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Per capita alcohol consumption and suicide mortality in a panel of US states from 1950 to 2002

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Abstract

Introduction and Aims—The relationship between per capita alcohol consumption and suicide rates has been found to vary in significance and magnitude across countries. This study utilizes a panel of time-series measures from the US states to estimate the effects of changes in current and lagged alcohol sales on suicide mortality risk.

Design and Methods—Generalized least squares estimation utilized 53 years of data from 48 US states or state groups to estimate relationships between total and beverage-specific alcohol consumption measures and age-standardized suicide mortality rates in first-differenced semi-logged models.

Results—An additional liter of ethanol from total alcohol sales was estimated to increase suicide rates by 2.3% in models utilizing a distributed lag specification while no effect was found in models including only current alcohol consumption. A similar result is found for men, while for women both current and distributed lag measures were found to be significantly related to suicide rates with an effect of about 3.2% per liter from current and 5.8% per liter from the lagged measure. Beverage-specific models indicate that spirits is most closely linked with suicide risk for women while beer and wine are for men. Unemployment rates are consistently positively related to suicide rates.

Discussion and Conclusions—Results suggest that chronic effects, potentially related to alcohol abuse and dependence, are the main source of alcohol's impact on suicide rates in the US for men and are responsible for about half of the effect for women.

Keywords

Suicide; aggregate; alcohol; beer; wine; spirits; unemployment

INTRODUCTION

The association between alcohol and suicide mortality has been established for both acute drinking episodes and chronic heavy drinking by dependent individuals (1–3). Chronic effects of alcohol on suicide risk have been hypothesized to operate through the reciprocal relationship between alcohol use disorders and depression, a major cause of suicide (4), while acute effects potentially occur through disinhibition, myopia, impulsivity and aggression (3,5). At the population level relationships between per capita alcohol sales and suicide mortality rates have been found for many countries (6–12), indicating that per capita consumption is related to drinking of the types implicated in suicide risk. However, these findings are less consistent in wetter drinking cultures (in this case meaning Southern European countries such as Italy) and among older age groups (11). Previous US studies have not found significant bi-variate associations between per capita alcohol consumption

and suicide mortality rates; however, one study found a relationship after controlling for unemployment rates in the US series (13) and another found a significant relationship with total consumption and especially with spirits consumption, but not with beer or wine, in a 20 year state panel also controlling for unemployment rates as well as other factors (14). These studies indicate the importance of controlling for unemployment rates and of considering beverage-specific models (14). Prior studies have shown that unemployment independently predicts both suicide and alcohol consumption at both the individual and aggregate levels (15). The most recent US analysis of suicide trends, from the same project as the current study, did not find a significant relationship between total or beverage-specific current year alcohol consumption and overall or male suicide trends (6). A positive and significant relationship between current spirits consumption and female suicide rates was found however, and the relationship with total alcohol was also marginally significant for women.

Modeling time-series data across multiple geographic units has generally taken one of two general approaches in alcohol epidemiology. In the first approach, time-series models of each aggregate unit are estimated separately and the individual estimates are then pooled. Autoregressive integrated moving average (ARIMA) methods are most commonly used. This approach was applied in European Comparative Alcohol Study of 14 EU countries on the relationship between per capita alcohol consumption and mortality rates for suicide (11) and other causes and similarly to study mortality rates in Canadian provinces (16). The ARIMA model is used to reduce the risk of spurious trend relationships (17–18), and to fully specify the structure of the error term to accommodate cross-country/state differences in variance (i.e. heteroskedasticity) and correlation of error terms. Alternatively, multiple series of the same dependent variable across geographic units can be analyzed simultaneously using cross-sectional time-series approaches, also called panel data models. Panel data models greatly improve efficiency through increased sample size when the data are pooled and analyzed together. Applications of panel data models in the alcohol field have involved a variety of specifications including fixed effects models, utilized in a previous analysis of US suicide rates (14) and the generalized least-square procedure (GLS), which for example, was used to examine alcohol and cirrhosis mortality relationships of five countries, allowing for heteroskedastic error structure and panel-specific first-order autocorrelation (19).

