THE RELATIONSHIP OF 16 UNDERAGE DRINKING LAWS TO REDUCTIONS IN UNDERAGE DRINKING DRIVERS IN FATAL CRASHES IN THE UNITED STATES

J.C. Fell, D.A. Fisher, R.B. Voas, K. Blackman, A.S. Tippetts
Pacific Institute for Research and Evaluation
Calverton, MD

ABSTRACT

The minimum legal drinking age 21 (MLDA 21) legislation in the United States (U.S.) has been documented as one of the most effective public health measures adopted in recent times. This study reports on an effort to evaluate and interrelate a basic set of 16 laws directed at younger than age 21 youth that are designed to (a) control the sales of alcohol to youth, (b) prevent possession and consumption of alcohol by youth, and (c) prevent alcohol impaired driving by those younger than age 21. The first objective of this study was to determine whether there was any relationship between the existence and strength of the various underage drinking laws in a State and the percentage of younger than age 21 drivers involved in fatal crashes who were drinking. After controlling for various factors, the only significant finding that emerged was for the existence and strength of the law making it illegal for an underage person to use fake identification ($p<0.016$). The second objective was to determine if the enactment of two of the sixteen provisions (possession and purchase laws) was associated with a reduction in the rate of underage drinking driver involvements in fatal crashes. Analysis of variance (ANOVA) showed that there was a national 11.2% reduction ($p<0.05$) in the ratio of underage drinking drivers to underage non-drinking drivers in fatal crashes after the possession and purchase laws were adopted in 36 States and the District of Columbia (DC). This suggests that the two mandatory elements of the Federal MLDA 21 law are having the desired effect of reducing underage alcohol-related highway deaths.

THE PROBLEM

Since 1988, the minimum legal age to purchase or possess alcohol has been 21 in the United States. Yet this has not eliminated underage drinking. Almost half of 8th graders and about three-quarters of high-school seniors report that they have consumed alcohol at some time during the past year. More than half of the high-school seniors reported being drunk within the past year (Johnston, O'Malley & Bachman, 2000), and almost a third of the youths in the U.S. reported drinking alcohol at age 16 or younger.

Research suggests that alcohol abuse is involved in many problem behaviors among young people including getting into fights (Substance Abuse and Mental Health Services Administration [SAMHSA], 1999), college academic problems including dropping out of school (National Institute on Alcohol Abuse and Alcoholism [NIAAA], 1997) and alcohol-related traffic crashes (National Highway Traffic Safety Administration [NHTSA], 2001). Underage drinking is also related to youth crime, suicides, rapes, assaults, alcohol poisoning, and unintentional injuries. This costs society close to $62 billion annually (Miller, Levy, Cohen, et al., 2006).

UNDERAGE DRINKING LAWS IN THE STATES

Stimulated by the scientific and safety advocate support for limiting underage access to alcohol, a basic set of 16 laws directed at (a) control of sales to youth, (b) possession and consumption of alcohol by youth, and (c) prevention of impaired driving by those aged 20 and younger has been adopted over the last two decades in many of the 50 States and the District of Columbia (DC). Evidence exists that such laws can influence underage alcohol-related traffic fatalities (O'Malley & Wagenaar, 1991; Shults, Elder, Sleet, et al., 2001; Voas, Tippetts & Fell, 2003; Ponicki, Gruenewald & LaScala, 2007). From 1988 (when all States had enacted such MLDA 21 legislation) to 1995, alcohol-related traffic fatalities for youth aged 15 to 20 declined from 4,187 to 2,212, a 47% decrease, with wide variability in these declines between States (National Center for Statistics and Analysis, 2003). Since that time, however, this decline has ended; youth alcohol-related fatalities now fluctuate between 2,200 and 2,400, including slight increases since 1998. The stagnation in further reducing youth alcohol-related traffic fatalities has occurred despite the passage by all States of zero-tolerance (ZT) laws that made it an offense for drivers aged 20 and younger to operate a vehicle with any amount of alcohol in their system (blood alcohol concentration [BAC] > .00). The ZT laws were designed to strengthen the prior MLDA 21 laws.

Despite the promise of such laws, however, considerable public ambivalence has resulted in substantial variation between States in the comprehensiveness of such legislation. For example, although all States

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

It is assumed that the variability in States' laws as well as their strengths and limitations work together to produce different levels of deterrence. Although there is strong evidence of their effectiveness, some officials from local jurisdictions strongly oppose these MLDA 21 laws (e.g., Wasley, 2007). In fact, some States have adopted provisions that would automatically repeal their MLDA 21 legislation if Congress repealed the penalty for not having such legislation (Toomey, Rosenfeld, & Wagenaar, 1996). In 2005, five States introduced legislation to lower the drinking age for some segment of their population. This opposition to MLDA 21 is also one of the reasons why some of the laws have numerous exceptions that weaken them. Thus, the extent to which States should devote resources to controlling alcohol sales and consumption by young people remains an important policy question, at least at the local level.

OBJECTIVES

This study has two primary objectives: (1) to determine if there is an association between the existence and strength of MLDA 21 law provisions in the States and reductions in the rate of underage drinking drivers involved in fatal crashes in those States; and (2) to determine if the enactment of certain MLDA 21 laws is associated with reductions in the rate of underage drinking drivers involved in fatal crashes after the enactment date.

