

Original Research
Alcohol consumption and Suicide in Belarus, 1980–2005

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Abstract: Background: Suicide is one of the leading external causes of death in many countries and its rates have increased globally over the last decades. The level of alcohol consumption and the suicide rates in the former Soviet republic Belarus range among the highest in the world. Aim: To estimate the aggregate level effect of alcohol on suicide rates in Belarus. Method: Trends in alcohol consumption per capita and suicide rates from 1980 to 2005 were analyzed employing autoregressive integrated moving average (ARIMA) time series analysis. Results: The results from the time series analysis indicated the presence of a significant association between alcohol consumption and blood alcohol concentration (BAC) positive suicide rates, while changes in the number of BAC-negative suicides were not related to fluctuations in alcohol consumption levels. The analysis suggests that an increase of alcohol consumption per capita by 1 litre would result in an 8.8% increase of the total suicides rate and 11.1% increase in BAC-positive suicides. Conclusion: this study suggests that the overall level of alcohol consumption is an important determinant of suicide rates at the aggregate level. The findings from the present study have important implications for suicides prevention indicating that a restrictive alcohol policy could be considered as an effective measure of suicide prevention in countries where rates of both alcohol consumption and suicide are high.

Key words: suicide, alcohol consumption, ARIMA, Belarus

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...e rates have risen in recent decades worldwide with an expected increase to 1.5 million deaths by the year 2020 (LaVecchia, Lucchini, & Levi, 1994; World Health Organization, 2005; Bertolote & Fleischmann, 2005). There are a number of possible reasons responsible for this, including lessened social integration, increase in psychiatric disorders, alcohol and drug abuse (Bertolote & Fleischmann, 2002; Bertolote, Fleischmann, De Leo & Wasserman, 2004; Pompilli, Serafini, Innamorati, Dominici, Ferracuti, Kotzalidis, et al., 2010). It is generally accepted that both acute and chronic alcohol use are among the major behaviorally modifiable factors that are associated with suicidal behavior (Norstrom, 1995; Lester, 1995; Bilban & Skibin 2005). Acute alcohol intoxication may trigger self-destructive behavior by provoking depressive thoughts, decreasing self-

control, and constricting cognition which impairs the generation of effective coping strategies to avoid psychological distress (Skog & Elekes, 1993; Rossov, 1993; Lester, 1998; Hufford 2001).

Several retrospective psychological autopsy studies have reported a high prevalence of alcohol use disorders among suicide victims (Pircola, Isometsa, Hikkinen, & Lonnqvist, 2000; Kolves, Varnik, Tooding, & Wasserman, 2006). To our knowledge, only two studies have addressed blood alcohol concentration (BAC) in suicide victims in the former Soviet republics. In particular, Nemtsov (2003) has highlighted that the number of BAC-positive suicides in Russia declined by 55%, while the number of BAC-negative suicides did not change substantially between 1984 and 1986. Similarly, in Estonia during the anti-alcohol campaign BAC-positive suicides decreased by 39.4%, while BAC-negative suicides increased by 3% (Varnik, Kolves, Vali, Tooding & Wasserman, 2006).

The international literature provides increasing evidence of an association between alcohol consumption and suicide rates at the

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aggregate level. Both longitudinal and cross-sectional aggregate-level studies usually report a significant and positive association between alcohol consumption and suicide (Cases & Harford 1998; Razvodovsky, 2001; Ramstedt, 2001; Makinen, 2000, 2006; Pridemore, 2006; Pridemore & Chamlin, 2006).

In Belarus, suicide is the second leading external cause of death (Kondrichin & Lester, 1998; Razvodovsky, 2006). Although suicide rates were comparatively high in the country, even during the later-Soviet period, the alarming rise that occurred during the post-Soviet period means that Belarus now has one of the highest suicide rates in the world (Razvodovsky 2007; Razvodovsky & Stickley, 2009). Alcohol plays an important role in the Belarusian suicide mortality crisis. A recent psychological autopsy study revealed that alcohol abuse and alcohol dependence has been diagnosed in 70% of the male and 71.4% of female suicide victims (Razvodovsky & Dukorsky, 2010). The aim of the present study was to examine the relation between alcohol consumption and suicide rates by using aggregate-level data from 1980 to 2005.

