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Alcohol Sale Status and Suicide in Kentucky, 2005-2012

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Abstract

Background: The current study aims to determine whether suicide decedents who are residents of wet counties have higher odds of alcohol involvement than suicide decedents who are residents of moist/dry counties; and determine whether the association between alcohol sale status and alcohol-related suicide exists only in counties with a high population size.

Methods: Multilevel logistic regression analysis was used to analyze decedents who died violently and were therefore included in the Kentucky Violent Death Reporting System, 2005-2012. Stratification by population size was done to study its possible interaction with alcohol sale status of the decedent's residence.

Results: Approximately 36% of suicide decedents who lived in wet counties had an alcohol-related suicide, compared to 33% among those in moist/ dry counties. After adjusting for potential confounders, residence in a wet county was associated with a 22% increase in the odds of alcohol-related suicide (aOR=1.22, 95%CI= 1.00-1.51). Population size was not an effect modifier.

Conclusion: Suicide decedents who resided in wet counties had increased odds of alcohol-related suicides in comparison to residents of moist/dry counties, after adjusting for potential confounders and population size. A multifaceted approach that aims to reducing gun accessibility, providing health care for the mentally ill and the elderly, improving the economic status of the community by increasing accessibility to education and providing job opportunities is needed.

Keywords: Suicide; Alcohol; Sale status

Introduction

Suicide is among the top ten leading causes of death among adults in the U.S. [1,2]. There is global consensus that alcohol consumption is a major public health problem and an important cause of preventable morbidity and mortality due to suicide [3,4]. Prior studies have shown that alcohol was present in about 30% of suicide victims [5,6]. State and local governments in the U.S and worldwide implemented several alcohol use-limiting policies to reduce alcohol-related injuries and deaths, such as, suicide, homicide, other violent crimes, and vehicle crashes. Such policies included banning alcohol sales, limiting number of alcohol outlets, [7-10] applying high alcohol taxes, [11] limiting hours of alcohol sales, [12,13] limiting days of alcohol sales, [14,15] setting a minimum blood alcohol level when driving, [16] and limiting drinking age [16]. Results of studies addressing these policies have been mixed.

Suicide is the most common manner of death (66%) among the violent deaths that occurred between 2005 and 2010 in Kentucky [17]. Kentucky has diverse and continuously changing alcohol laws that result in an intermingled combination of "wet", "moist", and "dry" counties. Dry counties are those that prohibit the sale of alcohol beverages, both by the drink and by the package. Wet counties permit full retail sales of alcohol under state license. Moist counties occur where there is a wet town or city in a dry county; alternatively, moist counties sometimes only allow sales at particular sites, such as golf courses or historic sites. This classification is not consistent, however, and moist cities can be in dry counties and vice versa [18].

No study to date has examined the association between alcohol sale status and alcohol-related suicides in Kentucky. This study aims to determine whether suicide decedents who lived in wet counties had higher odds of alcohol-related suicide than those who were residents of moist/dry counties. We also examined high population as a potential effect modifier.

Methods

Data source

Data for suicides occurring between the calendar years 2005 and 2012 were extracted from the Kentucky Violent Death Reporting System (KVDRS). The KVDRS is a passive surveillance system that provides a detailed account of all forms of violent deaths that have occurred in Kentucky since 2005. The (KVDRS) combines data from death certificates, coroner/medical examiner reports (CME), police reports, crime laboratory reports, toxicology reports, and child fatality review team reports. Data were either coded by an abstracter trained to extract data from these documents, or were imported electronically from other systems (i.e., Bureau of Vital Statistics DC files or CME data sets). To ensure accuracy and adherence to the National Violent Death Reporting System (NVDRS) coding manual, the abstractor reviewed all data. The abstractor assigned the manner of death using information from the death certificates, the CME reports, and law

enforcement reports. We identified suicide decedents from the KVDRS by the final manner of death assigned by the data abstractors.