METHODS

DATA SOURCES FOR UNDERAGE DRINKING LAWS – The primary source of data for underage drinking laws in the States is the NIAAA *Alcohol Policy Information System (APIS)* dataset (1998–2005). *APIS* provides information on 15 of the 16 laws examined in this study. NHTSA's *Digest of Impaired Driving and Selected Beverage Control Laws* (NHTSA, 2006) was also used to obtain information on the license sanctions for violating ZT laws. For the final law, GDL, information from the Insurance Institute for Highway Safety (IIHS, 2006) was used.

SIXTEEN KEY UNDERAGE LAWS – The public generally assumes that the MDLA-21 is embodied in a single law and, therefore, all States have essentially the same law. In actuality, the MLDA 21 has

multiple provisions targeting outlets that sell alcohol to minors; adults who provide alcoholic beverages to minors; and underage persons who purchase or attempt to purchase, possess, or consume alcohol. In addition, there are companion laws that provide for lower BAC limits for underage drivers, GDL, and other legislation such as keg registration and social host liability laws (Table 1). These laws vary considerably from State to State, and no State has all of the 16 law components or regulations that were documented. Thus, the current U.S. effort to control underage drinking involves a variable package of policies.

To assess the relative strength among States for each of the 16 laws, a scoring system was developed to assign points for components of laws that should deter young people from using alcohol and to deduct points (i.e., reduce scores) for components that increase the likelihood of underage alcohol use or that make law enforcement more difficult. These assessments of components were based on empirical evidence, where it exists, and/or reasoned theoretical arguments. The scoring system was also reviewed by legal and traffic safety experts. Provisions such as family member and location exceptions, the type and severity of sanctions for violations, and applicability of the law across situations or substances (e.g., beer, wine, and distilled spirits) were among the variables coded. In all cases, the scoring was designed so that a value of zero corresponds with a State not having a law and higher values represent stronger laws. Such a scoring scheme is similar to that developed by the IIHS in its assessment of key components of GDL (IIHS, 2007). Because each law differs in the number of components assessed (and possible point additions or deductions), the base scores and total scores vary across the 16 laws. Thus, the total possible number of points for a law does not imply relative importance of that law compared to the other laws. Each law's point scale is independent, and the magnitudes of scores are *not* comparable between laws. These differences between laws in absolute value of their scores, however, do not affect the statistical analyses (i.e., do not make one law inherently more likely to predict the outcome measure). This is the case because the analyses examine whether the *variation* in a law's scores co-varies with the variance in underage traffic fatalities.

More information is given in the description of the first law (Possession) in order to lay the foundation for how the remaining laws were scored.

(1) Possession – All States prohibit possession of alcoholic beverages by people aged 20 and younger; however, many States apply various statutory exceptions. Location exceptions permit youth to legally possess alcohol in certain places such as a private residence. Family exceptions allow youth to possess alcohol under certain conditions such as the presence or permission of a family member (e.g., a parent/guardian or spouse). In most States, possession refers to a container, not alcohol in the body. Several States, however, have enacted internal possession provisions that permit police to press charges against underage drinkers because of

what is in their bodies. The data for this law came from the NIAAA APIS (updated through 1/1/2005) and, in part, from a *Washington Post* article on February 5, 2006, regarding internal possession provisions.

The three location exceptions (any private location, any private residence, parents'/guardians' home only) represent an ordered variable; for any given State only one location exception applies. Any private location is the most liberal location exception and thus results in a larger point deduction from a State's base score than the exception for parents'/guardians' home only, which is the most limited location exception. In addition, location exceptions may be conditioned on family variables (i.e., a minor can possess in any private location if a parent gives consent). Such situations are more circumscribed than a location exception that is unconditional (i.e., minor can possess in any private location). For any given location exception, conditional exceptions result in one-half the point deduction from the base score than the same unconditional location exception.

Scores:

- Any private location: -6.0 points (unconditional); -3.0 points (conditional)
- Any private residence: -4.0 points (unconditional); -2.0 points (conditional)
- Parents'/guardians' home only: -2.0 points (unconditional); -1.0 (conditional)
- Provision for internal possession (i.e., use of positive BAC as evidence of possession): +1.0 point

With a base score of 7 points allotted for having a possession law, scores can range from 0 (no law) to 8.0 (law with no location exceptions and one point for an internal possession provision).

(2) Consumption – Most States specifically prohibit minors (defined in this document as being younger than age 21) from consuming alcoholic beverages. Note that this means observed drinking in most cases, not merely the presence of a positive BAC from a breath test. As with possession, many States have one or more statutory exceptions to this law.

With a base score of 7 points allotted to a State for having a consumption law, scores can range from 0 (no law) to 7.0 (law with no location exceptions).

(3) Purchase – States were coded as having this law if their policies specifically prohibit the purchase or attempted purchase of alcoholic beverages by minors.

With a base score of 1 point (for having an underage purchase law), States are coded as 0 (no law), 1 (law with no provision for youth to purchase alcohol for enforcement purposes), and 2 (law plus ability to use minors in compliance checks).