Methods

Data

The data on suicide used in this article were based on autopsy reports from the Bureau of Forensic Medicine. In Belarus, virtually all (99.1%) violent deaths undergo forensic autopsies, which include blood alcohol concentration (BAC) inspection. BAC in samples collected by forensic pathologists during the medical autopsies was assessed by gas chromatography and reported per million ($^{0}/_{00}$). BAC over $0.5^{0}/_{00}$ was termed 'inebriation' and denoted as 'BAC-positive'. The cause-of-death classification has been subject to several changes over the last decades. Until 1988 the cause of death classification was based upon the Soviet nomenclature which had a limited number of causes of death in comparison to the International Classification of Diseases (ICD) system. In 1989-2001 the Ministry of Statistics used the coding scheme based on ICD-9. In 2002 a new coding system based on ICD-10 has been introduced. However, the Belarusian coding system is claimed to be compatible with ICD-9 and ICD-10. For example code 173 (1989-2001) "suicide and self-inflicted injury" corresponds to the ICD-9 codes E950.0-E959.9 and code 249 (since 2002) corresponds to the ICD-10 codes X60.0-X 84.9. The overall level of alcohol consumption in Belarus has been estimated using the indirect method (Razvodovsky, 2010).

Statistical analysis

To examine the relation between changes in alcohol consumption and suicide mortality across the study period, a time-series analysis was performed using the statistical package Statistica. The dependent variables were the annual overall suicide mortality, the number of BAC-positive and the number of BAC-negative suicides. The independent variable was aggregate annual alcohol consumption. Bivariate correlations between the raw data from two time-series can often be spurious due to common sources in the trends and due to autocorrelation (Norstrom & Skog, 2001). One way to reduce the risk of obtaining a spurious relation between two variables that have common trends is to remove these trends by means of a 'differencing' procedure, as expressed by the formula:

$$\Delta x_t = x_t - x_{t-1}$$

This means that the annual changes ' Δ ' in variable ' x ' are analyzed rather than raw data. The process whereby systematic variation within a time series is eliminated before the examination of potential causal relationships is referred to as 'prewhitening'. This is subsequently followed by an inspection of the cross-correlation function in order to estimate the association between the two prewhitened time series. It was Box and Jenkins (1976) who first proposed this particular method for undertaking a time series analysis and it is commonly referred to as ARIMA (autoregressive integrated moving average) modeling. We used this model specification to estimate the relationship between the time series suicide mortality rate and alcohol consumption in this paper. In line with previous aggregate studies (Norstrom, 1995; Ramstedt, 2001), we estimated semi-logarithmic model with logged output. The following model was estimated:

$$\Delta \ln M_t = a + \beta \Delta A_t + \Delta N_t$$

where Δ means that the series is differenced, M is suicide mortality rates, a indicates the possible trend in mortality due to other factors than those included in the model, A is the alcohol sale, β is the estimated regression parameter, and N is the noise term. A semi-logarithmic model is based on the assumption that the risk of suicide increases more than proportionally for a given increase in alcohol consumption. The percentage increase in suicide mortality rates associated with a 1-litre increase in alcohol sale is given by the expression: $(\exp(\beta_1) - 1) \times 100$. The temporal structure of the error term was estimated by using autoregressive (AR) or moving average (MA) parameters in the model. A diagnostic test for residual correlation is given by the Box-Ljung Q-test, which indicates whether the model has been adequately fitted.

Table 1. Effects of alcohol consumption per capita on suicide mortality rates.

Lag	Alcohol/Suicide Total		Alcohol/Suicide BAC+		Alcohol/Suicide BAC-	
	r	SE	r	SE	r	SE
-3	0.217	0.213	0.176	0.213	0.245	0.213
-2	0.032	0.209	0.016	0.209	0.059	0.209
-1	0.130	0.204	0.159	0.204	-0.140	0.204
0	0.691	0.200	0.850	0.200	0.035	0.200
1	0.380	0.204	0.430	0.204	0.086	0.204
2	-0.030	0.209	-0.106	0.209	0.182	0.209
3	-0.209	0.213	-0.173	0.213	-0.196	0.213

Results of cross-correlation analysis between prewhitened time series.

Table 2. Estimated effects (bivariate ARIMA model) of alcohol consumption per capita on suicide rates.

Parameter	Model	Estim.	St. Error	t	p
Suicide Total	0,1,1*	0.088	0.012	5.636	0.000
Suicide BAC+	0,1,1	0.111	0.013	8.620	0.000
Suicide BAC-	0,1,1	0.003	0.015	0.233	0.818

*The general form of non-seasonal ARIMA model is (p,d,q), where p - the order of the autoregressive parameter, d - the order of differencing, and q - the order of the moving average parameter. Box-Ljung Q-tests for residuals were satisfactory in all models.

