



PACIFIC INSTITUTE FOR RESEARCH AND EVALUATION

# Scientific Evidence for Developing a Local Logic Model On Alcohol- Related Motor Vehicle Crashes

A Reference Guide for Community  
Environmental Prevention

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Scientific Evidence for Developing a Local Logic Model  
On Alcohol-Related Motor Vehicle Crashes: A Reference  
Guide for Community Environmental Prevention

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# Executive Summary

The trauma caused by drinking and driving is a major concern for communities especially given the number of deaths or injuries caused, as well as the costs in health care and property damages. Therefore, reduction of alcohol-related motor vehicle crashes is a primary goal of prevention. That outcome can be achieved by environmental prevention strategies.

The National Highway Traffic Safety Administration (NHTSA) reported a total of 5.5 million motor vehicle traffic crashes in the United States in 2009, including 30,797 fatal traffic crashes.<sup>1</sup> A total of 33,808 individuals were killed and over 2.2 million were injured, including vehicle occupants, motorcyclists, pedestrians and other non-motorists.

Approximately 32 percent of the fatal crashes involved alcohol-impaired driving. Of the fatal crashes occurring between midnight and 3 a.m., 66 percent involved alcohol-impaired driving. In summary, almost 11,000 people died from alcohol-related crashes in 2009.

For a local environmental prevention effort that wishes to reduce alcohol-related motor vehicle crashes, the best science must be utilized. To be highly effective, those factors that science has shown to be most related to alcohol-related motor vehicle crashes at the population level should be addressed. Here, such factors are defined as *intermediate variables* that research has demonstrated as significant contributors to driving after drinking and related crashes.

This executive summary supports local strategic environmental prevention planning using a logic model. The purpose is to identify those intermediate variables and strategies that have the potential to be effective in any community environmental prevention effort to reduce alcohol-related motor vehicle crashes and resulting injuries and deaths.

The figure below identifies the key intermediate variables involved in alcohol-related motor vehicles crashes as identified by science. In this figure, **Drinking** is associated with **Alcohol-Related Motor Vehicle Crashes** through the intermediate variable of **Driving After Drinking**. In other words, as drinking increases, the risk of driving after drinking can increase and result in an alcohol-related motor vehicle crash.

“Alcohol can affect motor skills, sense of balance, visual acuity, and reasoning. The level of impairment caused by alcohol varies, particularly at low levels of blood-alcohol concentration (BAC). However, laboratory tests have demonstrated repeatedly that most people show a lowered performance for response time and technical tasks as their BAC increases, sometimes even with the equivalent of only one drink and impairment will continue as BAC declines. Drinking can therefore increase one’s risk of harm and the potential for harm to others as a result of impaired functioning. Such harm can be immediate, and one does not have to await the end of a long drinking career to die in a drink driving accident.... A primary approach to preventing drinking in conjunction with a risky situation is deterrence.” (Edwards, et al., 1994, p. 153ff)

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1. The NHTSA 2009 National Statistics Report found at: <http://www-nrd.nhtsa.dot.gov/Pubs/811402EE.pdf>

The strength of the relationship between an intermediate variable and **Alcohol-Related Motor Vehicle Crashes** or between intermediate variables is shown by the prominence of the arrows.

- ➡ **Strong Relationship:** Strong evidence of relationship based on three or more studies of population level prevention effects; and/or strong effect on other intermediate variables that have population level prevention effects.
- ➡ **Moderate Relationship:** Strong evidence of the relationship based on one or two studies of population level prevention effects; and/or evidence of moderate effect on other intermediate variables that have population level prevention effects.
- ➡ **Minor Relationship:** Evidence of the relationship with only limited or no evidence of population level prevention effects but some evidence of target group effects.
- ➡ **Logical Relationship:** Theoretical, but no empirical evidence of relationship and/or no evidence of population level prevention effect or target group prevention effects only.

Each intermediate variable is described briefly here including scientific evidence about its contribution to alcohol-related motor vehicle crashes and relationships with other intermediate variables. A summary of published scientific research concerning the variables and strategies can be seen in the complete guide entitled: *Scientific Evidence for Developing a Logic Model on Alcohol-Related Motor Vehicle Crashes: A Reference Guide for Community Environmental Prevention*.

## Intermediate Variable: Price

Price is the cost of alcohol sold by retail outlets. The demand for alcohol, as for many other products, responds both to price and to available income. As alcohol becomes more expensive, consumption decreases. When it becomes less expensive, consumption increases. Similarly, when other factors remain unchanged, an increase in disposable income among consumers leads to an *increase* in consumption, whereas a decrease in income leads to a *decrease* in consumption.

Alcohol price has been linked to heavy drinking and increased risk of harm from heavy drinking. Many investigators have examined the association between alcohol beverage prices and alcohol-associated problems, including drinking-and-driving and crime, and the clear consensus is that they are inversely related (see recent review of research by Babor, et al, 2010).

## Intermediate Variable: Alcohol Serving & Sales Practices

**Alcohol Serving and Sales Practices** refers to the ways in which alcohol is served to customers in licensed on-premise establishments and the sales practices in off-premise establishments. This intermediate variable has been documented as having an effect on high-volume drinking for customers obtaining alcohol from licensed establishments. Therefore,

**Alcohol sales and serving practices** has a strong relationship to the intermediate variable **Drinking**.

## Intermediate Variable: Retail Availability

**Retail availability** is the level of access or convenience for individuals to obtain alcohol independent of the cost of alcohol. In general, when 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 the rates of alcohol problems are lower. Retail availability can be affected by license restrictions, hours of sale, minimum age of purchaser, and alcohol outlet density (distance to a retail outlet). These factors are shaped by state and local regulations that determine the number, location, types, and serving-and-selling practices of alcohol retailers. How states and localities regulate retail availability varies considerably. Some are very restrictive, whereas others have only limited controls. In the figure **Retail Availability** has a strong relationship to **Drinking**.

## Intermediate Variable: Alcohol Sales and Service Regulations, Enforcement and Sanctions

Regulations are the formal laws, rules, and standards that govern alcohol distribution, as well as sales and 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 for drinking and driving. 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. An example of *informal enforcement* is community members being unwilling to patronize stores that sell alcohol to minors. **Alcohol Sales & Service Regulations, Enforcement & Sanctions** has a strong relationship to both **Alcohol Serving & Sales Practices** and **Retail Availability**.

## Intermediate Variable: Perceived Risk of DUI Arrest

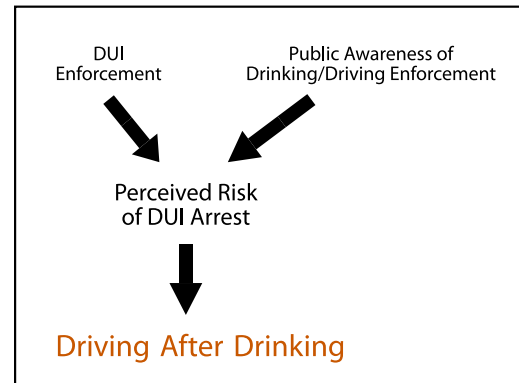
An individual who has been drinking has a belief or perception of how likely s/he might be detected by the police and arrested for driving under the influence (DUI) of alcohol. This expectation is one factor affecting her/his decision to drive after drinking. In the figure the intermediate variable is called **Perceived risk of DUI arrest**. Changes in the **Perceived Risk of DUI Arrest** have been confirmed as a result of the relationships in combination with **DUI Enforcement** and **Public Awareness of Drinking-Driving Enforcement**. While there are other factors influencing drinking-and-driving behavior, **Perceived Risk of DUI Arrest** is the key intermediate variable that can be directly influenced by an enforcement program (i.e., the greater the perception of risk, the fewer driving-after-drinking events) and directly affect **Drinking After Driving**.

## Intermediate Variable: DUI Enforcement

**DUI enforcement** refers to the level of enforcement used to detect drivers who are legally intoxicated (i.e., driving under the influence of alcohol). The level of legal intoxication is defined by the law as a specific level of blood alcohol concentration (BAC). Any driver with a measured BAC equal to or higher than this defined level is considered intoxicated and can be arrested for DUI.



The goal of DUI enforcement is to reduce the number of persons who drink and then drive, thereby reducing automotive crashes and fatalities. One way to do this is to remove impaired drivers from the roadways and punish them to deter similar occurrences in the future. The effectiveness of **DUI Enforcement** on **Alcohol-Related Motor Vehicle Crashes** has been demonstrated where increased DUI enforcement substantially decreased such crashes. A strong relationship between **DUI Enforcement** and **Perceived Risk of DUI Arrest** has been established by a number of studies.



## Intermediate Variable: Public Awareness of Drinking/Driving Enforcement

**Public awareness of drinking-and-driving enforcement** is the level of public attention given to DUI enforcement. While it does not influence alcohol-related motor vehicle crashes directly, **Public awareness of drinking-and-driving enforcement**, instead, works in conjunction with actual increases in **DUI Enforcement** to increase **Perceived Risk of DUI Arrest**.

## Intermediate Variable: Community Activism about DUI Enforcement

**Community Activism about DUI Enforcement** refers to organized action by community members and/or organizations to produce changes in drinking-and-driving policy and activity within the community and to support desired policies. As with most intermediate variables, **community activism about DUI enforcement** does not affect **alcohol-related motor vehicle crashes** directly, but rather works through **DUI enforcement** and **perceived risk of DUI arrest**. Community activism is an important factor in generating support and resources for **DUI Enforcement**. Increased community activism and mobilization help increase support for DUI enforcement.

## Intermediate Variable: Community Norms about Drinking and Driving

**Community Norms about Drinking and Driving** refers to the level of acceptability (or unacceptability) of drinking in general, as well as the level 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 herein 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 are unlikely. Powerful and complex values have developed around alcohol with related norms regarding when, where, and how alcohol use is appropriate and desirable. Some of these values and norms are part of the broader culture; others can exist on a smaller scale—within a given community, social group, or subculture. While there is little empirical evidence to relate **Community Norm about Drinking and Driving** to **Public Awareness of Drinking/Driving Enforcement**, there is a logical relationship between the two as shown on the logic model.

As the table below shows, environmental prevention strategies exist that have been shown by science to effect or have the potential to effect one or more of these intermediate variables. Each strategy is coded according to existing evidence of effects.

The relative strength of a strategy's effects on **Alcohol-Related Motor Vehicle Crashes, Drinking, or Driving after Drinking**, or other key intermediate variables is indicated by the number of stars given:

★★★ **Strong effect** (3 or more studies demonstrating effect)

★★ **Moderate effect** (1-2 studies demonstrating effect)

★ **Weak** (3 or more studies) **or Unknown effect** (insufficient research to date)

### Summary of Drinking Intermediate Variables and Related Strategies

INTERMEDIATE VARIABLES	STRATEGIES
Drinking	Dram shop liability laws *** Hours and days of sale *** note one more star Responsible beverage service programs *** Minimum drinking age *** Zero tolerance laws *** also here Alcohol policies at schools & universities * Restrictions on price promotion & alcohol discounts * Minimum purchase age law enforcement ** Alcohol law possession **
Alcohol Sales & Service Regulations, Enforcement & Sanctions	Legal liability concerning alcohol sales & service to youth ** Retail price controls **
Alcohol Serving & Sales Practices	Responsible beverage service programs *** Dram shop liability laws *** Legal liability concerning alcohol sales & service to youth ** Restrictions on price promotion & alcohol discounts *
Price	Increase in alcohol taxes *** Retail price controls **
Retail Availability	Responsible beverage service programs *** Densities or Concentrations of Retail Outlets ** Hours and Days of Sale *** Liquor by the Drink *** Types of Retail Outlets *** State Retail Monopolies ***

INTERMEDIATE VARIABLES	STRATEGIES
Driving after drinking	Low BAC limits for young drivers *** Lower BAC limits for all drivers *** License suspension/revocation *** Victim impact panels * Traffic safety education for DUI offenders ** Traffic safety education for young or inexperienced drivers * Driver license age restrictions *** Interlock devices *** Administrative license revocation *** Media awareness programs ** Prevention and education programs *
DUI Enforcement	Administrative license revocation *** Frequency of punishment ** Swiftmess of punishment *** Severity of punishment ** Random breath testing *** Sobriety checkpoints ***
Public Awareness of Drinking/ Driving Enforcement	Local news coverage of DUI enforcement ***
Community Norms – Drinking & Driving	Media Awareness Programs *
Community Activism about DUI Enforcement	Community activism and mobilization *** Community coalitions to prevent drunk driving **
Perceived risk of DUI arrest	Local news coverage of DUI enforcement *** Frequency of punishment ** Severity of punishment ** Random breath testing *** Sobriety checkpoints *** Administrative license revocation ***

The strategies listed are ones with most potential for effect. Communities are encouraged to select the strategies with the highest number of stars. Communities will also recognize those strategies that are already in operation in the community. Each strategy is briefly described below according to the strength of effect on **Alcohol-Related Motor Vehicle Crashes**. For more detailed information, refer to the complete guide: [Scientific Evidence for Developing a Local Logic Model On Alcohol-Related Motor Vehicle Crashes: A Reference Guide for Community Environmental Prevention](#).

This Executive Summary provides recommendations for including key intermediate variables and prevention strategies in developing a local strategic plan utilizing a logic model. See Babor, et al. (2010) for a summary of environmental policy research.

## References

Babor, Thomas, et al. (2010), *Alcohol: No Ordinary Commodity: Research and Public Policy*, Second Edition, Substantially Revised. New York: Oxford University Press.

# I. Alcohol-Related Motor Vehicle Crashes

Alcohol-related motor vehicle crashes include any traffic crash in which at least one driver had been drinking before the crash and that may involve a pedestrian, bicyclist or other non-motorist who may or may not have been drinking before the crash.

The basic causal model of alcohol-related motor vehicle crashes is:

**Drinking → Driving After Drinking → Alcohol-Related Motor Vehicle Crashes**

In this model, **Drinking** is associated with **Alcohol-Related Motor Vehicle Crashes** through the intermediate variable **Driving After Drinking**. In other words, as drinking increases, the risk of drinking and driving can increase and result in an alcohol-related motor vehicle crash.

