The Journal of Mental Health Policy and Economics
J Ment Health Policy Econ **6**, 37-46 (2003)

Estimating the Impact of Alcohol Policies on Youth Suicides

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Abstract

Background: Alcohol consumption has been identified as one of the most important risk factors for youth suicide. Previous research has shown a strong, empirical link between alcohol use and suicide. If alcohol use is a contributing factor in determining suicidal behaviors, then policies designed to reduce the alcohol consumption may succeed in reducing youth suicides as well.

Aims of the Study: This paper looks at the role of alcohol-related policies in reducing completed suicides by American youths and young adults. This hypothesis comes from two well established relationships: i) the observed correlation between alcohol consumption and incidents of suicide, and ii) the negative relationship between the full price of alcohol and consumption. The alcohol policies examined are excise taxes on beer, measures of alcohol availability, and drunk driving laws.

Methods: Data on completed suicides for each state in the United States are analyzed for the period 1976-1999. Negative binomial regressions are used to estimate a reduced form model of youth suicide. Suicides are analyzed by gender and age groups (ages 10-14, 15-19 and 20-24).

Results: The results indicate that increases in the excise tax on beer are associated with a reduced number of male suicides. This tax, however, has no impact on female suicides. Suicides by males ages 20-24 are positively related to the availability of alcohol, and negatively related to the presence of a 0.08 BAC (blood alcohol concentration) law and a zero tolerance law for drunk driving. Female suicides are not impacted by the availability of alcohol, although the drunk driving laws may impact suicides by teenage females.

Implications for Health Policies: Policies designed to reduce alcohol consumption may have the unintended benefit of reducing suicides, particularly among young males.

Implications for Further Research: While this research shows that alcohol policies may be successful in reducing male suicides, such policies have little impact on female suicides. Future research should explore other potential types of policies and programs to reduce female suicides. Also, illegal drug use has been linked to suicides in a similar manner as alcohol consumption. Future research should consider the role of illegal drug consumption and related policies in determining youth suicides.

Received 14 February 2003; accepted 12 May 2003

Introduction

In 1999, the Surgeon General of the United States issued a call to action to prevent suicide which states, ''The nation must address suicide as a significant public health problem and put into place national strategies to prevent the loss of life and the suffering suicide causes.''[1] This report highlights the seriousness of suicide as a public health problem, particularly among American youth. In 1999, suicides accounted for 12 percent of deaths among 15-19 year olds and 13.5 percent of deaths among 20-24 year olds. For these age groups, suicide ranks third as a leading cause of death behind accidents and homicide.[2] Completed suicide is most common among young males, and rates are particularly high in the 20-24 year old age group. The suicide mortality rate for this age group was 21.55 per 100,000 for males and 3.47 per 100,000 for females in 1999. Among 15-19-year-olds in the same year, the suicide mortality rate was 13.27 per 100,000 for males and 2.79 per 100,000 for females. Completed suicides are much less common among children under 15 years old, although this rate has been rising over time.

The current prevalence of suicide among youth reflects long-term growth in this outcome. Between 1950 and 1990, the suicide rate among 15-24-year-olds in the United States tripled. For this reason, many schools, communities, and states have made youth suicide prevention a top public health priority, and have developed a variety of suicide prevention programs. However, no evidence exists to suggest that any of these programs are effective in reducing suicidal behaviors.[3,4]

The absence of known effective policies to prevent suicide coupled with the high prevalence of suicide among youth necessitate additional research so that public policies can

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Source of Funding: Funding for this research was provided by a grant from the Robert Wood Johnson Foundation's Substance Abuse Policy Research Program to Montefiore Medical Center (grant number 43860) and a grant from the National Institute on Alcoholism and Alcohol Abuse (grant number AA00032803).

begin to effectively address the problem. Previous research has identified several risk factors that are associated with youth suicide, and one of the most important of these factors is alcohol consumption. There is a strong, empirical link between alcohol use and suicide ideation (suicidal thoughts or plans), suicide attempts, and completed suicide among youth.[5] If alcohol use is a contributing factor in suicide, then policies designed to reduce the alcohol consumption may succeed in reducing suicide rates as well. This paper looks at the direct impact of alcohol regulations on suicides by youths and young adults.

Background

Numerous researchers have documented the existence of a significant correlation between substance use and suicidal behaviors among young people. For example, in a review of studies on adolescent suicide, Brent[6] concludes that between one third and two thirds of adolescent suicide victims suffered from substance abuse disorders. In studies of gender differences in adolescent suicide, Shaffer *et al*[7] finds that alcohol abuse is a suicide risk factor for males only. Brent et al.,[8] however, finds that alcohol abuse raises the odds of suicide for both males and females. In a study of suicide attempts, Deykin and Buka[9] find high rates of attempts among youth dependent on alcohol and drugs, with 28 percent of males and 61 percent of females reporting a suicide attempt. Substance use also is positively associated with suicidal behaviors in non-clinical samples of youth.[10,11]

Despite this strong correlation between alcohol use and suicidal behaviors, researchers have not established that this use has a causal effect on young people's risk of suicide. Substance use and abuse often are correlated with other risk factors, making it difficult to establish causation. In particular, many researchers report that in addition to substance use disorders, other psychiatric conditions have been linked to suicidal behaviors among youth. In particular, Crumley,[5] Shaffer et *al*,[7] Deykin and Buka,[9] Runeson,[12] and many others find that depressive disorders are some of the most common psychiatric comorbidities associated with suicidal behaviors.

