Acute Use of Alcohol and Methods of Suicide in a US National Sample

Kenneth R. Conner, PsyD, MPH, Nathalie Huguet, PhD, Raul Caetano, MD, PhD, Norman Giesbrecht, PhD, Bentson H. McFarland, MD, PhD, Kurt B. Nolte, MD, and Mark S. Kaplan, DrPH

Objectives. We explored age, gender, and racial/ethnic differences with alcohol use and firearms, hanging or asphyxiation, and poisoning methods of suicide.

Methods. We analyzed data for 37 993 suicide decedents aged 18 years and older from the 2005–2010 National Violent Death Reporting System database. Multinomial logistic regressions examined associations of method with alcohol use defined by blood alcohol content. Two-way interactions tested the effects of age, gender, and race/ethnicity on the associations between alcohol use and method of suicide.

Results. Alcohol was present among decedents who used the 3 leading methods of suicide: firearm (35.0%), hanging (36.8%), and poisoning (32.7%). Two-way interaction tests suggested that in young and middle adulthood, individuals were more likely to drink alcohol when they used a firearm or hanging (compared with poisoning), but in older adulthood, the reverse was true, with alcohol use more likely with poisoning. Interaction tests also suggested that Asians and Pacific Islanders were most likely to use alcohol in poisonings and that Blacks were least likely to use alcohol in hangings.

Conclusions. The results suggested that alcohol use before suicide was influenced by several factors, including age, race/ethnicity, and suicide method. (*Am J Public Health.* 2014;104:171–178. doi:10.2105/AJPH.2013.301352)

Suicide is the 10th leading cause of death in the United States.[1] Suicide is among the leading types of injury mortality linked with alcohol consumption.[2] Most investigations of the alcohol-suicide relationship have examined the role of long-term patterns of alcohol use and related problems, including population studies of alcohol consumption or availability and suicide rates[3–5] and individual-level studies of the risk for suicide associated with alcohol use disorder.[6–8] There are more limited data on acute use of alcohol before suicide, although available data indicate that it plays a significant role. A meta-analysis of descriptive reports concluded that a median of 37% of suicides were preceded by acute use of alcohol.[9]

The lone study of acute alcohol use and suicide that included a nonsuicide control group examined firearm suicides in a northeastern urban area of the United States.[10] The study revealed that acute drinking conferred risk after adjusting for alcohol availability and other factors, and that the degree of risk was increased with the amount of alcohol consumed, consistent with a dose-response relationship. Studies of nonlethal suicide attempts that used a nonsuicide attempt control group and adjusted for ongoing alcohol consumption pattern or alcohol use disorder also showed that acute alcohol use conferred risk and suggested a dose-response relationship.[11,12] A study of suicide attempters using a case-crossover design in which participants served as their own controls provided similar results.[13] Overall, available data from controlled studies of suicide and suicide attempts indicated that both the presence of alcohol and the amount of alcohol consumed were key considerations in understanding their link with suicidal behavior.[10–13] These controlled studies were of fairly small samples, making them poorly suited to examine age, gender, or racial/ethnic differences in the relationship between drinking and suicidal behavior.

Several postmortem studies of suicide sought to determine if there were gender or age differences in the presence of acute alcohol use, with results generally showing that women and older adults were less likely to drink before suicide compared with men and other age groups.[9,14–16] There were fewer data on racial/ethnic differences in acute alcohol use before suicide, although a recent analysis of the US National Violent Death Reporting System (NVDRS) data highlighted that American Indians and Alaskan Natives (men and women) and Hispanic men were more likely than White men to be intoxicated at the time of death.[15]

Differences in acute drinking before suicide in gender, age, and ethnic groups may reflect population patterns in drinking; for example, men generally drink more often and more heavily than women,[17] a pattern that is observed at the time of suicide.[14,15] However, studies of acute alcohol and suicide do not always reflect population patterns. For example, an analysis of NVDRS data that examined suicides with blood alcohol content (BAC) of 0.08 grams per deciliter or greater, the legal limit for drinking and driving in United States, showed that men aged 25 to 34, 35 to 44, and 45 to 54 years were more likely to have BAC 0.08 grams per deciliter or greater at the time of suicide than those aged 18 to 24 years.[15] The results were not explained by epidemiological patterns of drinking, because men aged 18 to 24 years in the United States have the highest frequency of intensive drinking.[17] Such findings indicate that it cannot be taken for granted that patterns of drinking before suicide reflect general population patterns.

In the United States, 3 methods of suicide predominate; these are firearms, hanging or asphyxiation, and poisoning, which account for 90% of all suicides.[15] Somewhat different populations carry out these methods; for example, men are overrepresented in firearm suicides and women in poisonings.[15,18] The

extent to which acute use of alcohol may differ across methods is unclear. In a national study in Finland,[19] the presence of acute alcohol use was more likely among suicides by poisoning (45.8%) and firearms (46.0%) compared with hanging (36.6%). However, the group differences became nonsignificant in multivariate analyses, underscoring the importance of adjustment for confounding. A national study of US suicides found that a BAC of 0.08 grams per deciliter or greater was associated with suicide by firearms among men.[20] A limitation was that the researchers examined BAC at or above a specific level, ruling out analyses of alcohol concentration across the continuum. In a previous analysis of NVDRS data, men and women were more likely to have BAC of 0.08 grams per deciliter or greater when they died by hanging or firearm compared with poisoning.[15] The results suggested that heavy use of alcohol was less involved in poisoning suicides compared with other leading methods. However, more refined analyses are needed, including tests of effect modification associated with gender, age, and race/ethnicity as well as consideration of the full range of BACs.

