



# HHS Public Access

Author manuscript

*Alcohol Clin Exp Res.* Author manuscript; available in PMC 2017 October 01.

Published in final edited form as:

*Alcohol Clin Exp Res.* 2016 October ; 40(10): 2043–2055. doi:10.1111/acer.13203.

## Alcohol Policies and Suicide: A Review of the Literature

**Ziming Xuan, ScD, SM, MA,**

Department of Community Health Sciences, Boston University School of Public Health

**Timothy S. Naimi, MD, MPH,**

Section of General Internal Medicine, Boston Medical Center

**Mark S. Kaplan, DrPH,**

Department of Social Welfare, Luskin School of Public Affairs, University of California Los Angeles

**Courtney L. Bagge, PhD,**

Department of Psychiatry and Human Behavior, University of Mississippi Medical Center

**Lauren R. Few, PhD,**

Department of Psychiatry, Washington University School of Medicine

**Stephen Maisto, PhD,**

Department of Psychology, Syracuse University

**Richard Saitz, MD, MPH, and**

Department of Community Health Sciences, Boston University School of Public Health

**Robert Freeman, PhD**

National Institute on Alcohol Abuse and Alcoholism, NIH

### Abstract

Both intoxication and chronic heavy alcohol use are associated with suicide. There is extensive population-level evidence linking per capita alcohol consumption with suicide. While alcohol policies can reduce excessive alcohol consumption, the relationship between alcohol policies and suicide warrants a critical review of the literature.

This review summarizes the associations between various types of alcohol policies and suicide, both in the United States and internationally, as presented in English-language literature published between 1999 and 2014. Study designs, methodological challenges, and limitations in ascertaining the associations are discussed.

Because of the substantial between-states variation in alcohol policies, U.S.-based studies contributed substantially to the literature. Repeated cross-sectional designs at both the ecological level and decedent level were common among U.S.-based studies. Non-U.S. studies often used time series data to evaluate pre-post comparisons of a hybrid set of policy changes. Although

---

**Corresponding Author:** Ziming Xuan, ScD, Department of Community Health Sciences, Boston University School of Public Health, 801 Massachusetts Avenue, Crosstown 443, Boston, MA 02118; Tel: 617-638-4118; Fax: 617-638-4483 [zxuan@bu.edu](mailto:zxuan@bu.edu).

**Declaration of Conflicts of Interest:** Drs. Xuan, Naimi, Kaplan, Bagge, Few, Maisto and Freeman have no conflicts of interest to declare.

inconsistency remained, the published literature in general supported the protective effect of restrictive alcohol policies on reducing suicide as well as the decreased level of alcohol involvement among suicide decedents. Common limitations included measurement and selection bias, and a focus on effects of a limited number of alcohol policies without accounting for other alcohol policies.

This review summarizes a number of studies that suggest restrictive alcohol policies may contribute to suicide prevention on a general population level, and to a reduction of alcohol involvement among suicide deaths.

## Keywords

Alcohol Policies; Suicide; Blood Alcohol Content; Critical Review

---

## INTRODUCTION

Globally, over 800,000 people die due to suicide every year, accounting for 1.4% of the global burden of mortality and making suicide the 15th leading cause of death in 2012 (World Health Organization, 2014). Suicide was the tenth leading cause of death in the United States in 2013, resulting in 41,149 suicides approximately 113 suicides each day (Centers for Disease Control and Prevention, 2013). Age-adjusted suicide rates in the US have increased steadily from 1999 (10.5 per 100,000 population) to 2014 (13.0) despite almost a consistent decline in rates from 1986 through 1998. In 2014, the age-adjusted rate for males (20.7) was more than three times that for females (5.8) (Curtin et al., 2016). Curtin and colleagues (2016) further showed that suicide rates for females were highest for those aged 45–64 in 2014 (9.8) while suicide rates were highest among men aged 75 and over (38.8). The age group between 10 and 14 had the lowest suicide rates in 2014 (1.5 for females vs. 2.6 for males), yet this age group experienced a marked increase in suicide rates between 1999 to 2014 (e.g., largest percent increase for females and second largest percent increase for males across all age groups).

Although Durkheim's (1966) original work on suicide viewed alcohol consumption as an individual level psychopathological factor, scholarly work on the association between alcohol and suicidal behaviors (i.e., non-fatal suicide attempts and death by suicide) typically draws on a more comprehensive theoretical framework that includes sociological and ecological determinants. Like individual factors, these contextual determinants also explain variation in suicidal behaviors (Skog, 1991). Recent calls to action in suicide prevention have further emphasized distal preventive interventions which focus on modifiable social contexts and factors that alter the life trajectories of people before they become suicidal (Caine, 2013).

The association between alcohol and suicidal behaviors has been well established for both intoxication and regular heavy drinking (Bagge et al., 2013; Bagge and Sher, 2008; Berglund and Ojehagen, 1998; Borges and Loera, 2010; Bray, 2006; Brismar and Bergman, 1998; Cherpitel et al., 2004; Rossow, 2000; Kaplan et al., 2013). It has been posited that acute effects may occur through increased intensity of suicidal ideation, dysphoria, disinhibition,

impulsivity, myopia, and aggression, while effects of regular heavy alcohol use on suicide risk have been hypothesized to operate through the reciprocal relationship between depression and alcohol use disorders and/or by promoting interpersonal disruption that leads to stress-reactive suicidal behavior (Bagge et al., 2014; Bray, 2006; Conner et al., 2014; Conner et al., 2008; Hufford, 2001; Pompili et al., 2010). A complicating factor to bear in mind is the considerable difference across studies in how one defines a self-inflicted act with the intention to die (i.e., suicide attempts). For example, cases may be more accurately defined in studies conducted in mental health facilities as compared with those in community surveys (Kessler et al., 1994). For this reason, in this review, we focus on suicide mortality studies, where suicide death is commonly defined and coded according to the underlying cause of death as determined by a medical examiner and specified on death certificates. Although suicide death cases are more consistently determined, there is still variation in the practice by geographical areas and race (Huguet et al., 2012), especially on the proportion of autopsies performed to ascertain suicide as the underlying cause. Similarly, in studies where alcohol involvement is determined, the definitions and threshold of alcohol involvement, and the proportion of blood alcohol content (BAC) testing may also vary by study. Thus, caution regarding potential misclassification and confounding should be exercised when examining differences across studies, even though we only focus on suicide mortality in this review.

At the population level the positive relationship between per capita alcohol sales (or consumption) and suicide mortality rates have been documented in various studies across many countries, and the magnitude of the associations vary by gender and beverage types (Cook, 2007; Cook and Durrance, 2013; Kerr et al., 2011; Landberg, 2009; Lester, 2000; Norström, 1988, 1995; Norström et al., 2011; Ramstedt, 2001, 2005; Razvodovsky, 2009). Effective alcohol policies contribute to a reduction in excessive alcohol consumption at both population and individual levels (Anderson et al., 2009; Babor et al., 2010), among both general populations (Naimi et al., 2014; Xuan et al., 2015a) and youth (Xuan et al., 2015b). Yet, in contrast to the well-documented relationship between alcohol use and suicide, there has been much less research on the relationship between alcohol policies and suicide. While there is a strong need for identifying population-based preventive strategies for suicide in the United States (Caine, 2013), conceptually, alcohol policies may be capable of affecting suicide by altering alcohol consumption patterns at both the population and individual levels. Based on this framework, this article reviews the evidence base for the association between various types of alcohol policies and suicide mortality, both in the United States and in other countries, from literature published between 1999 and 2014. In this review, we will pay specific attention to study designs, methodological challenges, and limitations in ascertaining the associations, and will discuss implications for future research.

