Minimum-Age Drinking Laws and Youth Suicide, 1970–1990

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Injuries are the leading cause of death for youths aged 18 to 20 years, and alcohol consumption is a risk factor for mortality from injury. If alcohol use plays a causal role in injury, restricting alcohol intake by youths may be an effective method for reducing injury in this population subgroup. In this article we discuss the relationship between youth suicide and a state-level policy to restrict access to alcohol by youths: the minimum legal drinking age (MLDA).

Historically, MLDA have ranged from 18 to 21 years. Since 1970, numerous state legislatures have enacted changes in the legal drinking age. In 1970, 33 states had an MLDA of 21 years; 25 state legislatures reduced their state's MLDA between 1970 and 1975. Starting in 1977, many state legislatures began raising the MLDA. The 1986 National Highway Safety Act made the allocation of federal highway funds contingent upon a state policy that set the MLDA at 21 years. By 1988, the MLDA in all states was 21 years.

There is a well-documented association between suicide and alcohol consumption; it is estimated that between one third and two thirds of adolescent suicide victims have a measurable blood alcohol content. Alcohol use is more likely to be a risk factor for suicide among adolescents with a history of mental disorders and among adolescents under stress, such as those experiencing an interpersonal loss or difficulties with school or at home. Alcohol may increase the likelihood of suicide through a variety of mechanisms, including exacerbation of depression, adverse effects on decision-making skills under stress, and interference with the treatment of either stress or mental illness.

Minimum drinking-age laws are designed to influence alcohol consumption by youths. Available data suggest that MLDA affect the quantity of alcohol, especially beer, consumed by 18- to 20-year-old persons. Younger teenagers also may be affected by drinking-age laws, since they often gain access to alcohol through slightly older peers or purchase alcohol directly when they are close to the legal drinking age. Some evidence suggests that MLDA may affect youths even after they have reached the legal drinking age, with 21- to 24-year-old youths living in states with a minimum drinking age of 21 years consuming less alcohol than their counterparts in states with a minimum drinking age of 18 years.

Studies of motor vehicle fatalities among youths indicate that reductions in MLDA in the 1970s were associated with increases in such deaths and that increases in the MLDA after 1978 were associated with decreases in fatal crashes. Few studies have examined the relationship between MLDA laws and other causes of fatalities among youths. In the current study we examined the association between the MLDA and youth suicide rates.

Methods

We used pooled cross-sectional time-series data from the 48 contiguous states between 1970 and 1990 to examine the association between the MLDA and suicide among persons aged 18 to 20 years—the age group directly targeted by drinking-age laws. We also examined the association between MLDA and suicides among persons aged 15 to 17 years and among those aged 21 to 23 years.

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Data for the primary outcome of the study—the number of suicide victims classified by age and year in each of the 48 contiguous states—came from the Mortality Files of the National Center for Health Statistics. Although suicides are estimated to be underreported in this data set,\textsuperscript{1,12,13} there is no reason to expect that the degree of underreporting of suicide is related to a state’s MLDA. No reliable state-by-state data on alcohol-related suicides exist for the time period of interest, and the inclusion of non-alcohol-related suicides may mask the relationship between MLDA levels and suicides among youths. However, from a policy perspective, we were interested in the relationship between MLDA’s and all youth suicides, and our measure was appropriate for that analysis.

The average yearly number of suicides per state and by age group is presented in Table 1. Our data have an approximate Poisson distribution, and we used Poisson maximum likelihood regression to estimate the association between MLDA’s and suicide. The dependent variable in our model was the number of suicides per state per year in the age group under analysis. For comparative purposes, we report results of a weighted least-squares model with a logarithmically transformed dependent variable; undefined log rates were converted to zero.

We used a fixed-effects model that assumes the existence of factors within a state that have a constant effect on suicide rates across years and factors within a year that will have a constant effect on suicide rates across states. To control for these effects, we used dummy variables for each state and year in the set of independent variables in the regression.

The rate of suicide varies more with time for small states than for large states. To correct for the resulting heteroscedasticity, we weighted each regression by the state- and year-specific population of the age group under analysis. Population figures came from the US censuses for 1970, 1980, and 1990. For between-census years, we extrapolated data by attributing one tenth of the population change to each intervening year. To check the robustness of our analysis, we also ran a weighted regression analysis for the 37 largest states and for the 48-state model, weighting by the square root of the population.

