forms. One form is off-premises sales, which is the purchase of closed containers of alcohol for consumption elsewhere. The opportunities to affect these off-premises retail outlets are thus limited to regulations on the time, cost, and place of the alcohol sales. The other form of alcoholic beverage sales is in open containers (e.g., drinks served in glasses or other drinking vessels), with consumption usually occurring on or about the premises where the drink is purchased. These are typically called on-premises retail outlets. Here, the opportunities to influence drinking and its context, and the potential consequences, are broader, because there is an opportunity to directly influence what happens during and after the actual purchase. Regulations may specify drink sizes; disallow discounted drinks, such as during “happy hours”; and require responsible beverage service training, provide programs, such as *Safe Rides* for drinking drivers, and so on. Further, regulations may also control the design and furnishing of the tavern or restaurant and specify matters such as food service, availability of entertainment, and other non-alcohol-specific matters.

Regulation of on-premises alcohol outlets has a rich and detailed history in many societies. Within the on-premises category, restaurants are often differentiated from taverns, according to whether food or drinking is the primary activity. Cross-sectional studies have found that drinking and driving is associated with bars and restaurants and, in particular (in Australia), with bars serving beverages with high alcoholic content (Gruenewald, Stockwell, Beel, & Dyskin, 1999, Gruenewald, Millar, Ponicki, & Brinkley, 2000; Stockwell, Lang, & Rydon, 1993).

There is an interaction between restrictions on sales, such as hours and days (discussed previously) and the type of outlets. For example, the effects of changes in hours or days of sale are likely to be dependent on the context and may primarily affect specific subpopulations of drinkers. Often, much cheaper alcohol is available through off-premises than through on-premises sales, so the hours of operation of off-premises sales are likely to have the greatest effect on the most marginal drinkers. This effect, however, will be limited if the restrictions apply only to particular forms of alcohol. Those drinking late in taverns, particularly on weekdays, are usually an especially heavy-drinking segment of the population. Restrictions on closing hours for on-premises drinking should consider the collective nature of much on-premises drinking and the predictable violence and police problems that commonly occur in and around drinking places in many societies. Using local land-use powers, communities in California often enforce early-closing times to limit closing-time disturbances in the neighborhood to a reasonable hour (Wittman, 1997). Further, setting the closing hours at a later hour than the local public transport system runs invites unsafe journeys home.

Retail availability of alcohol is shaped by State and local regulations that determine the number, location, types, and serving and selling practices of alcohol retailers. There is a great deal of variation in how States and localities regulate retail availability. Some are very restrictive, whereas others have only limited controls.

5.2.4.6. Densities or Concentration of Retail Outlets

Several longitudinal studies have demonstrated that a change in the number of outlets is related to a change in alcohol use. When overall availability is low, the addition of a few outlets can have noticeable effects on drinking. Gruenewald, Ponicki, and Holder (1993) conducted a time-series cross-sectional analysis of alcohol consumption and density of alcohol outlets across 50 U.S. States. The results suggested that a 10% reduction in the density of alcohol outlets would reduce consumption of spirits by 1 to 3% and consumption of wine by 4%.

The number of outlets grows as the population grows, and the number of outlets located along roadway systems is in terms either of population densities (numbers of outlets per person) or of geographic densities (numbers of outlets per kilometer of roadway). In developed societies, people may easily obtain alcohol by driving or using public transport. Limiting the number of outlets for alcoholic beverages increases the effort required to find and travel to a liquor store, known in economic terms as “opportunity cost” for obtaining alcohol. Thus, limiting the number of outlets may raise the “full price” effect of obtaining alcohol (Grossman, Coate, & Arluck, 1987; Gruenewald, 1993). Greater levels of outlet density also exist in many cities in the U.S. today. Densities of bars, restaurants, and off-premises establishments have been observed to reach the level of one outlet for every 75 feet of roadway in many California cities (Gruenewald & Treno, 2000). The number of outlets may be restricted directly or indirectly through policies that make licenses more difficult to obtain (e.g., through increasing the cost of a license). Several States limit the number of alcohol outlets and control the price of alcohol by maintaining State-run (rather than privately owned) outlets. A trend in the last few decades has been to privatize such State monopolies.

5.2.4.7. Outlet Locations

The location of alcohol sales outlets may be limited by local, State, or national provisions. For instance, an outlet typically cannot be located in violation of local zoning laws that limit the outlet locations to particular kinds of commercial sites. Another common provision used by many States forbids location of an alcohol sales outlet near a school or place of worship. Further, the density of outlets may be limited by requiring a minimum distance between them. Alcohol sales may also be forbidden at such locations as highway rest stops. These laws and regulations serve various purposes outside the direct regulation of outlet behaviors (e.g., restricting the exposure of youth to alcohol sales and use), but all serve to restrict, directly or indirectly, the availability of alcohol within specific neighborhoods. Little evidence is available on the extent to which these provisions influence the overall rates of alcohol-related problems, though one study suggests that locating an outlet near a highway system may affect alcohol-related crashes more than locating the same outlet in a dense downtown area (Gruenewald & Treno, 2000).

5.2.4.8. State Retail Monopolies

One form of retail alcohol regulation is for the government to monopolize ownership of one or more types of outlets. The idea of government ownership of alcohol sales outlets in the interest of public order or public health first arose around 1850. A government monopoly typically greatly reduced the number of outlets, limited the hours of sale, and removed the private profit motive for increasing sales. Miller, Snowden, Birckmayer, and Hendrie (2006) determined that State retail alcohol monopolies are associated with reduced underage drinking and impaired-driver fatalities younger than 21. Using regression analyses, they estimated the effects of monopolies on drinking,

binge drinking, the impaired-driving fatality rate of drivers younger than 21, and the odds that a deceased driver younger than 21 was alcohol-positive. The regressions controlled for States with midnight driving curfews. In States with a retail monopoly over spirit or wine and spirit sales, an average of 14.5% fewer high-school students reported drinking alcohol in the past 30 days, and 16.7% fewer reported binge drinking in the past 30 days than did high-school students in nonmonopoly States. Monopolies over both wine and spirits were associated with larger reductions in consumption than monopolies over spirits only. Lower consumption rates were associated with a 9.3% reduction in the impaired-driving fatality rate of drivers younger than 21 in monopoly States versus nonmonopoly States, suggesting that alcohol monopolies prevent 45 impaired-driving fatalities each year.

The evidence is quite strong that these government alcohol monopolies hold down rates of alcohol consumption and alcohol-related problems (e.g., alcohol-related motor vehicle crashes). The evidence suggests that elimination of government off-premises monopolies typically increases total alcohol consumption. Thus, large-scale changes in alcohol distribution systems among States in the United States have led to much larger numbers of alcohol outlets (e.g., through the privatization of alcohol monopolies) resulting in increased alcohol sales (Holder & Wagenaar, 1990; Wagenaar & Holder, 1995). A summary of seven time-series analyses of six U.S. States and of New Zealand showed a consistent increase in total consumption when government-owned off-premises outlets were replaced with privately owned outlets (Wagenaar & Holder, 1996). Several studies showed substantial long-term increases in alcohol sales following privatization (Holder & Wagenaar, 1990; Wagenaar & Holder, 1991a, Wagenaar & Holder, 1995), although others showed only short-term increases (Mulford, Ledolter, & Fitzgerald, 1992). Until effects of such privatization are fully evaluated, States should consider preventing privatization because reversal of this process is not politically feasible. Typically, the network of stores in a government-operated system is sparse rather than dense, and the hours of operation are limited.

5.2.4.9. Liquor by the Drink

Allowing distilled spirits to be sold “over the counter” by the glass in licensed establishments (which has been called “liquor by the drink”) occurred in 20-plus States over several years after prohibition ended in America. Holder and Blose (1987) conducted an interrupted time-series analysis of liquor-by-the-drink sales in North Carolina, where in 1979 individual counties were allowed to implement over-the-counter sales. Analyzing those counties that sold liquor by the drink to a comparison set of counties that continued to ban liquor-by-the-drink sales from January 1973 through December 1982, they found that spirits sales rose between 6 and 7.4%. Liquor by the drink was also associated with statistically significant increases of 16 to 24% in both the number of police-reported alcohol-related crashes and in single-vehicle nighttime crashes among male drivers age 21 and older in counties allowing liquor-by-the-drink sales. No change in alcohol-related crashes was found for counties banning liquor-by-the-drink sales. Single-vehicle nighttime crashes involving male drivers younger than age 21 did not change for the experimental or the comparison counties (see Blose & Holder, 1987).

5.2.5. Promoting Responsible Alcohol Serving and Sales Practices

Alcohol consumption affects judgment and may lead to poor decisions about continued drinking. Bartenders and servers who are not drinking can observe customers and make sounder judgments regarding their state of intoxication. They have the opportunity to intervene with drinkers who may become illegal drivers or become involved in alcohol-related violence. Their job, however,

is to sell alcohol, and cutting off customers creates the risk of an unpleasant scene and the loss of a tip. Efforts to take advantage of the opportunity for servers to intervene with customers at risk have generally been called “responsible beverage sales programs.”

5.2.5.1. Responsible Beverage Service Programs

Beginning in the mid-1980s, a major effort was undertaken to encourage alcohol servers—bartenders, wait staff, managers, and owners—to comply voluntarily with laws prohibiting the sale of alcoholic beverages to visibly intoxicated patrons. Generally referred to as “*Responsible Beverage Service Programs*,” these efforts have been most comprehensively described by Mosher and Jernigan (1989). These programs generally involve three basic elements: (1) control of service to prevent intoxication, (2) refusal of service to visibly intoxicated individuals, and (3) actions to prevent intoxicated patrons from driving after leaving the premises. Actions that control service include avoiding reduced prices or oversized alcoholic drinks and serving food with alcoholic drinks. Refusal of service primarily involves training of servers so they can recognize signs of intoxication and learn techniques for persuading drinkers to switch to food or nonalcoholic beverages. Preventing patrons from driving impaired primarily involves relying on *Designated Driver* programs where the group’s driver is given free soft drinks or the establishment offers free *Safe Ride* programs to the patron’s home. Most State ABC laws only cover “refusal of service” (item 2). The other elements of the typical responsible beverage service program are voluntary. Managers must be motivated to adopt the sales policies, some of which may decrease profits (e.g., no low price promotions). This generally occurs when such programs are adopted by local hospitality organizations in response to public pressure; consequently, these policies have not been implemented consistently.

Thus, an important opportunity to reduce impaired driving by patrons of drinking establishments lies in the prevention of service to intoxicated individuals through the enforcement of State ABC laws. This has placed a focus on the service of alcohol in bars and restaurants – intervention by servers and managers that reduce service to potential impaired drivers because it does not rely upon appeals to avoid driving to drinkers whose judgment may be impaired by alcohol. Over the past decade, several “server intervention” programs have been developed and taught as a way to promote responsible serving practices (McKnight, 1996). Several States and many municipalities have enacted laws that either mandate server education directly or create strong incentives (e.g., providing some shelter from dram shop litigation) for outlet managers to send their serving staffs to training programs.

Evaluations of server training programs have shown some significant shifts toward more responsible service on the part of both servers and managers of licensed establishments (Russ & Geller, 1986; Saltz, 1987; Gliksman & Single, 1988; McKnight, 1988; Mosher, Delewski, Saltz, & Hennessey, 1989; Howard-Pitney, Johnson, Altman, Hopkins, & Hammond, 1991; Saltz & Hennessey, 1990a; Molof & Kimball, 1994; Stockwell et al., 1993; Saltz & Stanghetta, 1997). Favorable outcomes, however, have been largely limited to efforts aimed at preventing patrons from becoming intoxicated rather than those directed at refusing service. McKnight (1991) examined the effects of server education programs upon service to “pseudopatrons” who simulated signs of visible intoxication. The random-controlled experiment involved 1,500 observations of service. Results were extremely discouraging. Refusals of service only occurred 5% of the time before training and 7% of the time after training. There was a significant increase in efforts by servers to discourage further drinking, however, indicating they recognized the signs of intoxication. Stockwell (1993) found

refusal rates of only 10% before and after training, and reductions in the number of high BAC levels (>.15 g/dL) that were short lived.

One of the few studies reporting a favorable outcome for server training was that of Holder and Blose (1994), who reported a drop in SVN crashes following enactment of Oregon's statewide mandatory server education law. The drop did not coincide with implementation of the law, however; and without evidence that the drop occurred only among SVN with no change in daytime or multivehicle crashes, it could not legitimately be attributed to anything having to do with alcohol. Further, not paralleling the actual training of servers renders it questionable evidence of server training. Molof and Kimball (1994) reviewed the Oregon program in depth, including crashes where alcohol involvement was measured. As they observed no decline in alcohol-involved fatalities, they concluded that the available evidence did not support the conclusion that server training had a significant effect on either service to impaired customers or crashes resulting from server training requirement.

Saltz and Hennessy (1990a) concluded that server training alone was unlikely to have a significant effect upon patron intoxication and that management must be prepared to alter policies that lead to overdrinking. In a review of the literature on impaired driving countermeasures, Shults et al. (2001) contended that responsible beverage service could be effective in reducing patron intoxication when it was accompanied by strong and active management support. Experience has shown that, to refuse service, servers must have the strong support of management as demonstrated by actions such as the manager taking over when a patron becomes angry and replacing wait staffs' tips when unhappy patrons fail to provide a gratuity. Thus, the key to an effective policy of refusing service to obviously intoxicated patrons is to strongly motivate managers to support the denial of service. This generally must be accomplished by creating the perception that ABC laws are being strongly enforced and that illegal service will be detected, potentially resulting in the suspension of the establishment's liquor license. In the absence of this enforcement pressure on management, training of servers will have little effect.

5.2.5.2. Enforcement of Alcohol Service Laws

Based on an analysis of the four limitations on the effectiveness of the ABC laws against service to visually intoxicated individuals, a novel enforcement system was developed and tested in Michigan (McKnight & Streff, 1994). Here, the police department invited all the outlet managers in the city to meetings where they were informed that enforcement of the prohibition against service to intoxicated people was to be intensified through stepped up undercover visits to their establishments. Those officers would be looking for evidence that visually intoxicated patrons were being served. To help objectify the criteria on which the officers would act, a list of signs derived from McKnight and Marques (1990) was provided and explained to the attendees at orientation meetings. The nature of the enforcement effort and penalties for alcohol service violations were also detailed.

Each visit to an establishment by plainclothes officers resulted in either an immediate citation or a followup letter revealing that the visit had taken place. The officers used standard procedures for citing the establishment if they actually observed an intoxicated patron being served and issued a citation during the visit. In those much more numerous cases where the officer did not issue a citation, a letter was sent to the proprietor to make him or her aware of the visit and to report the officer's observations during the visit. The letter left the impression that enforcement officers could be present

at any time, thus increasing the deterrent effect of the program. It also provided a warning to managers about observed activities that appeared to put them at risk for a citation in the future.

The Michigan program's effectiveness was tested by applying it in one college community with a similar community serving as control. Two evaluation measures were used: (1) records of the place of last drink of drivers arrested for driving under the influence and (2) service to "pseudopatrons" simulating the specified signs of intoxication. The analysis showed arrested drinking drivers coming from licensed establishments in the experimental community declined from .317 to .233, a decrease of 25% in the relative number of DWI offenses, whereas the proportion increased slightly in the comparison site. Denial of service to "pseudopatrons" rose from 18 to 54% of purchase attempts at licensed establishments – a threefold increase – whereas service at the comparison site showed much smaller declines (McKnight & Streff, 1994). This study provides strong evidence that where the criterion for denial of service can be objectified and enforcement intensified, service to intoxicated individuals can be reduced.

An estimated 50% of impaired drivers had their last drink at a licensed establishment (O'Donnell, 1985). Toomey et al. (2004) reported that, across studies assessing propensity for alcohol sales to obviously intoxicated patrons, sales rate estimates ranged from 58 to 85% for on-premises establishments (e.g., bars). Obviously, the extent of high-volume consumption, high BAC levels, and high-risk drinking is influenced by the serving-and-sales practices of licensed retail outlets. Using actors presenting obvious signs of intoxication, Toomey et al. (1999) found that these actors were served alcohol more than 60% of the time. Several studies have found that, following server training and the initiation by a retail establishment of "responsible serving practices" (e.g., avoiding oversized drinks and drink specials), servers will curtail service to obviously intoxicated customers. Some studies, for example, have shown that, after training, servers reduce service to obviously drunk customers, resulting in fewer intoxicated patrons leaving the bar and fewer incidents of violence (e.g., Wallin, Norstrom, & Andreasson, 2003).

Intervention training programs for servers can include teaching servers about ABC laws, identifying intoxicated patrons, offering patrons food with drinks, delaying service to rapid drinkers, refusing service to intoxicated or underage patrons, and discouraging intoxicated patrons from driving. The content covered, instructional time, and the training method (e.g., face-to-face versus videotaped) varies widely. Some programs are offered in classroom settings by professional trainers; others consist only of a video or written material that employees are encouraged to use on their own. Some programs also evaluate the alcohol serving policies of a drinking establishment and recommend changes to reduce intoxication, such as eliminating drink promotions, serving a variety of nonalcoholic beverages, or increasing the availability of food (see Rydon & Stockwell, 1997, for a summary of RBS strategies for licensed establishments). RBS can be implemented at both on-premises (Saltz & Stanghetta, 1997) and off-premises establishments (Grube, 1997).

Saltz and Hennessy (1990b, 1990a) and Saltz (1988,) demonstrated that server training is most effective when coupled with a change in actual serving policy and practices of a bar or restaurant. RBS has been found to reduce the number of intoxicated patrons leaving a bar (e.g., Dresser & Gliksman, 1998; Gliksman et al., 1993; Saltz, 1987, 1989). RBS training may decrease the likelihood that customers will become intoxicated, thus decreasing the chance that customers will drive while intoxicated (Lapham, Skipper, Chang, Barton, & Kennedy, 1998). A key factor, however, is the extent to which management supports the servers by adopting strong, responsible serving practices.

McKnight (1988) conducted the largest national study of a server and manager training program and found that servers, following the training, intervened with pseudopatrons simulating obviously drunk individuals only 5% of the time. Whether RBS interventions can reduce minors' use of alcohol is less clear. Establishments with firm and clearly stated policies (e.g., that all patrons who appear younger than 30 must have their identifications checked), coupled with a system for monitoring staff compliance, are less likely to sell alcohol to minors (Wolfson et al., 1996a; Wolfson et al., 1996b). Some studies, however, showed interventions had little effect (Grube, 1997). In at least one study, however, RBS training was associated with an increase in self-reported checking of identification by servers. The apparent changes in behavior persisted among trained servers for as long as 4 years (Buka & Birdthistle, 1999).

5.2.5.3. *Laws That Support (Enforce) Server Training*

It is important for owners to support their servers through the adoption of responsible serving policies for their outlets. Among the factors that motivate owners to adopt such practices are the legal risks they face from third-party lawsuits related to injuries caused by their customers. To encourage owners to provide server training, some State laws provide some protection against such legal action if they participate in responsible beverage service programs.

Server Training Laws. Mosher, Toomey, Good, Harwood, and Wagenaar (2002) conducted a qualitative analysis of 23 State RBS laws that either mandated server training or supported server training by providing some liability protection to outlet owners. He found that RBS legislation was weak across all States overall. Although some States were strong in one or two of the RBS components, almost all States were weak in at least one component. Other factors, including other laws and regulations, can influence serving practices in licensed establishments. These factors include enforcement of existing ABC laws, server liability (or dram shop) laws, high-profile server liability cases, and community coalitions to encourage responsible serving practices.

Dram Shop Liability Law. Dram shop laws allow individuals injured by an adult or a minor who is under the influence of alcohol to recover damages from the alcohol retailer who served or sold alcohol to the person causing the injury (Holder et al., 1993; Mosher, 1979; Mosher et al., 2002; Sloan, Stout, Whetten-Goldstein, & Liang, 2000). In some jurisdictions, the retailer can also be liable for the damages the minor or drinker causes to himself or herself. Owners and licensees can be held liable for their employees' actions under most or all dram shop liability laws (Mosher et al., 2002). Many statutes covering dram shop liability include a responsible business practices defense. Key to the defense is evidence that the retailer had trained his or her staff, both servers and managers; had established management policies designed to deter irresponsible sales and service; and had fully implemented the training procedures and policies at the time of the sale or service.

Research suggests that implementation of dram shop liability may lead to significant increases in checking age identification and to greater care in service practices (e.g., Sloan et al., 2000). The available studies also indicate that dram-shop-liability laws can significantly reduce SVN crash fatalities, alcohol-related traffic crash fatalities, and total traffic crash fatalities among minors (Chaloupka et al., 1993; Sloan, Reilly, & Schenzler, 1994; Sloan et al., 2000). Further, the research indicates that such laws also reduce alcohol-related traffic crashes, total traffic crashes, homicides, and other unintentional injuries in the general population (Chaloupka et al., 1993; Sloan et al., 1994, Sloan et al., 2000). Overall, dram shop liability has been estimated to reduce alcohol-related traffic fatalities among underage drivers by 3 to 4% (Chaloupka et al., 1993). The perceived likelihood of being

successfully sued under dram-shop-liability statutes may be important. Wagenaar and Holder (1991b) examined effects on the frequency of injuries due to motor-vehicle crashes of a sudden change in exposure to legal liability of servers of alcoholic beverages in Texas. Using a multiple time-series quasi-experimental research design, including ARIMA and intervention-analysis statistical models on injury data from 1978 through 1988, they controlled for the effects of other policy changes expected to influence injury rates in Texas and for broader nationwide changes in injury rates in the 1980s. They found 6.5 and 5.3% declines in injurious traffic crashes following the filing of two major liability suits in 1983 and 1984.

The use of dram shop liability has been advanced as a potential tool to deter sellers and social hosts from irresponsible selling or providing of alcohol. This is discussed in reports by Mosher (1984) and Holder et al. (1993). Much of the research concerning the effects of tort liability, in general, and dram shop liability, in particular, has focused on intoxicated people who subsequently are involved in a traffic crash. Because selling or serving alcohol to people under the legal drinking age can also be grounds for liability in many States, this also becomes a part of the possible prevention strategies to reduce alcohol service and sales to youth, especially when an intoxicated minor is involved in a traffic crash. In addition, youth are more likely than are older people to be driving while impaired by alcohol (Gruenewald, Mitchell, & Treno, 1996b).

Legal (Tort) Liability. Liability and administrative regulations have the power of court or legal regulation to hold people or establishments responsible for sale or service of alcohol to youth and the social provision of alcohol (social hosts) to youth. Tort liability concerning drinking and alcohol sale or service establishes civil penalties, usually a fine or liability for civil suit, for those who are found responsible for specific types of alcohol-involved harm, including providing alcohol to minors (see discussion by Sloan et al., 2000). Most tort liability provisions and court actions have been directed at licensed establishments for providing alcohol to an underage person. The rationale for establishing third-party liability, rather than first-party offenders (e.g., drunks or minors), recognizes that such parties may lack the ability to make appropriate compliance decisions (Kraakman, 1998), that there are fewer third parties to regulate, that third parties can be efficient monitors of alcohol service practices, and that commercial sellers are in a better financial position to render compensation. Most States require that the individual must be eligible (i.e., of legal age) to consume the alcohol sold. Under these statutes, a third party, not the minor, may institute the legal action against the seller or provider of the alcohol. Therefore, even if a licensed establishment's sale/service of alcohol to the minor may be illegal, the minor cannot establish the statutory cause of action. Despite this limit, tort liability can affect sales to minors because, if the underage person is served alcohol and then injures a third party, that person can sue the bar or restaurant that provided the alcohol. Hence, making those who provide alcohol to youths, who then subsequently injure others, liable for damages should deter them and others from providing alcohol to youth.

Evidence of the relationship between alcohol regulations and alcohol-related motor-vehicle crashes is provided by Sloan et al. (2000), who analyzed traffic fatalities across all States and examined the potential effect of several fatality factors over time and across States. In particular, they examined the effect of tort liability on commercial servers for selling alcohol to underage drinkers and found that imposing such tort liability on commercial services resulted in reduced fatality rates for drivers younger than 21 (actually 15- to 20-year-olds) controlling for other dependent variables. Their single cross-sectional and time-series study demonstrated the potential of tort liability regarding the selling of alcohol to people younger than 21. Even though a single study, the use of data from all 50

States across time increases the strength of their conclusion and the import of their findings. The only issue for replication concerns the selection of other intervening and explanatory variables not included by these authors. For example, their study did not include a variable for social host liability.

5.2.5.4. Laws and Enforcement

Regulations are the formal laws, rules, and standards that govern alcohol distribution and sales or service in establishments that are licensed to sell alcohol. Enforcement refers to enforcing policies to decrease the use of alcohol. Official policies might include arrest, prosecution, and punishment to help reduce alcohol availability and alcohol-related violations. Punishment might include fines to stores that sell alcohol to minors or stiff penalties to drivers who drive after drinking. The distinguishing characteristic of the enforcement domain is the reliance on the formal criminal justice system to implement penalties. “Informal enforcement” is also an important complement to formal mechanisms. For example, “informal enforcement” might be the community members who unite to boycott stores that sell alcohol to minors.

Some alcohol policies, such as increases in excise taxes, can be implemented without significant enforcement effort. For many strategies, however, enforcement appears to be a key determinant of effectiveness. The deterrent effect of alcohol policies depends upon their severity, the probability of their imposition, and the swiftness of their imposition (e.g., Ross, 1982a). Although severe, penalties for many alcohol offenses are seldom enforced and, thus, can be expected to generate only a modest deterrent effect (Hafemeister & Jackson, 2004). Arrests of minors for possession of alcohol, for example, are rare. This is partly because of the burden of prosecuting them as a criminal violation and partly the reluctance of law enforcement and courts to enforce criminal penalties. Moreover, because criminal proceedings are often lengthy and removed in time from the infraction, the punishment is seldom swift or certain.

Janes and Gruenewald (1991) developed a classification system to measure physical and economic availability. They classified formal laws and regulations governing activities of State ABC agencies in the United States into 10 categories of physical availability and 4 categories of economic availability. These categories were subjected to similarity analysis to determine variation among States. Kruskal’s stress-one measure revealed three major dimensions of alcohol control laws: forms of retail sales, administrative penalties for violations of alcohol control laws, and price restrictions. This finding suggests that the license/monopoly distinction frequently used to categorize State alcohol control systems is inadequate to characterize the variations in control systems.

5.2.5.5. Laws against Serving Obviously Intoxicated Patrons

Currently, 47 States and the District of Columbia prohibit sales to obviously intoxicated people (Florida, Nevada, and Wyoming are the only exceptions). Nevertheless, alcohol sales to obviously intoxicated patrons in on-premises establishments, such as bars, occur 58 to 85% of the time. These laws are often not enforced by the police and are ignored by bar and liquor store owners. In one study, Toomey et al. (2004) used trained actors who tried to buy alcohol while appearing intoxicated. Over 10 months, these actors visited 372 bars and liquor stores in 11 communities. The research team found 79% of the establishments sold alcohol to these “pretend” drunks.

5.2.6. Factors Effectng Control Programs

5.2.6.1. Alcohol Advertising

Alcohol advertising and other pro-drinking messages are ubiquitous in many Western countries, including the United States. Images of alcohol are transmitted via billboards, signs in stores, sponsor logos, magazine and print messages, routine television and radio programming, and drinking events depicted in movies, books, and comics. Entertainment and sports that are popular among youth are strongly associated with alcohol industry sponsorships (Hill & Casswell, 2001). Portrayals of alcohol use in advertising are typically positive (i.e., a problem-free activity without harmful consequences). Media characters in alcohol advertising tend to be wealthy, upper class, managers and professionals who are familiar to viewers; and content analysis has linked alcohol with a highly valued lifestyle that is successful, relaxed, romantic, and adventurous (Grube, 1993).

Exposure to drinking in popular media, such as television and movies, also influences social norms regarding alcohol. Wallack, Grube, Madden, and Breed (1990) found that drinking occurs more often on television than in real life, thereby potentially creating the impression that drinking is normative, popular, and widespread. Skog (1985) reported that the extent to which a given group's consumption fell above or below a national average influenced the effects of media exposure on use.

5.2.6.2. Alcohol Promotion to Drinking

Several studies have explored the association between alcohol advertising experiences and drinking behavior, focusing on intentions to drink, and alcohol advertising effects, especially on youth. Atkin, Neuendorf, and McDermott's (1983) U.S. national survey of 1,227 respondents ages 12 to 22 showed a positive correlation between the amount of exposure to beer, wine, and liquor advertisements and excessive alcohol consumption and drinking in hazardous contexts. Respondents identified excessive consumption themes and hazardous drinking that were depicted in some ads, and many inferred an endorsement of such behaviors by the sponsoring company. A survey of 655 respondents in the 7th to 12th grades found that those who reported being exposed to more alcohol advertising on television and in magazines drank more or expected to begin drinking soon (Atkin, Hocking, & Block, 1984).

Kuo, Weschler, Greenberg, and Lee (2003) provided compelling evidence linking price and promotions to problem drinking among college students. They analyzed the 2001 College Alcohol Study, which surveyed more than 10,000 college students, as well as 830 on-premises and 1,684 off-premises venues at 118 colleges. Results showed that low price, heavy advertising, and other promotional activities were associated with increased heavy drinking among college students and with the total number of drinks consumed.

The intensity, omnipresence, and provocative content of advertising and other promotion practices raises questions about the contribution that alcohol promotion makes to problem drinking. Researchers have established links between exposure of children to advertising and their later attitudes toward alcohol, intentions to consume, and actual consumption.

Atkin (1990) noted that alcohol commercials have a slight affect on alcohol misuse and on drinking and driving. He also reported that commercials can contribute to a modest increase in overall consumption by teenagers and that advertising and programming with positive images of drinkers leads the viewer to develop favorable attitudes toward alcohol. Researchers who reviewed studies on

the content analysis of television programs concluded that the message conveyed is that alcohol consumption is widely practiced and normative in many situations (Atkin & Block, 1981; Atkin et al., 1983).

So far, a definitive answer has not emerged as to whether alcohol advertising is a consistent contributing cause of aggregate rates of consumption and drinking-related problems. Whatever the unique effects of alcohol advertising might be at the aggregate level, they are likely overshadowed by other environmental factors, such as the real price of alcoholic beverages, alcohol taxes, or alcohol retail availability or outlet density. Although empirical evidence of the direct effect of alcohol advertising on aggregate drinking levels remains ambiguous, research from the 1990s suggests that young people are influenced by media portrayals of alcoholic beverages (see Casswell, 1995a, and Grube, 1995). Future panel studies with longer timeframes should offer further insights into the direction and nature of influences.

Despite the lack of definitive evidence regarding the effects of alcohol advertising at the aggregate level, the rationale for its restriction is based more on its indirect effects on the social climate surrounding alcohol (Casswell, 1995b; Hill & Casswell, 2001; Partanen & Montonen, 1988). Alcohol advertising may communicate a meta-message of society's approval (Postman, Nystrom, Strate, & Weingartner, 1988) and may reduce the likelihood of other public policies being implemented (Farrell, 1985; Van Iwaarden, 1985; see also Casswell, 1995b).

5.2.6.3. Advertising Restrictions and Bans

At the aggregate level, a central focus has been on the trends in alcohol advertising, the per capita consumption, and the drinking problems. Studies on these trends have examined the effects of advertising restrictions, but methodological and practical issues (e.g., substitution of alternative sources of advertising for those banned, permeability of advertising from outside jurisdictions) suggest that the findings are inconclusive (Montonen, 1996).

Studies of natural experiments on partial advertising bans have shown conflicting results as to their effectiveness in reducing consumption levels (Montonen, 1996). Research on the partial advertising bans in Canadian provinces (Ogborne & Smart, 1980; Smart & Cutler, 1976) failed to show clear effects, perhaps because advertising from outside the province was not restricted. Other international researchers found that bans produced no drop in consumption and that stricter rules did not produce lower rates of drinking (Simpson, Beirness, Mayhew, & Donelson, 1985). In contrast, a major cross-national time-series study of advertising bans implemented in the European Community countries during the 1970s showed significant effects, including lower levels of consumption and alcohol-related problems, as indicated by motor-vehicle fatality rates (Edwards et al., 1994; Saffer & Grossman, 1987a; Saffer, 1991; Saffer, 1993a, 1993b, 1995, 1998).

Restrictions on alcohol promotion have been promulgated to reduce the attractiveness of alcohol as a socially acceptable and available item, particularly among youth for whom promotion appears to be designed primarily to recruit new users. The alcohol industry tends to argue that marketing serves only to set brand preference, not to attract new consumers. The alcohol industry has announced a voluntary ban on advertising to youth; despite that policy, however, considerable advertising occurs on electronic media that appeals to underage drinkers. A report from the Centers for Disease Control and Prevention (CDC, 2006) focused on advertising directed at underage drinkers. The report describes a survey conducted by the Center on Alcohol Marketing and Youth (Health

Policy Institute, Georgetown University, District of Columbia) that evaluated the placement of individual radio advertisements for the most advertised U.S. alcohol brands and the composition of audiences in the largest 104 markets in the United States. This report indicated that alcohol advertising is common on radio programs that have disproportionately large, youthful audiences and that this advertising accounts for a substantial proportion of all alcohol radio advertising heard by underage youth. Thus, the industries' current voluntary standards limiting alcohol marketing to youth appears to lack validity.

5.2.6.4. Counter-Advertising

Counter-advertising is the dissemination of information about a product, a product's effects, or the industry that promotes it to decrease its appeal directly (Stewart, 1997). Counter-advertising can take the form of health-warning labels on product packaging, media literacy efforts to raise public awareness of industry tactics, and a module in community or school prevention programs (e.g. Giesbrecht & Douglas, 1990; Greenfield & Zimmerman, 1993). Research on such media campaigns have thus far has been limited primarily to evaluations of the federally mandated warnings on alcoholic beverage containers.

Warning-label legislation is among the few U.S. Federal alcohol policies motivated by public health concerns to be successfully enacted after 20 years of legislative attempts (Kaskutas, 1995). It was enacted in 1988 (P.L. 100-690) and implemented in November 1989. The warning label mandated on all alcohol containers carried a "Government Warning" tagline and alluded to the Surgeon General as the source of the information covered. The warnings included (1) birth defect risks during pregnancy; (2) impairment when driving; (3) impairment when operating machinery; and (4) health problems. Some States also require posted warnings of alcohol risks in establishments that serve or sell alcohol.

A nationally sponsored evaluation showed that a significant proportion of the population report having seen the warning labels (Graves, 1993; Kaskutas & Greenfield, 1992). Self-reported precautionary behaviors have been found, including increased caution regarding drinking and driving and drinking during pregnancy (Kaskutas & Greenfield, 1992; Greenfield, 1997; Greenfield & Kaskutas, 1998; Greenfield, Graves, & Kaskutas, 1999). No direct effects of warning labels on alcohol-related problems have been reported. Much of the effect seen is consistent with the intent of Congress to remind the public of certain risks associated with drinking (Greenfield et al., 1999), although measured effect on youth (MacKinnon, Pentz, & Stacy, 1993) and college students has not been significant. In Snyder and Blood (1992) experimental study of college students, participants viewed advertisements for alcoholic products, some with the U.S. Surgeon General's warning, and some without. They found that the warnings did not increase perceptions of alcohol risk and even made products more attractive to both drinkers and nondrinkers. Conversely, the U.S. Warning-Labels Study showed that awareness—as indicated by conversations about risks—was greater among the more frequent drinkers, including young adults (Kaskutas & Greenfield, 1997; Greenfield & Kaskutas, 1998).

There is evidence that synergies are achieved by implementing multifaceted strategies, such as health messages on signs at the point of purchase and PSAs (Kaskutas & Graves, 1994; Kaskutas, Greenfield, Lee, & Cote, 1998). Greenfield and Kaskutas (1998) noted that, although after 4 or more years, warning-label exposure rates may have leveled off, penetration of the warning-label message had been sufficient to reach numerous heavy drinkers (Greenfield, 1997). The more drinkers handle

(open) containers, and the more alcohol they purchase, especially for men, the more likely they are to have seen and therefore will recall the label's messages. Thus, warning labels ensure that those most involved in drinking will have exposure to health messages.

Exposure to warning labels stimulated conversations about the risks of drinking during pregnancy among women of childbearing age (Kaskutas et al., 1998); this increase in attention was not limited to those with high levels of health consciousness (Kaskutas & Greenfield, 1997). Conversely, studies in prenatal clinics yielded little indication that the warning label had any effect on drinking by inner city ethnic minority women (Hankin, Sloan, & Sokol, 1998), so certain groups at particularly high risk probably are not being effectively reached.

Giesbrecht and Grube (2003) cite only one experimental evaluation of the effects of warning labels. Snyder and Blood (1992) apparently randomly assigned college students to view six advertisements for alcoholic products, both with and without the U.S. Surgeon General's warning. The warnings had no effect on perceptions of the risk of drinking; they actually made products more attractive. MacKinnon et al. (1993), in a survey of a national sample of youth, found increases in self-reported awareness of, exposure to, and memory of the labels after they were required, but as a consequence, they found no substantial changes in alcohol use or beliefs about the risks targeted by the warning. Lipsey and Derzon (2002) did a meta-analysis of 72 evaluations of media campaigns designed to discourage adolescent substance use. They estimated modest effect sizes as follows: alcohol use (53 to 51%), tobacco use (37 to 35%), and marijuana use (24 to 22.5%).

5.2.6.5. Community Norms About Drinking

Community norms about drinking refers to the level of acceptability (or unacceptability) of drinking in general, as well as of levels of drinking (such as heavy drinking or drinking to drunkenness). The norms, expectations, and values of a society are powerful determinants of behavior in a variety of ways. To some extent, all of the laws and policies and other strategies discussed above are the formal codification of these norms. Norms and values, however, exert a strong influence on behavior even when legal or formal detection and punishment is unlikely. These values and norms are part of the broader culture, but they can vary within a given community, social group, or subculture.

Communities that adopt laws and policies that restrict behavior or punish violations are more likely to shape norms and values that are less tolerant of alcohol excesses. Thus, many of the most well known strategies for preventing alcohol problems can be seen as expressions of community values. A well-publicized enforcement campaign to reduce sales of alcohol to minors not only reduces underage access to alcohol, but it also affirms the value the community places on protecting its young people. Similarly, prohibition of alcohol sponsorship of a community celebration is a control on alcohol advertising (and possibly of availability). It also asserts the community's commitment to an environment in which alcohol is less prominently featured.

Salience refers to the importance that individuals in a given group attribute to social norms regarding alcohol consumption. It appears to vary over time. For example, salience in terms of alcohol was demonstrated in the increased news coverage of drinking and driving in the United States in the 1980s and more recently (Clark & Hilton, 1991; Mouden & Russell, 1994). Although the salience of the concern with drinking and driving has shown some decay in relation to news coverage, social reinforcement appears to have maintained salience of the issue as measured by national surveys (Royal, 2003).

5.2.6.6. *Citizen Activism*

In the early 1980s, the public’s attitude toward drinking and driving was substantially transformed. Citizen activism is generally given credit for this change. The first citizen activist group dedicated to fighting drunk driving, called “Remove Intoxicated Drivers (RID),” was established by Doris Aiken in New York State in 1978. But it was not until 1980 that the victim activist movement began to garner national attention. Concurrent with the growth in national attention to the victims of drunk driving and the founding and growth of MADD, media coverage of alcohol safety issues increased substantially (Figure 5-3), as did the DWI laws being considered by State legislatures (Figure 5-4). Figure 5-3 clearly shows a major increase in media coverage of the drunk-driving issue beginning in 1980. Most observers (McCarthy, Wolfson, & Harvey, 1987) have given credit to victim activist groups, particularly MADD, for this sudden increase in press coverage. The sanctions for impaired driving also increased; hence, the strong growth in impaired-driving legislation shown in Figure 5-4. Merki and Lingg (1987) concluded that MADD had been a major force behind the adoption by the States and communities of eight effective impaired-driving strategies.

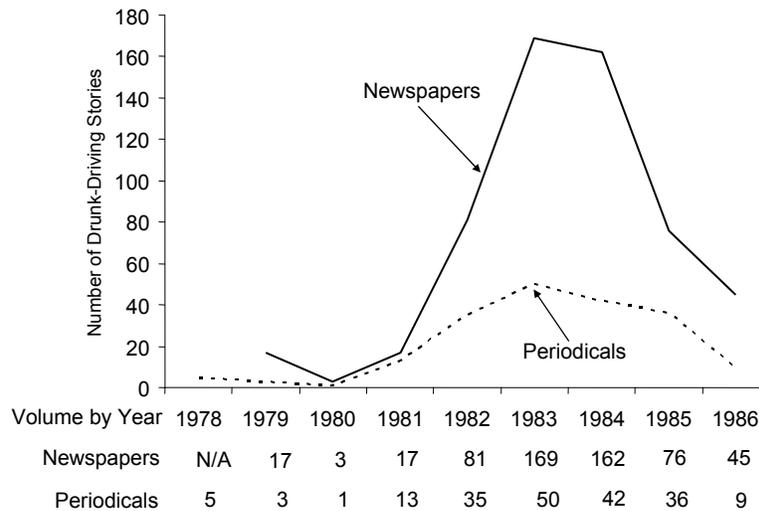
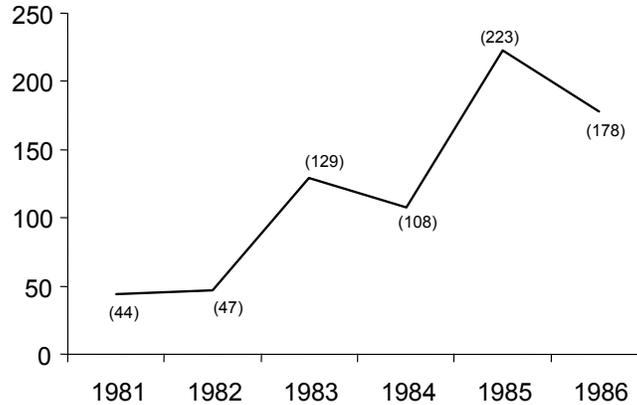


Figure 5-3. Number of news stories on drunk driving, 1979 to 1986¹. Adapted from (Howland, 1988)

¹ Volume of National Newspaper and Periodical Coverage of Drunk Driving by Year. Newspaper volume based on count of stories in the National Newspaper Index (includes *The New York Times*, the *Los Angeles Times*, *The Wall Street Journal*, and *The Washington Post*). Periodical volume based on the Magazine Index.



Source: Howland, 1988, pp. 163-176

Figure 5-4. Number of drunk-driving laws passed by States from 1981 to 1986. Adapted from (Howland, 1988)

In the following two decades, perhaps the six most important pieces of alcohol safety legislation in the last quarter century were enacted: (1) MLDA 21 laws, (2) zero tolerance for youth laws, (3) .08 BAC limit laws, (4) ALS laws, (5) illegal per se laws, and (6) increased sanctions for repeat DWI offenders. Activist organizations played a central role at both national and State levels in obtaining the passage of the first three laws, as was indicated by the MADD and RID presidents being invited to be present at the formal signing of a number of the bills. Moreover, during this period, Congress took the unusual step of authorizing the withholding of highway safety funds from States that did not enact MLDA 21, zero-tolerance, and .08 laws, the only three pieces of alcohol safety legislation on which this action has been taken.

One mechanism that helped move States to adopt new legislation was the “*Rating the States*” (RTS) program. Initiated by MADD in 1991, the program evolved into a continuing series of reports (Fell & Voas, 2006c) that provided a letter grade score in nine impaired-driving program areas: (1) DWI laws, (2) DWI enforcement, (3) DWI sanctions, (4) underage-drinking programs, (5) victims’ issues, (6) political leadership, (7) State traffic records systems, (3) regulation and control of alcohol sales, and (9) alcohol-related fatality trends. Each report was released at a national news conference, which stimulated extensive coverage by the news media. Individual State press events also were held, and in several States, the news coverage stimulated action by the State’s governor or the State’s legislature to adopt needed legislation (Russell, Voas, DeJong, & Chaloupka, 1995).

Although much of the information that went into the RTS program was qualitative, limiting its usefulness for program evaluation, Shults, Sleet, Elder, Ryan, and Sehgal (2002) found that the RTS grades that the States received were associated with self-reported impaired driving in those States. This association between MADD State grades and a measure of alcohol-impaired driving was calculated using multiple logistic regression analyses on the Behavioral Risk Factor Surveillance System (BRFSS) survey data from each State. Those living in States with a MADD grade of “D” were 60% more likely to report driving after drinking too much than those living in States that received an “A” grade from MADD. The association was for both men and women. These findings suggest that stronger State-level DWI laws, enforcement, and programs are associated with alcohol-impaired driving (Shults et al., 2002).

The role of victim advocate organizations in producing deterrence to drinking and driving is generally accepted but is difficult to quantify. The Harris polling organization, however, reported that its annual national survey of U.S. adults showed an increase (from 68% in 1983 to 74% in 1986) in respondents who said they never drink or they never drove after drinking (Howland, 1988, p. 169). CDC (1986a, 1986b) also reported reductions in impaired driving in its State behavioral risk surveys. The percentage of respondents in their BRFSS surveys who reported “driving after drinking too much” decreased from 5.5% in 1984 to 4.5% in 1986 (CDC, 1986a, 1986b). Two national Gallup surveys conducted in the early 1990s indicated that 71% of the public recognized MADD’s name unaided, and when the term “MADD” was recognized, 95% of the respondents perceived that the organization was effective in reducing impaired driving (Gallup Organization, 2000; Gallup Organization, 2005).

Only one study (McCarthy & Ziliak, 1990) has attempted to measure directly the contribution of an activist organization to crash reduction. Limited to the State of California, the authors, using data from the State’s crash files and the number of MADD chapters covering the years from 1982 to 1985, concluded that the incidence of DWI crashes in a locality increases the probability that a MADD chapter will be established in the community. Further, they found that the presence of a MADD chapter significantly reduced the number of DWI injury crashes. McCarthy and Ziliak also confirmed the expectation that a higher level of enforcement activity reduced alcohol-related crashes involving injuries.

In addition to the McCarthy and Ziliak (1990) study, Merki and Lingg (1987) found a measurable relationship between the presence of a MADD chapter and a reduction in DWI-related injury crashes. They concluded that MADD has been a major force behind whether States and communities adopted eight effective impaired-driving strategies. Marshall and Oleson (1996) also described the beneficial effects of MADD’s victim services, and McCarthy and Wolfson (1996) concluded that an affiliation with MADD appears to energize local leaders in countering impaired driving. Compton (1988) found a preliminary effect of the adjudication of DWI offenders due to MADD’s court-monitoring program. Fell and Voas (2006c), in a review of MADD’s first 25 years (1980 to 2005), found that the Nation has seen reductions in impaired drivers on the roads and alcohol-related fatalities. They surmised that these reductions are partially due to the increased news coverage of the drinking-and-driving problem and the growth of State DWI legislation, the impetus for which has come from MADD and other activist organizations.

5.2.6.7. Cultural Factors in Drinking

Countries differ in alcohol consumption, not only because of differences in the price and physical availability of alcohol, but also because of differences in social values and norms about drinking (Makela, Osterberg, & Sulkunen, 1981; Osterberg, 1991; Yang, 2002). Skog (1980) observed that the tendency of individuals living in “dry” environments (i.e., environments that do not sanction drinking and/or excess drinking) is toward becoming light, rather than heavy, alcohol consumers. Likewise, individuals inhabiting “wet” environments might show a propensity toward heavier use. Thus, the more prominent drinking is in a community, the lower the abstinence rates are likely to be. The percentage of population abstaining depends partly on the relative importance of drinking in the community.

Community norms about alcohol use may reflect society’s knowledge about and attitudes towards real or perceived outcomes associated with heavy use. For example, Paglia and Room (1998)

reported that, from a sample of 994 adults in Ontario, more than 75% of participants associated alcohol with aggression and held individuals responsible for their behaviors when intoxicated. Girasek, Gielen, and Smith (2002) conducted a telephone survey of 943 U.S. adults. Their sample accurately estimated the proportion of fatal fall, drowning, and poisoning victims who were legally impaired when they died. Although there were some issues about which participants were less accurate (e.g., an overestimation of the number of intoxicated drivers involved in fatal crashes), results generally indicated a high level of public awareness about alcohol's contribution to social problems.

Based on a survey of 149 offenders and 149 community participants in an Australian community, Baum (2000) reported that both groups showed a high level of knowledge generally but were less knowledgeable regarding the number of drinks that would likely put a driver over the legal limit. Both groups also agreed about the importance of measures to reduce impaired driving. The two groups differed, however, on attitudes towards impaired drivers, with the community members holding the more negative attitudes.

Perceptions regarding alcoholism are shaped by several competing factors. Based on a review of 266 articles on alcohol use, Crawford (1984) found that the term "alcoholism" had negative perceptions that varied according to the respondent's sociodemographic and drinking characteristics, as well as the time and location. In a later report, Crawford, Thomson, Gullion, and Garthwaite (1989) reported that attitudes towards deviancy, rather than perceptions of alcoholism as a disease, were important in determining humanitarian attitudes towards alcoholics. Greenfield and Room (1997) reported that U.S. national surveys conducted between 1979 and 1990 showed that drinking level, Protestant affiliation, and/or age were significant predictors of accepting drinking or drunkenness.