## **MATERIALS and METHODS**

The English-language literature in PubMed, PsycINFO and JSTOR was searched for articles published between 1999 and 2014 about alcohol policies and suicide mortality. We chose the year of 1999 as the start year because suicide rate experienced a steady uptrend from 1999 to 2014 (Curtin et al., 2016). A total of 17 studies involving one or multiple alcohol policies and suicide mortality published over a 16-year period (1999–2014) were obtained from the

three databases and hand searches of the reference lists of two well-regarded alcohol policy books (Babor et al., 2010; Cook, 2007). Articles from the same research group using the same sample were counted as one entry.

A variety of search strategies was implemented to locate entries efficiently. In addition to general terms (e.g., alcohol policy OR alcohol policies), we also searched using terms related to a variety of specific alcohol policies including: tax OR taxation OR excise tax OR pricing; state control OR monopoly; wholesale restriction; outlet density; dram shop; retail restriction; hours of sale; alcohol beverage control agency or agencies; sales to intoxicated patron; responsible beverage service training; days of sale; local option; warning label; direct shipment; social host laws; minimum legal drinking age (MLDA); minimum age of server or seller; house party law; keg registration; furnish alcohol to minor; false identification ID laws; alcohol advertising or marketing (Xuan et al., 2015a). We also conducted a search based on the terms related to policies to reduce alcohol-impaired driving including sobriety checkpoints, ignition interlocks, zero tolerance laws, and other alcohol impaired driving laws. Articles for this review were restricted to empirical research only and studies with outcomes focusing on death by suicide, suicide mortality or suicide death (expressed in counts or rates), or the likelihood or level of alcohol involvement (e.g., BAC level) in these fatalities. Articles focusing on “suicide attempts” or “suicide ideation,” or those with death by suicide but lacking empirical estimates, as well as study duplications were removed from the final list. Figure 1 shows the search process and counts. Table 1 provides details of year of publication, author(s), journal, sample, country, study period, alcohol policies, outcome, study design, and main findings.

## RESULTS

We identified 17 studies from 1999–2014 that examined associations between alcohol policies and suicide mortality (14 studies) or BAC levels among suicide decedents (3 studies). Of these, 6 studies were published prior to 2006, and 11 studies were published since 2007. Countries represented in the list include the United States (10 studies), among which 7 studies examined multiple states and 3 studies focused on smaller geographical units (e.g., zip code, communities) within a single state in U.S. (e.g., Alaska, California, and New Mexico); Canada (1 study); Estonia (1 study); Lithuania (1 study); Russia (1 study); Slovenia (2 studies); and Switzerland (1 study). A single study might evaluate the associations of one or multiple policies and suicide, while others focus on a primary alcohol policy while controlling for one or several other policies (e.g., a study on alcohol taxation while controlling for alcohol density). Policies represented in this review include alcohol taxation (4 studies), outlet density (4 studies), MLDA (3 studies), BAC  $\leq$  0.08 (1 study); zero tolerance (2 studies), and a hybrid of multiple policies as part of overall policy change being evaluated (7 studies). The majority of studies used counts or rates of suicide, while three studies focused on alcohol involvement (Yes/No) or BAC level among suicide decedents. Study designs varied, including pre-post comparison (3 studies); repeated cross-sectional design (5 studies); panel data design (4 studies); time series design (4 studies); and regression discontinuity design (1 study). Thirteen studies focused on ecological level data (e.g., zip, county, state, or country) and 4 studies examined individual level data (e.g., BAC  $>$  0 Yes/No; BAC level).

### Alcohol Price and Taxation (4 studies)

There is a general consensus that alcohol taxation is one of the most proven policies in reducing excessive alcohol consumption (Xuan et al., 2013; Babor et al., 2010). Overall, these studies show an inverse association between alcohol taxation and the suicide mortality rate, with the exception of one outlier study that found a positive association. They also have some design differences in type of beverage (e.g., beer vs. wine) and covariates controlled in the analyses. Early research by Sloan and colleagues (1994) found that higher beer prices were significantly associated with lower state-level suicide rates after controlling for a range of time-varying state characteristics and state fixed effects. Among the articles in this review, Birkmayer and Hemenway (1999) used beer tax adjusted for inflation to predict youth suicide rates from 1970 to 1990 and found no statistical relation for three age groups respectively (e.g., 15–17 years; 18–20 years; 21–23 years) while controlling for MLDA status. Yet, Markowitz and colleagues (2003) used youth suicide data for the period 1976–1999 and found that increases in the excise tax on beer were associated with reduced number of male suicides. However, excise tax on beer had no impact on female suicides. Unexpectedly, a study on suicide rate in Switzerland found that alcohol taxation was significantly positively related to the men's suicide rate (Yamasaki et al., 2005). A meta-analysis of the relationship between prices or taxes on mortality identified a total of 12 individual estimates of the effects of alcohol prices/taxes on suicide from the four articles just described (Wagenaar et al., 2010). This meta-analysis reports that five out of 12 individual estimates showed a statistically significant inverse association, and the inverse variance-weighted meta-estimate was statistically significant with removal of one positive estimate, specifically (Yamasaki et al., 2005), and was marginally significant otherwise. Although Yamasaki and colleagues (2005) found a significantly positive association between alcohol tax and suicide rate among men, this finding remained unexpected and appeared unrelated to consumption with the authors concluding that alcohol consumption level was not related to suicide rate in both sexes in Switzerland. Son and Topyan (2011) used state panel data between 1995 and 2004 to examine the effect of state excise taxes on three types of alcoholic beverages (spirits, wine, and beer) on alcohol-attributable injury mortality. Controlling for state sales taxes, alcohol outlet density, and state fixed effects, a small yet significant inverse association was detected between wine excise tax and suicide, but no association for spirit or beer excise taxes.

### Minimum Legal Drinking Age Law (3 studies)

Overall, there is consistent evidence that the enactment of the MLDA within the United States contributed to a reduction in youth suicide. Furthermore, these studies show evidence of an effect modification by gender, which is worth noting. Historically in the United States, MLDA has ranged from 18 to 21 years. In 1970, 33 states had an MLDA of 21 years. While many states reduced MLDA between 1970 and 1975, in 1977 major legislative efforts began raising the MLDA, as exemplified in the 1984 National Minimum Drinking Age Act which, as a condition of receiving state highway funds, prohibited persons under 21 years of age from purchasing and publicly possessing alcoholic beverages (King and Dudar, 1987). By 1988, all states had MLDA set at 21 years of age. This transition period provided many natural experiments, making MLDA one of the most well-studied alcohol policies in the United States (Wagenaar and Toomey, 2002; DeJong and Blanchette, 2014).

Although the implementation of MLDA legislation across the U.S. was not randomized by state, regression-discontinuity design appears to provide a method for a rigorous estimation of the effect of MLDA on alcohol-related outcomes. Regression-discontinuity design is well-suited for assessing the impact of the MLDA because MLDA defines the legality of alcohol purchasing and consumption that potentiates discontinuity between fitted regression lines. Furthermore, it assumes theoretical equivalence in observed and unobserved characteristics between individuals slightly younger than MLDA and those slightly older than the MLDA, except for reduced access to alcohol due to MLDA. Therefore, the “local” effect of MLDA can be inferred if the regression lines show a discontinuity at the MLDA cut-off age. Carpenter and Dobkin (2009) applied this design to the examination of suicide rates for young adults. They examined specifically those aged 19 to 22 in the United States between 1997 and 2004 and found a 16% increase in suicide mortality rate at MLDA of age 21. This is consistent with another study that used a regression-discontinuity design to assess the effect of MLDA on suicide-related injuries. Callaghan and colleagues (2013) employed a regression-discontinuity analysis on the rates of Canadian in-patient admission records of individuals aged 15–22 between 1997 and 2007. They found that removal of MLDA restrictions was associated with significant increases in hospital admission among young adults for suicide injuries, especially males.