Results

All 61165 suicide cases were examined according to the Bureau of Forensic Medicine autopsy reports between 1980 and 2005. According to the reports, the suicide rates increased by 58.9% (from 18.5 to 29.4 per 100.000), the number of BAC-positive suicide cases increased by 59.2% (from 12.5 to 20.0 per 100.000) and the number of BAC-negative suicides increased by 59.3% (from 5.9 to 9.4 per 100.000) during the time period. Alcohol in blood was found in 62% suicide victims for the whole period, with a minimum of 49.3% in 1988 and a maximum of 68.5% in 1981. As shown in Figure 1, the BAC-positive suicide time trend fluctuated over the period: increased steadily from 1980 to 1984, then dropped sharply in 1984-1986, began to increase in 1988, dramatically declined from 1991 to 1998. In 1999 there was a slight decrease in the rate and from 2000 onwards the rate increased again. A comparative analysis showed that the trend in BAC-positive suicides fluctuated across the time series to a much greater extent than BAC-negative suicides. Alcohol-related suicides were more affected by the restriction of alcohol availability during the anti-alcohol campaign: between 1984 and 1986 the number of BAC-positive suicide rates dropped by 54.2% (from 15.4 to 7.0 per 100.000), while the number of BAC-negative suicides decreased by 7.1% (from 7 to 6.5 per 100.000). Further, the upward trend in BAC-positive suicides in the 1990s was greater than the trend in BAC-negative suicides: from 1989 to 1998

the number of BAC-positive suicides increased by 96.7% (from 9.1 to 17.9 per 100.000), while the number of BAC-negative suicides increased by 36.6% (from 7.1 to 9.7 per 100.000). The graphical evidence also suggests a strong association between alcohol consumption and BAC-positive suicide trends (Figure 2).

As can be seen from Figures 1 and 2 there are linear and S-shape trends in the time series data across the study period. These trends were removed by means of a first-order differencing procedure. After pre-whitening the cross-correlations between alcohol consumption and suicide mortality, the time series were inspected. The outcome indicated statistically significant cross-correlation between alcohol consumption levels and total suicides number at zero lag ($r=0.69$; $SE=0.20$), as well as number of BAC-positive suicides at zero ($r=0.85$; $SE=0.20$) and at first lag ($r=0.43$; $SE=0.20$). At the same time, there was no relation between alcohol consumption level and BAC-negative suicide rates (Table 1). The specification of the bivariate ARIMA model and outcome of the analysis are presented in Table 2. The estimated effects of alcohol consumption on total suicides number and number of BAC-positive suicides are clearly statistically significant. The analysis suggests that a 1 litre increase in alcohol consumption per capita would result in a 8.8% increase in total suicide rate and 11.1% increase in the number of BAC-positive suicides.

Figure 1. Trends in BAC-positive and BAC-negative suicides in Belarus between 1980 and 2005.