Caetano (1987) surveyed 482 California residents regarding their attitudes towards alcoholism and its treatment. Most stated that alcoholism was an illness, but 40% asserted that alcoholics chose to drink. Participants were generally supportive of abstinence, rather than controlled drinking, as a desirable treatment goal. Responses did not differ according to whether the participant had been affected by alcoholism or whether they had their own drinking problem.

Community values regarding acceptable or unacceptable consumption levels may vary not only by subgroup, but also within a subgroup by drinking location. Greenfield and Room (1997) examined the results of eight comparable questions from national surveys and found that norms regarding the social acceptability of heavy drinking varied by situation, showing greater acceptability at home, and less in a bar, particularly among men. Trends indicated that there was increasing acceptance of both men and women drinking in bars. Parker (1995) showed that as drinking becomes a part of routine activities away from home, the risk of victimizations can increase. Moreover, they reported that fights and arguments are more likely to occur in bars and pubs than elsewhere.

Community norms can be expressed in public policies designed to restrict alcohol use and the drinking context. Public policies can serve as proxies that help indicate a given group's social norms, particularly regarding heavy use. Such attitudes, in combination with other types of research, might represent another means of understanding a group's alcohol-related community norms. Generally, results of surveys in both the United States and abroad showed increasing support over time for restrictions on alcohol access and use (e.g., Giesbrecht & Greenfield, 1999; Pendleton, Smith, & Roberts, 1990).

Based on a newly developed instrument to assess attitudes towards alcohol policies, Latimer, Harwood, Newcomb, and Wagenaar (2003) found that policies limiting underage use were among the

most widely supported of the five assessed (marketing, consumption in public places, distribution, tax increases, and youth access). They speculated that support for such policies might be partly because they do not directly affect adults. Least supported were policies that limited distribution, primarily because such policies reduced access for both heavy and average drinkers.

The public's view of alcohol has varied somewhat over time. In the early 1980s, when many of the activist organizations were founded, press coverage focused on the concerns with the problem of impaired driving. Torronen (2003) found a somewhat different perspective when he examined commentaries on alcohol policies from six daily newspapers between 1993 and 2000. Their results showed that editorials were slanted towards liberalization of alcohol policies. This perspective peaked, however, in 1996 and 1997 and then declined during the latter portion of the decade, as disruption from heavy drinking and use among youth became the more prominent issues. These findings are consistent with those of Lemmens, Vaeth, and Greenfield (1999) who conducted a content analysis of five major U.S. newspapers between 1985 and 1991 and found that most articles depicted alcohol either neutrally or negatively.

5.2.6.8. Community Support for Enforcement

Community participation and mobilization are important complements to formal enforcement efforts because inadequate community support for such interventions may serve to reduce resources dedicated to enforcement (Wagenaar & Wolfson, 1994, Wagenaar & Wolfson, 1995). Lewis et al. (1996) found that enforcement implemented through a community coalition could be just as effective in reducing youth access to alcohol as more traditional enforcement mechanisms. In their study, liquor stores under citizens' surveillance showed a reduction in underage sales, from 83% to 33%, compared to a decrease from 45% to 36% at control sites.

5.2.6.9. Legal Supports for Community Action

Typically, communities that become concerned with drinking and drinking-and-driving problems develop consortiums of local organizational leaders (Holder, 1996) who organize and support programs to reduce risky consumption. Such organizations can develop a comprehensive program to reduce dangerous alcohol consumption by using existing laws (which are often poorly enforced) and passing local ordinances. Among the legal opportunities is strengthened enforcement of minimum legal drinking age laws (Wagenaar et al., 2000b), impaired-driving laws (Voas, 1997), and laws against service to the obviously intoxicated (Saltz & Stanghetta, 1997).

Communities can also enact ordinances that provide special controls over the availability of alcohol. Some communities have established regulations to restrict "happy hours" and other price promotions of alcohol, especially in on-premises outlets (i.e., bars and restaurants). The relationship of such regulations to price and thus to consumption has been little researched, but given the price elasticity of alcohol consumption, it is reasonable to postulate that any action affecting the retail price to the consumer can influence the demand for alcohol. In a few jurisdictions, tort liability also includes social hosts based on the rationale that social hosts can monitor their guests' drinking before driving and the serving of alcohol to minors.

University communities can create special regulations related to the student population. These local regulations can limit the locations of bars relative to the university or control the noise and nuisances surrounding off-campus student housing. Universities generally have their own policies or

formal regulations that provide for sanctions against youth for the possession of alcohol on school or university property. The penalties are usually a part of the school's policies that ban or restrict the possession or provision of alcohol on school property. Such policies are so popular among schools, colleges, and universities that nearly half of the elementary, middle/junior high, and senior high-schools in the United States have explicit policies prohibiting alcohol use on campus and at school functions and, in some cases, any possession of alcohol by students (Modzeleski, Small, & Kann, 1999).

Universities have similar policies prohibiting alcohol on school facilities, prohibiting use by underage students, or restricting alcohol advertising on campus (Wechsler, Lee, Kuo, & Lee, 2000). Grimes and Swisher (1989) found that students report such policies are barriers to drinking, but there are few controlled evaluations of such policies. Odo, McQuiller, and Stretsky (1999), in their study of a newly enacted policy that prohibited alcohol in all university-affiliated living residences (i.e., dorms, fraternities, and sororities), found that the policy helped reduce the prevalence of drinking in the affected residences but did not affect the frequency of heavy drinking. A case study of a campus prohibition on underage drinking or possession of alcohol, public consumption, and use of kegs reported (Cohen & Rogers, 1997) positive findings but lacked a control or comparison condition; therefore, these findings can only be accepted conditionally. These studies provide promising but incomplete evidence of the potential for such administrative policies to reduce underage drinking.

5.2.7. Social Availability

Social availability is the access to substances through "social sources" (including receiving, stealing, or buying substances from friends, relatives, and strangers). Social sources for alcohol are particularly important for youth, given that access through retail sources has become more regulated. Alcohol consumed in social settings often contributes to the occurrence of specific alcohol problems. Underage-drinking parties offer the opportunity for high-risk consumption of alcohol (i.e., binge drinking) and the initiation of alcohol use by younger adolescents. Underage drinking parties have also been linked to other alcohol-related problems, such as impaired driving, sexual assault, other violence, and property damage (Mayer, Forster, Murray, & Wagenaar, 1998; Schwartz & Little, 1997; Wagenaar et al., 1993). Although adults can legally buy alcohol in retail outlets, social sources of alcohol remain important because they can directly contribute to the occurrence of serious negative outcomes.

Research on the use of social sources of alcohol by adults is limited. It is reasonable to assume, however, that the primary social sources of alcohol are parties and small gatherings of family, friends, and/or work colleagues. One of the most common means by which adolescents obtain alcohol is through third-party transactions (i.e., underage individuals asking an adult age 21 or older to purchase alcohol for them (Jones-Webb et al., 1997b; Smart, Adlaf, & Walsh, 1996; Wagenaar et al., 1993). Youth also cite their parents as a common source of alcohol, either using the alcohol that is present in the home or obtaining and drinking alcohol with the permission of their parents (Smart et al., 1996; Wagenaar et al., 1993).

Several studies indicate that younger youth rely on social sources for alcohol much more than older youth (Harrison, Fulkerson, & Park, 2000; Schwartz, Farrow, Banks, & Giesel, 1998; Wagenaar et al., 1996). Underage people obtain a substantial portion of alcohol from social sources (e.g., through friends, at parties, at home). Other people who purchase alcohol and provide it to underage individuals represent another social source. Such people may or may not be under the legal purchase age. Youth

appear to have ready access to alcohol. Most 12th graders report that it is “fairly” easy or “very” easy to obtain alcohol (Johnson, O'Malley, & Bachman, 2003). In their national study of adolescents in grades 7 through 12, Swahn, Hamming, and Ikeda (2002) found that youth report relatively easy access to alcohol in their homes.

Purchase surveys reveal that 30 to 70% of outlets sell alcohol to underage buyers, depending upon the geographical location (e.g., Forster et al., 1994; Forster et al., 1995; Grube, 1997; Preusser & Williams, 1992). Even at the lowest end of this range (30%), seven purchase attempts at different outlets will yield a 92% success rate. Given the likelihood that social networks of youth share information about outlets at which alcohol has been successfully purchased, the estimated maximum of six unsuccessful tries before an almost certain purchase is very conservative.

Focus groups have also shown that underage youth typically procure alcohol from social sources through adults or at parties where parents and other adults are not present (Jones-Webb et al., 1997b; Wagenaar et al., 1993). Wagenaar et al. (1996) found that 46% of 9th graders, 60% of 12th graders, and 68% of youth ages 18 to 20 obtained alcoholic beverages from an adult on their most recent drinking occasion. Students in the 9th grade rely on home sources of alcohol much more than older students. The reliance on home supply declines significantly by the end of high school, but social sources continue to remain an important means of access across all ages.

Wagenaar et al. (1996) reported that commercial alcohol outlets were the source of alcohol for underage people for about 3% of 9th grade students, 9% of 12th grade students, and 14% of youth ages 18 to 20 (see Table 5-1).

Table 5-1.

Sources of alcohol supply by age

Source of Alcohol	9 th Grade	12 th Grade	Ages 18-20
Commercial alcohol outlet	3*	9	14
Home	27	6	11
Another person aged 20 or younger	29	29	10
Another person aged 21 or older	46	60	68

Source: Wagenaar et al. (1996)

All numbers in percentages for current drinkers over the past 30 days.

Although not a direct demonstration of a relationship between social availability and alcohol-related motor-vehicle crashes, there is evidence of a relationship between social availability and driving after drinking. This suggests that any increase in drinking associated with increased social availability can increase crashes. Lang and Stockwell (1991) estimate that worldwide, 36 to 67% of the impaired-driving offenders had their most recent drink in some type of unlicensed premises (e.g., at home or at a party).

5.2.7.1. Strategies Designed to Control Social Availability

Drinking at local bars and restaurants is constrained by State alcohol control laws and local ordinances as well as the owner’s need to maintain a premises that attracts clients, but drinking that occurs in locations away from public view (in homes or parks) can be relatively unconstrained and

often produces a large number of impaired drinkers. Controlling drinking at such locations is generally dependent on the party host; however, some control can be exercised by local authorities.

Keg Registration. Keg registration laws require the purchaser of a keg of beer to complete a form that links their name to a number on the keg. Keg registration is viewed primarily as a tool for prosecuting adults who supply alcohol to young people at parties. Keg registration laws have become increasingly popular in local communities in the United States. There is apparently only one published study on the effectiveness of these laws. In that study of 97 U.S. communities, the investigators found that requiring keg registration was significantly and negatively correlated ($r = -.29$) with traffic fatality rates (Cohen, Mason, & Scribner, 2002). The evidence for the effectiveness of keg registration, however, is best considered inconclusive.

Party Patrols. Another major way that underage drinkers gain access to alcohol is at parties (e.g., Wagenaar et al., 1993). Underage drinking parties, frequently involving large groups, are commonly held in a home, an outdoor area, or another public location such as a hotel room. Party patrols are a recommended strategy to address underage drinking parties (Little & Bishop, 1998; Stewart, 1999). Parties are frequently cited as one of the settings at highest risk for youth alcohol consumption and related problems. These parties have been linked to impaired driving, sexual assaults, violence, property damage, and to the initiation of alcohol use by younger adolescents at the instigation of older adolescents (Mayer et al., 1998; Schwartz & Little, 1997; Wagenaar et al., 1993). Decreased sales to older minors are expected to reduce availability of alcohol to younger adolescents.

Party patrols involve police entering locations where parties are in progress. The police can use noise or nuisance ordinances as a basis for entering a party to observe if underage drinking is taking place. In party patrol strategies, police routinely, as a part of their regular patrol duties, (a) enter premises where parties that may involve underage drinking are underway; (b) respond to complaints from the public about noisy teenage parties where alcohol use is suspected; and (c) check open areas and other venues where teen parties are known to occur, usually on weekends. When underage drinking is discovered, the drinkers and the people supplying the alcohol can be cited. Even when it is not possible to cite the person who supplied the alcohol, awareness of increased police activity can act as a deterrent and can express community norms regarding the unacceptability of providing alcohol to minors. As with other environmental interventions, public awareness and media attention is an important tool in increasing the deterrence effect of this strategy. There is some evidence that this technique is effective. Oregon implemented a weekend drunk-driving and party patrol program that has law enforcement officers working with schools to identify in advance the anticipated location of teen parties, which the officers then patrol. An unpublished evaluation of this program revealed that arrests of youth for possession of alcohol increased from 60 to 1,000 individuals in one year (with a corresponding decrease of 35% in underage-drunk-driving crashes) (Little & Bishop, 1998).

Social Host Liability. Under social host liability laws, adults who provide alcohol to a minor or serve an intoxicated adult in a noncommercial setting can be sued through civil action for damages or injury caused by that minor or intoxicated adult. Social host liability laws may deter adults from hosting underage parties, purchasing alcohol for or providing alcohol to minors, and overserving. There is little research on the effectiveness of social host liability laws, and what evidence exists is in conflict. In one study across all 50 States for the years 1984 to 1995, the presence of social host liability laws was associated with decreases in alcohol-related traffic fatalities among adults but was unrelated to such fatalities among minors (Whetten-Goldstein, Sloan, Stout, & Liang, 2000). It was not related to SVN crashes for either group. Surprisingly, the presence of social host liability laws was

related to increases in total motor-vehicle fatalities among minors. In a second study, however, using self-reported drinking data spanning the 1980s to 1995, the implementation of social host liability laws were associated with decreases in reported heavy drinking and in decreases in drinking and driving by lighter drinkers (Stout, Sloan, Liang, & Davies, 2000). These laws had no effect on drinking and driving by heavier drinkers. These conflicting findings may reflect the lack of a comprehensive program that ensures that social hosts are aware of their potential liability. Social host liability laws may send a powerful message; however, that message must be effectively disseminated before it can have a deterrent effect (Holder & Treno, 1997).

5.2.8. *Drinking Context*

“Drinking context” refers to the environment in which alcohol is consumed, which leads to the consumption of high- or low-risk drinking behaviors and can be conceptualized as where one drinks, with whom one drinks, and when one drinks (Cahalan, Cisin, & Crossley, 1969). Others (Wilsnack, Wilsnack, & Klassen, 1984) have suggested adding to this definition “why one drinks.” Ashley and Rankin (1988) noted, “Under certain circumstances, relatively low levels of consumption on isolated occasions may result in damage to the individual drinker” (p. 232). When consumption is high, contextual risk or protective factors might be even more important. The identification of such characteristics has potential utility for developing prevention policies and programs. An underlying assumption of research into drinking contexts was postulated by Harford (1979) who suggested that alcohol consumption is a function of interactions between the individual and his/her environment. Thus, consumption of alcoholic beverages is situationally specific, rather than a trans-situational property of specific individuals (see p. 289).

As Jessor (1982) suggested, the five major ways of exploring drinking contexts include location of the drinking event, demographic/descriptive characteristics of the event and its participants, the meanings associated with drinking contexts, abstract dimensions of events such as social controls and norms, and personal perceptions associated with the context.

In a national study of drinking contexts, Hilton (1988) reported that, across all alcohol consumption patterns (i.e., abstainer, light, moderate, and heavy), contexts that included the presence of coworkers, close friends, and neighbors tended to be “wetter.” Demographically, men, more-educated respondents, Catholics, and respondents residing in heavy drinking areas were more likely to report drinking heavily across drinking contexts. Similarly, Hilton reported that men drank more than women did in both public (bars, restaurants, etc.) and private (parties and homes) contexts. In addition, Hilton reported that drinking in public and the interaction between drinking in public and education each correlated with alcohol problems.

Researchers have paid little attention to drinking contexts frequented by college students. In an early study, Kraft (1982) examined alcohol consumption patterns, related problems, and contexts of drinking at one East Coast university in the late 1970s. He reported that respondents tended to drink with friends, on weekends, and at parties most frequently. The heaviest drinkers often patronized bars as well. With the increase in frequency of attendance at parties or bars, there was also an increase in the frequency of self-reported problem behaviors, such as driving impaired, academic problems, belligerence, job-related problems, vandalism, and trouble with authorities. In a study of drinking contexts frequented by college females, Hunter (1990) reported that female college students drank more often at parties and in bars than in any other contexts. During the past decade, alcohol research

has focused largely on expectancies and perceptions related to alcohol use (Thombs, Beck, & Pleace, 1993; O'Hare, 1998).

In addition to responsible beverage service programs (described elsewhere), interventions to alter the serving context in bars and restaurants have shown success in reducing the BAC level of young people coming from such establishments. One successful program (called the “Border Project”) involved using media attention, law enforcement participation, and technical assistance/discussions with managers of bars and restaurants in border areas of Mexico to reduce the levels of high-volume drinking by young people in these establishments. The interventions resulted in partial bans on drinking in local on-premises establishments. Comparing the BAC levels of youth crossing into and returning from Mexico, these interventions achieved a statistically significant reduction in the levels of alcohol-impairment of young adults who traveled between Mexico and the United States (Lange & Voas, 2000; Voas, Lange, & Johnson, 2002c; Voas et al., 2002d).

Lange and Voas (2000) studied youths crossing the border from San Diego into Mexico on weekend evenings to drink at the Tijuana bars that cater to 18- to 20-year-olds (who cannot drink legally in the United States) and 21- to 30-year-olds. The survey’s researchers interviewed and breath-tested youths entering Mexico between 10 p.m. and midnight and again on their return to the United States after midnight. Almost half of those entering Mexico reported that they intended to get drunk. The Mexican drinking establishments catered to this intention with low-priced alcohol (generally sold on an “all you can drink” basis) and an atmosphere that encouraged heavy consumption and tolerated drunken behavior. The investigators identified three factors in the drinking context that promoted high-risk drinking: (1) ad lib alcohol availability, (2) relaxed controls over drunken behavior, and (3) peer support for heavy drinking. The third factor results from the tendency of those who seek out locations with the first two conditions to be heavy drinkers. They argue that those three factors are not unique to border drinking but characterize unsupervised keg parties attended by youths in locations such as the homes of an absent parent or in some fraternity parties that occur within the United States.

5.2.9. Summary: Opportunities to Reduce Risky Drinking

This first section of Chapter 5 on intervention programs focused on factors that influence risky drinking and policies that potentially can reduce the high-risk drinking that leads to impaired driving among other problems. The evidence to date suggests several strategies that can reduce such drinking. Among them are the following:

- Restrictions on who may purchase alcohol (the age 21 minimum purchase age law)
- Retail compliance checks by the police designed to enforce the MLDA
- State control of alcohol sales—unfortunately, a disappearing policy
- Alcohol outlet density restrictions
- Restrictions on location of outlets in sensitive areas such as schools
- Restrictions on hours and days of sale
- Increased alcohol taxes

- Retail price controls
- Media and awareness programs

Unfortunately, although there is research evidence for the effectiveness of each of these policies, with the exception of the evaluations of the minimum legal drinking age law, the evidence is limited to a handful of studies, not all of which agree. Further, although the public supports the MLDA law, they show less support for adult limitations. Instead, they support the alcohol industry's strong resistance to any measure that limits alcohol availability to adults. Still, controls over drinking provide an important opportunity to reduce impaired driving.

5.3. Secondary Prevention: Preventing Impaired Driving

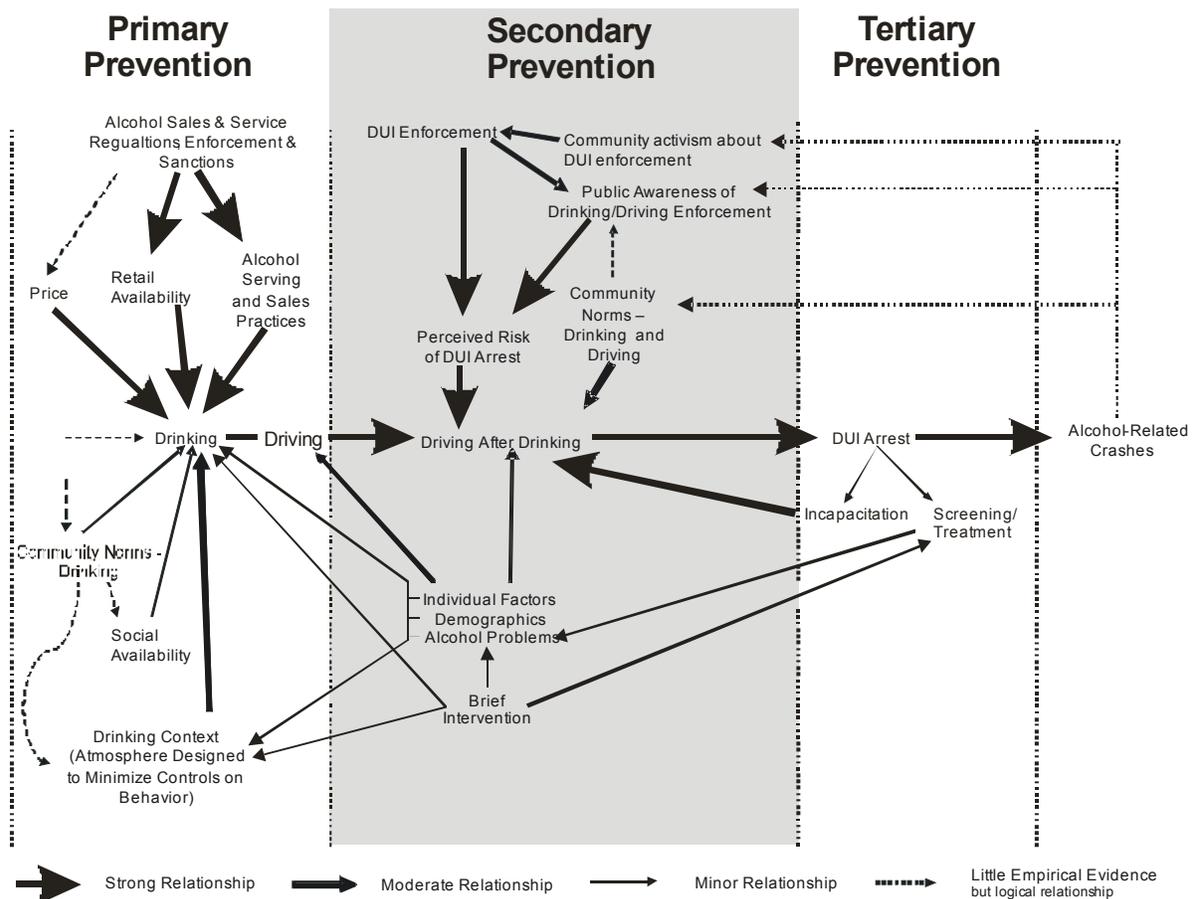


Figure 5-5. Alcohol-related motor-vehicle crash causal model—Secondary Prevention. Adapted from Birckmayer et al. (2008)

The *Primary Prevention* section of this chapter focused on programs that encourage abstinence or avoidance of risky drinking. Although many of the laws and policies reviewed appeared to be effective in reducing heavy consumption, 68% of men and 60% of women report drinking in the last year (see sections 3.3 and 3.4; and Chen et al., 2007). In the population of 293 million Americans in 2004, 237 million (80%) had driver’s licenses (NHTSA, 2004c). It has been well established that drinking and driving is prevalent in the United States. Further, as indicated by roadside surveys, about 1 in 10 motorists on weekend evenings have been drinking (Voas, Wells, Lestina, Williams, & Greene, 1997d). As shown in the causal model in Figure 5-1, the focus of the central section on *Secondary Prevention* is on deterring drinkers from driving after they have consumed too much alcohol. Deterrence is produced predominantly through laws, law enforcement, and publicity that increase the public’s perception of the risk of arrest if they drive while impaired by alcohol or other drugs (Ross, 1984). The process begins with State efforts to educate and ensure the training of new drivers through driver education programs and novice licensing programs, and continues through traffic laws and programs designed to reduce risky driving, particularly alcohol-impaired driving, and to promote general safety behavior while driving (e.g., the use of seat belts that protect all drivers but are more likely to be neglected by drinking drivers).

In this section, we first review the evidence for the effectiveness of driver education and licensing in reducing alcohol-related crashes of novice drivers, then move on to the interrelatedness of alcohol-impaired driving and nonuse of seat belts. Finally, we review the evidence for the effectiveness of DWI laws, enforcement, and sanction programs in deterring impaired driving.

5.3.1. Traffic Safety Education for Young or Inexperienced Drivers

As described in section 4.3, motor-vehicle crashes are the leading cause of death (approximately 36%) for young people ages 15 to 20 in the United States. Further, about 23 to 24% of the 15- to 20-year-old drivers involved in fatal crashes are estimated to have been drinking beforehand (Subramanian, 2005a). Although young people ages 15 to 20 make up between 8 and 9% of the U.S. population and only about 6 to 7% of the licensed drivers, their involvement in fatal traffic crashes is between 13 and 14% each year (NCSA, 2003). In recent years, between 6,000 and 7,000 young drivers and passengers ages 15 to 20 have been fatally injured in motor-vehicle crashes.

The high crash rate of young novice drivers, including their involvement in alcohol-related crashes, has been recognized for the last 50 years. Initially, school-based driver education programs as a prerequisite for high-school sophomores were adopted as a method for developing driving skills and promoting safety behavior that would help avoid impaired driving. But as enthusiasm for such courses grew, States passed legislation making these programs a prerequisite for licensing. This had the unintended effect of encouraging early licensing as obtaining a driver's license became the objective of taking the course. Consequently, many high-school youths who would normally have waited until they were in college or in the work force began driving at age 15 or 16. Whatever the benefits of the driver education program, it could not compensate for the increased exposure produced by the larger number of youthful drivers on the road. Thus, experience demonstrated that universal driver education in the public schools, although providing some driving skills, was not effective in reducing crashes (Williams & Ferguson, 2004). Many experts viewed driver education as counterproductive and support for it as a mandatory requirement for licensing has declined (Williams, 1996; Mayhew, Simpson, Williams, & Ferguson, 1998; Williams & Ferguson, 2004). One possible exception to the general lack of safety effectiveness of high-school educational programs is peer intervention, which does seem to produce enduring improvements in driving behaviors (McKnight & Voas, 2001; Stewart & Klitzner, 1990). Instead of reliance on high-school education, special policy strategies (graduated licensing and zero-tolerance laws) have been formulated to prevent impaired driving among this age group.

5.3.1.1. Graduated Licensing

Sixteen-year-old drivers have crash rates that are three times greater than 17-year-olds, five times greater than 18-year-olds, and even twice those of drivers age 85 (McCartt et al., 2003). Research has shown that three factors—inexperience, immaturity and risk taking, and greater exposure to risk—play a prominent role in crashes involving teenagers (Masten & Chapman, 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 vehicle, 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 & Haggge, 2004; Masten & Chapman, 2004).

Over the last decade, the alternative 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). The high crash rate of novice drivers in the first few months (Figure 5-6) 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 adopted GDL systems that require staged progression to full license privileges (NCSA, 2003). 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. GDL is the opposite of historic licensing systems in most States that generally have a quick and easy path to full driving privileges at a young age, resulting in extremely high crash rates for beginning drivers.

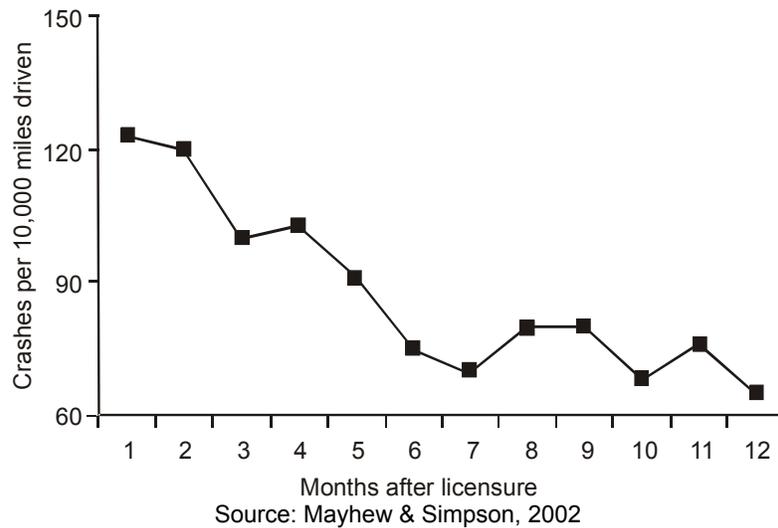


Figure 5-6. Novice drivers' crash risk drops with experience

Based upon the concept that an extended period of supervision curtails crashes by younger drivers, NHTSA and the American Association for Motor Vehicle Administrators, with assistance from IIHS, NSC, and NTSB, have developed an entry-level graduated licensing program that gives young beginning drivers more time to learn the complex skills required to drive a motor vehicle. The system consists of three stages: a learner's permit stage, an intermediate or provisional license stage, and a full licensure stage. Evaluations of State programs clearly show the benefits of adopting the GDL system. For example, the GDL law in Florida was associated with a 9% reduction in crashes for 16- and 17-year-old drivers (Ulmer, Preusser, Williams, Ferguson, & Farmer, 2000). Other examples come from recent evaluations in North Carolina (Foss, Feaganes, & Roggman, 2001; Foss & Goodwin, 2003) and Michigan (Shope, Molnar, Elliott, & Waller, 2001b; Shope & Molnar, 2004), where reductions in crashes for 16-year-old drivers in the GDL systems range from 26 to 27%. 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). Chen, Baker, and Li (2006) 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.

5.3.1.2. Nighttime Driving Restrictions

GDL laws have four major features that appear to reduce novice driver crashes: delayed licensing, extended periods of supervised driving, and restrictions on nighttime driving and teen passengers when driving unsupervised. Williams (1985) and Williams, Karpf, and Zador (1983) carefully compared U.S. States with differing ages of licensing and concluded that 65 to 85% reductions in fatal crash involvements by 16-year-old drivers could be achieved by raising the legal age of driving to 17. Such a long delay has proved to be unpopular, however, and most GDL laws allow learner's permits at age 15 or 16. Restrictions on teenage passengers have been found to be effective by Preusser, Ferguson, and Williams (1998) and by Chen (2000). However, the key component related to impaired driving is the nighttime restriction requiring the presence of an adult while driving. This nighttime restriction during the intermediate, solo-driving stage is designed to reduce the risk of late-night driving-and-drinking and driving by beginning drivers. Most underage drinking occurs at night, so the restriction on nighttime driving is designed to deter the underage drinker from driving to drinking locations. It also may reduce underage drinking itself because the beginning driver is not allowed to drive to underage-drinking locations during these nighttime hours.

Williams and his colleagues (1985) and Preusser, Williams, Zador, and Blomberg (1984) have explored the influence of nighttime curfew policies by comparing crash rates for young teenagers (ages 15, 16, or 17 depending on the State) in States with and without curfew laws. These researchers estimated reductions in the crash involvement of 16-year-old drivers during curfew hours ranging from 25 to 69% and concluded that the laws had very beneficial effects relative to their costs. More recent research on individual State GDL systems has shown a beneficial effect of nighttime restrictions on all crashes (not just fatal crashes) involving beginning drivers (Williams & Preusser, 1997; Mayhew et al., 2003). Williams, Ferguson, and Wells (2005) challenged this evidence. They examined fatal crashes involving 16-year-olds in the United States from 1993 to 2003, a period when a large number of States enacted GDL laws, and found that the proportion of crashes that occurred between midnight and 5 a.m. has remained at 11%. A possible explanation is the tendency of States to limit the driving to very late nighttime hours only. Williams (2005) reported that, although 38 States have some form of night restriction for beginning drivers, 23 of those States do not start the restriction until midnight or 1 a.m. No study to date has directly related nighttime restrictions to a reduction in alcohol-related crashes.

Williams (2005) found no reduction in nighttime fatal crashes involving 16-year-olds; in contrast, Chen et al. (2006) found that GDL programs were associated with an 11% decrease in fatal crashes involving 16-year-old drivers. These contrasting findings may suggest that GDL laws are primarily effective because they reduce the number of 16- and 17-year-olds who are licensed and on the roads rather than reducing the high-risk driving of those who are licensed through nighttime and passenger restrictions. Available data show that the number of licensed young drivers (ages 15 to 20) in the United States increased about 7% between 1993 and 2003 (NHTSA, 2004b), which is only a fraction of the population increase for this age group over the same period (about 12% according to the U.S. Census). How much of this relative reduction in the licensing rate is produced by GDL laws has not yet been determined.

5.3.2. Low BAC Limits for Young Drivers

Another law aimed at the high-level of crash involvement by young drivers—both the 16- and 17-year-old novice drivers and the 18- to 20-year-old drivers—is zero tolerance. In 1984, the U.S.

Congress adopted measures to sanction States that did not adopt 21 as their minimum legal drinking age. By 1988, all States and the District of Columbia had enacted such laws. Because it was illegal for those younger than 21 to drink any alcohol, it seemed logical that underage drivers should have no alcohol in their systems when they drove. So in 1995, the U.S. Congress passed a law requiring States to adopt so-called zero-tolerance laws for drivers younger than 21. By 1998, all States and the District of Columbia had passed laws making it illegal for any driver younger than 21 to have a positive BAC level. In some States, any BAC level at .02 g/dL or greater is illegal for youth; in other States, the BAC limit is set at .01 g/dL or greater; in the remaining States, any BAC higher than .00 g/dL is considered illegal for drivers younger than 21. These zero-tolerance laws for youth have proved effective in reducing the number of fatal crashes involving underage drinking drivers. Fell and Voas (2006b) have reviewed the evidence for the effectiveness of the zero-tolerance law in a broader study of the effect of lowering BAC levels and found strong evidence for the efficacy of zero-tolerance laws.

A study of zero-tolerance laws in Florida, Maine, Oregon, and Texas by Lacey, Jones, and Wiliszowski (2000) showed that SVN crashes were reduced by as much as 36% in Maine and 40% in Oregon, as little as 5 percent in Florida, and not at all in Texas for the targeted drivers. As expected, Maine and Oregon, which had more experience with the law and had higher levels of enforcement and publicity, had higher levels of effectiveness. The Maryland .02 g/dL BAC law for drivers younger than 21 was evaluated by Blomberg (1992). He collected data from 1985 through 1990 for young drivers who were involved in crashes and “had been drinking.” A comparison of the before-and-after crash data associated with the zero-tolerance law showed an 11% decrease. This reduction was in addition to a general reduction in alcohol-involved crashes and a reduction in all crashes (alcohol and nonalcohol) involving drivers younger than 21.

Hingson, Howland, Heeren, and Winter (1992) compared four States (Maine, New Mexico, North Carolina, and Wisconsin) that passed zero-tolerance laws before 1989 with four nearby States (Massachusetts, Arizona, Virginia, and Minnesota) without zero-tolerance laws. As a group, the States that lowered their BAC levels for youth had significantly greater post-law reductions in nighttime fatal crashes among adolescents relative to adults (34% teens versus 7% adults) than did the comparison States (26% teens versus 9% adults). In a followup study, Hingson et al. (1994) compared 12 States (Arizona, California, Georgia, Maine, Maryland, New Mexico, North Carolina, Ohio, Oregon, Rhode Island, Vermont, and Wisconsin) that lowered illegal BAC levels for youth before 1991 with 12 comparison States (Alabama, Colorado, Connecticut, Indiana, Massachusetts, Minnesota, New Hampshire, Pennsylvania, Texas, Utah, Virginia, and Washington) that did not lower their BAC levels. During the post-law period, the proportion of fatal crashes that involved single vehicles at night declined 16% among young drivers targeted by those laws, while it rose 1% among drivers the same age in comparison States where BAC limits were not changed. Adult crashes declined only 5 and 6% in the two groups during the post-law period. The significant declines in the proportion of SVN crashes among young drivers occurred only in States that lowered the underage BAC limit to .02 g/dL or lower. States with BAC limits of .04, .05, or .06 g/dL showed no significant difference from States that did not lower the limit at all. (Note: All States and DC have subsequently set their limits to .02 or lower.) This suggests that those States dropping the BAC level to .00 or .02 g/dL, the true zero-tolerance laws, sends a strong drinking-and-driving message to youth, rather than the mixed message sent to youth by States setting a higher limit.

Zwerling and Jones (1999) conducted a systematic review of zero-tolerance laws and their effect on alcohol-related injuries and fatalities. The six studies that met their strict selection criteria showed reductions in injuries and fatalities associated with the implementation of zero-tolerance laws, and in three studies, the reductions were statistically significant. The greatest reduction (22%) was reported in one study of SVN fatal crashes involving underage drivers in States adopting zero-tolerance laws. Despite some methodological difficulties cited by the authors, they concluded that the six studies presented supported the effectiveness of zero tolerance. The total evidence is strengthened even more because similar results were found in two countries (Australia and the United States) using different methods and different outcome measures. Voas, Tippetts, and Fell (2003b) used data on all U.S. drivers younger than 21 involved in fatal crashes from 1982 through 1997. Quarterly ratios of BAC-positive to BAC-negative drivers in each of the 50 States were analyzed in a pooled cross-sectional time-series approach. After accounting for differences among the 50 States in various background factors, changes in economic and demographic factors within States over time, and the effects of other related laws, results indicated a significant 24.4% reduction associated with the zero-tolerance laws for alcohol-positive drivers younger than 21 who were involved in fatal crashes.

Although most of the studies have been done in the United States, the evidence of effectiveness for low BAC limits for young drivers is quite strong. This conclusion is reinforced by Shults et al. (2001) review of both U.S. and Australian studies, during which they found reductions of between 9 and 24% in fatal crashes. Table 5-2 from Fell and Voas (2006c) summarizes the research on lowering the BAC limit for youth.

Table 5-2. Studies of the effectiveness of lowering the BAC limit for youth

Study	Results
Blomberg (1992) "Lower BAC Limits for Youth: Evaluation of the Maryland .02 Law."	A significant 11% decrease in police-reported alcohol crashes involving drivers younger than 21 associated with the .02 law. Decrease was 50% in six communities that highly publicized the law and the enforcement of it.
Hingson et al. (1992) "Reduced BAC Limits for Young People (Impact on Night Fatal Crashes)."	As a group, States that lowered BAC limits for youth had significantly greater post-law reductions in nighttime fatal crashes among drivers younger than 21 relative to drivers older than 21 (34% for teens; 7% for adults) than the comparison States that did not lower the limit (26% for teens; 9% for adults).
Hingson et al. (1994) "Lower Legal Blood Alcohol Limits for Young Drivers."	SVN fatal crashes declined 16% in 12 States that lowered the limit for youth while it rose 1% in 12 comparison States that did not lower the limit for youth. Adult nighttime fatal crashes declined 5% and 6%, respectively, in the two groups.
Zwerling and Jones (1999) "Evaluation of the Effectiveness of Low BAC Laws for Younger Drivers."	Systematic review of the effects of zero-tolerance laws indicate that all six studies showed significant reductions in injuries or fatalities associated with the implementation of lower BAC limits for youths younger than 21.
Voas et al. (2003b) "Assessing the Effectiveness of Minimum Legal Drinking Age and Zero-tolerance Laws in the U.S."	Lower limits for youth have resulted in an average 24.4% reduction in alcohol-positive drivers younger than 21 involved in fatal crashes since their implementation in the United States.
Lacey et al. (2000) "Zero-tolerance Laws for Youth: Four States' Experience"	Reductions in single-vehicle nighttime injury crashes associated with zero-tolerance laws in Oregon (-40%), Maine (-36%), and Florida (-5%). No observed reduction in Texas.

Source: Fell and Voas (2006c)

5.3.3. Programs to Reduce Driving After Drinking

Policy action and research in the *Primary Prevention* area has mostly focused on reducing high-risk drinking. It is well to keep in mind, however, that drinking and driving involves the use of a vehicle Ross (1992a) has pointed to the important opportunities available for reducing impaired driving by reducing the number of alcohol outlets that can only be reached by motor vehicles and by providing low-cost or free taxi service to and from bars. Although neither of these suggestions has found favor with officials and safety activists, harm reduction intervention approaches, such as *Safe Ride* and *Designated Driver* programs, have been studied with some promising results (Caudill, Harding, & Moore, 2000; Meier, Brigham, & Gilbert, 1998; Simons-Morton & Cummings, 1997). The designated-driver concept has gained momentum in the United States with most Americans endorsing it as a strategy to reduce driving under the influence (Winsten, 1994). Additionally, many community and national organizations have vigorously promoted the use of *Designated Driver* programs (Apsler, Harding, & Goldfein, 1987; Caudill, Harding, & Moore, 2001; DeJong & Wallack, 1992; Harding, Caudill, & Moore, 1998). *Safe Ride* programs, usually sponsored by drinking establishments or community organizations, provide a sober driver for individuals too impaired to drive safely. With *Safe Ride* programs, all drinkers in the group can drink heavily without risking driving while impaired. In contrast, the designated-driver concept requires one member of a group to refrain from alcohol consumption in order to serve as a sober driver.

Both the safe-ride and designated-driver harm-reduction strategies may produce unintended consequences for groups of drinkers. Individuals who become passengers rather than drivers may feel freer to drink heavily. This may increase their risk of other, non-traffic-related trauma (e.g., falls, fires, or violence). Telephone and barroom surveys of drinkers who had been transported by a designated driver have shown small but significantly elevated drinking outside the home when a designated driver was available (Harding & Caudill, 1997). DeJong and Wallack (1992) contended that encouraging the use of designated drivers sends a mixed message to people, as it appears to condone and enable heavy drinking. It may provide, for example, an excuse to resist server efforts to curtail service to obviously intoxicated drinkers. DeJong and Wallack acknowledge, however, that there is no empirical evidence to support their claims. Wagenaar (1992) also noted the lack of data on this point, stating, "We urgently need controlled studies of *Designated Driver* programs, including direct observation data on the specific patterns of response of drinkers to the availability of a designated driver" (p. 444).

Perhaps more serious than the question of "enabling" are the questions raised related to implementation of the designated-driver concept. In theory, the designated-driver concept holds great promise for reducing the incidences of impaired driving. It is simple, inexpensive, almost universally recognized, and as shown in several national polls, has overwhelming acceptance by most Americans. In practice, however, the implementation of the designated-driver concept is often difficult and fraught with logistical and psychological impediments (DeJong & Wallack, 1992). Studies have demonstrated that designated drivers often drink, sometimes at high levels (Fell, Voas, & Lange, 1997). However, perhaps the biggest impediment to the successful implementation of the designated-driver concept is a lack of planning concerning the designation of a driver for the evening. For instance, groups of drinkers may designate a driver after drinking has commenced or at the end of a night of drinking (Fell et al., 1997; Lange, Voas, & O'Rourke, 1998). In order for the designated-driver concept to function properly, it is imperative that the following steps occur: (1) the drinking group must designate

a driver before starting to drink, (2) the designee must abstain from, or substantially limit, drinking, and (3) the designee must fulfill his or her responsibility to be the driver. McKnight, Lange, and McKnight (1995) noted a number of instances in reports of drivers arrested for DWI who were driving because their designated drivers failed to fulfill their responsibility. Failure at any of these three steps could result in potentially impaired drivers either claiming to be the designated driver or usurping the role of the designated driver.

Lange, Reed, Johnson, and Voas (2006) recruited 376 groups from 988 pedestrians (57.8% male) as they crossed into Mexico from San Diego, California, to patronize Tijuana bars. Each group was assigned at random to one of seven experimental conditions before entering Mexico. The interventions were designed to (1) cue the use of designated drivers, (2) change attitudes about designated drivers, (3) provide monetary rewards for driver sobriety, and (4) increase group supportive norms for proper designated driver use. Participants' BAC levels were collected before entering Mexico and upon their return to the United States. These investigators found that using group members to deliver pro-designated-driver messages significantly decreased driver and passenger BAC levels relative to controls. Male drivers were more likely to return from Mexico with BAC levels of zero if they were rewarded. Among female drivers, wearing a bracelet with the printed words "designated driver," in addition to cuing, resulted in 9 of 10 drivers returning with BAC levels of zero. Although this program involved face-to-face contact a more intense intervention than just a message over mass media, these results demonstrated that designated-driver sobriety can be enhanced through brief interventions and that proper use of the designated-driver concept does not increase the risk of excessive alcohol consumption by passengers.

5.3.4. *Seat Belt Laws and Impaired Driving*

For more than two decades, the traffic safety community has focused on reducing two high-priority problem behaviors: alcohol-impaired driving and nonuse of seat belts. Effective public information and enforcement programs have been developed to deal with each problem. The considerable evidence (Dinh-Zarr et al., 2001; Shults et al., 2001) that the two problem behaviors are related with high-risk drinking drivers being less likely to buckle up suggest that the countermeasure efforts in the two areas should be combined. To date, most of the emphasis in these two areas has involved relatively independent programs, despite the growing belief that efforts in one area influence the other area. This study attempts to determine the influence on alcohol-related fatalities of recent large increases in safety belt use in four States.

5.3.4.1. *Interrelatedness of Alcohol impaired driving and Seat Belt Nonuse*

Both alcohol-impaired driving and nonuse of seat belts are most prevalent among high-risk drivers. Drinking drivers involved in fatal crashes are much less likely to buckle up than drivers on the roadway. A NHTSA report (NHTSA, 2002), indicated that 77% of intoxicated drivers (with a BAC level of $\geq .08$ g/dL) killed in crashes compared to 47% of fatally injured nondrinking drivers were not buckled up at the time of the crash. Glassbrenner (2003) reported on a field study in which researchers observed and recorded seat belt use from the sides of roadways at nationally representative sites. That survey indicated that *nonuse* of seat belts among drivers on the roadways was approximately 27%. Further, there is evidence that nonuse of seat belts is correlated with positive BAC levels. Klein and Walz (1998) tracked vehicle seat belt use in FARS from 1982 through 1995 and found nonuse to be highly correlated with BAC levels for every year. In 1995, the most recent year included in their study, they found seat belt nonuse among fatal crash-involved drivers to be 74, 56, and 34% for high

(BAC \geq .10 g/dL), moderate (BAC=.01–.09 g/dL), and zero BAC drivers, respectively. Figure 5-7 shows the percentage of belt use by front-seat passengers riding with drinking and nondrinking drivers in fatal crashes from 1987 to 2004.

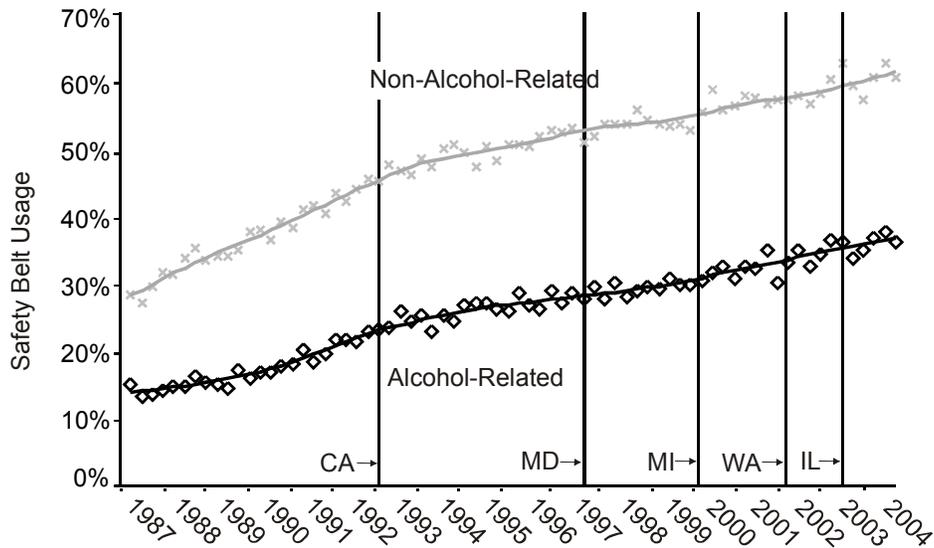


Figure 5-7. National rates of seat belt usage among passenger-car front-seat occupants. Adapted from Voas, Fell, Tippetts, Blackman, & Nichols (2007a)

5.3.4.2. Increasing Safety Belt Use Should Result in Fewer Alcohol-Related Fatalities

NHTSA estimates that seat belts, when worn in a passenger car involved in a serious crash, are 45% effective in preventing fatalities (Klein & Walz, 1998). As a result, increased seat belt use has reduced the fatalities per vehicle miles of travel on U.S. highways over time. This information, combined with the evidence that high-risk drivers are less likely to buckle up, suggests that increasing seat belt usage (particularly among young drivers, drinking drivers, and other types of drivers involved in fatal crashes) will result in significant reductions in fatalities. Further, it suggests that, if increases in observed seat belt use are associated with increases in usage among drinking drivers involved in crashes, such increases will be associated with significant reductions in alcohol-related fatalities per vehicle mile traveled.

Further evidence for the significance of primary laws in raising usage rates among impaired driver was collected by Lange and Voas (1998). Their roadside surveys were conducted in California when its primary belt law was implemented. They found, based on the California annual observational survey (independently verified by Ulmer, Preusser, and Preusser, 1994), usage rates increased from about 70% to about 83%. Following the primary law upgrade, usage rates by nondrinking drivers, as observed in their roadside surveys, increased from 70% to about 90% (an increase of 20 percentage points). In contrast, the usage rates by drivers with BAC levels greater than .10 g/dL increased from 50% to about 90% (an increase of 40 percentage points). In these surveys, motorists were stopped rather than passively observed from the roadside; therefore, it is possible that some buckled up before the interviewer got to them. Consequently, these usage figures may be high. Nevertheless, the relative difference illustrates the potential for a primary seat belt law to have a greater influence on drinking drivers than on nondrinking drivers.

