Alcohol Attributable Fraction of Suicide Mortality

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Abstract:

Background: *Suicide is one of the main causes of premature mortality in Belarus, brining considerable losses of human lives. There is strong evidence of a crucial role of alcohol in explanation of high suicide rate and its profound fluctuations over the past decades in this country. The aim of this study was to examine the relation between the overall alcohol consumption and suicide mortality rates in Belarus.*

Method: *Trends in alcohol consumption per capita and age-standardized male and female suicide rates from 1980 to 2010 were analyzed employing autoregressive integrated moving average (ARIMA) time series analysis.*

Results: *Alcohol consumption is significantly associated with both male and female suicide rates. The results suggest that 1 litre increase in overall alcohol consumption would result in a 7.4% increase in the male suicide rates and 3.2% increase in female suicide rates. The estimated effects of alcohol consumption on the age-specific suicide rates for men ranging from 0.024 (15-29 age group) to 0.082 (30-44 and 45-59 age groups). The estimated effects of alcohol consumption on age specific rates for women were positive for age groups 15-29 (0.017), 30-44 (0.047), 45-59 (0.039) and 60-74 (0.017).*

Conclusions: *The outcome of this study provides indirect support for the hypothesis that alcohol played a crucial role in the fluctuation in suicide mortality rate in Belarus during recent decades.*

Keywords: *Alcohol, suicide, ARIMA time series analysis, Belarus, 1980–2010.*

1. INTRODUCTION

Suicide rate has risen in recent decades worldwide with an expected increase to 1.5 million deaths by year 2020. [1,2]. There are a number of possible reasons responsible for this including lessened social integration, increase in psychiatric disorders, alcohol and drug abuse [3,4]. It is generally accepted that both acute and chronic alcohol use are among the major behaviorally modifiable factors that are associated with suicidal behavior [5, 6, 7, 8]. The international literature is providing increasing evidence of an association between alcohol consumption and suicide rates at the aggregate level. [9,10,11,12,13,14,15]. In his classic work Norstrom [16] argues that the effect of alcohol consumption on suicide rate is stronger in "dry" drinking culture, characterized by a low per capita consumption with the bulk of consumption concentrated on a few occasions, than in "wet" drinking culture 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 comparative time-series analysis based on the data for the period from 1950-95 covering 14 European Union countries Ramstedt [17] has shown that an increase in population drinking 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 [18] 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). In more recent study Landberg [19] showed a significant association between alcohol and suicide in 7 eastern European countries. Most importantly, he revealed that the sizes of the effects were stronger in countries in which spirits were the preferred form of alcohol. Collectively, these findings provided support for Norstrom's hypothesis suggesting that suicide rate was strongly influenced by alcohol consumption in the countries where the drinking culture was characterized by heavy drinking episodes.

In Belarus suicide is the second leading external causes of death [20]. The alarming increase in the occurrence of suicide in Belarus in 1990s has resulted in the country having one of the highest suicide rates in the world [21]. Alcohol plays an important role in Belarussian suicide mortality crisis [22]. A

recent study based on the autopsy reports of the Bureau of Forensic Medicine revealed that 61% of males and 30.6% of females were BAC (blood alcohol concentration)-positive at the time of death [23]. Positive blood alcohol cases were found more frequently in men age 30-39 (66%) and women age 19-29 (51.5%). A psychological autopsy study revealed that alcohol abuse and alcohol dependence was diagnosed in 70% of male and 71.4% of female suicide victims [24]. The findings suggest that in Belarus alcohol is an important determinant of suicide rates at the aggregate level. The results of time series analysis based on data from 1970-2005 highlighted that the alcohol psychoses rates as a proxy for alcohol consumption is among the most consistent predictors of the suicide rates in Belarus [25]. In this study we will further test the hypothesis of close relationship between alcohol and suicide in Belarus by analyzing time series data on overall alcohol consumption and sex- and age-specific suicide rates between 1980 and 2005.