This study extends previous US analyses by utilizing a much longer panel series than previous studies and by including both distributed lag and current alcohol measure to assess the nature of the alcohol-suicide relationship. We have focused on specifications utilizing differenced data with attention to heteroskedasticity, control for known potential confounders for which data were available, and control for temporally correlated error terms. We stress that model specification is not trivial and provide in-depth discussion of relevant issues for panel analyses of alcohol-related mortality in a recent paper (20). A key model specification choice is whether to adjust for a common trend as a function of time or to difference each series, remembering that both approaches have drawbacks. Because a common trend is not always present, adjusting for a national trend, through year indicator variables or quadratic time terms, may not capture regional or state-specific trends. Differencing is a more conservative approach which eliminates both cross-sectional variation and long-term series-specific trends. However, differencing can induce higher likelihood of type-II error (21) or spurious auto-correlation (22), and therefore preliminary diagnostics of stationarity should be used to decide whether differencing is appropriate (23–24). An additional consideration is the choice between alcohol consumption measured concurrently with the suicide rate and a distributed lag transformation of consumption that models the accumulative effect of alcohol. This specification was originally considered for models of cirrhosis mortality (25) but may also be relevant for suicide due to the effect of chronic drinking on depression, a major cause of suicide (3). We therefore present models

with both current and distributed lag versions of the alcohol measures to illustrate the relative importance of current and lagged impacts.

METHODS

Suicide mortality rates were taken from the National Center for Health Statistics Compressed Mortality File series (26–28) for the years 1968 to 2002 and from the Vital Statistics of the United States for each year from 1950 to 1967 (29–30). The number of deaths in each specific age group along with population estimates for that group were used to directly age standardize rates to the 2000 US population. Population estimates for each age group by state are from the same sources as the mortality data from 1968 to 2002. The 1968 population estimates, together with those from the 1950 and 1960 Census, were then used to calculate population estimates for years in between, assuming a constant rate of increase (or decrease). Suicide was defined across several revisions of the ICD using codes E963 and E970-E979 for ICD 6 and ICD 7, codes E950-E959 for ICD 8 and ICD 9 and codes X60-X84 and X87.0 for ICD 10.

Data for per capita consumption of ethanol from beer, wine, spirits (liters of ethanol) and combined for total alcohol are described in detail in (31). Total alcohol and beverage-specific models were estimated. Both current and distributed lags of alcohol measures were utilized. A flat distributed lag specification, similar to a moving average, was used, in which current alcohol consumption and lagged measures from the five preceding years were each weighted as one sixth. This lag specification was determined after examination of models which included current consumption and separate variables for each lagged year alcohol measure rate for each of the five preceding years. These showed that current consumption appeared to have an effect similar in magnitude to those of the lagged consumption rates from the five preceding years. Furthermore, comparison of coefficient estimates from the flat distributed lag model generally appeared stronger, in terms of significance level and coefficient magnitude, than those from the 0.7 geometric distributed lag models that have been utilized in previous alcohol-related mortality analyses (32). Four states (Alaska, Hawaii, Mississippi and Oklahoma) are missing data for mortality or alcohol consumption in the 1950's and early 1960's due to either not yet being a state or being dry, resulting in shorter series for those states. Because of substantial cross-border alcohol purchases between New Hampshire and Massachusetts and between the District of Columbia and Maryland and Virginia, two state groups were created with population-averaged variables utilized in each.

Unemployment rates by state from the Current Population Survey for the years 1976 to 2002 were obtained from the Bureau of Labor Statistics. For the years from 1950 to 1975 comparable state level unemployment estimates are not available and rates for the US as a whole in each year, also from the Bureau of Labor Statistics, were instead used for each state. Research on the state unemployment rates has emphasized the importance of utilizing first differences, rather than levels, and evaluated relationships with national rates, finding that while they were associated in 40 of the 50 states examined, state rates lagged the national rates in 22 states and led in eight, indicating some shifts in timing of national change (33).

Annual divorces per 1000 population from Vital Statistics of the United States were available only from 1956 to 2002 and had missing data in California, Colorado, Louisiana, Nevada, New Mexico and Oklahoma, Maine, New Jersey and Texas. Per capita disposable income for each state and year adjusted for inflation to the standard 1980–82 dollars were obtained from the Bureau of Economic Analyses and single years were missing in a few states. Neither divorce rates nor income were found to be significant predictors of suicide

rates in models controlling for unemployment and alcohol and both had missing data in some states and year, therefore both were dropped from the final models.