Earlier research by Jones and colleagues (1992) used data from 50 states in the period between 1979 and 1984 and found that among persons of a legal drinking age, the suicide rate was 9.7% greater than among persons of the same age who could not drink legally within their state. Birckmayer and Hemenway (1999) conducted a repeated cross-sectional study based on the mortality files of decedents from 48 US states from 1970 to 1990. They used Poisson regression to model the number of suicides and found that the suicide rate of 18- to 20-year-old youths in states with an 18-year MLDA was 8% greater than that among 18- to 20-year-old youths in states with an MLDA of 21 years. This study controlled for several state-level characteristics including inflation-adjusted beer excise tax. Based on decedents from the Multiple Cause of Death File across 39 states between 1990 and 2004, Gruzca and colleagues (2012) explored changes in MLDA as part of “natural experiments,” using a quasi-experimental approach with two-way fixed effects models (e.g., state and birth year) to control for unobserved state-level factors. Gruzca and colleagues (2012) found no association between MLDA and suicide. However women in states with higher minimum drinking ages had increased odds of suicide.

#### **Outlet Density (4 studies)**

Governments have the authority to restrict retail outlet density in on- or off-premises establishments at many levels (e.g., country, state, county). A study examining county-specific suicide rates in New Mexico from 1990 to 1994 found that greater availability of liquor outlets was associated with higher rates of suicide (Escobedo and Ortiz, 2002). Markowitz and colleagues (2003) similarly found that the density of liquor outlets was associated with suicides rates among young male adults, with a significant positive association among males 15–19, a marginally significant association among males 20–24, but a non-significant association among males 10–14. Yet no association was detected between outlet density and young female suicide mortality in the study. Another study by



Johnson and colleagues (2009) conducted a repeated cross-sectional analysis with a spatial random effects model on zip code-level suicide rates in California from 1995 to 2000 to evaluate the impact of outlet density. They found that death by suicide rates were higher in zip code areas with greater local and lagged bar densities, and higher in areas with greater local but not lagged off-premise outlet densities (e.g., liquor stores). Spatial lags were areas physically adjacent to or surrounding local areas. For example, lagged off-premise density could be calculated for each given zip code by averaging counts of off-premise outlets for all the zip codes adjacent to each given zip code.

A recent study by Giesbrecht and colleagues (2014) advances the evidence base of how alcohol outlet density influences the odds of alcohol involvement among suicide decedents. The study used data from 14 US states contributing to the National Violent Death Reporting System (NVDRS) from 2003 to 2011. Controlling for individual-level covariates and state indicator variables, this study found that greater off-premise alcohol outlet densities were associated with greater proportions of alcohol-related (BAC > 0) suicides among men, and greater on-premise densities (e.g., restaurants, bars) were associated with greater proportions of male suicide decedents with BACs > 0 and BACs = 0.08% respectively among men.

### **Other Alcohol Policies (3 studies)**

In response to high suicide rates among Alaska Native men aged 15–34 in rural communities, Berman (2014) evaluated the association of local alcohol control from 1980 to 2007 (operationalized as a combination of local option status and dry status indicating of sale or possession). The evaluation found that suicide rates were higher in communities prohibiting alcohol importation under state law, but that the effect was not statistically significant after controlling for other community-level factors including community access mode (e.g., by boat year round, in winter by snow machine, only by air), population size, married households, and poverty (Berman, 2014). With respect to zero tolerance laws, which are aimed at prohibiting drivers under the legal drinking age from drinking and driving, Carpenter (2004) examined youth suicide decedents aged 15–29 from 1981–1998 and found the presence of zero tolerance laws was associated with a 10.3% decline in suicides among males aged 15–17 and a 7.7% decline in suicides among males aged 18–20. No effects were found among older males and no consistent effects were detected among females. The study by Markowitz and colleagues (2003) found zero tolerance laws were associated with a reduction in suicides by males and females aged 15–19, but not with those aged 10–14 who are not typically licensed to drive. Interestingly, zero tolerance laws were also associated with a decrease in male suicides for those aged 20–24 in the study. The authors explained that as zero tolerance laws might be well publicized at the state level and could be correlated with state enforcement efforts, and this may result in less alcohol consumption across all young age groups and not just among the targeted age groups. Additionally, the presence of 0.08 BAC laws was associated with reduced suicides among males aged 20–24 and females aged 15–19 in the study.

### **Evaluation of Changes in Alcohol Policy Mix in Countries Other than the U.S. (6 studies)**

U.S.-based studies contribute substantially to the world's literature regarding the relationship between alcohol policies and alcohol consumption, in part because the presence of 50 states

with different alcohol policies provides opportunities for comparison. The association between alcohol consumption and suicide rates has been analyzed in 13 countries of the world; in 10 out of the 13 studies, suicide rates were positively associated with per capita consumption of alcohol (Lester, 2000). In terms of studies relating alcohol policies to suicide, many non-U.S. studies evaluate pre-post difference due to change of a hybrid of alcohol policies, usually using an interrupted time series design. Pridemore and colleagues (2013) used the autoregressive integrated moving average (ARIMA) model to assess the effect of a suite of Russian alcohol policies implemented in January 2006 on monthly male and female suicide mortality. These regulatory changes ranged from policies aimed at controlling the volume and quality of alcohol products and sales to requiring the registration of alcohol production and distribution facilities. They found an approximately 9% reduction in male suicides, with no effect on female suicides. Forensic records among suicide decedents in Estonia showed that BAC-positive suicides decreased by 39.2% for males and 41.4% for females during a major Soviet anti-alcohol reform in 1985, however after the reform ended, suicide rates began to rise (Värnik et al., 2006). In another study which focused on suicide decedents in Slovenia, forensic records showed that the average BACs of BAC-positive suicide victims were higher compared with those tested in the period after the implementation of a new national alcohol policy that limited alcohol availability in 2003 (Zupanc et al., 2013). Sauliune and colleagues (2012) evaluated the Year of Sobriety in 2008 in which the Lithuanian government implemented a series of alcohol policies including strengthening regulation against alcohol advertising despite alcohol industry opposition, limiting alcohol accessibility to the public, drunk driving control, curtailing illegal sales, and campaign efforts from non-governmental organizations. However, pre-post comparison of the years of potential life lost (YPLL) due to alcohol-related suicide showed a tendency to increase by 16.3% after 2008 mainly among males while those among females remained relatively stable. It might be that Lithuania's increasing YPLL due to alcohol-related suicide was affected by the economic recession and resulting large rises in unemployment. Such events may have led to increased psychological distress and heavy alcohol use among depressed persons, which did not reflect the reduced alcohol availability and anti-alcohol campaign. In another study, Zalzman and Mann (2007) evaluated the effects of the three stages of privatization of retail sale of alcohol in Alberta, Canada between 1985 and 1995, and their interrupted time series models showed significant increases in male and female suicide mortality rates in each of the three stages of privatization except for female suicide following the 1994 event. Another Canada-based study found the rapid rise in private liquor outlet density in British Columbia was associated with increase in alcohol-related mortality including suicide (Stockwell et al., 2011).