(4) Furnishing/Selling – All States have laws prohibiting the furnishing of alcoholic beverages to minors. As with possession and consumption, many States have one or more exceptions to this law.

With a base score of 8 points for having a furnishing law, scores can range from 0 (no law) to 8.0 (law with no location exceptions and no affirmative defense for sellers).

(5) Age for On-Premise Sellers/Servers – State laws specify a minimum age for employees who serve or dispense alcoholic beverages in on-premise establishments. In some States, the minimum age for serving and bartending beer, wine, and/or spirits is 21; however, some States permit those younger than age 21 to sell alcohol. Additionally, some States specify conditions that must be met if employees younger than age 21 are permitted to serve or dispense alcohol, such as having a manager present.

Scores range from 0 (law does not require age 21 for both serving and bartending and the law does not provide for any conditions that must be met for underage youth to serve/bartend) to 8.0 (law requires age 21 for both serving and bartending).

(6) Age for Off-premise Server/Sellers – Most States have laws that specify the ages at which employees may sell alcohol in off-premise establishments. As with laws regarding the minimum age for on-premise servers and sellers, some States require employees be age 21 to sell beer, wine, and/or spirits; those that allow minors to sell may require certain conditions be satisfied.

Scores range from 0 (law does not require age 21 to sell alcohol) to 4.0 (21 minimum age to sell alcohol at off-premise establishments).

(7) Zero Tolerance – In all States it is illegal for people younger than 21 to drive with any measurable level of alcohol in their systems. States were coded as having this law if the minimum BAC limit for underage operators of noncommercial automobiles, trucks, and motorcycles was $\leq$.02. Information on license sanctions for violating ZT laws were extracted and coded from NHTSA's *Digest of Impaired Driving and Selected Beverage Control Laws* (NHTSA, 2006).

Scores range from 1.0 (discretionary criminal license sanction only with a maximum suspension period of 30 days or less) to 10.0 (both mandatory administrative and mandatory criminal license sanctions of 91 days or longer).

(8) Use and Lose – This term describes laws that authorize driver licensing actions against persons found to be using or in possession of illicit drugs, and against young persons found to be drinking, purchasing or in possession of alcoholic beverages. States vary in how many of the alcohol violations (i.e., underage purchase, possession, consumption) lead to a violation as well as whether the license suspension or revocation for violating the law is mandatory versus discretionary.

Scores range from 0 (no use and lose law) to 8.0 (license sanction is mandatory for all three violations—purchase, possession, and

consumption; minimum length of license suspension is 91+ days, and law applies to all youth younger than 21).

(9) Keg Registration – States were coded as having this law if they required wholesalers or retailers to attach an identification number to their kegs and collect identifying information from the keg purchaser.

For States that allow keg sales, scores can range from 0 (no law) to 7.0 (law prohibiting both unregistered/unlabeled kegs and destruction of the label on a keg, requiring a deposit regardless of amount, requiring two additional pieces of information be collected from purchaser beyond name and address, requiring active warning to purchaser). Utah, which prohibits kegs altogether, was assigned a score of 8.0 as banning kegs is a stronger method of keg regulation.

(10) Responsible Beverage Service (RBS) Training –Responsible beverage service (RBS) or "server training" programs involve (1) development and implementation of policies and procedures for preventing alcohol sales and service to minors and intoxicated persons and (2) training managers and servers/clerks to implement policies and procedures effectively. Such programs may be mandatory or voluntary. In APIS, a program is considered to be mandatory if State provisions require at least one specified category of alcohol retail employees (e.g., clerks, managers, or owners) to attend training. States with voluntary programs offer incentives to licensees to participate in RBS training such as discounts on dram shop liability insurance and protection from license revocation for sales to minors or intoxicated persons.

Scores primarily range from 0 (no RBS law) to 8.0 (mandatory program requiring both managers and servers to be trained, covering both on- and off-premise outlets and both new and existing licensees). A few States have both a mandatory program and a voluntary program (booster sessions), so scores could theoretically be as high as 13.0 if a State had both a strong mandatory program and a voluntary or booster program that included all four incentives.

(11) Use of Fake ID – All States prohibit the use of false identification cards by minors.

Scores range from 1.0 (law with no license sanction procedure) to 3.0 (law with administrative or both administrative and judicial license sanction procedures).

(12) Transfer/Production of False IDs – In some States, it is illegal to produce false IDs and/or to transfer an ID to another person.

Scores range from 0 (no law against providing false ID) to 1.0 (one action above prohibited) to a maximum of 2.0 (both actions—manufacturing/distributing and lend/transfer/sale—prohibited).

(13) Retailer Support Provisions for False ID – Some States include provisions to assist retailers in avoiding sales to potential buyers who present false identification.

Scores range from 0 (no retailer support provisions for false ID) to 5.0 (all provisions except general affirmative defense).

(14) Social Host Liability—Underage Parties – Social host liability refers to a law holding individuals criminally responsible for underage drinking events on property they own, lease, or otherwise control.

Scores range from 0 (no law) to 10.0 (general statute covering all underage actions, all property types, with negligence as the knowledge standard and no exceptions).

