Assessing the Impact of Twenty Underage Drinking Laws

JAMES C. FELL, M.S.,[a],* MICHAEL SCHERER, PH.D.,[a] SUE THOMAS, PH.D.,[a] & ROBERT B. VOAS, PH.D.[a]

[a]Calverton Center, Pacific Institute for Research and Evaluation, Calverton, Maryland

ABSTRACT. Objective: Over the last two decades, many states have adopted several of the 20 laws that aim to control youth access to and possession of alcohol and prevent underage drinking in the United States. However, many of these laws have not been evaluated since their adoption. The objective of this study was to determine which minimum legal drinking age 21 (MLDA-21) laws currently have an effect on underage drinking-and-driving fatal crashes. **Method:** We updated the effective dates of the 20 MLDA-21 laws examined in this study and used scores of each law's strengths and weaknesses. Our structural equation model included the 20 MLDA-21 laws, impaired driving laws, seat belt safety laws, economic strength, driving exposure, beer consumption, and fatal crash ratios of drinking-to-nondrinking drivers under age 21. **Results:** Nine MLDA-21 laws were associated with significant decreases in fatal crash ratios of underage drinking drivers: possession of alcohol (-7.7%), purchase of alcohol (-4.2%), use alcohol and lose your license (-7.9%), zero tolerance .02 blood alcohol concentration limit for underage drivers (-2.9%), age of bartender ≥21 (-4.1%), state responsible beverage service program (-3.8%), fake identification support provisions for retailers (-11.9%), dram shop liability (-2.5%), and social host civil liability (-1.7%). Two laws were associated with significant increases in the fatal crash ratios of underage drinking drivers: prohibition of furnishing alcohol to minors (+7.2%) and registration of beer kegs (+9.6%). **Conclusions:** The nine effective MLDA-21 laws are estimated to be currently saving approximately 1,135 lives annually, yet only five states have enacted all nine laws. If all states adopted these nine effective MLDA-21 laws, it is estimated that an additional 210 lives could be saved every year. (*J. Stud. Alcohol Drugs, 77,* 249–260, 2016)

STIMULATED BY THE SCIENTIFIC AND SAFETY advocate support for limiting underage access to alcohol, a basic set of at least 20 laws directed at (a) control of furnishing and selling alcohol to youth, (b) possession and consumption of alcohol by youth, and (c) prevention of impaired driving by those age 20 and younger have been adopted over the last three 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; Ponicki et al., 2007; Shults et al., 2001; Voas et al., 2003). From 1988—when all states had enacted minimum legal drinking age 21 (MLDA-21) legislation—to 1995, alcohol-related traffic fatalities for youth ages 15–20 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). Efforts in further reducing youth alcohol-related traffic fatalities have included the passage by all states of zero-tolerance laws, which make it an offense for drivers age 20 and younger to operate a vehicle with any amount of alcohol in their systems (blood alcohol concentration [BAC] > .00). These zero-tolerance laws are 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. Although there is strong evidence of their effectiveness, some officials from various organizations strongly oppose these MLDA-21 laws (Fell, 2013; Wasley, 2007). 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 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 youth remains an important policy question.

Numerous studies (Klepp et al., 1996; O'Malley & Wagenaar, 1991; Voas et al., 1999; Wagenaar, 1982; Wagenaar & Toomey, 2002; Williams & Lillis, 1986; Yu et al., 1997), including a comprehensive review of literature from 1960 to 1999 by Wagenaar and Toomey (2002), uniformly showed that increasing the minimum drinking age significantly decreased self-reported drinking by young people, the number of fatal traffic crashes, and the number of arrests for driving under the influence involving youths ages 20 and younger. Shults et al. (2001) conducted a meta-analysis of 33 studies of the MLDA. They reported that the MLDA resulted in changes of 10% to 16% in fatal crashes: increasing fatal crashes if the MLDA was lowered, and decreasing fatal crashes if it was raised. Kypri et al. (2006) found that when New Zealand lowered its drinking age from 20 to 18, crash injuries among 15- to 19-year-olds increased.

Recent legal research involving the use of the Alcohol Policy Information System (APIS; National Institute on Alcohol Abuse and Alcoholism [NIAAA], 2013) has indicated that there are at least 20 MLDA-21 laws that have been adopted at the state level in the United States (Fell et al., 2015). Table 1 contains a brief summary of those 20 laws; in

TABLE 1.   Minimum Legal Drinking Age 21 (MLDA-21) law components and descriptions

MLDA-21 law components	Description
Core laws that apply to youth	
1. Possession	Illegal for youth under age 21 to possess alcohol (50 states + DC)
2. Purchase	Illegal for youth under age 21 to purchase or attempt to purchase alcohol (47 states + DC)
Expanded laws that apply to youth	
3. Consumption	Illegal for youth under age 21 to consume alcohol (34 states + DC)
4. Internal possession	Evidence of possession and consumption via a blood alcohol concentration test (9 states)
5. Use and lose	Alcohol citation for youth under age 21 results in driver's license suspension (39 states + DC)
6. Use of fake ID	Fake ID minor—illegal for youth under age 21 to use a fake ID to purchase alcohol (50 states + DC)
Apply to youth driving	
7. Zero tolerance	Illegal for a driver under age 21 to have any alcohol in their system when driving (50 states + DC)
8. GDL with night restrictions	Youth with intermediate or provisional license prohibited from driving without an adult in the vehicle past a certain hour at night (50 states + DC)
Apply to providers	
9. Furnishing or selling	Illegal to furnish or sell alcohol to a youth under age 21 (50 states + DC)
10. Age of on-premise servers	Minimum age 21 set for selling/serving alcohol (13 states)
11. Age of on-premise bartenders	Minimum age 21 for bartenders (23 states + DC)
12. Age of off-premise sellers	Minimum age 21 set for selling/serving alcohol (23 states)
13. Keg registration	Identification number for beer keg and purchaser required (30 states + DC)
14. RBS training	RBS training mandatory or voluntary (37 states + DC)
15. Retailer support provisions for fake ID	Provisions to assist retailers in avoiding sales to youth under age 21 (45 states)
16. Social host prohibition	Prohibits social hosting of underage drinking parties (28 states)
17. Dram shop liability	Action against commercial provider of alcohol (44 states + DC)
18. Social host civil liability	Action against noncommercial (private) provider of alcohol (33 states)
Apply to manufacturers or suppliers of fake ID	
19. Transfer/production of fake ID	Fake ID supplier—prohibits manufacturing and/or supplying fake ID to youth for the purposes of buying alcohol (24 states)
Apply to states concerning control of alcohol distribution	
20. State control of alcohol sales	A state-run retail distribution system of alcoholic beverages (i.e., beer, wine, distilled spirits) (11 states)