The exposure variable

The primary exposure variable is the status of alcohol sales in the suicide decedent's county of residence. This was coded as a binary variable (wet versus moist/dry). County of residence was abstracted from (KVDRS) and matched to a list of wet, moist, and dry counties released by the Department of Alcoholic Beverage Control in 2015. There were 35 wet counties (Anderson, Boone, Bourbon, Bracken, Breckinridge, Bullitt, Campbell, Carroll, Christian, Clark, Daviess, Fayette, Floyd, Franklin, Fulton, Gallatin, Harrison, Henderson, Jefferson, Kenton, Lyon, Magoffin, Marion, Mason, McCracken, Meade, Nelson, Nicholas, Owsley, Perry, Spencer, Trigg, Union, Wolfe, and Woodford), 48 moist counties (Barren, Bell, Boyd, Boyle, Caldwell, Calloway, Carter, Clay, Edmonson, Garrard, Grant, Graves, Grayson, Green, Greenup, Hardin, Harlan, Hart, Henry, Hopkins, Jessamine, Johnson, Laurel, Letcher, Lewis, Livingston, Logan, Madison, Marshall, Mercer, Montgomery, Muhlenberg, Oldham, Owen, Pendleton, Pike, Pulaski, Rowan, Scott, Shelby, Simpson, Taylor, Todd, Trimble, Warren, Washington, Wayne, and Whitley), and 37 dry counties (Adair, Allen, Ballard, Bath, Breathitt, Butler, Carlisle, Casey, Clinton, Crittenden, Cumberland, Elliott, Estill, Fleming, Hancock, Hickman, Jackson, Knott, Knox, Larue, Lawrence, Lee, Leslie, Lincoln, Martin, McCreary, McLean, Menifee, Metcalfe, Monroe, Morgan, Ohio, Powell, Robertson, Rockcastle, Russell, and Webster).

The outcome variable

The post-mortem blood alcohol level of suicide decedents was defined as a binary variable (positive, negative). Suicides were considered alcohol-related if post-mortem blood alcohol content was higher than 0.0% [10,19]. Those who were not tested, or were tested but the result was undetermined, were excluded from the multilevel regression analysis.

Confounding factors and effect modifiers

Sociodemographic variables included sex (male, female), age group (<=21, 21-30, 31-40, 41-50, 51-60, 61+ years), race (White, non-White), and educational level (8th grade, 9-12th grade, high school grade, above high school grade). Other confounding factors included county of residence (wet, moist, dry), county of injury (wet, moist, dry), presence of any mental illness (yes, no), physical health problem (yes, no), substance abuse problem (yes, no), intimate partner problem (yes, no), presence of argument before suicide (yes, no), marital status (married, never married/single, widowed, divorced/separated), and weapon type (firearm, poisoning, hanging, sharp objects, all others, unspecified/ unknown). County population was classified as follows: <=35,000; 35,001-100,000; >100,000 residents. Counties that had >100,000 residents included Boone, Fayette, Hardin, Jefferson, Kenton, and Warren. Counties that had a population between 35,001 to 100,000 residents included Barren, Boyd, Bullitt, Calloway, Campbell, Christian, Clark, Daviess, Floyd, Franklin, Graves, Greenup, Henderson, Hopkins, Jessamine, Laurel, Madison, McCracken, Nelson, Oldham, Pike, Pulaski, Scott, Shelby, and Whitley. The remaining counties had less than 35,000 residents.

Appalachian residence status of suicide decedents was also included as a binary variable. We used this variable because many health disparities have been noted previously between Appalachian and non-Appalachian residents of Kentucky with regard to alcohol drinking behavior [20,21]. Appalachian counties include Adair, Bath, Bell, Boyd, Breathitt, Carter, Casey, Clark, Clay, Clinton, Cumberland, Edmonson, Elliott, Estill, Fleming, Floyd, Garrard, Green, Greenup, Harlan, Hart, Jackson, Johnson, Knott, Knox, Laurel, Lawrence, Lee, Leslie, Letcher, Lewis, Lincoln, McCreary, Madison, Magoffin, Martin, Menifee, Metcalfe, Monroe, Montgomery, Morgan, Nicholas, Owsley, Perry, Pike, Powell, Pulaski, Robertson, Rockcastle, Rowan, Russell, Wayne, Whitley, and Wolfe [22]. The remaining counties were considered not Appalachian. A composite binary variable was created to indicate the presence of substances other than alcohol in the blood. That is, if the post mortem blood was positive for other drugs—including amphetamine, antidepressant, benzodiazepines, cocaine, marijuana, anticonvulsants, muscle relaxant, opiate, barbiturates, antipsychotics—the presence of other drugs was considered positive. If the post mortem blood test was negative for all of them, it was considered negative.