(15) GDL with Night Restrictions – GDL is a system in which beginning drivers are required to go through three stages of limited driving privileges. States were coded as having this law if they had a three-stage GDL system and if they had restrictions on unsupervised nighttime driving during the second stage. Limitations on nighttime driving are designed to reduce drinking and driving by underage drivers. Information for this law was provided by the IIHS (2006).

Scores range from 0 (no three-stage GDL with nighttime driving restrictions in intermediate phase) to 3.0 (three-stage GDL with nighttime restriction starting at 10 p.m. or earlier).

(16) State Control of Alcohol – There are two types of retail alcohol distribution: license and control (APIS uses the term "State-run"). For each alcohol beverage type (beer, wine, distilled spirits) a State may use a State-run distribution system, a system of private licensed sellers, or some combination of these. A State-run system is considered to have better control of the sale of alcohol.

Scores theoretically range from 0 (no part of retail distribution system is State-run) to 3.0 (State-run retail system for all three beverage types), although as no State has a State-run system for beer, scores range from 0 to 2.0.

In summary, Table 1 provides each State's scores for each law. Aside from issues relating to the level of enforcement and the publicity given to underage laws, there is substantial variation in the completeness with which States have adopted all components of these laws and the strength of adopted provisions.

Table 1. Status of 16 Key Underage Drinking Laws in the United States – January 2007

	(1) Possession (APIS)(1-8)	(2) Consumption (APIS)(0-7)	(3) Purchase (APIS)(0-2)	(4) Furnishing/selling (APIS)(5-8)	(5) Age 21 for on-premises servers/seller (APIS)(0-8)	(6) Age 21 for off-premises servers/sellers (APIS)(0-4)	(7) Zero tolerance (APIS)(1-10)	(8) Use and lose (APIS)(0-8)	(9) Keg Registration (APIS)(0-8)	(10) RBS Training (ABC)(0-11)	(11) Use of Fake ID (APIS)(1-3)	(12) Transfer/Production of False ID (APIS)(0-2)	(13) Retailer support provisions for false ID (APIS)(0-3)	(14) Social host—underage parties (APIS)(0-8)	(15) GDL with night restrictions (IIHS, CC)(0-3)	(16) State control of alcohol (PIRE)(0-2)
AL	7	7	2	8	5	1	7	7	0	7	2	0	0	5	2	1
AK	4	4	1	5	8	4	8	0	0	8	3	0	2	0	1	0
AZ	8	7	2	8	0	1	5	2	0	3	3	0	2	6	0	0
AR	7	0	1	8	5	1	3	0	0	6	2	2	2	0	0	0
CA	1	0	2	8	4	1	6	8	2	2	2	1	3	0	2	0
CO	4	4	1	5	2	4	8	6	0	2	2	0	3	0	2	0
CT	1	0	2	8	0	0	6	6	3	0	2	0	3	0	2	0
DE	5	5	0	6	4	4	8	4	0	8	1	0	0	0	3	0
DC	7	7	1	8	4	0	6	7	4	7	2	0	2	0	2	0
FL	7	0	1	8	0	0	8	5	0	7	2	0	2	3	2	0
GA	6	0	1	7	0	0	8	4	6	0	2	0	3	0	2	0
HI	4	0	2	8	2	1	7	0	0	0	1	0	1	5	2	0
ID	5	7	1	8	0	0	8	6	1	0	2	2	3	0	3	0
IL	5	5	2	8	0	0	8	3	0	3	3	2	2	4	2	0
IN	7	7	0	8	6	1	7	5	2	6	2	1	1	0	2	0
IA	5	0	1	6	0	0	6	3	0	0	3	0	2	0	1	0
KS	7	7	2	8	5	4	10	6	3	0	1	1	2	6	0	0
KY	7	0	1	8	0	1	2	0	0	0	2	0	2	0	0	0
LA	3	3	1	8	0	1	7	7	3	8	2	0	2	0	2	0
ME	5	5	1	6	2	1	7	0	3	2	2	1	3	7	2	0
MD	5	0	1	6	0	0	6	0	3	7	2	0	2	6	2	0
MA	7	0	1	8	0	0	7	6	3	0	2	2	2	6	2	0
MI	7	7	2	7	0	0	1	0	0	8	2	1	2	3	2	1
MN	5	6	1	7	0	0	6	0	3	0	2	1	3	0	0	0
MS	1	0	1	8	4	4	5	4	0	0	2	0	2	0	3	0
MO	8	0	1	8	4	1	7	0	3	0	2	1	2	0	1	0

Table 1. Status of 16 Key Underage Drinking Laws in the United States – January 2007 (cont.)