The ARIMA modeling technique was used to evaluate relationships between suicide mortality and per capita alcohol consumption for each state separately. The first difference of mortality rates and consumption series was used to remove unit roots. Unit root tests indicated that differencing was necessary and sufficient for stationary series. Models were fit in EViews version 5 (34), regressing the log of age-standardized suicide mortality rates on current total alcohol consumption volume. Control variables for unemployment and indicator variables for ICD changes in 1958 and 1999 were included in all models based on their significance in the analyses for the US as a whole (6). Autoregressive and moving average error terms were included as indicated by inspection of model errors and residual tests. The results of the ARIMA models for the 48 states or state groups were combined using meta-analysis methods where coefficients are weighted by the inverse of their standard errors.

Panel models of all states were estimated using Generalized Least Squares (GLS). GLS is a generalized method specifying the variance-covariance matrix of the error structure, allowing the modeling of differences in variances across panels (heteroskedasticity) as well as panel specific first order autoregressive error terms. First differenced data was utilized as unit roots in levels data for both alcohol consumption and unemployment indicate the potential for spurious results from models utilizing levels data. Hausman tests (35) for consistency between fixed and random effects models were performed for all models within the total population and among males and females separately. These tests showed no significant differences between fixed and random effects model coefficient estimates for any specification, implying that fixed and random effects models yield similar estimates for alcohol effects across all beverage-specific models for the total population, as well as for both males and females. Panel models were fit using STATA version 10 (36). Models utilizing current alcohol measures and distributed lag measures were estimated for men and women separately as well as for the whole population. Gender-specific models are motivated by previous findings of differential effects in the US literature. Models for total alcohol consumption and separate models where spirits, wine and beer volume were entered together were estimated controlling for unemployment and ICD version or changes between versions.

RESULTS

Suicide rates for the US as a whole averaged 15.5 per 100,000 of the population aged 15+ over the study period and ranged from a low of 13.1 in 2000 to a high of 17.3 in 1977. Male rates were 3 to 4 times higher than female rates in each year with female rates ranging between 5 and 10 and male rates ranging between 22 and 28. There was also considerable variation across states, with particularly high rates in Nevada, Montana, Wyoming and New Mexico and lower than average rates in Connecticut, New Jersey, New York, Massachusetts \New Hampshire and Illinois. Figure 1 illustrates suicide mortality rates, alcohol consumption and unemployment rates in four states from different areas of the country.

As was found in ARIMA models for the US as a whole (6), state-specific ARIMA models found that the estimated relationships between current year total alcohol consumption and population suicide rates were mostly non-significant. A positive significant relationship was found for only one state, Michigan, and the fixed effects pooled average (used due to a non-significant homogeneity test) of the coefficients in 40 states where models were successfully fit was -0.056 and not significantly different from zero. Of these states, error structures in 35 were successfully modeled with AR terms only or no ARMA terms, while 5 required MA

terms. This suggests that the state-specific AR(1) specification used in panel models should be generally adequate for handling autocorrelation in these data.

Panel model results are presented in Table 1 for the whole population, Table 2 for men only and in Table 3 for women only. In the sample overall and in the models for men only, no current measure of alcohol significantly predicted aggregate suicide mortality. In the models of women's suicide mortality a significant positive effect of alcohol of 3.25% per liter was found both before and after controlling for unemployment. This effect can be mainly attributed to spirits, which were significantly positively related to suicide rates with a current effect of about 6% per liter of ethanol. No significant effects from beer or wine were found in models including current consumption measures. Models including the distributed lag measures of alcohol consumption found significant relationships overall and for men and larger coefficients for women, indicating that lagged effects related to the effects of chronic alcohol abuse were larger than the effects of acute alcohol abuse in the US. At the population level, a significant effect of 2.3% per liter was found for total alcohol consumption. Controlling for unemployment, all beverage types were found to be significantly related to suicide with an effect size of 5.0% per liter of ethanol for beer, while wine and spirits had effects of 9.1% and 2.9%, respectively. In models including all three beverage types together, only beer was significant, with an effect of 4.0% per liter. Unemployment rates were consistently significantly positively related to suicide rates in all models with an effect of about 0.5% per 1 percentage point change in the unemployment rate overall and for men and an effect of about 0.6% for women in models including the distributed lag measures of alcohol consumption.

