Did changes in minimum age drinking laws affect adolescent drowning (1970-90)?

Jonathan Howland, Johanna Birckmayer, David Hemenway, Jennifer Cote

Abstract

Objective—To test the hypothesis that changes in the minimum legal drinking age (MLDA) laws would affect drowning among adolescents, the effects of changes in state MLDA laws on drowning were examined for the targeted (18-20 years) and two adjacent (15-17 years and 21-23 years) age groups, over a period of 21 years (1970-90).

Methods—Poisson maximum likelihood regression was used to estimate the effects of both lowering and increasing the MLDA. The dependent variable in these analyses was the number of drownings per state per year for the age groups observed. At first only state and year effects were controlled for and then any other variable potentially associated with the incidence of drowning was included. The other control variables included proportion of population living near border states with lower MLDA laws, urbanicity, unemployment, divorce, education, poverty, beer tax, and proxy measures for MLDA law enforcement.

Results—No significant association between drowning and MLDA was found for any of the age groups studied.

Conclusion—It is concluded that MLDA laws are not an important public policy strategy for affecting drowning rates among adolescents and young adults.

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Drowning rates are highest among children between the ages of 1 and 3 years and among adolescents and young adults between the ages of 15-24.¹ In 1990, there were 16 241 unintentional injury fatalities among adolescents and young adults between the ages of 15-24 years.² Most (78%) of these were due to traffic crashes.² However, the second most frequent (6%) cause of unintentional injury death among this age group was drowning.² During that year, 908 young people 15-23 years of age died by drowning.²

Although alcohol's total contribution to injury is unknown, the evidence that drinking increases the risk for traffic injuries is well documented.³⁻⁴ Alcohol's role in other unintentional injuries is less clear. Nevertheless, some epidemiological research supports hypotheses that alcohol causes a proportion of fall injuries,⁵ drownings,⁶ and burns due to residential fires.⁷⁻⁹ There is also a growing

literature on alcohol's involvement with intentional injury, including suicide,¹⁰⁻¹¹ homicide,¹²⁻¹³ domestic violence,¹⁴⁻¹⁷ and child abuse.¹⁸

Alcohol use in association with aquatic recreational activities is common.¹⁹⁻²⁰ A literature review concludes that 30-50% of adolescent and adult drownings are alcohol related.⁶ It has been suggested that gender differences in alcohol use in aquatic settings may, in part, explain the high drowning rate among adolescent and young adult males, compared with females of the same age.²¹

Between 1970 and 1990, a large number of US states changed their minimum legal drinking age (MLDA) laws and many states changed them twice. The early 1970s saw a trend toward decreasing the minimum drinking age. In 1970, 33 states had minimum drinking ages of 21 years, but between 1970 and 1975, 25 states reduced the MLDA laws. Starting in 1977, states began to increase the minimum drinking age; 15 states enacted increases by 1980 and another 23 between 1980 and 1985. Further increases in the MLDA were encouraged when the 1986 National Highway Safety Act tied federal highway funding to a minimum age of 21 years, so that between 1985 and 1988, 20 more states increased the MLDA. By 1988, all states had a MLDA of 21 years. Research supports the efficacy of these laws in terms of reducing traffic fatalities among targeted age groups.²² These effects could be due to shifting drinking venues (for example, from bars and restaurants to locations not requiring transportation home), actual reductions in alcohol consumption among 18-21 year olds,²² or some combination of these. Little, however, has been published on the effects of MLDA laws on other types of injuries. We studied the effects of lowering and raising MLDA laws on intentional (homicide, suicide) and unintentional (drowning) injury rates among targeted (18-21) and adjacent (15-17; 21-23) age groups between 1970 and 1990. We tested hypotheses that lowering the MLDA laws increased, and raising the MLDA laws decreased, these injury events among the age groups observed. This paper reports on the results of our analysis of the effects of changes in the MLDA for drowning.

Methods

Our study examines the effects of changes in the MLDA laws from 1970 to 1990 on drowning rates among youth in the 48 contiguous US states. We used pooled cross sectional time series analysis to test the effects of changes in the MLDA on drowning rates among the age

**Boston University
School of Public
Health**
J Howland
J Cote

**Health Policy
Program, Harvard
University, Boston**
J Birckmayer

**Harvard School of
Public Health, Boston**
D Hemenway

Correspondence to:
Dr Jonathan Howland, Social
and Behavioral Sciences
Department, Room W-251,
Boston University School of
Public Health, 715 Albany
Street, Boston, MA 0211,
USA.

group targeted by these laws (18–20 years) and among younger adolescents (15–17 years) and young adults (21–23 years). Our primary hypothesis was that among the directly affected age group (18–20 years), decreasing the MLDA would result in increasing drowning rates, while subsequent increases in the MLDA would result in decreasing drowning rates. Our secondary hypothesis was that drowning rates would be similarly, though to a lesser degree, affected for adolescents (15–17 years) and for young adults (21–23 years).