5.3.4.3. *The Effect of Baseline Levels of Safety Belt Usage on the Potential for Reducing Alcohol-Related Fatalities*

At relatively low levels of seat belt use, increases are most likely to be among those drivers and passengers who are least likely to be involved in crashes (Dinh-Zarr et al., 2001). Klein and Walz (1998) showed that, from 1982 through 1995 (when observed use rates increased from about 11% to about 68%), there were larger increases in seat belt use among nondrinking drivers (BAC = .00 g/dL) in fatal crashes than among drinking drivers (BAC \geq .01 g/dL) in fatal crashes. As a result, these researchers reported that the steady increases in observed seat belt use from 1982 through 1995 were associated with greater reductions in non-alcohol-related fatalities, compared with alcohol-related fatalities. Because proportionately more non-alcohol-related than alcohol-related fatalities were prevented by increased seat belt use during this period of relatively low seat belt use, Klein and Walz (1998) also suggested that some of the progress in reducing the alcohol-related crash problem, *as measured by the alcohol-related percentage of total fatalities*, was masked by the effect of increased seat belt use.

Voas, Fell, Tippetts, Blackman, and Nichols (2007a) hypothesized that major increases from relatively higher baseline usage rates should influence alcohol-positive drivers (and their passengers) to a similar or even greater extent than they affect lower-risk, nondrinking drivers. Theoretically, at some point, seat belt nonuse should be sufficiently more concentrated among high-risk drivers (e.g., drinking drivers), so any substantial increase in usage will involve a greater proportion of drinking than nondrinking drivers, most of whom will already be buckled up. If at high belt usage, the belt use by drinking drivers increases relatively more than that of nondrinkers, then the *percentage of all driver fatalities*, as well as the actual number of driver fatalities that are alcohol-related, should be reduced.

Voas et al. (2007a) studied five States where the usage rates were 70% or higher when the State implemented a primary seat belt law and rose at least by 10 percentage points following implementation of the law (see Table 5-3). In four of the five States, seat belt usage by front-seat occupants in alcohol-related fatal crashes increased more than it did for front-seat occupants in non-alcohol-related fatal crashes. Further, in those four States, alcohol-related fatalities of front-seat occupants were reduced more than non-alcohol-related fatalities of front-seat occupants. This provides substantial evidence that States with high current usage rates can reduce the proportion of their alcohol vehicle occupant fatalities by enacting primary seat belt laws.

Table 5-3.

Effects of primary seat belt laws in five States

(1) State	(2) Observed seat belt usage rate before law	(3) Observed seat belt usage rate after law	(4) Seat belt usage rate for front seat occupant fatalities before law: FARS	(5) Seat belt usage rate for front seat occupant fatalities after law: FARS	(6) Change in usage rate for alcohol- related fatally injured front-seat occupants: FARS	(7) Change in usage rate for non- alcohol- related fatally injured front-seat occupants: FARS	(8) Change in alcohol- related occupant fatalities after law: FARS	(9) Change in non- alcohol- related occupant fatalities after law: FARS
California (1993)	71%	85%	35%	53%	24%*	15%*	-28%*	0%
Illinois (2003)	74%	83%	44%	55%	19%	18%*	-15%	-5%
Maryland (1997)	70%	83%	56%	55%	-20%	-12%	+6%	-16%*
Michigan (2000)	70%	83%	48%	61%	37%*	7%	-13%*	-1%
Washington (2003)	82%	94%	47%	68%	63%*	35%*	-24%*	-13%*

Statistically significant ($p < .05$)

Source: Voas et al. (2007a)

5.3.5. Overview of Impaired-Driving Laws

Current DWI laws throughout most of the industrialized world are based on per se illegal laws, which make it an offense to operate a vehicle with a BAC level at or higher than a specified level. The first these per se laws was enacted by Norway in 1936 (Voas & Lacey, 1990). There is, however, a substantial difference between the specific provisions of these laws in Europe and Australia and the United States. Outside the United States, most countries' laws are modeled on what Ross (1982a) called the "Scandinavian system" (first employed in Sweden). This system allows a motorist to be stopped both on suspicion of impaired driving and at random, following which a handheld breath-test device is used to screen them for drinking. Acceptance of the screening test is mandatory; refusal carries the same penalties as a conviction. A positive screening test leads to an evidential test at the police station and a citation if that test is over the limit.

The most complete application of this system is the random breath test (RBT) used in Australia (Homel, 1981), which has been shown to reduce alcohol-related crashes in many studies (Shults et al., 2001). RBT has been applied in Australia by several methods. Individual officers have been required to devote a specified amount of time stopping vehicles at random and testing motorist. In other applications, "Booze Busses" with teams of police saturate a location where they stop and test motorists at random. Many of the Australian states devote sufficient time to RBT to test a number of drivers equal to the number of registered drivers each year.

Enforcement of impaired-driving laws in the United States dates from the second decade of the 20th century when States—New York, for example (Voas & Lacey, 1990)—began to criminalize impaired driving. Enforcement was based on police testimony regarding the impaired behavior of the driver. When chemical tests for BAC levels began to be used, an issue arose as to whether arrested offenders could refuse the test. That issue was resolved by the *Smerber v. California* (1966) 384 U.S.

757 decision, in which the U.S. Supreme Court ruled that chemical tests were physical evidence like fingerprints and that, if the arrest met constitutional requirements, DWI suspects had no right to refuse the test. This suggested, however, that resisting suspects might have to be restrained while a blood sample was drawn, a prospect that most States were anxious to avoid. This resulted in the development of the implied-consent compromise that allowed the offender to refuse at the cost of a license suspension penalty.

Although implied-consent laws ensured the test refusers would receive a license sanction, it was still possible that, without the BAC information, prosecution of suspects would be unsuccessful, and they therefore could avoid the more severe sanctions, such as jail. Further, because the requirement for an evidential test (one that can be used in court) is based on probable cause justifying an arrest, even where a test is conducted, defense attorneys can prevent its use in court if they can show that there was not sufficient behavioral evidence to justify the arrest. Thus, American police officers cannot rely on the breath test to produce a conviction, as is the case in most other countries, but must attempt to ensure that they have sufficient behavioral evidence to produce a conviction.

Indiana was the first U.S. State to pass a per se illegal law. Procedures for enforcing such laws in this country are quite limited compared to Europe and Australia, because not only could offenders sometimes avoid criminal penalties by refusing a chemical test, but also because the fourth amendment to the Constitution requires that searches and seizures be “reasonable.” In practice, this means that vehicles cannot be stopped (a seizure) at random but only for cause. Further, a screening breath test (a search) cannot be required without a reason to believe a crime has been committed. This prevents the application of RBT as practiced in Australia and Sweden because officers cannot require a breath test from every driver who is stopped. Although the U.S. Supreme Court in *Sitz v. Michigan State Police* provided for random stopping at sobriety checkpoints under certain specific conditions, the limitation on roadside breath testing remains unless there is reason to believe the offender has been drinking. So the officer must first interview the driver and derive sufficient evidence of drinking to justify an initial screening with a handheld breath-test device. Consequently, according to Ferguson, Wells, and Lund (1995), officers miss 50% of the drivers with illegal BAC levels passing through a checkpoint. Thus, random stopping at U.S. checkpoint operations might more appropriately be labeled “selective breath testing” rather than “random breath-testing.”

The history of adaptation over the last 30 years of chemical test and enforcement procedures to the U.S. Constitution and the U.S. judicial system has resulted in most State’s DWI laws being very complex, a fact recognized by NHTSA in its *Countermeasures That Work* guide. That guide states:

“DWI laws have evolved over the past 30 years to incorporate new definitions of the offense of driving while impaired (illegal per se laws), new technology and methods for determining impairment (BAC tests, Standardized Field Sobriety Tests), and new sentencing and monitoring alternatives (electronic monitoring, alcohol ignition interlocks). Many States modified their laws to incorporate these new ideas without reviewing their effect on the overall DWI control system. The result is often an inconsistent patchwork.

“Alcohol-impaired-driving laws in many States are extremely complex. They are difficult to understand, enforce, prosecute, and adjudicate, with many inconsistencies and unintended consequences. In many States, a thorough review and

revision would produce a system of laws that would be far simpler and more understandable, efficient, and effective.” (Hedlund, 2006, pp. 1-13)

The complexity of the DWI criminal justice system has been further described in a set of four volumes on the U.S. DWI enforcement, prosecution, sanctioning, and monitoring system published by the Traffic Injury Research Foundation of Canada (Simpson & Robertson, 2001; Robertson & Simpson, 2002a; Robertson & Simpson, 2002b; Robertson & Simpson, 2002c).

5.3.6. *Studies of DWI Laws*

Much of the research in traffic safety over the last quarter century has been focused on the evaluation of proposed new laws and the development of tools for use by the police and courts in the enforcement of DWI laws. The most significant of the laws in the DWI enforcement and adjudication system are listed in Table 5-4, and recent research on key DWI laws is described in the following sections.

Table 5-4.

Key DWI laws

DWI Law	Description
Impaired-driving laws	The traditional law against drinking and driving that depends on the officer presenting observations of the suspect’s behavior that demonstrate the driver was under the influence of alcohol. Does not depend on the presentation of a BAC test result, but if the BAC level is available, it becomes <i>presumptive</i> evidence of intoxication.
Per se laws	Operating a vehicle at a BAC level higher than allowed. When a BAC level is not available, the prosecution must be conducted under the impaired-driving law.
Zero-tolerance laws (a “status” law based on age)	Based on the minimum legal drinking age law, the zero-tolerance law makes it an offense for a person younger than age 21 to operate a motor vehicle with any measurable amount of alcohol in their bodies generally specified as a BAC level of .02 g/dL or greater.
Implied-consent laws	Establishes that, by accepting a driver’s license, a driver agrees to submit to a chemical test if an officer has probable cause to make an arrest for impaired driving. In the event of a refusal, most statutes provided that no test will be given, but the suspect’s license will be suspended. Alternatively, the officer can seek a warrant to require a blood test.
Administrative license revocation laws	Provides that a DWI suspect whose chemical test result is higher than the legal limit (currently .08 g/dL) is subject to an immediate license suspension. A provision must be made for a hearing if requested by the offender.
High BAC laws	Provides for increased sanctions for a convicted DWI offender’s whose BAC level is .15 g/dL or greater.
Test refusal laws	Provides for increased sanctions for DWI suspects who refuse the chemical test.
Anticonsumption, open container laws	Prohibits consumption of alcohol by the driver while in charge of a vehicle or more commonly prohibits an open alcohol container in the passenger compartment of a vehicle. Passengers in commercial vehicles such as buses are normally exempted.

5.3.6.1. Administrative License Revocation

Administrative license suspension or revocation laws provide for the arresting officer to seize the driver's license when an offender is arrested for DWI. The license is then sent to the motor vehicle department, following which driving privileges of the offender will be suspended within a short period following apprehension. Based on deterrence theory (see below), this should have a general deterrent effect on impaired driving. This conclusion has been supported by numerous studies. Zador (1991), in an early study of the States implementing ALR laws, found that a reduction in fatal crashes could be attributed to such laws. Voas et al. (2003b) conducted a panel study of the 50 States and the District of Columbia from 1982 to 1997 and found that ALR laws were associated with a 19% decline in alcohol-related fatal crashes. A meta-analysis of 46 studies of State laws, which included 12 evaluations of ALR laws by Zobeck and Williams (1994) found an average reduction of 5% in alcohol-related crashes and a reduction of 26% in fatal crashes associated with administrative licensing revocation. Miller, Galbraith, and Lawrence (1998) concluded that the benefit-to-cost ratio was \$11 per dollar invested when violators received a 6-month license suspension. As of 2005, 41 States have enacted ALR laws.

5.3.6.2. *Illegal Per Se: Reducing BAC Limits for Driving*

Although there has been little recent research on the traditional impaired-driving laws (the basic features of which are mostly unchanged), the efforts of safety advocates to lower the BAC limits specified in per se laws have provoked considerable controversy and stimulated research on the influence of BAC limits. When chemical tests first came into general use in the enforcement of impaired-driving laws, three levels were identified in most State legislations: (1) BAC levels of .15 g/dL or higher were established as a presumptive indication of impairment; (2) BAC levels between .05 and .15 g/dL were valid evidence of drinking to be considered with other evidence to determine impairment; and (3) BAC levels lower than .05 g/dL were evidence that the driver was not impaired. In a few cases, States initially adopted lower presumptive levels at .12 or .10 g/dL. The passage of the Highway Safety Act in 1966 established a State-funding program that encouraged States to adopt a .10 g/dL BAC level as the presumptive level for defining impaired driving. DOT also urged the States to enact laws that made it *illegal per se* to drive with a BAC level of .10 g/dL or higher. Research has provided evidence that driving impairment could be detected at BAC levels lower than .10 g/dL. As described in Chapter 3, there is substantial evidence from relative risk studies (Borkenstein et al., 1974; Blomberg et al., 2005; Zador, Krawchuk, & Voas, 2000b) that alcohol impairs skills required for driving and that there is a measurable increase in relative risk at BAC levels as low as .05 g/dL. Moskowitz and Fiorentino (2000) reviewed 112 studies on the influence of alcohol on skills related to driving and found evidence of impairment at BAC levels as low as .02 g/dL. A key issue for legislating BAC limits was the role of tolerance to alcohol, which provided a basis for arguing that reliance should be placed on observations of behavior rather than on the BAC levels because many heavy drinkers may be able to drive at elevated BAC levels without showing impairment. To study this possibility, Moskowitz, Burns, Fiorentino, Smiley, and Zador (2000), in a laboratory study, examined the driving-related skills of 168 subjects of both sexes and various ages with both light and heavy drinking histories. Their results indicated that the heavy drinkers performed no better than the light or moderate drinkers did. Thus, their study confirmed that significant impairment was present in relatively consistent levels across all age groups, sexes, and drinker types, supporting the use of a BAC level as a measure of impairment in per se laws and suggesting that crash risk is increased at BAC levels much lower than .10 g/dL.

Thus, from the time of the movement to adopt a .10 BAC level as the national standard, there were advocates for even lower BAC levels. Oregon and Utah led the way in 1983 by enacting .08 g/dL BAC per se laws. In 1986, DOT took its first formal step toward advocating a lower illegal limit by including a BAC level of .08 g/dL law as one of the regulatory criteria for a supplemental alcohol traffic-safety grant under the program authorized by the U.S. Congress (23 U.S.C. 408). On June 15, 2000, the Senate passed H.R. 4475 (the DOT Appropriations Bill for FY 2001) that included a general provision, sponsored by Senator Lautenberg from New Jersey, encouraging States to adopt .08 g/dL BAC laws by withholding a portion of a State's Federal highway funds. Beginning in FY 2004, funds were withheld from States that do not adopt .08 g/dL, and by 2004, all States and the District of Columbia had adopted laws making .08 g/dL the BAC limit.

5.3.6.3. Research on the Lowering of the BAC Limit to .08 g/dL

Fell and Voas (2006b) conducted a comprehensive review of studies on the effect of lowering the BAC per se limits. The highlights of that review are summarized here. Between 1991 and 2000, nine evaluations of .08 g/dL laws involving 11 States were conducted in the United States (REA, 1991; Johnson & Fell, 1995; Rogers, 1995a; Hingson et al., 1996a; Apsler, Char, Harding, & Klein, 1999; Foss, Stewart, & Reinfurt, 1998; Voas et al., 2000b; Hingson et al., 2000; Voas, Taylor, Kelley Baker, & Tippetts, 2000a). A scientific review by a committee of experts assembled by CDC concluded that the median treatment effect detected by the studies of the effects of .08 g/dL BAC laws was a 7% reduction in alcohol-related fatal crashes (Shults et al., 2001). A review by the U.S. General Accounting Office (1999, June) found that the .08 g/dL law was effective, but generally only when combined with an administrative license revocation law. To test the significance of the combination of the two laws, Hingson et al. (2000) compared States in which the two laws were implemented at about the same time with States where an ALR law had been in place for at least a few years before adoption of a .08 g/dL law. They found that the .08 g/dL law made a significant difference in States where the ALR law had been in place for some years.

As noted by DuMouchel, Williams, and Zador (1987), when research is conducted on multiple applications of the same law, one or two of the jurisdictions usually show no benefit or might even experience an increase in the problem. One example of this was the study by Foss et al. (1998) in North Carolina. They found no significant change because of the .08 g/dL law in North Carolina. Apsler et al. (1999), however, found a significant reduction in alcohol-related crashes in North Carolina associated with the .08 g/dL BAC law. REA (1991) reported a reduction in alcohol-related fatal crashes in California; conversely, Rogers (1995a), in a later analysis, did not find a significant reduction in fatal crashes in California attributable to the .08 g/dL law but did find a reduction in nighttime injury crashes in California due to the .08 g/dL law.

Voas et al. (2000b) considered the .08 g/dL BAC law as one of several alcohol safety measures in a study that included all 50 States plus the District of Columbia over a 16-year period. This study, which applied a common methodology to all the States from 1982 to 1997, found an 8% treatment effect of the .08 g/dL BAC law that was very similar to the CDC finding of a 7% median treatment effect (Shults et al., 2001). Voas et al. (2000b), in the most comprehensive study of lower BAC limits up to that time, controlled for many potentially confounding factors such as seat belt legislation and the economy.

One limitation when interpreting field studies of the implementation of new laws is the varying analytical methods and criterion measures used by the different investigators. To account for

this, Tippetts et al. (2005) conducted identical individual analyses of 19 U.S. jurisdictions with .08 g/dL laws using a common dataset, the same effect measure, and an identical analytical procedure. This permitted them to compare more directly the effectiveness of the .08 g/dL law in each jurisdiction where it was implemented. Further, it allowed the authors to perform a meta-analysis on the effect sizes in each of the 19 jurisdictions to derive an overall effectiveness measure for the .08 g/dL law, which indicated that lowering the BAC limit from .10 to .08 g/dL reduced the proportion of drinking drivers in fatal crashes by 14.8%. Based on this reduction, had the other States adopted a .08 g/dL law in 2000, the authors estimated that 947 lives might have been saved. Bernat, Dunsmuir, and Wagenaar (2004) examined the effects of .08 g/dL BAC laws in the same 19 jurisdictions using changes in SVN fatal crashes (when alcohol is most likely a factor) as their measure. The mixed-model regression analyses showed a significant 5.2% reduction in SVN fatal crashes associated with the .08 g/dL BAC law across all States after adjusting for ALR and trends.

Three other studies on the effectiveness of lowering the illegal BAC limit to .08 g/dL have appeared in the literature (Dee, 2001; Eisenberg, 2001; Gorman, Huber Jr., & Carozza, 2006). Dee used somewhat novel, panel-based evaluations of .08 g/dL laws, which in many respects addressed methodological limitations of previous studies. Using traffic fatality rates as the key measure, Dee (2001) analyzed 14 States that adopted .08 g/dL BAC laws between 1982 and 1998 and compared them to the other States that did not adopt .08 g/dL laws. Alaska, Hawaii, and the District of Columbia were excluded from the analyses. The regression analyses controlled for the potential effects of .10 g/dL BAC laws, ALR laws, dram shop laws, mandatory jail time for first DWI offenses, zero-tolerance laws for youth, mandatory seat belt laws (primary and secondary enforcement, separately), raising the speed limit on interstate highways to 65 and 70 miles per hour (mph), vehicle miles traveled in the State, State unemployment rate, and State personal income per capita. A statistically significant reduction of 7.2% in traffic fatality rates was associated with the adoption of .08 g/dL BAC laws. Dee (2001) estimated that 1,200 lives could be saved annually if the additional 23 States with ALR laws also adopted .08 g/dL BAC laws.

Eisenberg (2001) conducted a baseline analysis of the effects of .08 g/dL laws similar to that of Dee (2001), but also added controls for GDL laws and the presence of MADD in the State. Eisenberg's analysis showed that the .08 g/dL BAC limit is associated with a 5% reduction from the mean traffic fatality rate and that .10 g/dL BAC limit laws are associated with a 2.4% reduction. This estimate suggested that lowering the limit from .10 g/dL to .08 g/dL BAC level would garner a further reduction of 2.6% from the mean total fatal crash rate. This is a statistically significant reduction ($p < .05$). These methodologically rigorous studies verified that lowering the illegal BAC limit from .10 to .08 g/dL in the United States has had a significant safety effect. A recent study by Gorman (2006), however, did not find an effect of .08 g/dL BAC in Texas. They used a time-series analysis of FARS data and Texas State data.

Figure 5-8 (an update of Shults et al., 2001, Figure 2) summarizes the effectiveness of .08 g/dL laws in graphic form. It shows consistency and direction in the change in alcohol-related traffic fatalities that have occurred after .08 g/dL laws were adopted in the various States. The year of adoption of the .08 g/dL law by each State is shown in Figure 5-9.

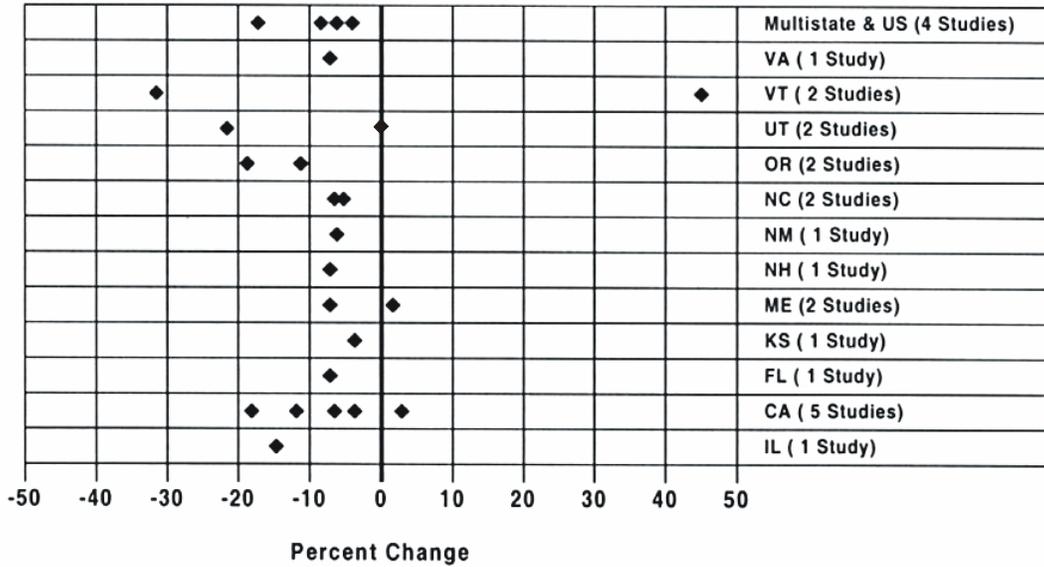


Figure 5-8. Percentage of change in alcohol-involved motor-vehicle fatalities following enactment of .08 g/dL laws. Adapted from Shults et al. (2001)

Table 5-5 summarizes all of the studies of the effectiveness of .08 g/dL BAC laws in the United States.

Table 5-5.

Studies of the effects of lowering the illegal BAC limit from .10 to .08 g/dL in the United States

Study	Results
Research and Evaluation Associates (1991) "The Effects Following the Implementation of an .08 g/dL BAC Limit and an Administrative Per Se Law in California"	12% reduction in alcohol-related traffic fatalities associated with the .08 g/dL and ALR laws.
Johnson and Fell (1995) "The Impact of Lowering the Illegal BAC Limit to .08 in Five States in the U.S."	Significant reductions in alcohol-related fatal crashes in four of five States ranging from 4 to 40%.
Rogers (1995b) "The General Deterrent Impact of California's .08 Percent BAC Limit and Administrative Per Se License Suspension Laws"	7% reduction in nighttime fatal and serious injury crashes. No significant decrease in alcohol-related fatal crashes.
Hingson et al. (1996a) "Lowering State Legal Blood Alcohol Limits to .08 Percent: The Effect on Fatal Motor Vehicle Crashes"	16 to 18% reduction in proportion of fatal crashes involving fatally injured drivers with BACs \geq .08 g/dL and BACs \geq .15 g/dL.
Apsler et al. (1999) "The Effects of .08 BAC Laws"	The .08 BAC law is associated with significant reductions in alcohol-related fatal crashes, alone or in conjunction with ALR, in 7 of 11 States.
Foss et al. (1998) "Evaluation of the Effects of North Carolina's .08 percent BAC Law"	No clear effect of .08 BAC law on already declining alcohol-related fatalities.

Study	Results
Voas et al. (2000b) "The Relationship of Alcohol Safety Laws to Drinking Drivers in Fatal Crashes"	The .08 g/dL BAC laws are associated with an 8% reduction in fatal crashes involving drinking drivers. If all States adopt a .08 BAC, an estimated 590 lives could be saved each year.
Hingson et al. (2000) "Effects of Recent 0.08% Legal Blood Alcohol Limits on Fatal Crash Involvement"	6% reduction in alcohol-related fatal crashes associated with .08 g/dL BAC laws in six States. If all States adopt .08 g/dL BAC, an estimated 400 to 500 lives could be saved each year.
Voas et al. (2000a) "Effectiveness of the Illinois .08 BAC Law" Also see Voas, Tippetts and Taylor (2001) "Effectiveness of the Illinois .08 Law: An Update with the 1999 FARS Data"	The .08 law reduced the number of drinking drivers in fatal crashes by 13.7% in the first 12 months. Followup study confirmed percent reduction over 30 months after .08 g/dL law adopted in 1997.
Shults et al. (2001) "Reviews of Evidence Regarding Interventions to Reduce Alcohol impaired driving"	Median 7% reduction in measures of alcohol-related fatal crashes associated with .08 g/dL BAC laws. CDC strongly recommends all States adopt .08 g/dL BAC laws.
Dee (2001) "Does Setting Limits Save Lives? The Case of .08 BAC Laws"	Statistically significant 7.2 percent reduction in the traffic fatality rate associated with the adoption of .08 laws in 14 States.
Eisenberg (2001) "Evaluating the Effectiveness of a 0.08% BAC Limit and Other Policies Related to Drunk Driving"	Statistically significant reduction of 2.6% in the fatal crash rate associated with .08 g/dL BAC laws in 14 States.
Bernat et al. (2004) "Effects of Lowering the Legal BAC to .08 on Single-Vehicle-Nighttime Fatal Traffic Crashes in 19 Jurisdictions"	Statistically significant reduction of 5.2% in SVN fatal crashes associated with .08 g/dL law across all States.
Tippetts et al. (2005) "A Meta-Analysis of .08 BAC Laws in 19 Jurisdictions in the United States"	Statistically significant decline of 14.8% in the rate of drinking drivers in fatal crashes after the .08 g/dL laws were adopted in 19 jurisdictions.
Gorman et al. (2006) Evaluation of the Texas .08 law	No statistically significant changes found in the time series analyses of the FARS or the Texas State data associated with the .08 g/dL law.

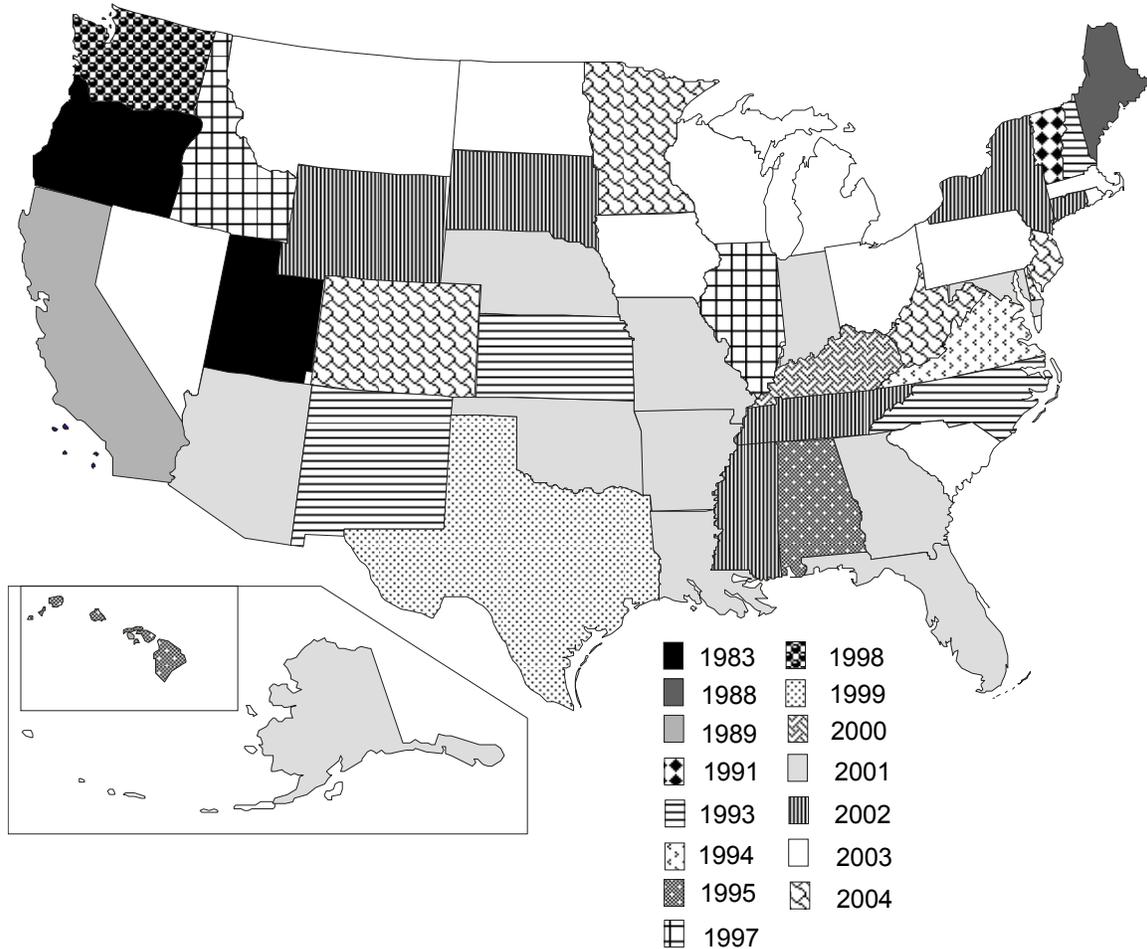


Figure 5-9. Map of U.S. showing implementation dates for .08 laws in the States. Adapted from Fell & Voas (2006b)

5.3.6.4. Summary of the Evidence for Lowering the BAC Limit to .05 g/dL

The BAC limit in most European nations and in Australia and New Zealand is .05 g/dL. This has led to considerable research on the effectiveness of BAC limits lower than .08 g/dL. Fell and Voas (2006b) summarized the evidence for lowering the illegal BAC limit for driving to .05 g/dL. A long-term study of the .05 BAC law in the Netherlands (adopted in 1974) concluded that it contributed to a sustained decline in the total number of drinking drivers involved in crashes (Noordzij, 1994). Another study from France evaluated the effect of lowering its BAC limit from .08 to .05 g/dL in 1996. Annual alcohol-related crash fatalities fell from approximately 100 before the legal change to 64 in 1997 in the province of Haute-Savoie, where the study was conducted (Mercier-Guyon, 1998). A study of the .05 law in Austria found that there was an overall 9.4% decrease in alcohol-related crashes relative to the total number of crashes (Bartl & Esberger, 2000). The authors noted, however, that intense media and enforcement campaigns also occurred around the time that the limit was lowered, making it nearly impossible to attribute the reductions to any one of these factors, at least in the short term. Bartl and Esberger (2000) concluded that “lowering the [il]legal BAC limit from .08 to .05 g/dL in combination with intensive police enforcement and reporting in the media led to a positive short-term effect.”

Henstridge, Homel, and Mackay (1995) conducted a time-series analysis of RBT and .05 g/dL BAC laws in Australia, controlling for many factors including seasonal effects, weather, economic trends, road use, alcohol consumption, and day of the week. Although their primary focus was on the influence of RBT, their findings on the effect of .05 g/dL BAC laws were also significant. They statistically accounted for the effect of other alcohol countermeasures to determine the specific values of the declines that were attributable directly to either RBT or the lower .05 BAC limit. They analyzed traffic data for periods ranging from 13 to 17 years and found that the Australian states that lowered their BAC limit from .08 to .05 g/dL experienced meaningful declines in alcohol-related crash measures. After Queensland, Australia, reduced its per se BAC limit to .05 g/dL in 1982, it experienced an 18% reduction in fatal collisions and a 14% reduction in serious collisions. These results were not confounded by the effects of RBT, as it was not introduced until 8 years after the .05 law. Similarly, the .05 g/dL BAC limit in New South Wales was estimated to have reduced serious collisions by 7%, fatal collisions by 8%, and SVN collisions by 11%. Although the .05 BAC limit was introduced only 2 years before RBT in New South Wales, the authors accounted for this in their analyses and attempted to determine the crash reductions specifically attributable to each of the interventions.

Smith (1988a) also evaluated the effects of lowering the BAC limit in Queensland from .08 to .05 g/dL BAC level. The proxy measure of changes in nighttime crashes as compared to daytime crashes was used. There was a significant 8.2% reduction in nighttime serious injury crashes (requiring hospitalization) and a 5.5% reduction in nighttime property-damage crashes associated with the .05 g/dL BAC limit in the first year. Smith partially attributes some of the crash reductions in the second and third years after the adoption of a .05 g/dL BAC level to increased enforcement.

In South Australia, the illegal BAC limit was not lowered to .05 g/dL until 1991. Kloeden and McLean (1994) reported that the number of nighttime drivers who had been drinking was reduced by 14.1% following adoption of the law. A second study of South Australia found that the .05 g/dL BAC limit did not significantly affect the number of fatally injured drivers who were legally impaired (McLean, Kloeden, McColl, & Laslett, 1995). This study did, however, show that the proportion of impaired drivers at BAC levels of .15 g/dL or greater declined from 1991 to 1993.

The last finding supports other Australian research indicating that the lower BAC limit has a substantial effect on drivers with BAC levels higher than .15 g/dL (Brooks & Zaal, 1992). It has been estimated that drivers with BAC levels higher than .15 g/dL are 244 times more likely to be involved in a fatal crash than are drivers with zero BAC levels (Simpson et al., 1996). Thus, even though a .05 g/dL BAC limit would appear to be aimed at drivers with moderate BAC levels, its potential effect on the behavior of high-BAC drivers has important traffic safety implications.

Table 5-6 summarizes the research on lowering the BAC limit to .05 g/dL.

Table 5-6.

Studies of the effects of lowering the illegal BAC limit to .05 g/dL

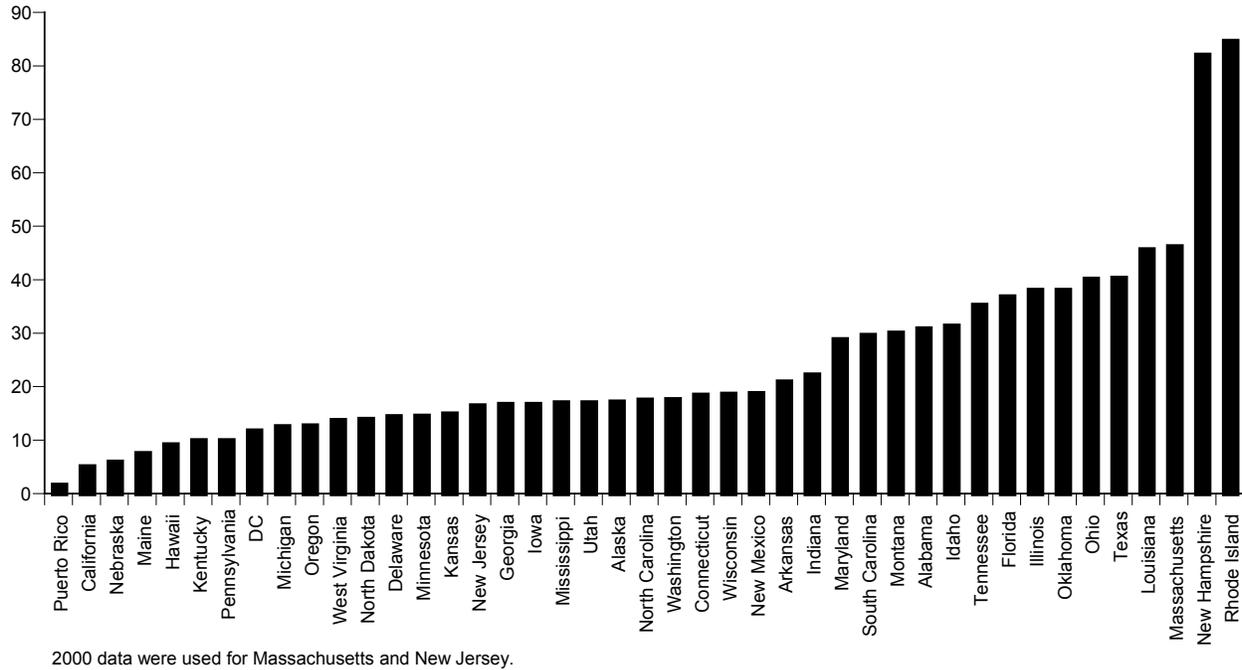
Study	Results
Noordzij (1994) "Decline in Drinking and Driving in the Netherlands"	Percentage of drivers with BAC levels of \geq .05 g/dL from roadside surveys decreased from more than 15% in the years before the .05 g/dL limit to 2% in the first year and then leveled off at 12% for 10 years after the law change.
Mercier-Guyon (1998) "Lowering the BAC Limit to .05: Results of the French Experience"	Alcohol-related traffic crash fatalities decreased from 100 before the limit was lowered to 64 in 1997, immediately after the law change in the French Province where the study was conducted.
Bartl and Esberger (2000) "Effects of Lowering the Legal BAC Limit in Austria"	Found 9.4% decrease in alcohol-related crashes. "Lowering the legal BAC-limit from .08 to .05 g/dL in combination with intense police enforcement and reporting in the media led to a positive short-term effect."
Henstridge et al. (1995) "The Long-Term Effects of Random Breath Testing in Adelaide"	Queensland experienced an 18% reduction in fatal crashes and a 14% reduction in serious crashes associated with lowering the BAC limit to .05 g/dL. These results were not confounded with the effects of RBT. New South Wales showed an 8% reduction in fatal cases, a 7% reduction in serious crashes, and an 11% reduction in SVN crashes associated with lowering the BAC limit to .05 g/dL.
Smith (1988b) "Effect on Traffic Safety of Introducing a .05 Percent Blood Alcohol Level in Queensland, Australia"	Significant 8.2% reduction in nighttime serious injury crashes and a 5.5% reduction in nighttime property-damage crashes associated with lowering the limit from .08 to .05 g/dL. Partly the result of increased enforcement.

Some countries have established BAC limits at levels lower than .05 g/dL. Jonah et al. (2000) reviewed the evidence internationally for the effect of lower BAC laws. They found that consistently, lower BAC limits produced positive results. The effect for Sweden of the .02 g/dL law that was introduced in 1990 was estimated at 6% reduction in fatal crashes (Norström & Laurell, 1997). Thus, in general, the literature reveals that lowering the BAC illegal limit reduces drinking-driver fatal crashes, whether the change is from .10 to .08 g/dL BAC or from .08 to .05 g/dL BAC for adults, or from .05 to .02 g/dL BAC.

5.3.6.5. Test Refusal Laws

Implied-consent laws, which have been adopted by all States, provide for license suspension for failure to submit to a chemical test. Although this provides a strong motivation for a DWI suspect to comply with the test, most defense attorneys advise their clients to refuse because an illegal BAC makes DWI conviction much more certain (Simpson & Robertson, 2001). This problem is likely to be exacerbated by the growth of high BAC laws (described below) that are based on the offender's BAC level. Jones, Joksch, and Wiliszowski (1991), in their study of implied-consent refusal rates in 1987, estimated that approximately 20% of DWI suspects refuse the chemical test nationwide. In a more

complete census, Zwicker, Hedlund, and Northrup (2005) developed estimates for 40 of the 50 States (see Figure 5-10). As can be seen, the frequency of refusal varies considerably across the States. In a study of the State of California, Tashima and Helander (2000) reported officers' experience refusals only 5% of the time. In contrast, Ross, Simon, Cleary, Lewis, and Storkamp (1995) reported a 50% rate. Simpson and Robertson (2001), in their survey of 2,731 police officers, found that officers experienced some type of refusal to cooperate in a DWI investigation about one-third of the time and that multiple offenders were more likely than first offenders to refuse the chemical test.



Source: Zwicker et al., 2005, Figure 1

Figure 5-10. Estimates of the percentage of breath-test refusals in 40 States, DC, and Puerto Rico

Based on their survey of police offices, Simpson and Robertson (2001) described five options for reducing chemical test refusals. The first option is to ensure that the penalty for refusal is at least as severe as for failing the test. This, however, is difficult because taking the test exposes the offender to court sanctions that the motor vehicle department cannot apply administratively. A second option is to implement laws that make refusal a criminal offense, subject to conviction and sanctioning by the court, a step that nine States had taken as of 2001 (Zwicker et al., 2005). Some States have moved in this direction by applying the same sanctions for refusal as they do for offenders convicted of a high BAC offense. A third option is to make refusal of the evidential test admissible in court (the authors noted that this has been done by most States). A fourth option, used in some States, is to make refusal a barrier to obtaining a hardship or limited license to go to and from work during the suspension period. The fifth option—supported by the Supreme Court in the *Smerber v. California* (1966) 384 U.S. 757 decision (already described)—provides that, if there is probable cause to make an arrest for DWI, the officers have a right to take a blood test, by force if necessary. This procedure is being used in some localities, but its effectiveness in increasing convictions has not been determined (Simpson & Robertson, 2001; Jones, Lacey, & Wiliszowski, 1998).

Zwicker et al. (2005) reviewed each State's law regarding refusal of the chemical test and reported, as might be expected, that test refusal rates are lower where the consequences of test refusal are greater than the consequences for failing the test. It is not clear, however, whether raising the penalties for refusal will reduce the number of refusals. Robertson and Simpson (2002c) noted that the availability of a BAC level is very important to the prosecutor's decision to file a charge, as well as to the outcome of the case itself. Moreover, the absence of a BAC level may preclude prosecuting an offender under a high BAC law in the 32 States that provide more severe sanctions for offenders with BAC levels of .15 g/dL or higher (see next paragraph). Although there is some evidence that the lack of a BAC level is associated with a lower probability of conviction, to date there have been no studies on the influence of test refusal laws on crash involvement.

5.3.6.6. High BAC Laws

An arrest for a BAC level of .15 g/dL or higher has been considered a signal for problem drinking since the Federal Government began to support community alcohol programs with the initiation of the Alcohol Safety Action Projects in 1969 (Voas, 1972; Levy et al., 1977; Nichols, Ellingstad, & Struckman-Johnson, 1978a; Voas, 1981). This focus on high BAC levels as a drinking problem indicator has increased with the concern with the hardcore drinking driver (see Chapter 3), which uses a BAC level along with repeated DWI offenses as the primary criterion for identifying such drivers (Simpson et al., 1996). There is some conflicting evidence regarding the significance of BAC as a predictor of recidivism. Marowitz (1996), in their study of a large group of DWI offenders in California, found only a relatively modest relationship between arrest BAC and recidivism. Similarly, Wiczorek, Miller, and Nochajski (1992) found only a low relationship of the BAC level to alcohol-related problems as measured on the Mortimer-Filkins test.

As of July 2005, 32 States and the District of Columbia have enacted high BAC laws (Hedlund, 2006), yet there has been only one study of their implementation. McCartt and Northrup (2004) conducted a study of Minnesota's high BAC law and detected a short-term increase in the severity of penalties for offenders with BAC levels of .20 g/dL or higher, the State's definition of a high BAC offense. Despite the apparent increase in the severity of the penalties for a high BAC level, the test refusal rate for first offenders decreased; however, the refusal rate for multiple offenders remained unchanged. The authors attribute this to the relatively severe penalties for refusal in Minnesota. They also reported a decline in the recidivism rate for first offenders that was reduced over time. Despite the wide adoption of high BAC statutes, no study has attempted to relate high BAC sanctions to crashes.

5.3.6.7. Open Container Law

Because underage youths cannot drink legally in licensed establishments and at social events supervised by adults, drinking frequently occurs in parks or on beaches, often in private vehicles. Private vehicles are also a frequent location of occupant drinking. It would therefore appear obvious that discouraging drinking in the motor vehicle is important to reduce impaired driving. Public support for banning open containers is high (Stuster, Burns, & Fiorentino, 2002). This has led to Federal legislation encouraging States to enact open container laws, resulting in 38 States adopting such laws as of July 2005 (Hedlund, 2006). Nonetheless, only one study of this law's effectiveness is available as of 2006. Stuster et al. (2002), using data from the FARS, evaluated the influence of open container laws on fatal crashes in four States. They found evidence of initial nonsignificant reductions in three of the four States during the 6 months after enactment of open container laws. Thus, the evidence to

support such laws is weak; however, their face validity as an expression of a societal negative attitude towards impaired driving probably makes these laws an important part of the overall effort to reduce alcohol-related crashes.

5.3.7. Deterrence

Classical deterrence theory is a psychological model designed to explain the influence of punishment on personal behavior. It holds that three factors—risk of detection, severity of the sanction, and the speed with which the sanction is applied—determine the response to laws. Ross (1982b) provides perhaps the clearest explanation of deterrence, emphasizing that it is the perception of each of the three factors—rather than the actual risk of detection, the sanction severity, and sanction celerity—that controls the behavior. The basic concept of the theory has been demonstrated in the many evaluations of traffic safety programs that have been conducted in the last half century. The relative influence of each of the elements of the theory, however, has been studied less. Ross and Klette (1995), based on his studies of Scandinavian laws, concluded that the perceived probability of arrest was a more significant factor than the severity of the penalty (Ross, 1992a). Some evidence for this position was developed from studies of DWI enforcement in the United States (Ross & Voas, 1990, Ross, McCleary, & LaFree, 1990).

5.3.7.1. Perceived Risk of Apprehension

The importance of perceived risk in determining driver behavior has been recognized by researchers concerned with drinking and driving (Reed, 1981; Ross, 1982a; Voas, 1997). The actual risk of arrest for DWI is quite small, however. In the United States, estimates have varied from 1 in 2,000, based on an analysis of average annual officer arrest rates (2 per year per officer) (Borkenstein, 1975), to about 1 in 88, based on responses to a national telephone survey and FBI crime statistics. (Zador, Krawchuck, & Moore, 2001). The most carefully developed risk estimates were those developed by Beitel, Sharp, and Glauz (2000), which they estimated from measures collected during actual enforcement operations. Working in Kansas City, Missouri, where roadside surveys had determined the percentage of drivers on weekend evenings who were over the limit, they employed research assistants to accompany dedicated DWI enforcement patrol officers searching for DWI suspects on weekend evenings. The research assistants counted the number of drivers the officers had the opportunity to observe and recorded the number of DWI citations. They found that the risk for a driver with a .10 g/dL BAC level of being issued a citation was 6 in 1,000. Their method was duplicated by Hause, Voas, and Chavez (1982) in Stockton, California, with closely similar results (see Table 5-7).

Table 5-7.

Probability of being arrested for DWI in Kansas City, Missouri, and Stockton, California, at various BAC levels

	BAC .10 g/dL	BAC .15 g/dL	MEAN BAC
STOCKTON STUDY			
Friday night	.004	—*	.166
Saturday night	.001	.010	.181
Weekend night	.004	.013	.174
KANSAS STUDY			
Patrol hours	.006	.013	.171

Source: Hause et al. (1982); Beitel, Sharp, & Glauz (2000)

Thus, the public's perception that the risk of detection and arrest is low is accurate. Modest changes in the actual risk of arrest are likely to have little effect on driver behavior (Ross, 1982a; Reed, 1981); and substantially bolstering DWI enforcement, though effective (Voas & Hause, 1987), may be politically and economically costly. When changes in traffic enforcement are implemented and highly publicized, the public may overestimate the new, increased risk, at least for a time—and the amount of drinking and driving decline. A clear example of this effect was provided by the British Road Safety Act, described in some detail by Ross (1973). The study conducted in Stockton, California, by Voas and Hause (1987) demonstrated that impaired driving decreased when an increase in enforcement was accompanied by publicity, but the effect of the enforcement effort was reduced by about 50% when the effort no longer received media coverage. The public draws its perception of risk both from the direct observation of enforcement activities and from the public media. When the initial publicity surrounding a new program dissipates, it may become clear that the actual risk of arrest has not risen as much as the public perceived; therefore, they may return to their former drinking-and-driving behavior.