Scientific research has shown that the only way a community can effectively reduce alcohol-related motor vehicle crashes is to impact the intermediate variables involved in such crashes.

Intervention strategies do not affect such problems directly. They can alter intermediate variables. Measuring changes in intermediate variables as a result of such strategies is essential to evaluation and environmental prevention monitoring by the local community.

**Intermediate variables** are factors that directly or in combination impact outcomes.

**Intervention strategies** are used to change intermediate variables in order to reduce alcohol, tobacco and other drug problems.

A community can address a number of intermediate variables to affect alcohol-related motor vehicle crashes. Key intermediate variables (having a strong effect on crashes) include:

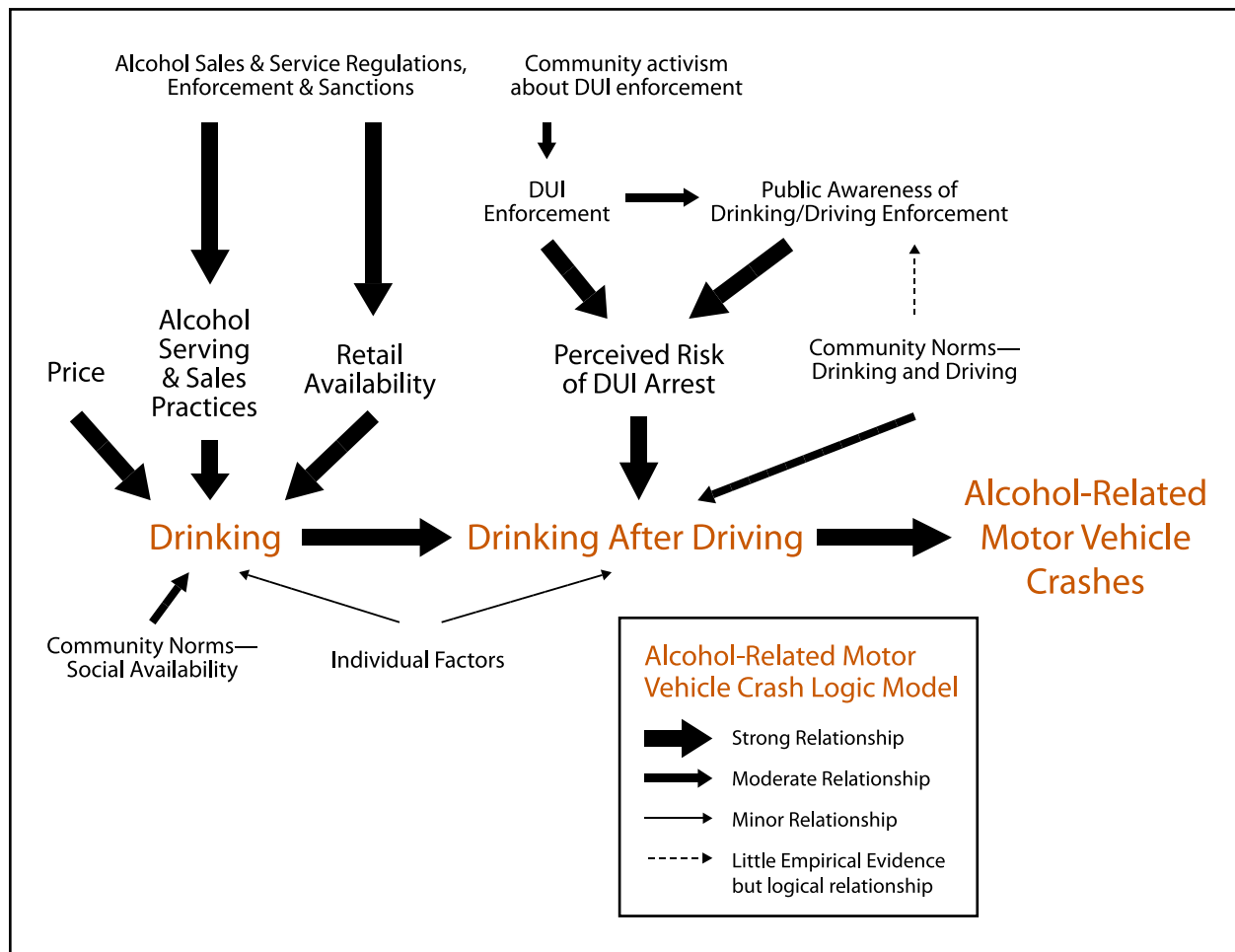
- **Driving after Drinking related to:**
  - Perceived Risk of DUI Arrest
  - DUI Enforcement
  - Public Awareness of Drinking/Driving Enforcement
- **Drinking as related to:**
  - Retail Alcohol Availability
  - Alcohol Serving and Sales Practices
  - Alcohol Sales & Service Regulations, Enforcement & Sanctions
  - Price

Other intermediate variables (having moderate or minor effects on crashes) include:

- Community activism about DUI enforcement
- Community norms about drinking and driving
- Community norms about social availability
- Individual factors

Figure 1 illustrates the relationships among these intermediate variables as confirmed by science.

**Figure 1. Alcohol-Related Motor Vehicle Crashes: A Logic Model**



Scientific studies demonstrate how these variables interact to produce the problem and provide evidence of intervention strategies that affect the overall outcome of reducing alcohol-related motor vehicle crashes.<sup>1</sup>

This guide is organized into two sections: (1) Driving after Drinking and (2) Drinking. For each there is a summary of the scientific evidence about the relationships among the intermediate vari-

1. A full discussion of the research can be found at [www.pire.org](http://www.pire.org), go to the right hand column under Featured Websites and select Logic Models for the Prevention of Alcohol, Tobacco and Other Drug Problems. Scroll down to find links to documents on these topics.

ables and a description of each prevention intervention and its effectiveness in reducing alcohol-related motor vehicle crashes.

## A. Definitions of the Intermediate Variables

INTERMEDIATE VARIABLE	DEFINITION
Alcohol-related motor vehicle crash	The outcome to be affected by prevention environmental strategies. Any traffic crash in which at least one driver had been drinking before the crash and that may involve a pedestrian, bicyclist or other non-motorist who may or may not have been drinking before the crash.
Alcohol Sales & Service Regulations, Enforcement & Sanctions	Regulations are the formal laws, rules, and standards that govern alcohol distribution, as well as sales and 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 for drinking and driving.
Alcohol Serving & Sales Practices	Ways in which alcohol is served to customers in licensed on-premise establishments and the sales practices in off-premise establishments.
Community Activism about DUI Enforcement	Organized action by community members and/or organizations to produce changes in drinking-and-driving policy and activity within the community and to support desired policies.
Community Norms – Drinking & Driving	The level of acceptability or unacceptability of drinking and driving; the informal standards that have the potential to influence individual decisions about drinking and driving.
Drinking	The consumption of alcohol prior to or concurrent with driving a motor vehicle or walking in traffic as a pedestrian. Since driving involves multiple tasks, the demands of which can change continually, to drive safely one must maintain alertness, make decisions based on ever-changing information present in the environment, and execute maneuvers based on these decisions. Drinking alcohol impairs a wide range of skills necessary for carrying out these tasks.
Driving after drinking	An event in which a driver of a motor vehicle was drinking before or while driving.
DUI Enforcement	The level of enforcement used to detect drivers who are legally intoxicated is defined by the law as a specific level of blood alcohol concentration (BAC). Any driver with a measured BAC equal to or higher than this defined level is considered intoxicated and can be arrested for DUI.
Individual Factors	Attributes of individuals that appear to increase or decrease risk of driving after drinking.
Perceived risk of DUI arrest	The expected likelihood of a driver who has been drinking to be arrested by the police.
Price	The cost of alcohol sold by retail outlets.
Public Awareness of Drinking/ Driving Enforcement	The level of public attention given to DUI enforcement.
Retail Availability	The level of access or convenience for individuals to obtain alcohol independent of the cost of alcohol.

## II. Driving After Drinking

The causal relationship between **Driving After Drinking** and **Alcohol-Related Motor Vehicle Crashes** has been confirmed by Voas, Holder, and Gruenewald (1997). When American drivers were asked at random about their personal behavior, 24 percent admitted to driving in the past year after having four or more drinks (Berger, Snortum, Homel, Hauge, & Loxley, 1990). Based upon roadside research (breath tests from a random sample of motorists) in the United States, an estimated 5 to 10 percent of drivers during night time leisure hours have moderate to high blood alcohol levels.

The relative crash risk of drivers at a blood alcohol concentration (BAC) of .05 is double the crash risk for a zero-BAC driver. At .08, the risk is multiplied by 10; and at .15 or higher, the relative risk is in the hundreds (Borkenstein et al., 1974). The risk curve is even steeper for serious and fatal crashes, for single-vehicle crashes, and for young people (Jonah, 1986; Mayhew et al., 1986).

Alcohol consumption, even at low levels, is also associated with the increased likelihood of being in a fatal crash (Liu & Chen, 2004; NHTSA, 1995b; Blincoe and Faigin, 1992; Miller, Lestina & Spicer, 1998b). However, the likelihood of being involved in a fatal accident increases with higher BAC levels. Individuals with BAC levels of .02 to .04 were 1.4 times more likely to be in a single-vehicle fatal accident. This risk was 11.1 times higher for BACs between .05 and .09, 48 times higher for BACs between .10 and .14, and a staggering 380 times higher for BACs of .15 or over (Zador, 1991).

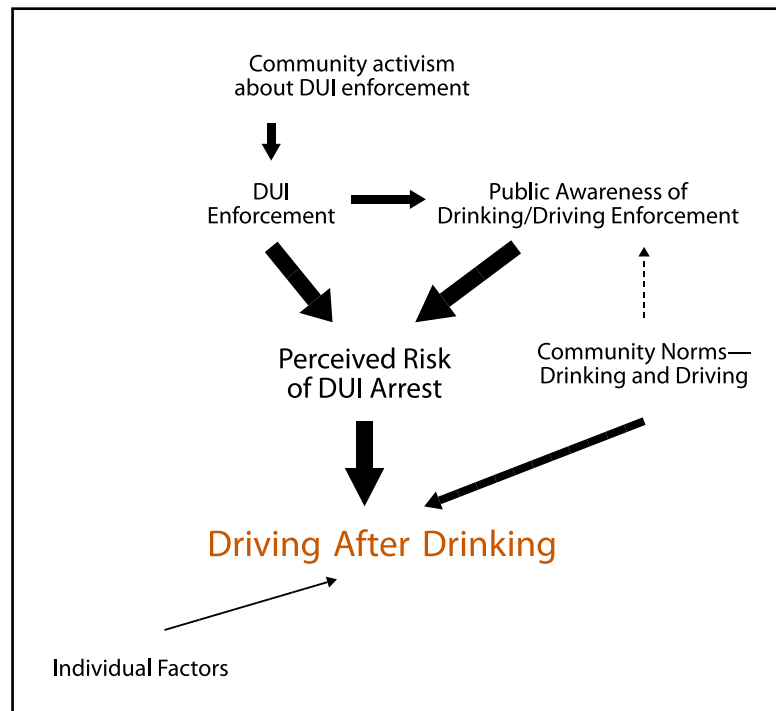
Alcohol has been found to be one of the biggest contributing factors in single vehicle nighttime (SVN) fatal crashes and crashes that occurred between 8 p.m. and 4 a.m., especially on weekends (Ostrom & Eriksson, 1993; Fell & Nash, 1989).

All countries have the problem of hard-core drinking drivers, characterized by persistent heavy drinking before driving. A surprisingly high percentage of these heavy drinking drivers have no prior drinking-and-driving convictions (Ross, 1992).

Young inexperienced drivers are also inexperienced drinkers. Combining the inexperienced drinking with inexperienced driving substantially increases the risk of crash. For young drivers, the association between alcohol use and likelihood of fatal crashes shows an even steeper slope for each increase of .02 BAC. In 1994, almost 7,800 drivers aged 16 through 20 were in fatal motor vehicle crashes (NHTSA, 1995). Of these drivers, for whom drinking any quantity of alcohol is illegal, 23 percent had BACs of .01 or higher, compared with 26% of drivers aged 21 and older. Get updated information!

The logic model shows that **Perceived Risk of DUI Arrest** has a strong relationship to **Driving After Drinking** and therefore with the problem of alcohol-related motor vehicle crashes. Further, **Perceived risk of DUI arrest** is directly related to enforcement of drinking-and-driving laws and public awareness of that enforcement.

The scientific evidence of each of these intermediate variables and their relationships is described in the following paragraphs. The following section describes intervention strategies and the effects of each.



## A. Intermediate Variables

### Intermediate Variable: Perceived Risk of DUI Arrest

An individual who has been drinking has a belief or perception of how likely s/he might be detected by the police and arrested for driving under the influence (DUI) of alcohol. This expectation is one factor affecting her/his decision to drive after drinking. In the logic model the intermediate variable is called **Perceived risk of DUI arrest**.

Changes in the **Perceived Risk of DUI Arrest** have been confirmed as a result of the relationships in combination with **DUI Enforcement** and **Public Awareness of Drinking-Driving Enforcement**.

An analysis conducted over 5 ½ years in three sites examined relationships between (a) self-reported drinking and driving, (b) blood alcohol content (BACs) at roadside, and (c) single-vehicle nighttime crashes. Both self-reported drinking and driving and independently collected BAC roadside data consistently predicted a decline in alcohol-related motor vehicle crashes due to increased enforcement and increased visibility of enforcement working together (Voas et al., 1997). Further, this study confirmed the hypothesized relationship of perceived risk of arrest to drinking and driving across six communities with different levels of DUI enforcement and enforcement publicity. It supports the generally accepted hypothesis (Gibbs, 1975; Ross, 1984) that it is the perception of risk rather than the actual risk of arrest that affects drinking-and-driving behavior. The objective probability of apprehension for an impaired driver in the USA is one in a thousand (Ross, 1992).