A few recent studies suggest that even after controlling for other psychiatric disorders, alcohol consumption remains a strong, independent predictor of suicidal behaviors. Wagner *et al*,[11] note that while co-morbid depression and conduct problems increase the probability that a substance abusing youngster attempts suicide, substance abuse also independently increases the probability of attempting suicide. Similarly, Cutler *et al*[13] find that among adolescent respondents in the National Longitudinal Study of Adolescent Health, alcohol use is a statistically significant predictor of suicide attempts after controlling for depression.

If alcohol use is an underlying cause of suicide, then it is possible that policies that reduce consumption may reduce the incidence of suicide. Numerous studies have shown that alcohol consumption is responsive to changes in prices and taxes.[14,15] Studies focusing on youth consumption also show a responsiveness to price and policies pertaining to availability, such as the minimum legal drinking age.[16-18]

To date, only a few studies have examined the role of alcohol policies in reducing suicide rates. Jones *et al*[19] examine the impact of the minimum legal drinking age on suicides and other fatal injuries among youth during the early 1980s. They find that the suicide rate among 15-24-year-olds was 9.7 percent greater among youth living in states where they could drink legally compared to youth of the same age who lived in states where they could not drink legally. In a similar study that uses data from 1970 to 1990, Birckmayer and Hemenway[20] find that the suicide rates among 18-20-year-olds and 21-23-year-olds are higher in states with a minimum legal drinking age of 18 compared to youth living in states with a minimum legal drinking age of 21. Minimum legal drinking ages have no impact on suicide rates of 15-17-year-olds. These results are puzzling since presumably these laws have the greatest impact on those under the legal drinking age, rather than on those over the legal age. This study also includes the state-level tax on beer, but finds no statistically significant impact of the beer tax on suicide rates. Lastly, Sloan *et al*[21] focus on adult suicide rates during the 1980s. They find that higher beer prices are associated with lower state-level suicide rates after controlling for a range of time-varying state characteristics and state fixed effects.

Although the two minimum legal drinking age studies provide interesting evidence about the potential role for a state-level substance use policy to prevent suicide among teenagers, this information is less relevant today because the legal drinking age is now uniformly 21 in all states. In addition, no information is available on the effectiveness of other alcohol policies, such as those relating to alcohol availability or drunk driving, as tools to prevent suicide among youth. This study is the first to investigate whether a number of commonly used alcohol regulatory policies affect youth suicides.

Data and Methodology

Data on completed suicides come from the National Center for Health Statistics's Compressed Mortality File, which contains information on all completed suicides over time. These data are collected from death certificates filed in each state and include the state of residence, age, and gender of each individual. Annual data from 1976 to 1999 are used to create death counts and rates by state, gender, and age group. Specifically, the suicide counts are calculated for children (ages 10-14), teens (ages 15-19) and young adults (ages 20-24). To create annual rates, the number of youth suicides in each state for each gender-age group is divided by the corresponding population of youths in that gender-age category. This process results in a time series of 1,224 observations (50 states plus the District of Columbia for 24 years) for each gender-age group.

The empirical specification is based on a simple model of the demand for health with an imbedded health production function. Alcohol is a negative input in the production of health; in this case, the outcome of interest is poor health

which is measured by suicide. A linear specification of the reduced form demand function is the following:

$$S_{ijt} = \delta_0 + \delta_1 P_{jt} + \delta_2 X_{jt} + \delta_3 \gamma_j + \delta_4 \mu_t + \epsilon_{ijt}. \quad (1)$$

Equation (1) specifies that suicides (S) for each gender-age group (i) in a state (j) at a point in time (t) is a function of state alcohol regulatory variables (P_{jt}), other state characteristics (X_{jt}), state effects (γ_j), year effects (μ_t), and an error term. The hypothesis tested is whether or not alcohol regulatory policies impact youth suicides. Given the strong evidence discussed above linking alcohol policies to consumption and consumption to suicides, we surmise that any estimated effects of the alcohol policies work through a reduction in alcohol consumption. There is little reason to believe that alcohol policies may impact suicides in any other way except through changes in consumption.

Several variables are used to measure state-level alcohol regulations. First, the real (1982-1984=1) state and federal excise tax on beer measures the price of alcohol. Beer taxes come from the Beer Institute's *Brewers Almanac*. The tax on beer is chosen because beer is the most popular alcoholic beverage among youths. Second, the percentage of each state's population living in counties dry for beer in each of the years is included. These data come from the Beer Institute's *Brewers Almanac* (various years). Third, the number of retail outlets per 1,000 population that are licensed to sell liquor for on-premise or off-premise consumption is included. These data come from *Jobson's Liquor Handbook* (various years). With larger percentages of populations living in dry counties or with fewer outlets available, travel time to obtain alcohol increases, adding to the full price of alcohol. If alcohol consumption contributes to suicide, then it is expected that policies which make obtaining alcohol more costly will reduce suicides.