## DISCUSSION

Consistent with the general conclusion that alcohol policies are among the most important population-level interventions that influence drinking levels and alcohol-related harms (Babor et al., 2010), our review demonstrated that alcohol policies are important determinants in reducing suicide mortality. Such policies may alter alcohol taxation and prices, density of outlets, the retail system, legal purchasing and drinking age, hours and days of sale, alcohol impaired driving, and general alcohol availability. Places with more



restrictive alcohol policies tend to have lower suicide rates. Policy changes toward more restrictive alcohol control are associated with decrease in suicide mortality. Similarly, liberalization of alcohol policies (e.g., privatization of alcohol retail market) tends to increase suicide mortality.

There are several limitations among the studies identified in this review. First, although increased alcohol taxation is one of the most effective alcohol policies in reducing excessive alcohol consumption and related problems, there are only a limited number of studies specifically addressing the taxation-suicide relationship. Moreover, all of the four studies identified for this review used an excise tax as the measure for alcohol taxation. Excise tax is a form of volume-based taxes, levied as a fixed dollar amount per unit volume. As few states have increased volume-based taxes to keep pace with inflation in the United States, the real value of an excise tax erodes over time. In contrast, 46 U.S. states also apply value-based taxes based on a percentage of price, and these value-based taxes include *ad valorem* taxes and sales taxes. Failure to include these value-based taxes while solely relying on volume-based taxes could lead to an inaccurate measure of the total taxes on alcoholic products. Recent research has shown that combined tax measures (i.e., those incorporating volume-based tax and value-based taxes) yield substantial improvement in model fit and find more negative tax elasticity and price elasticity predicting adult binge drinking prevalence in U.S. states (Xuan et al., 2015c). Future research on the association between taxation and suicide may benefit from using the combined measure of alcohol taxes to evaluate the tax effect on suicide.

This review further emphasizes that studies on taxation and outlet density account for the majority of the most recent U.S. studies on the alcohol policy-suicide relationship. This is not surprising, as both taxation and outlet density have a strong evidence base supporting the effects on general and excessive alcohol consumption, such as binge drinking (Xuan et al., 2015a). However, a possible limitation among these United States studies is that they only control for one or a few alcohol policies in the statistical models. This is in contrast with the reality that there are multiple alcohol policies in all states. To reduce potential residual confounding, these alcohol policies should be accounted for when assessing the overall impact of alcohol policies on suicide prevention. Recent methodological developments in characterizing the state-level alcohol policy environment (Xuan et al., 2015a ; Naimi et al., 2014) have the potential to assess the role of alcohol policies comprehensively, particularly those aimed at general alcohol consumption, on reducing overall suicide mortality, and more specifically, the likelihood of alcohol involvement or level of BAC among suicide decedents.

Conceptually, given the role of alcohol in influencing suicidal behaviors through binge drinking (i.e., drinking to the point of intoxication) and/or regular heavy drinking, the effect of alcohol policies on suicide likely operates through drinking patterns at both the population and individual levels. Intoxication and alcohol use disorder are correlated, but distinct constructs. Access to alcohol can be directly related to single use of alcohol prior to suicidal behavior but evidence is lacking connecting acute use in this circumstance to regular heavy alcohol use (Bagge et al., 2013). It is, therefore, essential in future research to evaluate the potential mediating roles of these separate drinking-related behaviors and consequences

at both population and individual levels in influencing the association between alcohol policies and suicide.

Finally, because suicide is a multifaceted public health problem that is determined by multiple risk factors, including other comorbid conditions, mental health problems, poly-drug use, and access to lethal weapons (Branas et al., 2016; Miller et al., 2002), it is important to recognize that other socio-contextual determinants (e.g., economic recession, divorce rate, firearm legislations) may independently or interactively affect suicide, in addition to alcohol policies.

Our review also has its own caveats. Due to the substantial heterogeneity of the policy interventions among the studies included in this review, no attempt was made to conduct a meta-analysis on the policy-suicide association. In addition, because our review only focuses on suicide mortality (e.g., excluding 7 studies on non-mortality outcomes from the search), the study of the effects of alcohol policies on non-fatal suicidal behaviors and morbidity, and other self-inflicted injuries or hospitalization not related to death are omitted. Conner and colleagues (2014) showed that alcohol was associated with the most “violent” methods of suicide, which usually resulted in severe injuries and the highest case fatality rates. To summarize evidence of alcohol-related suicidal behaviors and injuries warrants further attention.

## CONCLUSIONS

Between 1999 and 2014, a modest number of studies on alcohol policies and suicide were published. This review suggests alcohol policies may contribute to suicide prevention on a general population level, and to a reduction of alcohol involvement among suicide deaths. This population-based approach is consistent with Rose’s (1992) prevention paradox which posits that the majority of cases of a health condition arise from members at low or moderate risk of the disease, while members at high risk only contribute a minority of cases. Figure 2 illustrates the application of the prevention paradox framework on suicide prevention. Specifically, the figure shows a shift of the distribution of population suicide risk to a lower direction through more restrictive alcohol policy implementation. By making alcohol less available, it is possible to reduce the average risk of suicide especially those where alcohol is involved. Departing from approaches that narrowly target members deemed at “high risk” (Daniel and Goldston, 2009; Stone et al., 2009) and that commonly address suicidal behaviors almost exclusively as problems of individuals, this population-based approach is likely to maximize public health benefit and to show long-lasting influence on reducing suicide. Public health approaches, particularly those health laws, policies and strategies aimed at altering general socioeconomic, cultural and environmental conditions can be impactful in influencing individuals’ lifestyles and subsequent health outcomes (Burriss, 2011).

Future studies should address limitations of the current literature. Evaluation of the role of occasional binge drinking independent of regular heavy consumption in assessing the alcohol policy-suicide relationship is warranted. This review also highlights the need for improvement of current public health surveillance on violent death, including the

enhancement of the quality of death investigations and classification as well as the testing rate, and further expansion of the National Violent Death Reporting System to include all states, in order to advance the science. Overall, it is critical to better delineate the causal linkage from population-based alcohol policies to alcohol involvement in suicide, and to further understand possible interplay among the multiple socio-contextual determinants of suicide.

## Acknowledgments

Dr. Xuan and Dr. Naimi are supported by R01 grant no. AA023376 (National Institutes of Health/NIAAA). Dr. Kaplan was supported by R01 grant no. AA020063 and R01 grant no. AA021791. Dr. Few is supported by F32 grant no. AA023693. Dr. Maisto was supported by K05 grant no. AA16928. Dr. Saitz is supported by U01 grant no. AA020784 and R01 grant no. AA021335. We want to thank Ms. Lysie Ranker for reviewing this manuscript and Ms. Susanna Cooper for assisting with the literature search.

Dr. Saitz is and has been principal investigator of grants awarded to Boston Medical Center and Boston University from the National Institutes of Health (including NIAAA and NIDA, and the Substance Abuse and Mental Health Services Administration) to study the management of unhealthy substance use, including to test the accuracy of screening and the efficacy of screening, brief intervention and referral to treatment and the effectiveness of integrated care. He has been paid to speak or had travel reimbursed to speak or to consult for/at numerous professional and scientific organizations, all non-profit organizations for over a decade, such as the American Society of Addiction Medicine (ASAM), RAND, the Research Society on Alcoholism, The BMJ, the Institute for Research and Training in the Addictions, the International Conference on Treatment of Addictive Behaviors, and the International Network on Brief Intervention for Alcohol and other drugs, and numerous universities and hospitals. He is an author and editor for Springer, UpToDate, the American Society of Addiction Medicine, the BMJ and the Massachusetts Medical Society (royalties and/or honoraria). Wolters Kluwer has supported conference travel to an editors' meeting. He has been paid to serve as an expert witness in malpractice cases related to the management of alcohol and other drug disorders. In 2009 he consulted for Inflexxion and Medical Directions, in 2008 and 2004 for Saatchi and Saatchi healthcare, in 2006 for Fusion Medical Education, in 2004 for the Lewin Group, in 2002 for Axis-Shield ASA and Forest Pharmaceuticals. He has also consulted regarding research for Yale University, Brandeis University, Group Health Inc, Beth Israel-Deaconess Hospital, and other universities. He spoke at a National Press Foundation event on the terminology of addiction and received no compensation but the meeting was funded by ASAM, Open Society Foundations, Pew Charitable Trusts, Shatterproof, Hazelden Betty Ford Foundation and the Addiction Technology Transfer Center Network. He is employed by Boston University School of Public Health.