While there are other factors influencing drinking-and-driving behavior such as peer attitudes, available alternatives to drinking, and the perceived risk of injury (Berger & Snortum, 1986; Andenaes, 1988), **Perceived Risk of DUI Arrest** is the principal intermediate measure that can be directly influenced by an enforcement program (i.e., the greater the perception of risk, the fewer driving-after-drinking events). Like other behaviors, an irregular reward/punishment schedule is more likely



to elicit behavior change than a consistent one because the perception of risk remains high, even when a reward or punishment is not immediately forthcoming.

A five-year study has demonstrated that as the perceived risk increases (controlling for other factors), alcohol-involved motor vehicle crashes decline (Holder et al., 1997). These researchers found that increasing the perceived risk of DUI arrest was associated with reductions in single-vehicle night-time injury crashes in three experimental communities compared to the control communities over five years.

## Intermediate Variable: DUI Enforcement

**DUI enforcement** refers to the level of enforcement used to detect drivers who are legally intoxicated (i.e., driving under the influence of alcohol). The level of legal intoxication is defined by the law as a specific level of blood alcohol concentration (BAC). Any driver with a measured BAC equal to or higher than this defined level is considered intoxicated and can be arrested for DUI.

The goal of DUI enforcement is to reduce the number of persons who drink and then drive, thereby reducing automotive crashes and fatalities. One way to do this is to remove impaired drivers from the roadways and punish them to deter similar occurrences in the future. To accomplish this goal, DUI enforcement can use one or more of the specific regulations and rules such as BAC limits, per se laws, zero-tolerance laws, administrative license revocation, and automobile interlock devices. In terms of specific enforcement policies, the two most salient include random breath testing (used only outside of the United States) and sobriety checkpoints (legal in the United States). These are described in the next section on Intervention Strategies.

The effectiveness of **DUI Enforcement** on **Alcohol-Related Motor Vehicle Crashes** is demonstrated in a study where increased DUI enforcement substantially decreased such crashes (Voas and Hause, 1987). Several studies have demonstrated that increasing the total number of police patrols dedicated to apprehending impaired drivers will reduce alcohol-related crashes (Levy, Voas, Johnson, & Klein, 1978; Vingilis & Salutin, 1980; NHTSA, 1995a; Hingson, Howland, Schiavone, & Damiata, 1990). The most important limitation with this method is that, once the extra manpower is withdrawn, the influence on crashes disappears over time (Voas & Hause, 1987).

A strong relationship between **DUI Enforcement** and **Perceived Risk of DUI Arrest** has been established by a number of studies. Traditionally, law enforcement directed at drinking and driving has been designed to catch offenders, based on the assumption that such practices will prevent or deter people from driving after drinking. Deterrence, then, essentially increases the perceived probability or likelihood of apprehension for drinking and driving. Deterrence is also influenced by factors such as severity and swiftness of punishment (Ross, 1992). The relationship between enforcement and harm (alcohol-related motor vehicle crashes) is reciprocal in that frequent, severe, or publicly significant traffic crashes involving at least one drinking driver can stimulate increased DUI enforcement. It is also likely that DUI enforcement decays or becomes less significant to law enforcement when there is less attention to such crashes.

The importance of perceived risk in determining driver behavior has been recognized by researchers concerned with drinking and driving (Reed, 1981; Ross, McCleary, & Epperlein, 1981; Voas and Hause, 1987). The actual risk of arrest for DUI is quite small. It is estimated that in the USA there

is approximately one DUI arrest for every 2,000 driving events above the legal limit (Borkenstein, 1974). Subsequently, public perception of a low risk of detection and arrest is accurate.

The dynamic relationship between public perception of arrest risk and drinking-and-driving behavior has been demonstrated; however, although effective, substantially bolstering DUI enforcement may be politically and economically costly (Voas & Hause, 1987). When changes in traffic enforcement are implemented and publicity is widespread, the public may overestimate the risk, at least for a time, and the amount of drinking and driving declines. When it becomes clear that the actual risk of arrest has not risen appreciably, however, the public returns to its former behavior, and drinking and driving once again increases (Ross et al., 1981). Modest changes in the actual risk of arrest are likely to have little effect on driver behavior (Ross, 1982).

## Intermediate Variable: Public Awareness of Drinking/Driving Enforcement

**Public awareness of drinking-and-driving enforcement** is the level of public attention given to DUI enforcement. While it does not influence alcohol-related motor vehicle crashes directly, **Public awareness of drinking-and-driving enforcement**, instead, works in conjunction with actual increases in **DUI Enforcement** to increase **Perceived Risk of DUI Arrest**.

Public news attention to actual changes in DUI enforcement can actually increase perceived risk (Voas et al., 1997). The significance of public awareness to the success of any DUI enforcement program was first demonstrated in a classic review of the British Road Safety Act, where the effect of the new breath-test law on crashes was much greater than would have been expected from the number of tests actually conducted (Ross, 1973).

In the Community Trials Project, public awareness was the responsibility of each community's enforcement task force and project staff who were trained in media advocacy. A media advocacy consultant worked closely with the coordinator and the police department leadership in planning media events around enforcement operations. To retain the attention of the public, a policy of changing the news coverage foci every few months was adopted. News focused on the novelty of the passive sensor flashlights at one time, on checkpoints at a later time, and on multi-jurisdictional "sweeps" at a still later time, even though the same basic enforcement techniques were being used throughout (Voas, 1997).

This strategic use of news media increased perceived risk of arrest after drinking and driving (Holder et al., 1997; Voas, 1997). Other results indicated that (a) training in media advocacy can increase coverage of news events generated by local community members including volunteers; (b) increased news coverage can be generated for both electronic (television) and print media; (c) increased news coverage drew the public's attention to specific issues in support of prevention components; (d) although there are differential audiences/readers for the print (newspaper) and electronic (television) media, both audiences are affected; and (e) media advocacy can be more effective than a paid public information campaign in increasing public awareness of alcohol issues.

The effect of publicity wears off as the public becomes aware that police were not using their new authority as extensively as had been expected (Holder et al., 1997; Voas et al., 1997). A strong decline in nighttime crashes in the first year of an intensified DUI patrol program was halved in the second year when there was no publicity given to the program (Voas & Hause, 1987). Reductions in crashes were found to occur only when sobriety checkpoints were well publicized (Mercer, 1985).

The relationship between **DUI Enforcement** and **Public Awareness of Drinking-and-Driving Enforcement** reflects the interaction of changes in enforcement and the public awareness of those changes in enforcement. The community learns about DUI enforcement in two ways:

1. Observing actual enforcement as drivers (or passengers), and
2. Reports from others and in the news.

Thus, highly visible and frequent enforcement is observed by drivers while on the roadways, and any publicity, whether planned or natural local news attention, will increase public awareness; that is people will talk about their perceptions of enforcement (Voas and Hause 1987).

Enforcement and public awareness of enforcement activities are key elements in the effectiveness of most policies to prevent alcohol-related drinking and driving and associated crashes. The deterrent effect of alcohol policies is influenced by the drinkers' perceived likelihood of being detected if they drive, i.e., the probability of enforcement and the swiftness with which punishment is imposed (Ross, 1982). Severe penalties for many alcohol offenses are seldom enforced and thus generate only a modest deterrent effect.

Actual and perceived risk of arrest may or may not overlap. For example, if selective breath-testing checkpoints are set up for several days in a row, drivers may assume that risk of arrest is still high after the daily enforcement ceases, at least for a short time. Both the level of publicity and the visibility of enforcement may influence motorists' behavior and their perception of risks.

## Intermediate Variable: Community Norms about Drinking and Driving

**Community Norms about Drinking and Driving** refers to the level of acceptability (or unacceptability) of drinking in general, as well as the level 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 herein 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 are unlikely. Powerful and complex values have developed around alcohol with related norms regarding when, where, and how alcohol use is appropriate and desirable. Some of these values and norms are part of the broader culture; others can exist on a smaller scale—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 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.

There are several ways to depict the relationship between the frequency of alcohol-related motor vehicle crashes and **Community Norms about Drinking and Driving**. The frequency of the problem may be directly correlated to norms, so that increased frequency leads to increased concern. An alternate interpretation is that community concern will be high only when problem frequency is high and the problem is perceived as significant.

While there is little empirical evidence to relate **Community Norm about Drinking and Driving** to **Public Awareness of Drinking/Driving Enforcement**, there is a logical relationship between the two as shown on the logic model.

## Intermediate Variable: Community Activism about DUI Enforcement

**Community Activism about DUI Enforcement** refers to organized action by community members and/or organizations to produce changes in drinking-and-driving policy and activity within the community and to support desired policies.

As with most intermediate variables, **community activism about DUI enforcement** does not affect **alcohol-related motor vehicle crashes** directly, but rather works through **DUI enforcement** and **perceived risk of DUI arrest**.

Mothers Against Drunk Driving (MADD) is an example of activism that appears to have stimulated changes associated with reductions in alcohol-related motor vehicle crashes. MADD in 1991 released its report, “Rating the States,” showing all 50 U.S. states and their involvement in anti-drunk-driving measures including DUI enforcement. MADD’s support was instrumental in passage of zero-tolerance legislation, which lowered the BAC limit for young drivers, in 2000.

The 600<sup>th</sup> chapter of MADD was also established in the year 2000. As of July 2004, all 50 states have passed the .08 BAC law, thanks to the efforts of MADD. Other enforcement measures that have received MADD support include frequent, visible DUI enforcement sobriety checkpoints, which potentially can reduce fatalities by 20 percent, and stricter enforcement of safety belt usage laws to prevent additional injuries on the public roads.

Community activism is an important factor in generating support and resources for **DUI Enforcement**. Increases in community activism and mobilization helped increase support for DUI enforcement as part of a large-scale community trial to reduce alcohol consumption and associated problems in California (Voas, 1997).

Since MADD has been in existence, there has been a 43 percent decline in alcohol-related traffic fatalities (MADD statistics and resources homepage). NHTSA recently reported that alcohol-related traffic fatalities decreased 2.1% between 2003 and 2004. This figure translates into 16,654 deaths from preventable drunk driving, down from a high of 26,173 alcohol-related deaths in 1982. This evidence represents at least a potential link between alcohol-related motor vehicle crashes and community activism.

## Intermediate Variable: Individual Factors

**Individual factors** refer to those attributes of individuals that appear to increase or decrease risk of driving after drinking. In addition to a variety of environmental factors that influence the extent to which individuals engage in drinking and driving, researchers have recognized that there are certain individual-level influences shaping these behaviors. These factors do interact with the potential influences of family and peers, as well as environmental factors, to increase or limit the import of these influences.

**Individual factors** are associated with **Drinking** and with **Driving after Drinking**. A NHTSA report on fatal crashes in 2004 indicated that the highest percentage of drivers with BAC levels of .08 or

higher was for drivers ages 21 to 24 (32 percent), followed by ages 25 to 34 (27 percent) and ages 35 to 44 (23 percent). The percentages of motor vehicle operators with BAC levels of .08 or higher in fatal crashes in 2004 were 27 percent for motorcycles, 22 percent for passenger cars, and 21 percent for light trucks. The percentage of drivers with BAC levels .08 or higher in fatal crashes was the lowest for large trucks (1 percent). Safety belts were used by only 28 percent of the fatally injured drivers with BAC levels of .08 or higher, compared to 41 percent of fatally injured drivers with BAC levels between .01 and .07 and 57 percent of fatally injured drivers with no alcohol (BAC = .00).

In 2004, a total of 442 (21 percent) of the fatalities were children aged 14 and younger occurred in crashes involving alcohol. Approximately half (220) were passengers in vehicles with drivers who had BAC levels of .01 or higher. An additional 115 children were killed as passengers in vehicles with drivers who had not been drinking. Another 64 children aged 14 and younger who were killed in traffic crashes in 2004 were pedestrians or bicyclists who were struck by drivers with BACs of .01 or higher.

There are several individual factors that increase a person's likelihood of heavy drinking and/or developing alcohol use disorders. One such factor is genetics, although its relative contribution compared to environmental factors has not been empirically established. Evidence of genetic influences includes studies of animals (McKinzie et al., 1996), twins and adoptees (Cadoret, Yates, Troughton, Woodworth, & Stewart, 1995; Merikangas, 1990), and children of alcoholics (Bierut et al., 1998; Merikangas et al., 1998).

Age and gender also appear to be 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 aged 18 to 25 years; however, 70 percent of the binge-drinking episodes occurred among those aged 26 years and older (Naimi, 2003). Binge drinkers were 14 times more likely to report alcohol-impaired driving than non-binge drinkers (Naimi, 2003). *Heavy drinking* is 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 (NIAAA, 2004). In 2002, 5.9 percent of U.S. adults reported heavy drinking in the past 30 days; the prevalence of heavy drinking was greater for men (7.1 percent) than for women (4.5 percent) (CDC, BRFSS, various studies).

## B. Intervention Strategies for Drinking & Driving

Overall, given the strength of scientific evidence, the most effective measures to prevent injuries and deaths from drinking and driving include the following:

- Promptly suspending the driver's licenses of people who drive while intoxicated.
- Lowering the permissible BAC levels for all drivers.
- Low BAC limits (zero-tolerance laws) for drivers younger than 21.
- Sobriety checkpoints.
- Community comprehensive, multifaceted safety strategies for alcohol control and DUI prevention.
- Reducing the legal BAC limit to .05.



- Implementing compulsory blood alcohol testing when traffic crashes result in injury.

The federal Centers for Disease Control and Prevention (CDC) Task Force has recommended the use of sobriety checkpoints based on strong evidence of their effectiveness in reducing fatal and nonfatal crash injuries and in reducing alcohol-impaired driving and alcohol-related crashes. These findings should be applicable to all drivers in areas where sobriety checkpoints can be conducted.