Statistical analysis

Frequencies and percentages were used to describe characteristics of the sample. We calculated the unadjusted odds ratios and the 95% confidence intervals using the chi-square test in the bivariate analysis. Factors were considered as confounders if they were associated with both the exposure and the outcome in the bivariate analysis and their p-value less than 0.05. The unadjusted and adjusted odds ratios and the 95% confidence intervals were calculated to examine the association between the residence alcohol sale status and having an alcohol-related suicide. To control for county effects, a multilevel logistic regression model was used to identify risk factors that were significantly associated with alcohol-related suicides. The final model for suicides was adjusted for several other variables from the KVDRS, including the presence of mental illness, physical health problem, marital status, and population size. The factors were selected to remain in the final model if they had a p-value less than 0.0001 in a fully saturated model. The fully saturated models were adjusted for alcohol problem, age, mental health problem, physical health problem, manner of death, substance abuse, education level, population, presence of other drugs in the blood at the time of death, marital status, and incident years. These factors were associated with both the exposure and the outcome with p-value less than 0.05 using the chi square test of independence. Interaction by population density was not statistically significant and was removed from the final model. Proc glimmix was used to fit the multilevel logistic regression model with binary distribution, log link function, and the residence county as a random intercept. All analyses were conducted using SAS version 9.4. All statistical tests were one-sided with a significance level of 0.05.

Results

Of the 7,372 violent death decedents, only 3,805 (51.6%) had complete data and were included in the study. Of the 3,805 violent deaths, 2,422 (66%) were due to suicide. Overall, approximately 55% of the suicides occurred in wet counties, which are generally more urban and have larger populations. Indeed, suicide decedents were more likely to be residents of counties with populations over 35,000. Furthermore, they were more likely to be residents of counties with populations over 35,000. Compared to suicide decedents from moist or dry counties, a higher percentage of the suicide decedents from wet counties were 41-50 years old (25.5%), non-White (5.0%), female (20.2%), never married/single (32.3%), high school graduates (23.6%),

and from non-Appalachian counties (93.9%). With regard to life stressors, suicide decedents who were residents of wet counties were more likely to have had intimate partner problems (22.6%), physical health problems (17.1%), an argument before the incident (3.9%), mental health problems (34.6%), and current depression (43.2%) when compared to decedents from dry/moist counties (Table 1).

Table 1: Characteristics of the suicides by exposure (alcohol sale status).

	Total		**Wet**		**Moist/Dry**		
Characteristic	N	%	N	%	N	%	P-value
Total	**2,422**	**100**	**1,348**	**55.7**	1,074	44.3	
Physical Health Problem							0.02
Present	375	15.5	229	17	146	13.6	
Not Present	2,047	84.5	1,119	83	928	86.4	
Mental Health Problem							<0.0001
Present	728	30.1	467	34.6	261	24.3	
Not Present	1,694	69.9	881	65.4	813	75.7	
Marital Status							0.0002
Married	886	36.6	450	33.4	436	40.6	
Never Married/Single	706	29.1	435	32.3	271	25.2	
Widowed	149	6.1	89	6.6	60	5.6	
Divorced/Separated	681	28.2	374	27.7	307	28.6	
Population number of residence county							<0.0001
<= 35,000	868	35.8	201	14.9	667	62	
35,000-100,000	646	26.7	314	23.3	332	31.9	
>100,000	908	37.5	833	61.8	75	7	