The real state-level excise taxes on beer vary tremendously over the sample period. In addition to changes due to inflation, thirty-five states changed the nominal tax rate at least once, with 15 of those states changing the nominal tax rate two or more times. The state of Washington experienced the most variation in taxes with six legislated changes during the years 1976-1999.

The other measures of alcohol regulation are indicators for the presence of certain blood alcohol concentration (BAC) laws. These laws make it illegal per se to drive with a blood alcohol concentration greater than a certain level. In 1976, 12 states had a BAC law of 0.10 or higher. In 1983, Oregon and Utah were the first states to pass a BAC law of 0.08. By 1999, almost all states had passed BAC laws, with 18 states having 0.08 as the legal limit. Beginning in the mid 1980s, states also began enacting ''zero tolerance'' laws for underage drinking and driving. These laws typically set the BAC for underage drinkers at 0.02 or less. Federal legislation passed in 1995 encouraged all states to pass zero tolerance laws by allowing for the withholding of federal highway funds. By 1999, all 50 states plus the District of Columbia had a zero tolerance law in effect.

Three indicators for BAC laws are included: a dichotomous indicator for a BAC law of 0.10 or higher, a dichotomous indicator for a BAC law of 0.08 or higher, and a dichotomous indicator for the presence of a youth zero tolerance law. Note that for states in which the laws became effective at some point during the year, fractional values are used to represent the percentage of the year under which the law was in effect. Youth and young adults living in states with more stringent BAC laws face a higher full price of alcohol relative to youth living in less stringent states because the probability of being charged with drunk driving increases. Thus, it is expected that stricter BAC laws will reduce alcohol consumption and possibly reduce suicides.

Each model includes a number of other state-level variables to capture additional factors which may influence the number of suicides over time. These variables include the female labor force participation rate, the unemployment rate, real income per capita, the percentage of the population living in rural areas, and the percentage of the population 25 years and over that has obtained a bachelor's degree. The percentage of each state's population identifying with certain religions (Mormon, Southern Baptist, Protestant and Catholic) also is included. The religion data come from Jones et al.[22] All models include state and time dummies. The state dummies will help to capture any unobserved time-invariant state effects which may influence suicide and may be correlated with the alcohol control policies. Time dummies are included to capture secular trends in the suicide rates. The inclusion of these variables reduces the possibility that the observed correlations between state alcohol policies and suicide rates are confounded by unobserved, state-level factors or unobserved secular trends that affect both the enactment of these policies and the rate of suicide among youth.

Data Analytic Procedures

The dependent variables in the models are counts of annual suicides by state, gender and age group. Given the discrete nature of the dependent variable, a Poisson or a negative binomial distribution best describes the dependent variables.[23] The negative binomial distribution is chosen because likelihood ratio tests reject the null hypothesis that the underlying distribution is Poisson. Each model includes the relevant population as a right hand side variable to normalize for exposure. The coefficient on population is constrained to equal one.

The estimation of completed suicides in a time-series cross-sectional model may be confounded by a phenomenon called social contagion. The social contagion theory proposes that incidents of youth suicide are strongly influenced by peer suicides and, as a result, often occur in clusters.[24] The media may contribute to this social contagion by publicizing certain deaths.[25] Indeed, Cutler *et al*[13] find statistical evidence for the theory of contagion in youth suicide rates through an examination of the excess variance of suicide rates across areas. If the error terms are spatially correlated during a given time frame, large errors in one state might be associated with large errors in a neighboring state at the same point in time. This problem could lead to inefficient, although unbiased, estimates of the coefficients. To account for this issue, the tables below present standard t-statistics as