Models estimating the effects of the distributed lag measures of alcohol consumption on suicide rates indicated different relationships for men and women. Although men's suicide rates were much higher than women's, alcohol was found to have a larger proportional effect on women's suicide rates. Significant effects were found for both genders after controlling for unemployment with an effect size of 1.9% per liter of ethanol for men and 5.8% for women. Differential effects by beverage type were also seen with spirits having the strongest effect of about 13% per liter on women's suicide rates but no effect on men's suicide rates. Beer was found to be significantly related to women's suicide rate in models without the other beverage types but was not significant in models where spirits is included. Wine was not found to be significantly related to suicide for women. Conversely, for men, beer was found to be significantly related to suicide with an effect size of about 5% per liter of ethanol, as was wine, with an effect of about 12% per liter. These effects remained when controlling for all three beverages and unemployment.

DISCUSSION

The results from both our ARIMA and panel models where current year alcohol measures are used to predict suicide rates from the same year are consistent with those found by Landberg's (6) ARIMA model on the US national series with a significant effect for women only and for spirits, but not beer or wine, in beverage-specific models. We extend these results by estimating models utilizing a flat distributed lag of the current and previous five years for each alcohol measure. These measures are intended to capture the effects of chronic alcohol abuse and dependence on suicide risk through depression, a major cause of suicide which has been found to have a reciprocal relationship with alcohol dependence (4). Chronic alcohol abuse and dependence may also cause other problems for the individual, their family and others that could potentially contribute to suicide risk.

While population-level analyses cannot distinguish between these different mechanisms related to chronic alcohol use, the comparison of models estimating relationships between

current measures and distributed lag measures can differentiate to some extent between the effects from chronic drinking and acute influences on suicide risks such as disinhibition, constricted thinking, impulsivity and aggression (3). Results indicate that the predominant effect overall, and especially for men, is from chronic drinking, with no significant effects found for current consumption measures. For women, the coefficients of the distributed lag measures are about twice the size of those for the current measures and both are significant indicating a similar magnitude of effects related to acute and chronic drinking on suicide risk.

Results related to beverage type are also found to differ between men and women. For women, a particularly strong relationship is found with spirits consumption where a liter of ethanol from spirits is estimated to increase suicide rates by 6% in the current year and an additional 9% in the years following. No significant effects of beer and wine are seen for women in the multivariate models, but a significant effect of beer is seen in the model with only beer and unemployment. Results for men are quite different with no effect of spirits but significant effects of wine and beer found in both the single beverage type and multivariate model using distributed lag measures. For the total population, where these differential effects by gender are combined, results suggest that all three types of alcoholic beverages are related to suicide risk in the model using distributed lag measures but only beer remains significant when included together and unemployment is controlled. Overall, beverage-specific results suggest that all beverage types are related to suicide risk in the US population, with spirits being particularly associated with risks from both acute and chronic drinking for women and beer and wine being associated with risks from chronic drinking for men. Spirits have been linked with heavier drinking patterns for both men and women in the US (37) and women also drink proportionally less beer than men (38). However, it is surprising that spirits were not associated with men's suicide risk given that it has been linked to cirrhosis (39), heart disease (40) and head and neck cancers (41) in the US over the same time period, suggesting that particularly harmful drinking patterns are associated with spirits for both men and women. It may be that the larger effect of spirits on women's risk is related to men's drinking as well as their own. The estimated effect sizes in the beverage-specific models may also be exaggerated due to positive correlations between each and total alcohol sales and between wine and beer especially.

Unemployment rates were consistently found to be positively related to suicide rates for both men and women with an effect size of 0.5% per percentage point of unemployment in the better fitting models with distributed lag specifications of the alcohol variables. A slightly higher effect of 0.58% was found for women and a slightly lower effect of 0.44% was found for men. Alcohol and unemployment effects on suicide are also related to each other; the magnitude of alcohol coefficients decreases when unemployment is added to the models and the magnitude of the unemployment coefficients are reduced in the distributed lag models as compared to the current models for alcohol measures.