The purpose of the present study was to conduct a detailed analysis of acute use of alcohol and the 3 leading methods of suicide using NVDRS data and to explore age, gender, and racial/ethnic differences in the use of alcohol before suicide and the dosage of alcohol. Results could provide a more complete understanding of acute alcohol use in suicide, including insights into which demographic groups are most likely to carry out lethal acts of suicide while drinking, at what concentration of alcohol, and using which method. The central premise of the study was that blanket conclusions about drinking in the event before suicide (for example, the finding of a review that a median of 37% of suicides had used alcohol[9]) were likely to miss age, gender, and racial/ethnic differences, and that such differences might vary by method of suicide. There is growing evidence that public policies aimed at reducing alcohol consumption and availability might reduce rates of suicide.[21–23] Accordingly, the present study might suggest which groups could benefit most from such policies from the standpoint of suicide prevention.

METHODS

This study used restricted data for decedents aged 18 years and older from the 2005–2010 NVDRS. The NVDRS is an active surveillance system that provides a detailed account of violent deaths that occur in 18 participating states. As of 2005, 16 states

TABLE 1—Demographic Characteristics of Suicides With Positive and Negative BAC Results Among Those Tested for Alcohol: National Violent Death Reporting System Database, United States, 2005–2010

	Firearm (n = 19 621)		Hanging (n = 9494)		Poisoning (n = 8287)		Total (n = 37 402)	
Variable	BAC Positive, % (No.) or Mean ±SD	BAC Negative, % (No.) or Mean ±SD	BAC Positive, % (No.) or Mean ±SD	BAC Negative, % (No.) or Mean ±SD	BAC Positive, % (No.) or Mean ±SD	BAC Negative, % (No.) or Mean ±SD	BAC Positive, % (No.) or Mean ±SD	BAC Negative, % (No.) or Mean ±SD
Gender								
Male	35.9 (6122)	64.1 (10 908)	38.3 (2964)	61.7 (4780)	36.8 (1595)	63.2 (2737)	36.7 (10 681)	63.3 (18 425)
Female	28.9 (748)	71.1 (1843)	30.8 (539)	69.2 (1211)	28.3 (1119)	71.7 (2836)	29.0 (2406)	71.0 (5890)
Age, y[a,b,c]	43 ±14.7	51 ±18.8	38 ±12.8	41 ±16.1	46 ±12.1	47 ±13.9	42 ±14.0	47 ±17.5
18–24[a,b]	40.6 (849)	59.4 (1244)	35.3 (576)	64.7 (1055)	29.7 (127)	70.3 (301)	37.4 (1552)	62.6 (2600)
25–44[a,b]	43.2 (2806)	56.8 (3691)	41.5 (1821)	58.5 (2564)	34.2 (1055)	65.8 (2028)	40.7 (5682)	59.3 (8283)
45–64[a]	36.7 (2701)	63.3 (4666)	35.1 (1015)	64.9 (1879)	33.5 (1377)	66.5 (2732)	35.4 (5093)	64.6 (9277)
≥ 65[a,b]	14.0 (514)	86.0 (3150)	15.6 (91)	84.4 (493)	23.2 (155)	76.8 (512)	15.5 (760)	84.5 (4155)
Race/ethnicity								
White[a,b,c]	34.8 (5907)	65.2 (11 069)	37.3 (2748)	62.7 (4626)	32.7 (2418)	67.3 (4978)	34.9 (11 073)	65.1 (20 673)
Black	30.6 (456)	69.4 (1034)	25.5 (179)	74.5 (524)	29.8 (100)	70.2 (236)	29.1 (735)	70.9 (1794)
AI/AN	53.0 (148)	47.0 (131)	53.5 (108)	46.5 (94)	38.1 (40)	61.9 (65)	50.5 (296)	49.5 (290)
Asian/PI	26.8 (40)	73.2 (109)	27.0 (100)	73.0 (270)	37.8 (34)	62.2 (56)	28.6 (174)	71.4 (435)
Hispanic[a,b]	44.2 (314)	55.8 (396)	43.9 (361)	56.1 (461)	33.3 (117)	66.7 (234)	42.1 (792)	57.9 (1091)
Death investigation system								
ME	33.9 (4470)	66.1 (8704)	36.4 (2439)	63.6 (4263)	32.0 (1800)	68.0 (3819)	34.2 (8709)	65.8 (16 786)
Coroner	39.9 (1075)	60.1 (1620)	41.3 (480)	58.7 (681)	36.6 (404)	63.4 (699)	39.5 (1959)	60.5 (3000)
Mixed coroner/ME	35.3 (1325)	64.7 (2427)	35.8 (584)	64.2 (1047)	32.6 (510)	67.4 (1055)	34.8 (2419)	65.2 (4529)

Note. AI/AN = American Indian/Alaska Natives; Asian/PI: Asian/Pacific Islander; BAC = blood alcohol content (g/dL); ME = Medical examiner. Between groups differences in the proportion of BAC positive were estimated using logistic regression. Bonferroni correction was used to adjust for family-wise error.
[a]Firearm vs poisoning.
[b]Hanging vs poisoning.
[c]Hanging vs firearm.

(Alaska, Colorado, Georgia, Kentucky, Maryland, Massachusetts, New Jersey, New Mexico, North Carolina, Oklahoma, Oregon, Rhode Island, South Carolina, Utah, Virginia, and Wisconsin) contributed data to the NVDRS. In 2010, Ohio and Michigan were added. The data were gathered from coroner or medical examiner (C/ME) records, police reports, death certificates, and crime laboratories. Suicide decedents were identified as those with death certificates that listed *International Classification of Diseases, 10th Revision* codes X60–84 or Y87.0.[24]

Measures

The main outcome measure was method of suicide. The 3 most common suicide methods were analyzed and included firearm, hanging or suffocation (simply referred to as hanging hereafter), and poisoning.