5.3.7.2. *Severity of Punishment*

The sanctions for drinking-and-driving convictions have generally been increasing since 1980 when citizen advocacy groups first began to form (Fell & Voas, 2006c). Either the maximum penalties have changed or been strengthened, or mandatory minimum penalties have been introduced. There is limited evidence to support the positive influence of the severity of DWI sanctions on general deterrence (Nichols & Ross, 1990; Ross & Voas, 1989). Even so, more severe sanctions can be counterproductive if they motivate defendants to demand more jury trials in an already overburdened judicial system, resulting in increased plea bargaining and the use of diversion programs (Robertson & Simpson, 2002c; Little, 1975; Ross & Voas, 1989). Severe punishments do not appear to produce fewer crashes than less severe penalties (Homel, 1988; Ross, 1992a). Conversely, Falkowski (1984) and Cleary and Rodgers (1986), in their studies of a judicial policy to impose a 48-hour jail sentence for first DWI offenders in Minnesota, found a 20% reduction in nighttime fatal crashes. This result was somewhat clouded by an overall increase in the arrest rate in that State during the same period, suggesting that the reduction in fatal crashes represented a general increase in enforcement. Severe sanctions appear to have a limited role in creating general deterrence. As noted by Voas and Fisher (2001) and Voas (2001), however, they play a significant role in specific deterrence programs aimed at convicted offenders where tough penalties, such as imprisonment, can have beneficial indirect effects by providing a sanction of last resort to motivate repeat offenders to participate in more constructive programs, such as probation or residential treatment. (See the next section on *Tertiary Prevention*.)

5.3.7.3. *Swiftness of Punishment*

Swiftness of punishment is the proximity of punishment to the drinking-and-driving event. The best example of a law designed to take advantage of the swiftness factor is administrative license suspension. As of July 2005, 41 States have enacted administrative suspension laws. Two 50-State evaluations of ALR laws (Zador et al., 1988; Voas et al., 2000b) have shown them to be associated with substantial reductions in alcohol-related fatal crashes. Voas et al. (2000b) conducted a panel study of the 50 States and DC of the effect of ALR laws on adult (age 21 and older) drinking drivers in fatal crashes over 16 years (1982-1997). During that period, 39 of the 50 states had ALR laws. Their analysis indicated a 19% reduction in drinking drivers in fatal crashes with BAC levels in the

.00 to .09 g/dL range and a 13% reduction in drinking drivers with BAC levels .10 g/dL or higher attributable to the ALR laws.

In sum, there is strong evidence that the major factor in creating *general* deterrence is increasing the perceived probability of being apprehended for the offense. Sanctions play a bigger role in *specific* deterrence, controlling of the impaired driving of individuals arrested and convicted of DWI, which is discussed in the section on *Tertiary Prevention*. Because the perceived risk of apprehension is apparently the key issue in general deterrence, enforcement and publicizing enforcement have become the primary activities directed at the public to deter them from driving after drinking. In the following sections, recent research on DWI enforcement and on coordinated publicity campaigns is described.

5.3.8. *DWI Enforcement*

The goal of DWI enforcement is to reduce the number of impaired drinkers who drive, thereby reducing the number of automotive crashes and fatalities. In the process, enforcement serves as an intake system for the courts that are tasked to impose sanctions that will keep offenders from drinking and driving in the future. DWI enforcement must conform to several specific regulations and rules established by the courts over time as DWI laws have developed. In carrying out this mission, police officers have access to a number of technological tools that have been used with varying success. This section reviews research on enforcement and on the technology developed to support enforcement programs.

In the model shown on page 5-4, the level of DWI enforcement → effects perceived risk of DWI arrest, which mediates the relationship between drinking and driving after drinking → that leads to alcohol-related motor-vehicle crashes. DWI enforcement → also directly influences public awareness of drinking/driving enforcement, → which again influences perceived risk of DWI arrest. DWI enforcement is also influenced by community activism about drinking and driving. This relationship, as shown in the causal model, reflects the interaction of changes in enforcement and the public awareness of enforcement. The community learns about DWI enforcement in two ways: (1) observing actual enforcement as a driver (or passenger), and (2) reports from others as well as news coverage. Thus, highly visible and frequent enforcement is observed by drivers as they travel on roadways, and publicity (planned or natural local news attention) increases public awareness (i.e., people will talk about the perception of enforcement).

Because deterrence theory provides that it is the perception of the risk of arrest rather than the actual number of DWI citations issued, the visibility of the enforcement program is generally accepted as an important factor in its effectiveness (Fell, Lacey, & Voas, 2004). Visibility can be enhanced by publicizing the enforcement program in the media, and as described below, considerable effort has been dedicated to promoting programs that combine high-visibility enforcement and publicity (Lacey, Fell, Falb, & Brainard, 2005). Some enforcement procedures, notably sobriety checkpoints and saturation patrols, are more visible to the public. They are likely to attract public attention and create greater deterrence independent of the level of publicity provided. In addition, high-visibility enforcement operations are also easier to publicize because they are of more interest to the public and increase the motivation of the news media to cover them. Because of their assumed value, high-visibility enforcement operations have received most of the recent research attention.

5.3.8.1. Traditional DWI Enforcement

Procedures for enforcing laws against impaired driving have grown out of the standard traffic enforcement responsibilities of police departments. Traffic officers have many responsibilities, some of which include directing traffic, responding to crash scenes, and enforcing traffic regulations related to high-risk driving such as speeding and red light running. In addition, they may be called to crime scenes or tasked with security responsibilities for government officials. With these competing responsibilities, DWI arrest activity is generally limited. In a classic study of DWI enforcement for NHTSA, Borkenstein (1975) analyzed the enforcement activities in urban areas in the U.S. He noted that “In a typical American city, 10% of police resources are allocated to traffic law enforcement, but included in the violations are such mundane offenses as blocking driveways and parking violations. Competition for police and court resources is fierce.” (p. 656). In his survey of police departments, he reported that an officer, on average, made only two impaired-driving arrests per year (p. 659). Based on surveys of the number of drinking drivers on the roads, he estimated that at if the typical officer made only two arrests a year, the probability of being arrested with a BAC level of .10 g/dL at that time was 1 in 2,000.

5.3.8.2. Dedicated Patrols

Since Borkenstein’s study in 1975, State BAC limits have been reduced from .10 to .08 g/dL, Federal funding for DWI enforcement has increased, and many police department have established special DWI patrols. Consequently, the number of DWI arrests in the United States has increased from 1 million to 1.5 million (FBI crime statistics), making the odds of being arrested if over the limit substantially higher today. Nevertheless, arrest rates tend to be low where reliance is placed entirely on traditional traffic patrols. DWI arrest rates can be significantly increased by establishing “dedicated patrols” focused on DWI enforcement operating on weekends. Experience in the ASAP program indicated that one or two dedicated patrols would double the annual number of DWI arrests (Levy, Voas, Johnson, & Klein, 1978; Voas, 1981).

5.3.8.3. Sobriety Checkpoints

Sobriety checkpoints are an enforcement operation in which law enforcement officers stop all vehicles, or a systematic selection of vehicles, to evaluate drivers for signs of alcohol or other drug impairment. To minimize public concern about the activity and comply with court rulings, checkpoints typically are publicized in advance, and signs are posted at the approaches to the checkpoints warning drivers that a checkpoint is ahead. Law enforcement officers in uniform approach drivers and identify themselves, describe the purpose of the stop, and ask the driver questions designed to elicit a response that will permit the officer to observe the driver’s general demeanor. Drivers who do not appear impaired are immediately waved on; drivers who show signs of impairment are usually detained in a safe holding area where they are investigated further, and either arrested or released.

Sobriety checkpoints provide U.S. police departments with the closest approximation to the highly successful RBT enforcement procedure used in Australia and Sweden, among other countries. Because U.S. police are limited to a brief interview unless they have reason to believe the driver may be impaired, sobriety checkpoints appear not to be as effective as RBT programs. Henstridge, Homel, and Mackay (1997), in a time-series analysis for four Australian states, found that RBT was twice as effective as selective checkpoints. Sherman (1990) found that in Queensland, Australia, RBT resulted

in a 35% reduction in fatal crashes, compared with 15% for checkpoints. They estimated that every increase of 1,000 in the daily RBT testing rate corresponded to a decline of 6% in all serious crashes and 19% in SVN crashes.. Moreover, analyses revealed a measurable continuing deterrent effect of RBT on the motorist population after the program had been in place for 10 years. Homel (1988) showed that the deterrent influence of RBT also provided heavy drinkers with a legitimate excuse to drink less when drinking with friends.

Although possibly not as effective as RBT because of the inability to automatically test every driver stopped, the sobriety checkpoint procedure does effectively reduce alcohol-related crashes. Several studies in the early 1980s found significant decreases in alcohol-related crashes associated with sobriety checkpoint programs in Arizona (Epperlein, 1987); in Clearwater and Largo, Florida (Lacey, Rudisill, Popkin, & Stewart, 1986); and in Charlottesville, Virginia (Voas, Rhodenizer, & Lynn, 1985). Later studies confirmed those results by demonstrating that that checkpoint programs reduced alcohol-related crashes by 10 to 20% in locations such as New Jersey (Levy, Shea, & Asch, 1988; Levy, Asch, & Shea, 1990) and Binghamton, New York (Wells, Preusser, & Williams, 1992).

Reports that are more recent have added convincing and consistent evidence that sobriety checkpoints may be even more effective than previous research has indicated. Foss, Beirness, Tolbert, Wells, and Williams (1997) reported the results of the checkpoint program implemented in North Carolina in 1994 called “*Booze It and Lose It.*” Before the 2-month checkpoint blitz, 1.96% of the drivers at roadside surveys had BAC levels of .08 g/dL or greater. Roadside surveys following the checkpoint program demonstrated that the proportion dropped to .90% at a .08 g/dL BAC level or greater ($p < .05$). That was a 55% *relative* decrease in the proportion of drivers at illegal BAC levels. At around the same time, a demonstration program in Tennessee (*Checkpoint Tennessee*) was sponsored by NHTSA to determine if highly publicized sobriety checkpoints conducted throughout the State on a weekly basis would affect impaired driving. An evaluation of that program, using interrupted time series, showed a 20% reduction in alcohol-related fatal crashes extending at least 21 months after conclusion of the formal program (Lacey et al., 1999a). Finally, in 2001 Georgia conducted a highly publicized statewide checkpoint program, using roadside surveys and crash statistics to evaluate the program. Fell, Langston, Lacey, Tippetts, and Cotton (2008) reported a 20% drop in impaired-driving crashes in Georgia resulting from the program. Figure 5-11 provides a summary of the North Carolina, Tennessee, and Georgia programs; Figure 5-12 gives the results of the Charlottesville, Clearwater, Bergen, and Binghamton checkpoint programs.

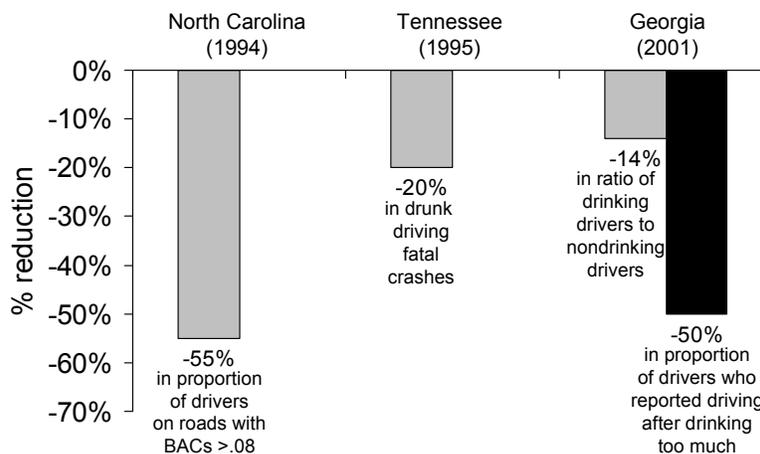


Figure 5-11. Effectiveness of statewide sobriety checkpoint programs

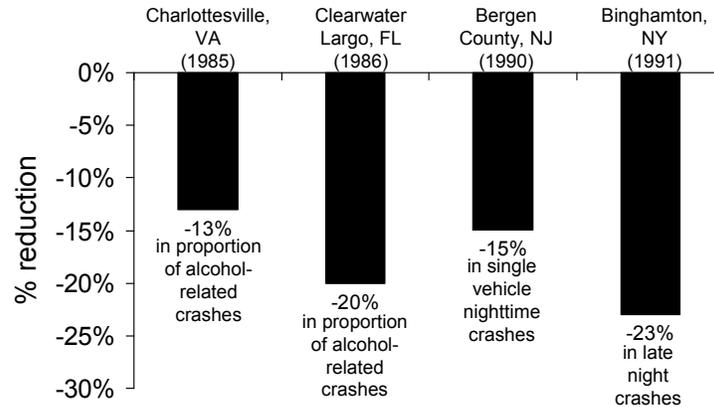


Figure 5-12. Effectiveness of sobriety checkpoint programs in four communities

Ross (1992c) summarized the evidence from nine checkpoint studies through the early 1990s and concluded that the cumulated evidence supported the hypothesis that checkpoints reduce impaired driving. Between 1999 and 2002, three reviews of the random breath test programs such as those used in Australia and the U.S. sobriety checkpoints programs were published. Peek-Asa (1999) reviewed 14 studies occurring between 1983 and 1996, six of which were evaluations of selective breath testing (SBT) checkpoints in the United States and eight of studies of RBT programs in Australia. Although the quality of the evaluations varied, all of the studies reviewed provided some evidence of reductions in total crash involvements or in proxy measures of alcohol-related crashes. Five of the eight RBT programs reported reductions in total fatalities varying from 20 to 76%, whereas one of the six U.S. SBT programs reported a 16% reduction. Four of the RBT studies reported on reductions in alcohol-related fatalities varying from 21 to 42%, and six of the SBT evaluation studies reported on alcohol-related fatalities varying from 17 to 75%.

A subsequent study of 15 U.S. checkpoint programs occurring between 1985 and 1999 and 17 random breath-test programs occurring between 1981 and 1997 was published in a somewhat different format in two reports (Shults et al., 2001; Elder & Shults, 2002). All of the cases studied reported reductions in one or another type of crash. The net percentage of change in crash frequency for SBT and RBT checkpoints is shown in Figures 5-12 (U.S. checkpoints) and 5-13 (random breath-test programs). Shults et al. (2001) noted that, by the rules governing the CDC Community Guide, the studies that they reviewed “provided strong evidence” that sobriety checkpoints are effective in preventing alcohol-related fatalities and injuries (p. 45). A survey of State checkpoint operations by Fell and colleagues (2004) reported effectiveness figures similar to those of Shults et al. (2001). They noted that there is “substantial and consistent evidence” from research that highly publicized, highly visible, and frequent sobriety checkpoints in the United States reduce impaired-driving fatal crashes by 18 to 24%.

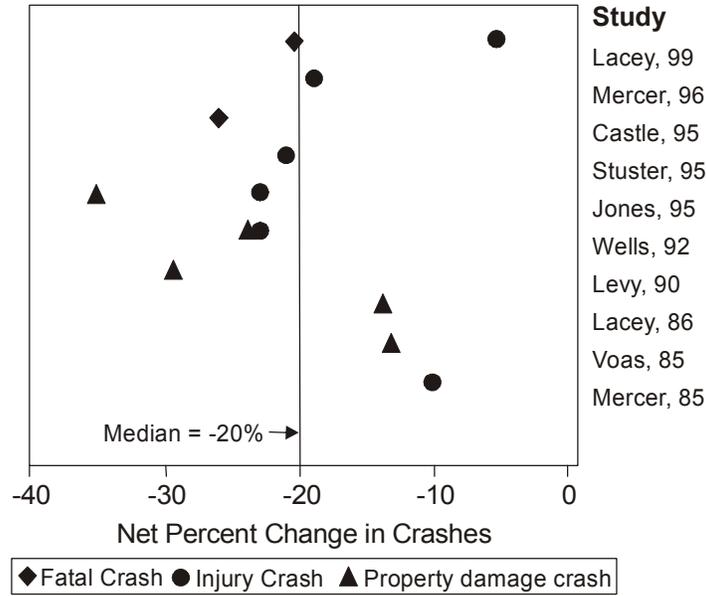


Figure 5-13. Percentage of change in crashes likely to involve alcohol after implementing SBT checkpoint programs. Adapted from Elder & Shults (2002)

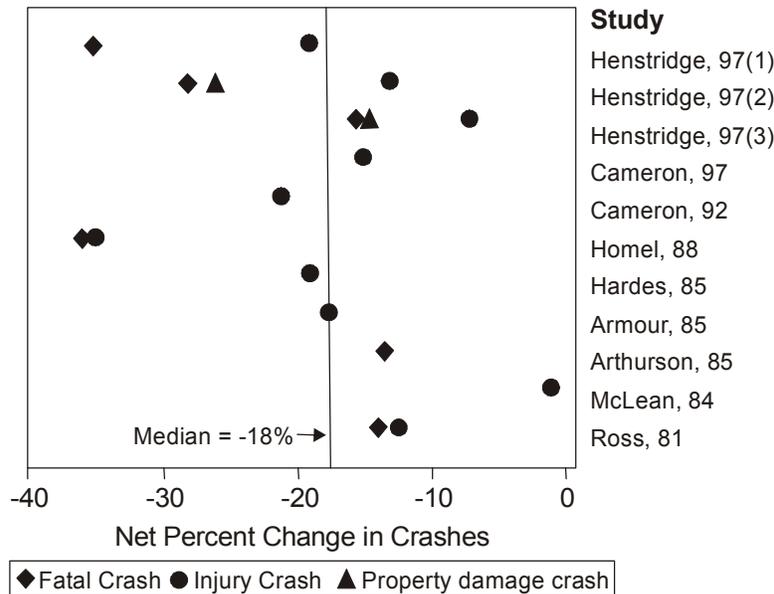


Figure 5-14. Percentage of change in crashes likely to involve alcohol after implementing RBT checkpoint programs. Adapted from Elder & Shults (2002)

5.3.8.4. Relative Efficiency of Sobriety Checkpoint Compared to Random Breath-Test Programs

Of particular interest in the three surveys (Peek-Asa, 1999; Shults et al., 2001; Elder & Shults, 2002) is that they all found little difference in the influence of RBT versus SBT. In an RBT, all drivers stopped can be required to provide a breath test, and in an SBT, only drivers providing evidence of drinking are normally requested to take a preliminary breath test; therefore, an RBT should be the more effective deterrent. As can be seen in Figures 5-13 and 5-14, however, the influence on crash

measures is similar from both types of checkpoints. This is particularly striking because as Elder and Shults (2002, p. 237) noted, there is evidence that the efficiency of SBT checkpoints could be significantly increased if police used passive sensors. Lund and Jones (1987) reported similar findings for the use of passive sensors and noted that they increased the efficiency of checkpoints in two ways: (1) by increasing the number of high-level BAC drivers identified at the checkpoint, and (2) by reducing the number of checkpoint drivers needlessly detained who had BAC levels lower than the limit. Table 5-8, drawn from the report on the Charlottesville checkpoint program (Voas et al., 1985), shows that the arrest rate per 1,000 vehicles when the officers were using the Sniffer PAS III² was 32.1, twice as high as the 13.6 arrest rate when the sensor was not used. Currently, passive sensors are rarely used at U.S. SBT checkpoints, but it appears that increased use of such devices might significantly increase the effectiveness of such checkpoints, perhaps making them more efficient in producing DWI arrests than the random breath-test programs in Australia.

Table 5-8.

Effect of the use of passive sensors on DWI arrests and warnings at the Charlottesville checkpoints

	With Sensor	Without Sensor
Number of vehicles	1,028	1,402
Number of arrests	33	19
Arrest rate per 1,000 vehicles	32.1	13.6
Number of warnings	44	43
Warning rate per 1,000 vehicles	42.8	30.7

Adapted from Voas et al. (1985)

5.3.8.5. Limited Use of Checkpoints

Despite these positive results for the sobriety checkpoints used in the United States, a recent survey of checkpoint use (Fell, Ferguson, Williams, & Fields, 2003) showed that only about a dozen of the 37 States that conduct checkpoints do so each week. This low checkpoint use is occurring despite the efforts of the U.S. DOT to encourage checkpoint use. Their survey found that lack of local police resources and funding, lack of support by State task forces and citizen activists, and the perception that checkpoints are not productive in producing DWI arrests or cost-effective in terms of crash reduction are the main reasons for their infrequent use. Similar reasons have been reported by other investigators (Ross, 1992d).

5.3.8.6. Cost-Benefit of Checkpoints

There is some evidence for the cost-benefit of checkpoints. As part of their survey of checkpoint studies, Shults et al. (2001) also reviewed two studies of the cost-effectiveness of random breath test programs (Arthurson, 1985; Wesemann, 1990). Arthurson estimated the annual total cost of the a program in New South Wales, which reached one in three drivers, as \$4 million (U.S. dollars) and the annual benefit as \$224 million (U.S. dollars). Wesemann evaluated a proposed random breath-test program for the Netherlands, which cost an estimated \$15.6 million to produce a 25% reduction in property-damage and injury crashes and saved an estimated \$31.4 million in societal costs. One study not included in that review indicated that sobriety checkpoint programs could yield considerable cost

² PAS Systems International, 1616 Princess Anne Street, P.O. Box 330, Fredericksburg, Virginia.

savings: \$6 for every \$1 spent on a weekly sobriety checkpoint program in a community (Miller et al., 1998).

5.3.8.7. DWI Arrest Productivity at Checkpoints Compared to Regular Patrols

One of the major factors discouraging police department managers from implementing checkpoints is the generally low rate of DWI apprehensions at such operations. The general policy in many checkpoint operations is to keep the interview period short (30 to 60 seconds) in order to contact as many motorists as possible during the checkpoint operation. This conflicts with the need for officers to conduct sufficiently long interviews to gather the amount of evidence of heavy drinking required for them to request a preliminary breath test. Consequently, up to half of the over-the-limit drivers passing through sobriety checkpoints are not apprehended (Ferguson et al., 1995; Lund & Jones, 1987; Lund & Wolfe, 1991). There is evidence, however, that officers at sobriety checkpoints can generate approximately as many arrests as officers on regular patrol. This is illustrated in Table 5-9, adapted from the study of the Charlottesville checkpoint program by Voas et al. (1985). Every 100 hours of officer time, devoted to checkpoints in Charlottesville produced 15.4 DWI arrests compared to the 12.7 arrests per 100 hours produced by traditional patrols. Because the number of DWI arrests increased by approximately 2.5 times when passive sensors were used (Table 5-8), the potential for checkpoints staffed by officers using passive sensors to out-perform traditional dedicated patrols is substantially greater than the figures in Table 5-9 indicate.

Table 5-9.

Comparison of the arrest productivity of traditional DWI patrols and checkpoint operations in Charlottesville

	Traditional DWI Patrol	Checkpoints
Period	Jan 1, 1983 – Oct 31, 1983	Dec 30, 1983 – Dec 31, 1984
Number of officers	2	5
Hours per night	4	4
Total nights	79	94
Total hours	632	1,880
Total DWI arrests	80	290
Officer hours per arrest	7.9	6.5
Arrests per 100 hours	12.7	15.4

Adapted from Voas et al. (1985)

5.3.8.8. Citations for Other Traffic Offenses at Checkpoints

Elder et al. (2002), in their review of sobriety checkpoints, noted that such operations result in the apprehension of suspended drivers or individuals carrying weapons (p. 273) that may provide benefits in addition to their influence on impaired-driving crashes. A number of examples of this can be cited. Tables 5-10, 5-11, and 5-12 show numerous other citations and arrests that took place during checkpoint operations in Tennessee (Lacey et al., 1999a), Georgia (Fell et al., 2008) and Charlottesville (Voas et al., 1985). Particularly important from a traffic safety viewpoint are the citations for seat belts (see section on Safety Belt Laws and Impaired Driving) and for driving while suspended (see section on Illicit Driving). Note that in Georgia there were more citations for those two offenses than for DWI. Because officers cannot check the status of an operator’s license unless the

driver is observed committing a traffic offense that allows the officer to stop the vehicle, suspended DWI offenders who drive with reasonable care to avoid attracting the attention of the police are rarely apprehended. Checkpoints where all drivers are stopped systematically provide a major opportunity to check the license status of drivers. Unfortunately, many departments do not take advantage of that opportunity either to move as many vehicles through the checkpoints as possible or to avoid the possibility of negative public reaction.

Table 5-10.

Georgia's Operation Zero Tolerance: A statewide highly publicized sobriety checkpoint program (checkpoints July 2000 – July 2001)

Checkpoints conducted	2,837
Drivers checked	280,082
Drivers arrested for DWI	2,322
Seat belt violations	5,348
Drug violation arrests	1,001
Felony arrests	236
Stolen vehicles recovered	57
Suspended/revoked licenses	2,481
Other traffic citations	14,776

Source: Fell et al., 2008

Table 5-11.

Checkpoint Tennessee: A statewide sobriety checkpoint program (checkpoints April 1994 – March 1995)

Checkpoints conducted	882
Drivers checked	144,299
Drivers arrested for DWI	773
Seat belt violations	1,517
Drug violation arrests	201
Felony arrest, stolen vehicles, weapons	88
Youth Offender violations	84
Other traffic citations	7,351

Source: Lacey et al., 1999a

Table 5-12.

Charlottesville Checkpoint: Summary activity December 30, 1983 – December 31, 1984

Activity	Number	Rate per 100 Vehicles
Checkpoint operations	94	—
Vehicles stopped	23,615	—
DWI arrests	290	1.228
Warnings issued	386	1.635
Other violations	—	—
Operator's license	141	0.597
Vehicle registration	66	0.280
Misc. violations	56	0.237
Total other violations	263	1.114

Source: Voas et al., 1985

5.3.8.9. Saturation Patrols

Saturation patrols provide a high-visibility alternative to checkpoints particularly suitable for the States with constitutional limitations on the use of sobriety checkpoints (Fell et al., 2003). This strategy involves sending substantially more officers than normal to patrol areas where alcohol-related crashes frequently occur or where there are a high number of arrests for DWI. The large number of police vehicles is intended to attract public attention to the enhanced enforcement and provide a basis for attracting press attention to the effort. Saturation patrols appear to be effective in reducing impaired driving if they are highly publicized, but recent research on this strategy is much more limited and is not as extensive or convincing as that on sobriety checkpoints. The one direct comparison of the checkpoint and saturation methods in California conducted by Stuster and Blowers (1995) favored checkpoints. In addition, saturation patrols may have the same major limitation as checkpoints in that they require a substantial number of officers.

The Stuster and Blowers (1995) study was particularly important because it was specifically designed to compare sobriety checkpoints with saturation patrols. The study examined the application of large and small staff checkpoint operations with moving or stationary locations in four California communities with two other communities using saturation patrols. All six communities were provided with funds to support publicity for the enforcement effort. The checkpoint programs produced crash reductions, averaging 28% across the four communities, compared to a 17% decline in communities that used saturation patrols. There were no differences in effectiveness for sobriety checkpoint programs with small staffing levels (3 to 5 officers per checkpoint) compared with high staffing levels (8 to 12 officers), or for checkpoints that stayed in one location versus those that moved around. Interpretation of the results is that, when highly publicized, both saturation patrols and checkpoints are effective in reducing crashes. Checkpoints, however, appear to be the more effective procedure where they can be applied. The evidence that small staff checkpoints can be as effective as larger operations is particularly important because it suggests that rather requiring special funding to conduct checkpoint operations, small to moderate-sized jurisdictions can mount checkpoints with their existing staffs (see section on *PASpoints*).

5.3.8.10. Low-Staff Checkpoints

In the survey of the use of checkpoints in the United States, Fell et al. (2003) found only 11 States in which checkpoints were conducted weekly somewhere in the State. Their study pointed to two major reasons for this limited application of the checkpoint procedure as a regular method for enforcing DWI laws: the high cost of such operations due to the requirement for a large number of officers to implement them and their low-arrest rate. The Stuster and Blowers (1995) study demonstrated that checkpoints with as few as 3 to 5 officers could be as effective as much larger staffs of officers. Further, the Charlottesville checkpoint program (Voas et al., 1985) demonstrated that officers could be as efficient in producing DWI arrests at a checkpoint as on regular patrol. Taken together, these two studies suggest that it is possible for relatively small police jurisdictions to adopt checkpoints as one type of standard enforcement operation along with the more traditional dedicated roving patrols and saturation patrols, which are more commonly implemented than sobriety checkpoints.

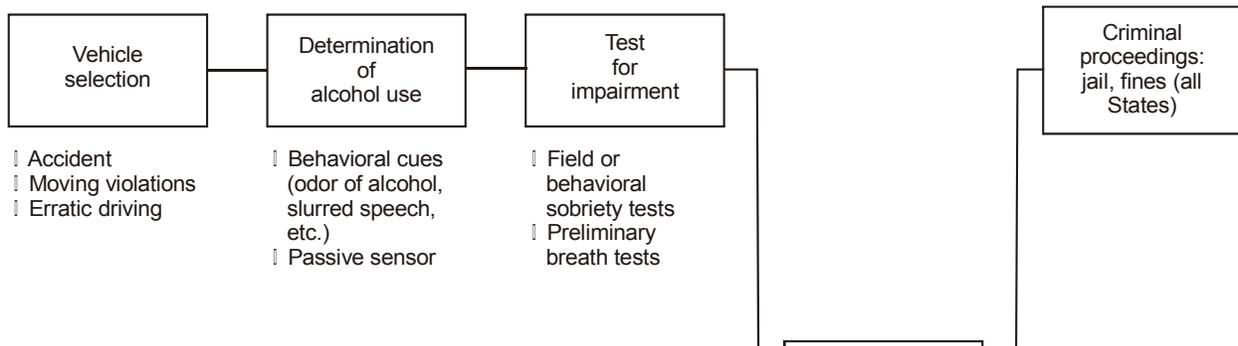
A method for low-staff checkpoint operations that uses auxiliary personnel and requires minimum time from officers on regular patrol has been proposed by Voas, Lacey, and Fell (2003a). They describe a procedure for making checkpoints a regular feature of weekend enforcement by using auxiliary personnel to set up the site and having officers on regular patrol converge on the location to establish a checkpoint for 2 or 3 hours before returning to their regular beats. Because, as demonstrated by the Charlottesville experience (Voas et al., 1985), the use of passive sensors substantially increases the number of DWI arrests at a checkpoint, use of that device is suggested as an integral feature of a *PASpoint* program. Their suggested program also involves the checking of driver licenses to deter driving while suspended.

A “mini-checkpoint” program, loosely model on the *PASpoint* concept, was undertaken by Lacey, Kelley-Baker, Ferguson, and Rider (2006) in West Virginia. Low-staff checkpoints (three to five officers) were conducted weekly in two experimental counties in the State (106 in one year). The low-staff checkpoints were relatively inexpensive to conduct, costing from \$350 to \$400 per checkpoint. In two similar counties, checkpoints were not conducted, but routine DWI enforcement was continued. After controlling for sample differences, a statistically significant 70% reduction in the proportion of drivers in roadside surveys with BAC levels higher than .05 g/dL was experienced in the experimental counties relative to the comparison counties associated with the checkpoint program. For drivers with BAC levels of .08 g/dL or higher, the decline in the checkpoint counties was 64% relative to the comparison counties, although this effect did not reach statistical significance. This study demonstrated that a sobriety checkpoint program using only three to five officers could be an effective deterrent against impaired driving in rural areas. Lacey and colleagues (2005) also released an article on how to conduct low-staff sobriety checkpoints. Another example of a small staff checkpoint operation was provided by the Charlottesville checkpoint program that employed five officers (Voas et al., 1985). During 1984, when the Charlottesville police department conducted sobriety checkpoints every weekend night, the percentage of nighttime crashes (10 p.m. to 4 a.m.) occurring in Charlottesville was reduced by 16.8%. This significant ($p=.000$) reduction could not be accounted for by a general statewide reduction in nighttime crashes because the reduction in Charlottesville was 11.33% greater than in the State of Virginia as a whole ($p=.013$).

5.3.9. Enforcement Technology

During the last 30 years, considerable effort has been expended in the development of technological methods and devices to increase the effectiveness of DWI enforcement. Research has been conducted on methods for each phase of the arrest process shown in Figure 5-14. The model shown in that figure (from Voas & Lacey, 1990) contrasts the “chemistry-based” enforcement system typical of Australia and Sweden with the “behavioral-based” system, which is the primary system used in the United States. Although the use of passive sensors at checkpoints provides U.S. police with a method that approximates the RBT system in Australia, most DWI arrests in the United States are based on the behavioral system (shown on the top line of Figure 5-14). The first element of that procedure is to identify and stop vehicles in the traffic stream likely to be driven by impaired drivers. Once such vehicles have been stopped, the next stage of the investigation is to identify the drivers who have been drinking heavily. Those drivers can then be invited them out of their vehicles to participate in sobriety testing. Each of these three steps have has received some research attention directed at producing methods and equipment that will increase the officer’s efficiency in apprehending impaired drivers.

A. Traditional U.S. “Behavioral Based” Enforcement



B. Scandinavian “Chemistry Based” Enforcement

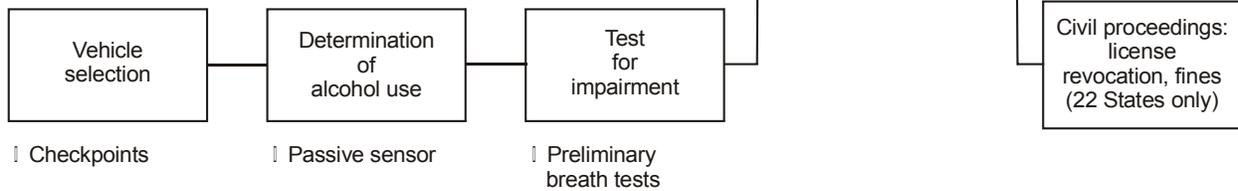


Figure 5-15. Models comparing “chemistry based” random breath-test programs with U.S. “behavioral based” DWI enforcement system. Adapted from Voas & Lacey (1990)

5.3.9.1. Detection of DWI-Driven Vehicles

NHTSA has funded several studies of the vehicle maneuvers that suggest the driver is impaired (Harris, Dick, Casey, & Jarosz, 1980; Stuster, 1993). A list of these prepared for use by

police officers in the most recent study by Stuster (1997) is shown in Figure 5-16. These signs provide the officers with probable cause to stop the vehicle and determine whether the driver has been drinking. These cues were developed by having research assistants ride with the police and record their observations of the cues that lead to stopping a motorist. BAC levels for all motorists stopped were obtained, either by an officer in connection with a DWI arrest or by a research assistant obtained voluntarily after the officer had dismissed the driver. Based on these data, a preliminary manual and cue list was assembled and field-tested. Figure 5-16 shows the probabilities that a vehicle exhibiting the behavior described is driven by an over-the-limit driver.

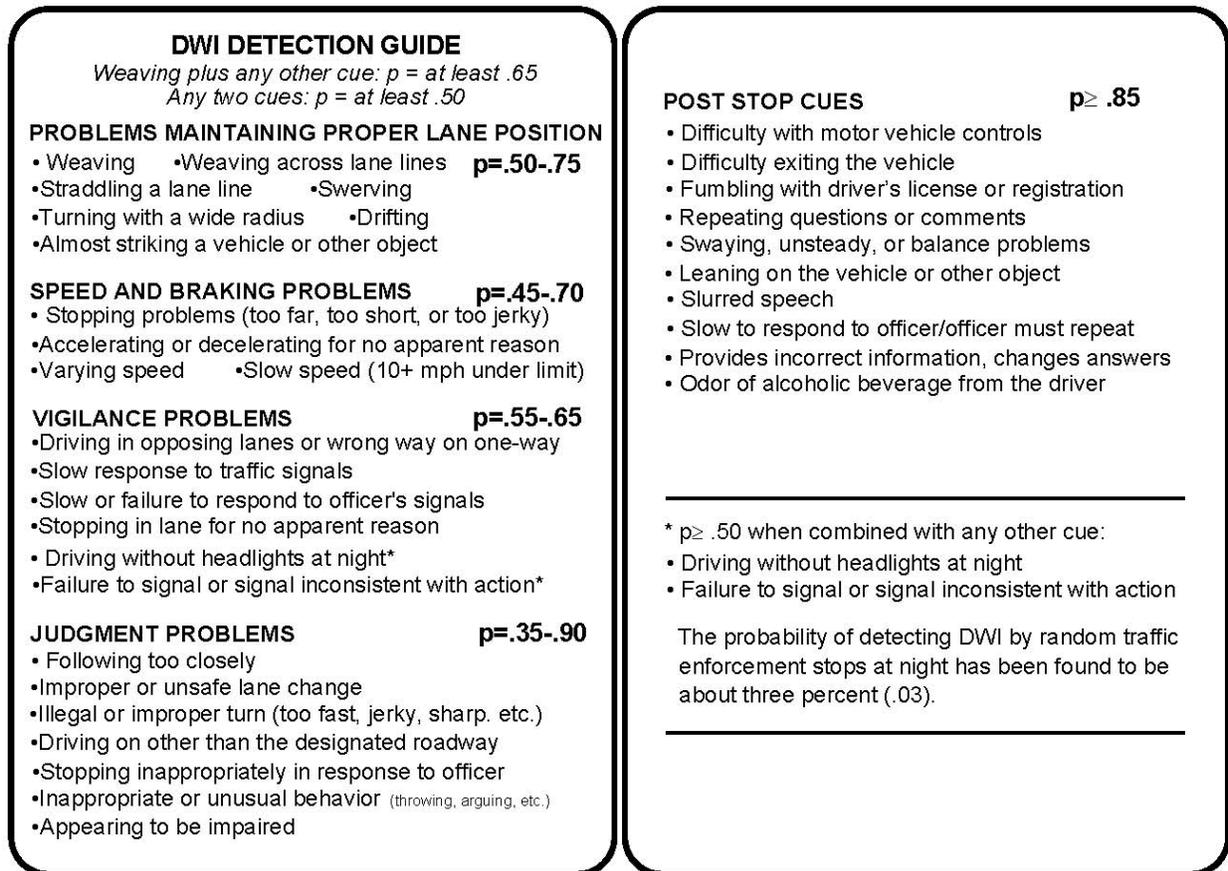


Figure 5-16. Recommended final version of the DWI detection guide. Adapted from Stuster (1997)

Brookhuis, DeWaard, and Fairclough (2003) have proposed the development of objective measures of impairment based on vehicle maneuvers (such as following too closely, straddling lanes, and speeding), using more detailed measures of vehicle movement to BAC. Several of the indicators they propose would involve measures that might have to be recorded inside the vehicle and would involve deviations too small to be visually detected by police officers. Development of objective indicators of impairment based on vehicle maneuvers, however, could be recorded external to the vehicle. Radar speed detectors and red-light cameras are examples of systems for recording vehicle motions that are currently in use in traffic enforcement.

5.3.9.2. *Detection of Drinking*

Because a breath test is generally viewed as a search under the fourth amendment to the Constitution, officers must develop evidence that supports a “reason to believe” the suspect has been drinking and may be impaired before proceeding with a DWI investigation. In the 1970s, the California Highway Patrol developed a list of signs—such as bloodshot eyes, smelling of alcohol on the breath, fumbling with the driver’s license—as indicators of impairment. The State of Oregon adopted such a list in its DWI legislation. In general, however, courts have shied away from specifying the signs that provide acceptable evidence of impairment, leaving that to the discretion of the officer and subject to challenge in court. Perhaps the most frequently occurring indicator appearing on police reports is the odor of alcohol. Moskowitz, Burns, and Ferguson (1999) found, however, that when individuals were limited to detecting drinking only through their sense of smell, they were unable to identify impaired drivers with any regularity. Thus, the validity for predicting impairment is limited when left to the sensory cues available to officers while they are interviewing a driver at the left-hand window of a vehicle.

The Stuster (1997) study (already described), designed to identify the vehicle maneuvers that indicate that the driver may be impaired, was also used to refine the driver behavior cues that police officers can use once the vehicle has been stopped to determine driver impairment. Those behaviors are shown in Figure 5-15. Evidence from studies of officers conducting DWI patrol operations suggest that when using cues, such as those shown in that figure, they miss over-the-limit drivers relatively infrequently—perhaps no more than 10% of the time (Lund et al., 1991; Kiger, Lestina, & Lund, 1993). Officers on patrol have the advantage of having seen driving behaviors such as those in Figure 5-16, which provided the basis for their stopping the vehicle. Conversely, officers at checkpoints miss that opportunity to observe on-the-road driving behaviors because the vehicle has already been stopped for an interview. Further, interviews at checkpoints are short, usually only 30 to 60 seconds. Consequently, officers miss up to 50% of the over-the-limit drivers they interview at checkpoints (Ferguson et al., 1995). An earlier study by McGuire (1986) of drivers arrested in an area where checkpoints were being conducted indicated that only 21% of the drivers with BAC levels higher than .10 g/dL were being arrested.

5.3.9.3. *Passive Sensors*

As described in Chapter 3, sobriety checkpoints have been shown to be effective in reducing alcohol-related crashes (Lacey et al., 1986, Lacey et al., 1999a; Levy, Shea, & Asch, 1989; Ross, 1992c; Shults et al., 2001; Stuster & Blowers, 1995; Voas et al., 1985; Williams & Lund, 1984). Police departments have resisted implementing this procedure, however, partially because few DWI arrests are made in checkpoint operations (Fell et al., 2004). As noted, this partially occurs because the officer cannot test every driver stopped, as they do in Australia, but must first determine that the individual has been drinking and may be impaired. A device designed to aid the officer in detecting drinking is the PAS III, a standard police flashlight with a built in passive alcohol sensor. It draws in a mix of expired and environmental air from in front of a person’s face (see Figure 5-16). These sensors can provide a good estimate of whether a driver has been drinking (Farmer et al., 1999; Voas et al., 2006c). The PAS appears to be particularly effective when observation time is short; therefore, it is a potentially helpful police aid at checkpoints. Furthermore, a series of studies has demonstrated that when officers use passive sensors at a checkpoint, more drinking drivers are detected and the arrest rate increases by approximately 50% (Ferguson et al., 1995; Lund & Jones, 1987; Lund et al., 1991; Lestina & Lund, 1989).



Figure 5-17. Passive sensor flashlight

Farmer et al. (1999) and Voas et al. (2006c) have demonstrated that there is a strong relationship between a positive indication on the PAS and the probability that the driver will have a measurable BAC level. Despite this evidence of their apparent utility, however, police officers who are provided with PAS units often do not adopt them over the long term (Leaf & Preusser, 1996). Some reasons for not using PAS units follow: (1) police officers would have to carry another piece of equipment on their belts; (2) arrests based on the PAS would be susceptible to legal challenges in court; and (3) the PAS is not accurate enough under less-than-optimal conditions. Examples of inadequate conditions follow: where applied by unskilled operators; where subjects avoid speaking directly to the officer; or where the PAS must be used at an excessive distance from the subject's mouth, and/or under windy, humid, or cold conditions) (WDOT, 2002). Arguably, the annoyances associated with using the PAS unit would likely be set aside by police officers if its legality and usefulness were guaranteed.

Aside from its effectiveness in increasing the detection of drinking drivers, the most important effect of the PAS on impaired driving may be its potential to increase the perceived risk of being apprehended for DWI if driving after drinking. If police use of the PAS is well publicized, it should increase general deterrence to impaired driving. Heavy drinkers who count on their increased tolerance to alcohol to avoid detection (Ross & Gonzales, 1988) might be deterred by the apparent ability of the police to detect drinking in an otherwise sober-appearing driver. Further, making underage drivers aware that even very small amounts of alcohol in the blood can be detected should increase their concern with being cited under the zero-tolerance law. Although the PAS has been used in many enforcement programs, relatively few (Voas, Holder, & Gruenewald, 1997a; Wells et al., 1992) have actively publicized its use. A more comprehensive test of publicizing PAS use in DWI enforcement is needed.

5.3.9.4. Preliminary Breath Testers

In the United States when the police have been provided with handheld preliminary breath-test (PBT) devices (see Figure 5-18) for use in testing motorists at the roadside, DWI arrests have increased (Cleary & Rodgers, 1986; Saffer & Chaloupka, 1989). Tests conducted by NHTSA indicate that, when properly used, these handheld devices are as accurate as the large desktop evidential units used in police stations (Frank & Flores, 1989). Currently, many if not most police departments have some handheld PBT units (Simpson & Robertson, 2001). They are legislatively authorized in 29 States and the District of Columbia. Simpson and Robertson (2001) found that most officers in their survey reported that PBT devices were very useful for detecting intoxication, and 69% indicated that

they would like to see an increase in their availability. The current operational procedures for using PBTs limits their effectiveness, however, because they are generally only used after the officer has conducted the Standardized Field Sobriety Tests (see below).



Figure 5-18. SD-4 preliminary breath-test device

This procedure has apparently been adopted because of the concerns about the officer's possible over-reliance on the PBT results. One concern, for example, is that if a PBT were used at the driver's window during an interview after finding preliminary evidence of drinking, the officer might arrest the offender based on the PBT result and fail to conduct the a SFST. The prosecution may therefore be handicapped by the lack of adequate behavioral evidence of impairment. Another concern is that the PBT measure might influence the officer's judgment in scoring the SFSTs. Consequently, the PBT is currently being used primarily to confirm the officer's judgment that the offender should be placed under arrest and transported to the station for an evidential test. This limits the potential value of the PBT as a device for identifying alcohol-tolerant offenders who show few behavioral signs of intoxication and therefore may be missed in the original roadside interview.

5.3.9.5. Standardized Field Sobriety Tests

Burns (2003) reviewed the studies that were conducted during the development and testing of the SFSTs. The current standard battery of three tests that have been approved by NHTSA and the IACP—the “one-leg stand,” the “walk and turn,” and the “horizontal gaze nystagmus”—was developed by Burns and Moskowitz (1977). Field evaluations by Tharp, Burns, and Moskowitz (1981); Burns and Anderson (1995); and Stuster and Burns (1998) have demonstrated that the test battery has substantial validity for identifying drivers with BAC levels of .10 g/dL or higher. Stuster and Burns (1998) and Burns and Dioquino (1997) demonstrated that the three-test battery was essentially equally accurate for identification of drivers at BAC levels of .08 g/dL. McKnight et al. (2002) and Stuster and Burns (1998) found that by modifying the scoring of the horizontal gaze nystagmus test, it was useful for identifying drivers with BAC levels as low as .04 g/dL. Most of the data collected in the field studies of the SFSTs has been collected from individuals who were arrested for DWI. Considerably less information is available on individuals tested and released. A study conducted by Burns and Anderson found that, when breath tests were collected after the officer had decided to release the driver, 36% of those released had BAC levels that exceeded the limit.

The SFSTs have some limitations. The accuracy of the battery of tests is mostly based on the horizontal nystagmus test (Moskowitz, 2006), which is the most difficult to conduct and, as Simpson and Robertson (2001) noted, for which many officers have not been trained and therefore do not

conduct. They also noted that, in many jurisdictions, the results are not admissible in court, and in the courts where the results are admissible, an expert witnesses may be required to authenticate the test procedure.

Experienced officers are highly capable of recognizing driver impairment if they have sufficient time to interview the potential offender; however, their opportunity to observe the crash-involved driver may be limited by the transporting of the injured person to a medical facility. Schermer, Moyers, Miller, and Bloomfield (2006) and Biffel et al. (2004) indicated that 85 to 90% of crash-involved alcohol-impaired drivers transported to ERs and trauma centers escape detection. This may be partially due to the time required by the officer to obtain a subpoena and go to the hospital to obtain a BAC report or have blood drawn for use in court. Much of the time, the hospital will not have a test result, and if it does, medical staff may be reluctant to provide it because they may be required to testify in court. Medical staff is also reluctant to participate in the coercive process of requiring the suspect to provide a sample or else be recorded as refusing, which results in automatic license suspension under ALS laws. Chezem (2004/2005) notes the cost in money, time, and energy for the ED staff if they must respond to subpoenas and hire counsel if the BAC data becomes an issue in a criminal trial.

The problem of impaired drivers escaping prosecution has led to the concern that the ER has become a safe haven for DWI offenders. The evidence is strong that transportation to the ER is protective. Runge, Pulliam, Carter, and Thomason (1996) studied 187 over-the-limit drivers treated in an ER and found that only 17% were convicted of DWI. Evett, Finley, Nunez, Britt, and Huff (1994) studied 245 over-the-limit drivers from ED records and found that only 9 were convicted of DWI. Lahn, Gallagher, Li, Touger, and Olmedo (2000) studied 22 over-the-limit drivers in EDs who were selected for the characteristics of their crash and their behavior that should have led to a maximum likelihood that they would be arrested; they found only 22% were arrested. Biffel et al. (2004) studied 113 high-BAC ED drivers and found that only 10 were convicted of DWI. Similar results have been reported by a number of other investigators: Cydulka, Harmondy, Barnoski, Fallon, and Emerman (1998); Krause, Howells, Bair, Bendick, and Glover (1998); and Soderstrom, Birschbach, and Dischinger (1998). Only Chang, Cushman, and Pasquale (2001), in their study of 213 intoxicated drivers, found that presentation at the ER significantly reduced an impaired driver's chances of prosecution and conviction for DWI. Rehm, Nelson, MacKenzie, and Ross (1993) noted that reasonable cause is required for legal blood alcohol requests and that this is difficult when the driver is unavailable for questioning. Further, they noted that, even when the BAC is obtained, inadequate legal followup often leads to nonprosecution.