	(1) Possession (APIS)(1-8)	(2) Consumption (APIS)(0-7)	(3) Purchase (APIS)(0-2)	(4) Furnishing/selling (APIS)(5-8)	(5) Age 21 for on-premises servers/seller (APIS)(0-8)	(6) Age 21 for off-premises servers/sellers (APIS)(0-4)	(7) Zero tolerance (APIS)(1-10)	(8) Use and lose (APIS)(0-8)	(9) Keg Registration (APIS)(0-8)	(10) RBS Training (ABC)(0-11)	(11) Use of Fake ID (APIS)(1-3)	(12) Transfer/Production of False ID (APIS)(0-2)	(13) Retailer support provisions for false ID (APIS)(0-3)	(14) Social host—underage parties (APIS)(0-8)	(15) GDL with night restrictions (IIHS, CC)(0-3)	(16) State control of alcohol (PIRE)(0-2)
MT	7	7	1	8	0	0	8	3	0	6	2	2	0	0	2	1
NE	5	5	2	8	0	0	7	0	3	0	1	1	2	0	2	0
NV	1	0	1	8	8	1	8	6	0	5	1	2	2	0	3	0
NH	8	0	1	8	0	1	10	4	5	8	2	1	1	4	1	0
NJ	1	1	1	8	0	0	2	6	0	5	2	1	2	4	2	0
NM	4	0	1	5	4	4	8	2	3	8	1	1	2	0	2	0
NY	7	0	0	8	0	1	10	0	6	4	2	0	3	0	3	0
NC	7	7	1	8	0	0	5	4	0	2	2	1	2	0	3	1
ND	7	7	1	8	5	4	7	0	1	0	1	0	2	0	0	0
OH	7	7	2	8	0	0	7	0	0	0	3	2	3	8	1	0
OK	1	0	2	8	4	4	9	7	3	0	2	0	2	0	2	0
OR	5	5	2	8	0	0	8	5	5	11	2	0	2	6	2	1
PA	7	7	2	8	0	0	3	7	0	6	2	2	1	6	2	2
RI	7	0	2	8	0	0	2	5	3	7	2	1	3	0	1	0
SC	5	0	1	6	4	0	8	5	0	0	2	0	2	4	3	0
SD	8	7	1	8	5	0	3	6	0	6	2	0	0	0	3	0
TN	7	7	2	8	0	0	3	6	0	6	2	0	2	0	2	0
TX	7	7	2	8	0	0	8	6	0	2	2	0	2	0	2	0
UT	8	7	2	8	8	4	8	3	8	7	2	1	3	0	2	2
VT	8	7	0	8	0	0	9	0	5	8	1	1	2	0	0	1
VA	8	0	1	8	4	0	7	2	6	0	2	0	2	0	2	0
WA	7	7	2	8	5	1	7	7	6	7	2	2	0	6	1	1
WV	7	7	2	8	2	0	8	0	0	0	3	0	2	0	2	0
WI	7	7	1	8	0	0	6	3	0	6	2	2	3	5	2	0
WY	1	0	2	8	4	4	8	2	0	3	1	0	2	0	2	0
Total # with law	51	30	47	51	24	24	51	37	26	33	51	25	46	18	44	18

EXISTENCE AND STRENGTH OF UNDERAGE LAWS ANALYSIS – The aim of the first analysis was to determine if the existence and strength of any of the 16 underage drinking laws was associated with a reduction in the percent of drivers younger than 21 years old involved in fatal crashes who were drinking. To compute these percentages, Fatality Analysis Reporting System (FARS) data from 1998 to 2004 were used (most recent 7 years available at the time of the study). Stepwise Linear Regression was used to determine the associations (a cross-sectional between-State design). The predictors in the models were the percentages of alcohol-positive drivers aged 21 to 25 years and 26-and-older (also from FARS) and the 16 laws, the existence and strengths of which were coded separately for each State. The total number of alcohol-positive and alcohol-negative drivers from 1998-2004 (FARS) was used to compute the percentages of drivers from the three age groups (under 21, 21-25, 26+) who were drinking. The analysis determined whether the States with more or stronger laws had lower percentages of younger than 21 drivers involved in fatal crashes who were drinking. Variations in alcohol-involvement rates for this group were tested across States, in a "static" design (i.e., lacking pre-post designation of the laws). Variations between States in the strength of each law (including presence/absence of the law) were tested to see if they covaried with alcohol-involvement rates in FARS.

EFFECT OF THE ENACTMENT OF POSSESSION AND PURCHASE LAWS – The aim of the second analysis was to determine if the enactment of the possession and purchase laws was associated with a reduction in the ratio of drinking to non-drinking drivers younger than 21 years old who were involved in fatal crashes. Annual FARS data from 1982 to 1990 were used in this analysis because: (a) imputed BAC data are available only from 1982 and later in FARS; (b) most States implemented possession and purchase laws between 1982 and 1988; and (c) a wave of impaired driving laws were introduced after 1990 (e.g., ZT laws for youth, .08 BAC limits for adults, primary safety belt laws) and would be confounded with the effects of possession and purchase laws if the analyses were extended beyond 1990.

An Analysis of Variance (ANOVA) was used with the dependent (outcome) variable chosen as the annual ratio of drinking to non-drinking younger than 21 drivers in fatal crashes from FARS in each State. Since the possession and purchase laws were implemented on the same date in each State, only one intervention variable was created to represent both laws, with values from zero to one: zero for the absence of the laws, one for the presence, and a decimal representing the portion of the year during which the law was present. Geographical and socio-economic data available for the analyses were "State", "region", annual State unemployment rates, annual State vehicular miles traveled per capita (VMT), annual percent of

the State population living in an urban area (urbanization) and the annual State percentage of alcohol-positive drivers over 25 years old involved in fatal crashes. All of these factors have been shown to be important in analyses of this type (Voas, et al. 2003; O'Neill & Kyrychenko, 2006). In addition, the dates when the key impaired driving laws were enacted for administrative license revocation (ALR), .10 per se, .08 per se, primary safety belt and secondary safety belt enforcement laws in each State were also available. No State had implemented true ZT laws by the end of 1989. Using the implementation dates for the above laws, variables indicating the absence or presence of each of these laws in each State for each year were created. In addition, as with the possession and purchase laws, decimals were used to represent the portion of the implementation year during which the laws were in effect. These laws were all used as covariates in the models.