Notes: DC = District of Columbia; ID = identification; GDL = graduated driver licensing; RBS = responsible beverage service.

parentheses is the number of states (including DC) that have currently adopted each law.

A major question concerning these laws is: It has been 30 years since some of these laws were adopted. Which laws are still effective in reducing underage drinking driver fatalities?

The 20 MLDA-21 laws used in this study were scored in a prior study for their strengths and weaknesses based on (a) the sanctions enacted for violating the law, (b) any exceptions or exemptions affecting the application and enforcement of the law, and (c) any provisions that could affect the law or its enforcement negatively or positively (Fell et al., 2015). In this current study, we adopted the strength scores of these laws to assess the impact of 20 MLDA-21 laws on underage alcohol-related outcomes, including underage drinking-and-driving fatal crashes and per capita beer consumption (for individuals ≥ age 15), while controlling for a series of potentially confounding variables. An example of how three MLDA-21 laws were scored appears in Table 2 (from Fell et al., 2015).

Method

MLDA-21 laws

We first conducted legal research to update the effective dates of 11 of the 20 MLDA-21 laws examined in our pre-

TABLE 2.   Examples of law strength scoring criteria (adapted from Fell et al., 2015)

Scoring criteria	Weight-point values
Possession law	
Law present	+11.0 points
Any private location exception	-6.0 points for unconditional
	-3.0 points for conditional
Any private residence exception	-4.0 points for unconditional
	-2.0 points for conditional
Parent/guardian home only exception	-2.0 points for unconditional
	-1.0 point for conditional
Parental and/or spousal exception not conditional on location exception	-4.0 points
Use and lose: Driving privileges law	
License sanction applicable to underage purchase	+2.0 points if mandatory
	+1.0 point if discretionary
License sanction applicable to underage possession	+2.0 points if mandatory
	+1.0 point if discretionary
License sanction applicable to underage consumption	+2.0 points if mandatory
	+1.0 point if discretionary
Upper age limit less than 21 years	-1.0 point
Minimum length of criminal license sanction	+0.0 points for 30 days and less
	+1.0 point for 31 to 90 days
	+2.0 points for 91 days or longer
False ID—Retailer support provisions	
Retailer support provisions	+1.0 point for incentives for retailers to use scanners
	+2.0 points for distinctive licenses for persons under age 21
	+1.0 point for seizure of suspicious ID by retailer permitted
	+1.0 point for right to sue minor
Affirmative defense	-1.0 point for general defense
	+0.0 points for specific or none

Note: ID = identification.

vious studies (Fell et al., 2009, 2014). The 11 laws examined previously include six laws from the first study (Fell et al., 2009; [1] possession, [2] purchase, [3] use and lose, [4] zero tolerance, [5] keg registration, and [6] graduated driver licensing [GDL] with nighttime restrictions) and five laws from the second study (Fell et al., 2014; [7] fake identification [ID] for minors, [8] fake ID for suppliers, [9] fake ID for retailers, [10] social host civil liability, and [11] social host prohibition). Subsequently, we conducted original legal research to determine the effective dates of the remaining nine MLDA-21 laws ([12] age of server, [13] age of bartender, [14] age of seller, [15] consumption, [16] dram shop, [17] furnishing, [18] internal possession, [19] responsible beverage service (RBS), and [20] state control of alcohol). Our legal research indicates that Utah is the only state that has adopted all 20 MLDA-21 laws, whereas Kentucky has adopted only 9 (Fell et al., 2015). Only 5 MLDA-21 laws have been adopted by all 50 states and DC (Table 1).

To complete this legal research, we used the APIS general protocol "Conducting Legal Research on Activity 6 Policies, General Protocols," the online legal research tools Westlaw and HeinOnline, and information obtained directly from states to complete the data set.

Our previous research has demonstrated that not only does the inclusion of law strengths provide for a better fit-

ting structural model, but also states with stronger key laws (i.e., laws that have been shown in prior research to have associations with decreases in fatal alcohol-related crash ratios) generally demonstrate lower rates of both fatal alcohol-related crashes among drivers under age 21 and lower rates of per capita beer consumption (Fell et al., 2015). As such, it was deemed necessary to incorporate law strengths into the current model as well.

Although most states prohibit individuals younger than age 21 from consuming alcoholic beverages, the consumption law specifically prohibits the observed drinking of alcohol rather than the presence of a positive breath alcohol concentration test. Conversely, the internal possession law deals with evidence of alcohol in a minor's body, which may be established by blood, breath, or urine tests and is not reliant on actually observing the minor possessing or consuming the beverage. If a minor was seen consuming alcohol and then tested positive for alcohol in a breath test, he or she would be in violation of the possession law (for having had the alcohol in his or her possession), the consumption law (for having been observed drinking alcohol), and the internal possession law (for having tested positive on a breath test). Many states have exceptions to these laws including location (i.e., private vs. public and private residences) and whether the underage person is with a parent or a spouse who is of legal drinking age.

Age of server, age of bartender, and age of seller are laws that specify a minimum age for employees who serve alcohol, bartend, or sell alcohol, respectively. In some states, the minimum age for handling beer, wine, and/or distilled spirits is 21. In some of the states that permit those younger than age 21 to handle alcoholic beverages, a manager must be present at all times to supervise.