BAC is part of the C/ME toxicological investigation. Seventy percent of all decedents were tested for the presence of alcohol. BAC was coded as positive (any BAC) versus negative and as a continuous measure in terms of weight by volume. The continuous BAC measure was categorized into interval steps of 0.08 grams per deciliter (i.e., 0.00, 0.01 to <0.08, 0.08 to <0.16, etc.). This categorization was chosen because BAC varies at unequal intervals. In addition, intervals of 0.08, the legal limit for drinking and driving in United States,[25] facilitated interpretation of the estimates.

Sociodemographic variables, obtained from death certificates, included gender, age groups (18–24, 25–44, 45–64, ≥ 65 years), and race/ethnicity (White, Black, American Indian/Alaska Native, Asian/Pacific Islander, and Hispanic). States were categorized based on their types of death investigation systems into 3 categories: ME system, coroner system, and mixed C/ME systems.[26]

Statistical Analysis

Prevalence estimates and BAC means were estimated for the different sociodemographic indicators by method of suicide. Between groups differences were tested using logistic regression and analysis of variance. Bonferroni correction was used to adjust for multiple comparisons. Multinomial logistic regression[27] was used to assess the association between BAC (defined as positive vs negative or as a continuous variable) and method of suicide after adjusting for gender, age, race/ethnicity, and death investigation system. Poisoning was used as the reference category. A model comparing firearms to hanging (referent category) was also tested.

First, we compared the presence of alcohol, based on BAC greater than 0 grams per deciliter, in the groups carrying out each method of suicide in analyses that adjusted for gender, age, and race/ethnicity. In these analyses, we also tested gender, age, and race/ethnicity as potential effect modifiers of the relationship between acute use of alcohol and method. Second, we repeated the analyses with the subsample of decedents who drank before suicide, that is, those with a BAC of 0.01 grams per deciliter or greater, to examine the dosage of alcohol. In these analyses, BACs were modeled as intervals of 0.08 grams per deciliter. Nonsignificant interaction terms were excluded from the final models. We based statistically significant comparisons and 2-way interactions on $\alpha = 0.05$. All analyses were performed using SPSS, version 19.0 (IBM, Armonk, NY).

Sensitivity analyses were conducted to test the robustness of the results when states with low BAC testing rates were excluded (Oregon and Alaska). The testing rate among the remaining states was 85%. The results presented herein were not altered by the removal of the 2 states.

RESULTS

There were a total of 59 555 suicides, among which 52 993 (89%) used 1 of the 3 leading methods of firearm, hanging, or poisoning. Of those using a leading method, 37 993 (72%) were tested for alcohol, 9099

TABLE 2—Blood Alcohol Content Among Suicides With BAC Positive Results: National Violent Death Reporting System Database, United States, 2005–2010

Variable	Firearm, Mean BAC (SD)	Hanging, Mean BAC (SD)	Poisoning, Mean BAC (SD)	Total, Mean BAC (SD)
Gender				
Male[a,b,c]	0.16 (0.11)	0.14 (0.10)	0.12 (0.11)	0.15 (0.11)
Female[a,b]	0.16 (0.11)	0.15 (0.10)	0.11 (0.10)	0.13 (0.11)
Age, y				
18–24[a,b,c]	0.14 (0.10)	0.12 (0.09)	0.08 (0.07)	0.13 (0.10)
25–44[a,b,c]	0.16 (0.11)	0.14 (0.09)	0.12 (0.10)	0.15 (0.10)
45–64[a,b,c]	0.16 (0.11)	0.14 (0.10)	0.12 (0.11)	0.15 (0.11)
≥ 65	0.12 (0.11)	0.12 (0.16)	0.11 (0.14)	0.12 (0.12)
Race/ethnicity				
White[a,b,c]	0.16 (0.11)	0.14 (0.09)	0.12 (0.11)	0.14 (0.10)
Black[a]	0.13 (0.11)	0.12 (0.08)	0.11 (0.09)	0.12 (0.10)
AI/AN	0.17 (0.12)	0.17 (0.08)	0.15 (0.11)	0.17 (0.11)
Asian/PI	0.11 (0.09)	0.11 (0.12)	0.11 (0.13)	0.11 (0.11)
Hispanic	0.16 (0.09)	0.15 (0.13)	0.13 (0.12)	0.15 (0.11)
Death investigation system				
ME[a,b,c]	0.16 (0.11)	0.14 (0.10)	0.11 (0.11)	0.14 (0.11)
Coroner[a]	0.15 (0.12)	0.14 (0.09)	0.12 (0.12)	0.14 (0.11)
Mixed coroner/ME[a]	0.16 (0.10)	0.14 (0.09)	0.13 (0.10)	0.15 (0.10)

Note. AI/AN = American Indian/Alaska Natives; Asian/PI: Asian/Pacific Islander; BAC = blood alcohol content (g/dL); ME = medical examiner. The sample size was n = 13 087. Of the cases with BAC positive, 5% were missing the results. Between group differences in the mean BAC were estimated using ordinary least square regression. Bonferroni correction was used to adjust for family-wise error.
[a]Firearm vs poisoning.
[b]Hanging vs poisoning.
[c]Hanging vs firearm.