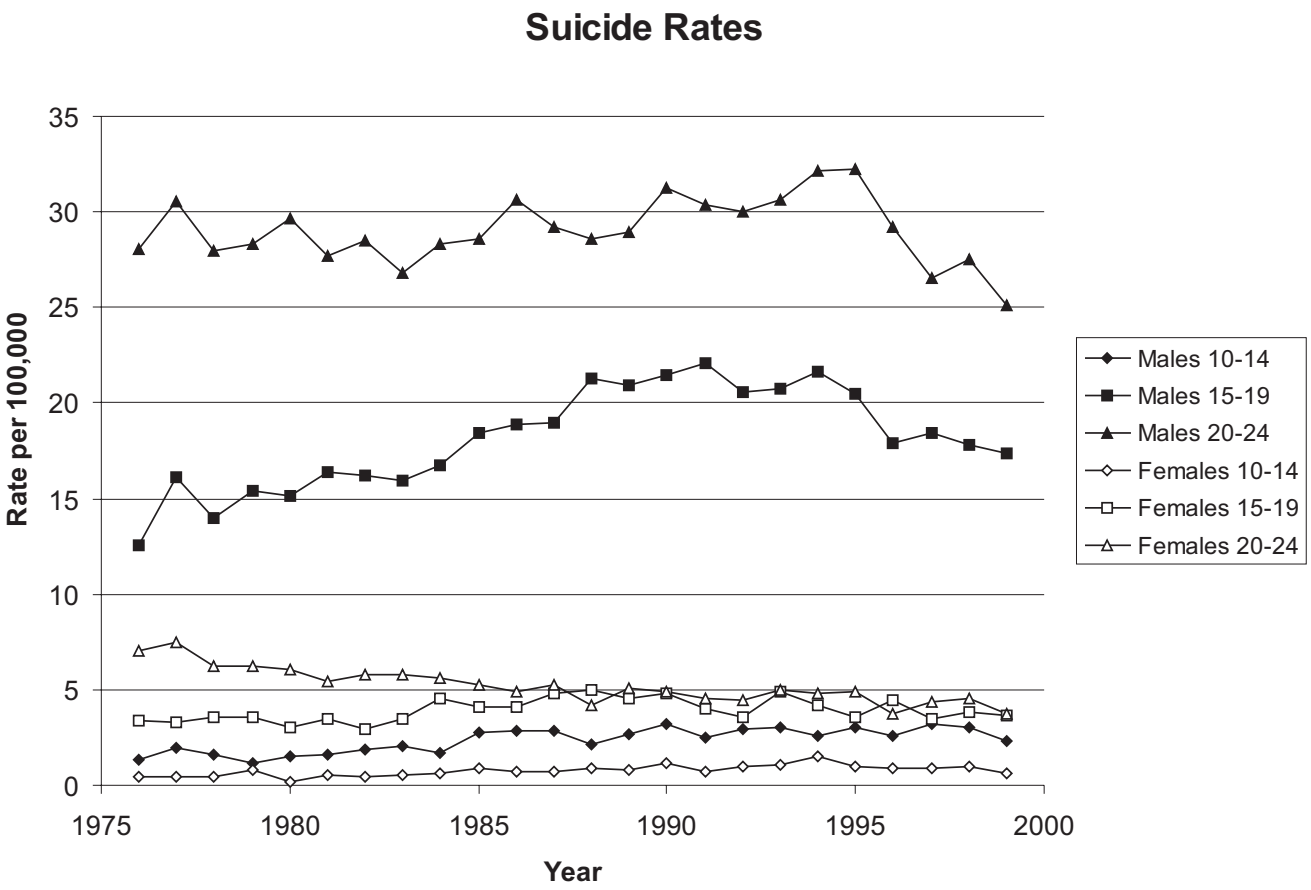

Figure 1. Variation in suicide rates over time.

well as t-statistics based on standard errors that are adjusted for clustering by year.

Results

Table 1 shows summary statistics for selected variables. This table shows that the average suicide rate across all years of data for males ages 10-14 is 2.35 per 100,000 population. Females of the same age have a much lower average rate of 0.76 per 100,000. Older age groups have higher average suicide rates. For males and females ages 15-19 the rates are 18.15 and 3.94, respectively. **Figure 1** shows the variation in suicide rates over time. These trends vary by gender and age group. For young females ages 10-14 and 15-19, the suicide rates have been fairly constant since 1976, ranging between 0.2 and 1.5 per 100,000 population for the youngest group and 3.0 and 5.0 for the older group. For older females ages 20-24, there has been a distinct downward trend in the suicide rate over time, with the rate falling from 7.0 in 1976 to 3.7 in 1999. By contrast, the rates for males ages 10-14 and 15-19 generally have risen over time. In 1976, the rate for boys ages 10-14 was 1.3, which rose by about 73 percent to 2.32 in 1999. The rate for boys ages 15-19 was 12.6 in 1976, which peaked at 22.11 in 1991, and fell slightly to 17.34 in 1999. Lastly, the suicide rate for males ages 20-24 was fairly constant until 1985 when an upward trend began. This trend lasted 10 years and has been falling since 1995.

As discussed previously, many studies have shown a strong positive relationship between alcohol consumption and suicide. The results in **Table 2** provide an example of this correlation. Here, suicide rates are regressed on a state-level measure of beer consumption and other state level variables. Data on beer consumption come from the *Brewers Almanac* and are expressed in gallons per capita. Note that these data apply to all consumers and include males and females of all ages, not just youth. Although this is far from an ideal measure of youth consumption, it is important to demonstrate a correlation between consumption and youth suicide rates if the reduced form results are to be believed.

The results show a positive relationship between beer consumption and suicides for males. For each age group, a 1 percent increase in the state per capita number of gallons of beer consumed is associated with approximately a 1 percent increase in male suicides. For females, however, the coefficients on beer consumption are positive for the older age groups, but are small and never statistically significant. Although the measure of consumption is not specific to gender or age, these results suggest that alcohol regulatory policies will have a much smaller impact, if any, on suicides by females.