In addition, evidence supports a conclusion that setting a reasonably low-level BAC, undertaking frequent and visible enforcement of existing BAC limits, threatening and actually suspending driving privileges, and establishing certainty of punishment, especially through randomized enforcement, form a combined strategy with the strongest potential for prevention success.

Another compelling finding is that comprehensive treatment including counselling or therapy plus license suspension can be effective in reducing recidivism. Restorative approaches, although promising if they incorporate license loss, require further evaluation. The application of ignition interlock devices has shown positive results but has not been widely tested in countries other than the United States.

Regarding young drivers, the scientific evidence shows that low BAC limits, delayed access to a full license, and curfews can be effective strategies for reducing drinking-and-driving among the young. Graduated licensing schemes can incorporate all these strategies within one system by controlling the rate and manner in which young drivers gain access to full driving privileges. These schemes have been well accepted where implemented, and the small number of evaluations all show safety benefits (Begg et al., 2000; Mayhew, 2000; Ulmer, Ferguson, Williams, & Preusser, 2000).

Research has focused on about 20 different strategies that affect **Drinking and Driving**.

Each of these strategies, including the ones highlighted above, is described below indicating the intermediate variable(s) it affects and the scientific evidence of its effects. In this summary of the scientific evidence, the relative strength of a strategy's effects on **Drinking and Driving** and thus on **Alcohol-Related Motor Vehicle Crashes** is indicated by the number of stars given:

★★★ **Strong effect**

★★ **Moderate effect**

★ **Weak or contradictory findings**

## ★★★ **Strategy: Sobriety Checkpoints**

Intermediate Variable(s): Perceived Risk of DUI Arrest, DUI Enforcement

Description: The traditional strategy for increasing perceived certainty of apprehension is to increase the frequency and visibility of drinking-and-driving enforcement, for example, by simply intensifying police enforcement in the form of short-term intensive checkpoints during holidays. Increasing the probability of arrest could translate into a higher perceived probability of detection and fewer accidents. At sobriety checkpoints, only motorists who are judged by police to have been drinking are asked to take a breath test. This approach greatly weakens the deterrent potential because experienced offenders believe (with some justification) that they can avoid detection.

### Scientific Evidence:

- The effectiveness of sobriety checkpoints was confirmed in a review of evidence of interventions to reduce alcohol-impaired driving. (Shults et al., 2001).
- Such campaigns do generally reduce accidents, but once again, their effects are generally short lived (Ross, 1982).
- The perception of risk was directly related to the level of enforcement as represented by the number of breath-test devices provided to the police departments, the number of officers trained at the experimental sites, and the amount of local newspaper coverage of enforcement activities (Voas et al., 1997).
- An estimate is that police miss as many as 50 percent of drivers with BACs higher than .10 at sobriety checkpoints (McKnight & Voas, 2001).
- Substantial and consistent evidence from research shows that highly publicized, highly visible, and frequent sobriety checkpoints in the United States reduce impaired driving fatal crashes by 18 to 24 percent. However, a recent survey of checkpoint use demonstrated that, despite the U.S. Department of Transportation's efforts to encourage checkpoint use through publications and the provision of funds for equipment and officers' overtime, only about a dozen of the 37 states that conduct checkpoints do so weekly due to lack of local police resources and funding, lack of support by task forces and citizen activists, and the perception that checkpoints are not productive or cost-effective (Fell, Lacey & Voas, 2004).
- Low-staffing sobriety checkpoints conducted by as few as three to five officers have been shown to be just as effective as checkpoints conducted by 15 or more officers.
- A modified sobriety checkpoint program using passive alcohol sensors (*PASpoints*) can be implemented by small- to moderate-sized communities in the United States to deter impaired driving. If implemented in a majority of communities, this strategy can potentially reach the high level achieved by several Australian states in their RBT programs. The *PASpoint* system calls for a small group of three to five officers on traffic patrol duty to converge on a preset site and conduct a mini-checkpoint, returning to their standard patrol duties within 2 hours.

## ★★★ Strategy: Random Breath Testing

Intermediate Variable(s): Perceived Risk of DUI Arrest, DUI Enforcement

Description: An alternative to such selective testing of drivers is random breath testing (RBT) or compulsive breath testing (CBT) as it is practiced in Australia, New Zealand, and some European countries. Motorists are stopped at random by police and required to take a preliminary breath test, even if they are not suspected of having committed an offense or having been involved in an accident. The defining feature is that any motorist at any time may be required to take a test, and he or she cannot influence the chances of being tested. Testing varies from day to day and from week to week. Although the testing schedule is not announced publicly in advance, testing nonetheless is always highly visible and publicized in the news media. Refusal to submit to a breath test is equivalent to failing a breath test.

### Scientific Evidence:

- By the mid-1990s, millions of motorists in Australia were being tested each year, at a rate of about .6 tests per license holder per year (Henstridge, Homel, & Mackay, 1997). In 1999, 82 percent of Australian motorists reported having been stopped at some time compared to 16 percent of motorists in the United Kingdom and 29 percent in the United States (Williams, Ferguson & Cammisa, 2000).
- A 22 percent decline in fatal crashes with slightly lower decreases for non-injury and other accidents (a review of 23 studies, Shults et al., 2001).
- RBT was twice as effective as selective checkpoints in four Australian states (Henstridge et al., 1997).
- RBT resulted in a 35 percent reduction in fatal accidents compared with 15 percent for checkpoints; an estimate that an increase of 1,000 in the daily testing rate corresponded to a decline of 6 percent in all serious accidents and 19 percent in single-vehicle night time accidents; analyses revealed a measurable deterrent effect of RBT on the whole population of motorists 10 years later in Queensland, Australia (Sherman, 1990).
- RBT provided heavy drinkers with a legitimate excuse to drink less when drinking with friends (Homel, 1988).

## ★★ Strategy: Severity of Punishment

### Intermediate Variable(s): DUI Enforcement, Perceived Risk of DUI Arrest

Description: Punishment for a drinking-and-driving conviction has typically been increased either by changing the maximum penalties or by introducing mandatory minimum penalties. A review of the literature by NHTSA and NIAAA on the effectiveness of a number of individual sanctions imposed for driving while under the influence of alcohol included incarceration, out-of-home placement, residential weekend intervention (for screening and assessment), probation, home detention, electronic home monitoring, driver's license suspension/revocation, license plate removal/registration revocation, community service, restitution, victim-offender mediation, attendance at victim impact panels, fines, emergency department visitation, education, and treatment. The report concluded that few of these sanctions have been empirically tested, either for adults or minors (September, 1999).

### Scientific Evidence:

- Only limited evidence supports the positive effect of these laws (Ross & Voas, 1989).
- Effects could be counterproductive if the judicial system is overburdened or if prosecutors fail to pursue these cases (Little, 1975; Ross & Voas, 1989).
- Severe penalties do not appear to produce fewer accidents than less severe penalties (Homel, 1988; Ross, 1992).
- 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 (McKnight & Voas, 2001).



- The police in Tulsa, Oklahoma, developed an emergency department visitation program in which minors spent time in an emergency room, preferably late at night on the weekend, to view the effects of drunk driving. In addition, youth visited a rehabilitation center for patients with spinal cord injuries, attended a VIP presentation, participated in a small group alcohol counseling session, and wrote an essay about their experiences in the program. A study of this program found reduced re-arrests for DUI among 16- to 25-year-olds over 2 years. Program participants had a recidivism rate of 1.2% compared to the national DUI re-arrest rate of approximately 30% (Police Executive Research Forum).
- One punishment that seems to be consistently effective is license disqualification for both alcohol-related and non-alcohol-related accidents. Offenders with no license suspension recidivate more (McKnight & Voas, 2001; Peck et al., 1985; Ross, 1992; Siskind, 1996). Offenders receiving longer suspensions tend to recidivate less, at least for non-alcohol-related offenses (Homel, 1981).
- As many as three-quarters of disqualified drivers continue to drive while unlicensed (Ross & Gonzales, 1988), but they tend to drive less and more cautiously, at least while suspended.

### ★★★ Strategy: Swiftmess of Punishment

Intermediate Variable(s): DUI Enforcement

Description: Celerity or swiftmess of punishment is the proximity of punishment to the drinking-and-driving event. One example is administrative license suspensions or revocations for drinking and driving where licensing authorities can suspend licenses without a court hearing, quickly and closer in time to the actual offense. Administrative suspension or revocation can occur in 40 of the 50 states in the United States.

Scientific Evidence:

- The effect on drinking-and-driving accidents is consistently positive, and its mechanism seems to be general deterrence (Ross, 1992; McKnight & Voas, 2001).
- The benefit-to-cost ratio was \$11 per dollar invested when violators receive a 6-month license suspension (Miller, Galbraith & Lawrence, 1998a).

### ★★ Strategy: Frequency of Punishment

Intermediate Variable(s): DUI Enforcement, Perceived Risk of DUI Arrest

Description: A strategy for increasing certainty of apprehension and punishment is to increase the frequency and visibility of drinking-and-driving enforcement. The objective probability of apprehension for an impaired driver in the United States is estimated to be one in a thousand (Ross, 1992). Increasing this probability may therefore translate into a higher *perceived* probability of detection and fewer accidents.

Scientific Evidence:

- The traditional way of doing this is simply to intensify police enforcement in the form of short-term intensive checkpoints, such as during holidays. Such campaigns generally reduce accidents, but once again, their effects are generally short lived (Ross, 1982).

## ★★ Strategy: Local News Coverage of DUI Enforcement

Intermediate Variable(s): Perceived Risk of DUI Arrest, Public Awareness of Drinking & Driving

Description: Local news stimulated by media advocacy can affect drinking-and-driving behavior by affecting the public's perception of the risk of being arrested.

Scientific Evidence:

- Media advocacy training and technical assistance is effective in producing increased media coverage (Community Trials Project, Treno et al., 1996; Holder & Treno, 1997).

## ★★ Strategy: Community Coalitions to Prevent Drunk Driving

Intermediate Variable(s): Community Activism about DUI Enforcement

Description: Formation of a coalition of persons with interest and concern about alcohol-related motor vehicle crashes. Active and mobilized communities have shown clear decreases in alcohol, tobacco, and other drug use and changes in perceived norms about substance use. In addition, these communities have improved perceptions of neighborhood quality by environmental changes, such as closing crack houses and removing billboards for alcohol and tobacco. Coalition membership must be appropriate to the shared purpose and plan for action, in this case, efforts to increase DUI enforcement in the community. If comprehensive service coordination is the task, organization leaders need to be involved, especially if an organization is expected to be a key contributor to a particular intervention. If community mobilization is the task, grassroots activists and community citizens must be involved. Community linkage coalition models require a mix of both types of community members. This mix results in diverse expectations and operating assumptions for the coalition that must be resolved to avoid conflict and role confusion.

The effectiveness of community-based processes is not a reflection of the coalition's organizational structure or design. It is a function of strategies and activity. If the intervention appears to be ineffective, changes and adjustments in the coalition's action plan, not its organizational structure, are required. Facilitating community-based collective action requires appropriate roles for paid staff. Paid coalition staff members operate more effectively as resource providers and facilitators rather than as direct community organizers. Paid staff can fill essential clerical, coordination, and communications functions that provide the glue to hold diverse coalitions together. Paid staff can also provide leadership through expertise in strategies and programmatic activities that will further the coalition goals. Leadership is essential and can take different forms. Effective leadership may reside with a dynamic or visionary individual. But one problem associated with this type of leadership is that it is not transferable. Well-functioning coalitions often create opportunities for satisfying and effective participation of members resulting in a "leadership of ideas" demonstrated in a well-articulated plan of action.

Scientific Evidence:

- An increase in organized community activism and mobilization can increase support for DUI enforcement as part of a large-scale community effort to reduce alcohol consumption and associated problems. Local coalition members can work with elected officials and stimulate media advocacy to mobilize the effort (Voas, 1997).
- An increase in community activism and mobilization helped increase support for DUI enforcement as part of a large-scale community trial to reduce alcohol consumption and associated problems in California (Voas, 1997).
- Community activism was influential as part of a larger set of community interventions targeting alcohol use and associated problems including media advocacy training and technical assistance, DUI news coverage, additional police officer hours for DUI enforcement, greater use of breathalyzers, increased officer training, and more checkpoints (Voas et al., 1997).
- Centers for Disease Control, Task Force on Community Preventive Services concluded that well-executed multi-component interventions with community mobilization are effective in reducing alcohol-related crashes (Shults, et al, 2009).

The following ten effective strategies are directly related to **Driving after Drinking** and are common practices in all states of the USA.

### ★★★ **Strategy: Administrative License Revocation**

Intermediate Variable(s): Drinking & Driving, DUI Enforcement, Perceived Risk of DUI Arrest

Description: Authorities can suspend licenses quickly and closer in time to the actual offense without a court hearing. Administrative suspension can occur in 40 of the 50 states in the USA.

Scientific Evidence:

- Promptly suspending the driver's licenses of people who drive while intoxicated (DeJong & Hingson, 1998).
- General deterrence and reduction in drinking-and-driving accidents (Ross, 1992; McKnight & Voas, 2001).
- An average 5 percent reduction in alcohol-related crashes and 26 percent reduction in fatal crashes (a meta-analysis of 46 studies by Zobeck and Williams, 1994).
- Benefit-to-cost ratio of \$11 per dollar invested when violators receive a 6-month license suspension (Miller et al., 1998b).
- Recidivism is lower for offenders receiving longer periods of suspension (Homel, 1981) and higher for offenders with no license suspension (McKnight & Voas, 2001; Peck, Sadler & Perrine, 1985; Ross, 1992).
- While suspended, up to three-quarters of drivers continue to drive though less often and more cautious (Ross & Gonzales, 1988).

### ★★★ Strategy: Interlock Devices

Intermediate Variable(s): Drinking & Driving

Description: Ignition interlock devices that prevent a vehicle from starting until the driver passes a breath test.