## REFERENCES

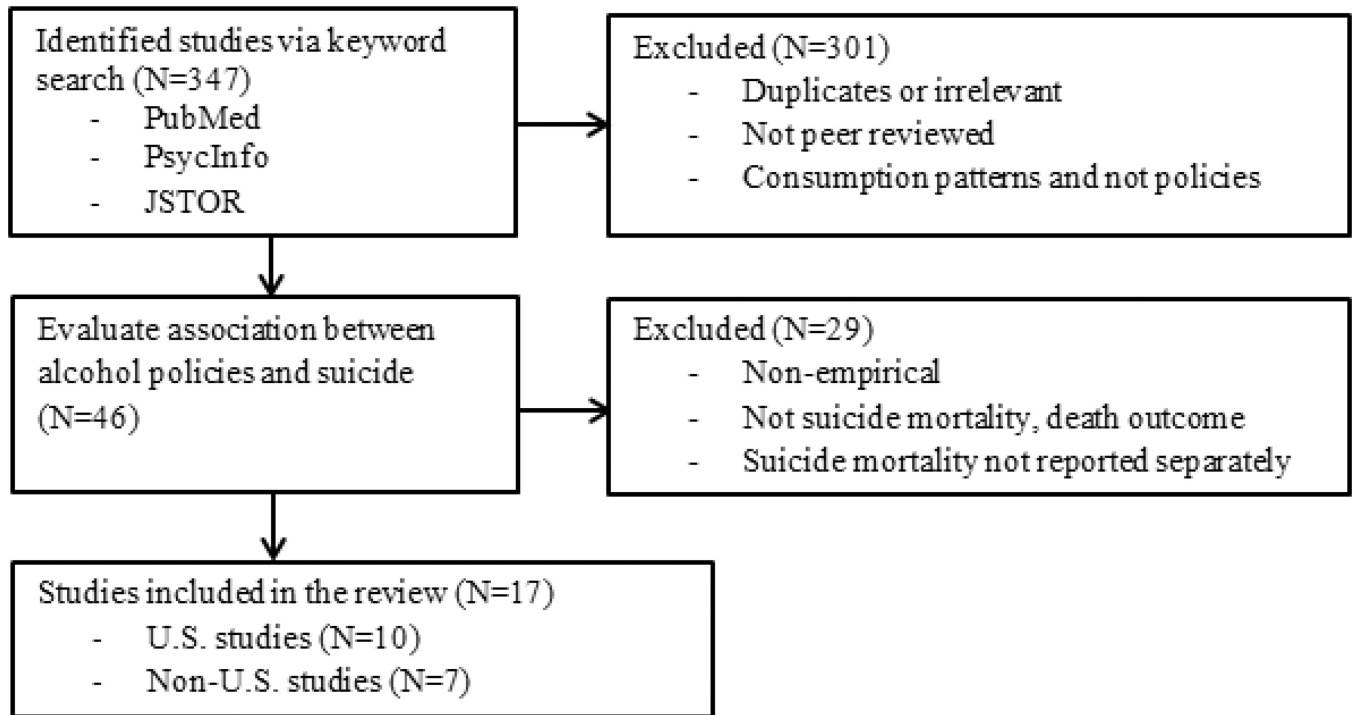
- Anderson P, Chisholm D, Fuhr D. Effectiveness and cost-effectiveness of policies and programmes to reduce the harm caused by alcohol. *Lancet*. 2009; 373:2234–2246. [PubMed: 19560605]
- Babor, T.; Caetano, R.; Casswell, S.; Edwards, G.; Giesbrecht, N.; Graham, K.; Grube, J.; Hill, L.; Holder, H.; Homel, R.; Livingston, M.; Österberg, E.; Rehm, J.; Room, R.; Rossow, I. *Alcohol: No Ordinary Commodity—Research and Public Policy*, revised. Oxford, UK: Oxford University Press; 2010.
- Bagge C, Lee H, Schumacher J, Gratz K, Krull J, Holloman G. Alcohol as an acute risk factor for suicide attempt: A case-crossover analysis. *J Stud Alcohol Drugs*. 2013; 74:552–558. [PubMed: 23739018]
- Bagge C, Littlefield A, Conner K, Schumacher J, Lee H. Near-term predictors of the intensity of suicidal ideation: An examination of the 24 hours prior to a recent suicide attempt. *J Affect Disord*. 2014; 165:53–58. [PubMed: 24882177]
- Bagge C, Sher K. Adolescent alcohol involvement and suicide attempts: Toward the development of a conceptual framework. *Clin Psychol Rev*. 2008; 28:1283–1296. [PubMed: 18676078]
- Berglund M, Ojehagen A. The influence of alcohol drinking and alcohol use disorders on psychiatric disorders and suicidal behavior. *Alcohol Clin Exp Res*. 1998; 22(Suppl 7):333S–345S. [PubMed: 9799958]
- Berman M. Suicide among young Alaska Native men: Community risk factors and alcohol control. *Am J Public Health*. 2014; 104:S329–S335. [PubMed: 24754505]