Table 3 presents the results of the negative binomial regression of male suicides on the alcohol regulatory variables by age group. Elasticities are presented in the

Table 1. Summary Statistics of Selected Variables

Variable	Definition	Mean	Standard Deviation
Male suicide rate ages 10-14	Number of male suicides, ages 10-14, per 100,000 males ages 10-14	2.35	2.20
Male suicide rate ages 15-19	Number of male suicides, ages 15-19, per 100,000 males ages 15-19	18.15	8.74
Male suicide rate ages 20-24	Number of male suicides, ages 20-24, per 100,000 males ages 20-24	29.03	10.81
Female suicide rate ages 10-14	Number of female suicides, ages 10-14, per 100,000 females ages 10-14	0.76	1.20
Female suicide rate ages 15-19	Number of female suicides, ages 15-19, per 100,000 females ages 15-19	3.94	3.04
Female suicide rate ages 20-24	Number of female suicides, ages 20-24, per 100,000 females ages 20-24	5.23	3.50
Male suicides, ages 10-14	Number of male suicides, ages 10-14	3.57	3.86
Male suicides, ages 15-19	Number of male suicides, ages 15-19	29.36	27.96
Male suicides, ages 20-24	Number of male suicides, ages 20-24	50.20	52.71
Female suicides, ages 10-14	Number of female suicides, ages 10-14	1.14	1.60
Female suicides, ages 15-19	Number of female suicides, ages 15-19	6.35	7.23
Female suicides, ages 20-24	Number of female suicides, ages 20-24	9.22	11.84
Real beer tax	State and federal excise tax on beer, adjusted for inflation	0.55	0.23
Percent dry	Percentage of state population living in counties that are dry for beer.	4.19	9.65
Liquor outlets	Number of liquor outlets per 1,000 population, by state	1.37	0.75
0.10 BAC law	Dichotomous variable that equals 1 if per se illegal to drive with a blood alcohol concentration of 10 percent or greater	0.61	0.48
0.08 BAC law	Dichotomous variable that equals 1 if per se illegal to drive with a blood alcohol concentration of 8 percent or greater	0.09	0.29
Zero tolerance law	Dichotomous variable that equals 1 if state has zero tolerance laws for youth underage drinking and driving	0.26	0.43
Labor force participation	Labor force participation rate of women	56.60	5.88
Unemployment	Unemployment rate	6.24	2.10
Real income	Per capita income, adjusted for inflation	136.03	24.95
Percent rural	Percentage of the state's population living in rural areas	31.02	15.03
College degree	Percentage of state population 25 years and older that has graduated from a 4-year college	19.28	5.08

columns next to the coefficients. For dichotomous variables, the elasticities are the percentage changes in the mean number of suicides resulting from a switch from zero to one. Across all age groups, the results show that increases in the excise tax on beer are associated with reductions in male suicides. The coefficients on the beer tax are statistically significant whether or not the standard errors are clustered by year. For the youngest males, a ten percent increase in the beer tax will lower the average number of suicides by 5.0 percent. The effects are slightly smaller for the older age groups, where a ten percent increase in the beer tax will lower the average number of suicides by 3.1 percent (ages 15-19) and 2.4 percent (ages 20-24). It may be somewhat surprising that beer taxes affect suicides by the youngest males (those ages 10-14), but this result is plausible given that children of this age do drink. Data from the 1999 National Household Survey on Drug Abuse show that 19.4 percent of children ages 12-13 report lifetime alcohol use, 12.9 percent report past year alcohol use, and 4.4 percent report past month alcohol use.*

The availability and ease of obtaining alcohol may also impact male suicides. The results in **Table 3** show that higher percentages of population living in dry counties are associated with a lower number of suicides for the oldest

* To demonstrate the plausibility, assume that the elasticity of demand for alcohol is –0.5. If 20 percent of young males drink, a 10 percent increase in the beer tax would reduce drinking by 1,000 per 100,000 children. If only one of these children who stops drinking does not commit suicide as a result, this would represent a 50 percent change in the suicide rate for males in this age group (1 per 100,000 is roughly 50 percent of the average of 2.35 deaths per 100,000). Thus, the 5 percent change in the number of suicides predicted by the result shown in **Table 3** is not an unreasonable estimate.