TABLE 3—Correlates of Method of Suicide Among Decedents Tested for Alcohol and the Subgroup Testing BAC Positive: National Violent Death Reporting System Database, United States, 2005–2010

Variable	Firearm vs Poisoning, OR (95% CI)	Hanging vs Poisoning, OR (95% CI)	Firearm vs Hanging, OR (95% CI)
	Suicides tested for BAC[a]		
BAC categorized (positive vs negative)	1.03 (0.97, 1.09)	1.01 (0.94, 1.09)	1.02 (0.96, 1.08)
BAC categorized × age	0.89*** (0.87, 0.91)	0.92*** (0.90, 0.94)	0.97*** (0.95, 0.99)
BAC categorized × Black	0.77 (0.59, 1.02)	0.63** (0.46, 0.86)	1.23 (0.99, 1.52)
BAC categorized × Asian/PI	0.46* (0.26, 0.83)	0.45** (0.27, 0.75)	1.03 (0.67, 1.61)
Male (vs female)	5.89*** (5.55, 6.26)	3.99*** (3.72, 4.28)	1.48*** (1.38, 1.58)
Age, 5-y interval as continuous	1.06*** (1.05, 1.08)	0.90*** (0.89, 0.92)	1.18*** (1.16, 1.19)
Black (vs White)	2.02*** (1.73, 2.35)	1.80*** (1.53, 2.13)	1.12 (0.99, 1.25)
AI/AN (vs White)	1.13 (0.82, 1.56)	1.38 (0.99, 1.93)	0.82 (0.62, 1.08)
Asian/PI (vs White)	1.21 (0.87, 1.70)	6.18*** (4.58, 8.35)	0.20*** (0.16, 0.25)
Hispanic (vs White)	0.75** (0.63, 0.90)	1.63*** (1.38, 1.94)	0.46*** (0.40, 0.53)
Coroner system (vs ME)	1.08 (0.99, 1.17)	0.87** (0.79, 0.96)	1.24*** (1.15, 1.34)
Mixed system (vs ME)	1.01 (0.94, 1.09)	0.86*** (0.79, 0.93)	1.18*** (1.11, 1.27)
	BAC positive suicides[b]		
BAC continuous	1.47*** (1.40, 1.54)	1.26*** (1.19, 1.32)	1.17*** (1.13, 1.22)
BAC continuous × age	0.96*** (0.94, 0.97)	0.97*** (0.95, 0.99)	0.98* (0.97, 0.99)
BAC continuous × Asian/PI	0.67* (0.46, 0.99)	0.82 (0.58, 1.14)	0.83 (0.62, 1.10)
BAC continuous × Hispanic	0.79** (0.66, 0.94)	0.93 (0.78, 1.11)	0.84** (0.75, 0.96)
Male (vs female)	5.46*** (4.89, 6.11)	3.54*** (3.11, 4.00)	1.55*** (1.37, 1.76)
Age, 5-y interval as continuous	0.94*** (0.92, 0.95)	0.82*** (0.80, 0.84)	1.14*** (1.12, 1.16)
Black (vs White)	1.65*** (1.28, 2.13)	1.12 (0.84, 1.50)	1.47*** (1.21, 1.79)
AI/AN (vs White)	1.27 (0.87, 1.86)	1.60* (1.08, 2.37)	0.80 (0.61, 1.04)
Asian/PI (vs White)	0.50** (0.30, 0.83)	2.46*** (1.58, 3.83)	0.20*** (0.14, 0.30)
Hispanic (vs White)	0.94 (0.74, 1.18)	1.82*** (1.44, 2.30)	0.51*** (0.44, 0.61)
Coroner system (vs ME)	1.06 (0.93, 1.21)	0.94 (0.81, 1.10)	1.12 (0.99, 1.27)
Mixed system (vs ME)	0.98 (0.86, 1.11)	0.87* (0.75, 0.99)	1.12* (1.01, 1.26)

Note. AI/AN = American Indian/Alaska Natives; Asian/PI: Asian/Pacific Islander; BAC = blood alcohol content (g/dL); CI = confidence interval; ME = Medical examiner; OR = odds ratio.
[a]BAC is categorized as alcohol present or absent.
[b]BAC is a continuous variable, with a 1-unit increase in the OR results based on an increase of 0.08 g/dL, consistent with the legal limit for drinking in United States.
*$P < .05$; **$P < .01$; ***$P < .001$.

(17%) were not, and 5921 (11%) were missing the testing information. The characteristics of the suicides that were tested and not tested for alcohol appear as a supplement to the online version of this article at http://www.ajph.org. Women, younger age groups, Blacks and Hispanics, those who used poisoning, and suicides investigated by an ME were significantly more likely to be tested.

Remaining analyses were based on 37 402 suicides with BAC data that used 1 of the 3 leading methods and were tested for alcohol. Acute alcohol was present in at least one third of suicides carried out by each method of firearm (35.0%), hanging (36.8%), and poisoning (32.7%). Poisonings were most often with opiates. Descriptive data on suicides carried out by each method stratified by the presence of acute alcohol and gender, age, racial/ethnic groups, and death investigation system types are presented in Table 1. Among suicides that were BAC positive, compared with individuals using firearm or hanging, those using poisoning were generally older and less likely to be White or Hispanic.

Descriptive data including means (SD) of BACs on the subgroup of decedents who drank before suicide (n = 13 087) are presented in Table 2. In many instances, use of firearms was associated with the highest BACs compared with use of hanging or poisoning. In particular, BAC levels were highest among individuals using firearms in men, all age groups except those aged 65 years and older, Whites, and deaths investigated by an ME. Moreover, as a group, women who used a firearm had higher BACs compared with those who used poisoning. Although there was a significant range of BACs across demographic groups, the means were universally high, with each exceeding 0.08 grams per deciliter.