The key independent variable in our model was an indicator for the MLDA for beer, the alcoholic beverage most frequently consumed by youths. We obtained state-by-state legal drinking ages by reviewing each state’s statutes for changes in that state’s MLDA. We coded the MLDA variable as 0 for a 21-year MLDA and 1 for an 18-year MLDA, with intervening increments for 20- (0.33) and 19-year (0.67) MLDas. When changes in the MLDA occurred within a year (rather than on January 1), the variable was weighted at one twelfth the number of months for which the original drinking age was in effect.\textsuperscript{9} When MLDA’s increased, some state laws included grandfather clauses exempting those who at the time of the effective date had reached the prior legal age for buying alcohol. Such laws were treated as if the age change occurred when half the population of a particular age was first prohibited from purchasing alcohol.\textsuperscript{14} In all models, the estimated coefficient on the MLDA variable can be interpreted as the percentage difference in the suicide rate associated with a 21-year MLDA vs the suicide rate when the MLDA is 18 years.

To control for factors that vary within states across time or within years across states, we included in our model 3 independent variables that have been found to be associated with suicide: the percentage of a state’s population completing high school, the state divorce rate, and the state unemployment rate.

The potential effect of MLDA’s on alcohol consumption is a function not only of drinking age but also of the level of enforcement of drinking laws. We used 2 proxies for drinking-law enforcement in our analyses: police per capita and all-age liquor-law arrests. Liquor-law arrests vary widely with time within states. To minimize the effects of unusual years, we calculated an annual arrest rate by averaging arrest rates over a 5-year period.

Since young people in some states can legally buy alcohol in neighboring states with lower drinking ages, we created an independent variable to capture the potential effect of youths traveling across state borders to obtain alcoholic beverages: the fraction of each state’s target population (18- to 20-year-old persons) residing within 30 miles of a bordering state with a lower drinking age. We also controlled for another alcohol policy: state tax on beer. Descriptions of the control variables are found in Table 2.

### Results

Between 1970 and 1990, the MLDA was strongly associated with suicides among 18- to 20-year-old youths. Holding other factors constant, we found that states with an 18-year MLDA had an 8% higher suicide rate ($P < .01$; Table 3) than states with a 21-year MLDA. Higher levels of education, divorce, and unemployment were also significantly associated with higher youth suicide rates ($P < .01$). After we controlled for these variables, the coefficient for beer tax was not statistically significant. Among the 2 proxies for drinking-law enforcement in our model, only the coefficient for liquor-law arrests was significant, with higher levels of arrests associated with lower levels of suicide. The model showed no bordering-state effect.

We found a smaller but still significant association between legal drinking age and suicide among 21- to 23-year-old youths. States with an 18-year MLDA had a 6% higher suicide rate ($P < .05$; Table 3) among 21- to 23-year-old youths than did states with a 21-year MLDA. The effects of the control variables in the model for 21- to 23-year-old youths were similar to those in the model for 18- to 20-year-old youths.

For 15- to 17-year-olds we found no evidence of an association between MLDA and suicide rate. Among the control variables in the model for this age group, only the coefficient for the percentage of the population completing high school was statistically significant.

We found similar estimates of the MLDA coefficient for the weighted least squares model. The coefficient remained statistically significant.
TABLE 2—Control Variables: Mean, Standard Deviation, Definition, and Source