2. MATERIAL AND METHODS

2.1. Data

The data on age-adjusted sex- and age-specific suicide mortality rates per 100,000 of the population used in the article were taken from the Belarusian State Statistical Committee. The cause-of-death classification has been subjected 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 with the International Classification of Diseases (ICD) system. In 1989-2001 the Ministry of Statistics used coding scheme based on ICD-9. In 2002 a new coding system based on ICD-10 has been introduced. 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 with ICD-9 code E 950.0-E 959.9 and code 249 (since 2002) corresponds with ICD-10 code X 60.0-X 84.9. The overall level of alcohol consumption in Belarus has been estimated using the indirect method [26].

2.2. Statistical Analysis

To examine the relation between changes in the alcohol consumption and suicide mortality across the study period a time-series analysis was performed using the statistical package "Statistica 10" StatSoft. 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 [13]. 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 in formula:

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

This means that the annual changes '∇' 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 an inspection of the cross-correlation function in order to estimate the association between the two prewhitened time series. It was Box and Jenkins [27] 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 [16, 17], we estimated semi-logarithmic model with logged output. The following model was estimated:

$$\nabla LnM_t = a + \beta \nabla A_t + \nabla N_t$$

where ∇ 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 because alcohol may trigger the impact of other suicidogenic factors [28]. The percentage increase in suicide mortality rates associated with a 1-litre increase in alcohol sale is given by the expression: (exp (β1)-1)*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. In addition to the estimated effect parameter, the alcohol effect will also be expressed in terms

of alcohol attributable fraction (AAF), which is interpreted as the proportion of suicides that is attributable to alcohol. AAF can be calculated from the estimates obtained in ARIMA models according to following formula: AAF = 1-exp(-bX), where X is alcohol consumption for the whole study period and b is the estimated effect parameter.

3. RESULTS

The trends in alcohol consumption per capita and sex-specific suicide rates are displayed Figures 1-2. The graphical evidence suggests quite a strong association between the two time series: it dropped sharply in the mid-1980s, dramatically increased in the late-1980s – first half of the 1990s. It is important to point out, however, that the pattern of suicide mortality for men and women was not uniform. Suicide rates dropped more sharply for males than for females during the anti-alcohol campaign. Further, the rates of suicide increased for both sexes during the 1990s, but it appears that males were more adversely affected during this period. In general, the male suicide rates tend to fluctuated across time series to a much greater extent than the female rates. It should be also emphasis that working-age males showed greater decrease in suicide mortality in the mid-1980s and subsequent increase in the early 1990s.
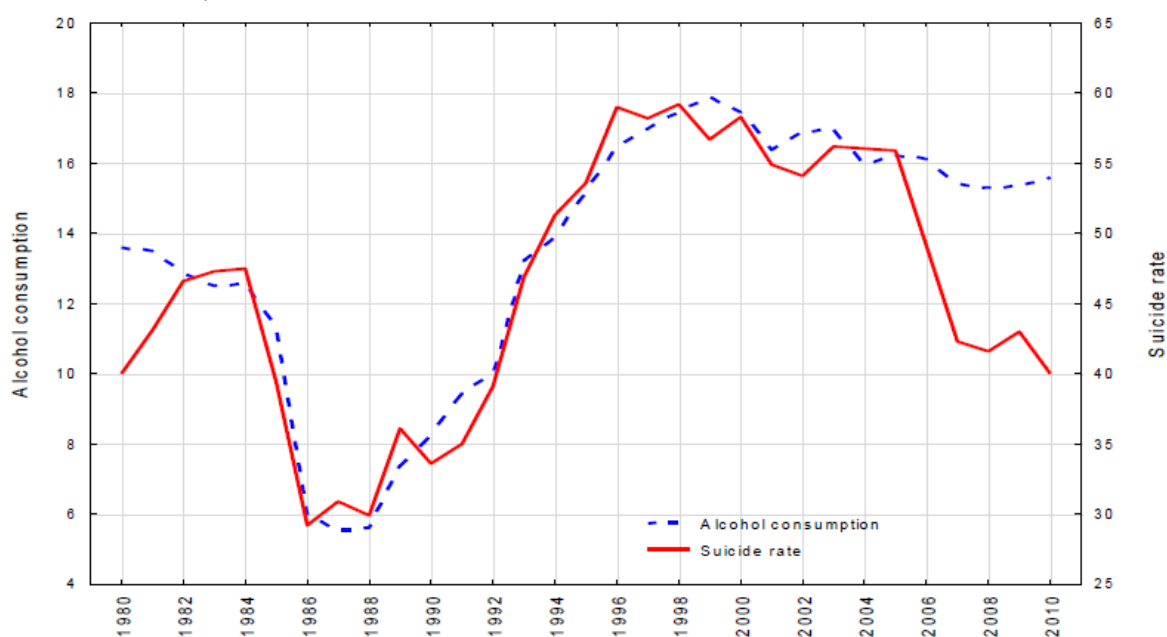