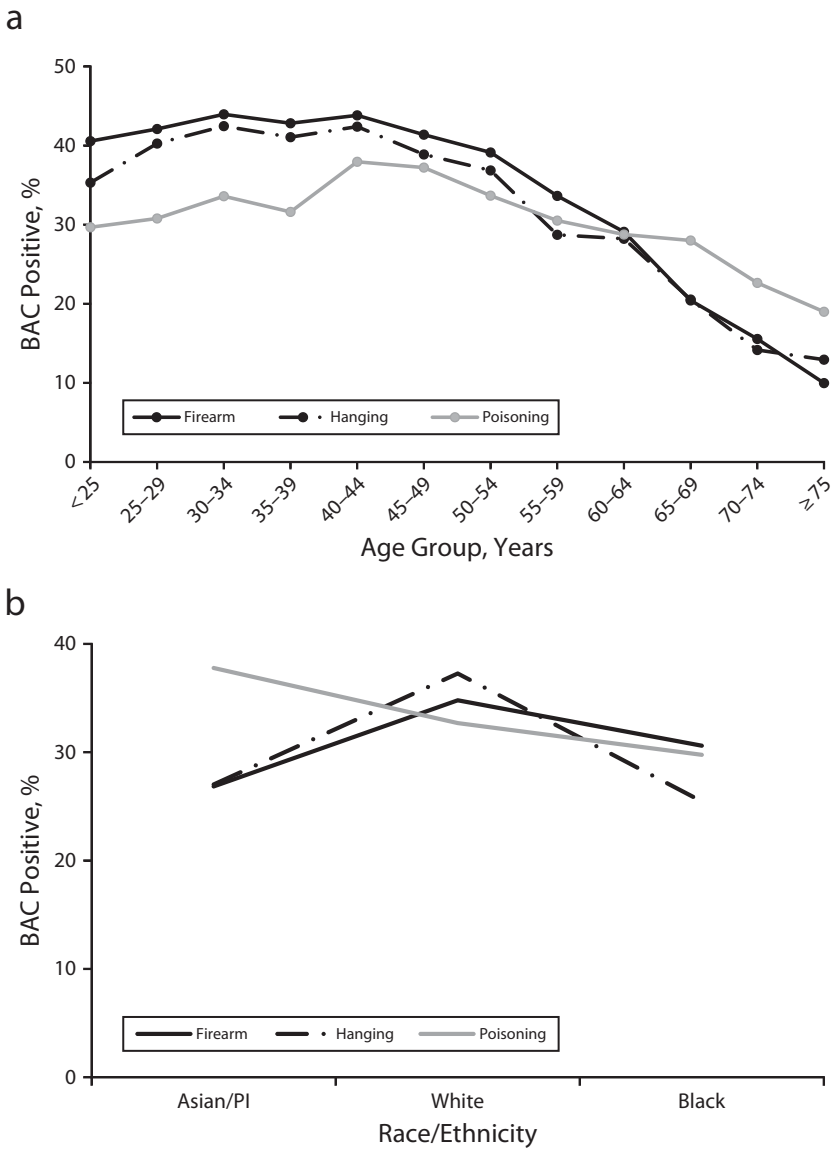
Multivariate Results for Presence of Alcohol and Suicide

Results of multinomial logistic regression analyses are presented in Table 3 as odds ratios (ORs) and 95% confidence intervals (CIs). Results for acute alcohol measured as a categorical variable (present or absent) showed that the presence of alcohol did not differ at a statistically significant level among the

3 methods of suicide. There were statistically significant interactions between positive BAC and age, Blacks, and Asian/Pacific Islanders. These interactions are presented in Figure 1.

The interaction of a BAC positive result and age (Figure 1a) showed that during young and middle adulthood, individuals were more likely to be drinking at the time of suicide when they used a firearm or hanging (compared with poisoning), but in older adulthood, the reverse was true, with drinking more likely with use of self-poisoning than firearm or hanging. Figure 1a also depicts the main effect of age, with the likelihood of drinking decreasing in the second half of life.

The interaction of BAC and race (Figure 1b) illustrated that Asians/Pacific Islanders were most likely to use alcohol in poisoning suicides and that Blacks were least likely to use alcohol in hanging suicides.



Note. PI = Pacific Islander.

FIGURE 1—Interaction between blood alcohol content (BAC) present or absent and (a) age and (b) race: National Violent Death Reporting System database, United States, 2005–2010.