Table 2. Negative Binomial Regressions Suicides and Per Capita Beer Consumption

	Males 10-14	Males 15-19	Males 20-24	Females 10-14	Females 15-19	Females 20-24
Beer Consumption	0.059	0.042	0.039	-0.012	0.009	0.006
	(4.43)	(8.70)	(9.91)	(-0.48)	(0.87)	(0.64)
	[5.57]	[8.55]	[9.09]	[-0.67]	[1.13]	[0.50]
Labor Force Participation	-0.007	-0.002	0.008	0.018	0.001	0.009
	(-0.55)	(-0.51)	(2.23)	(0.81)	(0.13)	(1.13)
	[-0.46]	[-0.44]	[2.83]	[0.90]	[0.15]	[1.25]
Unemployment	0.013	0.008	0.013	0.028	0.022	0.030
	(0.81)	(1.30)	(2.73)	(0.92)	(1.75)	(2.95)
	[0.61]	[1.35]	[1.94]	[1.03]	[1.43]	[1.97]
Real Income	-0.006	-0.002	-0.002	-0.004	0.003	0.002
	(-1.61)	(-1.42)	(-2.10)	(-0.56)	(1.08)	(0.70)
	[-1.48]	[-1.23]	[-2.31]	[-0.72]	[0.78]	[0.51]
Percent Rural	-0.020	0.001	-0.015	-0.049	-0.026	-0.021
	(-1.32)	(0.13)	(-3.04)	(-1.67)	(-2.02)	(-1.86)
	[-1.18]	[0.16]	[-2.49]	[-2.23]	[-2.24]	[-2.23]
College degree	-0.016	-0.009	-0.005	0.004	-0.011	0.009
	(-1.01)	(-1.46)	(-1.04)	(0.16)	(-0.83)	(0.76)
	[-0.83]	[-1.34]	[-0.92]	[0.18]	[-0.69]	[0.59]
Percent Mormon	0.069	0.098	0.067	0.201	0.007	0.247
	(0.98)	(3.64)	(2.82)	(1.35)	(0.12)	(4.08)
	[0.84]	[3.31]	[2.89]	[1.20]	[0.11]	[3.81]
Percent Southern Baptist	0.019	0.013	0.029	0.099	0.080	0.062
	(0.53)	(1.02)	(2.80)	(1.56)	(3.02)	(2.70)
	[0.67]	[1.05]	[2.95]	[1.47]	[3.06]	[3.18]
Percent Protestant	-0.019	-0.002	-0.009	-0.032	-0.040	0.009
	(-1.29)	(-0.47)	(-2.09)	(-1.24)	(-3.59)	(0.94)
	[-1.05]	[-0.50]	[-1.93]	[-1.09]	[-4.53]	[0.87]
Percent Catholic	-0.033	-0.007	-0.007	0.015	-0.005	-0.028
	(-2.16)	(-1.26)	(-1.46)	(0.55)	(-0.42)	(-2.89)
	[-2.54]	[-1.40]	[-1.55]	[0.63]	[-0.47]	[-3.33]

Note: t-statistics in parentheses, t-statistics based on standard errors clustered by year in brackets, and intercept not shown. All models include state and year dummies. N=1,224.

males, but have no deterrent effect for younger males. More outlets licensed to sell liquor are also associated with an increase in male suicides. A 10 percent increase in the number of outlets licensed to sell liquor increases teenage male suicides by 0.98 percent, and young adult male suicides by 0.51 percent (at about the 10 percent significance level). The result for liquor outlets must be interpreted with caution. While it is likely that more outlets in an area increases alcohol consumption, the converse likely holds as well. Liquor outlets may simply be an alternative representation of aggregate consumption in an area.

The laws pertaining to drunk driving have limited impact on male suicides. Not surprisingly, the 0.10 BAC law and the 0.08 BAC law have no impact on suicides for males under the legal drinking age, although having a BAC law of 0.08 is associated with a 6.5 percent decrease in suicides for males ages 20-24. Zero tolerance laws, which are aimed at drivers under the legal drinking age, are associated with a decrease in suicides by males ages 15-19, but not those ages 10-14 who typically are not licensed to drive. In addition, zero tolerance laws are associated with a decrease in male suicides for those aged 20-24. This result is somewhat puzzling since such laws do not pertain to people over the legal drinking age (currently age 21, but ranging between 18 and 21 from 1976 to 1989). One possible explanation is that the zero tolerance laws may be well publicized and may be correlated with state enforcement efforts, resulting in less drinking across all ages.

Table 4 contains the results of alcohol regulatory variables on suicides by females. Here, very few of the alcohol regulatory variables have an impact on female suicides. Recall that **Table 2** shows no relationship between beer

Table 3. Negative Binomial Regressions Male Suicides and Alcohol Regulatory Variables