Dram shop liability often pertains to private legal and civil litigation against a commercial alcohol retailer for damages or injuries caused by providing alcohol to minors. Similarly, the furnishing law prohibits the sale or dissemination of alcoholic beverages to minors. The key difference between these two laws is the person or entity bringing about legal action as a consequence of providing alcohol to a minor. For example, if a minor was to enter a bar, become intoxicated, and get into a multiple-vehicle crash on his or her way home, the driver the minor crashed into would be able to take legal action against the bar under the state dram shop law. The state may also pursue additional penalties against the establishment for providing alcohol to the minor under the furnishing law.

RBS laws require or incentivize retail alcohol providers to participate in programs to develop and implement policies and procedures for preventing alcohol sales and services to minors and intoxicated individuals. RBS programs may also provide guidelines and incentives for establishments to train managers and servers to implement alcohol-related policies and procedures effectively. Such programs vary considerably throughout the United States and can include mandatory or voluntary RBS training components, or both.

State control of alcohol refers to the type of retail alcohol distribution system used by a state. For each alcoholic beverage type (beer, wine, or distilled spirits), a state may consider a distribution system that involves a network of private licensed sellers, a state-run distribution system, or a combination of the two. A state may have control over one, two, or all three types of alcohol.

Traffic fatalities

Annual traffic fatality data from 1982 to 2012 for each state were drawn from the National Highway Traffic Safety Administration's (NHTSA) Fatality Analysis Reporting System (FARS; NHTSA, 2014). FARS is a continuous census of vehicular crashes that (a) resulted in the death of an individual within 30 days of the crash, (b) occurred on U.S. public roadways, and (c) had been investigated and reported by police. The involvement of driver alcohol in the crash is drawn from positive BAC tests. When these data are incomplete or missing, the BACs of drivers in the FARS database are imputed from police assessment of drinking, time of the crash, number of vehicles in the crash, and age and gender of the driver (Subramanian, 2002). The imputation process was validated on cases with

a tested BAC but using only the other variables to estimate a BAC and produced very close matches to the measured BACs in those validations.

Any number of variables could potentially affect the rates of crashes involving drinking drivers (e.g., road conditions, geographical considerations, variations in enforcement). Although it would be ideal to measure and control for each of these variables, obtaining accurate operational measures for each variable in each state would not be possible. However, because many of these unknown factors likely also affect crashes not involving drinking drivers, the use of a "nondrinking driver" control condition should provide an adjustment for the unmeasured factors that potentially affect fatal crashes.

One method of accounting for a control condition is the use of ratios of drinking drivers involved in crashes to nondrinking drivers in crashes (Fell et al., 2009; Voas et al., 2007). The use of ratios would mean that drinking drivers in crashes would be in the numerator, and nondrinking drivers in crashes would be in the denominator. As a result, any change in the number of drinking drivers in crashes will only change the numerator and, subsequently, allow for a more accurate appraisal of the change. For the purposes of the current study, these outcome measures were computed from FARS data for each year by state using two driver age groups: age 20 and younger versus age 26 and older. This gave us the ratio of positive to negative BACs for those age 20 and younger and for those age 26 and older. As was the case in Fell et al. (2009), we also avoided using data on drivers between ages 21 and 25 (Fell et al., 2009), which allowed us to examine two groups of drivers without concern of potential MLDA-21 law carryover effects. By carryover effects, we mean, for example, driving under zero-tolerance laws (illegal to have any alcohol in their system when driving) during the years when drivers are under age 21 might still affect the behavior of drivers ages 21 to 25 by habit. By age 26, however, it is reasonable to assume that the effect (if any) has worn off.

Beer consumption

Per capita beer consumption rates were obtained for individuals age 15 and older by year and state from the annual publication of NIAAA's Alcohol Epidemiologic Data System. Beer consumption rates were only available as general numbers by state and year and not available for partitioning into age groups. In the current research, we hypothesized that almost all MLDA-21 laws (with the exception of GDL nighttime) could have a potential impact on beer consumption because underage drinkers consume at least 11% of all beer (Office of Juvenile Justice and Delinquency Prevention, 2005), and this would also affect underage FARS ratios (Voas et al., 2007).

Impaired-driving laws

As was the case in our previous studies, we selected three laws that have been empirically shown to affect drinking-and-driving behaviors (Klein, 1989; Shults et al., 2001; Voas et al., 2000; Wagenaar & Maldonado-Molina, 2007; Wagenaar et al., 2007). These laws include (a) lowering the BAC limit for driving from .15 to .10, followed later by (b) lowering the BAC limit from .10 to .08, and (c) administrative license revocation laws—automatic and immediate license revocation if BAC exceeds the legal limit. All three of these laws were coded as 0 if the law was absent and 1 if the law was present, whereas years in which the law was implemented were coded as a fraction to indicate what percentage of the year was covered by the law. For example, a law in effect in September would be present for only one third of that year and was coded as 0.33.

Seat belt safety laws

We also included laws that generally address the safety of drivers on the road, which would likely affect traffic fatalities. Specifically, these refer to primary and secondary seat belt laws (Voas et al., 2007). Both primary and secondary seat belt laws were coded as 0 if they had no law or 1 if they had each law. With secondary seat belt use laws, police must stop a driver for another traffic violation (e.g., speeding) before they can cite the driver for not wearing a seat belt. Primary seat belt laws allow police to stop and issue citations to drivers directly for not wearing a seat belt. Previous research has demonstrated that states that change to primary seat belt enforcement laws experience significantly lower rates of alcohol-related fatal crashes compared with non–alcohol-related fatal crashes (Voas et al., 2007).