Scientific Evidence:

- Devices are very effective for many alcohol-impaired offenders (An analysis of 8 studies, McKnight & Voas, 2001).
- Effects limited to the period of the court order unless combined with treatment within a case management framework to deal with the underlying problems (DeYoung, Tashima, & Maston, 2005; Marques & Voas, 1995, 1998, 2005).

### ★★★ Strategy: Driver License Age Restrictions

Intermediate Variable(s): Drinking & Driving

Description: Delay of legal driving to age 17 and/or night time curfews for teenage drivers.

Scientific Evidence:

- Between 65 and 85 percent reductions in 16-year-old driver fatal crashes (Williams, 1985; Williams, Karpf, and Zador, 1983).
- Reductions between 25 percent and 69 percent in crash rates for 16 year old drivers in states with curfew laws compared to those without such laws (Williams, 1985; Preusser, Williams, Zador, & Blomberg, 1984).

### ★ Strategy: Traffic Safety Education for Young or Inexperienced Drivers

Intermediate Variable(s): Drinking & Driving

Description: Traditional programs such as driver training and school-based education programs.

Scientific Evidence:

- Either ineffective or have yielded mixed results with the exception of peer intervention that seems to produce enduring improvements in intervention behaviors (McKnight & Voas, 2001; Stewart & Klitzner, 1990).

### ★★ Strategy: Traffic Safety Education for DUI Offenders

Intermediate Variable(s): Drinking & Driving

Description: Traditional educational approaches used to reduce driving after drinking.

### Scientific Evidence:

- May be successful in increasing readiness to change, but they have little influence on DUI recidivism. Drivers with no prior DUI alcohol-related offense were significantly more likely to display additional impaired driving when jailed as opposed to those enrolled in the educational program, whereas those with previous alcohol-related offenses may have fared better in jail. Drivers younger than 21 years of age were also at elevated risk for repeat offenses (Socie, Wagner, and Hopkins, 1997).
- A novel educational curriculum for first time DUI offenders in Florida, the Preventing Alcohol-Related Convictions (PARC) program, has the ultimate goal of reducing DUI recidivism (Rider et al., 2006). PARC teaches students to control their driving to prevent a future DUI rather than control their drinking. Research shows that PARC is effective in moving participants toward more readiness for change and toward a strategy of avoiding driving to any venue in which drinking may occur.

## ★ **Strategy: Victim Impact Panels**

Intermediate Variable(s): Drinking & Driving

Description: Victim impact panels (VIP) provided to an estimated 400,000 DWI (driving-while-intoxicated) offenders per year by more than 200 Mothers Against Drunk Driving (MADD) chapters in the United States. MADD encourages its activists to serve in peer support roles, without minimizing therapy with professionally educated counselors (Shinar & Compton, 1995).

### Scientific Evidence:

- Mixed and inconclusive results. Anecdotal reports and some studies indicate that DUI offenders are often moved by victims' stories and vow to reform their ways (Fors & Rojek, 1999; Police Executive Research Forum).
- 72 percent decreased recidivism of offenders when compared to more traditional criminal justice responses such as incarceration, probation, court-ordered restitution (An analysis of 32 studies of restorative programs, Latimer, Dowden, and Muise, 2001).
- Contradictory findings, no significant difference in changes or recidivism when VIPs compared to a DWI school (Polacsek et al., 2001; Shinar & Compton, 1995).
- No differences in alcohol consumption, drinking-and-driving behavior, or recidivism found within 2 years between participants attending the VIP and those not attending (Wheeler, Rogers, Tonigan, and Woodall, 2004).
- VIP referral not statistically associated with recidivism of first-time and repeat offenders in New Mexico between 1989 and 1994. Female repeat offenders referred to VIPs were significantly *more* likely to be re-arrested compared with those not referred (deBaca, Lapham, Liang, and Skipper, 2001).

## ★★★ Strategy: License Suspension/Revocation

Intermediate Variable(s): Drinking & Driving

Description: Sanction of suspending or revoking a license.

Scientific Evidence:

- Combining alcohol treatment with either license restriction or suspension is associated with the lowest DUI recidivism rates when comparing alcohol treatment, driver's license actions, and jail terms (An analysis of all drivers with a California license convicted of DUI during 1990 and 1991, DeYoung, 1997).
- Implementing compulsory blood alcohol testing when traffic crashes result in injury (National Committee on Injury Prevention and Control, 1989).

## ★★★ Strategy: Community Comprehensive Safety Strategies

Intermediate Variable(s): Drinking & Driving

Description: Multifaceted local safety programs that typically mix DUI enforcement and general public information and awareness with enforcement of speeding and seatbelt laws. Programs might include a task force of city departments implementing activities such as media campaigns, business information programs, speeding and drunk-driving awareness days, speed watch telephone hotlines, police training, high-school peer-led education, Students Against Drunk Driving chapters, and college prevention programs.

Scientific Evidence:

- Multifaceted community-based approaches to alcohol control and DUI prevention (Holder et al., 2000; DeJong & Hingson, 1998).
- A 25 percent greater decline in fatal crashes in 6 communities in Massachusetts compared to the rest of the state, including a 42 percent reduction in fatal automobile crashes, a 47 percent reduction in the number of fatally injured drivers who were positive for alcohol, an 8 percent decline in 16- to 25-year-old crash injuries, a 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 (Hingson et al., 1996).

## ★★★ Strategy: Lowering BAC Limits for All Drivers

Intermediate Variable(s): Drinking & Driving

Description: *Per se* laws— a specific BAC level (usually .05 or .08) at which a driver can be arrested (Andenaes, 1988). The BAC can be measured by taking a blood sample from a driver or via an analysis of the exhaled breath. The invention of the breathalyzer and other portable devices for collecting samples of drivers' breaths, combined with *per se* legislation, revolutionized law enforcement of drinking and driving.

All USA states have longstanding laws prohibiting driving while impaired by alcohol. The U.S. Congress included a provision in the Fiscal Year 2001 Department of Transportation and Related Agencies Appropriations Act 213 requiring states and territories to implement .08 BAC laws by October 1, 2003 or risk losing federal highway construction funds. Certain policies depend upon laws that clearly define drinking and driving with a BAC at or higher than a prescribed level for the whole population (e.g., .08 or .05) or for young drivers (usually zero or .02).

Scientific Evidence:

- Lowering the permissible BAC levels for adults to .08 in all states (Shults et al., 2001).
- Reducing the legal BAC limit to .05 (Howat, Sleet, & Smith, 1991; National Committee on Injury Prevention and Control, 1989).
- Strong evidence of the general deterrent influence of these *per se* laws although the effects tend to be temporary. The deterrent effect gradually wears off as drivers realize that their chances of detection are in fact not very high (Ross, 1982).
- Internationally, lower BAC limits produced positive results consistently (Bartl and Esberger, 2000; Norström, 1997; Henstridge et al., 1997; Kloeden and McLean, 1994).
- Effects in USA are mostly positive, long-term, and cost-effective (Mann et al., 2001).
- Making motorists *uncertain* about the real risk of detection may paradoxically be the key to cost-effective deterrence (Homel, 1988; Nagin, 1998).

### ★★★ Strategy: Low BAC Limits for Young Drivers

Intermediate Variable(s): Drinking & Driving

Description: Lower BAC limits for young drivers (sometimes called zero-tolerance laws) set BAC limits at the minimum that can be reliably detected by breath-testing equipment (i.e., .01-.02). Zero-tolerance laws also commonly invoke other penalties, such as automatic confiscation of the driver's license.

Scientific Evidence:

- Zero-tolerance laws for drivers younger than 21 in all states (Shults et al., 2001).
- A 20 percent relative reduction in the proportion of single vehicle nighttime (SVN) fatal crashes among drivers aged 20 and younger, compared with nearby states that did not pass zero-tolerance laws (Hingson et al., 1994; Martin, Grube, Voas, Baker, & Hingson, 1996).
- A reduction in injuries and crashes (A review of six studies on the effects of zero tolerance, Zwerling and Jones, 1999).
- A net decrease of 24 percent in the number of young drivers with positive BACs after implementation of zero-tolerance laws in the first 12 states; a 19 percent reduction in self-reported driving after any drinking and a 24 percent reduction in driving after five or more drinks in 30 states (Wagenaar, O'Malley, and LaFond, 2001).



- Reductions of between 24 percent and 9 percent in fatal crashes in a review of USA and Australian studies (Shults et al., 2001).

## ★★ Strategy: Media and Awareness Programs

Intermediate Variable(s): Community Norms about Drinking and Driving; Driving after Drinking

Description: Potential strategies to influence community norms might be called “carrot or reward” strategies and “stick or punish” strategies. Awareness and education are directed at changing community values and norms through campaigns and media efforts. Punishment or threat strategies establish a civil liability for the social serving of alcohol (i.e., parties and other informal venues). These strategies are designed to work directly on community norms and values.

Scientific Evidence:

- *Awareness or information campaigns* seek to educate large numbers of individuals with informational messages delivered through various forms of media, through contests, and through the distribution of materials (e.g., key chains, pamphlets). Limited research reporting minimal effects on consumption or related problems dependent on longevity of the campaign and appeal of the messages.
- *Coordinated media efforts* center around a particular policy-based prevention approach. For example, coordinated media may be used to highlight attention to a specific alcohol problem and its causes and to generate community support for a policy or policies that will address those causes. Effects on alcohol-related problems dependent on the longevity of the campaign.

## ★★ Strategy: Prevention and Education Programs

Intermediate Variable(s): Individual Factors; Drinking; Driving after Drinking

Description: Although strategies have not been developed to change genetic factors and biological markers, other individual-level interventions have been developed. See Table 7. For example, many prevention programs have been developed to convey information about alcohol (and other drugs) to children and youth. These programs seek to change attitudes and cultivate values that are inconsistent with substance use or (in the case of adults) are inconsistent with responsible use of substances. Strategies designed to shape knowledge, attitudes, and values overlap and are interrelated with strategies designed to change community values. For example, awareness campaigns educate communities and are intended to change community norms. They also can change an individual’s knowledge and attitudes.

Scientific Evidence: The major categories of strategies focused on individual knowledge, attitudes, and values follow.

- *Prevention programs* – Prevention programs are usually implemented in schools, though they may also be delivered in other settings, such as community centers. They often consist of packaged curricula that include information about substances, resistance skills, and expressions of personal commitment. Short-term effects on consumption.



- *Normative education* – This strategy is based on youth’s tendency to overestimate the amount of heavy drinking among their peers. The program uses prominently displayed informational materials to provide accurate information about drinking norms. Limited research shows no effects on consumption or alcohol-related problems
- *Family-oriented programs* – These programs are often operated in schools and community hubs and involve intensive participation in classes and meetings by both parents and children. Limited research shows effects on consumption and related problems
- *Rehabilitative programs for impaired drivers* – Rehabilitative programs are designed in part to change the knowledge and attitudes of individual drivers such that understanding of risks and responsible attitudes and behavior are reestablished. Effects on consumption and impaired driving.

**Table 1. Summary of Drinking and Driving Intermediate Variables and Related Strategies**

INTERMEDIATE VARIABLE	STRATEGIES
Driving after drinking	Low BAC limits for young drivers ★ ★ ★ Lower BAC limits for all drivers ★ ★ ★ Community comprehensive safety strategies ★ ★ ★ License suspension/revocation ★ ★ ★ Victim impact panels ★ Traffic safety education for DUI offenders ★ ★ Traffic safety education for young or inexperienced drivers ★ Driver license age restrictions ★ ★ ★ Interlock devices ★ ★ ★ Administrative license revocation ★ ★ ★ Media awareness programs ★ ★ Prevention and education programs ★ ★
DUI Enforcement	Administrative license revocation ★ ★ ★ Frequency of punishment ★ ★ Swiftness of punishment ★ ★ ★ Severity of punishment ★ ★ Random breath testing ★ ★ ★ Sobriety checkpoints ★ ★ ★
Public Awareness of Drinking/ Driving Enforcement	Local news coverage of DUI enforcement ★ ★
Community Norms – Drinking & Driving	Media Awareness Programs ★ ★
Community Activism about DUI Enforcement	Community activism and mobilization ★ ★ ★ Community coalitions to prevent drunk driving ★ ★
Individual Factors	Prevention and Education Programs ★ ★

INTERMEDIATE VARIABLE	STRATEGIES
Perceived risk of DUI arrest	Local news coverage of DUI enforcement ★ ★ Frequency of punishment ★ ★ Severity of punishment ★ ★ Random breath testing ★ ★ ★ Sobriety checkpoints ★ ★ ★ Administrative license revocation ★ ★ ★

# III. Drinking

The causal relationship between **Drinking** and **Driving After Drinking** and **Alcohol-Related Motor Vehicle Crashes** has been confirmed by Voas, Holder, and Gruenewald (1997). As established, the basic causal model is:

**Drinking → Driving After Drinking → Alcohol-Related Motor Vehicle Crashes**

In this context, drinking refers to the consumption of alcohol prior to or concurrent with driving a motor vehicle, bicycling or walking in traffic as a pedestrian. Drinking alcohol impairs a wide range of skills and certainly those necessary for driving. To drive safely, one must maintain alertness, make decisions based on ever-changing information present in the environment, and execute maneuvers based on these decisions. There is clear evidence that motor vehicle crash risk increases with alcohol consumption.

BAC is a measure of the relative level of alcohol in a person's blood. In the field of traffic safety, BAC is expressed as the percentage of alcohol in deciliters of blood: for example, .10 percent is equal to .10 grams per deciliter.

Blood alcohol concentration (BAC) has been shown to be a good indicator of motor vehicle crash risk. Studies have shown alcohol impairment of driving skills substantially increases the risk of a crash even allowing for driving skill, fatigue, speed, and weather conditions. For example, a 160-pound man will have a BAC of approximately .04 one hour after consuming two 12-ounce beers or two other standard drinks on an empty stomach. Although the effects of BAC on driving performance depend on factors such as an individual's weight, rate of drinking, and stomach content (i.e., food in stomach), deterioration in performance becomes quite marked between BACs of .05 and .08. Regardless, BACs between .01 and .09 are associated with increased crash risk, and even BACs as low as .02 affect response times to dangerous road situations (West, Wilding, French, Kemp, & Irving, 1993; Zador, 1991).