This concern with ERs being a safe haven has resulted in a call for hospitals to report to the police those drivers admitted to treatment with BACs higher than the legal limit. This has been resisted partially from a concern that the hospital would be open to a lawsuit for compromising the patient's privacy. Two laws have grown out of this controversy: one protects the hospital against legal action by patients if they do report to the police, and the other holds the medical staff responsible for reporting to police a crash-involved driver if his or her BAC level is higher than the legal limit. A national meeting in 1999 on ER reporting of BACs found that relatively few States had enacted such legislation (NCADD, 1999).

5.3.10. Publicizing Enforcement Programs

Although it is generally accepted that enforcement programs must be well publicized to be effective, research on the influence of publicity on deterrence has been limited. Publicizing general safety messages, such as *If You Drink Don't Drive*, without an associated law or enforcement level, have generally failed to show an effect as a highway safety measure. Wilde, Hoste, Sheppard, and Wind (1971) conducted a comprehensive review of safety campaigns and concluded that public information efforts that were not part of an “action” program were unlikely to be effective in changing behavior. Conversely, Ross (1973) demonstrated in his study of the British Road Safety Campaign that, where new legislation leading to new enforcement procedures that provided for roadside breath testing was being implemented, publicity had a major influence on alcohol-related crashes.

Sometimes, the enforcement program itself attracts enough media attention to make the public aware of the program without a special media program. The Charlottesville checkpoint program (Voas et al., 1985) described above provided an example of such naturally occurring publicity. A telephone survey of the residents indicated that 50% had seen a checkpoint in operation, 79% reported that the probability of being arrested for DWI had increased over the previous year, and 94% were aware that checkpoints were being conducted in Charlottesville. That level of public knowledge was achieved without a specially funded media program, but this type of publicity is dependent upon the interest of the local media in covering the program. The media coverage was augmented by some bar owners who put up signs noting, “police are conducting checkpoints tonight.”

Another study illustrating both the strength and limitations of naturally occurring media attention was reported by Voas and Hause (1987). That study involved a NHTSA-funded test of saturation patrols in Stockton, California, where the normal one patrol vehicle for special DWI patrols was expanded to 10 patrol cars for 3½ years. Although the extra patrol officers were funded by NHTSA, no funds were provided for special equipment, such as PBTs, and no funds were provided for public information programs, so the operation was a pure test of a saturation patrol using traditional officer observational methods for apprehending DWI offenders. Figure 5-18 provides a moving average of monthly weekend nighttime (8 p.m. to 4 a.m.) crashes across a 9-year period encompassing 3 years before the January 1976 start date and 2½ years following the June 30, 1979, ending date of the saturation patrol effort. As can be seen, in 1976—the first year of the program, the weekend nighttime crash rate fell by approximately 30%. During that year, the program benefited from considerable coverage by the local newspaper and electronic media. By 1977—the second year of the program, the enforcement effort was no longer “news,” so there was little media coverage. During that year, about half of the reduction achieved in 1976 was lost. The crash-reduction benefit remained relatively flat during the following 18 months of the saturation patrol program, which ended June 30, 1979, and for 6 months after the program terminated. In 1980, the crash rate returned to the preprogram level.

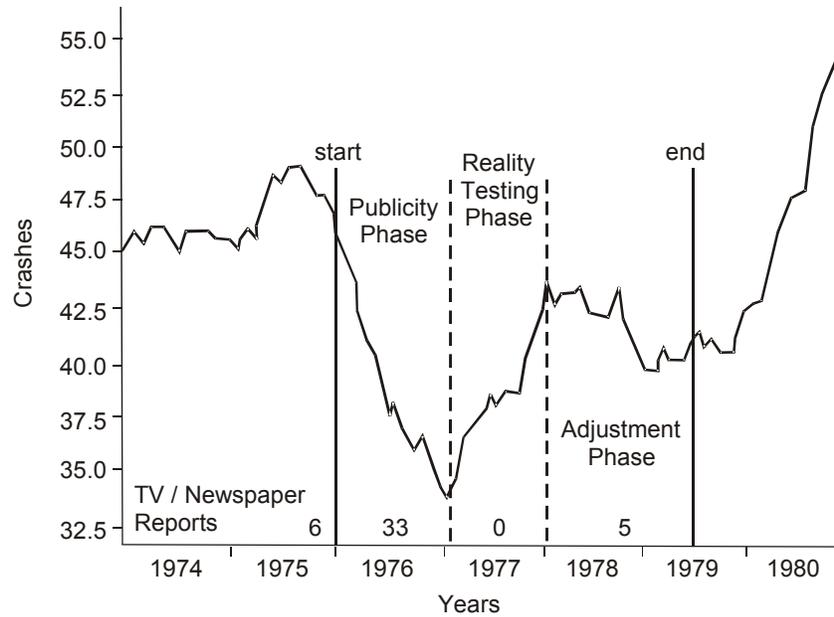


Figure 5-19. Comparison of crashes by period in Stockton, California. Adapted from Voas & Lacey (1990)

Thus, the Stockton program experience illustrates how a high-visibility enforcement activity, such as saturation patrols, can produce a large effect when it has the benefit of media coverage, but that effect declines when deprived of media attention. An interesting feature of the program was the persistence of the enforcement effect for 6 months *after the program had been terminated*. As the termination of the project was not widely announced, it took the public about 6 months to recognize the changed enforcement environment. This is similar to the residual deterrent effect reported by Wagenaar, Toomey, and Erickson (2005a) for enforcement of the MLDA law with off-premises licensed outlets. In that study, the reduction in sales to minors lasted 3 months following termination of the enforcement activity.

Another clear demonstration of the role of media in influencing DWI enforcement is provided by the results of the “Community Trials” program (Holder et al., 2000), which documented a major effort to use media advocacy to publicize high-visibility checkpoint programs using passive sensors in three communities. The enforcement component of that community effort described by Voas (1997) measured media and enforcement resources and the immediate outputs of each effort, such as the number of mentions of the enforcement program on the local nightly news and the number of checkpoints conducted. The combined influence of the two factors was measured through the increased perception of risk of arrest by the public as measured through telephone surveys; a reduction in the number of high-level BAC drivers on the roadways measured through roadside surveys; and finally, by reductions in alcohol-related crashes (Voas et al., 1997a). The resulting reductions in nighttime crashes were clearly produced by the combined effects of enforcement and publicity rather than the either factor alone.

Although the research evidence is limited, publicizing enforcement is clearly essential to its effectiveness. Unfortunately, the most effective methods for attracting media coverage are not well documented, and the resources available to most police departments for publicizing their programs are

limited, particularly in the growing suburban areas where the major newspapers and television stations devote little coverage to local community affairs. A partial response to this problem is to use enforcement methods that attract public attention and that are easily publicized.

NHTSA's *Click It or Ticket* mobilizations to increase seat belt usage have proven to be successful (Solomon, Ulmer, & Preusser, 2002). A typical mobilization model includes two to three intensive blitzes over 3 to 6 weeks, during which paid ads are coupled with increased seat belt enforcement. States that use this model have had a significant effect on observed belt usage. It thereby seems logical that a similar strategy would successfully reduce impaired driving.

Between 2000 and 2003, with this evidence as background, NHTSA sponsored seven State-level demonstration projects that emphasized highly visible enforcement coupled with intensive publicity to reduce impaired driving. These enforcement programs were implemented in Georgia, Indiana, Louisiana, Michigan, Pennsylvania, Tennessee, and Texas. The major goal of these alcohol program demonstration projects, modeled after Lacey et al. (1999a), was to reduce alcohol-related traffic fatalities using a comprehensive and sustained enforcement effort combined with publicity about the consequences of receiving a citation for DWI. The enforcement techniques differed in each State. In Georgia, a statewide sobriety checkpoint program was featured, whereas in Indiana, both sobriety checkpoints and saturation patrols were used. Louisiana used saturation patrols and, later on, sobriety checkpoints. In Michigan, saturation patrols and selective patrols were used (because sobriety checkpoints are prohibited by State law). Pennsylvania used saturation patrols, sobriety checkpoints, and mobile awareness patrols. In Tennessee, another statewide checkpoint program was used. Finally, in Texas, enforcement by smaller agencies was increased, and impaired-driving enforcement equipment (in-vehicle video cameras, mobile breath-testing machines, etc.) was distributed as an incentive. Texas was also restricted by law on the use of sobriety checkpoints.

Paid and earned media played an important role in these projects. Earned media was used exclusively in Louisiana, Pennsylvania, and Tennessee. Paid media was used in Indiana, Michigan, and Texas. Georgia's publicity efforts, using both earned and paid media, were statewide, whereas in Indiana, media coverage of enforcement efforts reached 80% of the State, and enforcement activities were conducted in 29 counties. In Louisiana, media efforts were only conducted in certain parishes, but in Michigan, both the media and the enforcement activities covered 80 to 85% of the State. Pennsylvania used earned media only in the counties with the increased enforcement. In Tennessee, media coverage was statewide, whereas in Texas, the increased enforcement covered small police agencies in the 14 most populous counties. In each State, a wide variety of data was collected about the publicity campaigns and enforcement-related activities.

To compare outcomes across States, an analysis of the Fatality Analysis Reporting System dataset was conducted using an interrupted time-series analysis (ARIMA) for each program and a regressor series to factor out time trends for the rest of the Nation. States adjacent to the intervention States were used in aggregate as comparisons in the FARS analyses to control for any regional changes. This technique allowed comparisons across sites, holding constant variables such as vehicle miles traveled and accounting for National, State, and regional trends in alcohol-related fatalities.

From the study by Fell et al. (2008), it appears from the unified FARS analyses that Georgia showed a statistically significant ($p < .005$) decrease of 14% in the ratio of drinking drivers to nondrinking drivers involved in fatal crashes compared to their surrounding States. This was accompanied by a 5% decrease in the number of alcohol-related traffic fatalities per 100 million

VMT, which was not significant. An estimated 60 lives were saved in the first year due to Georgia's program. In its 29 intervention counties (covering 80% of the State), Indiana experienced a statistically significant decrease of 13% ($p < .02$) in the ratio of drinking drivers to nondrinking drivers involved in fatal crashes. The State also showed a 20% decrease ($p < .002$) in alcohol-related fatalities per 100 million VMT, compared to the neighboring States, associated with their publicized enforcement program (Fell et al., 2008). There was evidence of an "overflow effect" to the nonintervention counties as indicated by an almost identical decrease to that of the intervention counties. Compared to the neighboring States the nonintervention counties experienced a 12% reduction in the drinking-driver ratio ($p < .04$) and a 20% reduction in the VMT measure ($p < .002$). An estimated 25 lives were saved in the intervention counties and 17 in the rest of the State due to the Indiana enforcement program. It is believed that publicity about the Indiana enforcement program affected the entire State. Louisiana experienced no significant decreases in their four measures, although one decrease approached statistical significance.

The FARS analyses showed that Michigan experienced a 14% decrease ($p < .07$) associated with the enforcement program. The ratio of drinking drivers to nondrinking drivers involved in fatal crashes in the intervention counties (85% of the State) were compared to the neighboring States. This finding was considered significant because of the large standard error in the comparison neighboring States. Michigan also experienced a significant decrease of 18% ($p < .003$) in the number of alcohol-related fatalities per 100 million VMTs associated with the program. This resulted in an estimated 57 lives saved during 1 year of the program.

Although Pennsylvania showed decreases in four measures when compared to neighboring States, none was statistically significant. Tennessee experienced a relative decrease in the ratio series (-10.6%, $p < .035$); however, the State showed no change in alcohol-related fatalities per 100 million VMT. In Texas, the 14 intervention counties showed no significant change in the ratio of drinking drivers to nondrinking drivers involved in fatal crashes nor in the alcohol-related fatality rate, whereas the 240 within-State comparison (nonintervention) counties experienced a significant reduction of 11% ($p = .04$) in the ratio measure associated with the enforcement program. It is not clear why this occurred.

These findings are consistent with past research considering that Georgia followed very closely the *Checkpoint Tennessee* model of 1994–1995, but Georgia conducted more checkpoints per capita and used paid advertising, sponsored by a corporate donor, to increase public awareness of the program. Indiana and Michigan used two to three mobilization blitzes when both the media and enforcement were intensified. Between the blitzes, there were weekly enforcement operations with some publicity occurring from time to time. This may have contributed to the significant reduction in impaired-driving fatal crashes. In the other States, Pennsylvania came close to experiencing an effect, but the program was not conducted statewide, which may have limited its effectiveness. Louisiana also used only certain parishes (counties) in its effort; it was hindered, however, by the prohibition against using sobriety checkpoints until partway through the implementation phase. Louisiana also conducted only a limited number of checkpoints during its enforcement period. Tennessee conducted approximately 800 publicized checkpoints throughout the State during the implementation phase, which resulted in a significant reduction in fatal crashes involving drinking drivers. The Texas strategy of funding smaller police agencies for increased enforcement coupled with publicity did not show an effect in the intervention counties. There was, however, a significant reduction in the rate of drinking-driver fatal crashes in the rest of Texas. One explanation is that the publicity, which was concentrated

in the most populous counties, and the Selective Traffic Enforcement Programs (STEPS), which were used in numerous counties in Texas, were combined to produce the 11% effect in the rest of the State.

In summary, it appears that significant decreases in drinking-driver fatal crashes can be realized if States use an impaired-driving enforcement model. This model should include (a) a statewide effort; (b) numerous checkpoints or highly visible saturation patrols conducted each weekend throughout the year; and (c) intensive publicity coverage of the enforcement activities (including paid advertising) at least two to three times during the year, as Georgia, Indiana, Michigan, and Tennessee accomplished (Fell et al., 2008). An issue remains, however—which is, how can communities intensify their DWI enforcement programs within the resources of their own budgets. Although communities can take advantage of the seasonal statewide mobilizations, maintaining a high level of DWI deterrence will require a more continuous high-visibility program such as those described in the section on community programs below.

5.3.11. Methods for Developing Public Awareness

Public awareness of impaired-driving laws and the extent to which they are being enforced is a critical element in controlling impaired driving. As already noted, two broad methods of developing public awareness are critical to promoting perceived risk of arrest and subsequent sanctions: through direct experience or observation of enforcement activity and through public information. Three general types of information campaigns have been used to educate the public on impaired-driving laws and enforcement: public service announcements, paid media campaigns, and media advocacy programs. Each type of program has its strengths and limitations. Few media campaigns of any type have been adequately evaluated.

5.3.11.1. Public Service Announcements

PSAs, which local televisions must air as a part of their continued licensing requirements from the Federal Communications Commission in the United States, have been a major method for warning the public about the danger of impaired driving and for promoting safety behaviors, such as “Friends don’t let friends drive drunk.” Because the PSAs are generally funded by the communications industry, they are attractive, high-quality products that are based on standard industry focus group research procedures. Local stations, although providing airtime free, are likely to air the PSAs during nonprime time when other paying advertisements are not being aired (i.e., usually during late-night or early-morning hours). These times have the lowest viewer coverage of all TV periods. Because PSAs displace paid advertising, they are usually short and are less likely to receive replication over time. Another important limitation is that they lack reference to the local community, so it is easier for the public to dismiss them as general cautionary statements without personal significance. Studies have indicated that PSAs can familiarize the public with safety slogans, but no studies have demonstrated a reduction in impaired driving or risky drinking based on a program of PSAs (Holder & Treno, 1997). Giesbrecht and Grube (2003) reviewed research on the effects of media designed to reduce alcohol use or its related problems. The types of media they reviewed included public service announcements, news coverage of alcohol issues, and counter-advertising. They cited a single study of the effects of PSAs about drinking during pregnancy that showed increased awareness of the dangers of drinking while pregnant. The study, however, did not have a control group that did not receive publicity. They suggested that news coverage could have an effect on both individual drinking behavior and public policymaking, but there seemed to be no experimental evaluations of the effects of different types of news coverage.

5.3.11.2. Paid Media Campaigns

Mass communication campaigns have often been used to increase public awareness of specific public health problems. The research evidence concerning these campaigns has repeatedly demonstrated that public education campaigns can increase public awareness and informational levels, but there is little to no evidence that they affect behavior. Holder (1994) concluded that mass communication alone is not sufficient to produce a reduction in alcohol-involved trauma. Media campaigns are most effective when combined with action programs, but general national public service programs rarely match local enforcement activities. The most positive effect of the use of media alone in an impaired-driving campaign was reported by Worden et al. (1988). They evaluated a campaign in which *Know Your Limit* wallet cards were distributed in a small New England community to drivers from restaurants and bars and other merchants and promoted over the radio by disc jockeys. Pre and post roadside surveys demonstrated that the campaign was associated with a reduction in the average BAC level of drivers using the roads.

Flynn et al. (1994), evaluated a media campaign designed to deter smoking initiation rather than impaired driving. Flynn et al. (1994) reported that, when students were in grades 10 through 12, those exposed to the media campaign were less likely to have smoked in the previous week than those who only received the school-based program. Balancing those positive results are two studies that yielded negative results. Bauman, LaPrelle, Brown, Koch, and Padgett (1991) randomly assigned media markets in the Southeastern United States to receive one of three media campaigns or no campaign. One campaign used radio only and focused on expected health and social consequences of smoking. A second used the same radio spots, but added a contest in which young people wrote about why they would not smoke. The third campaign added television to the radio and contest components. Surveys of 12- to 14-year-olds from communities in each condition did not indicate that any of the campaigns affected smoking behavior. Flay et al. (1995) compared the effectiveness of a school-based social resistance curriculum alone with a program plus television programming designed to encourage parent-child interactions about tobacco use, with the television intervention alone, and with two control conditions. Followup assessments in grades 7, 8, 9, and 12 did not find that the media affected adolescent smoking.

There are two major disadvantages of public information campaigns: cost and duration. The design and production of messages for professional campaigns are costly, especially if space and time are purchased in the local media. Most communities simply do not have sufficient funds to mount one such campaign, much less frequent or regular public information campaigns. Holder and Treno (1997) concluded that planned mass media campaigns are most effective as reinforcers of specific environmental efforts to reduce high-risk drinking in general and drinking and driving in particular but that they are insufficient in themselves. Friend and Levy (2002) conducted a comprehensive review of tobacco mass media campaigns. Results suggested that well-funded and implemented mass media campaigns targeted at the general population and implemented at the State level, in conjunction with a comprehensive tobacco control program, are associated with reduced smoking rates among both adults and youth. Studies of youth-oriented interventions specifically have shown mixed results, particularly for smaller, community-level media programs, but they indicate strong potential to influence underage smoking rates. The scale and duration of expenditures, the content of advertisement messages, and other tobacco control policies are aspects of media programs that may help explain differences among study results. In particular, tobacco control policies that are

implemented during the campaign often make it difficult to identify the specific influence of media campaigns alone.

5.3.11.3. Media Advocacy

Media advocacy refers to the strategic use of news media by those seeking to advance a social or public policy initiative. Unlike specifically designed public information campaigns, media advocacy works directly with the local news outlets (radio, television, newspapers, and magazines) to increase local news attention to a specific public health problem and solutions and ongoing activities. Media advocacy encompasses a range of strategies aimed at reframing public debate of issues (Wallack et al., 1990; Wallack, Dorfman, Jernigan, & Themba, 1993). In this context, consistent with the name, the mass media are used to bring attention to a specific alcohol problem, to advance the importance of one or more specific policies that are designed to reduce the problem, to put pressure on decision-makers who can make new policies or change existing policies, and to bring about a desired policy change.

Unlike health education or other uses of public communication, media advocacy generally is not used simply to change individual behavior directly. It generally does not target offenders or potential offenders; rather, it appeals to community members to support local agencies such as the police and city council to support enforcement and educational efforts. As such, media advocacy is a major component of the community programs described herein. For any issue to come forward to the public agenda, it must be brought to the community's attention. An effective means to accomplish this is through the local news media. Thus, local media news and feature coverage are often an important part of local prevention tactics. This coverage may be a carefully planned news event that attracts press attention and covers an important community issue or organization. Such events are generally based on research data that have uncovered an important problem for the community, such as a growing number of teenage fatalities in alcohol-related crashes. A community leader is enlisted to report the information in a TV interview or press conference. The message projected is that local citizens have a problem in their community that requires attention and about which local leaders are concerned. This local relevance of the message is an important feature that differentiates media advocacy programs from mass media efforts, which avoid being community-specific so that they can be used broadly throughout the country.

A good example of this use of media advocacy in a community impaired-driving program was the border project evaluated by Voas et al.(2002d). For more than 50 years, underage youths and young adults in San Diego have been crossing the border to drink in Tijuana where the legal drinking age is 18 and alcohol is inexpensive. Although San Diego citizens were aware this was happening, there was little concern because it was viewed as involving only a few young men for whom it was a relatively benign rite of passage. A survey of the youthful crossers revealed, however, that far from involving only a few young men, there were up to 7,000 crossers on a typical Friday or Saturday night and some of the girls crossing into Mexico to drink were as young as age 14. This information led to the development of a community consortium that implemented a media advocacy effort, recruiting the mayor and council members to make media appearances to raise concern with the number of youths returning drunk from Mexico. The result was that the police department received additional funds to conduct sobriety checkpoints at or near the border and to station police at the border to turn back youths younger than age 18 who could not legally cross into Mexico without their parents. Special enforcement efforts were mounted once a month, with each being publicized by a special news event developed by the media advocacy specialist. Over the year following initiation of the campaign, the

number of youths returning late at night from Mexico decreased by a third, and the proportion who were impaired (BAC level higher than .08 g/dL) by alcohol was reduced by 29% ($p=.004$).

Although this use of the news media is an important part of public communications, the media may or may not be the sole means to communicate with people about a particular issue. Organizing a set of supporting speakers at the city council is a form of public communication designed to lend support or opposition to policy action that the council may be considering. Holder and Treno (1997) found in a three-community prevention trial that purposeful training of local advocates followed by purposeful application of the tools and techniques of media advocacy increased local news coverage of alcohol-related problems, especially drinking and driving, with a subsequent change in public support of action to reduce drinking and driving.

Changing community norms (see community norms already discussed) in support of preventing drinking and driving is essential but not a sufficient part of a comprehensive prevention strategy for reducing alcohol-related motor-vehicle crashes. Based upon the evidence of actual effects on crashes, the key to success appears to be purposeful use of local news about the problem of drinking and driving, the importance and success of enforcement to deter actual drinking and driver, and finally, complementary strategies to change community norms about drinking and driving. The evidence concerning planned mass media campaigns and professional public education suggests that such strategies alone are unlikely to reduce either drinking and driving or alcohol-related motor-vehicle crashes.

5.3.11.4. Counter-Advertising

Counter-advertising is designed to counter directly the persuasive appeal of advertising for a product. It includes warning labels on alcohol containers and advertisements. Giesbrecht and Grube (2003) cite only one experimental evaluation of the effects of warning labels. Snyder and Blood (1992) randomly assigned college students to view six advertisements for alcoholic products, either with or without the U.S. Surgeon General's warning. The warnings had no effect on perceptions of the risk of drinking; they actually made products more attractive. MacKinnon et al. (1993), in a survey of a national sample of youth, found increases in self-reported awareness, exposure to, and memory of the labels after they were required, but no substantial changes in alcohol use or beliefs about the risks targeted by the warning. Derzon and Lipsey (2002) did a meta-analysis of 72 evaluations of media campaigns designed to discourage adolescent substance use. They estimated modest effect sizes of alcohol use (53 to 51%), tobacco use (37 to 35%), and marijuana use (24 to 22.5%).

5.3.11.5. Media Campaigns Directed at Minorities

Overall, most peer-reviewed studies evaluating the effect of U.S. policies on driving-related policies have focused on policies promoting seat belt use (Greenberg-Seth, Hemenway, Gallagher, Ross, & Lissy, 2004; Greenberg-Seth, Hemenway, Gallagher, Lissy, & Ross, 2004; Cohn, Hernandez, Byrd, & Cortes, 2002). Peer-reviewed studies on whether policy changes differentially affect impaired driving among minority populations are rare. There is a more extensive literature that examines key characteristics that effective health-related programs should have. Schmidt, Greenfield, and Mulia (2006) reviewed the reasons why culturally specific alcohol-treatment programs may show different outcomes to conclude that (1) different racial/ethnic groups follow different pathways to recovery (e.g., Le Fauve, Lowman, Litten III, & Mattson, 2003), and (2) some racial ethnic groups vary in their response to treatment (e.g., Tonigan & Miller, 2002).

Although there is consensus about the need to develop culturally sensitive messages, there is no clear understanding of what such messages must be. Culturally competent health care—broadly defined as services that are respectful of and responsive to the cultural and linguistic needs of patients—is gaining attention as a strategy to reduce racial/ethnic disparities (Betancourt, Green, Carrillo, & Ananeh-Firempong, 2003; Betancourt, Green, Carrillo, & Park, 2005). According to the National Center for Cultural Competence (<http://gucchd.georgetown.edu/nccc/framework.html#lc>), cultural competence requires that organizations involved in health-promoting efforts (agencies, communities, etc.)—

- have a defined set of values and principles and demonstrate behaviors, attitudes, policies, and structures that enable them to work effectively cross-culturally;
- have the capacity to (1) value diversity, (2) conduct self-assessment, (3) manage the dynamics of difference, (4) acquire and institutionalize cultural knowledge, and (5) adapt to diversity and the cultural contexts of the communities they serve; and
- incorporate the above in all aspects of policymaking, administration, practice, and service delivery, and involve systematically consumers, key stakeholders, and communities.

It has been suggested that peers and friends may become valid conduits to disseminate positive information among Hispanic and White teenagers (Marin, 1996; Beck & Bargman, 1993). Compared with Whites and Hispanics, however, the role of peers on alcohol and substance use might be relatively modest among Asians and African Americans. Kim, Boski, and Yamashita (2002) studied Asians, and Resnicow, Soler, Ahluwalia, Butler, and Braithwaite (2000) studied African Americans. Both studies reported a particularly strong protective role of family for alcohol and substance use in these racial/ethnic groups.

It has also been suggested that elders may have a positive role in prevention programs targeting some Asian communities (NCADI, 1997). The NCADI also suggests the need for program designers to be aware that most Asian/Pacific Islander cultures allow for moderate use of alcohol; to be knowledgeable of traditional drinks such as kava or sakau; and to use writers and editors from the target ethnic group (NCADI, 1997). The same report warns that the messages developed for the Asian community must consider the large variety of ethnicities and languages within Asian communities (e.g., messages aimed toward Chinese Americans may need to be written or spoken in both Cantonese and Mandarin). The same report suggests the need for these messages to avoid “blaming the victim” or emphasizing problems or pathologies. For instance, the report suggests avoid saying “high-risk youth,” but instead to refer to “youth living in high-risk environments.”

Finding a proper medium is another important step in disseminating health-promoting information among minority groups. Focus groups at Science Applications International Corporation (SAIC, 2005) said that newspapers might not be the optimal medium to reach Hispanics, given the limited educational levels among many Latinos, whereas television and fotonovelas (a series of still photography or drawings with balloon captions) appear to be a more efficient media. Focus groups in the 1995 NHTSA report said, however, that a common mistake is to assume that all Hispanics want to speak Spanish. According to one participant, “This is patronizing and can be a turnoff.” The preferred language depends on age and acculturation, with recent immigrants more likely to prefer materials in

Spanish (NHTSA, 1995). In any case, because the literacy is low among many Hispanics, messages regarding drinking and driving must be clear, consistent, and free of jargon (SAIC, 2005).

Another sensitive problem for racial/ethnic communities embarked in prevention efforts to reduce drinking and driving is the need to include enforcement officials, a need that is hampered by the relative lack of trust some minority communities have for police officers. This problem may be particularly severe in some African-American communities (e.g., Taslitz, 2003). Although Taslitz suggests Hispanic communities may also show distrust of enforcement officials, the 1995 NHTSA's study found that most Hispanics respect Spanish-speaking officers (NHTSA, 1995). A study conducted in California in 2005 (Cooper, Wilder, Lankina, Geyer, & Ragland, 2005) identified improving relations between law enforcement and the community as a key element for progress.

For Hispanics, some aspects of the Latino culture that have been suggested as relevant to the design of effective prevention programs include *respeto* (respect), *confianza* (trust), and the value of a personal connection (e.g., Whetten et al., 2006). For instance, it has been suggested that some alcohol prevention programs that work with Hispanics (teenagers in particular) may benefit from the involvement of family members in the prevention efforts (Caetano & Raspberry, 2001; Epstein, Botvin, Baker, & Diaz, 1999). Soriano (1994) also suggested that some programs should take advantage of institutions already established in the Hispanic community, such as social clubs and churches.

Related to the need for trustworthy figures to deliver health-promoting messages is the role of priests in delivering positive interventions for Hispanics (Marin & Gamba, 1996) and African Americans (Castro & Gutierrez, 1997). For Native Americans, promising prevention programs should establish a collaborative relationship with Native-American authorities (community, tribal, and spiritual leaders and traditional healers) and allow for guidelines and participation in spiritual ceremonies, social events, and other traditional activities (Stubben, 1997; Jones-Saumty et al., 2003). The inclusion of elder community members in prevention programs (Stubben, 1997; May & Moran, 1995), as well as a long-term commitment by practitioners with the tribal community, has been suggested as requisites for the success of prevention programs aimed to Native Americans (Stubben, 1997).

5.3.12. Community Alcohol Safety Programs

Although national laws and publicity programs have an important influence on impaired driving, DWI enforcement is primarily an activity of local police departments, which are generally overburdened with broad responsibilities for law enforcement. Consequently, drinking and driving may be of a relatively low priority. Maintaining a sufficient level of enforcement activity to create strong deterrence to impaired driving requires support from the local government and community residents. Moreover, the requirement that enforcement activities be publicized requires support from the local news media. Thus, effective DWI enforcement involves a complex system at the community level. An effective system creates and maintains the public's concern with the impaired-driving problem and supports police activities, as well as other prevention activities that reduce impaired driving.

This recognition of the community as the basic locus of impaired-driving prevention has led to broad support by Federal agencies (such as NHTSA and the NIAAA) and private foundations (such as the Robert Wood Johnson Foundation) for alcohol problem-reduction programs in communities.

Relatively few of the many community AOD reduction efforts have been adequately evaluated. Four comprehensive programs directed at drinking and drinking-and-driving within the community have received relatively extensive evaluations: the *Saving Lives Program* (Hingson et al., 1996b), the *Communities Mobilizing for Change Program* (Wagenaar, Murray, & Gehan, 2000a; Wagenaar et al., 2000b), the *Community Trials Program* (Holder et al., 2000), and the *Fighting Back Community Program* (Hingson et al., 2005b). In addition, three community efforts in specialized settings have been evaluated, two of which relate to community/college campus programs—the *Matter of Degree Program* (Nelson, Weitzman, & Wechsler, 2005) and the *College Community Environmental Prevention Program*, (Clapp et al., 2005)—and a third related to a border community, *Operation Safe Crossing* (Voas et al., 2002d).

The *Communities Mobilizing for Change Program* (Wagenaar et al., 2000b) was directed at changing the liquor sales environment to reduce underage drinking and impaired driving by enforcing MLDA laws prohibiting sales to those age 20 and younger. Fifteen communities were randomly assigned to the intervention or control condition for a period of 2½ years. A local organizer was provided to mobilize the community to take action to reduce alcohol sales to minors. Surveys were conducted of outlet owners and high-school students. Purchase surveys, in which adults age 21 and older who appeared to be underage attempted to purchase beer at off-premises sales establishments were also conducted. The treated communities, when compared to the untreated communities, demonstrated that sales to underage individuals were significantly reduced. Further, reported consumption by 18- to 20-year-olds decreased. DWI arrest and crash data for the two target groups—18- to 20-year-olds and 15- to 17-year-olds—were compared with similar data for drivers age 21 and older, using a before-and-after control design. Both crash and DWI arrest frequency declined for both target groups, but only the decline in arrests was significant.

The *Community Trials Program*. Holder et al. (2000) was a multifaceted environmental program designed to reduce alcohol-involved injuries and fatalities. The program, which was implemented in three communities (with three comparison sites), featured five mutually reinforcing environmental strategies: (1) community mobilization, (2) responsible beverage service, (3) drinking-and-driving enforcement, (4) underage-drinking enforcement, and (5) limiting alcohol access. Each site was provided with a specified model for each of the five elements and given assistance in forming a local consortium to promote the project. In addition, each site was provided with a project manager and media assistant. Each community implemented the five elements with some variation to accommodate local needs. Community support was mobilized to reduce underage drinking. Safer alcohol serving standards were established for bars and restaurants, reducing the risk of serving intoxicating and underage customers. Local DWI enforcement efficiency increased, which created the perceived risk that drinking drivers would be detected. Increased underage-drinking enforcement reduced retail availability of alcohol to youth, and municipal controls (e.g., local zoning of outlet numbers and density) reduced availability of alcohol in general.

This national community prevention trial presented clear evidence that the use of local environmental strategies not only reduced alcohol-involved traffic crashes, but also reduced the violence associated with alcohol. Heavy drinking was reduced by 13%, the proportion of alcohol-related assaults appearing in emergency rooms was reduced by 43%, nighttime injuries from crashes were reduced by 10%, and DWI crashes were reduced by 6% (Holder et al., 1998, Holder et al., 2000). In the treated communities, self-reported driving after drinking too much decreased significantly.

The *Saving Lives Project* (Hingson et al., 1996b), conducted in six communities in Massachusetts, was designed to reduce alcohol-impaired driving and related problems (such as speeding, red-light running, and low belt use) by applying a broad range of traditional traffic safety program activities. In each community, a full-time coordinator from the local government organized a task force representing various city departments. In contrast to the *Communities Mobilizing for Change Program* and the *Community Trials Program*, this project's activities at each of the six sites were designed locally. The activities involved media campaigns, business information programs, speeding and drunk-driving awareness days, speed watch telephone hotlines, police training, high-school peer-led education, SADD chapters, college prevention programs, and a host of other activities. In addition to impaired driving, the program volunteers focused on behaviors that drinking drivers frequently exhibit, such as speeding, running red lights, and failing to use seat belts. Other sites (not in the project) in the State of Massachusetts served as a comparison for analysis. Results of the evaluation indicated that, during the 5 years that the program was in operation, cities that received the *Saving Lives* intervention experienced a 25% greater decline in fatal crashes than did cities in the rest of Massachusetts. Specifically, the intervention sites experienced a 42% reduction in fatal auto crashes, a 47% reduction in the number of fatally injured drivers who were positive for alcohol as well as a statistically significant 5% decline in visible crash injuries, and an 8% decline in crash injuries among those 16 to 25 years old. In addition, there was a significant decline in self-reported driving after drinking (specifically among youth), as well as observed speeding. The greatest fatal and injury crash reductions occurred in the 16- to 25-year-old age group.

The *Fighting Back Community Program* awarded grants to 12 communities covering a period from 1992 to 1997. Five of the 12 communities that displayed the most concentrated effort to expand substance abuse treatment and reduce alcohol availability were selected for evaluation by Hingson et al., 2005b. Sites established consortiums to conduct problem assessments and develop programs to reduce alcohol availability and increase substance abuse treatment. The programs were designed to support both individually oriented traditional treatment programs and environmental initiatives to reduce alcohol availability. Using the ratio of alcohol-related to non-alcohol-related crashes based on FARS data, the investigators compared the *Fighting Back* sites with the control sites before and after the program. The results indicated that the *Fighting Back* communities experienced a 22% lower ratio of drinking drivers (BAC > .00 g/dL) in fatal crashes than did the control communities.

A Matter of Degree (AMOD) Program (Nelson et al., 2005) is directed at changing the student-drinking environment by bringing together "key stakeholders" in the university and in the surrounding community to implement a variety of programs. These programs include responsible beverage service training, keg registration, parental notification of alcohol-related offenses, increased supervision of Greek organization-sponsored social events, substance-free residence halls, and increased alcohol-free campus activities. Self-reported drinking and drinking-and-driving data, collected from 1997 to 2001 through student telephone surveys at 10 program sites, were compared with similar data from 32 comparison colleges. Trend analyses were conducted to compare the experimental and contrast sites. Figure 5-20 illustrates the outcome for the percentage of students who regularly drive who reported driving after any drinking in the five highest and lowest *AMOD* implementation sites in comparison to the 32 reference sites. The five high implementation sites experienced a reduction in the percentage reporting driving after drinking, but the reduction was not statistically significant. Somewhat similar results were obtained for driving after 5+ drinks. Confidence in these results is somewhat diminished by the fact that the high-implementation

campuses had the highest rates of drinking and driving, raising the possibility that regression to the mean played a role in the results.

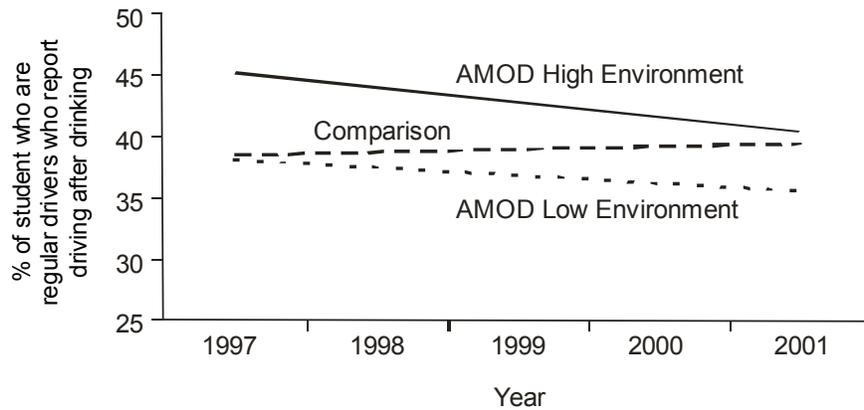


Figure 5-20. Fitted plots of the percentage of students who regularly drive who reported driving after any alcohol consumption over time by AMOD Program (high and low implementation) and comparison sites. Adapted from Nelson et al. (2005)

The *College Community Environmental Prevention Program* (Clapp et al., 2005), based on the model shown in Figure 5-21, was derived from the *Community Trials Program* (Clapp, Segars, & Voas, 2002). This program was designed to evaluate the activities of a large Southwestern university near the Mexican border in reducing alcohol consumption by students. A similar Southwestern university was used as a control. During the study, the five program areas shown in Figure 5-21 were evaluated. These programs follow:

- Reduction in alcohol promotion—an effort to control on-campus advertising of outlets featuring low-cost drink specials.
- Social norms—a program designed to influence social norms based on correcting misperceptions regarding student drinking.
- Formal regulation and control—a DWI enforcement program designed to increase the students' perceptions of the risk of arrest for driving after drinking.
- Retail sales and availability—a program to train owners and servers of outlets catering to students.
- High-risk context of use—a program to discourage students from crossing into Mexico to binge drink (Clapp et al., 2003a; Clapp et al., 2005).

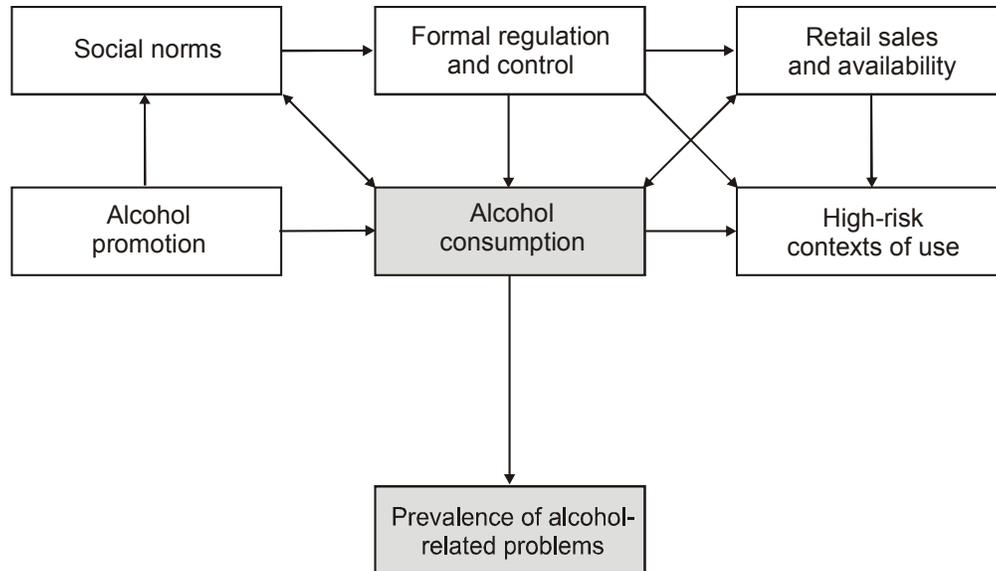


Figure 5-21. Model of College Community Environmental Program. Adapted from Source: Clapp et al. (2002)

Operation Safe Crossing (Voas et al., 2002d) was the title applied to the key DWI enforcement element of a community program led by James Baker (1997), who organized a community coalition to reduce cross-border binge drinking in Mexico by young Americans. *Operation Safe Crossing* was comprised of researchers and government and community leaders from both the United States and Mexico, who came together to address the problem of cross-border binge drinking by young Americans. The coalition (1) used media advocacy to support the planned increased enforcement efforts at the border and in the Tijuana bars; (2) pressured bar owners to train staff on responsible beverage service processes; (3) educated the public on the risks of cross-border binge drinking; and (4) supported college and military efforts to limit underage-targeted advertising of cross-border bars on campuses and military bases (Baker, 1997; Lange, Lauer, & Voas, 1999). This environmental strategy led to three significant outcomes: a 31.6% reduction in late-night weekend border crossers, a 39.8% reduction in underage pedestrian crossers who were legally intoxicated (BAC > .08 g/dL), and a 45% reduction in the number of 16- to 20-year-old drivers in alcohol-related crashes (Voas et al., 2002d).

5.3.12.1. Local Funding of Community Programs

The studies of programs combining high-visibility enforcement with strong publicity efforts reviewed above demonstrate that they can deter impaired driving and reduce alcohol-related crashes. The well-evaluated and successful programs (e.g., Holder et al., 2000; Stuster & Blowers, 1995; Lacey et al., 1999a; Hingson et al., 1996b, Hingson et al., 2005b; Voas & Hause, 1987), however, have involved substantial outside Federal funding, and their influence has tended to dissipate once the outside funding was cut off. If long-term progress in the reduction of alcohol-related crashes is to be achieved, communities must institutionalize the enhanced DWI enforcement procedures so they become a standard part of the local police department activity.

The challenge that this presents is indicated by the enforcement model shown in Figure 5-22 developed by Voas (1997) for the *Community Trials Program*. For that program, which increased the

perception of the risk of arrest and reduced impaired driving and alcohol-related crashes (Voas et al., 1997a), a substantial investment in both a media advocacy program and in additional officer hours and equipment was required to produce the positive results. A substantial portion of those requirements was met by a combination of State and Federal grants. If communities are dependent on such outside sources for funding to cover project activities, it is unlikely that the intensified enforcement programs shown to be effective will be adopted by most communities. Procedures are needed to help communities mobilize resources to conduct effective deterrence efforts without depending on outside funding.

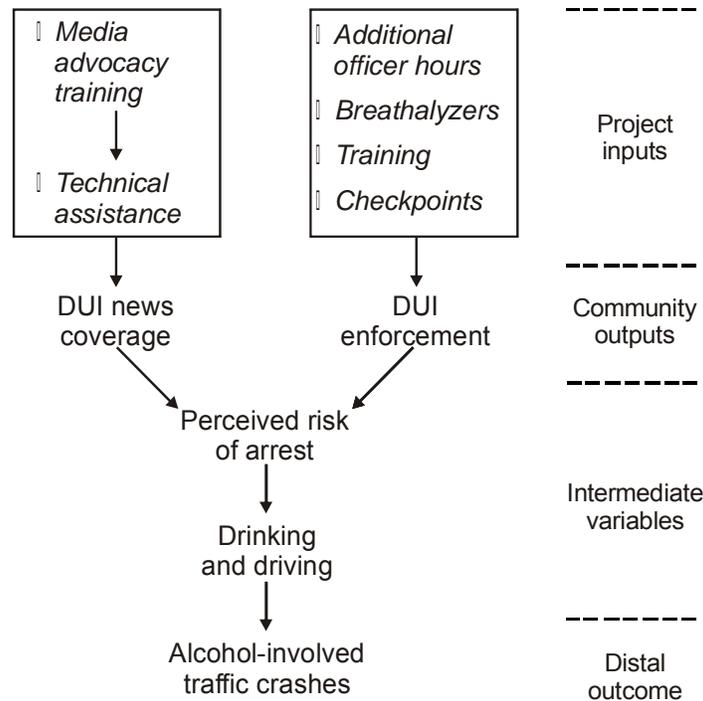


Figure 5-22. Model enforcement plan. Adapted from Voas (1997)

An example of a program for which resources were developed primarily from within the community was the *Operation Safe Crossing* (Voas et al., 2002d; Baker, 1997). The San Diego community mobilized to deal with the problem of youths, who were enticed by a drinking age of 18 and inexpensive alcohol to cross the border into Mexico to binge drink (Baker, 1997; Lange & Voas, 2000). One model illustrating the mobilization of a community effort with minimal outside support is the *Community Learning System* shown in Figure 5-23. That conceptualization of a community learning system, originally described by Springer & Phillips, 1994 was expanded by Voas et al., 2002c and Clapp et al., 2002. The *Community Learning System* depicted in Figure 5-23 is an iterative process involving four major components: (1) data collection and analysis (for problem specification), (2) community mobilization, (3) strategy selection, (4) strategy implementation, returning to (1) data collection and analysis (for program evaluation). The evaluation of the strategies implemented provides both further material for strengthening the consortium and information for modifying the initial strategies. Thus, the learning system continuously cycles; and over time gradually perfects programs.



Figure 5-23. Community learning model. Source: Clapp et al. (2002)

5.3.12.2. Data Collection

The process should begin with an initial *data-collection* phase, which will serve as baseline data for the evaluation of the program and will be used to define the problem that the community effort will attack (Holder et al., 1997). Sometimes a triggering event related to an important problem prompts a community to initiate the process. In other instances data collection is triggered by local individuals with special concern for a community problem. In either case, the objective of the initial data collection is twofold: to specify the problem and to develop information to be used in mobilizing the community to action (Treno, Lee, Freisthler, Remer, & Gruenewald, 2005; Holder & Treno, 2005). An example of this was provided in the *Operation Safe Crossing Program* (Voas et al., 2002d), where the San Diego public tended to see cross-border drinking by youthful Americans as relatively benign—a “rite of passage” involving only a few adolescents. The investigators initiated a survey triggered by news reports of underage youths drinking across the border, painted a different picture. They found that thousands of youth crossed the border to drink every weekend. Up to a third of these youths returned from a night of drinking and drove home with illegal BAC levels. Results from that survey provided both a basis for confronting the community with the problem and for identifying its main features.

5.3.12.3. Community Mobilization

The data collection phase provides information that can be used to mobilize the community to action. The “news” that the number of youths getting drunk across the boarder was very large was used to attract the press to news conferences where community leaders presented the data. In this way, the leaders participating in the news events were co-opted into the community’s border action consortium. Holder and Treno (1997) point to this use of data in the community trials program as part of the community mobilization process. Community mobilization is an essential component of effective community health programs (Treno & Holder, 1997b). The process of informing the community helps enlist the support of key opinion leaders, local government officials, and the public. In the border project, this process resulted in the establishment of a large consortium of organization

leaders and citizen activists. An action group such as this is vital to success of the program (Baker, 1997).

5.3.12.4. *Strategy Selection*

The formation of a consortium through the community mobilization process leads to the development of an organization capable of selecting, implementing, and managing strategies to deal with the community's alcohol-related problems. Aside from collecting data that describes the community problem that is the focus of the effort, data on the status of community facilities may be collected as part of a community "needs analysis," which was an essential part of the Robert Wood Johnson "Fighting Back" program (Hingson et al., 2005b). Selection of strategies and identification of targets for enforcement operations draws on information collected during the data collection and analysis phase of the effort. For example, in the "Saving Lives Program" (Hingson et al., 1996b), the crash data indicated that speeding was an important component in underage crash involvement. The initial enforcement strategy was therefore modified to include efforts to reduce high-risk driving as well as impaired driving. Where the action falls on the police department, consortium members frequently must assist the department in obtaining a budget increase to cover additional officer enforcement hours or training time or to provide special equipment, such as handheld preliminary breath-test devices (Voas, 1997).

The strategies considered for the *Safe Crossing Program*, which addressed a problem unique to communities near the U.S. border, were identified by the consortium's members and were influenced by the community's available resources. The city and State police departments, as in most communities, were the agencies most immediately available and equipped to act. Thus, the resulting action program, *Operation Safe Crossing*, featured law enforcement at or near the border. The key feature of the border program was that the community, rather than the research team, developed the countermeasures. The researchers participated mainly in providing data to assist in the strategy selection process and in providing process, output, and effect measures (Voas et al., 2002c; Baker, 1997).

5.3.12.5. *Strategy Implementation*

A local consortium can play a key role in *strategy implementation*. Although action programs are normally carried out by existing government agencies, such as the police, the consortium may need to assist in fund raising for the action agencies. In *Operation Safe Crossing*, the citizens' consortium successfully motivated the local health agency to provide funds for a program director and staff (Baker, 1997). A consortium and its leadership must also implement a media advocacy effort to provide publicity for the enforcement operations. Although the natural focus of such publicity may be on the enforcement targets (alcohol outlets, drinking drivers, or underage drinkers), the purpose of the media effort should go well beyond this to the development of support for the key agencies carrying out the programs, such as the police (Treno et al., 1996; Treno & Holder, 1997a). In the case of enforcement programs, news events should feature individual officers and the police chief or division captain, surrounded by city officials, parents, and teenagers, to reinforce community support for the program and to motivate the department and its officers to continue the program.