- Birckmayer J, Hemenway D. Minimum-age drinking laws and youth suicide, 1970–1990. *Am J Public Health*. 1999; 89:1365–1368. [PubMed: 10474554]
- Borges G, Loera C. Alcohol and drug use in suicidal behavior. *Curr Opin Psychiatr*. 2010; 223:195–204.
- Branas C, Han S, Wiebe D. Alcohol use and firearm violence. *Epidemiol Rev*. 2016; 38:32–45. [PubMed: 26811427]
- Bray J. The association between alcohol misuse and suicidal behaviour. *Alcohol Alcohol*. 2006; 41:473–478. [PubMed: 16891335]
- Brismar B, Bergman B. The significance of alcohol for violence and accidents. *Alcohol Clin Exp Res*. 1998; 22(Suppl 7):299S–306S. [PubMed: 9799952]
- Burris S. Law in a social determinants strategy: A public health law research perspective. *Public Health Rep*. 2011; 126(Suppl 3):22–27. [PubMed: 21836733]
- Caine E. Forging an agenda for suicide prevention in the United States. *Am J Public Health*. 2013; 103:822–829. [PubMed: 23488515]
- Callaghan R, Sanches M, Gatley J. Impacts of the minimum legal drinking age legislation on in-patient morbidity in Canada, 1997–2007: a regression-discontinuity approach. *Addiction*. 2013; 108:1590–1600. [PubMed: 23679958]
- Carpenter C. Heavy alcohol use and youth suicide: Evidence from tougher drunk driving laws. *J Pol Anal Manag*. 2004; 23:831–842.
- Carpenter C, Dobkin C. The effect of alcohol consumption on mortality: regression discontinuity evidence from the minimum drinking age. *Am Econ J Appl Econ*. 2009; 1:164–182. [PubMed: 20351794]
- Centers for Disease Control and Prevention (CDC). [Accessed June 1, 2016] Web-based Injury Statistics Query and Reporting System (WISQARS) [Online]. 2013. Available at: <http://www.cdc.gov/violenceprevention/pdf/suicide-datasheet-a.pdf>
- Cherpitel C, Borges G, Wilcox H. Acute alcohol use and suicidal behavior: a review of the literature. *Alcohol Clin Exp Res*. 2004; 28(5 Suppl):18S–28S. [PubMed: 15166633]
- Conner K, Bagge C, Goldston D, Ilgen M. Alcohol and suicidal behavior: What is known and what can be done. *Am J Prev Med*. 2014; 47:S204–S208. [PubMed: 25145740]
- Conner K, Huguet N, Caetano R, Giesbrecht N, McFarland B, Nolte K, Kaplan M. Acute use of alcohol and methods of suicide in a US national sample. *Am J Public Health*. 2014; 104:171–178. [PubMed: 23678938]
- Conner K, McCloskey M, Duberstein P. Psychiatric risk factors for suicide in the alcohol-dependent patient. *Psychiatric Annals*. 2008; 38:742–748.
- Cook, P. Alcohol Control as Injury Prevention. In: Cook, P., editor. *Paying the Tab: The Costs and Benefits of Alcohol*. Princeton, New Jersey: Princeton University Press; 2007. p. 82–106.
- Cook P, Durrance C. The virtuous tax: Lifesaving and crime-prevention effects of the 1991 federal alcohol-tax increase. *Journal of Health Economics*. 2013; 32:261–267. [PubMed: 23220460]
- Curtin, S.; Warner, M.; Hedegaard, H. NCHS data brief, no 241. Hyattsville, MD: National Center for Health Statistics; 2016. Increase in suicide in the United States, 1999–2014.
- Daniel S, Goldston D. Interventions for suicidal youth: a review of the literature and developmental considerations. *Suicide Life Threat Behav*. 2009; 39:252–268. [PubMed: 19606918]
- DeJong W, Blanchette J. Case closed: research evidence on the positive public health impact of the age 21 minimum legal drinking age in the United States. *J Stud Alcohol Drugs Suppl*. 2014; 75(Suppl. 17):108–115.
- Durkheim, E. *Suicide: A Study in Sociology*. New York: Free Press; 1966.
- Escobedo L, Ortiz M. The relationship between liquor outlet density and injury and violence in New Mexico. *Accident Analysis and Prevention*. 2002; 34:689–694. [PubMed: 12214963]
- Giesbrecht N, Huguet N, Ogden L, Kaplan M, McFarland B, Caetano R, Conner K, Nolte K. Acute alcohol use among suicide decedents in 14 US states: impacts of off-premise and on-premise alcohol outlet density. *Addiction*. 2014; 110:300–307. [PubMed: 25310999]

- Grucza R, Hipp P, Norberg K, Rundell L, Evanoff A, Cavazos-Rehg P, Bierut L. The legacy of minimum legal drinking age law changes: Longterm effects on suicide and homicide deaths among women. *Alcohol Clin Exp Res.* 2012; 36:377–384. [PubMed: 22085045]
- Hufford M. Alcohol and suicidal behavior. *Clinical Psychology Review.* 2001; 21:797–811. [PubMed: 11434231]
- Huguet N, Kaplan M, McFarland B. Rates and correlates of undetermined deaths among African Americans: results from the National Violent Death Reporting System. *Suicide Life Threat Behav.* 2012; 42:185–196. [PubMed: 22486604]
- Johnson F, Gruenewald P, Remer L. Suicide and alcohol: do outlets play a role? *Alcohol Clin Exp Res.* 2009; 33:2124–2133. [PubMed: 19764933]
- Jones N, Pieper C, Robertson L. The effect of legal drinking age on fatal injuries of adolescents and young adults. *Am J Public Health.* 1992; 82:112–115. [PubMed: 1536313]
- Kaplan M, McFarland B, Huguet N, Conner K, Caetano R, Giesbrecht N, Nolte K. Acute alcohol intoxication and suicide: a gender-stratified analysis of the National Violent Death Reporting System. *Inj Prev.* 2013; 19:38–43. [PubMed: 22627777]
- Kerr W, Subbaraman M, Ye Y. Per capita alcohol consumption and suicide mortality in a panel of US states from 1950 to 2002. *Drug Alcohol Rev.* 2011; 30:473–480. [PubMed: 21896069]
- Kessler R, McGonagle K, Zhao S, Nelson C, Hughes M, Eshleman S, Wittchen H, Kendler K. Lifetime and 12-month prevalence of DSM-III-R psychiatric disorders in the United States. Results from the National Comorbidity Survey. *Arch Gen Psychiatry.* 1994; 51:8–19. [PubMed: 8279933]
- King R, Dudar D. The politics of denial: The use of funding penalties as an implementation device for social policy. *Policy Sci.* 1987; 20:307–337.
- Landberg J. Per capita alcohol consumption and suicide rates in the US, 1950–2002. *Suicide Life Threat Behav.* 2009; 39:452–459. [PubMed: 19792986]
- Lester, D. Alcoholism, substance abuse, and suicide. In: Maris, R.; Berman, A.; Silverman, M., editors. *Comprehensive Textbook of Suicidology.* New York: The Guildford Press; 2000. p. 357–375.
- Markowitz S, Chatterji P, Kaestner R. Estimating the Impact of Alcohol Policies on Youth Suicides. *J Ment Health Policy Econ.* 2003; 6:37–46. [PubMed: 14578546]
- Miller M, Azrael D, Hemenway D. Household firearm ownership and suicide rates in the United States. *Epidemiology.* 2002; 13:517–524. [PubMed: 12192220]
- Naimi T, Blanchette J, Nelson T, Nguyen T, Oussayef N, Heeren T, Gruenewald P, Mosher J, Xuan Z. Development of a composite measure to characterize the alcohol policy environment in U.S. states, and its relationship to binge drinking. *Am J Prev Med.* 2014; 1:10–16. [PubMed: 24355666]
- Norström T. Alcohol and suicide in Scandinavia. *Br J Addict.* 1988; 83:553–559. [PubMed: 3382813]
- Norström T. Alcohol and suicide: a comparative analysis of France and Sweden. *Addiction.* 1995; 90:1463–1469. [PubMed: 8528031]
- Norström T, Stickley A, Shibuya K. The importance of alcoholic beverage type for suicide in Japan: A time-series analysis, 1963–2007. *Drug Alcohol Rev.* 2011; 31:251–256. [PubMed: 21450045]
- Pompli M, Serafini G, Innamorati M, Dominici G, Ferracuti S, Kotzalidis G, Serra G, Girardi P, Janiri L, Tatarelli R, Sher L, Lester D. Suicidal behavior and alcohol abuse. *Int J Environ Res Public Health.* 2010; 7:1392–1431. [PubMed: 20617037]
- Pridemore W, Chamlin M, Andreev E. Reduction in Male Suicide Mortality Following the 2006 Russian Alcohol Policy: An Interrupted Time Series Analysis. *Am J Public Health.* 2013; 103:2021–2026. [PubMed: 24028249]
- Pridemore W, Snowden A. Reduction in suicide mortality following a new national alcohol policy in Slovenia: an interrupted time-series analysis. *Am J Public Health.* 2009; 99:915–920. [PubMed: 19299669]
- Ramstedt M. Alcohol and suicide in 14 European countries. *Addiction.* 2001; 96(Suppl. 1):S59–S75. [PubMed: 11228079]
- Ramstedt M. Alcohol and suicide at the population level—the Canadian experience. *Drug Alcohol Rev.* 2005; 24:203–208. [PubMed: 16096123]