Employment and driving exposure

Employment and driving exposure were estimated by using two measures: state unemployment rates and vehicle miles traveled (VMT). Data on VMT were drawn from the Federal Highway Administration, which produces an annual estimate of total VMT by state and year. Unemployment statistics were drawn from the Bureau of Labor Statistics, which publishes monthly employment statistics by state. To ensure that the population that is unemployed but no longer counted in the census, the current study used unemployment statistics designated as U-4, U-5, and U-6 that capture discouraged workers or those no longer counted by the census. Both of these indicators have been found to be associated with drinking driver rates in fatal crashes (Tippetts et al., 2005; Voas et al., 2000, 2003).

Data analysis

The data were analyzed using structural equation modeling (SEM) techniques with Analysis of Moment Structures

(AMOS v21), an SPSS package (IBM Corp., Armonk, NY). SEM is a statistical technique frequently used to estimate causal relationships based on qualitative assumptions represented in a path diagram. SEM allows for confirmatory and exploratory modeling of both observed variables and latent variables derived from combinations of other observed variables (Jöreskog, 1966, 1967, 1969). The use of SEM has gained notable popularity among researchers both for its utility in exploring relationships beyond what is possible with simple analyses of variance or multiple regression analyses, and for its applicability to a variety of functions. SEM was deemed appropriate for use in the current analysis to more accurately account for simultaneous effects of laws on multiple outcomes (i.e., FARS ratios and beer consumption) and because beer consumption was modeled as an intermediate variable, as well as both a predictor of FARS ratios and an outcome measure of MLDA-21 laws.

Hypothesized model

The model we used is illustrated in the path diagram in Figure 1 and is composed of (a) the 20 MLDA-21 laws, (b) impaired driving laws, (c) seat belt safety laws, (d) economic strength and driving exposure, (e) beer consumption, (f) under age 21 FARS ratios, and (g) age 26 and older FARS ratios. The model assumes that all MLDA-21 laws except GDL nighttime predict both under age 21 FARS ratios and beer consumption. GDL nighttime predicts only under age 21 FARS ratios, and keg registration predicts beer consumption and both under age 21 and age 26 and older FARS ratios. Impaired driving laws, economic strength, and driving exposure predict beer consumption and both FARS ratios, whereas seat belt safety laws only predict the two FARS ratios. Beer consumption itself also predicts the two FARS ratios.

Results

Table 3 presents the estimates and significance levels of coefficients representing direct relationships between predictor variables and each outcome; estimates are presented regardless of level of significance. The structural model indicated that significant associations can be made for 11 of the 20 MLDA-21 laws. Figure 2 represents total (both direct and indirect) impact of predictors on the under age 21 FARS ratios. For those younger than age 21, laws predicting a significant decrease in FARS ratios were possession (-7.7%), purchase (-4.2%), use and lose (-7.9%), zero tolerance (-2.9%), age of bartender (-4.1%), RBS training (-3.8%), fake ID retailer (-11.9%), dram shop liability (-2.5%), and social host civil liability (-1.7%). Two laws predicted significant increases in FARS ratios: furnishing (+7.2%) and keg registration (+9.6%). The remaining laws—consumption, internal possession, fake ID minor, GDL nighttime, age of
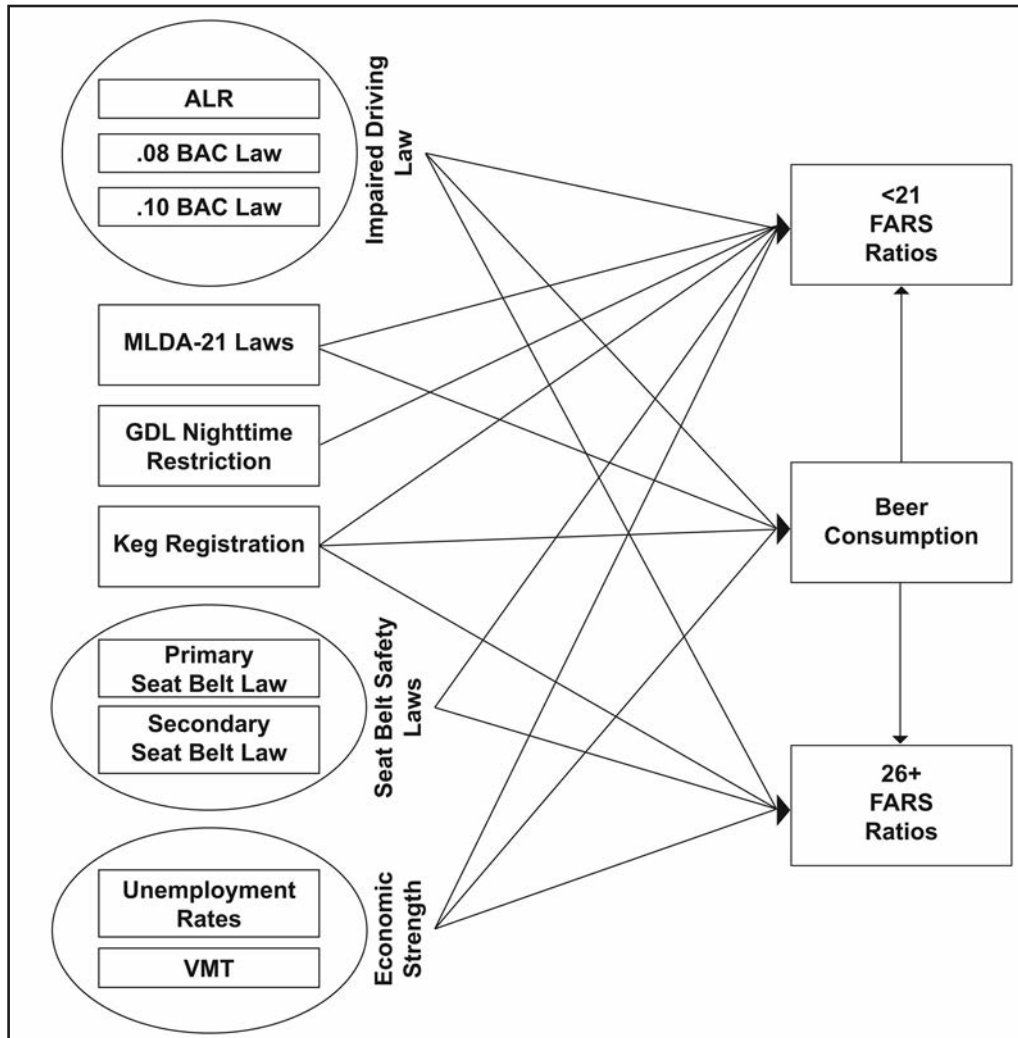
FIGURE 1. Hypothesized structural pathways predicting beer consumption and Fatality Analysis Reporting System (FARS) ratios. ALR = administrative license revocation; BAC = blood alcohol concentration; MLDA-21 = minimum legal drinking age 21; GDL = graduated driver licensing; VMT = vehicle miles traveled.