Our finding of a significant positive effect of alcohol on suicide rates of 2.3% per liter of ethanol is similar to the result from a previous time series analysis of the US as a whole from 1934–1987 where an effect of 3% per liter was estimated (13) and to a previous panel analysis of the US from 1970 to 1989 where an elasticity of 0.217 was found (14), indicating an effect of about 2% per liter of ethanol given a national mean of around 10 liters per capita during this period. Despite the relative similarity of effect sizes across studies, the earlier studies only considered contemporaneous alcohol measures while our study found this relationship only when lagged effects potentially related to chronic drinking were included, making the interpretation somewhat different. Our results suggest that the suicide risk in the US has been mainly associated with the effects of chronic alcohol consumption, possibly due to the reciprocal impact of alcohol dependence on depression and the effects of chronic

abuse and dependence on family, social, work and health problems that may contribute to the risk of suicide for the drinker, family members and potentially others. Acute effects of drinking were also suggested for women and were particularly associated with spirits. One focus of efforts to influence suicide risk should be on alcohol dependent individuals and their families, particularly those with co-occurring chronic depression, who are known to be at especially elevated risk of suicide (3).

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REFERENCES

1. Cherpitel CJ, Borges GLG, Wilcox HC. Acute alcohol use and suicidal behavior: a review of the literature. *Alcohol Clin Exp Res*. 2004 May; 28 Suppl. 1(5):18S–28S. [PubMed: 15166633]
2. Rossow I. Suicide, violence and child abuse: a review of the impact of alcohol consumption on social problems. *Contemp Drug Prob*. 2000 Fall;27:397–434.
3. Brady J. The association between alcohol misuse and suicidal behaviour. *Alcohol Alcohol*. 2006 September–October; 41(5):473–478. [PubMed: 16891335]
4. Pompili M, Serafini G, Innamorati M, Dominici G, Ferracuti S, Kotzalidis GD, et al. Suicidal behavior and alcohol abuse. *International Journal of Environmental Research and Public Health*. 2010 April; 7(4):1392–1431. [PubMed: 20617037]
5. Steele CM, Josephs RA. Alcohol myopia: its prized and dangerous effects. *Am Psychol*. 1990; 45(8):921–933. [PubMed: 2221564]
6. Landberg J. Per capita alcohol consumption and suicide rates in the US, 1950–2002. *Suicide Life Threat Behav*. 2009 August; 39(4):452–459. [PubMed: 19792986]
7. Mann RE, Zaleman RF, Rush BR, Smart RG, Rhodes AE. Alcohol factors in suicide mortality rates in Manitoba. *The Canadian Journal of Psychiatry*. 2008 April; 53(4):243–251.
8. Norström T. Alcohol and suicide in Scandinavia. *Br J Addict*. 1988; 83:553–559. [PubMed: 3382813]
9. Norström T. Alcohol and suicide: a comparative analysis of France and Sweden. *Addiction*. 1995; 90(11):1463–1469. [PubMed: 8528031]
10. Pridemore WA. Heavy drinking and suicide in Russia. *Soc Forces*. 2006 September; 85(1):413–430. [PubMed: 17160138]
11. Ramstedt M. Alcohol and suicide in 14 European countries. *Addiction*. 2001; 96 Suppl. 1:S59–S75. [PubMed: 11228079]
12. Skog O-J, Elekes Z. Alcohol and the 1950–90 Hungarian suicide trend. Is there a causal connection? *Acta Sociologica*. 1993; 36:33–46.
13. Caces F, Harford T. Time series analysis of alcohol consumption and suicide mortality in the United States, 1934–1987. *J Stud Alcohol*. 1998 July; 59(4):455–461. [PubMed: 9647428]
14. Gruenewald PJ, Ponicki WR, Mitchell PR. Suicide rates and alcohol consumption in the United States, 1970–89. *Addiction*. 1995; 90:1063–1075. [PubMed: 7549775]
15. Goldman-Mellor SJ, Saxton KB, Catalano RC. Economic contraction and mental health. *International Journal of Mental Health*. 2010 Summer;39(2):6–31.
16. Ramstedt M. Alcohol consumption and liver cirrhosis mortality with and without the mention of alcohol: the case of Canada. *Addiction*. 2003 Sept; 98(9):1267–1276. [PubMed: 12930214]
17. Skog O-J. Testing causal hypotheses about correlated trends: pitfalls and remedies. *Contemp Drug Prob*. 1988 Winter;15(4):565–606.
18. Norström T, Skog O-J. Alcohol and mortality: methodological and analytical issues in aggregate analyses. *Addiction*. 2001; 96 Suppl. 1:S5–S17. [PubMed: 11228078]