	Males 10-14		Males 15-19		Males 20-24	
	Coefficient	Elasticity	Coefficient	Elasticity	Coefficient	Elasticity
Real beer tax	-0.907	-0.503	-0.555	-0.308	-0.437	-0.242
	(-3.40)		(-5.96)		(-6.04)	
	[-4.26]		[-5.70]		[-6.67]	
Percent dry	-0.016	-0.066	-0.0005	-0.002	-0.006	-0.024
	(-1.51)		(-0.13)		(-1.90)	
	[-1.23]		[-0.15]		[-2.02]	
Liquor outlets	0.088	0.121	0.072	0.098	0.037	0.051
	(1.16)		(2.59)		(1.64)	
	[1.06]		[3.18]		[1.56]	
0.10 BAC law	-0.061	-0.067	-0.017	-0.019	-0.027	-0.025
	(-0.81)		(-0.66)		(-1.32)	
	[-1.00]		[-0.72]		[-1.69]	
0.08 BAC law	0.010	0.011	-0.048	-0.053	-0.073	-0.065
	(0.09)		(-1.11)		(-2.06)	
	[0.08]		[-1.08]		[-2.20]	
Zero tolerance law	-0.0001	-0.0001	-0.042	-0.047	-0.085	-0.077
	(-0.001)		(-1.74)		(-4.18)	
	[-0.001]		[-1.60]		[-4.02]	
Labor force participation	-0.006	-0.345	-0.004	-0.219	0.005	0.266
	(-0.49)		(-0.83)		(1.24)	
	[-0.42]		[-0.78]		[1.35]	
Unemployment	-0.001	-0.005	-0.001	-0.004	0.003	0.021
	(-0.05)		(-0.11)		(0.72)	
	[-0.04]		[-0.11]		[0.49]	
Real income	-0.004	-0.522	-0.001	-0.150	-0.002	-0.244
	(-1.01)		(-0.81)		(-1.66)	
	[-0.97]		[-0.74]		[-1.59]	
Percent rural	-0.016	-0.508	0.004	0.125	-0.014	-0.430
	(-1.08)		(0.67)		(-2.79)	
	[-0.98]		[0.78]		[-2.16]	
College degree	-0.028	-0.541	-0.017	-0.332	-0.013	-0.259
	(-1.78)		(-2.78)		(-2.61)	
	[-1.64]		[-2.50]		[-2.08]	
Percent Mormon	0.079	0.232	0.110	0.323	0.076	0.225
	(1.10)		(3.97)		(3.17)	
	[0.93]		[3.70]		[3.46]	
Percent Southern Baptist	0.076	0.547	0.038	0.276	0.048	0.347
	(1.88)		(2.60)		(4.06)	
	[2.25]		[2.95]		[4.11]	
Percent Protestant	-0.026	-0.574	-0.008	-0.171	-0.012	-0.261
	(-1.69)		(-1.42)		(-2.67)	
	[-1.34]		[-1.51]		[-2.46]	
Percent Catholic	-0.037	-0.702	-0.006	-0.123	-0.009	-0.171
	(-2.29)		(-1.08)		(-1.89)	
	[-2.42]		[-1.11]		[-1.77]	

Note: t-statistics in parentheses, t-statistics based on standard errors clustered by year in brackets, and intercept not shown. All models include state and year dummies. N=1,224.

Table 4. Negative Binomial Regressions Female Suicides and Alcohol Regulatory Variables

	Females 10-14		Females 15-19		Females 20-24	
	Coefficient	Elasticity	Coefficient	Elasticity	Coefficient	Elasticity
Real beer tax	-0.114	-0.063	-0.227	-0.126	-0.262	-0.145
	(-0.26)		(-1.22)		(-1.70)	
	[-0.22]		[-1.52]		[-1.71]	
Percent dry	-0.007	-0.030	-0.005	-0.021	-0.009	-0.038
	(-0.36)		(-0.69)		(-1.42)	
	[-0.61]		[-0.73]		[-1.81]	
Liquor outlets	0.076	0.104	-0.010	-0.014	-0.021	-0.029
	(0.58)		(-0.18)		(-0.43)	
	[0.68]		[-0.14]		[-0.41]	
0.10 BAC law	0.021	0.021	-0.097	-0.106	-0.029	-0.027
	(0.16)		(-1.79)		(-0.66)	
	[0.19]		[-1.94]		[-0.54]	
0.08 BAC law	-0.064	-0.062	-0.125	-0.130	-0.020	-0.019
	(-0.31)		(-1.40)		(-0.26)	
	[-0.37]		[-1.75]		[-0.27]	
Zero tolerance law	-0.041	-0.040	-0.103	-0.109	-0.027	-0.024
	(-0.38)		(-2.04)		(-0.58)	
	[-0.45]		[-2.21]		[-0.78]	
Labor force participation	0.013	0.733	-0.002	-0.114	0.007	0.387
	(0.57)		(-0.20)		(0.79)	
	[0.66]		[-0.25]		[0.83]	
Unemployment	0.030	0.188	0.018	0.113	0.027	0.170
	(1.01)		(1.49)		(2.67)	
	[1.10]		[1.18]		[1.87]	
Real income	-0.005	-0.691	0.002	0.254	0.002	0.240
	(-0.71)		(0.65)		(0.71)	
	[-0.79]		[0.47]		[0.59]	
Percent rural	-0.048	-1.498	-0.026	-0.822	-0.023	-0.714
	(-1.64)		(-2.03)		(-1.99)	
	[-2.14]		[-2.13]		[-2.23]	
College degree	0.008	0.154	-0.012	-0.222	0.008	0.163
	(0.29)		(-0.86)		(0.69)	
	[0.32]		[-0.68]		[0.54]	
Percent Mormon	0.199	0.585	0.001	0.003	0.249	0.733
	(1.34)		(0.02)		(4.08)	
	[1.20]		[0.02]		[4.28]	
Percent Southern Baptist	0.107	0.769	0.093	0.669	0.087	0.625
	(1.46)		(2.99)		(3.21)	
	[1.45]		[2.91]		[4.11]	
Percent Protestant	-0.043	-0.937	-0.046	-0.995	0.003	0.068
	(-1.55)		(-3.85)		(0.31)	
	[-1.33]		[-3.97]		[0.25]	
Percent Catholic	0.024	0.457	-0.004	-0.082	-0.028	-0.531
	(0.83)		(-0.35)		(-2.74)	
	[0.94]		[-0.40]		[-3.15]	