DATA SOURCES

Data on drowning were derived from the National Health Statistics Mortality files. Because the mortality data did not specify whether a drowning was alcohol related, all drownings in the age groups of interest were included in the analyses. As some drownings among the age groups studied were not causally related to alcohol, the inclusion of all drowning would tend to mask the hypothesized relationship between drowning and MLDA laws. Nevertheless, since the purpose of this inquiry was to assess the efficacy of MLDA as a strategy for reducing drownings, we feel our approach is justified from a policy perspective. For each of the three age groups, 1008 observations were calculated (21 years $\times$ 48 states). Over the period 1970–90, the average drowning rate per 100 000 population was 5.4 for 15–17 year olds, 5.5 for 18–20 years olds, and 4.7 for 21–23 year olds.

MODEL SPECIFICATION

Because of the distribution of our data, we used Poisson maximum likelihood regression to estimate effects. We used a fixed effect model, assuming that there are factors within each state that have a constant effect on drowning rates across years and factors within each year that have constant effects on drowning 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 drowning varies more over time for small states than for larger states. To correct for the resulting heteroscedasticity, we weighted each regression by the state and year specific population of the age group under analysis.

DEPENDENT VARIABLE

The dependent variable in our model was the number of drownings per state per year for the age groups under analysis. Drowning events were enumerated using the following International Classification of Diseases (ICD) 8 codes for 1970 to 1981 and ICD9 codes for 1982 to 1990: 830, 832, and 910. Drownings were attributed to the state of the victim's residence. Data from 1972 were doubled to account for the sampling procedure used in that year only.

INDEPENDENT VARIABLES

The key independent variable is an indicator for the MLDA for beer, the beverage alcohol most frequently consumed by the age groups studied. MLDA laws were obtained by review-

ing each state's statutes. The MLDA variable was coded as 0 for a minimum drinking age of 21 and 1 for a minimum drinking age of 18. Intervening ages were coded as 0.33 for 20 years and 0.67 for 19 years. The code represents the percentage of 18–21 years olds eligible to drink in a particular state for a given year (1=100%). When changes in the MLDA occur within one year (as opposed to on the first day of the year), the variable takes a weight of one 12th times the number of months the new law was in effect. This method follows that developed by Cook and Tauchen.²³ When MLDA laws increased, some states grandfathered those who had reached the previous MLDA. To account for these states, such laws were treated as though the age change occurred when half the population at a particular age was first prohibited from purchasing alcohol. This approach follows that developed by Du-Mouchel *et al.*²⁴

To control for factors that vary within states over time, or within years over states, we also included additional independent variables that potentially affect drowning. These factors were urbanicity, unemployment, poverty, education, and divorce. Urbanicity was included because drowning rates are substantially higher in rural areas than in cities¹; unemployment was included because job status might affect opportunities for aquatic activities (higher disposable income might increase opportunities for recreation); poverty and education were included because these factors are also associated with drowning¹; and divorce was included because family status might be associated with the general level of parental supervision over recreational activities.

The potential effect of MLDA laws is a function of both the minimum drinking age specified by the law and the level of associated enforcement of the law. We use two proxy measures of enforcement: police per capita and all age liquor law arrests. Liquor law arrests vary widely within states over time. Accordingly, we calculated state annual liquor law arrests by averaging over five years.

Because young people can buy liquor in neighboring states with lower drinking ages, we created an independent variable to capture the effect of cross border alcohol purchases: the fraction of the targeted population (18–20 years) in each state residing within 30 miles of a border state with a lower drinking age. In addition, we controlled for the state tax on beer because research has indicated a negative relationship between beer price and consumption by youth.²⁵

ANALYSES

We first examined the effects of changes in the MLDA (with state and year dummy variables only) for the entire period 1970–90. This model assumes that the effects of raising and lowering the drinking age are symmetric. We also ran this model for two separate time periods: from 1970–77, when states were dropping their drinking ages; and, from 1978–90, when states were raising their drinking ages. Analyses were run for each of the three age groups con-

Table 1 Average annual drownings by age group, 1970–90

Age group (years)	Mean (SD) No of drownings/ state/year	Maximum	No of observations with zero with drownings (n=1008)
15–17	12 (12)	82	53
18–20	12 (13)	79	37
21–23	10 (11)	79	53

sidered. Next, we ran models including the other independent variables for the three age groups for the time period 1970–90.

These analyses make several assumptions. First, we assumed that the annual drowning rates are independent of each other, that is, that there is no autocorrelation in drowning rates across years. (The Durin-Watson statistic of 2.1 supports this assumption.) Second, we assumed that the effects of changes in MLDA laws are the same across states and across time, and that the effect is the same whether it is a change from 18 to 19 or 20 to 21. We also assumed that changes in the MLDA laws are exogenous, that is, that changes in the dependent variable do not influence changes in the independent variables. While raising the MLDA laws was primarily a response to increasing alcohol related traffic fatalities among youth, drowning rates were not part of the policy debate on changing minimum drinking ages.