A summary of research concerning the effect of BAC level on motor skills and cognitive processing found that impairment begins when the BAC is  $\geq .01$ , or practically after the first drink (Moskowitz & Fiorentino, 2000; Vogel-Sprott, 1992; Burns & Fiorentino, 2001). Any departure from a zero BAC increases crash probability and any amount of alcohol in the system of a driver clearly increases the risk of crash (Helander, 2001).

Any drinking is associated with increased crash risk, and the risk increases sharply as consumption increases (Hurst, Harte, & Frith, 1994; Levy and Miller 1995). Research has demonstrated that the relative crash risk of drivers with a BAC of .05 is double the crash risk for a zero-BAC driver; at .08, the risk is multiplied by 10, and at .15 or higher, the relative risk is in the hundreds (Borkenstein et al., 1974). The risk curve is even steeper for serious and fatal crashes, for single-vehicle crashes, and for young people (Jonah, 1986; Mayhew, Donelson, Beirness, & Simpson, 1986).

Risk curves relating BAC to crash involvement are based on a fixed relationship between the distribution of BACs in drivers using the road at times and places of alcohol-related crashes and the number of such incidents (Borkenstein, Crowther, Shumate, Ziel & Zylman, 1974; Zador, 1989; Hurst, 1973).

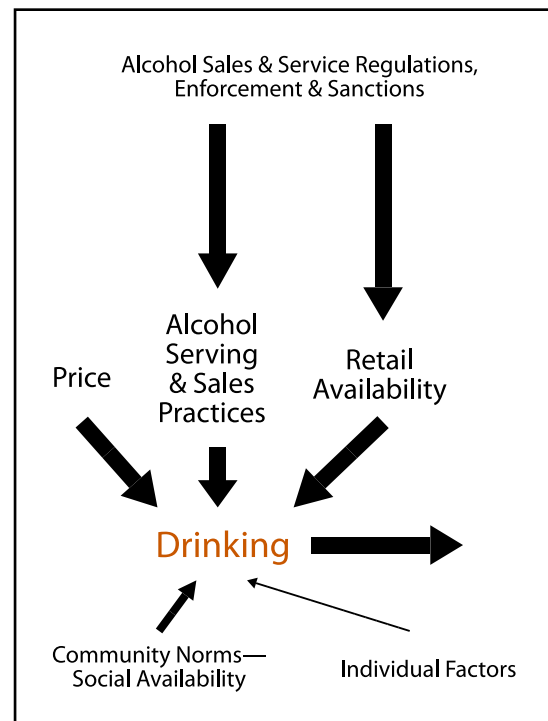
The many skills involved in driving are not all impaired at the same BAC level. For example, a driver's ability to divide attention between two or more sources of visual information can be impaired by BACs of .02 or lower (Howat, 1991; Moskowitz, Burns, & Williams, 1985). However, it is not until BACs of .05 or higher are reached that impairment occurs consistently in eye movements, glare resistance, visual perception, reaction time, certain types of steering tasks, information processing, and other aspects of psychomotor performance (Hindmarch, Bhatti, Starmer, Mascord, & et al., 1992; Finnigan & Hammersley, 1992).

Roadside surveys indicate that young people are less likely than adults to drive after drinking. Their crash rates, however, are substantially higher than those of other groups especially at low and moderate BACs (Mayhew et al., 1986). Each .02 BAC increase higher than zero places 16- to 20-year-old drivers at greater risk for a crash than older drivers (Hingson et al., 1994, 1995). When this is combined with a penchant for risk-taking behavior while driving, such as speeding, along with a tendency both to underestimate the dangerous consequences of such behaviors and to overestimate driving skills, it contributes to the high crash rate among young drivers (Brown & Groeger, 1988; Jonah, 1986).

Scientific evidence about the general population shows (1) average consumption, particularly at drinking events, increases for young people (especially males) aged 25 and younger; and (2) after age 25 there is an average drop in heavy drinking (although a small percentage continues to drink at high levels beyond age 30). Using data from the National Highway Traffic Safety Administration's Fatal Accident Reporting System (FARS) and a high BAC cutoff, one study found that the highest alcohol involvement occurred in drivers slightly older than the legal drinking age (Helander, 2001).

As the logic model shows, **Retail Availability, Alcohol Serving & Sales Practices**, and **Price** have strong relationships to **Drinking**. In addition, the model shows that **Alcohol Sales & Service Regulations, Enforcement & Sanctions** has a strong relationship to both **Retail Availability** and **Alcohol Serving & Sales Practices**. Therefore, the combination of these intermediate variables can affect **Drinking**.

The scientific evidence of each of these intermediate variables and their relationships to each other is described in the following paragraphs. The following section describes intervention strategies and effects of each.



## A. Intermediate Variables

### Intermediate Variable: Retail Availability

**Retail availability** is the level of access or convenience for individuals to obtain alcohol independent of the cost of alcohol. In general, when 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 the rates of alcohol problems are lower.

Retail availability can be affected by license restrictions, hours of sale, minimum age of purchaser, and alcohol outlet density (distance to a retail outlet). These factors are shaped by state and local regulations that determine the number, location, types, and serving-and-selling practices of alcohol retailers. How states and localities regulate retail availability varies considerably. Some are very restrictive, whereas others have only limited controls.

Formal alcohol markets are those regulated by government, whether at the community, the regional, or the national level. Regulation is to ensure purity, safety, and accurate description of the product and the collection of taxes. Other special sales regulations address concerns about health, safety, and public order that govern limits on hours or days of operation as well as the location of the retail market. Further, restrictions may be placed on advertising and marketing of the alcoholic products and on who may purchase the products. Special taxes on alcoholic beverages may also be part of the regulatory regime. Restricting alcohol availability through law has been a key policy in Canada, the United States, and Scandinavian countries.

Restrictions on retail availability are intended to limit consumer access to products or to regulate the context in which products are used. Most availability policies, however, do not restrict access altogether; rather, they serve to increase the effort required to obtain substances or change the context in which consumption occurs, thus changing consumption practices. In general, research concerning restrictions or limits on retail availability of alcohol has demonstrated overall effects on the general population's level of consumption and alcohol-related problems.

Whether in a formal or an informal market, alcoholic beverages are sold to retail customers in two forms. One form is for consumption elsewhere (off-premise). This form influences drinking, the drinking occasion, and the potential consequences through the conditions of sale, but generally stops at the point when the sale is made. The opportunities to affect these off-premise retail outlets are thus limited to regulations on the time, costs, and place of alcohol sales.

The other form in which alcoholic beverages are sold is as drinks served in glasses or other drinking vessels, with the actual consumption usually occurring on or about the premises where the drink is served. These are typically called “on-premise” retail outlets. Here, the opportunities to influence drinking—its context and its potential consequences—are broader, as 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 include requirements for responsible beverage service training, programs to provide “safe rides” for drinking drivers, and so on. Regulations may also apply to the design and furnishing of the tavern or restaurant, food service, availability of entertainment, and other non-alcohol-specific matters.

There is an interaction between restrictions, such as hours and days of sale 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-premise sales, rather than through on-premise sales, so that hours of operation for off-premise 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-premise drinking need to take account of the collective nature of much on-premise drinking and the predictable violence and police problems that commonly occur in and around drinking places in many societies.

The number of outlets may be restricted directly or indirectly through policies that make licenses more difficult to obtain (e.g., by 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. Typically, the network of stores in such a government-operated system is sparse rather than dense, and the opening hours are limited. A trend in the last few decades has been to privatize such state monopolies. Until effects of such privatization are fully evaluated, states should consider preventing privatization because reversal of the privatization process is not politically feasible.

## Intermediate Variable: Alcohol Serving & Sales Practices

**Alcohol Serving and Sales Practices** refers to the ways in which alcohol is served to customers in licensed on-premise establishments and the sales practices in off-premise establishments.

**Alcohol sales and serving practices** do not have a direct effect on **alcohol-related motor vehicle crashes**, but they have been documented as having an effect on high-volume drinking for customers obtaining alcohol from licensed establishments.

In the United States, an estimated 50 percent of impaired drivers had their last drink at a licensed establishment (O'Donnell, 1985). Across studies assessing propensity for alcohol sales to obviously intoxicated patrons, sales rate estimates ranged from 58 to 85 percent for on-premise establishments such as bars (Toomey et al., 2004).

Wait persons in licensed alcohol establishments often encounter intoxicated patrons and frequently continue to serve alcohol to these individuals. The level of drinking, especially high volume or high BAC levels, and high-risk drinking are influenced by the serving and sales practices of licensed retail outlets.

## Intermediate Variable: Alcohol Sales and Service Regulations, Enforcement and Sanctions

Regulations are the formal laws, rules, and standards that govern alcohol distribution, as well as sales and 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 for drinking and driving. 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. An example of *informal enforcement* is community members being unwilling to patronize 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 is affected by their severity, the probability of their imposition, and the swiftness with which they are imposed (e.g., Ross, 1982). 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, in part, because of the burden of prosecuting them as a criminal violation and reluctance on the part of law enforcement and courts to enforce criminal penalties in such cases. Moreover, because criminal proceedings are often lengthy and removed in time from the infraction, the punishment is seldom swift or certain.

The formal powers and resources of state alcohol beverage control agencies place them in a position to regulate access to alcoholic beverages through restrictions on retail distribution and sales. For example, monopoly states restrict access to spirits, and sometimes wine, by allowing retail sales only through state stores. On the other hand, license and monopoly states share in restricting sales through the use of price posting and fixing provisions. The degree to which these powers are realized in restrictions on alcohol outlets (e.g., licenses) and subsequent alcohol consumption (e.g., sales) was investigated by Gruenewald and Janes (1991). A cross-sectional analysis of data available from 44 ABC jurisdictions in the United States showed that states with greater restrictions on retail sales had greater resources for the conduct of ABC activities and lower densities of spirit outlets. These states, however, had greater densities of wine and beer outlets. States with greater marketplace restrictions had more resources for ABC enforcement activities and lower outlet densities across all beverage types. Further, supporting the suggestion that availability and demand may be simultaneously related, greater outlet densities were related to greater alcohol consumption (for beer) and greater levels of consumption were related to greater outlet densities (for wine).

This intermediate variable is also linked to **price** through a logical relationship that has not been empirically established. Some communities have established regulations to restrict “happy hours” and other price promotions of alcohol, especially in on-premise outlets (i.e., bars and restaurants). The relationship of such regulations to price and thus to consumption has little research, but given the price elasticity of alcohol consumption, it is reasonable to postulate that any action that effects eventual retail price to the consumer can influence the demand for alcohol.

The intermediate variable is expressed as actual enforcement of sales and service laws and regulations and sanctions for violations of these laws and regulations. It has largely been studied in terms of specific enforcement, as described in the Intervention Strategies section below.

## Intermediate Variable: Price

Price is the cost of alcohol sold by retail outlets. The demand for alcohol, as for many other products, responds both to price and to available income. As alcohol becomes more expensive, consumption decreases. When it becomes less expensive, consumption increases. Similarly, when other factors remain unchanged, an increase in disposable income among consumers leads to an *increase* in consumption, whereas a decrease in income leads to a *decrease* in consumption. 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). In general, increasing the price of alcohol decreases consumption and problems.

Alcohol prices remained stable during the last quarter of the 20<sup>th</sup> century, which, with inflation, amounts to price reductions over time. Thus, the real price of distilled spirits dropped by 32 percent, wine by 28 percent, and beer by 20 percent between 1975 and 1990 (Bureau of Labor Statistics; Chaloupka et al., 2002).

Alcohol price has been linked to heavy drinking and increased risk of harm from heavy drinking. Many investigators have examined the association between alcohol beverage prices and alcohol-associated problems, including drinking-and-driving and crime, and the clear consensus is that they are inversely related (see recent reviews by Birckmayer, Holder, Yacoubian, & Friend, 2004; Chaloupka et al., 2002; Mast, Benson, & Rasmussen, 1999; Cook 1981).

Although the government can raise the price of alcohol through increasing excise taxes, tax hikes have not been widely used to influence drinking in the United States. Much research on the effect of taxes has focused on the drinkers who cause the most social damage, including underage drinkers and heavy or abusive drinkers. Studies of the effect of price on youth typically also consider effective enforcement of minimum legal drinking age laws (MLDA), as the two are highly associated with youth access to alcohol.

Many studies have consistently reported that young drinkers are more price sensitive than adults, particularly heavy young drinkers, and that price effects increase over time (Grossman, Chaloupka, & Sirtalan, 1998). Studies of youth have also reported gender effects. As a result of a tax increase the number of women college students who drank decreased by 15 percent and who binge drank by 20 percent, but no effect for male college students (Chaloupka & Wechsler, 1996). These results may be attributable to the fact that the cost of alcohol on college campuses 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 non-abusive ones. The Rational Model of Addiction hypothesized that addicts consider the future consequences of the decision to consume their chosen substance of abuse, so price increases will decrease use likelihood among addicts, just as it might for nondependent individuals (Becker & Murphy, 1988; Becker, Grossman, & Murphy 1994).

## B. Intervention Strategies for Drinking

Overall, given the strength of scientific evidence, the most effective measures to prevent injuries and deaths due to drinking include the following:

Responsible beverage service programs.

- Dram shop liability practices.
- Restrictions on who may purchase alcohol.
- Minimum drinking age.
- Government control of alcohol sales.



- Retail compliance checks.
- Outlet density restrictions.
- Restrictions on location of outlets.
- Prohibition of minors from bars.
- Controls on manner of sale aimed at preventing underage drinking.
- Restrictions on hours and days of sale.