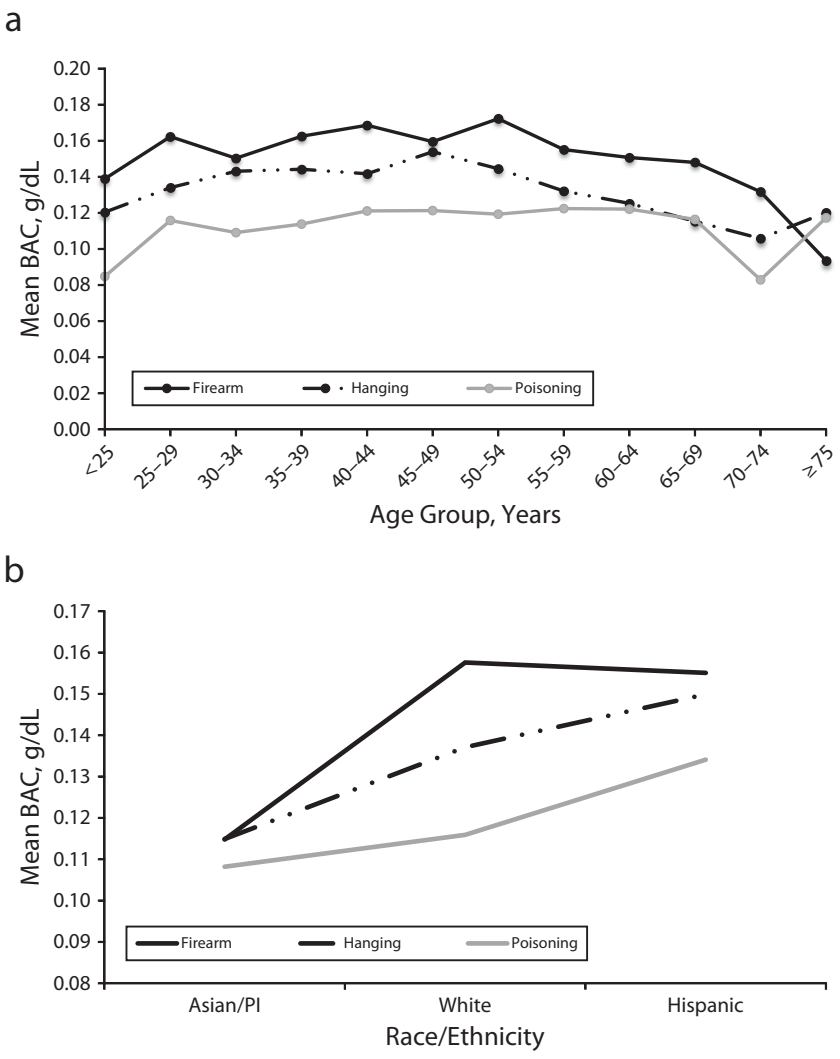
Multivariate Results for Amount of Alcohol and Suicide

Results of multinomial logistic regression analyses for the subsample who were BAC positive are presented in Table 3. In these analyses, the focus of the BAC data were the level of alcohol consumed, with a 1-unit increase in the OR results based on an increase of 0.08 grams per deciliter. Compared with the amount of alcohol consumed before poisoning, results pointed to increased alcohol use before suicide by firearm (OR= 1.47; 95% CI = 1.40, 1.54) and by hanging (OR = 1.26; 95% CI = 1.19, 1.32). Results also showed increased alcohol use before suicide by firearm compared with hanging (OR = 1.17; 95% CI = 1.13, 1.22).

Table 3 also illustrates that there were statistically significant interactions of BAC and age, Asian/Pacific Islander race, and Hispanic ethnicity. The interaction of BAC and age is depicted in Figure 2a. The interaction suggested that among suicide decedents using alcohol, throughout the life course, BAC was generally highest among firearm suicides and lowest among poisoning suicides until late life (aged 75 years and older), when this pattern reversed. The interaction of race/ethnicity and BAC appears in Figure 2b. Among suicide decedents using alcohol, in poisoning and hanging suicides, BAC was highest for Hispanics, intermediate for Whites, and lowest for Asians/Pacific Islanders, yet for firearm suicides, BAC was comparably high in Whites and Hispanics.

DISCUSSION

To our knowledge this was the first study to examine the moderating effects of gender, age, and race/ethnicity on the presence of acute alcohol and the level of drinking across leading methods of suicide in a national sample. Results showed that among suicides tested for alcohol in the United States, alcohol was present in more than one third of the time in each of the leading methods of suicide. Moreover, among suicides that were tested and drank, alcohol levels were high, with the mean exceeding the legal limit of 0.08 grams per



Note. PI = Pacific Islander.

FIGURE 2—Interaction between blood alcohol content (BAC) continuous and (a) age and (b) race/ethnicity: National Violent Death Reporting System database, United States, 2005–2010.

deciliter for drinking and driving. These results underscored the importance of considering both alcohol use and alcohol dosage in models of the drinking–suicide link.

Among those tested for alcohol, there were no differences in the presence of alcohol across methods of suicide, yet there were differences in the amount of alcohol consumed, with suicides by firearm and hanging having higher BAC than poisonings. Firearm and hanging are violent methods of suicide, and there is strong evidence for a link between acute drinking and violence,[28] particularly at higher concentrations of alcohol.[29] Therefore, higher drinking levels would be expected to be observed in violent methods of suicide (compared with self-poisoning, a nonviolent method), which was consistent with the results. Another likely contributor to the finding was that the generally longer time to death in poisonings, often associated with a mechanism of anoxic encephalopathy, allowed greater time for alcohol metabolism than those by firearm and hanging, when death occurs more rapidly.[30] Finally, BAC was higher in firearm than hanging suicides; however, in both methods, death occurs rapidly, and thus, would not explain such a result. Perhaps a contributing factor was that at very high concentrations of alcohol, hanging might be difficult because of the degree of preparation and coordination that might be required.

Compared to other methods, poisoning was less likely to involve acute alcohol use in young and middle age groups, but it was more likely to be accompanied by drinking in later life. Pharmacological interactions between alcohol and medications tend to be more life-threatening in older adults because of increased frailty and medical morbidity with aging, among other factors.[31] Increased lethality of alcohol-drug interactions with age might be a factor contributing to why the general age-related trend of decreasing alcohol involvement in suicides was least apparent in self-poisonings during older age.

There were variations in alcohol use and suicide methods within race and ethnic groups; for example, Whites were more likely to drink before hanging than other methods. Between groups, Asians/Pacific Islanders were most likely to drink before using poisoning, whereas Whites were least likely to drink when using this method. Like other aspects of suicide, the preference for means of suicide was influenced by cultural values[32,33] and public policy.[34,35] Therefore, suicide method might be influenced by the culture of particular ethnic groups, which would also then influence its prevalence and who in a particular group would choose what suicide method.