- Razvodovsky Y. Beverage-specific alcohol sale and suicide in Russia. *Crisis*. 2009; 30:186–191. [PubMed: 19933064]
- Rose, G. *The strategy of preventive medicine*. Oxford, UK: Oxford University Press; 1992.
- Rossow I. Suicide, violence and child abuse: a review of the impact of alcohol consumption on social problems. *Contemp Drug Prob*. 2000; 27:397–434.
- Sauliune S, Petrauskiene J, Kalediene R. Alcohol-related injuries and alcohol control policy in Lithuania: effect of the year of sobriety, 2008. *Alcohol Alcohol*. 2012; 47:458–463. [PubMed: 22454304]
- Skog O. Alcohol and suicide-Durkheim revisited. *Acta Sociol*. 1991; 34:193–206.
- Sloan F, Reilly B, Schenzler C. Effects of prices, civil and criminal sanctions, and law enforcement on alcohol-related mortality. *J Stud Alcohol*. 1994; 55:454–465. [PubMed: 7934053]
- Son CH, Topyan K. The effect of alcoholic beverage excise tax on alcohol-attributable injury mortalities. *Eur J Health Econ*. 2011; 12:103–113. [PubMed: 20306111]
- Stockwell T, Zhao J, Macdonald S, Vallance K, Gruenewald P, Ponicki W, Holder H, Treno A. Impact on alcohol-related mortality of a rapid rise in the density of private liquor outlets in British Columbia: a local area multi-level analysis. *Addiction*. 2011; 106:768–776. [PubMed: 21244541]
- Stone M, Laughren T, Jones M, Levenson M, Holland P, Hughes A, Hammad T, Temple R, Rochester G. Risk of suicidality in clinical trials of antidepressants in adults: analysis of proprietary data submitted to US Food and Drug Administration. *BMJ*. 2009; 339:b2880. [PubMed: 19671933]
- Värnik A, Kõlves K, Väli M, Tooming L, Wasserman D. Do alcohol restrictions reduce suicide mortality? *Addiction*. 2006; 102:251–256. [PubMed: 17222279]
- Wagenaar A, Tobler A, Komro K. Effects of alcohol tax and price policies on morbidity and mortality: A systematic review. *Am J Public Health*. 2010; 100:2270–2278. [PubMed: 20864710]
- Wagenaar A, Toomey T. Effects of Minimum Drinking Age Laws: Review and analyses of the literature from 1960 to 2000. *J Stud Alcohol*. 2002; (Suppl. 14):206–225.
- World Health Organization. *Preventing Suicide: a Global Imperative*. Geneva: WHO; 2014.
- Xuan Z, Nelson T, Heeren T, Blanchette J, Nelson D, Gruenewald P, Naimi T. Tax policy, adult binge drinking, and youth alcohol consumption in the United States. *Alcohol Clin Exp Res*. 2013; 37:1713–1719. [PubMed: 23711219]
- Xuan Z, Blanchette J, Nelson T, Heeren T, Oussayef N, Naimi T. The alcohol policy environment and policy subgroups as predictors of binge drinking measures among US adults. *Am J Public Health*. 2015a; 105:816–822. [PubMed: 25122017]
- Xuan Z, Blanchette J, Nelson T, Nguyen T, Hadland S, Oussayef N, Heeren T, Naimi T. Youth drinking in the United States: Relationships with alcohol policies and adult drinking. *Pediatrics*. 2015b; 136:18–27. [PubMed: 26034246]
- Xuan Z, Chaloupka F, Blanchette J, Nguyen T, Heeren T, Nelson T, Naimi T. The relationship between alcohol taxes and binge drinking: evaluating new tax measures incorporating multiple tax and beverage types. *Addiction*. 2015c; 110:441–450. [PubMed: 25428795]
- Yamasaki A, Chinami M, Suzuki M, Kaneko Y, Fujita D, Shirakawa T. Tobacco and alcohol tax relationships with suicide in Switzerland. *Psychol Rep*. 2005; 97:213–216. [PubMed: 16279328]
- Zalcman R, Mann R. The effects of privatization of alcohol sales in Alberta on suicide mortality rates. *Contemp Drug Prob*. 2007; 34:589–609.
- Zupanc T, Agius M, Videti Paska A, Pregelj P. Reduced blood alcohol concentration in suicide victims in response to a new national alcohol policy in slovenia. *Eur Addict Res*. 2013; 19:7–12. [PubMed: 22948237]





**Figure 1.** Flow diagram of search results for the period 1999–2014 and number of studies excluded and included in the review

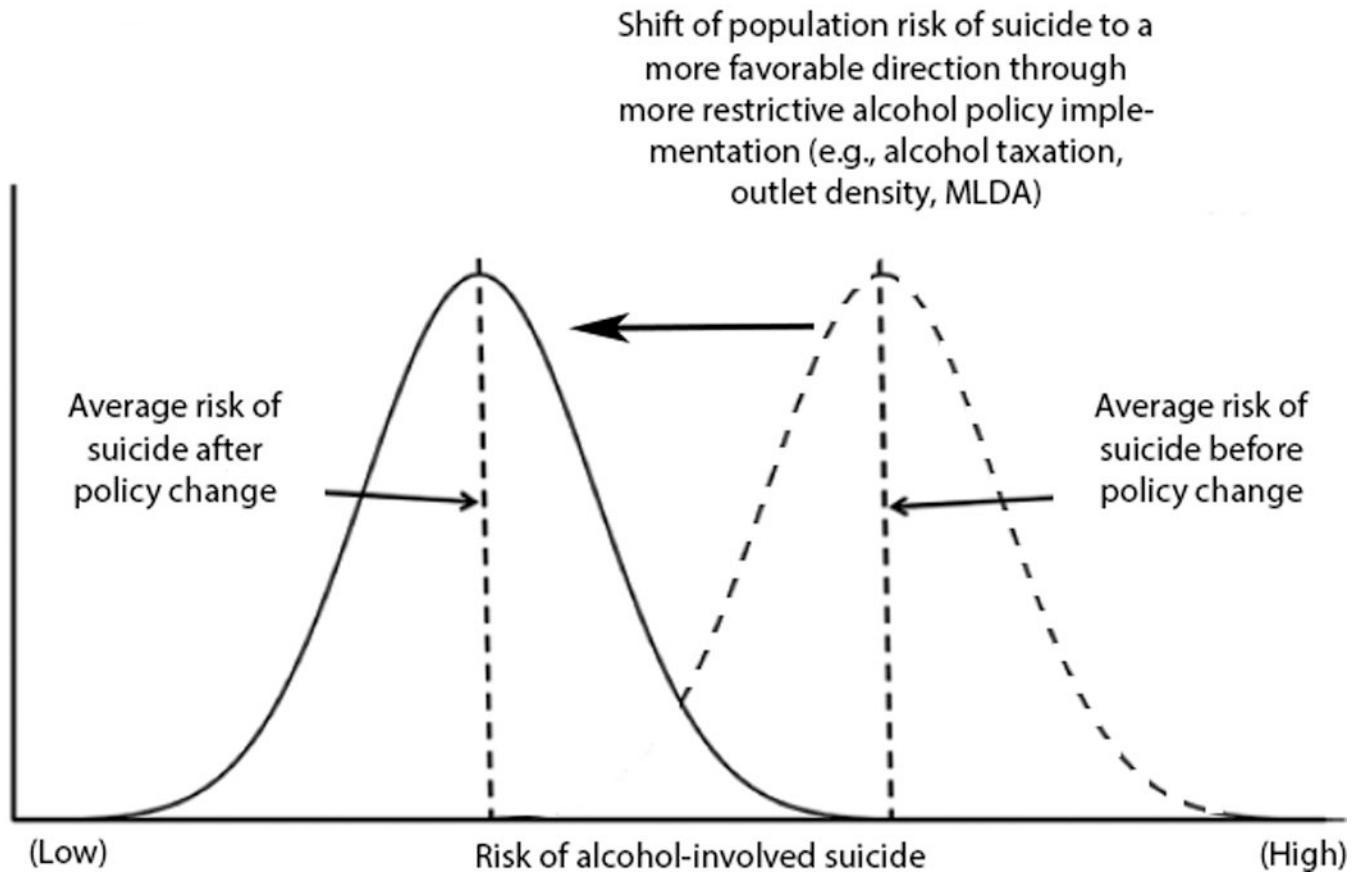


Figure 2.