<table>
<thead>
<tr>
<th>Variable Name</th>
<th>Mean (SD)</th>
<th>Definition</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>MLDAs</td>
<td>0.4 (0.4)</td>
<td>Minimum legal drinking age</td>
<td>State law statutes</td>
</tr>
<tr>
<td>Border population</td>
<td>0.06 (0.1)</td>
<td>% of 18- to 20-year-olds living within 30 mi of lower-MLDAs state</td>
<td>Rand McNally maps</td>
</tr>
<tr>
<td>Education*</td>
<td>67.5 (9.7)</td>
<td>% of population over age 18 years with at least a high school education</td>
<td>Vital Statistics, NCHS</td>
</tr>
<tr>
<td>Divorce*</td>
<td>5.1 (2.2)</td>
<td>Rate of divorce/annulment per 1000 couples</td>
<td>Vital Statistics, NCHS</td>
</tr>
<tr>
<td>Unemployment</td>
<td>6.4 (2.2)</td>
<td>% of civilian labor force unemployed</td>
<td>US Bureau of Labor Statistics</td>
</tr>
<tr>
<td>Police per capita</td>
<td>2.4 (0.5)</td>
<td>Police per 1000 population</td>
<td>Statistical Abstracts of the United States</td>
</tr>
<tr>
<td>Liquor-law arrests</td>
<td>1.4 (0.9)</td>
<td>Rolling 5-year average rate of all-age liquor-law arrests per 1000 population</td>
<td>Uniform Crime Reports</td>
</tr>
<tr>
<td>Beer taxes</td>
<td>0.6 (0.6)</td>
<td>Beer tax, adjusted by the CPI</td>
<td>Beer Institute</td>
</tr>
</tbody>
</table>

Note. SD = standard deviation; MLDAs = minimum legal drinking age; NCHS = National Center for Health Statistics; CPI = consumer price index.

*Education and divorce data were not available for all years; values for missing observations were extrapolated from surrounding years.

Discussion

We found that MLDAs between 1970 and 1990 were associated with suicide rates among 18- to 20-year-olds: lower drinking ages are associated with higher rates of suicide. We found a statistically significant but smaller association for MLDAs and suicide rate among 21- to 23-year-olds. However, we found little evidence to support the hypothesis that drinking ages are associated with suicides among 15- to 17-year-olds.

All of the control variables in our model had the expected signs. We found, as have other investigators, that higher suicide rates were associated with higher levels of education,14 higher rates of divorce,15 and higher rates of unemployment.16,17

In the case of our 2 crude proxies for enforcement of the MLDAs, police per capita and a rolling 5-year average of all-age liquor-law arrests, we found an association for liquor-law arrests only. Liquor-law arrests include a diverse range of violations and do not provide a direct measure of MLDAs enforcement. However, Wagenaar and Wolfsen18 suggest that all-age liquor-law arrests reflect an underlying tendency in states' enforcement of alcohol laws. We found no evidence that potential border crossings from states with higher legal drinking ages to states with lower drinking ages are associated with suicides. Changes in state-level beer tax were also not associated with youth suicide in our model.

How MLDAs affect the drinking patterns of youths once they reach the age of 21 years is not well documented. O'Malley and Wagenaar8 compared drinking patterns of youths 21 years and older who came from states with MLDAs of 18 years with those of youths 21 years and older who came from states with MLDAs of 21 years. They found that higher levels of drinking associated with lower MLDAs continued into the respondents' early 20s. This finding suggests that MLDAs may plausibly influence suicide rates among youths aged 21 to 23 years. We would expect any such association to be weaker than for youths aged 18 to 20 years, a hypothesis that is supported by this study.

The similarity of the MLDAs coefficient estimates found for the 48-state model weighted by the total population, the 48-state model weighted by the square root of the population, and the 37-largest-state model suggests that weighting the Poison regression used in our study by age-group population adequately adjusted for any heteroscedasticity in the data without overemphasizing the larger states. We assessed the sensitivity of the analyses to influential observations in the full state/year model and found no states that systematically altered the estimated coefficients.

Two other studies have examined the relationship between suicide and changes in MLDAs. In a single-state study of suicides before and after Massachusetts raised its drinking age from 18 to 20 years, Hingson et al.19 found no significant reduction in the sui-

TABLE 3—Poisson Maximum Likelihood Regression Results: Factors Associated With Youth Suicide Rates by Age Group in the 48 Contiguous US States, 1970–1990*