Similarly, they were more likely to have substance abuse (16%), alcohol problems (12.6%), and other drugs in the blood (51.3%) than suicide decedents from dry/moist counties. In contrast, a higher percentage of suicide decedents from dry/moist counties were in age groups other than 41-50 years, white, male, high school graders, married, and residents of the Appalachia. Table 2 shows the unadjusted odds ratio, the adjusted odds ratio, and the 95% confidence interval of the point estimates between residence in wet areas and having an alcohol-related suicide. About 35.0% of suicides were alcohol-related. About 36.3% of suicide decedents who were residents in wet counties had alcohol-related suicides compared to 33.2 % of those who were residents in moist/ dry counties. The difference was statistically significant (one sided p-value =0.04), after adjusting for confounders (Table 2).

Table 2: The unadjusted and adjusted odds ratio and 95% confidence interval of the association between residence in wet counties and having alcohol related suicides.

	Alcohol Related		Alcohol unrelated		Unadjusted OR, 95% CI	Adjusted OR, 95%CI*	one sided P-value
	N	%	N	%			
Suicides (n= 2,422)	**846**	**34.9**	**1,576**	**65.1**			
Wet (n=1,348, 55.7%)	489	36.3	859	63.7	1.14 (0.96-1.36)	1.22 (1.00-1.51)	0.04
Moist/Dry (n= 1,074, 44.3%)	357	33.2	717	66.8	Ref	Ref	
*Suicides model was adjusted for mental health problem, physical health problem, marital status, and population.							

After adjusting for mental illness, physical health problems, marital status, and population size, residence in wet counties was associated with a statistically significant 22% increase in the odds of having alcohol-related suicides (aOR=1.22, 95%CI= 1.00-1.51, p-value=0.04). Interaction between county sale status and the population size in each

model was not statistically significant and was removed from the final model.

There were three counties where all suicide cases were excluded from 2005 to 2012. These were Campbell (wet), Laurel (moist), and Green (moist).

Discussion

Alcohol and its association with violent death is considered a public health problem, rather than an individual problem, because of the major impact (physical illness, injuries, and violence) on communities and their economies. Globally, alcohol-attributable injuries were responsible for 9.7 deaths per 100,000 people and 422.6 potential years of life lost (PYLL) per 100,000 people in 2010 [3]. Furthermore, alcohol-attributable injuries were responsible for 13.2% of all injury deaths and 12.6% of all injury PYLL. In the US, the alcohol attributable deaths rate range was 22.4 per 100,000 to 50.9 deaths per 100,000 and the median age-adjusted PYLL rate range was 634 PYLL per 100,000 to 1,534 PYLL per 100,000 during 2006-2010 [23]. The rates of alcohol attributable deaths and PYLL varied by age, sex, and race [23,24]. Besides, estimates from a Swedish study predict that for every 0.35 litre increase in the total alcohol consumption, there will be approximately a 9% increase in alcohol related mortality, 1% increase in accidents, 1% increase in suicide, 4% increase in homicide, 3% increase in assaults, and 4% increase in sickness absence [25].

This is the first study of the association between local alcohol sales alcohol-related suicides in Kentucky. This research adds to the current literature by studying the association between residence in wet counties and having an alcohol-related suicide at the individual level while adjusting for individual level factors and county effects using multilevel modelling [26]. The underlying theory is that living in wet areas may create an environment that encourages drinking and possibly promote associated harms [27].

In this study, alcohol was present in 35% of suicides. A higher percentage of suicide decedents (36.3%) who reside in wet counties tested positive for alcohol in comparison to suicide decedents who resided in moist/dry counties (33.2%). These percentages were similar to findings from studies in the U.S of the impact of the density of the alcohol outlets on acute alcohol use among suicide decedents, which suggested that higher alcohol outlet densities were associated with greater proportions of alcohol-related suicides [9,10]. In addition, we found that suicide decedents who resided in wet counties had a statistically significant increase in the odds of having an alcohol-related suicide (OR=1.22, 95% CI=1.00-1.51), in comparison to residents of moist/dry counties, after adjusting for potential confounders and population. We found that having a physical health problem and being in any kind of a relationship other than married were both positively and significantly associated with alcohol-related suicide, whereas having a mental illness was negatively associated with alcohol-related suicide.