A categorical factor for "region" was included in the analyses because the available socio-economic variables were not adequate to explain all of the between-State variation in the outcome (ratio of drinking to non-drinking drivers under 21). "Region" represented the ten geographic divisions of the country (e.g., New England, Mid-Atlantic, Southeast, etc.) corresponding to the Regions that NHTSA uses. Economic conditions correlating with traffic risk and exposure have been shown to vary by region. The NHTSA Regions were included in the models as a way to control for unmeasured external factors that vary between States in a consistent manner. Panel-style models such as this would typically use "State" as a main effect to partial out all this between-State variance, but doing so uses 50 parameters or degrees of freedom (many of which would be non-significant individually). With so few data points available, using such a "State" factor risks overfitting the model. Because many of these unknown external factors that affect the outcomes are likely related to economic, demographic, and other environmental factors that cause these State-to-State differences to be similar within geographic region, tests were conducted to see if a "region" could account for much of this between-State "error" variance in a more parsimonious way, i.e., sacrificing far fewer degrees of freedom than a "State" factor. This greater statistical efficiency of "region" was indeed the case, and was used for these analyses instead of "State". (Incidentally, the "region" model also produced a more conservative estimate of the law effects than did the "State" model.)

"Year" was not used as a factor in the models since the presence or absence of the law is a linear function of "Year" and could produce colinearity problems. Finally, beer consumption was used as a covariate in the models because past studies have shown that this is significant in predicting alcohol involvement in fatal crashes. It is important to note that this consumption measure was total per capita beer consumption for the State and no separate figure for underage drinkers

was available. This measure also does not account for the fact that abusive drinkers drink on average much more than non-abusive drinkers.

There were 14 States that had implemented possession and purchasing laws prior to 1982. Because these States did not change law status during the years studied, they functioned as comparison States, and their alcohol involvement rates were used as a covariate in the model. As the 14 States that already had MLDA 21 were distributed throughout 8 of the 10 regions of the country that were used in the analyses, it was possible to pool the annual number of drinking and non-drinking crashes for those comparison States within the same region to compute an annual regional comparison ratio of drinking to non-drinking younger than 21 drivers. For these comparison States, the variation in the number of fatal crashes was less *within* regions than between regions. Therefore, the "region comparisons" model was considered a better alternative to using a single national comparison ratio of all 14 States that implemented the laws before 1982. However, since there were no comparison States in Region 1 (the New England States) and Region 2 (New York and New Jersey) with the possession and purchase laws implemented by 1982, the comparison States ratio for Region 3 (Delaware, District of Columbia, Maryland, Pennsylvania, Virginia and West Virginia) was also used as the comparison for both Regions 1 and 2. Plots of the ratios for the States with and without MLDA 21 laws prior to 1982 are shown in Figure 1. Note the convergence of the ratio in years 1988-1990 when all 50 States had MLDA 21.

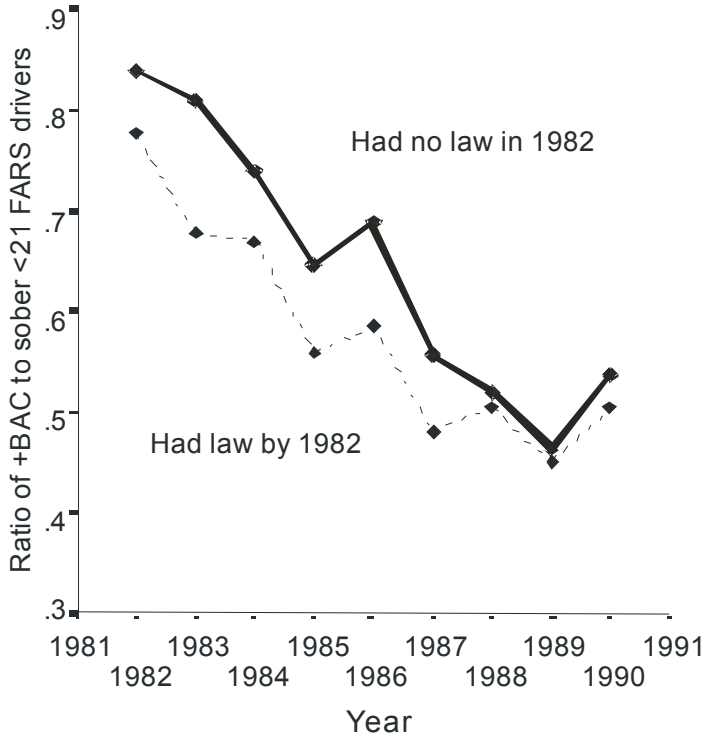

Figure 1. Ratio of drinking (alcohol-positive) to non-drinking (alcohol-negative) younger than age 21 drivers from FARS for States that had enacted the possession and purchase laws by 1982 and States that had not.