<table>
<thead>
<tr>
<th>Age Group</th>
<th>Intercept</th>
<th>MLDAs</th>
<th>Border population</th>
<th>Education</th>
<th>Divorce</th>
<th>Unemployment</th>
<th>Liquor arrests</th>
<th>Police</th>
<th>Beer tax</th>
<th>Log likelihood</th>
</tr>
</thead>
<tbody>
<tr>
<td>15–17 Years</td>
<td>−12.1</td>
<td>0.01 (0.04)</td>
<td>0.08** (0.03)</td>
<td>0.04*** (0.006)</td>
<td>−0.01 (0.02)</td>
<td>0.01 (0.007)</td>
<td>−0.03 (0.02)</td>
<td>0.08 (0.07)</td>
<td>0.05 (0.05)</td>
<td>−2618</td>
</tr>
<tr>
<td>18–20 Years</td>
<td>−11.4</td>
<td>0.06 (0.02)</td>
<td>0.02 (0.07)</td>
<td>0.03*** (0.006)</td>
<td>0.06*** (0.002)</td>
<td>0.02*** (0.005)</td>
<td>−0.06*** (0.02)</td>
<td>0.08 (0.05)</td>
<td>0.0003 (0.04)</td>
<td>−3030</td>
</tr>
<tr>
<td>21–23 Years</td>
<td>−11.7</td>
<td>0.06* (0.02)</td>
<td>0.03 (0.06)</td>
<td>0.04*** (0.005)</td>
<td>0.06** (0.01)</td>
<td>0.02*** (0.005)</td>
<td>−0.04*** (0.01)</td>
<td>0.07 (0.04)</td>
<td>0.01 (0.03)</td>
<td>−3097</td>
</tr>
</tbody>
</table>

Note. MLDAs = minimum legal drinking age.

*All values other than those for intercept and log likelihood are given as mean (SD).

Analysis is based on 1008 observations. Coefficient estimates for state and year effects are not included and are available from the authors.

*P < .05; **P < .01; ***P < .001.
cide rate. Jones et al. 20 used mortality data for the 50 states from 1979 to 1984 and found that, after controlling for temporal trends in suicide, the suicide rate among 18- to 20-year-old youths who could legally buy alcohol was 9.7% higher than that among youths of the same age who could not legally buy alcohol. Our results are consistent with that finding.

Our study used aggregate data to model what is an individual choice to commit suicide. With these data, we were unable to determine whether those who drank more under less restrictive drinking-age laws were the same youths who committed suicide. Consequently, our conclusions are limited to establishing an association between levels of the MLDA and suicides, but not a causal relationship between these 2 variables.

In addition, several assumptions in our analysis should be noted. First, we assumed that yearly rates of suicide are independent of each other (i.e., that there is no autocorrelation in suicide rates across years). The Durbin–Watson statistic of 1.9 suggests that this assumption is reasonable. Second, our model assumes that the effects of raising and lowering the drinking age are symmetric: that a 1-year increase or decrease in the MLDA will be associated with the same percentage change in suicides. Our model also assumes that the effect of differences in drinking ages is the same across states and time and that the effect of any 1-year change is the same whether it is a change from 18 to 19, 19 to 20, or 20 to 21 years of age.

Omitted variables are always a concern in statistical analyses. We explicitly controlled for baseline state differences and national time trends in suicide rates in our analysis and included various state-level confounders, such as education, divorce, and unemployment. However, these factors probably represent only a small number of the variables affecting suicide among youths. Although no study has suggested that any suicide-related variable follows a change pattern similar to that of the MLDA, our analysis may not account for some reasons why states with lower MLDAs may have higher youth suicide rates.

Although the potential for endogeneity exists in almost all regression analysis, changes in MLDA laws appear to be exogenous in our model. While the impact of the MLDA on youth traffic fatalities played a part in policy discussions about appropriate drinking age, the potential effect of the MLDA on youth suicide did not.

Our analysis suggests that when various factors are kept constant, the suicide rate among 18- to 20-year-old youths who can legally buy alcohol is approximately 8% higher than the rate among those who cannot do so. If this 8% figure is taken as an accurate causal measure, then lowering the drinking age from 21 to 18 years in all states would lead to an annual increase of approximately 125 suicides among 18- to 20-year-olds and of 100 suicides among those aged 21 to 24 years. These figures may underestimate the impact of legal drinking ages, since some single-vehicle nighttime traffic crashes may be suicides, and lower MLDAs are associated with higher rates of these types of crashes. 21

It is fairly well established that lower legal drinking ages correlate with increased motor-vehicle fatalities among 18- to 20-year-olds. Our findings are consistent with the hypothesis that lower MLDAs are also associated with higher levels of suicide in this population subgroup. 21

Contributors
J. Birckmayer analyzed the data and wrote the paper. D. Hemenway planned the study, supervised the data analysis, and contributed to the writing of the paper.

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References