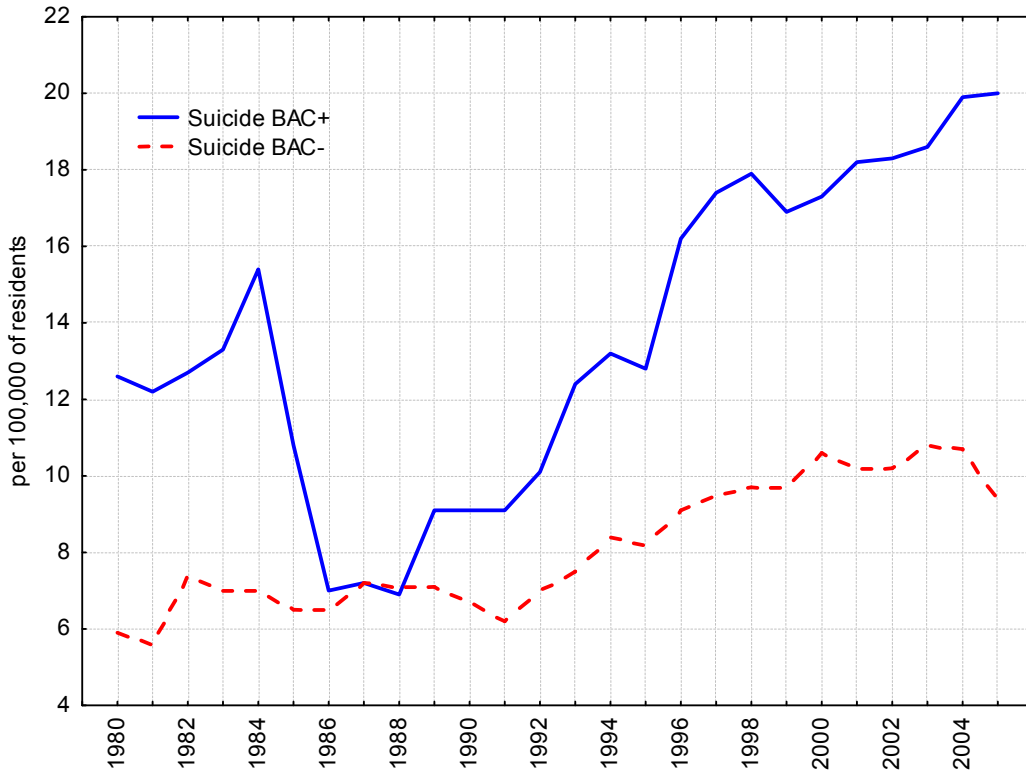
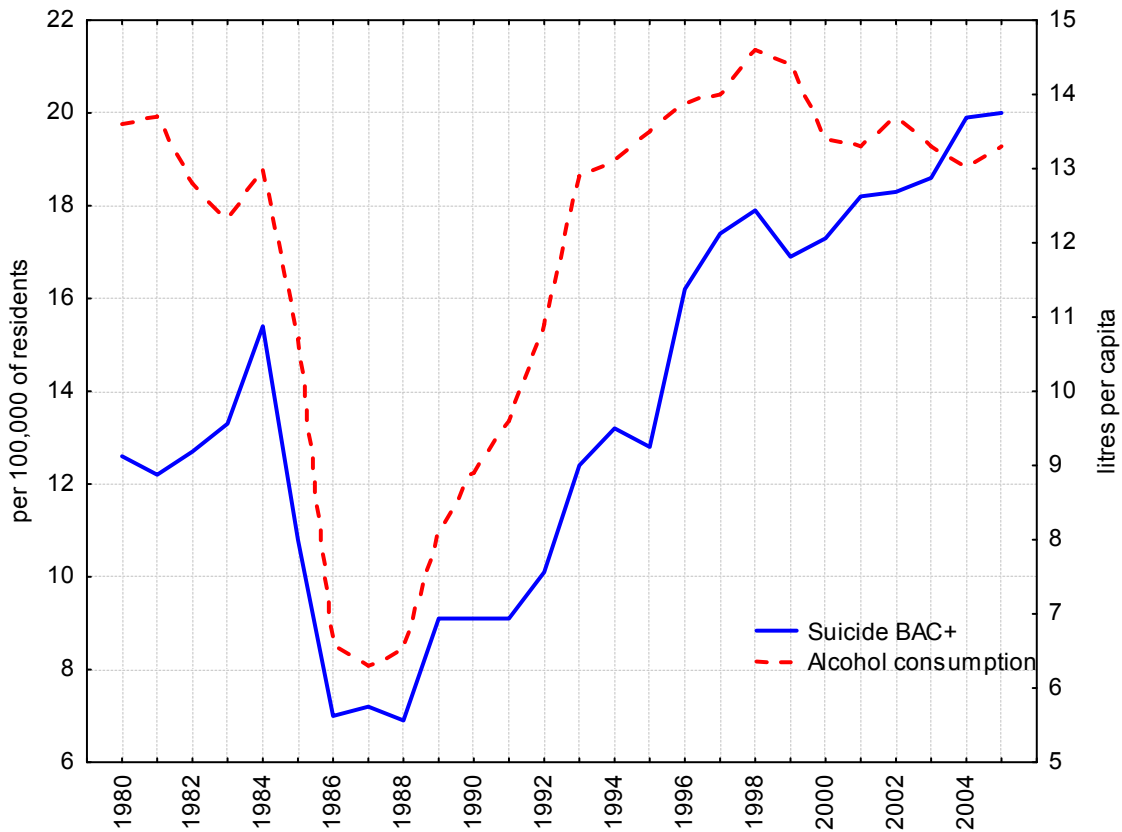


Figure 2. Trends in alcohol consumption per capita (right scale) and BAC-positive suicides (left scale) in Belarus between 1980 and 2005.



Discussion

Before discussing the main findings, several potential limitations of this study must be mentioned. First, we relied on estimated overall level of alcohol consumption across the period. However, the accuracy of the assessment of actual alcohol consumption using indirect methods depends significantly on whether the level of alcohol consumption is the only factor influencing the index chosen as the indicator of alcohol-related problems (Norstrom, 1998). This represents an essential drawback of such methods, because many other factors influence the level of alcohol-related problems (Razvodovsky, 2010). Further, there may also have been potential problems with the suicide mortality data we used. However, an earlier study has confirmed the reliability of the statistics on violent deaths for the Soviet period (Wasserman & Varnik, 1998). In the post-Soviet period virtually all deaths from external causes were examined by forensic autopsies, which include BAC inspection and histological examination of organs (Stickly, Leinsalu, Andreew, Razvodovsky, Vagero, McKee, 2007). Finally, there was also the risk of omitted variable bias in this work.