Results

The average yearly number of drownings for the states and age groups studied is presented in table 1. Over the 21 years observed, the average number of drownings was 12 for 15–17 years olds, 12 for 18–20 year olds, and 10 for 21–23 years olds.

Table 2 MLDA decreasing and increasing, decreasing, and increasing. Estimates of drowning equation Poisson model, parameter estimates, and standard errors

	15–17 years	18–20 years	21–23 years
MLDA decreasing and increasing (1970–90, n=1008)			
Intercept	–10.7	–9.2	–9.6
MLDA	–0.003 (0.04)	0.03 (0.04)	0.03 (0.04)
Likelihood	–2418	–2495	–2384
MLDA decreasing (1970–77, n=384)			
Intercept	–9.7	–9.2	–9.6
MLDA	–0.04 (0.06)	0.04 (0.06)	0.08 (0.07)
Likelihood	–1018	–1002	–934
MLDA increasing (1978–90, n=624)			
Intercept	–10.0	–10.4	–10.5
MLDA	–0.04 (0.07)	0.05 (0.06)	0.01 (0.06)
Likelihood	–1369	–1458	–1417

Table 3 Estimates of drowning equation Poisson model, 1970–90, parameter estimates and standard errors (n=1008)

	15–17 years	18–20 years	21–23 years
Intercept	–7.7	–7.3	–8.7
MLDA	–0.01 (0.04)	0.06 (0.04)	0.02 (0.05)
Border population	–0.006 (0.10)	0.04 (0.10)	–0.06 (0.12)
Urbanicity	–0.02 (0.10)	–0.03 (0.01)*	–0.01 (0.01)
Unemployment	–0.002 (0.01)	0.01 (0.01)	0.01 (0.01)
Divorce	0.004 (0.02)	–0.03 (0.02)	–0.02 (0.03)
Education	–0.01 (0.01)	0.01 (0.01)	0.0001 (0.01)
Poverty	0.01 (0.01)	–0.02 (0.10)	–0.02 (0.01)
Beer tax	–0.05 (0.05)	0.03 (0.05)	0.05 (0.06)
Police	–0.04 (0.07)	0.03 (0.07)	–0.1 (0.02)
Liquor arrests	0.0001 (0.0003)	0.0001 (0.0002)	–0.0001* (0.0003)
Likelihood	–2416	–2489	–2378

*p<0.05.

Table 2 presents the results of the models (for each age group) for the period 1970–90, with MLDA decreasing and increasing, controlling for state and year effects only; results of this model run for the period when MLDA laws were decreasing (1970–77); and results for the period (1978–90) when MLDA laws were increasing. We find no association between MLDA levels and drowning for any of these analyses.

Table 3 presents the results of the models for the three age groups for the entire time period (1970–90) including the other independent variables. MLDA was not significant in any of these models. Urbanicity was significant for the age group 18–20: drownings decreased as urbanicity increased. Liquor arrests were also significant for the age group 21–23 years (drownings decreased as liquor arrests increased).

Coefficients for state and year dummy variables are not presented but may be obtained from the authors.

Discussion

We failed to find an association between drowning and changes in the MLDA laws. These results were consistent with those of Jones *et al* who found no significant relationship between raising the MLDA (1979–84) and non-vehicular, unintentional injury fatalities among the age group targeted by these laws.²⁶

There are several explanations for these findings. First, it is possible that alcohol's role in drowning is negligible, although other studies contradict this interpretation.^{6–10} Second, it is possible that MLDA laws do not substantially affect drinking in aquatic settings. O'Malley and Wagenaar's review of the effect of MLDA laws on adolescent alcohol consumption, however, suggests this is not the case, and that raising the drinking age law decreases the targeted age group's alcohol consumption by 13.3%.²² Nevertheless, drinking on or near the water may be an exception. Howland *et al* have suggested that people tend to drink more frequently in association with aquatic activities compared with other recreational pursuits.²⁰

A more likely explanation for the failure to find an effect between MLDA laws and adolescent drowning is that during the period of observation other, more powerful factors, were affecting drowning rates. Between 1970 and 1990 the number of drownings for all ages declined by 39%, from 7860 to 4800.² The drowning rate declined even more precipitously, from 3.9 to 1.9/100 000 population, a decrease of 51%.² Thus, the period observed was marked by a strong secular trend in declining drowning rates. The reasons for this trend are not apparent. It is noteworthy, however, that increasing urbanicity was significantly associated with decreasing drowning. The period between 1970 and 1990 continued the longer trend in population shift from rural to suburban and urban areas. Urbanization is likely associated with greater supervision of aquatic activities. It is possible, therefore, that

the MLDA laws had small, but undetected, effects on drowning rates. Nevertheless, given that our study was framed from the perspective of public policy, we cannot conclude on the basis of our findings that MLDA laws are an important strategy for reducing drowning among adolescents and young adults.

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