In the *Operation Safe Crossing Program*, the survey data were used to create interesting topics that would attract the media to press conferences on upcoming *Operation Safe Crossing* functions. Each month, a fresh topic was used to bring public attention to the enforcement program.

One month, the press conference focused on college students drinking in Mexico, and the next month it focused on cross-border drinking by the military or high school students or underage females. Press events always featured community leaders, citizens, and the police presenting or commenting on the survey data and the enforcement effort.

5.3.12.6. Follow-on Data Collection and Analysis

Although the emphasis for a consortium is on implementing the original strategy, it is critical to evaluate programs as they are executed. Because the nature of the target problem shifts or is displaced to a different location, or because a method tends to lose effectiveness over time, or because the membership and leadership of the action group as well as community leadership varies over time, operations must be reviewed and changed periodically. Thus, the four elements of the learning model must be revisited regularly. Groups undertaking this process must understand the need for a dynamic system that “learns” as it goes and continually adjusts to new conditions (Clapp et al., 2002). For example, periodic data collection and analysis in the *Operation Safe Crossing Program* provided evidence that the enforcement effort was associated with fewer impaired youth returning from Mexico. This information was used to stimulate and help ensure continuation of the enforcement effort.

5.4. Tertiary Prevention: Reducing Recidivism Among DWI Drivers

5.4.1. Introduction

Referring back to the comprehensive DWI Prevention Model (repeated in Figure 5-24), we see that, if the effort to control risky drinking and the effort to deter impaired driving fails, the last line of defense is to apprehend the intoxicated driver and take action to prevent future impaired driving. In this *Tertiary Prevention* mode, the State gains authority over the high-risk drivers through the sanctions that can be applied by the criminal justice system. Having identified a specific offender, individualized interventions can play a much stronger role than in *Primary* and *Secondary Prevention* where the high-risk drinkers and drinking drivers are hidden in the much larger population of road users. For the large population of unidentified drinking drivers, environmental interventions featuring laws and law enforcement appear to be the most cost effective.

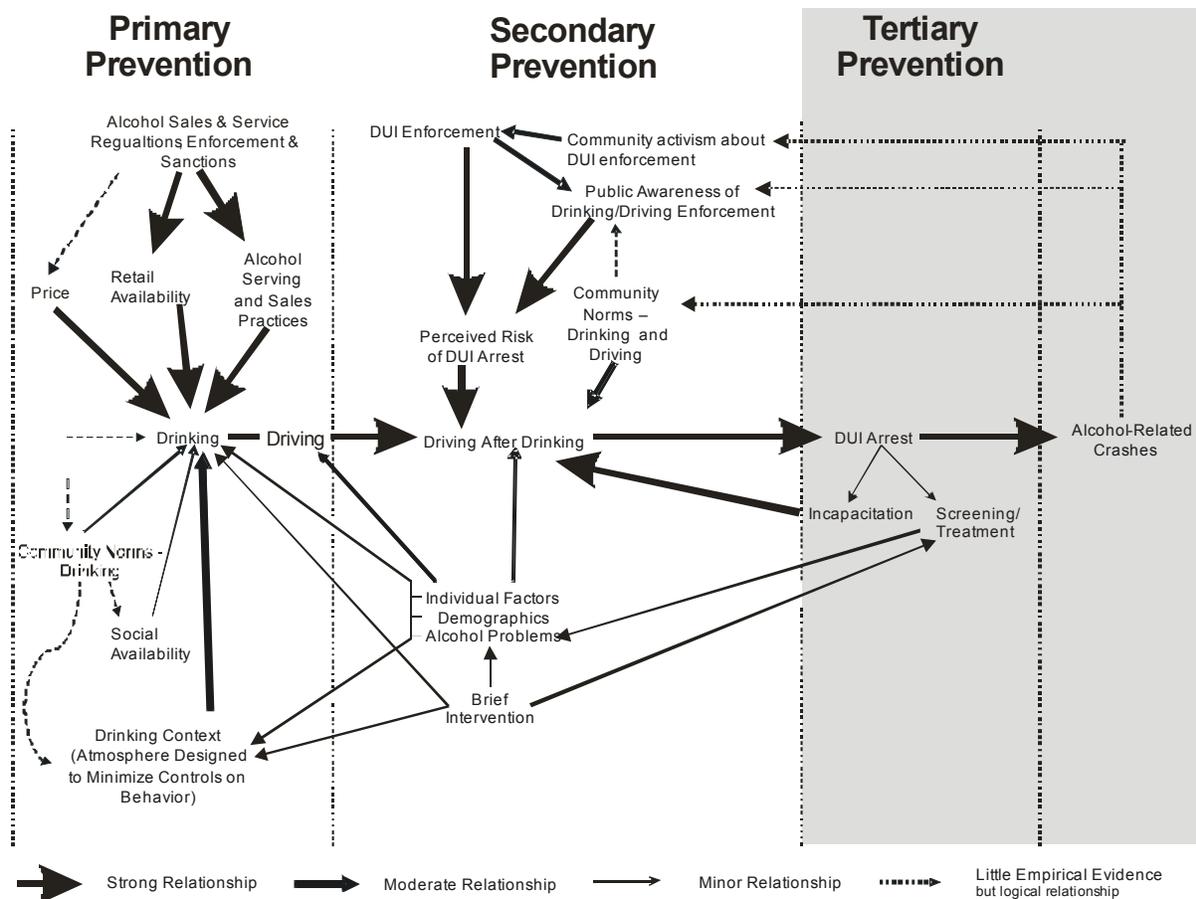


Figure 5-24. Alcohol-related motor-vehicle crash causal model—Tertiary Prevention. Adapted from Birckmayer et al. (2008)

5.4.2. Overview of the Tertiary Prevention Area

The role of sanctions in the criminal justice system has been most clearly described by Ross (1982a, p. 7). He identified *retribution*, *incapacitation*, and *rehabilitation* as the principal functions of *simple deterrence*. He suggests that retribution (punishment) plays a role in identifying the limits of socially acceptable behavior and that, in the long run, it can have an educational effect by establishing

protective habits based on use over time. Voas (1999) provided a somewhat simpler set of functions based specifically on drinking-and-driving laws. He suggested that the three functions of sanctions for DWI offenses involved the “three Rs,” *Restriction, Rehabilitation, and Restitution*. *Restriction* involves actions to prevent future impaired driving (incapacitation), and *Rehabilitation* focuses on treatment to support recovery of the offenders from their drinking problem. *Restitution*, generally fees or fines, provides a means for making the DWI criminal justice system at least partially self-supporting (McKnight & Voas, 1982). Although funding enforcement and court expenses through restitution remains a significant feature of the DWI sanctioning system, the two primary objectives of the sanctions for impaired-driving offenders are (1) to restrict their driving to protect the public from the DWI offenders and (2) to ensure that they receive assistance in overcoming their demonstrated inability to control their drinking (Voas & Fisher, 2001, p. 33).

Restriction of driving is achieved through “incapacitation” for some specified period by creating a barrier to driving by the offender while impaired. Logically, three possibilities are available: (1) prevent drinking, (2) prevent driving, or (3) prevent the combination of drinking followed by driving. Until recently, prevention of drinking has taken the form of supervision through intensive probation with regular chemical tests and surprise home inspections with breath tests or, infrequently, the use of mandatory Antabuse™ (Disulfiram). Because of the high cost of intensive probation programs, electronic monitoring of BAC tests in connection with home confinement systems has been widely used to ensure abstinence. New technological advances in monitoring the BAC from the surface of the skin show promise of being able to monitor abstinence 24/7 (Marques, Voas, & McKnight, 2006).

Traditionally, incapacitation for driving has been achieved through suspension of the driver’s license. Jail also provides a method of denying access to a vehicle but is rarely imposed for a sufficiently lengthy period to have a significant effect on driving exposure (Voas & Fisher, 2001, p. 33). In the last decade, interest has increased in the separation of offenders from their vehicles through impoundment, immobilization, or forfeiture (Voas & DeYoung, 2002). Finally, over the last two decades, the technology for vehicle alcohol interlocks has evolved so that it now prevents an offender from driving while impaired by requiring a breath test when starting the vehicle (Beirness & Marques, 2004). As illustrated in the DWI Prevention Model, these systems react to prevent driving after drinking.

Programs to promote recovery fall into three broad classes. The first is 10 to 12 hours of education covering drinking and drinking-and-driving facts with the development of an action plan to avoid the DWI problem in the future (Rider, Voas, Kelley-Baker, Grosz, & Murphy, 2007). Second are the screening programs in connection with criminal justice processing (Lapham, 2004/2005). Third are the treatment programs involving one-on-one or group therapy, generally lasting 3 to 6 months, designed to deal with the underlying drinking problem and associated comorbidities (Dill & Wells-Parker, 2006).

In addition to the programs established by the courts for convicted DWI offenders, there are intervention programs in emergency rooms and hospitals aimed at drinking drivers who are not arrested in crashes. Some drivers avoid arrest because they are transported to the hospital before an officer can initiate an investigation. Simpson and Robertson (2001) reported that 20 to 30% of DWI crashes resulted in drivers receiving or requesting medical attention and that the officers they surveyed reported that, 50% of the time, the medical personnel refused to cooperate in the collection of BAC data on those cases. Orsay et al. (1994) reported that in their survey of DWI offenders admitted to

hospitals, 80% were not convicted (see below). This provides strong support for the initiation of the brief intervention programs in emergency rooms to motivate these individuals to undergo treatment.

This *Tertiary Prevention* section of Chapter 5 describes the issues presented by the criminal justice system related to the prosecution and conviction of arrested DWI suspects and the effectiveness of traditional sanctions, fines, jail, and license suspension in reducing recidivism and alcohol-related crashes. It goes on to describe methods for screening offenders to determine the extent of their need for treatment and the types of intervention programs typically applied to DWI offenders. It concludes with a description of the developing technological approaches to monitoring DWI offenders to prevent their driving while impaired.

5.4.3. Prosecution and Conviction of DWI Offenders

Before any of the measures described can be applied, the arrested DWI offender must either receive an administrative license suspension or be convicted of the DWI offense so that criminal penalties can be applied. The process by which these actions occur are regulated by law and by judicial precedent, with the result that sanction alternatives are often limited before the court's sentencing process begins. In general, increasing the severity of a sanction increases the offender's effort to avoid conviction and becoming subject to the sanction. Robertson and Simpson (2002c) surveyed 390 prosecutors from 35 States to collect information on the problems being encountered in the prosecution of DWI cases. They identified 10 problem areas among which were issues that have already been discussed, such as complexity of State impaired-driving laws and refusal of the breath test. Seventy-three percent of the prosecutors responding to the survey reported that the breath test is the single most convincing piece of evidence (p. 45). In the absence of the test, more pressure is imposed on the officer's observations of the suspect and the detailed recording of the arrest procedures. The complexity of the arrest process, including the failure of some police departments to follow the specified procedures for the administration of the of the SFSTs, frequently leads to the suppression of evidence, which is a major factor in acquittal reported by 47% of the respondents (p. 32).

Aside from the problems associated with obtaining a conviction, crowded court dockets have resulted in pressure to dispose of DWI cases through plea bargains. In Robertson and Simpson (2002c) study, the prosecutors they surveyed estimated that 44% of the defendants plead guilty, and of those, 67% have negotiated an agreement that generally results in a reduced penalty (p. 91). In some cases, such agreements allow the offender to plea to a non-alcohol-related offense, such as reckless driving, or allow multiple offenders to plea to a first DWI offense. Such sanction reductions not only reduce the power of the court to apply control measures on the defendant, but also result in not recording the actual offense on the driver's record. Consequently, a subsequent offense will be treated at a lower level than if the original charge appeared on the record. Sanction reductions can also occur during post-trial procedures. For example, the "probation before judgment" program in Maryland provides that if the offender complies with the conditions of probation during the year following conviction, the record of the DWI conviction will be expunged from the driver record (Rauch et al., 2002c). Taxman and Piquero (1998) reported that between 1985 and 1993, 65% of first offenders and 11% of multiple offenders in Maryland received probation before judgment, which resulted in lower penalties and the deletion of the DWI conviction if they met the probation requirements. Voas and Fisher (2001) provide a review of pre- and post-trial diversion programs, noting that safety advocates usually strongly resist pretrial programs that result in offenders avoiding a DWI on their records. Some States, such as Illinois and California, have developed terms such as "court supervision"

(Illinois) and “wet reckless” (California), which serve to indicate that the original charge was DWI even though the offender plead to a lesser offense.

In sum, the typical prosecution process provides opportunities for offenders to avoid conviction for DWI offenses, not only by being found innocent of the charge, but also by accepting plea bargains or opting for remedial presentencing diversion programs that result in conviction for a lesser offense. These programs have been implemented in part to relieve the pressure on court dockets but also because of the belief that they are more likely to reduce recidivism than traditional sanctions, such as jail or license suspension. The evidence for such diversion programs is mixed (Voas & Fisher, 2001). Two studies (Taxman & Piquero, 1998; Voas & Tippetts, 1990) have shown that the Maryland “probation before judgment” program reduced recidivism, but Rauch et al.(2002a, 2002b) found no evidence of a reduction in recidivism. None of the studies, however, involved a randomized trial, so the observed recidivism could be a function of group differences rather than program features. Similar evaluations of other programs in Oregon, Washington, and New York by Voas and Fisher (2001) suffered from the same limitation. Because such diversion programs involve the offenders volunteering for the diversion, it is unlikely that they can be adequately evaluated.

5.4.4. Traditional Sanctions for DWI Offenses

5.4.4.1. Jail

In the decade between 1910 and 1920, the States began to pass laws to incarcerate impaired drivers. Despite the early and continuous use of this sanction for over a century, the evidence for its effectiveness in reducing impaired driving is limited. One problem in evaluating its utility is that it potentially has both a general and specific deterrent effect, so it can be evaluated in two ways: by its overall affect on alcohol-related crashes and by its specific effect on the crashes of DWI offenders. Wagenaar, Zobeck, Hingson, and Williams (1995) and Zobeck and Williams (1994) reviewed 87 evaluation studies of laws providing mandatory jail and minimum fines covering the 30-year period from 1960 to 1991 and found only limited evidence for the effectiveness of those sanctions. One reason that the jail sanction may not have as strong a general deterrent effect as might be expected has been proposed by Ross, who argued that the probability of apprehension is more salient than the severity of the sanction (Ross & Voas, 1990). Another problem presented by the use of incarceration is the limited availability of jail facilities and the expense of jail confinement. Avoiding these problems has resulted in the diversion of offenders (who would normally be jailed) into community service programs or electronically monitored home confinement. Efforts by advocate groups, such as MADD, to have States mandate jail for first DWI offenders (Fell & Voas, 2006c) have generally failed because of the cost and overcrowding of local and State jail facilities (Voas, 1986).

Jail is a difficult sanction to evaluate because of the complex role it plays in both general (reducing impaired driving by the public) and special (reducing recidivism of DWI offenders) deterrence. Particularly complex is its role in the imposition of other sanctions on DWI offenders because it is the threat behind every court sanction. Failure to follow the courts probation requirements can be punished by jail time so, independent of its direct effect on recidivism and or crashes through its incapacitating effect, it is important to maintain jail as a threat to back up other measures such as treatment programs, house arrest, and interlock programs.

Wagenaar et al. (2007) surveyed the literature between 1991 and 2006 and found 20 studies of the effectiveness of jail penalties. Nine of the studies evaluated the effect of the jail sanction on traffic

fatalities. Two of those found a significant reduction in alcohol-related crashes but five similar studies failed to find a reduction in crashes. Wagenaar et al. (2007) concluded from this review that the evidence for the effectiveness of jail was at best mixed. They followed up that review with their own analysis of 18 States that implemented mandatory minimum jail sentences for first DWI offenders between 1976 and 2002. In that analysis, they found five States with decreases and two with significant increases in single-vehicle nighttime crashes. They concluded that the evidence for the effectiveness of mandatory jail penalties was weak.

In summary, incarceration of DWI offenders is a controversial issue. It is not clear whether it has a general deterrent effect, but it does have a specific deterrence of effect on DWI offenders, as it temporarily keeps them from driving. Unless it is combined with a strong treatment program (Kunitz et al., 2002), however, jail time does not reduce the likelihood of impaired driving after the offender is released, and it costs up to \$30,000 annually. Sentences are generally brief, and studies show that long sentences are no more of a deterrent than short ones (Voas, 1986). Nevertheless, the threat of a substantial jail sanction can motivate offenders to participate in treatment programs and to comply with interlock and other sanction requirements. In particular, drug courts and DWI/drug courts use the coercive power of incarceration as leverage to ensure that offenders receive the treatment they need (Tauber & Huddleston, 1999; Breckenridge, Winfree, Maupin, & Clason, 2000; Freeman-Wilson & Wilkosz, 2002).

5.4.4.2. *Fines*

Like jail, fines can play a role in both general and specific deterrence. In addition, fines and court fees are often established to meet the costs to the public of the elements of the criminal justice system dedicated to enforcing DWI laws. A long-term objective of the safety community has been to make the DWI enforcement self-funding through funds collected from arrested impaired drivers. (McKnight & Voas, 1982). Two elements of the DWI sanction system—fines/fees and community service programs—provide a means for restitution to the community for the injury and property damage caused by the DWI offender and for the communities expense in providing DWI enforcement and prosecution services. Fines and special fees that may cover costs (such as breath testing, screening, or vehicle impoundment) have played a substantial role in funding the DWI criminal justice system. Thus, the significance of fines cannot be judged simply for their effectiveness in deterring impaired drivers. Legal provisions for community service primarily have been provided as a substitute for jail where community jails are overcrowded. There is no evidence, however, that it has either a general or a specific deterrent effect on alcohol-related crashes, and its value to the community has been controversial. Attempts to evaluate the monetary value of the services have been limited and usually suggest that the costs of offender supervision approximate the monetary value of the services provided (Voas, 1985).

Wagenaar et al. (2007) have produced some evidence that fines may affect DWI alcohol-related crashes. They studied 26 States that implemented minimum fine policies between 1976 and 2002 and reported that six of those States demonstrated a significant reduction in single-vehicle nighttime fatal crashes. In four of those six States, however, the increase in fines was implemented at the same time as other important DWI laws, so the changes could not be attributed solely to the increased fines. When they analyzed the average reduction in fatal crashes across all 26 States as a function of the drivers' BAC levels, they found an average decline in fatal crash involvement of 1.06 per month per State for crashes involving drivers with BAC levels higher than .08. Their review of 19 studies of the effect of fines between 1992 and 2006 identified six that showed reductions in

recidivism or alcohol-related crashes. Because many States that implemented minimum fines did not show reductions and, in some of those States that did have reductions, other important DWI legislation was enacted simultaneously, they summarized their interpretation of the previous studies and their own as suggesting that mandatory fines do “not have demonstrable general deterrent or preventive effects.” (p. 18)

5.4.4.3. *License Suspension*

License suspension is effective but suspended DWI offenders are high-risk drivers. For the last century, license suspension has been the most widely used and most effective sanction for impaired driving. Studies on the effect of State administrative license revocation or administrative license suspension laws have shown them to be a general deterrent (Klein, 1989; Zador, 1991; Voas et al., 2000b). These laws also have been effective as a specific deterrent in reducing the recidivism and crash involvement of drivers apprehended and convicted of impaired driving (Coppin & Oldenbeek, 1965; Peck, 1991; Williams, Hagen, & McConnell, 1984; Peck, Sadler, & Perrine, 1985; McKnight & Voas, 1991). Voas, Tippetts, and Taylor (2000d) found that the DWI reoffense rates were approximately 40% lower for suspended DWI offenders compared to reinstated DWI offenders. Despite such evidence for the effectiveness of the suspension sanction, it must be kept in mind that suspended and revoked offenders are high-risk drivers. Based on FARS data, 7.4% of all drivers in fatal crashes have suspended or revoked licenses, and 20% of drivers in fatal crashes in the United States are improperly licensed (Griffin III & DeLaZerda, 2000). DeYoung, Peck, and Helander (1997) found that, in California, suspended or revoked drivers were 3.7 times more likely to be at fault in a two-vehicle crash.

Risk of apprehension for driving while suspended is low. License suspension has gained much of its effectiveness because it incapacitates the driver (i.e., prevents offenders from driving, thus preventing them from causing crashes). It is only partially effective, however, because up to 75% of suspended offenders drive illicitly (Ross & Gonzales, 1988). Early in the 20th century when there were more horse-drawn carriages than motor vehicles, people were generally aware that a driver was suspended. Thus, illicit driving was relatively rare. Today, with 231 million motor vehicles on the roadways, it is difficult for the police to adequately enforce the laws against driving while suspended. Under the Fourth Amendment, stopping a vehicle is a “seizure” that requires the officer to have reason to believe that the driver has committed an offense. Thus, if a law enforcement officer stops a vehicle for a driving offense, the officer can require the offender to produce his or her driver’s license. Suspended, but careful, drivers can drive while suspended with very little risk on highly traveled roads if they avoid traffic violations.

Thus, many suspended offenders perceive that they can drive with relatively little risk of apprehension, producing the relatively high rate of illicit driving reported by Ross and Gonzales (1988). Despite this, there is evidence that strong sanctions against DWI and DWS can reduce illicit driving. McCartt, Geary, and Nissen (2002) covertly observed driving by suspended DWI offenders in two jurisdictions. They found that 88% of the DWI offenders in Milwaukee, Wisconsin, where the penalties for DWI and DWS were perceived to be relatively low, drove illicitly, compared to 36% of offenders in Bergen County, New Jersey, where the penalties were perceived to be relatively high. Both of these studies reported that suspended offenders reported considerable concern about being apprehended for DWS and indicated that they limit or manage their driving to avoid detection. Despite this, offenders apparently accept the risk and continue to drive as is indicated by the substantial number of suspended DWI offenders who accumulate citations and crashes on their records.

DWI offenders delay reinstatement. A further indication that DWI offenders find it possible to drive while suspended with relatively little risk of apprehension is the large number of suspended drivers who do not reinstate their licenses when they are first eligible. Early studies of the effect of license suspension noted that the reduced rate of repeat offenses demonstrated by suspended DWI offenders compared to those who avoided suspension continued beyond the end of the suspension period (Hagen, 1977). Later, followup studies reported that this probably was because up to 50% of the suspended DWI offenders were not reinstating their licenses when eligible. Consequently, those offenders continued to have a reduced rate of recidivism (Sadler & Perrine, 1984; Tashima & Helander, 1999). In a study funded by NHTSA, Voas and McKnight (1989) evaluated the relative efficacy of limited vocational licensing versus full suspension for DWI offenders in Washington State. They found that only one-third of first DWI offenders reinstated their licenses when eligible after 90 days. Another third reinstated during the following year, and the last third remained suspended after 2 years. In a 1999 study of California's DWI offenders, Tashima and Helander (1999) followed first and second DWI offenders convicted in 1993 for 6 years. They found that only 34.7% of the first offenders suspended for 6 to 12 months in 1993 had reinstated by 1996, three years after their conviction. Of the second DWI offenders suspended for 18 months in 1993, only 16.4% had reinstated 3 years later in 1996.

Because license suspension is clearly effective in reducing recidivism and crash involvement, there is a strong possibility that the delay in reinstatement has a safety benefit to the community. The delay, however, may involve some continued hardship for offenders and their families. Further, there may be some financial risk to the public because of the lack of supervision of the insurance requirements. This raises an important policy issue for State legislators and motor-vehicle administrators: To what extent should DWI offenders be encouraged to reinstate their licenses?

Several administrative factors may influence the reinstatement of DWI offenders, some of which provide the DMV with an opportunity to influence reinstatement. Offenders who leave the State before becoming eligible for license reinstatement will not be among those who reinstate. Additionally, those who commit another DWI or DWS offense will have their suspensions extended. Offenders who succeed in obtaining a limited vocational license during their hard suspension periods often continue to drive on that license rather than seeking full renewal. State renewal requirements may also present a barrier to reinstatement. These include the State's fee for reinstatement, administrative measures such as a vision and driving test, and possibly an application to a medical review board or an interview with a driver analyst. Most importantly, though, is the often-required completion an SR22 form, which informs the insurance company of the suspension for DWI and results in a large increase in the insurance premium. Another potential impediment to reinstating the license in some States is the requirement to install an alcohol interlock on the offenders vehicle. Congress, through the Transportation Equity Act for the 21st Century (TEA-21) enacted in 1999, required that States either impound the vehicles or require interlocks on the vehicles of multiple DWI offenders. One method provided to the States for imposing the interlock was to require it for relicensing, which some States did. Although the TEA-21 legislation has been superseded, in those States with that provision, it will probably present a barrier to DWI offenders considering license reinstatement (see discussion of interlock programs hereinafter).

To determine the extent of delay in reinstatement typically exhibited by DWI offenders and the implication of the delay on the recidivism rate of first and multiple offenders, NHTSA contracted with PIRE to conduct a seven-State study. The study involved an evaluation of 3 million drivers'

records from the seven largest States (shown in Table 5-13) covering 7 to 14 years between 1988 and 2001 (Fell et al., 2008). The seven States included a driver population of more than 40 million. To identify drivers apprehended for DWI, the records of all drivers with a DWI offense, an administrative license suspension, or a t-test-refusal (implied consent) suspension were selected for study. The data set did not include the relatively few individuals who were arrested but not cited for ALR or test refusal or convicted of DWI.

The analyses of driver records proceeded in two sections. First recidivism rates per unit of time were calculated using Kaplan-Meier survival analysis. A first set of survival analyses focused on the occurrence of reinstatement, relative to the eligibility date. A second set of survival analyses focused on the occurrence of a recidivist alcohol event, during two key periods: while the offender was suspended and following the offender's reinstatement. An analysis of the data regarding the date of reinstatement relative to the date of eligibility indicated that approximately half of second offenders reinstated within a year of becoming eligible (Figure 5-25). Three of 10 offenders had no record of ever being relicensed.

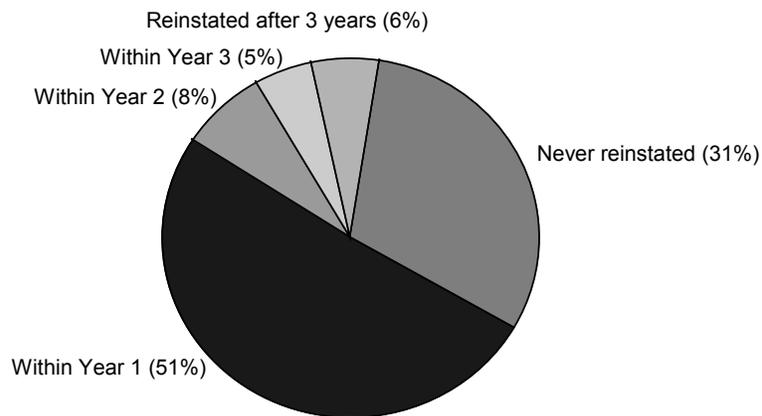


Figure 5-25. Second offender delay in reinstatement

Two factors were related to delay in reinstatement: (1) whether the offender was a first or multiple offender ($p=.056$), and (2) the length of the court or DMV-ordered suspension that the offender received ($p=.013$). Whereas 73% of the first offenders who received short suspensions reinstated within a year of becoming eligible, only 44% of the multiple offenders receiving long suspensions were relicensed within a year of their eligibility.

The relationship of the delay in reinstating to recidivism was studied in two phases: (1) the period before the reinstatement occurred during the time the offender was suspended and (2) the period following reinstatement when the offender was relicensed. As would be expected, the analysis of recidivism during the suspension period before reinstatement occurred showed that prior offenses ($p=.037$) and the length of court/DMV-ordered suspension ($p=.000$) were significantly related to the recidivism rate. Of greater interest for this study was that recidivism during the period before the offenders made their reinstatement decision was significantly ($p=.013$) related to their eventual delay in reinstatement.

The separate analysis of variance for the period following the date on which the offenders were relicensed found that the original length of the suspension was not related to recidivism after the

offenders were reinstated; however, multiple offenders did have a higher recidivism rate than first offenders once they were reinstated ($p=.000$).

In sum, it appears that suspended DWI offenders in the seven States substantially delayed reinstating their licenses. Only half reinstated within a year, and for about a third, there is no record of reinstatement. The delay in reinstatement was associated with the number of prior offenses, the length of the court-mandated suspension period and their level of recidivism during the time they were suspended before they were reinstated. All of these factors are interrelated because multiple offenders generally receive longer suspension sentences and have higher recidivism rates. Thus, much of the delay appears to be the consequence of the status and characteristics of the offender. Drivers with multiple offenses are assigned to more intensive treatment programs that generally must be completed before they become eligible for reinstatement. They will also receive higher fines and will have to pay higher collision insurance fees, which may limit their capability to own and operate a motor vehicle or meet the monetary requirements for reinstatement. In addition, some of the apparent delay may be a result of inadequate driver record systems that do not capture the cases of drivers who leave the State or change their names. *Should motor vehicle departments encourage reinstatement?* Based on the regression analysis conducted in the NHTSA study (Voas, Mcknight and Tippetts, 2010), the length of the offender's delay in reinstating, once the number of priors, length of suspension sentence, and reoffenses during suspension have been accounted for, is not related to the recidivism rate after reinstatement. As shown in Figure 5-26, however, recidivism is particularly high for offenders who remain suspended during the first 18 months following their suspension date, so DWI offenders who qualify for and apply for reinstatement during that period have lower recidivism rates despite their increased exposure to driving. Despite the effort to control for prior offenses, this is probably due to the characteristics of the offender who qualifies for early reinstatement rather than the factors that enter into the offender's decision to reinstate.

Recidivism following reinstatement. What is particularly striking is the persistence of an elevated level of recidivism following reinstatement. It is apparent that the traditional sanctions and treatment programs that follow a DWI conviction are failing to promote complete recovery from drinking and driving. This suggests the need for programs and policies that continue the recovery process or continue to restrict the driving of offenders after they reinstate. The contrast between the long-term downward trend for those who remain suspended compared to those who reinstate may be related to a reduction in driving by offenders with the most serious drinking problems who are no longer driving due to job loss or hospitalization.

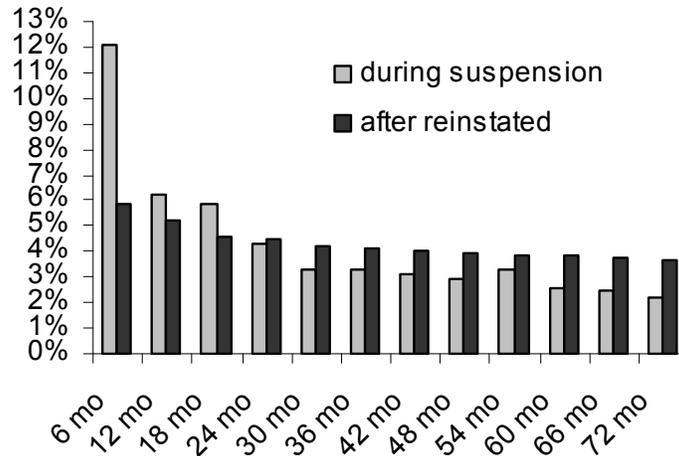


Figure 5-26. Six-month recidivism rates over 6 years from date of suspension for suspended compared to reinstated multiple DWI offenders

5.4.4.4. Overview of Traditional DWI Sanctions

Jail, fines, and license suspension continue to play significant roles in reducing the recidivism of DWI offenders. Jail clearly incapacitates the offenders while they are incarcerated, but its effect on the long-term behavior of offenders and general deterrence appears to be minimal at best. With the increasing interest in DWI courts, interlocks, and BAC monitoring, the value of the threat of jail coercing participation in other effective sanctions is important. The role of fines in reducing impaired driving is also uncertain to minimal, but the funds collected through fines and fees help fund the DWI criminal justice system. License suspension continues to play an important role in both general and specific deterrence. Its effectiveness, however, in reducing recidivism among convicted DWI offenders has been weakened by the difficulty in enforcing laws against driving while suspended. This is due to the large number of vehicles on the roads and an inability to stop drivers and check their license status unless they commit a traffic offense.

5.4.5. Overview of Recovery Programs

In the early years of developing remedial programs, their effectiveness was unclear because offenders were offered incentives (e.g., they could avoid license suspension) to attend these programs. Consequently, the driving exposure of offenders who received treatment was greater than that of comparable offenders who did not enter treatment and remained suspended. Some researchers have suggested that remedial programs might even contribute to increases in recidivism and collisions (Mann, Vingilis, Leigh, & deGenova, 1983; Preusser, Ulmer, & Adams, 1978; Sadler, Perrine, & Peck, 1991). Nevertheless, when remedial programs in which the offender did not receive a reduction in their license suspension were studied, it was found that treatment led to a greater reduction in recidivism than was achieved by suspension alone (Peck et al., 1985). Thus, recent evidence indicates that remedial programs can reduce recidivism and collisions as well as bring other health and social benefits (Mann et al., 1983; Wells-Parker, Bangert-Drowns, McMillen, & Williams, 1995; DeYoung, 1998). Research on the effects of remedial programs for convicted DWI offenders provides the strongest evidence for the efficacy of rehabilitative measures to address alcohol problems (Mann et al., 1994; Smart & Mann, 2000; Wells-Parker et al., 1995; Dill & Wells-Parker, 2006). To be effective in

reducing overall collision and recidivism rates, however, such programs must be used in coordination with, and not as a replacement for, sanctions such as license suspension and other incapacitating measures (e.g., Mann, Vingilis, Gavin, Adlaf, & Anglin, 1991; Voas & Fisher, 2001). Both sanctions and treatment programs can reduce the risk of traffic crashes (Nichols & Ross, 1989; Voas & DeYoung, 2002; Voas, 1999).

In the past, the primary focus in recovery programs for impaired drivers has been on treatment for alcohol problems. This has been based on the nature of the offense itself and evidence from studies of impaired-driving offenders that from a third to a half of first offenders and up to 90% of multiple offenders met the criteria for dependence or abuse of alcohol. The characteristics of impaired drivers are highly variable, however, as has been shown by the review of impaired driver typologies conducted by Perrine, Peck, and Fell (1989). For example, a cluster analysis of the characteristics of convicted impaired drivers by Arstein-Kerslake and Peck (1985) and Reis (1982) produced nine subgroups of DWI offenders. Peck and Helander (2001a) called attention to the high-risk driver who also happens to drink as an important component of the impaired-driving problem. Based on data from the California driver record system, they analyzed the relationship between moving traffic offenses and DWI offenses as predictors of crash risk. The results of their study are shown in Table 5-13, which lists the probability of involvement in a crash in the subsequent 3 years by offenders with various combinations of DWI and non-alcohol-related moving traffic violations. As can be seen, a first DWI offender with six traffic citations ($p=1.129$) is twice as likely as a second offender with no traffic citations ($p=.557$) to be in a crash during the next 3 years.

Table 5-13.

Crash risk as a function of DWI citations and 1-point citations over a concurrent 7-year (1985-1991) period (N=145,645)

DWI citations	Total 1-point countable citations							Total
	0	1	2	3	4	5	6+	
0	0.233	0.377	0.482	0.572	0.649	0.757	0.935	0.357
1	0.441	0.556	0.668	0.735	0.841	0.985	1.129	0.628
2	0.557	0.658	0.815	1.078	0.905	1.128	1.283	0.778
3+	0.676	0.784	0.837	0.767	1.379	0.818	1.294	0.817
Total	0.240	0.387	0.496	0.589	0.669	0.779	0.959	0.317

Source: Peck & Helander (2001a)

It is important to keep in mind the significance of alcohol-related versus non-alcohol-related crashes in assessing the effectiveness of treatment programs. Although 39% of fatal crashes involve alcohol, it plays a far smaller role (about 5%) in the much more numerous “run-of-the-mill” injury and property-damage-only crashes. At the same time, alcohol-related crashes tend to be more serious than non-alcohol-related crashes. Peck and Helander (2001a) calculated that drivers with one or more DWI offenses were 1.7 times more likely than the average driver to be in some type of crash in the next 3 years but were 14 times more likely to be in alcohol-related crash. Treatment programs appear to be effective in reducing alcohol-related crashes, but as might be expected, they have little effect on the more numerous non-alcohol-related crashes (Peck et al., 1985; McKnight & Voas, 1991). Thus, even DWI offenders who are fully recovered from their alcohol problem may still have higher crash rates than the average driver.

Recovery programs imply the need to determine the underlying problems that led to the impaired-driving behavior in order to apply the most effective remedies. Thus, the topic naturally divides into two major areas: (1) screening and assessment (identification of the problem), and (2) education and treatment (dealing with the problem). Screening is the frontline triage system generally used to determine for the court whether offenders should be assigned to a brief education program or to a more intensive treatment program. The specific treatment needs of the individual offender are then assessed at the treatment agency. Remedial programs include short-term education programs for those without AUD symptomology, inpatient or outpatient treatment for those exhibiting AUD signs, and brief interventions for impaired drivers not subject to court sanctions.

5.4.6. Screening

Screening is the term generally applied to brief, inexpensively administered tests and procedures used as a first step in establishing the presence or absence of an alcohol or drug problem and in determining the risk of recidivism. This information allows the court to determine the type of rehabilitation program appropriate for the DWI offender. Because screening can be administered relatively quickly and inexpensively, it frequently is done in court before deciding upon the sanction. It also frequently occurs before the trial, and the recommendations that stem from the screening become part of a plea agreement. Most States mandate screening to evaluate the alcohol abuse problems of DWI offenders and to determine the offenders' needs for further assessment and treatment (Chang, Gregory, & Lapham, 2002). Current guidelines for sentencing DWI offenders recommend that all offenders be screened for alcohol and drug use problems and recidivism risk (NHTSA & NIAAA, 1996). For a simple screening without an assessment component, an instrument—typically, a brief questionnaire—is used to determine whether the client should be transferred to an education program or to treatment.

Issues related to screening and assessment of DWI offenders arose at the same time that courts, researchers, and clinicians first began to develop and implement remedial options, including education, treatment, and rehabilitation. The national Alcohol Safety Action Program, which funded 35 community programs in the early 1970s (Levy et al., 1977; Stewart & Ellingstad, 1989; Nichols, Weinstein, Ellingstad, & Struckman-Johnson, 1978b), stimulated the development of court treatment programs for DWI offenders. The ASAP model focused on the “problem drinker” and the need to identify such individuals from “social drinkers” for whom extended treatment was not justified (Nichols et al., 1978b). The court probation officers were not well trained to assume that responsibility, and they lacked the screening tools needed for that purpose. To meet this need, some courts hired pretrial investigators with a background in alcohol abuse treatment (frequently recovering alcoholics). In addition, NHTSA funded the development of a special diagnostic tool: the Mortimer-Filkins structured interview and behavioral inventory for use by pretrial investigators (Mortimer, Filkins, Kerlan, & Lower, 1973). Over time, the interview portion of the screening tool was dropped and just the self-report form retained as the Mortimer-Filkins test.

The Mortimer-Filkins test was developed because the principal measure available at that time was the Michigan Alcoholism Screening Test (MAST) (Selzer, 1971). The MAST was developed for a clinical population; therefore, the responses that indicated problem drinking as infrequent in the less deviant DWI population were too obvious to be useful with offenders who recognized that their answers would affect the length of the treatment program to which they would be assigned. The challenges of screening in the court adjudication process have been summarized by Lapham (2004/2005). She notes that the coercive nature of the court process may motivate offenders to resist

the process by understating their drinking symptoms, both to minimize the length and the intensity of the treatment to which they will be mandated and to avoid the costs of lengthier, more intense treatment. She suggests that well-trained interviewers are required to deal with this problem; however, many, if not most, courts cannot afford highly skilled staff (Knight et al., 2002, in Lapham, 2004/2005). The State of California has attempted to solve this problem by establishing a separate program of private providers for first-offender screenings (Stewart, Laurence, Klitzner, & Epstein, 1987).

Over the years, an impressive amount of data on the value of screening and assessment procedures and the context within which they are conducted has been collected. This work has resulted in a body of literature describing instruments that can identify recidivism risk and factors known to influence recidivism risk, such as levels of substance abuse, with a known and useful degree of accuracy (Lacey, Jones, & Wiliszowski, 1999b; Anderson, Snow, & Wells-Parker, 2000; Chang et al., 2002; Lapham, Skipper, & Simpson, 1997; Nochajski, Bell, & Augustino, 1995; Nochajski, Walter, & Wiczorek, 1997; Allen & Wilson, 2003). The number of screening instruments runs into the hundreds; the major ones are documented in *Assessing Alcohol Problems: A Guide for Clinicians and Researchers*, published by the NIAAA. Lacey et al. (1999b) reviewed the screening test most used with DWI offenders and found that the Mortimer-Filkins test was among the most effective for identifying those at high risk for recidivism. Chang et al. (2002) also reviewed the available instruments and identified those that appear to be most useful for use with criminal justice offenders. She notes that other more objective measures that may be useful adjuncts to screening include the use of collateral interviews in addition to self-report measures, routine breath-alcohol testing at screening appointments, and the requirement that offenders submit to biochemical tests to identify excessive or illegal alcohol or drug use (Chang et al., 2002).

5.4.6.1. Assessment

Screening is generally an initial triage of cases used by the court to determine which education/treatment program to make a condition of probation. In contrast, assessment generally involves an intensive, systematic collection and analysis of data to uncover dependency or abuse problems with substances other than alcohol and psychiatric comorbidities that will require attention as part of the recovery treatment. Many DWI offenders have co-occurring disorders, most commonly other drug abuse or dependence, depression, posttraumatic stress disorder, and antisocial personality disorder (Lapham, C'de Baca, McMillan, & Hunt, 2004; Cavaiola & Wuth, 2002). Consequently, assessments should also include information on the offender's personal life, family life, and social life and on his or her mental health status that condition the offender's readiness to change negative health and safety behaviors. Unlike screening, which should rely more heavily on standardized tests and court records and which can be conducted by court personnel who are not trained medically or psychiatrically, assessment requires trained specialist who can make more in-depth use of information from clinical interviews. One reason for the use of more highly trained interviewers is that assessment clinical interviews provide an opportunity to apply motivational enhancement techniques as part of a brief intervention.

5.4.6.2. DWI Screening Instruments

The AUDs, which can lead to impaired driving and which are a major concern in interventions with drinking drivers, were described in Chapter 3, as was the general status of drinking in America. Because most drivers do not have an AUD that justifies their being referred to treatment, it is

important to have methods for determining which drinkers are in need of intervention services. As noted, this is particularly important for brief interventions that are generally applied in primary health facilities and educational institutions where the number of moderate drinkers among the population contacted may be high. A positive response to two of the four items is considered a sign of a potential alcohol abuse problem. The most widely used measure applicable to court-screening procedures is the AUDIT, which was described in section 3.3.1. As noted in that discussion, a score of eight or more is considered an indicator of an AUD problem, but elements of the AUDIT can be used for a more refined analysis. For example, question 1 differentiates current abstainers from drinkers. Question 2 identifies heavy drinkers, and question 3 identifies binge drinkers.

There are literally hundreds of self-report and structured interview instruments for assessing alcohol problems. The most complete compendium of such diagnostic tests is provided in *Assessing Alcohol Problems: A Guide for Clinicians and Researchers* (published by the NIAAA and edited by Allen and Wilson (2003), which is available online (www.niaaa.nih.gov). That compendium is based on a review of reports covering more than 250 measures and includes those specific to alcohol treatment on which there has been published research since 1995. Chang et al. (2002) published a review of the 12 screening instruments listed in Table 5-14 that are the most widely used by the courts that deal with DWI offenders. Figure 5-27 shows the percentage of States using each measure as listed in her report. Most of the 12 measures Chang et al. (2002) reviewed are appropriate for use in screening as indicated by the relatively few items in the tests allowing them to be administered relatively rapidly and by the fact that with some exceptions, they do not require substantial training to administer them. In many areas, however, court dockets are so large relative to the availability of personnel to conduct screening that even those that can be administered and scored rapidly strain the resources available. This was illustrated by the Mortimer-Filkins' inventory (Filkins, Mortimer, Post, & Chapman, 1973). Constructed in 1971 specifically for court use, it contains both a self-report inventory and a structured interview that, when used together, require 90 minutes of the screener's time (Table 5-15). Although some court systems continue to use both elements, it soon became clear that the caseload for most screeners was too high to devote 90 minutes to each case, so most screeners dropped the interview portion of the instrument.

Table 5-14.

*List of 12 instruments reviewed and evaluated by Chang et al. (2002)**

Instrument	Length (# of Questions)	Testing Time	Training Required
Alcohol Severity Index (ASI)	200	50-60	Yes, self-training possible
Alcohol Use Inventory (AUI)	288	35-60	Yes
CAGE	4	1	No
Driver Risk Inventory (DRI)	140	30-35	No
Life Activities Inventory (LAI)	115	60	No
MacAndrew Alcoholism Scale (MAC)	49	10	No
Minnesota Assessment of Chemical Health (MACH)	11>200	30	No
Mortimer-Filkins Questionnaire (MF)	58	45-90	No
Michigan Alcoholism Screening Test (MAST)	25	10	No
RIA Self-Inventory Screening Instrument (RIASI)	52	14	No
Substance Abuse Life Circumstance Evaluation (SALCE) / NEEDS	98	20	No
Substance Abuse Subtle Screening Inventory (SASSI)	78	10-15	No

*Instruments in bold were found to have some validity for identifying problem drinkers

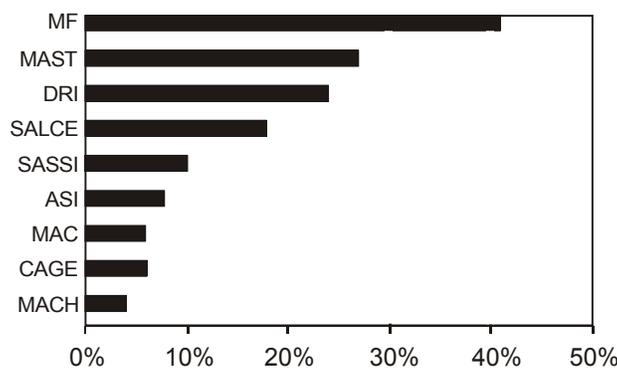


Figure 5-27. Percentage of the 50 States that reported using each of the screening devices. Adapted from Chang et al.(2002)

In their survey, Chang et al. found that 6 of the 12 instruments they reviewed had been evaluated for their ability to predict DWI recidivism. Using data from those studies, they calculated the sensitivity and specificity of five instruments (AUI, MAC, MAST, MF, and RIASI). Sensitivity is

the percentage of offenders who are predicted to recidivate by the test and who do recidivate. Specificity is the percentage of offenders who do not recidivate and who were correctly identified by the instrument. To be maximally effective, a test should be sensitive enough to identify the majority of those who will not recidivate as well as the majority of those who will. Figure 5-28 provides the results of their analysis graphically for the five instruments for which they could compare sensitivity and specificity.

To be effective, the test should fall into the upper right-hand quadrant of the graph. As can be seen, however, most fall into the lower right-hand quadrant, primarily because of low specificity. Chang et al. (2002) also provided a good illustration of the significance of specificity relative to sensitivity to the utility of the screening instruments (p.24). They note that, typically, over a 5-year period, approximately 30% or 300 of 1,000 DWI offenders will recidivate. A test with 70% sensitivity will correctly identify 210 of the 300, but if the test has a specificity of only 50%, it will also identify 350 of the 700 nonrecidivating offenders as likely to reoffend. On that basis, 350 plus 210 equals 560 offenders who would be selected for treatment. Yet the probability of those 560 recidivating would be only 560/210 or 38%, which is only 8% higher than if no screening test had been administered.