RESULTS

In the initial regression analyses that were used to examine the effect of the existence and strength of the 16 law components, only the percentages of drivers in the older age groups who were drinking and "False ID Use" were significant (Table 2). From State to State, a unit increase in the strength of the False ID Use law (law number 11 in Table 1) was associated with a 7.3% reduction in the outcome measure. The difference between the weakest and strongest False ID Use laws (two units on our scoring scale) represents a 14.1% difference. (Excluding the two older cohorts increases the effect size of False ID Use slightly but the other laws remained non-significant.)

Table 2. Final model for percent of younger than age 21 drivers with a positive BAC with the two older driver age groups and the 16 MLDA 21 laws included as covariates.

Parameter	B	Effect Size (% change)	SE	P-value	Tolerance
(Constant)	-0.484		0.440	.276	
Natural log of % of 26+ with +BAC	0.689		0.156	.000	.508
Natural log of % of 21-25 with +BAC	0.437		0.158	.008	.496
False ID- Use	-0.076	-7.32	0.035	.034	.966

Dependent Variable: Log of % under 21 drivers with +BAC. R^2 = 0.68

The ANOVA results pertaining to the effect of the enactment of the possession and purchase law components in 36 States plus DC between 1982 and 1990 are shown in Table 3. The "region" model for the reduced dataset was used because it makes use of the under-21 ratios for the regional comparison groups (the 14 States that already had MLDA 21). In this model, the significant predictors are the possession and purchase laws, the .08 law, the ALR law, the under-21 ratios in the comparison States, "urbanization", unemployment rates, per capita VMT, and "region". These results suggest that in the presence of the aforementioned covariates, the possession and purchase laws account for an 11.2% (p = 0.041) reduction in the ratio of alcohol-positive to sober younger than age 21 drivers involved in fatal crashes.

Table 3. Parameter estimates for the natural log of the ratio of drinking to non-drinking drivers younger than age 21 in fatal crashes. In this model, "region" and data from the 14 States that had the possession/purchase laws in place in 1982 serve as a covariate. (R^2 = 0.49).

Parameter	B	SE (B)	Effect Size* (%)	P-Value	95% CI for B		Variance explained (partial Eta^2)
					Lower	Upper	
Possession & Purchasing Laws	-0.12	0.06	-11.2 %	0.041	-0.23	0.00	0.01
.08 Law	-0.80	0.24	-55.1 %	0.001	-1.27	-0.33	0.03
ALR Law	-0.26	0.05	-22.6 %	<0.001	-0.35	-0.17	0.09
Under 21 ratio in comparison[1] States *(in log transformed metric)*	0.46	0.11		<0.001	0.24	0.68	0.05
% Urbanization	-0.32	0.15		0.038	-0.62	-0.02	0.01
Unemployment	0.03	0.01		0.022	0.00	0.05	0.02
VMT per licensed driver	0.03	0.02		0.048	0.00	0.06	0.01
Categorical Factors	F-statistic	df		P-Value			partial Eta^2
Region (Region 10 = Ref cat)	16.68	9		<0.001			0.32

*Effect size is the percentage change in the outcome variable's metric, per unit change in the predictor variable. For binary variables representing presence/absence of a law, it can be interpreted as the proportional amount of change in the outcome associated with the presence of a law.

The effect size found for the .08 law here should be viewed with caution. The estimate is based on the four earliest States to implement the law—Oregon Utah, Maine, and California—and for each of these States there were very few pre- or post-law data points from which to estimate the change. This parameter for the .08 effect is likely biased and not

reflective of the entire breadth of .08 States, nor even of the longer-range experience of these four States.

An alternative model (not shown here) that includes a covariate for the older-aged driver cohorts within the same States as a comparison produces similar results (unemployment and VMT were no longer significant, as the within-State cohort likely explained much of the same variance these covariates had). Although that alternative model explains a slightly greater proportion of total variance (R^2= .55), it is also likely to dampen the parameter estimates for any law implementation that should impact both youth and adult drivers, such as ALR and .08. With the inclusion of the older cohort, the effect size of the Possession and Purchase Laws is slightly less at 9.1% but still significant. (p=.047)

DISCUSSION

Only 1 of the 16 laws examined showed an association with reductions in underage drinking drivers in fatal crashes. While this appears surprising, there were various methodological limitations that made detection of an impact difficult. Perhaps the way the "strengths" of the laws were coded had something to do with this. Although the coding was guided by extant empirical evidence, theory, and consultation with traffic safety and legal experts, such assessments of key legal provisions are not simple or straightforward. This is relatively new territory in the analyses of underage drinking. Although some similar attempts have been undertaken such as by IIHS to quantify the components of GDL laws by using a point system, few precedents exist. Secondly, the statistical analysis method—cross-sectional between-State design—that had to be used (because APIS did not document the implementation dates for most of the laws) made it impossible to incorporate a pre-post element. This essentially "static" design, in which all test relationships are between-State, greatly reduces the sensitivity to detect effects of laws. Similarly, the pooling of years within each State into a single data point per State meant having a sample N of only 51 cases for this analysis, which likely influenced the results (or lack thereof). Also, the 16 laws were tested in the model simultaneously, and with the amount of overlap (or cross-correlation) among the laws, finding an incremental or differential effect for additional variables would be very difficult once the most significant law has been modeled. Finally, it should be noted that our outcome variable, drivers in fatal crashes, only represents the tip of the iceberg of the crashes that these laws were designed to impact. If moderate or lower risk youth drivers are being prevented from drinking and driving, it may not be discernable within the most serious crashes (fatalities) whereas it might be detectable within the much larger pool of non-fatal crashes.