19. Kerr WC, Fillmore KM, Marvy P. Beverage-specific alcohol consumption and cirrhosis mortality in a group of English-speaking beer-drinking countries. *Addiction*. 2000 March; 95(3):339–346. [PubMed: 10795350]
20. Ye Y, Kerr WC. Alcohol and liver cirrhosis mortality: comparison of methods for the analyses of time-series panel data models in the US. *Alcohol Clin Exp Res*. in press.
21. Skog O-J. Alcohol consumption and overall accident mortality in 14 European countries. *Addiction*. 2001; 96 Suppl. 1:S35–S47. [PubMed: 11228076]
22. Rehm J. Aggregate time-series regression in the field of alcohol. *Addiction*. 2001; 96(7):945–954. [PubMed: 11440604]
23. Kerr WC, Fillmore KM, Marvy P. Additional comments on the aggregated-level associations between spirits consumption and cirrhosis mortality. *Addiction*. 2000; 95(8):1265–1272.
24. Kerr WC, Fillmore KM, Marvy P. New hypothesis and methodological challenges: a reply to the commentaries. *Addiction*. 2000; 95(3):347–358. [PubMed: 10795351]
25. Skog O-J. The risk function for liver cirrhosis from lifetime alcohol consumption. *J Stud Alcohol*. 1984; 45(3):199–208. [PubMed: 6748660]
26. National Center for Health Statistics. Compressed Mortality File 1968–1988. CD-ROM, Series 20, No. 2A. Hyattsville, MD: National Center for Health Statistics; 2000.
27. National Center for Health Statistics. Compressed Mortality File 1989–1998. CD-ROM, Series 20, No. 2E. Hyattsville, MD: National Center for Health Statistics; 2003.
28. National Center for Health Statistics. Compressed Mortality File 1999–2002. CD-ROM, Series 20, No. 2H. Hyattsville, MD: National Center for Health Statistics; 2004.
29. National Office of Vital Statistics. Vital Statistics of the United States, 1950–1958. Washington, DC: U.S. Public Health Service; 1954–1960
30. National Center for Health Statistics. Vital Statistics of the United States, 1959–1967. Washington, DC: U.S. Public Health Service; 1961–1969
31. Kerr WC, Greenfield TK, Tujague J. Estimates of the mean alcohol concentration of the spirits, wine, and beer sold in the U.S. and per capita consumption: 1950–2002. *Alcohol Clin Exp Res*. 2006 September; 30(9):1583–1591. [PubMed: 16930221]
32. Kerr W. Per capita alcohol consumption and IHD mortality in a panel of US states from 1950 to 2002. *Addiction*. in press.
33. Payne JE, Ewing BT, George EP. Time series dynamics of US State unemployment rates. *Applied Economics*. 1999 November; 31(11):1503–1510.
34. EViews. EViews 5 User's Guide. Irvine, CA: Quantitative Micro Software; 2004.
35. Hausman JA. Specification tests in econometrics. *Econometrica*. 1978; 46:1251–1271.
36. Stata Corp.. Stata Statistical Software: Release 10.0. College Station, TX: Stata Corporation; 2007.
37. Kerr WC, Greenfield TK. Distribution of alcohol consumption and expenditures and the impact of improved measurement on coverage of alcohol sales in the 2000 National Alcohol Survey. *Alcohol Clin Exp Res*. 2007 October; 31(10):1714–1722. [PubMed: 17651465]
38. Kerr WC, Greenfield TK, Bond J, Ye Y, Rehm J. Age, period and cohort influences on beer, wine and spirits consumption trends in the US National Surveys. *Addiction*. 2004 September; 99(9): 1111–1120. [PubMed: 15317631]
39. Gruenewald PJ, Ponicki WR. The relationship of alcohol sales to cirrhosis mortality. *J Stud Alcohol*. 1995 November; 56(6):635–641. [PubMed: 8558895]
40. Kerr WC, Ye Y. Population-level relationships between alcohol consumption measures and ischaemic heart disease mortality in U.S. time-series. *Alcohol Clin Exp Res*. 2007 November; 31(11):1913–1919. [PubMed: 17877780]
41. Kerr WC, Ye Y. US time series evidence regarding alcohol-related risk of oral cancers and protection against stomach cancers: are higher concentration beverages different? *Contemp Drug Prob*. 2007 Fall; 34(3):495–511.