The results of the present study indicate that a restrictive alcohol policy can be considered as an effective intervention for suicide prevention. Indeed, the potential benefits of this action in Belarus were clearly demonstrated during Gorbachev's anti-alcohol campaign when a reduction in the per capita consumption of alcohol from 13.3 to 6.7 liters between 1984 and 1986 was accompanied by a decrease in the number of BAC-positive suicide rates from 15.4 to 7.0 per 100.000 of residents. Several researchers believed that the decrease in suicide rates in the former Soviet republics in the mid-1980s could have been related to the political and social liberalization during the period known as "perestroika", which gave rise to social optimism and new hope (Wasserman, Varnik & Eklund, 1994). However, the results of the present study suggest that the number of BAC-positive suicides shrank by 54.2%, while the number of BAC-negative suicides did not change substantially during Gorbachev's perestroika.

Some scholars have argued that the psychosocial distress resulting from the "shock therapy" economic reform and the sudden collapse of the Soviet paternalist system was the main determinant of the suicide mortality crisis in the former Soviet republics in the 1990s (Leon & Shkolnicov 1998, Stone 2000). Similarly, Lester (1998) suggested that the increase in suicide rates in this period could be a result of the disappointment over the changes in the living standards after an initial hope that social conditions would improve

rapidly. However, the fact that the number of BAC-suicides dramatically increased in the 1990s strongly supports an alcohol related hypothesis and suggests that rather than playing a major causal role, psychosocial distress may represent a confounding factor. It seems plausible that the psychosocial distress resulting from the reforms was the main cause of an increased demand for alcohol at this time. This demand was met by factors that increased supply. Following the repeal of the state alcohol monopoly in 1992, the Belarusian alcohol market fragmented, including many private producers and importers operating without a license or registration (Razvodovsky, 2010). The country was practically flooded by a wave of homemade, counterfeit, and imported alcohol of low quality. In the second half of the 1990s, the overall level of alcohol consumption grew to 14-14.5 litres per capita, the highest rate in the countries history. The negative outcomes of an increase of alcohol consumption during this period included a sharp rise in suicide mortality. After an introduction of measures against illegal alcohol production, import, and sale in 1998, the overall level of alcohol consumption began to diminish.

In his classic work Norstrom (1995) argues that the effect of alcohol consumption on suicide rate is stronger in "dry" drinking cultures, characterized by a low per capita consumption with the bulk of consumption concentrated on a few occasions, than in "wet" drinking cultures with a high average consumption, which is more evenly distributed throughout the week. The reason for this is that heavy drinkers in the "dry" culture are more likely to experience weakened family and community bonds because their behavior is viewed as marginal. In more recent comparative time-series analysis based on the data for the period from 1950-95 covering 14 European Union countries Ramstedt (2001) has shown that an increase of the drinking population had the largest impact on suicide in northern Europe (8.6% per litre for men and 11.4% for women) than in mid-Europe and southern Europe (0.6% per litre for men and 0.5% for women). Similarly, Nemtsov (2003) has reported that a 1-litre increase in alcohol consumption in Russia is expected to increase suicide by 11.4% for total population (13.1% for men and 6.6% for women). Collectively, these findings provided support for Norstrom's hypothesis suggesting that the suicide rate was strongly influenced by alcohol consumption in the countries where the drinking culture was characterized by heavy drinking episodes.

It is of interest to compare our findings with results from other countries. The estimate for Belarus (8.8% increase in the suicide rate per liter) is markedly larger than the estimates observed for

countries with less hazardous drinking patterns (southern and mid-Europe), and similar to those observed in countries with more detrimental drinking patterns (northern Europe, Russia). The findings add to the growing evidence that a binge drinking pattern (i.e. excessive consumption of alcohol in the form of spirits) results in quicker and deeper levels of intoxication, increasing the propensity for an autodestructive behavior. This may be especially true, as the level of per capita vodka sales in Belarus seem to be a better predictor of the suicide rate than the overall level of alcohol sales (Razvodovsky, 2001).

In conclusion, this study suggests that the overall level of alcohol consumption is an important determinant of suicide rates at the aggregate level. The findings from the present study have important implications for suicides prevention indicating that a restrictive alcohol policy can be considered as an effective intervention for suicide prevention in countries where rates of both alcohol consumption and suicide are high.

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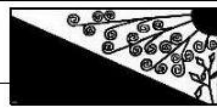
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