**Table 1**  
List of studies on the association between alcohol policies and suicide mortality, 1999–2014

Year	Author(s)	Journal	Sample	Location	Study Period	Alcohol Policies	Outcome	Design	Main Findings
1999	Birckmayer & Hemenway	AJPH	Decedents aged 18–20	U.S. 48 states	1970–1990	MLDA; beer excise tax	Number of suicides	Repeated cross-sectional	The suicide rate of 18- to 20-year-old youths living in states with an 18-year MLDA was 8% higher than the suicide rate among 18- to 20-year-old youths in states with a 21-year MLDA ( $p<0.01$ ).
2002	Escobedo & Ortiz	Accid Anal Prev.	Decedents	New Mexico (U.S.)	1990–1994	Liquor store outlet density	County-specific suicide rates	County panel data	Greater availability of liquor outlets was associated with higher suicide rates ( $p=0.03$ ).
2003	Markowitz et al	J Ment Health Policy Econ	Youth decedents aged 10–24	U.S. states	1976–1999	Beer excise tax; outlet density; blood alcohol content (BAC); zero tolerance.	Suicide rates	State panel data	Increases in the excise tax on beer were associated with a reduced number of male suicides, but has no impact on female suicides. Suicides by males aged 20–24 are positively related to the availability of alcohol and negatively related to the presence of a 0.08 BAC law and zero tolerance laws for youth impaired driving. Female suicides were not impacted by the availability of alcohol.
2004	Carpenter	JPAM	Youth decedents aged 15–29	U.S. states	1981–1998	Adoption of Zero Tolerance Laws	Suicide rates	State panel data	The presence of a zero tolerance policy was associated with a 10.3% reduction in suicides among 15–17-year-old males and a 7.7% reduction in suicides among 18–20-year-old males, and both were significant. No effects were found among 21–29-year-old males, and no consistent effects were found among females.
2005	Yamasaki et al	Psychol Rep	Decedents	Switzerland	1965–1994	Alcohol specific tax	Suicide rates	Time series analysis	The tax on alcohol was positively correlated with male suicide rate in an autoregressive model ( $p<0.01$ ), but no association was detected for female suicide rate.
2006	Värnik et al	Addiction	Decedents	Estonia	Before, during and after a major Soviet anti-	Reduction of state alcohol production and sales by some 60%; raising prices by 45%;	BAC level among decedents	Pre-post comparison	During the reforms, BAC-positive suicides decreased by 39.2% for males and 41.4% for females, and the largest fall occurred at the BAC 2.5‰ plus level for both sexes. However, after the reform ended,

Year	Author(s)	Journal	Sample	Location	Study Period	Alcohol Policies	Outcome	Design	Main Findings
2007	Zalcman & Mann	Contemp Drg Probl	Decedents	Alberta, Canada	1976–1999	Three stages of privatization of retail sale: opening of privately owned wine stores in 1985; opening of privately owned beer stores and selling spirits and wine in hotels in rural areas in 1989; privatization of all liquor stores in 1994	Suicide rates	Interrupted time series design	Significant increase in male and female suicide rates were found after both 1985 and 1989 privatization, and significant increase in male suicide rate was found in 1994, but not among female.
2009	Johnson et al	ACER	Decedents	California (U.S.)	1995–2000	Outlet density	Suicide rates	Repeated cross-sectional level at zip code level	Completed suicide rates were higher in zip code areas with greater local and lagged bar densities, and those with greater local but not lagged off-premise outlet densities. Completed suicide rates were lower in zip code areas with greater local restaurant densities. Completed suicide rates were lower among blacks and Hispanics, but higher among rural, older, low income whites.
2009	Fridemore & Snowden	AJPH	Decedents	Slovenia	1997–2005	New national alcohol policy in 2003 that limited alcohol availability with MLDA and hours of sale	Monthly suicide counts	Interrupted time series design	There was a significant overall decrease in the number of monthly suicides following the policy's implementation. A significant association was detected among men, but not women.
2009	Carpenter and Dobkin	AEJ: Applied Economics	Decedents aged 19–22	U.S. states	1997–2004	MLDA	Suicide rates	Regression discontinuity design	The suicide rate increased by over 16 percent at age 21.

Year	Author(s)	Journal	Sample	Location	Study Period	Alcohol Policies	Outcome	Design	Main Findings
2011	Son & Topyan	Eur J Health Econ	Decedents	U.S. states	1995–2004	State excise taxes	Number of suicides	State panel data	Wine excise taxes were negatively associated with suicides rates, but no association was detected for spirit tax or beer tax.
2012	Gruza et al	ACER	Decedents	U.S. states	1990–2004	MLDA	Suicide (Y/N)	Repeated cross-sectional	Significant policy-by-sex interactions were observed: women exposed to permissive drinking age laws were at higher risk for suicide, with stronger effect for those born after 1960; no significant effects were observed for women born prior to 1960. No overall effect or effect on men was observed.
2012	Sauliune et al	Alcohol Alcoholism	Decedents aged 15–64	Lithuania	2006–2009	Implementation of comprehensive alcohol control policy in 2007–2008 that increased excise taxes and restricted alcohol advertising, availability, drunk driving, and illegal imports and sales	Years of potential life lost due to (YPLL) alcohol-related suicide	Pre-post comparison	Years of potential life lost due to alcohol-related suicides showed significant increase among males, but was stable among females.
2013	Pridemore et al	AJPH	Decedents	Russia	2000–2010	Policies restricting sales volume and quality, requiring registration of production and distribution, requiring new fee, equipment costs and new excise tax stamp	Number of suicides	Interrupted time series design	No impact of on female suicide mortality but a reduction of about 9% in male suicides ( $p=0.01$ ).
2013	Zupanc et al	Eur Addict Res	Decedents	Slovenia	Before, during and after policy change in 2003	New national alcohol policy in 2003 that limited alcohol availability with MLDA and hours of sale	BAC level among decedents	Pre-post comparison	Among BAC-positive suicide victims, BACs were lower after the policy change compared to those tested in the period before the change.

Year	Author(s)	Journal	Sample	Location	Study Period	Alcohol Policies	Outcome	Design	Main Findings
2014	Berman	AJPH	Alaska native men aged 15–34 in rural communities	Alaska (U.S.)	1980–2007	Dry status (1 = importation or possession prohibited, 0 = any other status); any local option adopted (1 = yes, 0 = no)	Number of suicides	Repeated cross-sectional	Suicide rates were higher in communities prohibiting alcohol importation under state law, but the effect was not significant after controlling for other community characteristics.
2014	Giesbrecht et al	Addiction	Decedents	U.S. states (14 states)	2003–2011	Outlet density	Alcohol Involvement (Y/N) among suicide decedents	Repeated cross-sectional	Higher off-premises alcohol outlet density was associated with greater proportions of alcohol-related (BAC>0) suicides among men. There was a significant interaction between off-premises alcohol availability and American Indian/Alaska Native race such that this subgroup had highest BAC positivity. On-premises density was also significantly associated with BAC >0 and BAC 0.08 among male decedents.