Figure1. *Trends in per capita alcohol consumption and suicide rate for men in Belarus between 1980 and 2010.*
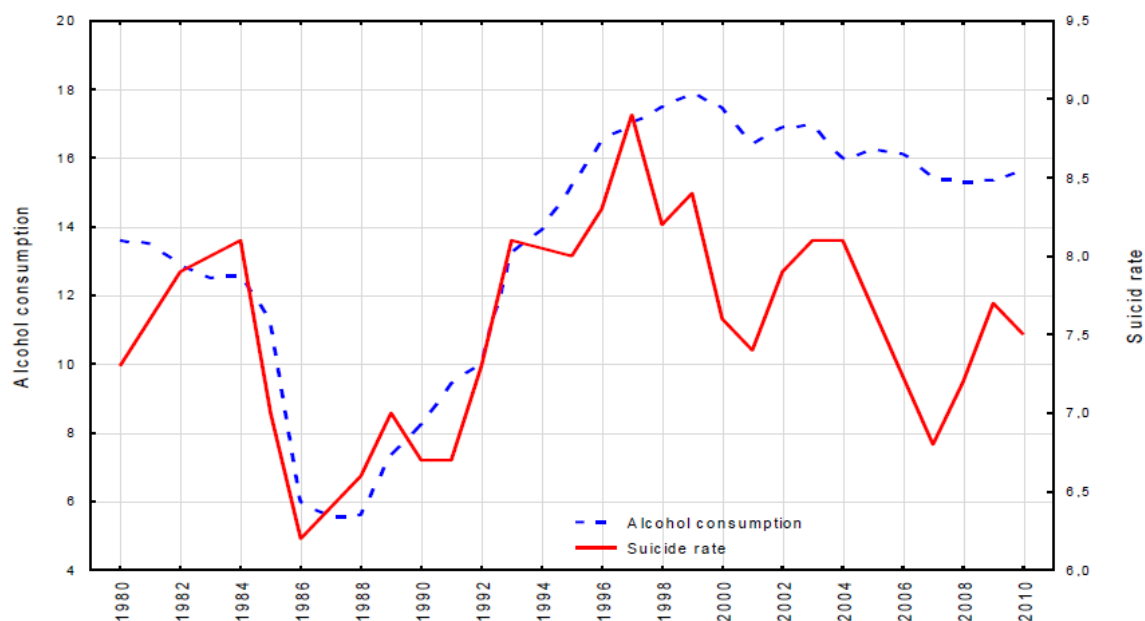

Figure2. *Trends in per capita alcohol consumption and suicide rate for women in Belarus between 1980 and 2010.*