server, age of seller, social host prohibition, fake ID production, and state control of alcohol—demonstrated no significant relationship to the under age 21 FARS ratios. Table 4 provides the bivariate effects of each law on the under age 21 FARS ratios before correcting for unique contributions of each of the 20 MLDA-21 laws.

Beer consumption

As was the case in previous studies, beer consumption was an intermediate variable (meaning it was both an outcome and a predictor variable). Figure 3 represents the direct effects of 19 MLDA-21 laws on per capita beer consumption—recall that GDL nighttime was the only one of the MLDA-21 laws not hypothesized to affect beer consumption. Possession, keg registration, and fake ID retailer were found to demonstrate the most significant reductions in beer

consumption (-16.3%, -18.9%, and -22.5%, respectively). A reduction in beer consumption was also found for use and lose (-7.0%), fake ID minor (-5.3%), zero tolerance (-4.7%), and age of bartender (-4.3%). Conversely, an increase in beer consumption was associated with internal possession (6.8%), furnishing (8.5%), age of server (3.7%), RBS (6.9%), and fake ID production (5.7%). The other MLDA-21 laws were not found to be significantly associated with beer consumption.

Direct effects of latent constructs

Impaired-driving laws were associated with significant decreases in both under age 21 and age 26 and older FARS ratios (-.173, $p < .001$, and -.108, $p < .001$, respectively) and per capita beer consumption (-.139, $p < .001$). Seat belt safety laws were significantly related to decreases in both

TABLE 3. Regression weights and significance level for direct effects of revised model including standardized law strengths

Predictor	Under age 21 FARS ratio		≥26 years FARS ratio		Beer consumption	
	Est.	p	Est.	p	Est.	p
Economic strength	-.003	.272	-.003	.124	**-.028**	**<.001**
Seat belt safety laws	**-.017**	**<.001**	**-.020**	**<.001**	–	–
Impaired driving laws	**-.173**	**<.001**	**-.108**	**<.001**	**-.139**	**<.001**
Possession law	**-.038**	**<.001**	–	–	**-.163**	**<.001**
Purchase law	**-.037**	**<.001**	–	–	-.025	.083
Consumption law	-.010	.245	–	–	.007	.552
Internal possession law	-.018	.310	–	–	**.068**	**.005**
Use-or-lose law	**-.063**	**<.001**	–	–	**-.070**	**<.001**
Fake ID—minor law	.012	.495	–	–	**-.053**	**.022**
Zero-tolerance law	**-.044**	**.044**	–	–	**-.047**	**<.001**
GDL nighttime law	-.017	.112	–	–	–	–
Furnishing law	**.092**	**<.001**	–	–	**.085**	**.002**
Age of server law	.028	.051	–	–	**.037**	**.030**
Age of bartender law	**-.031**	**<.001**	–	–	**-.043**	**<.001**
Age of seller law	.001	.987	–	–	.019	.138
Keg registration law	**.141**	**<.001**	**.037**	**.001**	**-.189**	**<.001**
RBS law	**-.055**	**<.001**	–	–	**.069**	**<.001**
Fake ID—retailer law	**-.066**	**<.001**	–	–	**-.225**	**<.001**
Social host prohibition law	.015	.279	–	–	-.032	.085
Dram shop law	**-.020**	**.016**	–	–	-.022	.055
Social host civil liability law	**-.020**	**.012**	–	–	.014	.189
Fake ID—production law	.001	.914	–	–	**.057**	**<.001**
State alcohol control law	.021	.243	–	–	-.007	.762
Beer consumption	**.237**	**<.001**	**.194**	**<.001**	–	–

Notes: FARS = Fatality Analysis Reporting System; est. = estimate; ID = identification; GDL = graduated driver licensing; RBS = responsible beverage service. **Bold** indicates statistical significance.
χ^2 = 13,889.958, $p < .001$; comparative fit index = .25; normed fit index = .24; root mean square error of approximation = .150.

under age 21 and age 26 and older FARS ratios (-.017, $p < .001$, and -.020, $p < .001$, respectively). Finally, unemployment and driving exposure were found only to be a significant predictor of beer consumption (-.028, $p < .001$).

In summary, the nine MLDA-21 laws found to be associated with significant decreases in the FARS ratios (graphically shown in Figure 2) are estimated to be saving lives in the states. Using lives saved estimations similar to our previous research (Fell et al., 2009, 2014), we determined the relative risk of being involved in a fatal crash for drivers based on BAC levels. Specifically, we determined that drivers who had a BAC level of .010–.049 have a relative risk similar to drivers with no measurable BAC. However, drivers with a BAC between .05 and .079 and those over .08 BAC were twice and 7.3 times as likely to be involved in a fatal crash as those with no measurable BAC, respectively (Terhune et al., 1992). We then examined BAC values in the FARS crash data set to determine the annual fatalities attributable to drivers under age 21 with a BAC level above .01. Next, by examining the unique variance explained by each law in Figure 2, we then estimated the number of lives saved by each law. Finally, this number was divided by the number of states that had each law, as described in Table 1. In this way, we were able to determine that possession (-7.7% effect size) and zero-tolerance (-2.9% effect size) laws—which are present in every state and DC—save 231 and 102 lives each