The 16 laws examined here should generally function to reduce youth access to alcohol and related problems. Thus, our analyses sought to assess the full complement of relevant laws to determine overall which

laws are most strongly related to reductions in underage drinking driver fatalities. It is important to note, however, that differences across States in patterns of underage use and drinking-related problems may exist that call for varying mixes of legal provisions. Such differences across States in effectiveness of laws could also explain why we found few significant results.

A likely additional explanation is that the awareness of these laws by youth and the enforcement of these laws plays a much greater role than their existence or strength. The one law that indicated an association with reductions in underage drinking drivers in fatal crashes was that law prohibiting the use of fake identification. This seems logical for the following reasons: (1) most youth are probably keenly aware that it is illegal to use a fake ID (this is especially true after 9/11); (2) this is a premeditated illegal act (the youth must show the ID to some authority such as a bouncer, bartender, store clerk) that may inherently decrease its occurrence if the sanction is considered severe; (3) there is at least a loss of one's driver's license for a conviction and many youth highly value their driving privilege. Some youth may even think that getting caught with a fake ID is a more severe offense since 9/11. There has been some enforcement of this provision in the States and it has the potential to cut back on some of the commercial access to alcohol that youth were using—thus, its potential impact on drinking and driving.

The finding that the possession/purchase laws were associated with a significant reduction in the ratio of drinking to non-drinking underage drivers in fatal crashes is consistent with previous research even though substantially different methods were used. The 11% reduction may be considered conservative compared to findings from other studies (Arnold, 1985; Hedlund, Ulmer, & Preusser, 2001; O'Malley et al., 1991; Shults et al., 2001; Toomey et al., 1996; Voas et al. 2003; Womble, 1989). In this study, more factors were accounted for as covariates (including regional variation); the period selected was unique; and the comparison to 14 States that already had MLDA 21—with contrasts stratified within region—was unique and might serve to dampen the effect found by others. Our earlier study (Voas et al., 2003) which suggested a 19% decrease, had used many of the same covariates as this study, but without the explicit contrast of comparison States within region, or the regional stratification to account for the 'panel' effect of cross-sectional correlated error within regions. Our earlier study had also examined a longer time period that overlapped with the wave of ZT laws being implemented in the 1990s, which we excluded in this study. Another likely explanation for the more conservative effect size found here is that any within-State temporal correlation of errors was not fully accounted for using time series style parameters. We expect that doing so would result in smaller error variance, and likely greater sensitivity to detecting the laws' effects.

Most of the basic underage drinking laws have been in place since the mid-1980s and have produced a substantial reduction in underage

drinking. Some laws (GDL, Keg Registration, and ZT) have been adopted more recently. Nevertheless, teenagers as young as 13 appear to find it easy to obtain alcohol, and alcohol-related deaths of drivers aged 20 and younger have not changed in the last decade and remain a serious problem. The lack of differentiation between 16 laws considered in this study suggests that MLDA laws are primarily having their impact through deterrence created through public media and general familiarity with the age 21 limit. It is doubtful that youth are aware of the existence of each of the MLDA 21 law components in their State. Where differential impacts of the various component laws might be measured is in the extent to which they are enforced which is believed to vary substantially from State to State. Unfortunately, information on the level of enforcement of MLDA laws is very difficult to obtain. Some of the MLDA elements may lend themselves to effective enforcement more than others and as a result providing a better basis for mounting programs that will be effective in producing a further reduction in underage drinking. This study, which could only analyze the presence or absence of the law, did not have the opportunity to uncover the impact of enforcement, which may be the most important factor in MLDA effectiveness.

CONCLUSION

The results seem to support stronger laws against use of false ID and to confirm previous research and recommendations regarding the presence (but not strength) of purchase and possession laws. Even without substantial enforcement, it is important that States adopt effective MLDA 21 laws (Toomey et al. 1996) to have a good foundation in preventing, or at least reducing, underage drinking. Further research is needed to address the following questions:

- What are the enforcement levels of the 16 components of the underage drinking laws and are they related to underage drinking deterrence?
- What characteristics of the State (e.g., other laws, enforcement intensity) are associated with significant decreases in underage drinking driver fatal crashes?

The enactment dates are also available for ZT laws, GDL laws, keg registration laws, and use-and-lose laws in the States. Thus, analyses similar to the second one described in this report will be performed to test the effects associated with their implementation. The results of these and other analyses will help States establish a legislative agenda that will focus on the most effective laws and policies they do not already have.

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