While our findings are certainly not definitive, they indicate that alcohol-restricting policies could play a role in limiting alcohol-related suicides. However, alcohol-restricting policies may need to be accompanied by efforts to reduce other social detriments of alcohol production and consumption in order to avoid consequences, such as illegal distribution and sale of alcohol [28]. In addition, our finding of reduced odds of alcohol-related suicide among those with mental illness suggest the need to focus on other venues of prevention of suicide for the mentally ill, such as reducing access to firearms or improving access to health care.

Findings from this study add to those from prior studies of the association between acute alcohol consumption and suicide rates, [19] limited alcohol sale hours and suicide rates, [29] alcohol consumption due to economic recession and suicide rates, [30] alcohol outlet density and violence, [31] alcohol outlet density and alcohol related suicides, [10] and heavy drinking and suicide mortality [32]. Findings from this study could inform social agencies, research institutes, suicide prevention programs, law enforcement, violence surveillance systems, the media, and public health programs to plan prevention programs to reduce suicide, in general, and alcohol-related suicide, in particular. There is a need for collaboration between lawmakers, social outlets, research, suicide prevention, law enforcement, and public health programs to create planned multifaceted interventions based on ecological and community-level models to reduce alcohol burden on communities [33]. Moreover, as Allamani and colleagues suggested—prevention of alcohol-related violence can be achieved through community-based initiatives and complex social movements and efforts implemented by the communities [34]. Furthermore, evidence from previous studies and the current study suggest that policies designed to discourage alcohol sales are not isolated policy interventions, and alcohol consumption at the community and the individual level is a complex behaviour that requires complex interventions [34]. To prevent suicides, interventions might include: increasing the access to health care for the mentally and the physically ill patients; providing counselling for couples; providing care for the elderly; improving the socioeconomic status of the society by increasing access to education and providing job opportunities; reducing advertising for alcohol, and reducing access to drugs and alcohol.

This study has several strengths. To our knowledge, this is the first study of the association between residence sale status and alcohol-related suicides in Kentucky. In addition, the use of the multilevel modelling in this study made it possible to adjust for both county-level and as individual-level confounders, such as, mental illness, sex, and alcohol problems. The multilevel approach overcomes the ecologic fallacy that is a major limitation in prior aggregate studies [10].

This study has several limitations as well. First, approximately 48% of all violent deaths have missing data on either alcohol sale status for the county of residence, blood alcohol content, or other variables, and were excluded from the study. This may have resulted in non-differential bias because the data is from the relatives of suicide decedents who might or might not know whether the decedents were having alcohol at the time of death. Moreover, the alcohol level was determined by a blood test, so there is no way the sale status would have been affected by the knowing the blood alcohol content of the decedents. This non-differential bias may have reduced the estimate towards the null. Second, although we assumed that restriction of alcohol in dry counties might have led to illegal alcohol consumption among decedents, there was no information about the type of the alcohol consumed to validate this assumption. Third, the alcohol sale status of counties is continuously changing, which may lead to non-differential misclassification of the counties and underestimation of the measure of the association.

Lastly, another important limitation of data from the KVDRS is that "No" answer to the questions of the coroner investigation forms does not necessarily mean that this information is negative rather it means that we do not know because the information is extracted from the

decedent's relative who may or may not have accurate information about the decedent. Furthermore, there was no information available from KVDRS that explained why blood samples were not tested for alcohol. We therefore suggest improving KVDRS data collection protocols, or even evidence gathering procedures for suicide investigations, to minimize missing data. Furthermore, prevention of alcohol-related suicide requires a multifaceted approach rather than just focusing on alcohol prohibition. This means, for example, educating the people about the importance of limiting access to firearms for alcoholic individuals, and providing adequate health care for the mentally ill.

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