TABLE 4. Uncorrected regression weights for 20 minimum legal drinking age 21 (MLDA-21) laws on under age 21 alcohol-related fatal crash ratios

Predictor	Under age 21 FARS ratio Estimate
Possession law	**-.170**
Purchase law	**-.130**
Consumption law	**-.046**
Internal possession law	**-.073**
Use-or-lose law	**-.113**
Fake ID—minor law	**-.094**
Zero-tolerance law	**-.089**
GDL nighttime law	**-.024**
Furnishing law	**-.010**
Age of server law	.017
Age of bartender law	-.004
Age of seller law	.009
Keg registration law	**.100**
RBS law	-.003
Fake ID—retailer law	**-.014**
Social host prohibition law	.001
Dram shop law	.008
Social host civil liability law	-.007
Fake ID—production law	.009
State alcohol control law	.003

Notes: FARS = Fatality Analysis Reporting System; ID = identification; GDL = graduated driver licensing; RBS = responsible beverage service. **Bold** indicates statistical significance.
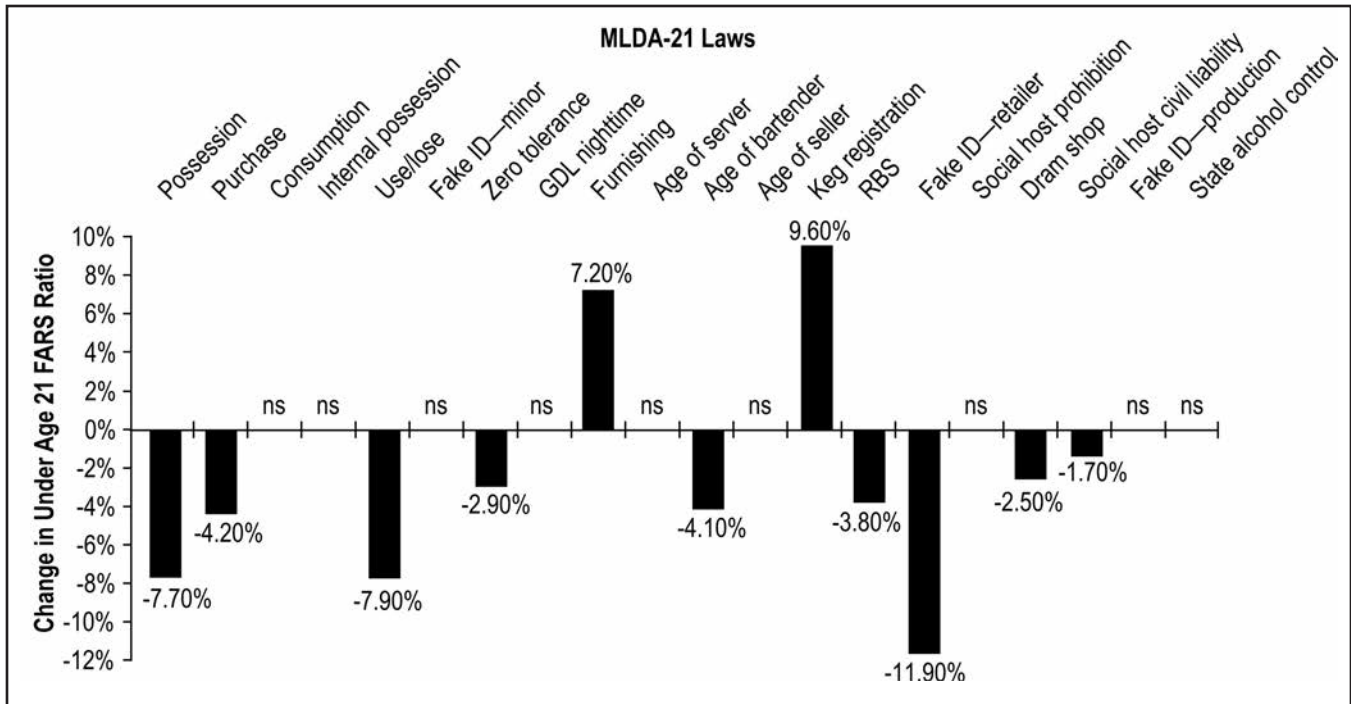
FIGURE 2.   Total effects of minimum legal drinking age 21 (MLDA-21) laws on under age 21 Fatality Analysis Reporting System (FARS) ratios (1982–2012). ID = identification; GDL = graduated driver licensing; RBS = responsible beverage service; ns = not statistically significant.