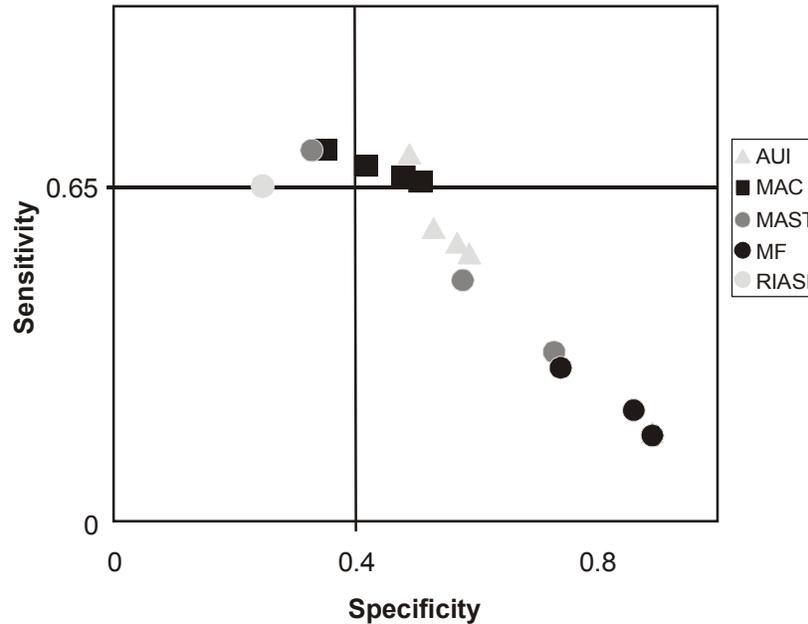


Figure 5-28. Sensitivity and specificity of instruments designed to predict recidivism. Adapted from Chang et al.(2002)

Chang et al. (2002) summarized the conclusions of their study as follows:

“Questions remain about the accuracy of even the best-rated screening instruments. Predictive validity varies across instruments and receiver operator characteristic curves demonstrate that none of these instruments meets the stringent criteria for predictive validity that are an accepted standard in medical practice. The screening methods developed to date cannot accurately predict who will recidivate and who will not. Even the best assessments accurately detected only approximately 70% of recidivists and identified approximately 50% of offenders as problem drinkers. No

evaluations have been shown to be valid for accurately determining drug-use disorders. Since drugs other than alcohol may impair a substantial proportion of drivers, it is critical that methods for determining drug-use disorders in this population be developed and evaluated.” (p. 6)

Chang et al. (2002) described several research needs related to the use of screening instruments. They noted that current instruments do not adequately evaluate drug abuse and that there is a need to develop measures appropriate to identifying individuals driving under the influence of drugs. They also noted that the current instruments generally predict AUD status better than DWI behavior. This is partially because of the limitations in recidivism as an outcome measure based on the low probability of being arrested for DWI. Given the relatively poor sensitivity and specificity of current measures, they suggest additional development and evaluation of predictive instruments, with particular attention to those instruments that are currently widely used but inadequately tested. In their survey of screening and assessment instruments used by States, they found that several States used instruments that had not been validated on samples of convicted DWI offenders. Finally, they pointed to the problem of client defensiveness and suggested greater use of “lie” scales and of objective information from court records to test the veracity of offenders’ reports. It should be noted, however, that several instruments that claim to detect deception have been demonstrated to be inaccurate.

One important possibility for influencing recidivism through screening that does not seem to have been exploited is the opportunity to conduct a brief intervention. Chang et al. pointed out that “All of the conditions necessary for a brief intervention may be met when a DWI offender meets with the court assessor. Yet the research found no study that evaluates the effectiveness of face-to-face interviews in this population. Considerable evidence suggests that brief interventions with alcohol users help a substantial proportion to reduce their alcohol intake. More information is needed on the efficacy of different interviewing approaches for this population” (p. 6). This failure may be both related to the training level of the screeners and the time available to them to deal with each of their clients.

5.4.7. Alcohol Treatment Programs for DWI Offenders

The proportion of first offenders who exhibit alcohol use disorders (AUDs) is not entirely clear as research studies have varied in the number identified as dependent or abusers with estimates varying from 10 to 80% (Cavaiola & Wuth, 2002, p.61). A significant problem in the coercive diagnoses of DWI offenders is that they are aware that assessment is likely to influence the length and intensity of treatment; therefore, they are unlikely to be forthcoming in describing their symptomatology (Lapham, 2004/2005; Lapham et al., 2004). It is clear, however, that a substantial proportion of first offenders and essentially all multiple offenders can profit from a therapeutic program that goes beyond a short classroom educational effort.

5.4.7.1. Evaluation Issues

A key issue in evaluating such programs is the criterion used to assess their value. Because of their lack of candor, self-reported data are unlikely to be very useful from offenders receiving coercive treatment. Recidivism, on the other hand, is a weak measure because of the relatively low frequency with which impaired-driving events are detected (see “Risk of Apprehension for DWS” hereinbefore). Evaluations of rehabilitation programs for impaired drivers also frequently suffer from design limitations. A substantial number of offenders fail to report to treatment programs when ordered to do

so by the court. Other offenders fail to complete treatment. The strongest evaluations of treatment efforts are based on “intent to treat” programs that relate recidivism or other beneficial outcomes to all offenders eligible for the program, not just those who ultimately complete treatment. Finally, most studies on the effectiveness of DWI treatment programs do not assess improvements in problems, such as job retention or reduced alcohol-related injuries not related to driving.

5.4.7.2. Evidence for Effectiveness

Despite these limitations, there is substantial evidence that treatment programs are effective in reducing crashes in which alcohol plays a role (McKnight & Voas, 1991; Peck et al., 1985). DeYoung (1997a) and Peck et al. (1985) have shown that the effect of routine punishments for repeat offenders can be enhanced if combined with alcohol treatment. Wells-Parker et al. (1995) conducted a meta-evaluation of 215 evaluations of drinking-and-driving remediation (treatment) programs. The conclusion of that meta-analysis was that the best designed studies indicate that treatment can produce an additional 7 to 9% reduction in drinking-and-driving recidivism and alcohol-related crashes when compared with control groups that largely received license restrictions only (sometimes more severe than for the treatment groups). The 7 to 9% reduction in recidivism may be conservative in that a number of the less well-designed studies produced larger reductions.

Recent evaluation studies have found remedial interventions (treatment and educational programs) to be more effective than traditional punitive sanctions, such as jail terms and fines, in reducing recidivism and alcohol-related crashes, particularly when combined with license restrictions (DeYoung, 1997a; Green, French, Haberman, & Holland, 1991; Jones & Lacey, 1998b; Jones, Wiliszowski, & Lacey, 1996; Kunitz et al., 2002; Martell, Stewart, & Jamburajan, 1998; Nochajski, Miller, Wiczorek, & Whitney, 1993; Tashima & Helander, 2000). Wells-Parker and Williams (2002), commenting on their review of court-mandated treatment, noted that “In general, research has consistently shown that treatment has a modest effect on reducing drinking-driving and alcohol-impaired crashes among offenders who are mandated to attend and *who actually receive the intervention*” [emphasis added]. Dill and Wells-Parker (2006), in their review of mandated treatment for DWI offenders, indicated that such programs have shown less effectiveness in reducing the severity of alcohol-related problems other than impaired driving. A notable exception, however, was the study by Mann et al. (1994): he found that offenders who received treatment had lower mortality rates compared to similar members of a comparison group.

Three examples of effective treatments. Research conducted on the efficacy and effectiveness of psychosocial and pharmacological alcohol treatments in non-DWI contexts have identified several interventions that are effective in *reducing alcohol use* (Project MATCH Research, 1998; Irvin, Bowers, Dunn, & Wang, 1999; Miller & Wilbourne, 2002; Moyer, Finney, Swearingen, & Vergun, 2002; Swearingen, Moyer, & Finney, 2003). These interventions have common features in that they emphasize abstinence or reduced drinking and consider individual social support systems and social contexts. Three examples of these interventions follow.

1. *Motivational enhancement therapy (MET)* assumes that individuals have the inherent skills necessary to change their drinking with the help of a professional who provides support and encouragement throughout the process (Donovan et al., 1994). MET relies on an individual’s ability to develop his or her own coping mechanisms and internal agents of change to stop drinking. The therapist provides feedback, reviews progress, and renews the client’s motivation and commitment.

2. *Cognitive-behavioral coping skills training* assumes that if individuals learn to address their broader problems, rather than their drinking problem specifically, they will be less likely to rely on alcohol as a coping mechanism. The goal is to help people improve their skills in dealing with the stress of high-risk situations that might otherwise lead to heavy drinking. Core therapy sessions focus on “understanding the importance of coping skills to prevent relapse, coping with cravings and urges to drink, managing thoughts about alcohol and drinking, general problem-solving skills, drink refusal skills, seemingly irrelevant decisions that lead the person closer to drinking, and development of plans to help cope with emergencies and relapse if they occur” (Donovan et al., 1994).
3. *Twelve-step facilitation*, implemented through Alcoholics Anonymous (AA), is based on the disease model of alcoholism (i.e., that the individual has no control over alcohol once it is ingested, but the individual does have control over how he or she chooses to work the 12-step recovery program that treats the disease). Core therapy sessions focus on achieving the primary goals of 12-step facilitation: (1) Get the individual to accept his or her powerlessness over alcohol and the unmanageability of his or her life because of uncontrollable drinking; (2) Incorporate AA’s belief system into the individual’s life and become active in living the principles of the 12 steps; and (3) Recognize that being unable to control one’s drinking requires working the 12 steps, participating in the fellowship of AA with other alcoholics in recovery, and turning to a “higher power” for support (Donovan et al., 1994).

5.4.7.3. *Co-Occurring Disorders*

As noted earlier (5.4.6, “Recovery Programs”), individuals convicted of impaired driving are a heterogeneous group. Along with those whose primary problem is heavy drinking are those whose primary problem is risky driving. Among those with diagnosable drinking problems are individuals who also use drugs and who may exhibit psychiatric problems such as depression or bipolar disorders. Lapham et al. (2001) found that among DWI offenders, 50% of the women and 33% of the men had at least one psychiatric disorder in addition to alcohol or drug abuse. Nationally, between 1995 and 1999, one-fifth of substance abuse treatment admissions were for abuse of alcohol with a secondary drug problem (Office of Applied Studies, 2004). The 2001-2002 National Epidemiologic Survey on Alcohol and Related Conditions (NESARC; National Institute on Alcohol Abuse and Alcoholism, 2006) shows that substantial comorbidity—substance use disorders along with independent mood and anxiety disorders—is pervasive in the general U.S. population. About 20% of those with a current substance use disorder (i.e., at the time of the survey or within the past year) also experienced a mood or anxiety disorder at the same time. Similarly, about 20% of those with a current mood or anxiety disorder also have a current substance use disorder (Grant et al., 2004a). Approximately 28.6% of individuals with a current alcohol use disorder and 47.7% of those with a current drug use disorder had at least one co-occurring personality disorder (Grant et al., 2004b). Given this relationship in the general population, it is not surprising that DWI offenders exhibit other substance use and psychiatric comorbidities. Cavaola and Wuth (2002) provided a recent review of that topic. There is little information, however, on the effectiveness of those programs in dealing with comorbid psychiatric conditions because evaluations of DWI treatment programs have focused on recidivism as an outcome measure.

5.4.7.4. *Pharmacotherapy*

Recent advances in neurobiology have indicated that addiction is a chemical disorder affecting the brain's biochemical control mechanisms. As of December 2004, the following three medications were licensed for the treatment of alcohol use disorders: (1) *Disulfiram* better known as Antabuse® has been in use for many years. It interferes with the metabolism of alcohol and causes unpleasant effects such as headache, tremor, blood pressure changes, nausea, and vomiting, if the individual drinks. It can cause liver damage; (2) *Naltrexone* (ReVia®) is an opiate antagonist that blocks brain opiate receptors. It reduces the "high" created by alcohol and may reduce the craving. There appear to be no ill effects from drinking while taking naltrexone; and (3) *Acamprosate* (Campral®) is a glutamate antagonist that also appears to reduce the intensity of craving. Research has shown that these pharmacotherapies for alcoholism have produced small but consistent effects *when combined with psychosocial treatment* interventions (Mann, 2004). Not all patients benefit, however, and it is currently impossible to predict which ones will. Nonetheless, pharmacotherapy is a reasonable and growing adjunctive treatment for alcohol abuse and dependence.

5.4.7.5. *Post-Treatment Monitoring*

Relapse is a major problem in the treatment of addictions, and most therapeutic programs have made provisions for some continued support for clients following the end of the treatment program. Traditionally, this may involve a continuing outpatient program and/or efforts to enroll the client in a self-help group-support program in the community. Continued participation in such groups during post-treatment is associated with lower relapse rates and with improved psychosocial functioning. AA has traditionally been a significant part of the *de facto* system of care for alcohol problems in the United States. At one time, it was the principal therapeutic program available to the courts. AA policies, however, precluded reporting information to the court—in many cases, not even verifying attendance. Further, AA affiliation alone, absent collateral professional treatment, has not resulted in routinely improved outcomes (Emrick, Tonigan, Montgomery, & Little, 1993; Wells-Parker et al., 1995; Kownacki & Shadish, 1999). Self-help groups that do not use the 12-step program (such as the Secular Organization for Sobriety [SOS], SMART Recovery, and Women for Sobriety) have not been sufficiently evaluated to determine their effectiveness (Humphreys et al., 2004).

Court sanctioning of DWI offenders can provide an important system for supporting offenders following the completion of a treatment program. In addition to the varied elements in treatment programs available through the courts, other court sanctions applied to DWI offenders provide opportunities for enhancing treatment effects. Most multiple offenders are placed on probation and are generally required to be abstinent during the probation period. Thus, unlike the nonoffender, they are subject to monitoring during and following treatment. This can both increase attendance at treatment and reduce relapses following treatment. When probation staffs have the resources to meet regularly with offenders, they can support recovery by monitoring drinking and by assisting the offender in dealing with driving, family, and employment problems.

5.4.8. *Combined Programs*

Better outcomes have been obtained with a combination of interventions that serve both to reduce consumption (alcoholism treatment; see strategies under "Drinking") and to decrease opportunities to get behind the wheel. DeYoung (1997a) examined which sanctions (including alcohol treatment, driver's license actions, and jail terms) work best to reduce impaired-driving recidivism.

The quasi-experimental study examined the relationships between the sanctions that drivers convicted of DWI receive and their subsequent reconviction of DWI, while statistically controlling for pre-existing differences among groups receiving different sanctions. Separate analyses were conducted for subjects having 0, 1, 2, or more prior DWI convictions on their driving records. The study analyzed impaired-driving recidivism throughout the State of California. All drivers holding a California driver's license who were convicted of DWI by a California court during 1990 and 1991 were selected for inclusion in the study. A number of demographics, prior personal driving history, and surrogate traffic environment measures were collected and used as covariates in the analyses. Data were also gathered on subsequent DWI convictions and the number of days to first subsequent DWI conviction; these data were used as outcome variables in the study. Results of the analyses showed that for all levels of prior DWI convictions, combining alcohol treatment with either driver's license restriction or suspension is associated with the lowest DWI recidivism rates. Based on this research and the results of prior studies, it can be persuasively argued that combining license actions with alcohol treatment represents an effective strategy for combating DWI recidivism.

Dill and Wells-Parker (2006) have pointed to the benefits of combined treatments for DWI offenders: "Combining (treatment) strategies may be more effective, regardless of treatment length or intensity, because DWI offenders have diverse and complex problems, and offering varied approaches may help address this range of problems" (p. 43). More recently, court systems have been devoting more resources directly to supporting treatment programs and long-term recovery through the "drug court" and "DWI/drug court system."

5.4.8.1. Drug Courts

Drug courts involve the coordination of the judiciary, prosecution, probation, defense bar, law enforcement, social services, mental health, and the treatment community to intervene with chronic offenders to break the cycle of substance abuse, addiction, and criminal activity. Drug court offenders undergo an intensive regimen of substance abuse treatment, case management, drug testing, probation supervision, and consistent monitoring. They report to regularly scheduled meetings with the judge who has special expertise in the drug court model (Fox & Huddleston, 2003). In a critical review of 120 evaluations of numerous drug court programs, the National Center on Addiction and Substance Abuse at Columbia University concluded that drug courts lower recidivism, reduce drug use, and reduce both direct and indirect costs of investigating and adjudicating drug-related crime (Belenko, 1998; also Belenko, 2001). An evaluation of six drug courts in New York State—Bronx, Brooklyn, Queens, Suffolk, Syracuse, and Rochester—showed that they reduced offender recidivism by an average of 29% over the 3-year post-arrest period when compared to similar offenders receiving standard treatment (Rempel et al., 2003). Drug courts appear to succeed because they manage to engage offenders and keep them engaged in their rehabilitation programs. In a survey conducted by the American University Drug Court Clearinghouse and Technical Assistance Project (2000), drug court jurisdictions reported retention rates ranging from 67 to 71%.

Drug courts take a rehabilitative approach to justice, which usually is applied to nonviolent, addicted offenders. This approach includes some common components: intensive drug treatment, close supervision, and offender accountability. These components have been shown to be a cost-effective alternative to jail for nonviolent offenders and an effective way to reduce recidivism. Consequently, the number of drug courts in the United States has grown from 1 in 1989, to 12 in 1994, to 1,100 in 2003, to more than 1,600 in 2005.

5.4.8.2. *DWI/Drug Courts*

Based on the effectiveness of drug courts, more DWI courts have begun to emerge. Modeled after drug courts, DWI or DWI courts (hereinafter referred to as DWI courts) are designed to provide constant supervision of offenders by judges and other court officials who closely administer and monitor compliance with court-ordered sanctions coupled with treatment. DWI courts generally involve frequent interaction of the offender with the DWI court judge, intensive supervision by probation officers, an appropriate level of treatment, random alcohol and other drug-testing, community service, lifestyle changes, positive reinforcement for successful performance in the program, and jail time for noncompliance. Mostly nonviolent offenders who have had two or more prior DWI convictions are assigned to a DWI court, if one exists in the jurisdiction.

DWI courts reportedly have held offenders accountable for their actions, changed offenders' behavior to end recidivism, reduced alcohol abuse, treated the victims of DWI offenders in a fair and just way, and protected the public (Tauber & Huddleston, 1999; Freeman-Wilson & Wilkosz, 2002). Breckenridge et al. (2000) reported that a DWI court program significantly reduces recidivism among alcoholic DWI offenders. Other studies of this type of program are currently underway, and DWI courts are being implemented in Georgia, Pennsylvania, and several other States. Specialized DWI courts provide greater opportunity for close monitoring and offender accountability. In the current environment, however, only the most egregious offenders are assigned to these courts (Robertson & Simpson, 2002a). As of June 2005, there were approximately 86 specialized DWI courts, 90 hybrid DWI/drug courts, and 1,621 drug courts operating in the United States (Huddleston, Freeman-Wilson, & Marlowe, 2005). One report on a DWI court in New Mexico (Bernalillo County) indicated that recidivism was reduced by more than 50% for 341 offenders who completed the DWI court program compared to similar offenders not assigned to the DWI court (Guerin & Pitts, 2002). Those results, however, were preliminary and did not include statistical tests.

NHTSA is completing an evaluation of the Maricopa County (Phoenix), Arizona, DWI court using a random assignment design (Frank & Jones, 2004). In this research, more than 250 felony DWI offenders were randomly assigned to the DWI court and a comparable number of offenders were assigned to traditional probation services. Preliminary results indicate a lower recidivism rate for DWI court participants for the first 3 years. The Maricopa County DWI court was initiated in 1997 as a form of intensive court supervision of felony DWI offenders. Offenders assigned to the DWI court (after serving a typical 4 to 6 months in jail) are required to enter into a contract with the court that clearly describes the requirements of their treatment plans. Those contracts, reviewed monthly by personal court appearances before the sentencing DWI court judge, include requirements for frequent contact with an assigned probation officer, regular meetings with treatment personnel, participation in AA group meetings and designating an AA sponsor, and attendance at VIP sessions, in addition to required sobriety. DWI court offenders are also subject to periodic, random surveillance visits by a probation officer with the capability of alcohol breath testing. Obtaining gainful employment and stable housing is also an important part of the overall program. The DWI court judge has the power to send offenders back to incarceration if they fail to meet the requirements of the program. Qualifications for graduation from the program include meeting all treatment and program contractual requirements, maintaining steady employment for 6 months, remaining alcohol-free (sober) for 6 months, and having a stable residence at the time of graduation. The graduation is usually completed within 12 to 16 months from the beginning of the program and typically occurs in the courtroom

presided over by the DWI court judge. After graduation, the offender emerges into another stage of less supervised probation.

In the Kootenai County (Idaho) DWI court, an intensive alcohol treatment program is administered to offenders with two or more DWI convictions within 5 years or for first or multiple offenders who were arrested with a BAC level of .20 g/dL or greater. An evaluation (Crancer, 2003) showed a 70% program completion rate by 46 graduates of the court compared to only a 40% completion rate for similar offenders not assigned to the DWI court. Only 4% of the DWI court graduates were subsequently arrested for DWI compared to 14% among a comparison group of 100 offenders who were eligible for the court but did not participate.

5.4.8.3. *Education Programs for DWI Offenders*

For the “social drinkers” among DWI offenders whose screening results indicate that they do not have an AUD problem, a short (8- to 10-hour) educational program is generally prescribed (Voas & Fisher, 2001). These are usually modeled on the “DWI Phoenix” program developed by Stewart and Malfetti (1970). Results indicate that such programs may be successful in increasing intermediate goals, such as readiness to change, but have little effect on DWI recidivism. Rider et al., 2007 described the *Preventing Alcohol-Related Convictions (PARC)* program, a novel educational curriculum for first-time DWI offenders, with the ultimate goal of reducing DWI recidivism. It differs from traditional DWI education and prevention programs in that it does not suggest to DWI offenders that they must abstain from alcohol entirely or that they must control their drinking to prevent a future DWI; rather, it teaches students to prevent a future DWI by not driving their motor vehicles to drinking events. Thus, the emphasis of the curriculum is on controlling driving rather than controlling drinking to avoid future DWI convictions. The program has been tested in a random clinical trial with 43,000 first offenders in Florida. The initial study of the program (Rider et al., 2006) involved the use of a readiness to change questionnaire (Prochaska, DiClemente, & Norcross, 1992) to gauge the extent to which the first offenders accepted the contrasting traditional “control drinking” approach to the PARC “control driving” approach. This first study demonstrated that the PARC program was effective in moving participants toward more readiness for change and toward a strategy of planning to avoid driving to any venue in which drinking may occur. A followup study compared the recidivism of the first 10,000 of the 43,000 first offenders in the study based on a full year of exposure to recidivism. That study (Rider et al., 2007) demonstrated that the first DWI offenders exposed to the PARC curriculum were associated with a 42% reduction ($p = .019$) in recidivism when compared to the traditional curriculum.

There is some evidence that the effectiveness of an education program when compared to jail may vary according to whether the DWI was a citation for a first or a multiple offender. Socie, Wagner, & Hopkins (1997) selected for study drivers who were sentenced either to jail or to a certified driver intervention program (DIP) in Franklin County, Ohio, in 1987 after their first impaired-driving (DWI) conviction. Although random assignment to treatment was apparently not possible, the authors claimed that because each impaired-driving charge was assigned to one of a pool of 15 judges with widely varying sentencing patterns, there was no apparent bias in subject allocation to jail or the DIP program. Socie et al. compared the likelihood of subsequent impaired driving of 124 jailed offenders with 218 DIP offenders over 4 years following conviction. After controlling for potentially important covariates (such as gender, age, race, BAC, additional charges filed at the time of arrest, and driving history), they derived logistic regression results indicating that DIP attendees had significantly lower rates of subsequent impaired driving. Drivers who had no prior history of at least

one non-DWI alcohol-related offense were significantly more likely to again drive while impaired when jailed as opposed to those enrolled in a DIP (odds ratio [OR] = 2.53, confidence interval [CI] = 1.44, 4.45), whereas those with previous alcohol-related offenses may have fared better in jail (OR = .56, CI = .11, 2.76). Drivers younger than 21 years of age were also at elevated risk for repeat offenses (OR = 2.46, CI = 1.13, 5.35). DIPs appear most effective when used for people who have not had previous alcohol-related crashes or driving offenses.

5.4.8.4. *Victim Impact Panels*

A widely used offender program—the victim impact panel (VIP)—is designed to increase the DWI offender’s appreciation for the damage that impaired driving can cause. At the VIP, victims of impaired drivers describe their injuries and the problems they have experienced as a result of their involvement in an alcohol-related crash (Shinar & Compton, 1995). VIPs are provided to an estimated 400,000 DWI offenders per year by more than 200 MADD chapters in the United States. The empirical evidence regarding the effectiveness of VIPs is mixed and inconclusive. Anecdotal reports indicate that DWI offenders are often moved by victims’ stories and vow to reform their ways. Some empirical studies also support this assertion (Fors & Rojeck, 1999; Police Executive Research Forum, n.d.). In a meta-analysis of 35 randomized studies of recovery programs (although most did not involve drinking drivers), Latimer, Dowden, and Muise (2001) found this process decreased the recidivism of offenders (72% of 32 studies yielded a reduction in recidivism) when compared to more traditional criminal justice responses (i.e., incarceration, probation, and court-ordered restitution).

Other studies, however, largely contradict these findings (Shinar & Compton, 1995). Polacsek et al. (2001) examined the influence of MADD VIPs specifically compared to a 10- to 12-hour DWI school. Results showed no significant difference in movement through the stages of change or in recidivism over the 2-year followup period. Wheeler, Rogers, Tonigan, and Woodall (2004) reported similar findings, within 2 years, between attendees and nonattendees on the VIP intervention on alcohol consumption, drinking-and-driving behavior, or recidivism. In fact, some research suggests that VIPs may actually have an effect on recidivism *opposite* to that desired. deBaca, Lapham, Liang, and Skipper (2001) examined re-arrest rates of 6,702 first-time and repeat offenders in New Mexico between 1989 and 1994 following referral to VIPs. Results showed that, after controlling for multiple risk factors, VIP referral was not statistically associated with recidivism for female or male first offenders. In fact, female repeat offenders referred to VIPs were significantly *more* likely to be re-arrested compared with those not referred. Possible reasons for these inconsistent results may lie in the research designs that were quasi-experimental. Further, they lacked randomization and equivalent groups.

5.4.9. *Methods for Controlling Impaired Driving by DWI Offenders*

Motorists convicted of DWI offenses are high-risk drivers, as shown in the study of the extent to which they delay reinstatement. They are at particularly high risk in the period immediately after arrest and conviction, which is the time they should be receiving treatment. The public needs protection from these high-risk drivers. Conceptually, this can be accomplished in three ways: (1) by preventing driving (which is the intent of license suspension, but which is no longer fully effective), (2) by preventing drinking, or (3) by preventing the combination of the two. Seizing and impounding, immobilizing, or forfeiting the offender’s vehicle, in addition to license suspension, prevents driving. Monitoring abstinence through surprise breath or urine test programs, remote electronically monitored in-home tests, or sensors worn on the body prevents drinking. Finally, vehicle alcohol interlocks

provide a parsimonious method of preventing the combination of drinking with driving. The status of each of these preventive approaches is briefly discussed in the following paragraphs.

5.4.9.1. Vehicle Sanctions

Because of the large number of suspended DWI offenders driving illegally and the limited enforcement resources available to deal with the problem, many States have begun to enact legislation directed at the vehicles owned by offenders to limit their illicit driving. Such policies fall into three broad categories: (1) programs that confiscate or impound the vehicle; (2) programs that confiscate the vehicle plates and vehicle registration and/or require special plates on the vehicles of DWI offenders; and (3) devices installed in the vehicle that prevent its operation if the driver has been drinking alcohol (ignition interlock). None of these vehicle controls is foolproof; each one can be circumvented if the offender drives another vehicle registered in someone else's name. Nevertheless, as with license suspension, several of the vehicle sanctions have been found to have a specific deterrent effect of reducing recidivism for DWI offenders (DeYoung, 1997b; DeYoung, 2000; Voas & DeYoung, 2002; Beck, Rauch, Baker, & Williams, 1999; Voas & Tippetts, 1995; Voas, Tippetts, & Taylor, 1997c; Voas, Tippetts, & Taylor, 1998a). The only study of the general deterrent effect of vehicle impoundment was conducted in California by DeYoung (1998). He found no evidence that impoundment had a general deterrent effect on the driving public as a whole.

In 1992, NHTSA funded a national survey (Voas, 1992) of the use of vehicle sanctions in the 50 States. State officials, interviewed in an open-ended discussion, were asked to identify any corrections or clarifications needed in the reports of States' vehicle sanctions laws. These discussions also included (1) the extent to which individual vehicle sanction laws were being used; (2) if laws were not being used, why they were not; and (3) the extent to which they were aware of any successes or problems associated with the enforcement of the laws and of any evaluations of the effectiveness of vehicle sanction programs. As part of the study, Voas also conducted a literature review.

The literature survey indicated that with the exception of studies evaluating impoundment and interlock laws, there was little new research data available at that time on the effectiveness of vehicle sanction laws. The number of vehicle sanction laws and the number of States with such laws have increased substantially since 1992, but it has been difficult to get authoritative information on the extent that such laws are actually being used. Vehicle registration data are maintained in a separate file from driver's license records, and court actions against the vehicle in DWI and DWS prosecutions do not appear on the offenders' driving records. Without a central source for such information, it was necessary to consult individual court or police department records to determine the extent of use and the effectiveness of vehicle sanctions. This has been done in only a relatively few studies (Voas et al., 1998a; Voas et al., 1998a; Peck & Voas, 2002; DeYoung, 1999; Crosby, 1995). The studies that have been conducted are described hereinafter by the type of vehicle action.

Registration/license plate actions: A number of States have laws requiring the registration of a DWI offender-owned vehicle be suspended for the same period as the driver's license. This helps ensure that the vehicle is covered by insurance. In concept, offenders should surrender their registration document and license plates to the DMV. A significant limitation in most jurisdictions is ensuring that the offender actually surrenders these documents. In some jurisdictions, the courts require these documents be submitted at the time of trial. Failing that, DMVs must depend upon local enforcement agencies to apprehend drivers operating vehicles with suspended registrations. Because most Sheriffs' offices are overwhelmed with a large number of warrants to be served, many for

serious criminal offenses, obtaining the license plates of suspended DWI offenders has generally proved to be impractical. There have been no evaluations of the provisions for canceling registrations (Voas, 1992).

Although the traditional programs canceling the registration at the time of suspension have not been evaluated, two other applications of registration cancellation and license plate forfeiture have been evaluated and have been shown to be effective. The States of Washington and Oregon implemented a law that allowed officers who apprehended an unlicensed driver to seize the vehicle registration and place a sticker on the license plate that permitted them to stop the vehicle to check on the status of the driver's license. Voas, Tippetts, and Lange (1997b) studied the before-and-after effects of this law, considering alcohol-related offenses, DWS offenses, moving traffic violations, and crashes among drivers suspended for DWI. Their results showed a significant general deterrent effect in Oregon, but not in Washington, which had a similar but more limited law and a weaker enforcement effort.

Minnesota implemented license plate seizure at the point of arrest. When the seizure was dependent on court actions, few plates were confiscated, but when the law became an administrative offense, rather than a criminal offense, plate seizures increased and were demonstrated to have a specific deterrent effect. Leaf, Zwicker, and Preusser (2004, under review) compared first offenders who had BAC levels of .20 g/dL or higher who were affected by the plate seizure law with first DWI offenders who had BAC levels of .17 to .19 g/dL, which were slightly less than the .20 g/dL BAC limit and, therefore, not subject to plate impoundment. During the first year after the offense, when sanction differences were greatest, the drivers subject to plate impoundment (BACs = .20 g/dL or greater) had a recidivism rate 25% lower than the drivers who were not subject to plate impoundment (BACs = .17 to .19 g/dL). Beyond the first year, the two groups of offenders experienced no significant differences in recidivism rates. Leaf and colleagues concluded that the plate impoundment was effective, at least in the short term while the sanctions were in place.

Special license plates: Several States, most notably Ohio and Minnesota, provided for the suspension of the registration of vehicles owned by DWI offenders for the period of the driver's license suspension. These States also provided for a special license plate (a "family plate") for the DWI offender's vehicle to permit family members to use the vehicle while the offender-owner is suspended. The license plate is marked so that the police can stop the vehicle and determine whether the suspended offender is driving illegally. No evaluations of family plate laws have been conducted.

Impoundment/immobilization: Impoundment and immobilization laws are similar in that they are designed to deny the offender the use of a vehicle for a span of time to help ensure that suspended individuals will not drive illegally. Immobilization provides a low-cost alternative to having the vehicle stored by a commercial towing service, a cost communities often pay when an offender fails to retrieve the vehicle. Several studies of impoundment laws have been conducted. Manitoba ALS and vehicle impoundment programs went into effect in 1989. Under these programs, vehicles are seized and held for 30 days when an offender is apprehended for DWS. Beirness, Simpson, Mayhew, and Jonah (1997) evaluated both the general and specific deterrent effects of Manitoba's program. Although the analysis did show a decline in both measures contemporaneous with the introduction of impoundment, the results are ambiguous because Manitoba introduced the ALS law at the same time as the impoundment law.

In 1995, the State of California enacted a law providing for a 1-month administrative impoundment of the vehicle driven by an unlicensed driver. Implementation of this law varied to some extent between communities but, in general, the vehicles belonging to nonoffenders were held for the month unless the owner claimed that the vehicle had been driven without permission. DeYoung (1997b) evaluated the specific deterrent effect of a 1995 California law allowing police officers to seize and impound vehicles driven by suspended/revoked or unlicensed drivers for 30 days. Drawing records of DWS offenders from four cities (Riverside, San Diego, Stockton, and Santa Barbara), he compared the 1-year subsequent driving records of offenders whose vehicles were impounded with similar offenders whose vehicles were not impounded. DeYoung found that first offenders (no prior convictions for DWS or DWU [driving-while-unlicensed]) whose vehicles were impounded had significantly fewer DWS/DWU convictions (24%), total moving violation convictions (18%), and crashes (25%) than the comparison group of first offenders whose vehicles were not impounded. Impoundment had an even greater effect on repeat offenders, that is, those who had prior convictions for DWS/DWU. They had significantly fewer 1-year subsequent DWS/DWU convictions (34%), moving violation convictions (22%), and crashes (38%) than repeat offenders whose vehicles were not impounded.

To determine the general deterrent effect of the California impound law, DeYoung (2000) used interrupted time-series analysis (ARIMA models) to study the change in the crash rate of all suspended or revoked drivers in California. He found that, when the vehicle impoundment law was implemented, there was a 13.6% decline in crashes among that group. However, a comparison group of nonsuspended/nonrevoked drivers also demonstrated an 8.3% reduction in crash involvements during the same period. When the experience of the comparison group was included in the analysis, the difference for the suspended/revoked group was only marginally significant, suggesting that the vehicle impoundment law had relatively little general deterrent effect.

In September 1997, the State of Ohio strengthened its vehicle immobilization law to include sanctions of 30 and 60 days applicable to first and second DWS offenders and 90 and 180 days applicable to second and third DWI offenders. Although officially titled an immobilization law, vehicles were impounded at the time of arrest and only in some areas were they later immobilized on the property of the offender. Voas et al. (1997c) evaluated the Ohio program in Franklin County where both vehicle impoundment and immobilization were used. The effect on moving violations and repeat DWI offenses while the vehicle was not available to the offender was analyzed separately from the postsanction period when the vehicle was released to the registered owner. The comparison group consisted of DWI or DWS offenders who were eligible for a vehicle sanction but did not receive it. The results showed that there was a significant reduction in both DWS and DWI offenses in the year following the sanction for offenders whose vehicles were impounded or immobilized, compared to the control group of offenders who did not experience this sanction.

Effect sizes of 50 to 60% were observed during the vehicle impoundment period, and effect sizes of 25 to 35% were found during the post-sanction period. These results demonstrated that the influence of vehicle impoundment may extend beyond the impoundment period itself. Whether this is a deterrent or incapacitation effect is not clear. The offender may avoid committing offenses fearing future vehicle impoundments—a deterrent effect. Alternatively, the offender may not have access to the vehicle once it is released by the police, either because it was not retrieved from impoundment or because the vehicle's owner would no longer allow the offender to use it—an incapacitation effect.

Voas et al. (1998a) replicated the Franklin County study in Hamilton County where only impoundment was used (immobilization was not used). The results were essentially similar to those in Franklin County. During the sanction period, recidivism for DWI offenders was reduced by 60 to 80%; during the post-sanction period, recidivism was reduced from a third to a half of the level of the comparison group. The extended effect of impoundment is generally unique among vehicle sanctions, in that neither basic license suspension, nor interlocks have been definitely demonstrated to have a continuing influence beyond the period of the sanction itself.

Forfeiture. Unlike the temporary holding of the offender's vehicle involved in impoundment actions, forfeiture involves seizing and selling the offender's private property (the vehicle) by a government agency. This process usually involved considerably more litigation than impoundment. The state of knowledge regarding the usefulness of forfeiture remains sketchy. Nonetheless, a fairly strong quasi-experiment has been conducted on the forfeiture program in Portland, Oregon, resulting in some interesting anecdotal evidence that sheds some light on forfeiture programs in New York City and California.

The city of Portland enacted a civil forfeiture program in 1989 that focused not on the behavior of the offender, but rather, on the unlawful use of the vehicle irrespective of the culpability of the owner. Thus, in Portland, vehicles are seized for forfeiture as a public nuisance when drivers have lost their driving privilege because of a DWI conviction or when the driver is arrested as a habitual traffic offender. Crosby (1995) conducted a study in which all offenders whose vehicles were seized for forfeiture between 1990 and 1995 were compared with all offenders whose vehicles were not seized but were arrested for the same offenses. The results showed that the rearrest rate was about 50% lower for offenders whose vehicles were seized than for their counterparts whose vehicles were not seized. The study also examined whether the effects of forfeiture were different than for impoundment and found that offenders whose vehicles were simply impounded had about the same rearrest rate as offenders whose vehicles were forfeited.

Safir, Grasso, and Messner (2000) reported on a forfeiture program in New York City. Beginning in February 1999, the city police seized the vehicles of first and multiple DWI offenders. Forfeiture action was taken under three circumstances: (1) when the impaired driver owned the vehicle; (2) when the impaired driver was not the owner but the owner knew or should have known of the criminal use of the vehicle; and (3) when the impaired driver was the "beneficial owner" of the vehicle. Between February 22, 1999, and December 31, 1999, the New York Police Department seized 1,458 vehicles in connection with DWI arrests and commenced 827 forfeiture actions. During that period, the police department instituted a pilot settlement policy for DWI forfeiture cases that allowed the return of the vehicle to the defendant upon successful completion of an authorized alcohol-treatment program and the payment of a sum of money (\$1,000 or less) to cover administrative and litigation costs. To qualify for that program, the driver had to have an arrest BAC level of less than .20 g/dL and no previous DWI offenses. This allowed some first offenders to avoid having their vehicles forfeited. Although the authors reported anecdotal evidence showing that while the ordinance was in effect, DWI arrests and DWI crashes decreased, no scientific evaluation of the program effectiveness was conducted.

Concurrent with the implementation of a 30-day vehicle impoundment law for first-time DWS offenders described, California also implemented a vehicle forfeiture law for repeat DWS offenders. Although the first offender impoundment law was widely applied throughout the State, with more than 100,000 vehicles impounded in the first year of the legislation, the companion forfeiture law was

implemented in only two or three communities. Peck and Voas (2002) surveyed police departments receiving State grants to conduct impoundment programs to determine why they did not use the forfeiture provisions of the law. They identified five factors that accounted for the low application of forfeiture: (1) lack of support from the district attorneys (apparently because of prosecution costs); (2) cumbersome administrative procedures; (3) poor cost recovery (sale of vehicles does not return cost of seizure); (4) a high percentage of third-party owners to whom forfeiture does not apply; and (5) the 30-day impoundment was often equivalent to forfeiture because half of the offenders did not retrieve their vehicles. Despite the failure of most California communities to implement forfeiture programs, those that did (Santa Barbara and San Diego) found the process relatively straightforward and easy to apply. Because of the limited use of the second DWS offender forfeiture law, there has been no effectiveness evaluation of that legislation.

Vehicle sanction overview. Overall studies to date suggest that impoundment is an effective method of reducing the recidivism of DWI and DWS offenders. To be effective, the vehicle must be impounded at the time of the arrest, and a procedure must be devised to deal with nonoffender owners. In Ohio, impoundment legislation was strengthened by two additional pieces of legislation—one prevented an offender from registering another vehicle while the vehicle driven at the time of arrest was impounded, and the other allowed the police to hold the vehicle of a nonoffender unless the owner could demonstrate that it had been driven without permission. Because a substantial proportion of offenders do not retrieve their vehicles, some localities will be liable for storage and towing expenses if the sale of the offender's vehicle does not raise sufficient funds to cover such expenses.

Of the various vehicle sanctions, impoundment appears to be the most clearly effective for reducing recidivism for both DWI and DWS offenders. License plate forfeiture appears to have considerable promise but has received limited evaluation. Among the general findings on impoundment from the studies reviewed are the following:

- Impoundment programs implemented administratively appear to be much less cumbersome than those that are implemented through the courts (DeYoung, 1997b; Peck & Voas, 2002).
- At least half the vehicles driven by suspended drivers are owned, in part or in whole, by a nonoffender, and most laws provide for holding the vehicles of nonoffender owners. The courts will generally support impoundment of non-offender-owned vehicles if the owner knew or should have known that the driver was unlicensed or intoxicated (Voas et al., 2000d).
- Generally, impoundment laws provide that vehicles must be returned to nonoffender owners if they can prove they were unaware of the offender's status. In such cases, the owner is usually required to execute a "stipulated vehicle release agreement" which provides that the vehicle must be forfeited to the State if the owner allows the offender to operate the vehicle while still suspended. Such agreements appear to be effective in making the vehicle inaccessible to offenders (Voas et al., 2000d; Peck & Voas, 2002).
- Most vehicle impoundment programs provide for collection of towing and storage charges before the vehicle is returned to a nonoffender owner. The owner can then attempt to recover those costs from the offender (Voas et al., 2000d). A successful

alternative to vehicle impoundment is to immobilize the vehicle with a “boot” or “club” in the offender’s driveway. This avoids storage costs.

- The most successful vehicle impoundment and forfeiture laws provide for a service fee (generally at least \$100) for the return of a seized vehicle. This helps to defray the costs of operating impoundment programs (Peck & Voas, 2002).
- Nearly all successful impoundment programs provide for seizing and holding the vehicle at the time of arrest. Waiting for the outcome of the court trial often results in the vehicle having been disposed of and, thus, not available to the police. To deal with this problem, Ohio passed a law prohibiting offenders from transferring vehicle titles following a DWI or DWS arrest (Voas et al., 2000d; Peck & Voas, 2002; Voas, 1992).
- Because many DWI and DWS offenders are driving “junkers” (vehicles of little value), successful forfeiture programs provide for rapid hearings and forfeiture actions to allow for quick lien sales, thus avoiding high storage costs (Voas, 1992; Peck & Voas, 2002).
- Peck and Voas (2002) study in California indicated that many vehicles seized for impoundment ultimately go to lien sale, so many cases of impoundment become de facto forfeitures. A study of Oregon’s program indicates that vehicle forfeiture versus impoundment added no traffic safety benefits (Crosby, 1995). More research is needed in this area.

5.4.9.2. *Interlocks*

The second and perhaps most direct and specific method for preventing impaired driving by DWI offenders is to require that they place on their vehicles a device that will not permit the engine to start if the prospective driver has been drinking. This interferes only minimally with the offender’s life while protecting the public from the risk of impaired driving by suspended drivers. As of 2004, 43 States have laws providing for interlock programs, but only a small proportion of DWI offenders have been motivated to install interlocks despite the strong evidence for their effectiveness when on the vehicle.

Vehicle alcohol interlock devices (sometimes referred to as breath alcohol ignition interlock devices or BAIIDs), when attached to the ignition of a vehicle, require the operator to provide a breath sample for analysis each time the engine is started. The units have four basic elements: (1) A breath alcohol sensor that records the driver’s BAC level and can be set to provide a warning if any alcohol is detected that prevents starting the vehicle if the BAC level is .03 g/dL or higher; (2) A rolling retest system requires a new test every few minutes while driving to prevent an offender from starting the vehicle for a person who has been drinking; (3) A tamper-proof system for mounting the unit in the vehicle that is inspected every 30 to 60 days; and (4) A data-logging system that records both the BAC tests and engine operation, thus ensuring that the offender is actually using the vehicle and not simply parking it while driving another vehicle. In 1992, NHTSA issued “Model Specifications for Breath Alcohol Ignition Interlock Devices” (Voas & Marques, 1992) that recommended standards for sensitivity and reliability and provided for the incorporation of rolling retests and data-recording systems on ignition interlocks to make circumvention difficult.

To be effective, the interlock device must be implemented as part of a program to monitor the integrity of the unit and its installation in the vehicle. Generally, a State-licensed service provider must install the unit, inspect it regularly (generally, every 30 to 60 days), and provide a report on any attempt to circumvent the device to a court probation officer or a department of motor vehicles driver analyst. Such monitoring systems, with substantial consequences for tampering with the device, are essential for ensuring that offenders will not drive the interlock-equipped vehicle while impaired. Courts vary with the stringency of the monitoring requirements they establish and the severity of the penalties imposed for evidence of attempts to circumvent the device or high BAC tests. The interlock may be used as a method of monitoring abstinence by establishing a sanction for any record of a high BAC level, but offenders should be maintained on the interlock because the device prevents the offender from driving.

Voluntary interlock programs. Initially, the courts or the DMV offered the interlock to offenders as a method of driving legally for some portion to the suspension period that had been imposed for the DWI offense. Several studies of such programs were conducted in West Virginia (Tippetts & Voas, 1998); in California (DeYoung, Tashima, & Maston, 2005); in Alberta, Canada (Voas, Marques, Tippetts, & Beirness, 1999a), and in Quebec (Vézina, 2002). Because the decision whether to participate in an interlock program is left to the offender, such programs can be viewed as “voluntary” or “discretionary.” It soon became clear that only about 10% of the eligible offenders took advantage of such “voluntary” programs. Some of the eligible offenders may have elected not to drive while suspended; however, research suggests that up to 75% of offenders drive illicitly while suspended (Ross & Gonzales, 1988).

Undoubtedly, some offenders avoid the units because they interfere with their drinking. The other reasons for such low participation rates are unclear, but apparently the offenders find them annoying and embarrassing. Cost also appears to be a factor. Many DWI offenders drive vehicles registered to others and may have been unable to get the owners to install the devices. Finally, some State interlock programs were poorly advertised, and some offenders were unaware of their existence (Tippetts & Voas, 1998).

Although relatively few offenders voluntarily install interlocks, if they do participate in an interlock program, there is strong evidence that their recidivism is substantially reduced while the devices are on their vehicles (Coben & Larkin, 1999; Willis et al., 2004). The offenders who do participate in interlock programs have 36 to 90% lower DWI recidivism rates than similar DWI offenders who remain suspended. Nine examples of the recidivism rate of offenders with interlocks installed on their vehicles, compared to offenders who did not to enter an interlock program, are shown in Figure 5-29. The horizontal line shows the recidivism level for noninterlock offenders, and each dark bar shows the recidivism level for similar offenders while an interlock was installed on their vehicles. As can be seen, while the interlocks are on the offenders’ vehicles, their recidivism is half or less than that of the noninterlock offenders.

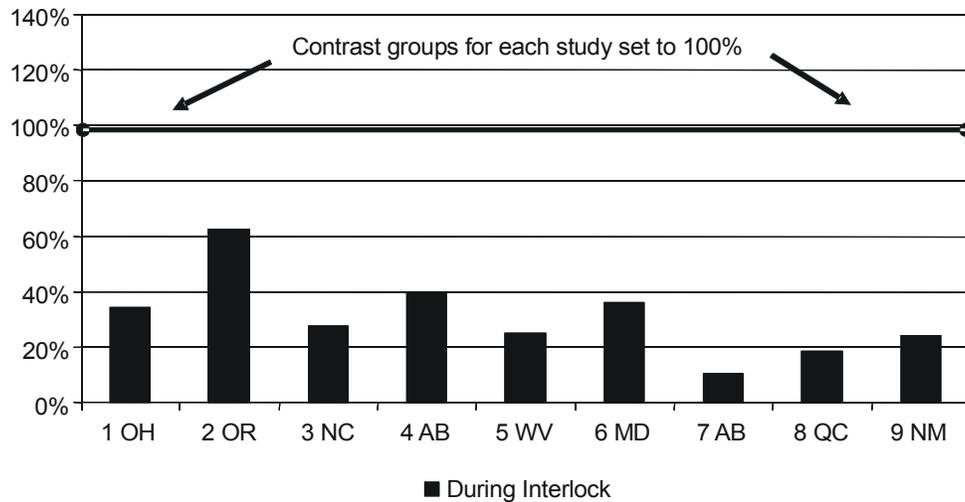


Figure 5-29. Nine Studies: Recidivism with an interlock relative to contrast groups

Although this appears to provide relatively strong evidence for the effectiveness of interlocks, the small number of offenders who elect to install interlocks in discretionary programs leads to the question of whether this is simply the result of their being a selected group of offenders who might be expected to have lower recidivism rates. The best answer to this question is to randomly assign offenders to interlock and noninterlock status, but this is difficult because not all offenders have vehicles, and offenders must agree to have an interlock installed in their vehicles. Given the lack of random assignment studies, the best evidence that interlocks are effective is provided by comparing the recidivism rates of interlock users while the unit is installed in their vehicles with the period after the unit is removed. This is shown in Figure 5-30, for the same groups studied in Figure 5-29. The light bars show the recidivism rate following the removal of the interlock, and the return of that rate to the level of the noninterlock offenders. Figure 5-30 compares the same offenders with and without interlocks installed, so there is clear evidence of the effect of the interlock itself. This graph illustrates the limits of interlock programs; there is little carryover of the habits acquired during the period the unit was installed.