Strengths and Limitations

There were noteworthy strengths to this study. We examined suicide, the most serious form of self-injury. The NVDRS is the only US national data set available to examine BAC among suicide decedents. The surveillance data were accurate and timely. Although only 18 of 50 US states participate in NVDRS, participating states are comparable to the country as a whole in terms of gender, age, ethnic/racial composition, urban/rural characteristics, and overall suicide mortality rates.[15] There were also limitations. The analyses did not include a nonsuicide comparison group. We did not examine other factors (e.g., alcohol use disorders, availability of alcohol) that might

also influence associations between acute alcohol use and method of suicide. About 28% of decedents were not tested for alcohol, with the potential to bias results. The amount of time from the act of suicide to death was not routinely available in NVDRS. Such time might affect BAC results because death generally takes minutes with firearms and hanging, but can take several hours in self-poisonings, providing more time for alcohol metabolism in this group. Data on access to medical care was also not available in NVDRS, another factor that might affect time to death. The quality of race/ethnicity data in NVDRS was limited; for example, Asians/Pacific Islanders could not be differentiated. Data on some major aspects of suicide, including planning or intent, were not available in NVDRS.

Implications for Suicide Prevention

There is growing evidence that public health campaigns targeting alcohol availability and consumption may reduce rates of suicide.[21–23] There is also good evidence that restrictions on common methods of suicide may reduce suicide rates.[34,36] Moreover, specific populations stand to benefit most from such initiatives. For example, restrictions on commonly used pesticides for farming are presumably associated with a lowered rate of pesticide suicides in rural Asian populations.[34,36] Results of the present analyses indicated that the likelihood of using alcohol before suicide and the amount of alcohol consumed differed by method of suicide and were influenced by age and race/ethnicity patterns. Accordingly, the results of public health campaigns targeting alcohol availability could have a differing impact on method-specific suicide rates in age and racial subgroups. For example, based on the present analyses, it might be hypothesized that population-level reductions in the frequency of alcohol use or drinks per drinking occasion among younger and middle-aged adults might lower firearm suicide rates in particular. Tests of this idea and related hypotheses that might be generated from the present results are needed. ■

About the Authors

Kenneth R. Conner is with the Department of Psychiatry, University of Rochester Medical Center, Rochester, NY. Nathalie Huguet is with the Center for Public Health Studies, Portland State University, Portland, OR. Raul Caetano is with the University of Texas School of Public Health, Dallas Regional Campus, Dallas. Norman Giesbrecht is with the Social and Epidemiological Research Department, Centre for Addiction and Mental Health, Toronto, ON. Bentson H. McFarland is with the Department of Psychiatry, Oregon Health & Science University, Portland. Kurt B. Nolte is with the Office of the Medical Investigator, University of New Mexico School of Medicine, Albuquerque. At the time of the study, Mark S. Kaplan was with the School of Community Health, Portland State University.

Correspondence should be sent to Mark S. Kaplan, DrPH, Department of Social Welfare, UCLA Luskin School of Public Affairs, PO Box 951656, Los Angeles, CA 90095-1656 (e-mail: kaplanm@luskin.ucla.edu). Reprints can be ordered at http://www.ajph.org by clicking the "Reprints" link.

This article was accepted March 16, 2013.

Contributors

K. R. Conner originated the study, led the writing, and synthesized the analyses. M. S. Kaplan and N. Huguet acquired the data. B. H. McFarland provided statistical expertise. M. S. Kaplan, R. Caetano, N. Giesbrecht, and K. B. Nolte helped conceptualize ideas, interpret findings, and review drafts of the article. All the authors reviewed and approved the final draft of the article.

Acknowledgments

This research was funded by the National Institute on Alcohol Abuse and Alcoholism (grant R01 AA020063; M. S. K., principal investigator). Data for this study were made available through the Centers for Disease Control and Prevention.

Note. All analysis, interpretations, and conclusions based on these data are solely the responsibility of the authors. None of the authors has any interests that might be interpreted as influencing the research.

Human Participant Protection

The Human Subject Review Committee at Portland State University reviewed and approved the study on August 11, 2010.

References

1. Murphy SL, Xu J, Kochanek KD, Division of Vital Statistics. Preliminary data for 2010. *Natl Vital Stat Rep.* 2012;60(4):1–52.

2. Babor TF, Caetano R, Casswell S, et al. *Alcohol: No Ordinary Commodity — Research And Public Policy.* Revised edition. Oxford, UK: Oxford University Press; 2010.

3. Johnson FW, Gruenewald PJ, Remer LG. Suicide and alcohol: do outlets play a role? *Alcohol Clin Exp Res.* 2009;33(12):2124–2133.

4. Ramstedt M. Alcohol and suicide at the population level–the Canadian experience. *Drug Alcohol Rev.* 2005; 24(3):203–208.

5. Rossow I. Alcohol and suicide–beyond the link at the individual level. *Addiction.* 1996;91(10):1413–1416.

6. Kõlves K, Värnik A, Tooding L-M, Wasserman D. The role of alcohol in suicide: a case-control psychological autopsy study. *Psychol Med.* 2006;36(7):923–930.

7. Lesage AD, Boyer R, Grunberg F, et al. Suicide and mental disorders: a case-control study of young men. *Am J Psychiatry.* 1994;151(7):1063–1068.