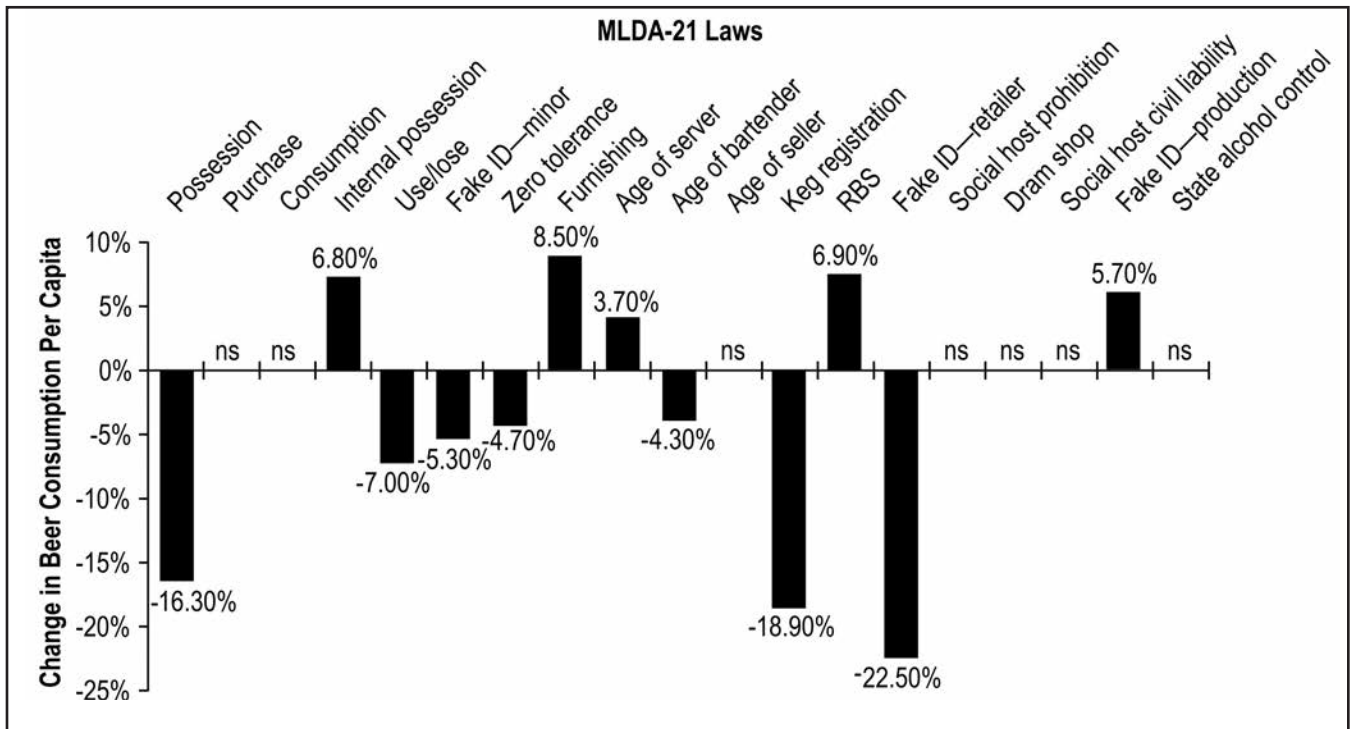FIGURE 3.   Total effects of minimum legal drinking age 21 (MLDA-21) laws on annual per capita beer consumption (1982–2012). ID = identification; RBS = responsible beverage service; ns = not statistically significant.
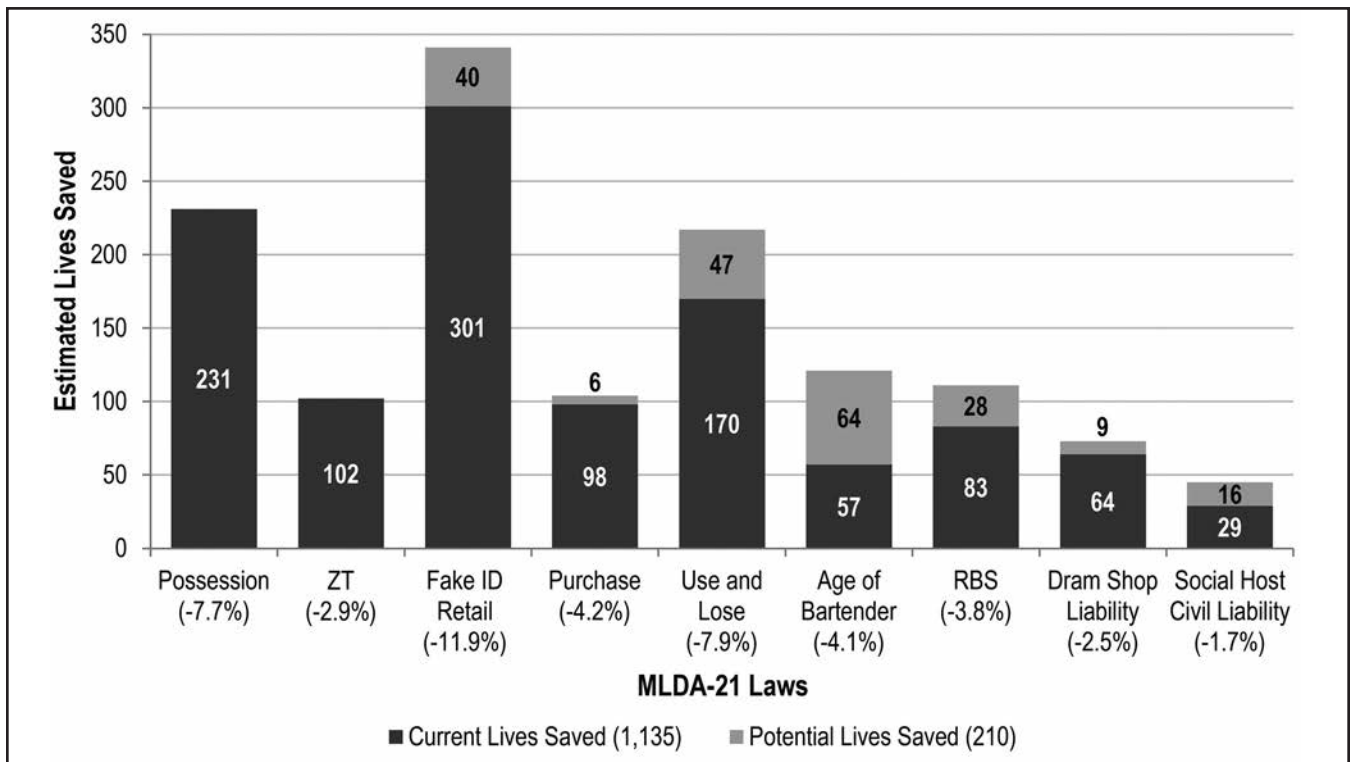
FIGURE 4.   Current and potential annual lives saved by nine minimum legal drinking age 21 (MLDA-21) laws. ZT = zero tolerance; ID = identification; RBS = responsible beverage service.

year, respectively. Further, fake ID retail laws (-11.9% effect size) save an estimated 301 lives in the 45 states that currently have the law and could save an additional 40 lives if the remaining five states and DC adopted the law. Purchase laws (-4.2% effect size) currently save 98 lives and could save an additional 6 lives if the laws were adopted in the three states without them. Use-and-lose (-7.9% effect size) and age of bartender (-4.1% effect size) laws currently save 170 and 57 lives each year, respectively, but an additional 47 and 64 lives could be saved, respectively, if all states adopted these laws. RBS training laws (-3.8% effect size) currently save 83 lives annually, but could save an additional 28 lives. Finally, dram shop liability (-2.5% effect size) and social host civil liability (-1.7% effect size) laws save 64 and 29 lives, respectively, but could save an additional 9 and 16 lives, respectively.