Research has focused on about 18 different strategies that affect **Drinking**. Each of these strategies, including the ones highlighted above, is described below indicating the intermediate variable(s) it affects and the scientific evidence of its effects. In this summary of the scientific evidence, the relative strength of a strategy's effects on **Drinking** and thus on **Driving After Drinking** and on **Alcohol-Related Motor Vehicle Crashes** is indicated by the number of stars given:

★★★ **Strong effect**

★★ **Moderate effect**

★ **Weak or contradictory findings**

## ★★ **Strategy: Alcoholism Treatment**

Intermediate Variable(s): Drinking

Description: For persons who are alcohol-dependent, the primary intervention is the treatment for alcoholism. There are specific strategies for reducing their overall drinking that can affect (if successful) the future risk of **driving after drinking**.

Scientific Evidence:

- From a policy perspective, well-designed treatment programs are probably worth the investment if a reduction in alcohol-related crashes is the goal (Wells-Parker, 2000).
- A meta-evaluation of 215 evaluative studies on drinking-and-driving treatment programs concluded that treatment without license suspension is generally ineffective (Wells-Parker et al., 1995; Tashima & Marelich, 1989).
- License suspension plus education, psychotherapy-counselling or follow-up contact-probation (preferably in combination) can produce an additional 7 to 9% reduction in drinking-and-driving recidivism and alcohol-related accidents when compared with control groups that largely received license restrictions only (sometimes more severe than for the treatment groups). The effect of routine punishments for convicted drinking-and-driving offenders can be enhanced if combined with alcohol treatment (DeYoung, 1997).

## ★★★ Strategy: Responsible Beverage Service Programs

Intermediate Variable(s): Drinking, Retail Availability

Description: Reduction of the probability of alcohol sales to obviously intoxicated patrons through server training and/or changes in establishment policies such as promoting nonalcoholic beverages and food or overtly delaying service of an alcoholic beverage. RBS involves the creation of clear policies such as checking identification for all customers appearing to be younger than 30 and recognize altered or false identification. RBS can be implemented at both on-license (Saltz & Stanghetta, 1997) and off-license establishments (Grube, 1997). See Rydon & Stockwell, 1997, for a summary of RBS strategies for licensed establishments.

Scientific Evidence:

- Training of servers and changing the establishment's serving policies effectively reduce service to obviously intoxicated customers, which reduces in number of intoxicated patrons leaving a bar and the number of violent incidents surrounding on-premise outlets (Wallin, Norstrom & Andreasson, 2003).
- An early evaluation of server intervention—the Navy Server Study—that produced changes in club policies and practices and an 18-hour training course for all staff resulted in a fairly dramatic reduction (from 33 percent to 15 percent) in the proportion of patrons whose drinking was estimated to be higher than the legal BAC limit (Saltz, 1985, 1987a; Hennessy & Saltz, 1989; Saltz & Hennessy, under review).
- Server training is most effective when coupled with a change in actual serving policy and practices of a bar or restaurant (Saltz and Hennessy, 1990b; Saltz, 1988; Saltz et al., 1987b).
- RBS has been found to reduce the number of intoxicated patrons leaving a bar (Dresser & Gliksman, 1998; Gliksman et al., 1993; Saltz, 1987b, 1989) and decrease the number of vehicle crashes (Holder & Wagenaar, 1994).
- Responsible beverage service 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).
- Establishments with firm and clearly stated policies (e.g., that all patrons who appear younger than 30 must have their IDs 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 influence (Grube, 1997; Lange, Stockwell, Rydon, & Beel, 1996, 1998).
- In at least one study, however, RBS training was associated with an increase in self-reported checking of identification by servers for as long as four years (Buka & Birdthistle, 1999).
- A qualitative analysis of 23 state RBS laws determined that RBS legislation was weak across all states overall. Although some states were strong in one or two of the RBS com-

ponents, almost all states were weak in at least one component (Mosher, Toomey, Good, Harwood & Wagenaar, 2002)

- Factors other than server training can also influence serving practices in licensed establishments, such as enforcement of existing ABC laws (Lange et al., 1998), server liability (or dram shop) laws (Buka & Birdthistle, 1999), high-profile server liability cases (Buka & Birdthistle, 1999), and community coalitions to encourage responsible serving practices. These factors can influence the degree of management support for server training and improvements in serving practices, essential for changing server behavior (Wolfson et al., 1996b).
- Currently, 47 states and the District of Columbia prohibit sales to obviously intoxicated persons (Florida, Nevada, and Wyoming are the only exceptions). Despite these laws, alcohol sales to obviously intoxicated patrons in on-premise establishments, such as bars, continue to occur 58 to 85 percent of the time. These laws are often not enforced by the police and are ignored by bar and liquor store owners (Toomey et al., 2004).
- An evaluation of the influence of increased enforcement of laws prohibiting service to obviously intoxicated patrons was conducted in licensed establishments in Washtenaw County, Michigan. Plainclothes police officers visited bars and restaurants monitoring beverage service for one year. Service to pseudopatrons feigning intoxication declined from 84 to 47 percent, while service in a comparison site showed declines of a much smaller magnitude. The proportion of DUI arrestees coming from licensed establishments declined from 32 to 23 percent (with no changes in DUI enforcement practices) where the proportion increased slightly at the comparison site (McKnight and Streff, 1993).

## ★★ Strategy: Legal (Tort) Liability Concerning Alcohol Sales and Service to Youth

Intermediate Variable(s): Alcohol Sales & Service Regulations, Enforcement & Sanctions; Alcohol Serving & Sales Practices

Description: Liability and administrative regulations are strategies that have the power of court or legal regulation to hold persons 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 sales and service establishes civil penalties, usually some form of 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), includes a recognition that such parties may lack the ability to make appropriate compliance decisions (Kraakman, 1998). Further, there are fewer third parties to regulate, third parties can be efficient monitors of alcohol service practices, and commercial sellers are in a better financial position to render compensation. Most states require that the individual who is held liable must be old enough to consume alcohol. Thus a legal age third party, not the minor, is held liable for underage legal action. Therefore, even if a licensed establishment's sales and service of alcohol to a minor may be an illegal sale, the minor cannot establish the statutory cause of action (Matthew Bender & Co., *Liquor law Liability*, Ref. 14-401, Pub. 498).

#### Scientific Evidence:

- An analysis of traffic fatalities across all states of the effect of tort liability on commercial servers for selling alcohol to underage drinkers showed a reduction of fatality rates for drivers aged 15 to 20 over time and states (Sloan et al., 2000).

### ★★★ Strategy: Dram Shop Liability Laws

Intermediate Variable(s): Drinking, Alcohol Serving and Sales Practices

Description: A special form of Tort Liability that allows individuals injured by a minor who is under the influence of alcohol or by an intoxicated adult 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). Although retail alcohol outlets have long contended that drinkers who purchase alcohol from legal licensed establishments are responsible for the consequences of their own drinking, State legislatures and the courts under dram shop liability have established that providing alcohol to an obviously intoxicated person or in amounts that obviously lead to impairment can be grounds for a civil suit and possible damages. The use of dram shop liability has been advanced as a potential tool to deter sellers and social hosts from irresponsible selling or provision of alcohol (Mosher 1984; Holder et al., 1993). Youth are more likely than older people to be driving while impaired by alcohol (Gruenewalk et al., 1996). In some jurisdictions, the retailer can 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 dram shop liability statutes include a Responsible Business Practices Defense. This provision allows retailers to avoid liability if they can establish that they took reasonable steps to avoid serving minors and obviously intoxicated adults. Key to the defense is evidence that the retailer trained his or her staff, including both servers and managers; 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.

#### Scientific Evidence:

Research suggests that implementation of dram shop liability may lead to significant increases in checking age identification and greater care in service practices (Sloan et al., 2000).

- The available studies also indicate that dram shop liability laws can significantly reduce SVN crash deaths, alcohol-related traffic crash deaths, and total traffic crash deaths among minors (Chaloupka, Saffer, & Grossman, 1993; Sloan, Reilly & Schenzler, 1994; Sloan et al., 2000).
- 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, 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).
- A sudden change in exposure to legal liability of servers of alcoholic beverages in Texas resulted in 6.5 percent and 5.3 percent declines in injurious traffic crashes following the filing of two major liability suits in 1983 and 1984 (Wagenaar and Holder, 1991).

## ★★★ Strategy: Minimum Drinking Age

Intermediate Variable(s): Drinking

Description: For persons who are alcohol-dependent, the primary intervention is the treatment for alcoholism.

Scientific Evidence:

- A review of 32 published research studies both before and after the minimum drinking age law changed found solid scientific evidence that increasing the minimum age for purchasing alcohol reduced the number of alcohol-involved traffic crashes for those younger than 21 (U.S. General Accounting Office, 1987).
- 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 DUI. The result of implementation of a minimum drinking age of 21 years in New York state showed a 70% decrease in self-reported alcohol purchases by 19- and 20-year-olds (Yu, Varone & Shackel, 1997).
- The minimum age affected self-reported alcohol use among young people and reduced traffic crashes and the effect on vehicle crashes continued well after young people reached the legal drinking age (O'Malley & Wagenaar, 1991).
- Implementation of the uniform minimum legal drinking age of 21 in the United States reduced the overall prevalence of drinking and driving (Klepp, Schmid & Mirray, 1996).
- Raising the minimum legal drinking age from 18 to 21 decreased SVN crashes involving young drivers from 11 percent to 16 percent at all levels of crash severity (Saffer & Grossman, 1987a,b; Wagenaar, 1981, 1986b; Wagenaar & Maybee, 1986).
- Data from all 50 states and the District of Columbia for the years 1982 through 1997, showed that enactment of age 21 as the minimum drinking age law was responsible for a 19 percent 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 (Voas et al., 1999).
- The most comprehensive review to date analyzed 78 measures on all identified published studies (a total of 132) on the drinking age from 1960 to 1999 and 45 percent showed that a higher legal drinking age was associated with reduced alcohol consumption among youth except for five studies (Wagenaar & Toomey, 2002).
- In 57 published studies that assessed the effects of changes in the legal minimum drinking age on over 100 crash outcome measures (e.g. fatal crashes, drink-driving crashes, self-reported driving after drinking), more than 50 percent indicated that raising the drinking age reduced crashes and lowering the age raised the crash rate. The studies showed a statistically significant effect of changing the drinking age on vehicle crashes (Wagenaar & Toomey, 2002).

## ★★ Strategy: Minimum Purchase Age Law Enforcement

Intermediate Variable(s): Drinking

Description: Restrictions on retail access to alcohol through the establishment of minimum purchase age (MPA) laws. The minimum drinking age in all 50 states is 21 years. Similar to laws regarding youth tobacco access, restrictions on youth alcohol access were shown to be effective only with an enforcement component.

Scientific Evidence:

- Raising the MPA has resulted in decreased alcohol consumption (O'Malley & Wagenaar, 1991; Wagenaar, 1982; Williams & Lillis, 1986; Wagenaar & Toomey, 2002).
- An undercover buying operation conducted by the Michigan State Police found that underage purchases were reduced by 73%, from 75% at baseline to 20% by the program's conclusion (Michigan State Police, 1989).
- Underage police cadets in Denver were able to purchase 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 more the norm, resulting in youth apparently having readily available access to alcohol (Jones-Webb et al., 1997; Radecki & Strohl, 1991; Wagenaar et al., 1993).
- Strategies to limit youth access to alcohol have generally involved some combination of merchant education, community participation and mobilization, and enforcement through compliance checks and penalties for violators (OJJDP, 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, Murray & Gehan, 2000; Lewis et al., 1996).
- 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, 1995).
- Without adequate penalties, attempts to enforce the MPA are greatly reduced (Forster, Murray, Wolfson & Wagenaar, 1995; Wagenaar & Wolfson, 1994).

## ★★ Strategy: Alcohol Law Possession

Intermediate Variable(s): Drinking

Description: Another strategy used to reduce drinking among minors involves issuing penalties to youth themselves for possessing alcohol.

Scientific Evidence:



- Consistent enforcement of MPA laws, combined with penalties for possession, has been found to reduce alcohol-related crashes (Preusser & Williams, 1992).

## ★★ Strategy: Zero-Tolerance Laws

Intermediate Variable(s): Drinking

Description: Lower BAC limits for underage drivers and/or create a risk of loss of license when an underage youth has been found to be drinking, even if the youth was not driving. Usually this limit is set at the minimum that can be reliably detected by breath-testing equipment (i.e., .01-.02 BACs). Zero-tolerance laws also commonly invoke other penalties such as automatic license revocation.

Scientific Evidence:

- An analysis of the effect of zero-tolerance laws in the first 12 states enacting them showed a 20% relative reduction in the proportion of SVN fatal crashes among drivers younger than 21, compared with nearby states that did not pass zero-tolerance laws (Hingson et al., 1994; Martin & Andreasson, 1996).
- A review of reviewed six studies on the effect of zero-tolerance laws showed a reduction in injuries and crashes attributed to youthful drivers (Zwerling & Jones, 1999).
- A study of all 50 states and the District of Columbia in the United States demonstrated a net decrease of 24 percent in the number of young drivers with positive BACs that resulted from implementation of zero-tolerance laws (Voas et al., 1999).
- A 19 percent reduction in self-reported driving after any drinking and a 24% reduction in driving after five or more drinks was found using *Monitoring the Future (MTF)* survey data from 30 states (Wagenaar, O'Malley, & LaFond, in press).
- Differences in enforcement of zero-tolerance laws have been identified as a key issue in understanding why some programs are less successful than others (Ferguson, Fields, & Voas, 2000), as has lack of awareness on the part of young people (Balmforth, 1999; Hingson et al., 1995). The use of media campaigns to increase young peoples' awareness of reduced BAC limits and of enforcement efforts can significantly increase the effectiveness of zero-tolerance laws (Blomberg, 1992).

## ★ Strategy: Restrictions on Price Promotions and Alcohol Discounts

Intermediate Variable(s): Drinking, Alcohol Serving and Sales Practices

Description: Regulation or restriction of “happy hours” and other price promotions of alcohol, especially in on-premise outlets (i.e., bars and restaurants).

Scientific Evidence:

- Although this is a reasonable strategy, there is no research on its effectiveness.