8. Wilcox HC, Conner KR, Caine ED. Association of alcohol and drug use disorders and completed suicide: an empirical review of cohort studies. *Drug Alcohol Depend.* 2004;76(suppl):S11–S19.

9. Cherpitel CJ, Borges GLG, Wilcox HC. Acute alcohol use and suicidal behavior: a review of the literature. *Alcohol Clin Exp Res.* 2004;28(5):18S–28S.

10. Branas CC, Richmond TS, Ten Have TR, Wiebe DJ. Acute alcohol consumption, alcohol outlets, and gun suicide. *Subst Use Misuse.* 2011;46(13):1592–1603.

11. Borges G, Rosovsky H. Suicide attempts and alcohol consumption in an emergency room sample. *J Stud Alcohol.* 1996;57(5):543–548.

12. Powell KE, Kresnow MJ, Mercy JA, et al. Alcohol consumption and nearly lethal suicide attempts. *Suicide Life Threat Behav.* 2001;32(suppl 1):30–41.

13. Borges G, Cherpitel CJ. A case-crossover study of acute alcohol use and suicide attempt. *J Stud Alcohol.* 2004;65(6):708–714.

14. Hayward L, Zubrick SR, Silburn S. Blood alcohol levels in suicide cases. *J Epidemiol Community Health.* 1992;46(3):256–260.

15. Kaplan MS, McFarland BH, Huguet N, et al. Acute alcohol intoxication and suicide: a gender-stratified analysis of the National Violent Death Reporting System. *Inj Prev.* 2013;19(1):38–43.

16. Shields LBE, Hunsaker DM, Hunsaker JC, Ward MK. Toxicologic findings in suicide: a 10-year retrospective review of Kentucky medical examiner cases. *Am J Forensic Med Pathol.* 2006;27(2):106–112.

17. Substance Abuse and Mental Health Services Administration. *Results From the 2010 National Survey on Drug Use and Health: Summary of National Findings.* Rockville, MD: Substance Abuse and Mental Health Services Administration; 2011.

18. Värnik A, Kõlves K, van der Feltz-Cornelis CM, et al. Suicide methods in Europe: a gender-specific analysis of countries participating in the "European Alliance Against Depression." *J Epidemiol Community Health.* 2008;62(6):545–551.

19. Pirkola S, Isometsa E, Lonnqvist J. Do means matter? Differences in characteristics of Finnish suicide completers using different methods. *J Nerv Ment Dis.* 2003; 191(11):745–750.

20. Kaplan MS, McFarland BH, Huguet N. Characteristics of adult male and female firearm suicide decedents: findings from the National Violent Death Reporting System. *Inj Prev.* 2009;15(5):322–327.

21. Grucza RA, Hipp PR, Norberg KE, et al. The legacy of minimum legal drinking age law changes: long-term effects on suicide and homicide deaths among women. *Alcohol Clin Exp Res.* 2012;36(2):377–384.

22. Pridemore WA, Snowden AJ. Reduction in suicide mortality following a new national alcohol policy in Slovenia: an interrupted time-series analysis. *Am J Public Health.* 2009;99(5):915–920.

23. Värnik A, Kõlves K, Väli M, Tooding L-M, Wasserman D. Do alcohol restrictions reduce suicide mortality? *Addiction.* 2007;102(2):251–256.

24. *International Classification of Diseases, 10th Revision.* Geneva, Switzerland: World Health Organization; 1996.

25. National Transportation Statistics, 2010. US Department of Transportation. Available at: http://www.bts.gov/publications/national_transportation_statistics. Accessed January, 4, 2013.

26. Hanzlick R, Butcher B, Fierro M, et al. Death investigation systems and NAME, ABMDI, IACME representations in States. 2011. Available at: http://www.swgmdi.org/web_documents/iscomrpt1-systems.pdf. Accessed April 11, 2013.

27. Hosmer DW, Lemeshow SA. *Applied Logistic Regression*. New York, NY: Wiley and Sons; 2000.

28. Leonard K. *The Role of Drinking Patterns and Acute Intoxication in Violent Interpersonal Behaviors. Alcohol and Violence: Exploring Patterns and Responses*. Washington, DC: International Center for Alcohol Policies; 2008.

29. Duke AA, Giancola PR, Morris DH, Holt JCD, Gunn RL. Alcohol dose and aggression: another reason why drinking more is a bad idea. *J Stud Alcohol Drugs*. 2011;72(1):34–43.

30. Spitz WU. Forensic Aspects of Alcohol. In: Spitz WU, Spitz DJ, eds. *Medicolegal Investigation of Death: Guidelines for the Application of Pathology to Crime Investigation*. Springfield, IL: Charles C. Thomas; 2006:1218–1229.

31. Moore AA, Whiteman EJ, Ward KT. Risks of combined alcohol/medication use in older adults. *Am J Geriatr Pharmacother*. 2007;5(1):64–74.

32. Kaplan MS, Huguet N, McFarland BH, Mandle JA. Factors associated with suicide by firearm among US older adult men. *Psychol Men Masc*. 2012;13(1):65–74.

33. Kaplan MS, Geling O. Sociodemographic and geographic patterns of firearm suicide in the United States, 1989-1993. *Health Place*. 1999;5(2):179–185.

34. Yip PSF, Caine E, Yousuf S, et al. Means restriction for suicide prevention. *Lancet*. 2012;379(9834):2393–2399.

35. Lewiecki EM, Miller SA. Suicide, guns, and public policy. *Am J Public Health*. 2013;103(1):27–31.

36. Florentine JB, Crane C. Suicide prevention by limiting access to methods: a review of theory and practice. *Soc Sci Med*. 2010;70(10):1626–1632.