Figure 1. Suicide mortality rates per 100,000 population (right axis), per capita alcohol consumption in liters of ethanol per person aged 15+ for total, beer, wine and spirits (left axis) and unemployment rates (left axis) in four states.

Table 1

Models of the Total Suicide Mortality Rate (logged) are presented using both current and distributed lag specifications. Generalized least squares models on first differenced data correcting for heteroskedasticity, panel specific first order auto-correlation and changes in the ICD version. Standard errors in parentheses.

Measure	Current		Distributed	Lag
Total Alcohol	0.0051	(0.0048)	0.0234	(0.0066)**
Unemployment	0.0080	(0.0013)***	0.0050	(0.0014)***
Beer	0.0024	(0.0087)	0.0502	(0.0142)***
Unemployment	0.0080	(0.0013)***	0.0048	(0.0014)***
Wine	0.0200	(0.021)	0.0906	(0.0376)*
Unemployment	0.0078	(0.0013)***	0.0053	(0.0014)***
Spirits	0.0057	(0.0086)	0.0285	(0.012)*
Unemployment	0.0080	(0.0013)***	0.0056	(0.0013)***
Beer^l	-0.0074	(0.0093)	0.0401	(0.017)*
Wine	0.0170	(0.0220)	0.0410	(0.044)
Spirits	0.0043	(0.0094)	0.0038	(0.015)
Unemployment	0.0078	(0.0013)***	0.0049	(0.0014)***

[†]
 $p < .10$,

*
 $p < .05$,

**
 $p < .01$,

 $p < .001$.

^l
 Beer, wine, spirits analyzed together.

Table 2

Models of the Male Suicide Mortality Rate (logged) are presented using both current and distributed lag specifications. Generalized least squares models on first differenced data correcting for heteroskedasticity, panel specific first order auto-correlation and changes in the ICD version. Standard errors in parentheses.

Measure	Current		Distributed	Lag
Total Alcohol	-0.0006	(0.0051)	0.0190	(0.0072)**
Unemployment	0.0076	(0.0014)***	0.0044	(0.0015)**
Beer	-0.0021	(0.0093)	0.0502	(0.015)**
Unemployment	0.0076	(0.0014)***	0.0040	(0.0015)**
Wine	0.0160	(0.023)	0.1206	(0.039)**
Unemployment	0.0074	(0.0014)***	0.0043	(0.0015)**
Spirits	-0.0064	(0.0093)	0.0133	(0.013)
Unemployment	0.0074	(0.0014)***	0.0050	(0.0015)**
Beer^l	-0.0004	(0.010)	0.0499	(0.019)**
Wine	0.0210	(0.023)	0.1045	(0.046)*
Spirits	-0.0084	(0.010)	-0.0264	(0.017)
Unemployment	0.0072	(0.0014)***	0.0038	(0.0015)**

[†]
 $p < .10$,

*
 $p < .05$,

**
 $p < .01$,

 $p < .001$.

^l
 Beer, wine, spirits analyzed together.

Table 3

Models of the Female Suicide Mortality Rate (logged) are presented using both current and distributed lag specifications. Generalized least squares models on first differenced data correcting for heteroskedasticity, panel specific first order auto-correlation and changes in the ICD version. Standard errors in parentheses.

Measure	Current	Distributed	Lag
Total Alcohol	0.0325 (0.0093) ***	0.0583 (0.013) ***	
Unemployment	0.0075 (0.0024) **	0.0058 (0.0026) *	
Beer	0.0330 (0.017) †	0.0758 (0.028) **	
Unemployment	0.0075 (0.0024) **	0.0064 (0.0026) *	
Wine	0.0520 (0.041)	0.0673 (0.071)	
Unemployment	0.0073 (0.0025) **	0.0076 (0.0026) **	
Spirits	0.0630 (0.017) ***	0.1320 (0.025) ***	
Unemployment	0.0085 (0.0024) **	0.0065 (0.0025) *	
Beer^l	0.0085 (0.018)	0.0062 (0.034)	
Wine	0.0051 (0.043)	-0.1535 (0.083) †	
Spirits	0.0600 (0.019) **	0.1555 (0.031) ***	
Unemployment	0.0084 (0.0025) ***	0.0070 (0.0026) **	

† $p < .10$,

* $p < .05$,

** $p < .01$,

*** $p < .001$.

^l Beer, wine, spirits analyzed together.