Based on this, the nine MLDA-21 laws are currently saving an estimated 1,135 lives each year in the states that have these laws. However, if all states adopted all nine MLDA-21 laws, an additional 210 lives could be saved every year across the United States (Figure 4).

Discussion

Possession (-7.7%) and purchase (-4.2%) laws were the first MLDA-21 laws to be adopted by most states in response to the federal legislation in the 1980s. These laws received considerable media attention, so it is not surprising that in this study, as in other studies, both laws had an effect on underage drinking driver rates in fatal crashes. Possession and purchase laws have continued to have an effect up through 2012, but not as much as in the earlier years of adoption. Use-and-lose (-7.9%) and zero-tolerance (-2.9%) laws have also been shown in other studies to be effective on underage drinking drivers (Blomberg, 1992; Fell et al., 2009; Voas et al., 2003). The requirement that bartenders be at least age 21 (-4.1%) had an effect, whereas the ages of sellers and servers did not. Bartenders make and serve drinks directly to patrons at the bar, giving them greater latitude to respond to their relationship to the patrons without involving other employees or outlet managers. Bartenders who are age 21 or older may be more likely to not serve underage patrons, especially if they have completed RBS training. Bartenders age 21 and older may have greater confidence in denying service to minors and may be more likely to support the wait staff in applying RBS service practices.

The RBS training (-3.8%) result is in line with the literature on the effectiveness of training servers to deny service to underage drinkers provided that they have strong management support (Centers for Disease Control and Prevention [CDC], 2010; Jones et al., 2011; McKnight & Streff, 1994). The magnitude of the effect of the fake ID retailer support

laws and technologies was somewhat surprising (-11.9%). However, these retailer policies support ID checking by increasing the motivation of outlet managers to conform to MLDA-21 laws and also by enhancing their ability to detect underage patrons. It seems clear that if retailers have the use of ID scanners to spot fake IDs, have the right to seize suspicious IDs, and can sue a patron for using a fake ID, and if the state they work in has distinctive licenses for those under age 21 (e.g., portrait rather than landscape), they would be much less likely to sell alcohol to underage youth. Yörük (2014) found that the retailer fake ID laws significantly reduced reported underage drinking up to a 0.22 drink decrease per day. Once the effect of the retailer fake ID is accounted for, dram shop laws had only a moderate effect (-2.5%), probably because the threat of a third-party suit is mitigated somewhat by insurance coverage. However, the relatively modest impact is somewhat surprising given that even at low BACs, drivers ages 16–20 have a much higher risk of being involved in a fatal crash than older drivers (Voas et al., 2012). Social host civil liability laws (-1.7%) are similar to dram shop laws in that hosts of underage drinking parties can be sued for significant amounts of money if an underage drinker coming from that party injures or kills someone in a crash. Apparently, that threat has a modest effect.

The counterintuitive effect of beer keg registration laws (+9.6%) may reflect the tendency of states with high underage drinking and alcohol-related crash rates to enact such legislation. The significance of this legislation is difficult to study in an era when underage alcohol use is evolving away from the primary consumption of beer to the consumption of distilled spirits (CDC, 2007; Johnston et al., 2009; Substance Abuse and Mental Health Services Administration, 2011). These keg registration laws could be supporting this trend by increasing bring-your-own drinks to the party, which may encourage underage youth to bring higher alcohol content or greater quantities of alcohol to drinking events. The furnishing law effect (+7.2%) is somewhat puzzling, but although all states and DC have such laws, most are weak (only 19 states achieved the maximum score), with numerous exceptions written into the legislation (Fell et al., 2015). Further, all but seven states had enacted the furnishing law before 1982 (the first year data were collected for the current study), which means that almost all states had the furnishing law for all 31 years of the study. This lack of variance in the law may have inaccurately portrayed the relationship between this law and our outcome variables over time.

Finding no effect for some of these MLDA-21 laws on underage drinking driver fatal crashes does not necessarily mean these laws are ineffective. We use an extremely severe outcome measure in underage drinking drivers in fatal crashes. These MLDA-21 laws could be affecting underage alcohol consumption, binge drinking, drinking driver nonfatal crashes, underage drinking violence, suicides, homicides,

and other injuries. Further research needs to be conducted to uncover these other effects.

Changes from previous models

Notably, the results of the current model differ somewhat from our previous research into the topic (Fell et al., 2009, 2014). This discrepancy is likely attributable to three primary and significant changes in our approach. First and foremost, the current model uses all 20 laws as opposed to our previous endeavors, which used only a small subset of those laws. When the structural model shifts to accommodate these new laws, the variance explained by the old models will necessarily shift as well. Second, in our previous research, we hypothesized that only keg registration directly affected beer consumption, whereas all laws predicted under age 21 FARS ratios. After reconsideration of the original model, we reasoned that with the exception of the GDL nighttime law, any of the MLDA-21 laws could conceivably have a significant impact on beer consumption. This change requires the model to estimate a greater number of parameters and redistribute variance accordingly. Subsequently, we would expect to see notably different explanations of variance in the current study compared with previous studies.

Finally, the current model uses law strengths (as defined in Fell et al., 2015) in its measurement of the MLDA-21 laws. As Fell et al. (2015) discussed the importance of including law strengths in research on law effectiveness, we again should expect to see different explanations of variance in the current study when compared with the 2009 and 2014 studies.

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