Note: t-statistics in parentheses, t-statistics based on standard errors clustered by year in brackets, and intercept not shown. All models include state and year dummies. N=1,224.

consumption and female suicides; thus, the results in **Table 4** are consistent with those in **Table 2** and it is not surprising that female suicides are generally not impacted by policies which may influence alcohol consumption. Higher beer taxes only appear to impact suicides by females ages 20-24. A 10 percent increase in the beer tax will lower female suicides in this age group by 1.45 percent, although this result is not estimated very precisely. Two of the drunk driving laws may also impact female suicides, with the law for a 0.10 BAC and a zero tolerance law being negatively associated with female suicides for those ages 15-19.

One concern with the models in **Table 3** and **Table 4** is that the alcohol regulatory variables may be highly collinear and as a result, discerning the unique effect of each policy may be difficult. Models were tested which include only one alcohol variable at a time along with the other state-level variables. The resulting coefficients and standard errors are very similar to those presented below. Only a few changes are worth noting. For males ages 10-14, the coefficient on liquor outlets remains positive and becomes statistically significant at the 10 percent level. For males ages 20-24, the coefficient on percent living in dry counties becomes insignificant, while the coefficient on liquor outlets becomes significant at the 5 percent level. Lastly, the coefficient on the beer tax in the suicide equation for females ages 20-24 falls below the 10 percent significance level, thus casting further doubt that higher beer taxes will lower suicides by females. These results are available upon request.

Each model in **Table 3** and **Table 4** also contains the female labor force participation rate, the unemployment rate, real income per capita, the percentage of the population living in rural areas, and percent with a college degree. These variables have very little impact on the youth suicide rates. For males shown in **Table 3**, a higher percentage of the population with a college degree is the only variable which is associated with a lower number of suicides across all age groups. Higher incomes and more people living in rural areas are also negatively associated with suicides for males ages 20-24. **Table 4** shows that more people living in rural areas are negatively associated with female suicides across all age groups. Lastly, higher unemployment rates are associated with more female suicides in the 20-24 age group.

Discussion

One of the most important risk factors for youth suicide is alcohol consumption. Given the strong link between alcohol use and suicide among youth, this paper seeks to determine whether policies designed to reduce the consumption of alcohol may succeed in reducing youth suicides as well. The results of negative binomial regressions indicate that increases in the excise tax on beer will have no impact on female suicides. Higher beer taxes are associated with a reduction in the number of male suicides, with a 10 percent increase in the beer tax resulting in a 2.4 to 5 percent decrease in suicides, depending on the age group under consideration. In other words, a 5.5 cent increase in the beer tax will save on average about one male life in the 15-19 and 20-24 age groups per state and year. It would take a 33 cent increase (a 60 percent increase) in the beer tax to save approximately one male life in the 10-14 age group, on average.

Other alcohol regulatory variables may also be effective in reducing suicides, with most of the impact occurring among males ages 20-24. Suicides by this group are positively related to the availability of alcohol, and negatively related to the presence of a 0.08 BAC law and a zero tolerance law for drunk driving. Female suicides are not impacted by the availability of alcohol, although the drunk driving laws may impact suicides by teenage females. In sum, policies that effectively reduce alcohol consumption among youth may have the added benefit of preventing suicides, at least among young males.

While this study is one of the first to suggest that state level policy tools may be effective in reducing suicides among males, there are some limitations to this research that must be considered. First, this research does not provide much policy guidance on ways to reduce suicides for females, perhaps with the exception of strict drunk driving laws. This is certainly a direction for future research. Second, by 1999, all states had enacted zero tolerance laws, and as a result, these laws are no longer a viable policy tool which can be used to further reduce suicides. Third, while the state dummies help capture time-invariant state-level factors which may be correlated with alcohol regulatory policies and suicides, time-variant factors may still remain in the error term and have the potential to bias the results. However, it is difficult to predict the direction of any such bias.

Another limitation of this study is that it does not take into account the impact of psychiatric disorders on suicides. Indeed, depressive disorders are some of the most common psychiatric comorbidities associated with suicides.[7,9] Changes in the incidence of mental illness in a state will likely influence the suicide rate. However, so long as the incidence of mental illness is uncorrelated with the state-level alcohol control policies, the exclusion of any such measures will not bias the results. Similarily, this study does not consider the role of illegal drugs. The use of such substances has been linked to suicides in a similar manner as alcohol consumption.[5,26] Future research should consider the role of illegal drug consumption and related policies in determining youth suicides.

Acknowledgement

The authors would like to thank Dhaval Dave, Jeff De Simone and Ed Schumacher for providing helpful comments, and Jennifer Tennant for excellent research assistance.

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