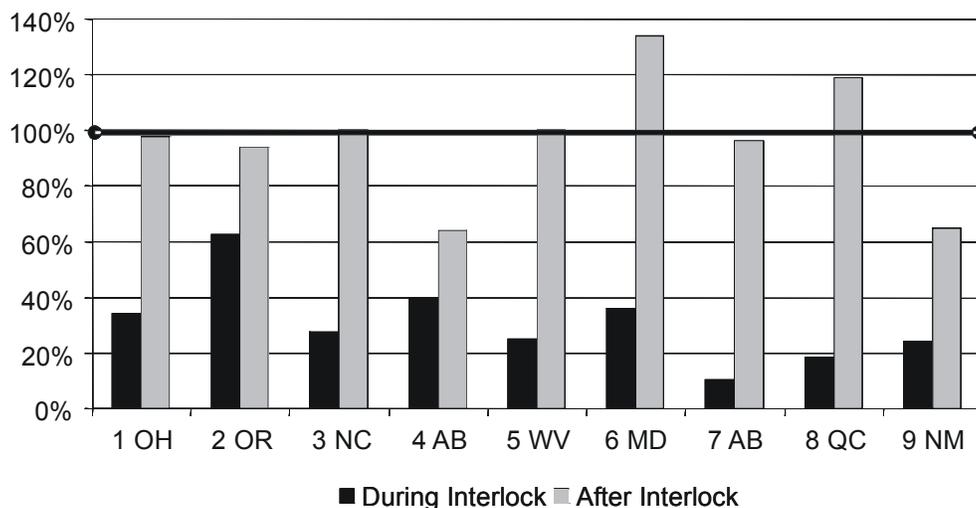


Figure 5-30. Effective while installed; less so after removed (bar pairs are within-subjects change and represent % DWI rate difference from control)

Mandatory interlock laws. To date, laws mandating interlocks have not been successful in substantially increasing the number of units actually installed on the vehicles of DWI offenders. Once again, the reasons for this are not entirely clear. Most such legislation exempts offenders who can prove they do not own a vehicle or who agree not to drive. Not all courts are well informed on such mandatory legislation, and some have no local interlock providers. Courts have also found the cost of the interlock program to be a barrier for low-income offenders, even though most interlock-service companies will reduce the price of the program for indigent offenders.

Because of these problems, some issues have arisen as to the ability of courts to mandate offenders to install interlocks. There is evidence, however, from a study in Indiana (Voas, Blackman, Tippetts, & Marques, 2002a) that offenders can be pressured into installing units if the alternative is more unpleasant. In that study, the court used house arrest as the alternative to the interlock with the result that 62% of the offenders agreed to install interlocks. Thus, it appears that a larger proportion of the offenders can be motivated to install interlocks if a less desirable alternative is imposed if they fail to do so. Currently, most courts have the authority to impose substantial jail sentences on multiple offenders, but jail time is expensive for to the government and very disruptive to the life of the offender and to his or her family members. House arrest, which has been shown to reduce recidivism by reducing recreational driving (Jones et al., 1996), appears to be the most practical solution for those offenders who refuse to install the units. BAC monitoring devices (see below) may also offer a viable alternative.

On July 1, 2005, New Mexico implemented what is currently the most comprehensive interlock law, requiring a full year on the interlock for first DWI offenders, two years for second offenders, three for third offenders, and lifetime for fourth offenders. The legislation requires that the offender obtain and show to the court an interlock license, which in turn is obtained by taking a vehicle equipped with an interlock to the department of motor vehicles that issues the special license. The legislation is silent on the sanctions to be applied to offenders who do not comply with this mandate, but it does excuse those who claim not to own a vehicle. Whether this mandatory law will result in a larger percentage of offenders installing interlocks has not yet been evaluated, but NHTSA has funded a study to determine the effectiveness of the innovative interlock program in New Mexico.

Requiring interlocks for reinstatement. Some States (such as Michigan, Colorado, and Florida) have enacted legislation requiring the installation of an interlock on second offenders' vehicles for up to a year. Interlock installation is a prerequisite for reinstatement of the offender's license to drive. This procedure appears well justified as multiple-DWI offenders continue to have high rates of recidivism after their reinstatement, as shown in Figure 5-30. Further, the same figure shows that recidivism is highest early in the reinstatement period. In some States, this legislation permits the offender to avoid the interlock reinstatement requirement simply by delaying application for reinstatement during the period to which the interlock requirement applies. Because many offenders delay their reinstatement for a year or more, this may not be a significant issue for many offenders (Tashima & Helander, 1999).

The State of Florida, along with several others (e.g., Michigan and Colorado), has passed laws requiring the installation of an interlock no matter how long offenders delay reinstatement. Second DWI offenders can never reinstate unless they install an interlock for a period of a year. That law, which became effective in February 2004, was the subject of a study by Voas et al. (2008) conducted in May 2006. Between those dates, the Florida Department of Motor Vehicles and Driver Licensing staff sent 51,043 (41,759 males; 9,264 females) notices to second and multiple offenders informing

them of their eligibility to reinstate their licenses if they installed an interlock. Of those 51,043 offenders, 13,413 or 26.3% responded to the invitation by installing interlocks. The remainder continued to be suspended. Of those responding, 689 or 5.1% dropped out of the program before completing the required period on the interlock. In addition, another 13.6% (1,822) of the interlock program participants were referred to treatment based on a high-level BAC attempt to start the vehicle that was recorded on the interlock breath-test recording system. The effectiveness of the Florida program requiring the installation of an interlock to reinstate the driver's license remains to be determined, but it is clear that its effectiveness will be limited because only one in four offenders offered the opportunity to reinstate with an interlock are choosing to do so.

Relicensing of long-term suspended DWI offenders. In 2003, the State of New Mexico enacted a unique law that allows any driver suspended for DWI to receive a permit to drive an interlock-equipped vehicle by demonstrating that they have installed an interlock. Offenders, however, may not drive any vehicle without an interlock for the full period of their suspension, which can run up to 10 years. This option was expected to be attractive to offenders who lose their licenses under the ALR law and to third-DWI offenders who have received 10-year revocations. A preliminary study of drivers with 10-year revocations is underway. Early results suggest that very few of the drivers with long-term revocations are taking advantage of the opportunity to drive legally with an interlock (Voas, Roth, & Marques, 2005).

Use of interlock data in treatment. Suspension and vehicle sanctions protect the public from high-risk DWI drivers, but in addition, such interventions can assist offenders to recover from their alcohol problem. Bjerre, 2005 found that the number of applications for medical services related to drinking problems was reduced in interlock users compared to other similar offenders. The interlock record of all breath tests associated with driving can provide the treatment specialist with important information for use in evaluating the status of participating offenders, and the information can also be used in therapy sessions to help the offenders confront their drinking problem (Marques & Voas, 1995; Beirness et al., 2003). Timken and Marques (2001b; 2001a) developed a *Support for Interlock Program (SIP)* that uses the data from the interlock recorder in therapy sessions for DWI offenders. A preliminary test of the SIP program was conducted and evaluated in Texas (Marques et al., 2004b; see also Marques et al., 2004a). Participants in the SIP program demonstrated large decreases in self-reported drinking and drinking problems.

The interlock data recorder also provides important information for predicting future recidivism (Marques, Voas, & Tippetts, 2003; Marques, Tippetts, & Voas, 2003a; Marques, Tippetts, & Voas, 2003b), particularly when combined with the prior record of the offender. This opens up the possibility that, rather than assigning interlock requirements for fixed periods, the time during which the offender would be required to have the interlock on the motor vehicle would be determined by the interlock breath-test record. For example, offenders might be required to maintain the interlock on the vehicle until they have driven for 6 months without recording a positive breath test. Therapists could use the status of the interlock BAC record to assist them in determining how long DWI offenders should remain in treatment. Currently, a problem exists because therapists rarely have access to the interlock record. The utilization of interlock BAC information in the treatment and the monitoring of DWI offenders will require courts to improve their current record systems and make them more readily available to treatment providers.

A substantial amount of research on interlock programs still needed. Although there is evidence that the interlocks currently in operation perform well, it is clear that there are serious

deficiencies in the programs for their use. Several important questions remain regarding the ultimate contribution interlocks can make to the control of high-risk drinking drivers.

- *Can the number of offenders on interlocks be increased?* Most immediately, there is the issue of whether current mandatory programs will succeed in motivating a larger percentage of the offenders to install interlocks. Experience suggests that it will be necessary to apply pressure by having the alternative be house arrest or incarceration to motivate offenders to install interlocks.
- *Will offenders pressured into installing interlocks have reduced recidivism?* Most of the experience with interlocks to date has been with volunteers (i.e., offenders who chose to install an interlock to drive legally). Offenders who are pressured by the threat of jail or house arrest to install an interlock may be higher risk drivers than those in discretionary programs, and they may therefore make a greater effort to circumvent the interlock by driving another vehicle. Consequently, these offenders may not show the same reductions in recidivism that have been seen in studies to date.
- *Will the courts be willing and able to pressure offenders to install interlocks?* If jail and electronic home confinement are to become an alternative to the interlock, they will need to be readily available to the court system. Courts will also need to have the legal authority to impose relatively lengthy periods of home confinement, not only on multiple offenders, but also on first-DWI offenders if they are to be effective in motivating acceptance of periods of up to a year on the interlock. Thus, the threatened penalties necessary to motivate interlock program participation, although rarely imposed, should be more severe than those currently typical of the DWI sanctioning process.
- *While interlocks reduce impaired driving, will they reduce overall crash involvement?* Most studies of the effectiveness of interlocks have been limited to recidivism as the measure of effectiveness because crashes are relatively rare events and therefore more difficult to use in evaluation studies. More studies of the effect of interlock programs on crashes are needed. This need is exemplified by the study of DeYoung et al. (2005), who found interlock users had fewer DWI offenses, but experienced more crashes, than fully suspended offenders. They interpreted this result as indicating that, although interlocks prevent impaired driving, offenders in interlock programs will tend to drive more than offenders who are suspended because they do not fear apprehension for DWS. Consequently, interlock users are more exposed to non-alcohol-related crashes than are suspended offenders, who tend to minimize their illicit driving to reduce their chances of apprehension for DWS. Because alcohol-related crashes generally produce greater injury and property damage than non-alcohol-related crashes, interlock programs may be cost-effective, even if participants have more total crashes (but less severe ones). This remains to be demonstrated, however.
- *Potential improvements in interlock technology.* Further, future systems may make current interlock technology more efficient and effective. As noted in section 3.2.5,

highly sensitive passive alcohol detection devices that can detect small amounts of alcohol in a vehicle are under development (Lambert et al., 2006). Such passive devices cannot distinguish between ethanol from the driver and that from passengers. Several practical problems remain to be solved (e.g., how to prevent vehicle owners from blocking the sensor intakes or driving with all the windows open). However, these systems may have value as a method for activating a driver interlock system only when there is evidence of a drinking driver in the vehicle. Preventing the vehicle from starting only when a possible drinking driver has already been detected would greatly reduce the intrusiveness of the interlock device. Such a system might be integrated with the developing infrared technology described in section 3.2.5 that appears to measure the BAC level through the skin and provides an identification system that ensures it is the offender (not someone else) who is providing the test. These new technological devices appear to be a decade away but may eventually offer the basis for implementing interlock systems that are more effective in preventing impaired driving and less intrusive for the driver.

5.4.9.3. BAC Monitoring

The third method of controlling impaired driving by DWI offenders is through the monitoring of their alcohol consumption to ensure that they cannot drink and drive. In the past, offender abstinence has been monitored in several ways. Some courts implemented closely supervised *Antibuse* administration. Others have implemented intensive supervision programs in which probation officers make surprise visits to the homes of offenders and conduct breath tests. DWI courts also generally provide for intensive monitoring of abstinence. Such systems are labor intensive and expensive for the courts. In the last couple of decades, innovative technological methods for collecting BAC data have received considerable attention. One of these systems has been in use for some time by providers of electronically supervised home confinement programs. This involves telephone-monitored electronic remote breath test systems, which allows frequent monitoring of the BAC level while the offender is at home. These devices offer an alternative to vehicle sanctions and the interlock.

More direct monitoring systems that are worn on the body and monitor the BAC level 24/7 are just beginning to be used by the judicial system. As described in section 3.3.3, two devices are currently under development—the SCRAM™ ankle bracelet and the WrisTAS™, which is about the size of a large wrist watch. The SCRAM™ incorporates a system for detecting circumvention. According to the AMS company, there is evidence that at least 1,000 units are currently in use by courts in the United States and Canada. These systems provide the promise of monitoring abstinence with a minimum of limitations on the offender's behavior. The experimental evidence reviewed in section 3.2.3 appears to confirm that these devices estimate BAC levels with approximate accuracy when they are working well. Neither class of devices has attained anything close to perfection; both have some problems and peculiarities. Overall, the idea of measuring alcohol at the skin surface is valid: both devices can do it, and with further developments, alcohol monitoring of this type is likely to be more widely used.

5.5. Summary

Some individuals with alcohol problems pose significant risks to the public, and as a result, courts often order them to remain completely abstinent from alcohol. Sometimes these sentences are

enforced by jail or the threat of jail along with various forms of monitoring. Although jail can successfully enforce abstinence, it is at best a costly and short-term remedy because that environment does not offer much opportunity to practice self-control.

Alcohol ignition interlock devices very effectively prevent use of a vehicle after alcohol has been consumed (Willis et al., 2004; Voas et al., 1999a; Marques et al., 2001), but because these are specific to a vehicle, they are not a deterrent to drinking when not driving. To address the possible risks posed by alcohol abusers, sometimes the courts will confine a problem drinker to his home using electronic proximity monitors coupled with regular breath tests either through a telephone linked device with voice recognition or via house calls by probation services. Biomedical measures of alcohol use can include ethanol itself (typically a 6- to 12-hour window of detection), or a longer-lasting marker of alcohol use such as urinary EtG that offers 36 or more hours of detection (Wurst et al., 2003b; Helander & Beck, 2005; Borucki et al., 2005). All of these approaches have strengths and weaknesses and all require periodic specimen collection.

Chapter 6.

Summary and Conclusions

This chapter reviews the findings of the 2001 report and notes the principle studies that relate to the research that the earlier report indicated was needed. It also describes three other reviews of research and comments on the studies conducted since 2001 that relate to those reviews. The major research areas covered in this 2006 summary are highlighted along with those areas of research that appear most likely to be actively pursued in the future.

6.1. Status of Research in Alcohol Safety

Jones and Lacey (2002), in the last State of Knowledge report, summarized the status of research on the impaired-driving problem by noting that—

“In general, the literature suggests that data from existing research are sufficient for defining broad groups of alcohol-crash targets, but are still inadequate for identifying more narrowly defined target groups. For example, there are sufficient data to say that young male drivers should be a target group, but not enough data to say that young, unemployed males without a college diploma who drive light trucks are an important subgroup to be singled out for special countermeasure action. In a word, more research is needed on the characteristics of alcohol-crash-involved drivers and their relative risk” (p. 154).

The current update identifies some areas where later research has provided more details on target groups and sometimes has identified new target groups. For example, Chapter 3 reviews recent research on repeat and high-level BAC offenders. Chapter 4 covers research since the 2001 update on a few target groups. There has been much additional research on the characteristics of teenagers and college students who are at risk for impaired driving. Research described in Section 4.2 examines the early onset of drinking, a new area of study for traffic safety researchers. Since the last State of Knowledge report, FARS analysts in the States have been adding ethnicity to the fatal crash reports providing researchers with more details on the characteristics of crash-involved drivers for different race/ethnicity groups (see section 4.6).

Although a substantial amount of research over the last 5 years has been in pursuit of a better understanding of potential target groups, the largest effort has gone into the study of methods for (1) changing the drinking environment and reducing high-risk drinking (section 5.2); (2) creating deterrence to impaired driving through high-visibility enforcement and public information (sections

5.3.7 and 5.3.8); and (3) through improved control over the driving of DWI offenders (Chapter 5, section 4).

6.2. Research Needs

The 2001 State of Knowledge report listed the specific “knowledge gaps requiring significant research efforts” that Jones and Lacey (2002, p. 154) identified. See Table 6-1 for their list of knowledge gaps.

Table 6-1. Knowledge gaps identified in the 2001 State of Knowledge report

Description
1. Nonfatal alcohol-related crashes.
2. Characteristics of drivers not involved in alcohol-related crashes (i.e., low-risk drivers).
3. Alcohol-related crash risk as a function of biographical and other pertinent variables.
4. The relationship of biographical variables other than age and sex (especially race and ethnicity) to alcohol-related crashes.
5. Data on other variables needed to better define the alcohol-related crash problem (e.g., sociological, economic, and environmental variables).
6. Driving history and its relationship to alcohol-related crashes.

Perhaps the most significant research on nonfatal alcohol-related crashes was repeating the classic Borkenstein Grand Rapids Study by Blomberg and his associates (2005). Many of the crashes in that study were nonfatal, and the data contain much information on both the crash and the noncrash drivers in the control group that provided some insight into the characteristics of low-risk drivers. The information on driver characteristics goes substantially beyond age and gender and will provide a basis for a more detailed description of at risk groups (see Chapter 3). The extensive work of Shope and her associates (Shope et al., 2001c; Bingham & Shope, 2004a) (section 4.3) on the characteristics of teenage drivers at risk for alcohol-related crashes has extended our knowledge of that high-risk group. A major area of research over the last 5 years has been on environmental and economic factors in drinking and impaired driving (see section 5.2). Finally, the interest in the role of drivers with alcohol use disorders, including hardcore drinking drivers, in crashes has lead to considerable study of the relationship of multiple DWI offenses and high BAC levels on crash involvement (section 3.6.3). Thus, the areas needing research identified in the 2001 State of Knowledge report have received some attention in the period between that publication and the current report.

The Committee on Alcohol and Other Drugs of the Transportation Research Board, which published a report on *Research Needs and Priorities* in 2001, developed another list of research needs about the same time. The report contains 16 papers by a group of experts brought together to determine the highest research priority needs. Table 6-2 lists the top 20 of 50 alcohol research priorities considered by that group. Only a limited amount of research has been conducted in those areas since the report was issued. Although there has been great interest in drugs and driving (topic #1), new research has been limited. NHTSA issued a report on that topic in 2003 (Jones, Shinar, & Walsh, 2003), which is beyond the scope of this review. Several studies on the effects of specific deterrent vehicle sanctions (topic #2) have been conducted (Voas & DeYoung, 2002), but the study of other sanctions for DWI offenders has been limited. Sweedler et al. (2004) reviewed the worldwide trends in crashes and fatalities (topic #3). Little work has been undertaken by highway safety

researchers on topics #4 and #5. The interest in topic #6 has mainly focused on first DWI offenders with high BAC levels (.15 g/dL) who are defined as “hardcore” offenders. Several States have passed increased sanctions for such offenders, but research on the effectiveness of such laws is limited (McCartt & Northrup, 2004).

Table 6-2. Rankings of research priorities

Priority	Votes	No. Description
1.	16	D-3. Research on the behavioral and pharmacological impairing effects of drugs.
2.	16	R-2. Determine the extent to which programs and policies have a specific deterrent effect on repeat offenders.
3.	15	G-1. Study global trends in alcohol-related crashes and fatalities.
4.	15	Y-10. What are the drinking patterns and cultures unique to youth? What are the best intervention points?
5.	13	D-1. Develop methodologies and protocols for drugged-driving epidemiology and risk assessment; use the protocols to conduct case studies.
6.	13	R-1. Develop and evaluate a model first-time driving-while-intoxicated offender classification system for assigning interventions.
7.	13	S-1. Determine and understand differences in alcohol-related crash rates across ethnic groups and by gender.
8.	13	Y-6. Will addressing other risky driving behaviors also reduce youth drinking-and-driving crashes, injuries, and fatalities?
9.	12	G-8. Compare the impaired-driving populations on the road, arrested, and in crashes.
10.	12	S-3. Determine how drivers make decisions about drinking and driving.
11.	12	Y-1. What features of zero-tolerance laws are most effective?
12.	10	G-12. Study the etiology, development, and natural history of drinking drivers.
13.	10	R-3. Assess the problem of drivers who do not reinstate their licenses after suspension.
14.	10	Y-4. Relate the age of drinking onset to adult drinking and driving and study whether delaying onset has an effect on later drinking and driving and other alcohol problems.
15.	9	D-2. Develop noninvasive drug detection technology for use in the field.
16.	9	G-3. Study the effects of lower legal BAC limits on crashes, injuries, and fatalities
17.	8	D-5. Explore secondary analysis linking data on drug use and data from traffic crashes, trauma files, DOT drug and alcohol databases for the different modes, criminal justice records (violence), and medical claims.
18.	8	G-11. Study the effects of different alcohol control strategies, including taxes.
19.	8	S-4. Determine the knowledge base of ethnic and gender groups on drinking and driving.
20.	8	Y-3. Determine the most effective minimum drinking age law enforcement strategies.

Excerpt from Table 1, Alcohol and Other Drugs in Transportation. Peck & Helander (2001a; 2001b)

The information on alcohol-related crashes of various ethnic groups (topic #7) remains sparse (see section 4.6). Voas, Tippetts, and Fell (2003b) showed the .08 g/dL BAC limit directed at risky adult drivers (topic #8) reduced the number of underage-drinking drivers in fatal crashes, despite the illegality of their drinking at all. NHTSA has funded a 2007 National Roadside Survey that will speak

to topic #9. Little is known about how drivers make decisions (topic #10). Ferguson, Fields, and Voas (2000) have provided some information on the problems of enforcing zero-tolerance laws, but the most effective features of the law (topic #11) are yet to be determined. Chapter 4 provides some limited information on the etiology of drinking and driving in special groups (topic #12), but much more remains to be learned in this area. NHTSA has funded a large study (Voas et al., 2010) of the failure of DWI offenders to reinstate their licenses (topic #13). Some initial information on that study is provided in Chapter 5. Hingson and his coworkers (Hingson et al., 2002; Hingson et al., 2003) have conducted several studies on the age of drinking onset (topic #14) and alcohol-related problems.

Noninvasive oral fluid collection systems (topic #15) have been developed and will provide a means of collecting information on the 2007 NRS (Lacey & Kelley-Baker, 2004). Fell and Voas (2006b) reviewed the laws providing for lower BAC limits for drivers (topic #16). (As noted above, NHTSA has published a report on drugs and driving [topic #17] that covers this area [Jones et al., 2003]). Although studies of tax policies have been limited (topic #18), much interest has been shown in environmental strategies for reducing alcohol consumption and impaired driving (Gruenewald et al., 2000; Gruenewald & Treno, 2000). An important issue related to the knowledge of alcohol safety laws (topic #19) is acculturation, which is only beginning to be studied (Romano, Tippetts, Blackman, & Voas, 2005). Wagenaar and his coworkers completed a comprehensive study of the effectiveness of police enforcement of laws against sales to minors showing both the effectiveness of enforcement stings and the need for renewed enforcement effort every 3 months (Wagenaar et al., 2005b).

6.2.1. 2001 Status of DWI Countermeasures

Regarding remedies or countermeasures for the impaired-driving problem, Jones and Lacey (2002) noted that—

“While the state of knowledge about ways of dealing with the alcohol-crash problem has grown enormously since the first comprehensive report on alcohol and traffic safety, significant knowledge gaps remain. The most glaring of these is the knowledge about the effect of countermeasures that do not rely on the Criminal Justice System. These other countermeasures include approaches focusing on technology, the vehicle, the highway environment, and the more effective control of alcohol consumption. To date, such approaches have either been insufficiently developed, insufficiently evaluated, or both. Two additional areas where significant new knowledge is needed are countermeasures targeted at specific groups of drinking drivers (e.g., groups defined by such variables as race/ethnicity and type of vehicle), and pedestrian countermeasures.” (p. 155)

They list the countermeasures in Table 6-3 as “having strong evidence favoring their effectiveness”:

Table 6-3.
Effective countermeasures from the 2001 State of Knowledge report

Description
1. ALR laws in conjunction with strong public information and education (PI&E) activities and efficient case-processing procedures.
2. Laws reducing the legal BAC limit to .08 g/dL, in conjunction with ALR laws.
For drivers younger than 21—
3. <ul style="list-style-type: none"> • Laws raising the minimum legal drinking age; and • Laws lowering the legal BAC to zero or near zero.
4. Comprehensive changes to State laws accompanied by enhanced media activity to implement those laws.
5. Enforcement of existing DWI laws in general (and sobriety checkpoints in particular) with strong PI&E components.
6. Traditional sanctions using actions against the driver's license.
7. Carefully designed treatment and rehabilitation programs when used in combination with other sanctions.
8. Certain alternative sanctions requiring extended contact with offenders, including intensive supervision probation, electronic monitoring, and sanctioning programs tailored to individual offenders.
9. Removal of an offender's vehicle (or access to it).
10. Alcohol interlocks (while the interlocks are installed).
11. Comprehensive community-based programs.
12. Multi-component pedestrian programs.

The evidence for the effectiveness of ALR laws (item 1) has increased since the 2001 SOK report (Shults et al., 2001; see section 5.3.5). As of March 2006, 41 States had such laws according to the NHTSA Office of Program Development and Delivery. Since the 2001 update, all 50 States have passed .08 g/dL (item 2) and zero-tolerance laws (item 3) applicable to people age 20 and younger. Additional evaluations have demonstrated the effectiveness of those policies (Shults et al., 2001). Research on sobriety checkpoints (item 5) has received substantial attention because of the extensive funding of national and regional high-visibility enforcement efforts by NHTSA (Fell et al., 2003; see section 5.3.8). The traditional license suspension penalty (item 6) has received more study, mainly because of the interest in the failure of DWI offenders to reinstate their licenses when eligible (Tashima & Helander, 1998) (Chapter 5).

Treatment programs for DWI offenders (item 7) have received much attention (Dill & Wells-Parker, 2006; see section 5.4.5). Electronic monitoring systems (item 8) have undergone significant development, providing new methods that are being applied in the criminal justice system (sections 3.2.3 and 3.2.5). Most have not yet been evaluated for their influence on recidivism reduction. There is little new research on vehicle sanctions (item 9); however, the number of States with such laws has recently increased substantially (Voas, McKnight, Falb, & Fell, 2010). The greatest research

evaluation activity in the technology area has centered on vehicle alcohol interlocks (item 10; Marques et al., 2001; see section 5.4.9). Several reports on community alcohol safety programs (item 11) conducted in the 1990s have appeared since the last SOK report (see Chapter 5). There have been no new comprehensive pedestrian programs (item 12) reported in the literature since the last SOK report.

In 2001, the same year NHTSA published the last State of Knowledge update, the American Automobile Association (AAA) Foundation for Traffic Safety issued a report titled *Seeking Additional Solutions*, which listed the recommendations for improvement of DWI laws and programs (Hedlund & McCartt, 2002). The focus of that publication was on improving DWI system operations rather than on passage of new legislation. Since the adoption by the 50 States of .08 g/dL per se, this focus reflects the recent program emphasis on more efficient and effective implementation of existing laws rather than on passing new legislation. This trend is reflected by the series of studies conducted by Robertson and Simpson on the criminal justice system (Robertson & Simpson, 2002a; 2002b; 2002c; Simpson & Robertson, 2001).

The AAA report specifically calls for evaluating “current drunk driving laws” (p. 65). The report notes the difficulties in evaluating laws in the real world under constantly changing conditions. It does not specify which laws are most in need of evaluation, but it underlines the importance of collecting BAC information in the FARS. Unfortunately, the proportion of road users in fatal crashes tested for BAC levels with known results in the FARS file has been reduced in recent years. Based on the current review, however, the evidence for the most important laws—.08 g/dL per se, ALR, and MLDA—appears to be strong. Most in need of further evaluation are enhanced penalties for high-BAC offenders, lower BAC limits for DWI offenders, open-container laws, and sanction alternatives that will motivate DWI offenders to install interlocks.

Several proposals listed in the AAA Foundation paper need more research to confirm their effectiveness. For example, establishing penalties for breath-test refusals is logical and has been shown to reduce refusals (Zwicker et al., 2005), but the overall effect of such laws on offender convictions and recidivism remains to be demonstrated. The AAA Foundation discussion of equipment and training to provide the tools laws enforcement officers need to enforce DWI laws effectively did not mention passive alcohol sensors, which have been shown to improve arrest efficiency significantly at checkpoints but have not been fully tested in highly publicized enforcement programs to determine their value as a deterrent (see section 5.3.9).

In 2003, NHTSA published a report titled *Initiatives to Address Impaired Driving* (www.nhtsa.dot.gov/IPTReports.html, NHTSA, 2003). The report resulted from forming Integrated Project Teams (IPTs) of experts in four specialty areas, one of which was impaired driving. Each team was charged with recommending effective strategies in their assigned area using “comprehensive science and evidence-based analysis” (p. 4). The impaired-driving IPT identified six critical State program countermeasures (see Table 6-4) for State action. These programs involve implementing existing legislation rather than enacting new laws. The first item focuses on checkpoints and the statewide or regional mobilizations supported by NHTSA-funded public information programs. One response to those programs is implementing low-staff checkpoints, which can be mounted by smaller communities and have been shown to reduce crashes effectively (Stuster & Blowers, 1995; Lacey et al., 2006). Specialized DWI courts (Breckenridge et al., 2000) are receiving increased research attention, but the information available is limited (Chapter 5). The one alternative sanction that has received extensive research attention over the last 5 years is interlock programs (Chapter 5).

Table 6-4.

Countermeasure needs

Six critical State program countermeasures are identified for State action.

1. High-visibility law enforcement
 2. Specialized DWI courts
 3. DWI prosecutors
 4. Increased efficiency of offender processing
 5. Strong ABC policy and enforcement
 6. Alternative sanctions/limitations on pre-conviction diversion program
-

Source: NHTSA (2003)

In summary, articles published since the last State of Knowledge report on the effectiveness of countermeasures and needed research have mostly focused on procedures for making the legislation in existence at the turn of the century more effective, rather than on proposals for enhanced legislation. An interesting omission in most of the summary reports reviewed in this chapter is the absence of commentary on GDL programs, which have demonstrated great promise (Baker et al., 2006). Chapter 5 contains a fuller discussion of GDL programs. Considering that a Congressional act required States to implement zero-tolerance laws and all 50 States have complied, there has been rather little research on the effectiveness of that law and the methods for enforcing it efficiently (see Chapter 5). The widely imposed laws providing for enhanced severity of penalties for high-level BAC drivers have yet to be adequately evaluated, particularly given the questions on the significance of arrest BAC to future recidivism (see section 5.3.5). The potentially promising laws providing for lower legal BAC limits for convicted DWI offenders have not been adopted by a sufficient number of States to provide a basis for an effectiveness evaluation.

6.2.2. Current Status of Research on DWI Countermeasures

In March 2006, NHTSA's Office of Program Delivery released the status of key highway safety legislation in the 50 States. All 50 States have enacted .08 g/dL laws, mostly during the first 4 years of the new millennium. Although not shown in the table, most States have also passed GDL laws; only 5 States are without such laws. In contrast, there appears to have been no progress in implementing ALR laws since the turn of the century. Nine States still do not have ALR legislation. Importantly, considering the evidence for the effectiveness of sobriety checkpoints (Stuster & Blowers, 1995), 11 States have legislation that prohibits their use. NHTSA guidelines call for the use of saturation patrols by localities where checkpoints are not legal. Although evidence shows that such patrols increase the number of DWI arrests, the evidence showing reduction of alcohol-related crashes is limited (Voas & Hause, 1987; Stuster & Blowers, 1995). Further, little research has been conducted of patrol methodologies and publicity procedures to enhance the effectiveness of saturation patrols. Fewer than half the States have passed primary seat belt laws, which have implications for alcohol safety as impaired drivers are less likely to buckle their seat belts and are more likely to be injured in crashes. The one study showing a relationship between primary seat belt laws and impaired-driving crashes (Voas et al., 2007a) is in need of replication.

6.2.3. Prevention of risky drinking

The first section of Chapter 5, which covers the research on primary prevention, deals mostly with programs directed at reducing heavy drinking, especially in situations that lead to impaired

driving. There is substantial evidence that raising the price of alcohol through excise taxes or other means reduces consumption and alcohol-related crashes, particularly among underage drinkers. Laws that limit the number of alcohol outlets, such as State monopoly of sales, or restrict the times or locations where alcohol can be sold also reduce consumption and alcohol-related crashes. The evidence for the effectiveness of responsible beverage service programs is more questionable and is limited to reductions in drinking by bar patrons (Shults et al., 2001). The one study that indicated a statewide influence over server training (Holder & Wagenaar, 1994) was contradicted by another study that showed no evidence of server training influence (Molof & Kimball, 1994). Strong enforcement of ABC laws against service to the obviously intoxicated appears to produce effective responsible beverage service programs (McKnight & Streff, 1994). The designated-driver concept has received much public attention and some encouragement from research studies. Nonetheless, Ditter and his colleagues' (2005) review of the evidence for the effectiveness of the designated-driver concept found it insufficient.

One of the most active fields of investigation since the last update has been the study and evaluation of screening and brief intervention procedures that are being implemented primarily in medical service facilities, emergency rooms, and trauma facilities. There is research evidence for the effectiveness of brief interventions in reducing risky drinking. The evidence for their effectiveness in reducing impaired driving and alcohol-related crashes is more limited (for more information on Alcohol Screening and Brief Interventions, see the *Special Report on Screening and Brief Intervention for Alcohol Problems: A Community Approach to Improving Traffic Safety*).

6.2.4. Underage Drinking and Impaired Driving

There is strong agreement that MLDA laws effectively reduce underage drinking and driving (Shults et al., 2001), but enforcing underage-drinking laws varies substantially among States. Wagenaar et al. (2005a) demonstrated that police decoy operations using underage officers who try to buy alcohol can substantially reduce sales to minors, but deterrence produced by such operations fades after 3 months. The effects of other types of enforcement operations are not as well documented. There is also substantial evidence for the effectiveness of zero-tolerance laws (Shults et al., 2001; Voas et al., 2003b); however, enforcement of the laws has been complicated by some conflicting elements of the laws as enacted by the States (Ferguson et al., 2000). As noted in section 5.3.1, school programs have generally not resulted in behavioral changes.

6.2.5. Impaired Driving Laws

Although .08 g/dL and zero-tolerance laws have been proven to be effective (Shults et al., 2001; 2002) and have been enacted by all the States and the District of Columbia, the current issue regarding those laws is the extent to which States and communities choose to enforce them. There have been many research studies on DWI enforcement (section 5.3.8); however, more work on enforcement methods is needed to develop more effective low-cost, high-visibility programs that can be more readily carried out by local police agencies. Yet to be achieved is the passage of ALR laws, which have been proven to be effective, by all 50 States (Wagenaar et al., 2007; Voas et al., 2003b). As of 2006, nine States still did not have ALR laws (Hedlund, 2006). Although they appear to hold some promise, several laws that have been passed in a few States have not yet been shown to reduce alcohol-related crashes. For example, Zwicker et al. (2005) provided evidence showing that increased penalties for refusal to take a BAC test reduces the number of DWI suspects who refuse the test; however, it has yet to be proved that this results in reduced alcohol-related crashes. Similarly, as noted

in section 5.3.5, both the laws providing for more severe penalties for offenders with high BAC levels and the laws banning open-containers in vehicles have received little research attention. The extent of their effectiveness is therefore uncertain. The extensive surveys of the DWI criminal justice system (Robertson & Simpson, 2002a; 2002b; 2002c; Simpson & Robertson, 2001) suggest the laws in most States need to be simplified and better organized. Although this appears to be logical, research studies showing the effectiveness of such reorganization are lacking.

6.2.6. Law Enforcement

Most of the national current effort in the DWI program area is on implementation of high-visibility enforcement efforts at the State and regional levels. Evidence for the effectiveness of checkpoints is extensive (Elder et al., 2002); however, as noted in Chapter 5, they are underused by the States, and especially by the local police department, because of the concern that they require substantial staffing and resources but result in few arrests. The review in section 5.3.8 of the Stockton DWI enforcement program (Voas & Hause, 1987) indicates that saturation patrols can substantially reduce impaired driving and alcohol-related crashes. As noted in Chapter 5, the study by Voas et al. (2007a) on the effect of primary seat belt laws on alcohol-related crashes provides more evidence of the potential for combined enforcement efforts. There is strong evidence that passive alcohol sensors increase the detection of impaired drivers at checkpoints (Ferguson et al., 1995), but unfortunately, passive sensors have been used too rarely to discover their effect on alcohol-related crashes. Both PBTs and passive sensors assist officers in detecting impaired drivers. PBTs are much more widely used. Further, there is evidence that they increase the number of DWI arrests made by officers who are equipped with them. The evidence suggests that passive sensors are most effective when used at checkpoints where they can increase arrests by up to 50% (Ferguson et al., 1995).

6.2.7. Prosecution/Adjudication

Among the traditional penalties for the DWI offense—license suspension, fines, and jail—there is strong evidence for the effectiveness of license suspension in reducing recidivism and alcohol-related crashes of DWI offenders (Peck, 1991; see also Chapter 5). The effectiveness of license suspension has been eroded by the limitations imposed on the police in their enforcement of laws against DWS (Chapter 5). Wagenaar et al. (2007) reviewed 39 research reports on fines and jail sanctions from 1992 to 2006. They reported that only 6 of the 19 studies that evaluated fines showed a relationship of such sanctions to drinking or impaired driving. Wagenaar et al. concluded that fines may deter impaired driving and reduce crashes. This evidence was strengthened by their own study of fine-related policies in 26 States between 1976 and 2002, in which they found that six States showed significant declines in SVN crashes when mandatory fines were imposed. Safety experts have opposed diversion programs that result in expunging the DWI offense from the driver's record, thus allowing a less serious charge on the offender's record. As noted in Chapter 5, plea agreements that result in less severe penalties are required to handle overloaded court dockets, yet little is known about the effect of reduced penalties on crashes or recidivism.

Jail is a sanction that is much more difficult to evaluate because of the complex role it plays in both general (reducing impaired driving by the public) and special (reducing recidivism of DWI offenders) deterrence (Chapter 5). Particularly complex is the role of jail in the sanction of DWI offenders because it is the threat behind every court sanction. Failure to follow the court's probation requirements can be punished by imprisonment, so, independent of its direct effect on recidivism and or crashes through its incapacitating effect, it is important to keep jail as a sanction to reinforce other

measures, such as treatment program requirements and house arrest or interlock programs. In the Wagenaar et al. (2007) review, they identified 20 studies of the jail sanction between 1991 and 2006. Only two of those reported decreases in traffic fatalities, whereas five similar studies failed to show a relationship to fatalities. Their own study of 18 States, which imposed minimum jail penalties between 1976 and 2002, found five States with decreases and two with significant increases in SVN crashes. They concluded the evidence for the effectiveness of mandatory jail penalties was weak.

6.2.8. Treatment, Monitoring, and Control of Offenders

Treatment programs have been shown to reduce DWI offender recidivism and alcohol-related crashes, particularly when combined with other sanctions (Wells-Parker et al., 1995). As might be expected, however, treatment chiefly affects alcohol-related crashes rather than non-alcohol-related crashes that are primarily a function of the extent of driving exposure (McKnight & Voas, 1991; Sadler et al., 1991). As noted by Hedlund, offender monitoring includes several types of programs (including intensive probation supervision) and is an element in DWI courts and interlock programs, which are receiving increased attention. DWI courts, which have derived from the apparent success of drug courts, are just beginning to be fully evaluated (see Chapter 5). Among sanctions for repeat offenders, ignition interlock programs have received the greatest research attention (see 5.4.9), and the effectiveness of this device while on the offender's vehicle is well established (Willis et al., 2004). To date, however, only about 10% of the eligible offenders have been motivated to install interlocks (Beirness & Marques, 2004; Voas & Marques, 2003a). A summary of the status of vehicle sanctions as of 2004 was due for publication by NHTSA in 2007. The most widely used vehicle sanction is impoundment, but the most promising may be license plate confiscation as it avoids court hearings and the potential cost to the community of long-term storage of vehicles if offenders fail to retrieve them (see section 5.4.9). Studies of Maine's law providing for lower BAC limits for repeat DWI offenders suggest that such laws can be effective (Hingson, Heeren, & Winter, 1998), but more research is needed and this sanction has not been widely adopted or evaluated.

6.3. Looking Ahead

Although public attention to impaired driving has declined since its peak in the 1980s and 1990s, government support for traffic safety research and safety demonstration programs has continued to increase, but certainly not commensurate with the magnitude of the problem. What we know about alcohol safety laws and programs suggests considerable room for revising and strengthening current State and community efforts to reduce impaired driving. Progress in understanding the drinking-and-driving problem, combined with development of new technologies, is offering opportunities to resume the decline of alcohol-related crashes nationwide, which stagnated in 1995. The most promising of these opportunities for future progress in alcohol and highway safety, based on the research reviewed in this document, are described in the following paragraphs.

6.3.1. Primary Prevention: Reducing Risky Drinking

Except for the studies on the effect of raising the MLDA to 21, traffic safety researchers have mostly neglected the opportunities to reduce impaired driving by reducing risky drinking. Recent research suggests, however, at least two areas that merit more attention both by researchers and policy advocates. These areas potentially influence drinking, leading to impaired driving. A third area,

Screening and Brief Interventions, is addressed in a separate report (See *Special Report on Screening and Brief Intervention for Alcohol Problems: A Community Approach to Improving Traffic Safety*).

6.3.1.1. Problems Related to Early Onset of Drinking

Studies by Grant and Dawson (1997) and by Hingson et al. (2002) of individuals who began regular alcohol consumption in their early teens have indicated that they are at high risk of becoming alcohol-dependent and of being involved in alcohol-related crashes. The risk presented by early-onset drinkers has been supported by the studies of brain development, indicating that brain cells continue to grow and differentiate into the early twenties (NIMH, 2001). Further, some studies suggest that heavy teen drinkers suffer structural impairment of memory and other skills (Brown et al., 2000). Despite growing evidence of the risks associated with underage drinking, especially by pre-high-school youths, many parents continue to treat youthful drinking that does not appear to lead to immediate problems as a minor concern. Some parents even serve alcohol in the home, rationalizing that it is better to have their children drink under their supervision than illicitly outside their homes. This attitude has led to an inability to motivate parents to monitor their children's drinking and to participate in school and community anticonsumption programs and to support MLDA enforcement efforts. The growing understanding of the risk of underage drinking, and pre-high-school drinking in particular, may provoke new attention and energy to underage drinking. If so, this new attitude may spark new interest in school-based K-12 programs that have generally been ineffective in reducing consumption without parental participation.

6.3.1.2. MLDA Enforcement

The work of Wagenaar and associates (2005a; 2005b) has demonstrated that off-site sales to minors can be substantially reduced through decoy enforcement programs. Their studies have even demonstrated the frequency of enforcement operations required to maintain the reduction in sales. Their model for enforcement policy can be applied in communities willing to commit the resources required to enforce the MLDA law. This provides an important opportunity in the future for policymakers to decrease alcohol availability to those age 20 and younger.

6.3.2. Secondary Prevention

Deterring from driving those drinkers who consume risky amounts of alcohol remains a difficult problem. Most States have had key legislation—per se laws, ALR laws, zero-tolerance laws, and .08 g/dL limit laws—for some time, yet impaired-driver fatalities have not decreased significantly in the last decade. This suggests that enforcement, rather than legislation, will offer greater opportunities for further reductions in impaired driving. Research suggests, however, that two general deterrence legislative initiatives have some potential for reducing alcohol-related driver fatalities, as does strengthening enforcement efforts.

6.3.2.1. Graduated Driver Licensing for Novice Drivers

The high rate of crashes by novice drivers in the first few months of driving has led to developing staged entry into full license status that has effectively reduced driver fatalities among 16- and 17-year-olds (see section 5.3.1). Substantial evidence indicates that this licensing system, which has yet to be adopted by all 50 States, is effective in reducing all types of crashes, including alcohol-related crashes (Chen et al., 2006). The growing evidence for the effectiveness of GDL should

stimulate States to pass a GDL law or extend their current law if it does not contain all the recommended elements leading to increased benefits in the future. To obtain maximum effectiveness, GDL laws rely on parental supervision. Research is needed to determine how to persuade parents to become more active in GDL programs.

6.3.2.2. Lowering the Legal Limit to .05

There is strong evidence that lowering the legal BAC limit reduces alcohol-related fatalities (Fell & Voas, 2006a). This was demonstrated by the success of the recent movement to reduce the limit to .08 g/dL, which reduced alcohol-related fatal crashes by 7% (Shults et al., 2001). Further lowering of States' BAC limits appears to be unlikely in the near future.

6.3.2.3. Increased Use of High-Visibility Enforcement

Current efforts to reduce impaired driving focus on periodic State and national mobilizations stressing high-visibility enforcement and paid media. This activity has had some success (see section 5.3.8) that will undoubtedly continue in the future. Overall, however, national alcohol-related fatal crashes have not declined significantly since 1995, suggesting either more effort on general deterrence or developing novel methods for increasing general deterrence. Two programs appear to have promise: community efforts to enforce impaired-driving laws and laws against service to underage drinkers, and mini-checkpoints (checkpoints with fewer officers).

Effective DWI enforcement programs require great support for the police department by both the community and the local government. As described in section 5.3.12 under community programs, providing the services demanded by residents in the police departments' jurisdictions has stretched their resources to the limit. A local consortium or organization of concerned people can influence the allocation of resources to the impaired-driving problem and help the department obtain adequate funding for an enhanced enforcement effort. Such a community group can also provide the media advocacy effort that will make the enforcement effort more effective. The basic methods for implementing effective community safety programs have been demonstrated but not widely implemented. Disseminating information about the organization and operation of community safety programs to many jurisdictions in the United States represents an important opportunity to reduce the impaired-driving problem.

There is strong evidence that sobriety checkpoints are effective in reducing alcohol-related fatalities and injuries (Elder et al., 2002; Shults et al., 2001). As discussed in section 5.3.8, however, they are generally viewed by police agencies as requiring a large police staff and yielding few arrests, despite evidence to the contrary (Stuster & Blowers, 1995; Voas et al., 1985). There has been increasing interest in encouraging police departments to run checkpoints with fewer officers and conduct checkpoint operations regularly (at least once a month) (Lacey et al., 2006; Neil, 2006, Spring). Small checkpoints conducted more often, enhanced by the use of passive sensors and the mobilization of community activists to help publicize the effort, can increase the detection of over-the-limit drivers by 50%. Research evidence suggests combining those elements implemented in communities across the country could have a major influence on impaired driving (Lacey, Ferguson, Kelley-Baker, & Rider, 2005, March; NHTSA, 2006).

6.3.3. Tertiary Prevention

Although treatment remains the key to recovery from alcohol abuse problems that underlie impaired driving, the most promising recent research has focused on methods that keep offenders from driving while impaired. These methods include vehicle impoundment, alcohol ignition interlocks, and monitoring of alcohol consumption through intensive probation surveillance or technologically through alcohol monitoring systems based on transdermal alcohol sensing.

6.3.3.1. Vehicle Sanctions

As discussed in section 5.4.9 vehicle impoundment legislation as a sanction for DWI and DWS offenders has effectively reduced recidivism and crash involvements (Voas & DeYoung, 2002). The number of States with vehicle sanction laws has grown in recent years, so this sanction may be more widely used in the future. Seizing vehicles driven by offenders, however, can involve great expense, especially when vehicles are owned by nonoffenders or vehicles are of little value and are not retrieved by the owners (Voas et al., 2008). Seizing the license plate may overcome those limitations because it does not involve a court action (Hedlund, 2006). So far, plate seizure has only been evaluated in Minnesota (Rodgers, 1994). If additional evaluation confirms its effectiveness, plate seizure may provide a low-cost method for reducing recidivism, and it can be imposed upon arrest.

6.3.3.2. Alcohol Ignition Interlocks

There is ample evidence that ignition interlocks are effective in reducing recidivism *while on the offender's vehicle* (see section 5.4.9). This resulted in 40 States passing interlock laws by 2006. As of now, however, less than 10% of the DWI offenders, eligible under those laws, have installed interlocks because of several problems. Many offenders either do not have a vehicle or claim not to own a vehicle; others are unable to pay the \$2 cost per day of the interlock program; judges are reluctant to use the interlock sanction because of the burden on other family members who use the vehicle. Evidence suggests that it will be necessary to threaten to impose a less desirable sanction, such as house arrest, as the alternative to the interlock to motivate eligible offenders to install the units (Voas et al., 2002a). If the low rate of participation in the interlock program can be overcome, this technology shows promise for producing a large drop in DWI recidivism. Several features recommend it over the more traditional sanctions. It allows offenders and their family members to use the vehicle for employment and household needs. The interlock breath-test record system provides information for treatment programs and for recidivism, which can be used to decide when the offender should be allowed to remove the interlock (Marques, Voas, Timken, & Field, 2005).

6.3.3.3. BAC Monitoring

Traditionally, alcohol consumption has been monitored through breath or urine tests. During the last decade, methods have been developed for measuring the approximately 1% of ingested alcohol that is lost through the skin. This has opened the possibility of continuous monitoring of drinking, 24/7 (Swift, 2003; also see section 3.2.3). One such device—the SCRAM™—is already used with more than 1,000 offenders in the United States and Canada. Currently, the technology is expensive, and although tested in the laboratory setting (Marques & McKnight, 2007), it has not been tested in a field setting. Devices of this type can potentially keep DWI offenders from driving while impaired, yet minimally affect their employment or their families. These devices also provide

recorded data that can be used by treatment providers in their intervention programs with the offenders.

6.3.3.4. Emerging Technologies

New technological developments promise vehicle systems that may eventually make driving while alcohol-impaired rare. A recent NHTSA report to Congress reviewed these technologies. The allure of such a possibility is likely to stimulate research in advanced technology for detecting alcohol in the environment and in the body, with the related technology of how such devices can be integrated with the vehicle.

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