## ★ Strategy: Alcohol Policies at Schools and Universities

Intermediate Variable(s): Drinking;

Description: School and university policies are 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 school policies that ban or provide restrictions for possession or provision of alcohol on school property. Such policies are popular among schools, colleges, and universities. 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, prohibiting the possession of alcohol by students (Modzeleski, Small, & Kann, 1999).

Scientific Evidence:

- Several studies provide promising but incomplete evidence of the potential for such administrative policies to reduce underage drinking (Wechsler, Kuo, Lee & Dowdall, 2000; Grimes & Swisher, 1989; Odo, McQuiller & Stretsky, 1999; Cohen & Rogers, 1997).

## ★★ Strategy: Increase in Alcohol Taxes

Intermediate Variable(s): Price, Alcohol Sales & Service Regulations, Enforcement & Sanctions

Description: Alcohol taxes are imposed either as *gallage taxes* that are based on the quantity of beverage sold or as a *percentage taxes* that are based on the selling price. Affects all individuals in jurisdiction.

Scientific Evidence:

- Effective in reducing consumption, motor vehicle fatalities, violence, and property crime.

## ★★ Strategy: Retail Price

Intermediate Variable(s): Price, Alcohol Sales & Service Regulations, Enforcement & Sanctions

Description: Retail price controls limit or prohibit the sale of alcohol using discounted prices.

Scientific Evidence:

- Price increases reduce motor vehicle accident fatalities among those aged 18 to 20 years (Dee, 1999; Dee & Evans, 2001). For example, an increase of 10 percent in alcohol price is estimated to result in 7 percent less drinking and driving among all men and more than 8 percent less drinking and driving among all women.
- Price effects were estimated to be even greater among young men and women, 13 and 21 percent, respectively (Kenkel 1993).
- After adjusting for inflation, increased beer taxes, combined with raising the MLDA, would reduce fatal crashes among those aged 18 to 20 by 15 percent (Saffer & Grossman, 1987a).

- Many studies have shown that increased alcohol costs are associated with reductions in both violent and nonviolent crimes (Cook & Moore, 1993; Grossman & Markowitz, 2001; Markowitz, 2000; Markowitz & Grossman, 1998, 2000; Saffer, 2001).
- Researchers have confirmed that higher taxes on alcohol consumption can reduce public health problems associated with alcohol including traffic crashes (Chaloupka et al., 1993; Cook & Tauchen, 1982).
- In general, using alcohol taxes as instrumental variables, traffic fatalities are found to be negatively related to prices, which follows the finding that alcohol consumption is strongly positively related to fatalities (Cook, 1981).
- Raising the MDLA to age 21 across all states, combined with higher beer taxes, decreased youth drinking, particularly among heavy users (Laixuthia and Chaloupka, 1993).
- A 10 percent increase in alcohol price would reduce cirrhosis mortality, which is typically seen in heavy drinkers, by an estimated 8 to 13 percent (Grossman, 1993; Cook & Tauchen, 1982).
- Data from the 1971-1975 and 1976-1980 National Health and Nutrition Examination Surveys indicated that raising beer prices and the MLDA appeared to decrease consumption among both light and heavy young drinkers (Coate & Grossman, 1988; Grossman et al. 1987).
- Discrepant results have shown that moderate drinkers were most price-responsive, whereas both light and heavy drinkers were not (Manning, Blumberg, & Moulton, 1995).

## ★★★ Strategy: Types of Retail Outlets

Intermediate Variable(s): Retail Availability

Description: As described under the intermediate variable, Retail Availability, whether in a formal or an informal market, alcoholic beverages are sold to retail customers in two forms: one is for consumption elsewhere (off-premise) and the other form is “on-premise” retail outlets. See the description there for more information on these forms.

Scientific Evidence:

- For off-premise outlets, a major policy decision has been whether (and which kinds of) alcoholic beverages can be sold in conjunction with other goods, and which other goods. When Finland changed in 1968 from selling beer only in government monopoly stores to selling it also in grocery stores, alcohol consumption rose by 50% in the next year, and alcohol problem rates also shot up (Bruun, Edwards, & Lumio, 1975). This practical impediment can be easily overcome if purchases of alcohol are combined with other routine life activities e.g. shopping for other goods (Abbey, Scott & Smith, 1993).
- Cross-sectional studies have found that drinking and driving is associated with bars and restaurants and particularly (in Australia) with bars serving beverages with high alcohol content (Gruenewald, Stockwell, Beel, & Dyskin, 1999; Gruenewald, Millar, Ponicki, & Brinkley, 2000; Stockwell, Lang, & Rydon, 1993).

- Using local land-use powers, communities in California often enforce early closing times to keep the closing-time disturbance in the neighborhood to a reasonable hour (Wittman, 1997). Setting closing hours at a time later than local public transport systems run invites unsafe journeys home.

## ★★ Strategy: Densities or Concentrations of Retail Outlets

Intermediate Variable(s): Retail Availability

Description: The number of outlets grows in response to population, and outlets are usually established along roadway systems. Outlet counts are either in terms of population densities (numbers of outlets per person) or geographic densities (numbers of outlets per kilometre of roadway). In developed societies, people may easily drive or use public transport to obtain alcohol.

The number of outlets may be restricted directly or indirectly through policies that make licenses more difficult to obtain (e.g., by 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.

Scientific Evidence:

- To limit the number of outlets for alcoholic beverages increases opportunity costs for obtaining alcohol, and may thus deter use and problems (Grossman, Coate, & Arluck, 1987; Gruenewald et al., 1993a).
- Outlet density is also higher in many U.S. cities today. Densities of bars, restaurants, and off-premise establishments have reached the level of one outlet for every 75 feet of roadway in many California cities (Gruenewald & Treno, 2000).
- Several longitudinal studies have demonstrated that changes in the number of outlets are related to changes in alcohol use. When overall availability is low, the addition of a few outlets can have noticeable effects on drinking. The results of a time-series cross-sectional analysis of alcohol consumption and density of alcohol outlets across 50 U.S. states results suggested that a 10 percent reduction in the density of alcohol outlets would reduce consumption of spirits from 1 to 3 percent and consumption of wine by 4 percent (Gruenewald, Ponicki & Holder, 1993b).
- The evidence is quite strong that formal systems hold down rates of alcohol consumption and alcohol-related problems. For example, alcohol retail monopolies are associated with lower levels of alcohol-related motor vehicles crashes. The evidence suggests that elimination of government off-premise monopolies typically increase total alcohol consumption. Thus, large-scale changes in alcohol distribution systems among states in the United States have led to great increases in the number of alcohol outlets; for example, the privatization of alcohol monopolies has resulted in increased alcohol sales (Holder & Wagenaar, 1990; Wagenaar & Holder, 1995).
- A variety of alcohol-related problems are more likely to occur where drinking places are clustered. These include motor vehicle crashes (Watts & Rabow, 1983; Rush, Glikson, & Brook, 1986; Scribner, MacKinnon, & Dwyer, 1995; Jewell & Brown, 1995; Gruenewald

et al., 1996) and pedestrian injury collisions (LaScala, Gerber, & Gruenewald, 2000; LaScala, Johnson, & Gruenewald, 2001). Findings have shown that alcohol-related problems respond to alterations in the availability of alcohol (e.g., measures of abuse [Chiu, Perez, & Parker, 1997] and motor vehicle crashes [Blose & Holder, 1987]).

## ★★ Strategy: Hours and Days of Sale

Intermediate Variable(s): Retail Availability, Drinking

Description: Changes in licensing provisions that substantially modify hours of service can have a significant effect on drinking and drinking-related problems overall. Studies suggest that reduced hours and days of sale can have net effects in reducing overall alcohol consumption and problems levels, with the effects concentrated during the times of closure but not matched by counterbalancing changes at other times of the week. Some states and communities prohibit on-premise or off-premise purchase of alcoholic beverages on Sundays or after a certain evening (not early morning) hour.

Scientific Evidence:

- A number of studies have indicated that changing either the hours or the days of alcohol sales can redistribute the times at which many alcohol-related crashes and other alcohol-related violent events occur (e.g., Smith, 1988; Ligon & Thyer, 1993; Nordlund, 1984, 1985; Hauge & Nordlie, 1984; Österberg & Säilä, 1991).
- The introduction of Sunday alcohol sales in the city of Brisbane, Australia, was related to casualty and reported property damage traffic crashes (Smith, 1988).
- Using local land-use powers, communities in California often enforce early closing times to keep the closing-time disturbance in the neighborhood to a reasonable hour (Wittman, 1997). Setting closing hours at a time later than local public transport systems run invites unsafe journeys home.
- The effect of longer hours of sales for licensed hotels in Perth, Western Australia, associated with impaired-driver road crashes and driver's breath-alcohol levels (BALs) resulted in a significant increase in monthly crash rates and assaults due to the high-alcohol-content beer, wine and spirits purchased in greater quantities by ETP hotels (Chikritzhs & Stockwell, 2002).

## ★★ Strategy: Outlet Location

Intermediate Variable(s): Retail Availability

Description: The location of alcohol sales outlets may be limited by a number of provisions at the local, state, or national level. For instance, typically the outlet cannot be located in violation of local zoning laws, which limit the outlets to particular kinds of commercial sites. Other common provisions, for instance in many U.S. states, forbid location near a school or place of worship. The density of outlets may be limited by requiring a minimum distance between them. Alcohol sales may also be forbidden at locations such 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.

#### Scientific Evidence:

- Little evidence is available on the extent to which these provisions influence overall rates of alcohol-related problems, although one study suggested 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).
- Studies of alcohol regulations suggests that restrictions on the physical availability of alcohol, including retail availability, can contribute to the reduction of alcohol-related problems. Specific effective policies include reductions in the hours and days of sale and the number of alcohol outlets, as well as restrictions on access to alcohol (Babor, et al, 2003).
- A spatial analysis of drinking-and-driving and alcohol-related crashes revealed that physical availability was unrelated to self-reports of driving after drinking and driving while intoxicated. However, physical retail availability was significantly related to rates of single vehicle night time (SVN) crashes and affected both local and adjacent area rates of crashes (Gruenewald et al., 1996).
- Studies of alcohol regulations suggests that restrictions on the physical availability of alcohol, including retail availability, can contribute to the reduction of alcohol-related problems. Specific effective policies include reductions in the hours and days of sale and the number of alcohol outlets, as well as restrictions on access to alcohol (Babor, et al, 2003)

### ★★★ Strategy: State Retail Monopolies

#### Intermediate Variable(s): Retail Availability

Description: One form of retail alcohol regulation retail outlets is for the government to monopolize ownership of one or more types. 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 operation for sales, and removed the private profit motive for increasing sales.

#### Scientific Evidence:

- State retail alcohol monopolies are associated with reduced underage drinking and reduced deaths of impaired drivers aged 20 and younger. In states with a retail monopoly over spirits or wine and spirits, an average of 14.5 percent fewer high school students reported drinking alcohol in the past 30 days and 16.7 percent fewer reported binge drinking in the past 30 days than did high school students in non-monopoly states. Monopolies over both wine and spirits were associated with larger consumption reductions than monopolies over spirits only. Lower consumption rates in the monopoly states, in turn, were associated with a 9.3 percent reduction in the impaired-driving death rate of drivers aged 20 and younger in monopoly states versus non-monopoly states. The analysis suggests that alcohol monopolies prevent 45 impaired-driving deaths each year (Miller, Snowden, Birckmayer & Hendrie, 2006).

- 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-premise outlets were replaced with privately owned outlets (Wagenaar & Holder, 1996).
- Several studies show substantial long-term increases in alcohol sales following privatization (Holder & Wagenaar, 1990; Wagenaar & Holder, 1991, 1995), although others only found short-term increases (Mulford, Ledolter, & Fitzgerald, 1992).

## ★★★ Strategy: Liquor by the Drink

Intermediate Variable(s): Retail Availability

Description: Allowing distilled spirits to be sold over the counter in licensed establishments (which has been called “Liquor by the Drink” or “LBD”) occurred in 20 plus states over several years after the end of American Prohibition.

Scientific Evidence:

- In an interrupted time-series analysis of North Carolina’s change in distilled spirits availability, individual counties that implement LBD in 1978 were compared to counties that continued the LBD ban from January 1973 through December 1982. Spirits sales rose from between 6 and 7.4 percent and LBD was also associated with statistically significant increases of 16 to 24 percent in both the number of police-reported alcohol-related accidents and in SVN accidents among male drivers aged 21 and older. No change in alcohol-related accidents was found for non-LBD counties (Blose & Holder, 1987).

**Table 2. Summary of Drinking Intermediate Variables and Related Intervention Strategies**

INTERMEDIATE VARIABLE	STRATEGIES
Drinking	Alcoholism treatment ★ ★ Dram shop liability laws ★ ★ ★ Hours and days of sale ★ ★ Responsible beverage service programs ★ ★ ★ Minimum drinking age ★ ★ ★ Zero tolerance laws ★ ★ Alcohol policies at schools & universities ★ Restrictions on price promotion & alcohol discounts ★ Minimum purchase age law enforcement ★ ★ Alcohol law possession ★ ★
Alcohol Sales & Service Regulations, Enforcement & Sanctions	Legal liability concerning alcohol sales & service to youth ★ ★ Increase in alcohol taxes ★ ★ Retail price controls ★ ★

INTERMEDIATE VARIABLE	STRATEGIES
Alcohol Serving & Sales Practices	Responsible beverage service programs ★ ★ ★ Dram shop liability laws ★ ★ ★ Legal liability concerning alcohol sales & service to youth ★ ★ Restrictions on price promotion & alcohol discounts ★
Price	Increase in alcohol taxes ★ ★ Retail price controls ★ ★
Retail Availability	Responsible beverage service programs ★ ★ ★ Densities or Concentrations of Retail Outlets ★ ★ Outlets Location ★ ★ Hours and Days of Sale ★ ★ Liquor by the Drink ★ ★ ★ Types of Retail Outlets ★ ★ ★ State Retail Monopolies ★ ★ ★



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