As can be seen from Figures 1-2 there were sharp trends in the time series data across the study period. These trends were removed by means of a first-order differencing procedure. The specification of the bivariate ARIMA model and outcome of the analyses are presented in Tables 1. Alcohol consumption is significantly associated with both male and female suicide rates. The results suggest that 1 litre increase in overall alcohol consumption would result in a 7.4% increase in the male suicide rates and 3.2% increase in female suicide rates. The estimated effects of alcohol consumption on the age-specific suicide rates for men ranging from 0.024 (15-29 age group) to 0.082 (30-44 and 45-59 age groups). The estimated effects of alcohol consumption on age specific rates for women were positive for age groups 15-29 (0.017), 30-44 (0.047), 45-59 (0.039) and 60-74 (0.017). Gender and age-specific AAF estimates are presented in Table. The estimates for females (35%) were considerably lower than the estimates for males (63%).

Table1. *Estimated effects (bivariate ARIMA model) of total alcohol consumption per capita on suicide rate and alcohol attributable fraction (AAF).*

	Males				Females			
	Model	Estim.	p	AAF	Model	Estim.	p	AAF
15-29	0,1,0*	0.024	0.003	0.278	1,1,0	0.017	0.000	0.206
30-44	0,1,0	0.082	0.000	0.672	0,1,1	0.047	0.018	0.472
45-59	0,1,0	0.082	0.000	0.672	0,1,1	0.039	0.023	0.441
60-74	0,1,1	0.052	0.003	0.506	1,1,0	0.017	0.025	0.206
75+	1,0,1	0.001	0.738	-	1,0,1	0.010	0.581	-
15-75+	0,1,1	0.074	0.000	0.634	1,1,0	0.032	0.000	0.352

*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. Q test for residuals are satisfactory in all models.

4. DISCUSSION

The dramatic development in suicide rates in Belarus coincided with two major political events: the anti-alcohol campaign during the mid-1980s, and the political and economic transition following the break up of the Soviet Union in 1991. The results of present study indicate that a restrictive alcohol policy can be considered as an effective measure of 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 fall in the suicide rates from 15.4 to 7.0 per 100.000 of residents.

Some 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 [29]. However, the results of recent study suggest that the number of BAC-positive suicides shrank by 54.2%, while the number of BAC-negative suicides did not change substantially in Belarus during Gorbachev's perestroika [30].

Several scholars have argue that psychosocial distress resulting from the "shock therapy" economic reform and sudden collapse of the Soviet paternalist system was the main determinant of the suicide mortality crisis in the former Soviet republics in the 1990s [31,32]. Similarly, Lester [11] suggested that the increase in suicide rate in this period may be a result of the disappointment over the changes in the standard of living after initial hope that social conditions would improved rapidly. To address these points it is necessary to focus on the social and economic changes that have occurred in Belarus in the 1990s. The collapse of communism and the initial moves to establish a market economy resulted in the newly independent country experiencing a severe economic and social crisis. The levels of unemployment and poverty rose sharply while increasing social dislocation was manifested in falling birth and marriage rates and growing number of divorces [33]. So, psychosocial distress may be an important underlying factor of suicide mortality crisis the 1990s. However, close aggregate level association between alcohol consumption and suicide rates, as well as the recent findings highlighting the fact that the number of BAC-suicides dramatically jumped in the 1990s strongly supports an alcohol related hypothesis and suggests that rather that playing major causal role, psychosocial distress may represent a confounding factor. It seems plausible that the psychosocial distress resulting from the reforms were the main causes of increased demand for alcohol at this time. This demand was met by factors that increased supply. Following the repeal of state alcohol monopoly in 1992. 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 [34]. The negative outcomes of

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 [34].

It is important to point out, that the size of the bivariate association between alcohol consumption and suicide rates for men is substantially greater than for women. This mean that alcohol-related suicide is mainly a male phenomenon, as was shown in previous studies. For example, Wasserman and coauthors [29] estimated for the former USSR that the attributable fraction of alcohol for male suicides (more than 70%) exceeded considerably that for females (24%). Harmful drinking pattern might be responsible for the gender differences. Findings from representative population surveys carried out in Grodno city suggest that 57% of men and 9% of women had a consumption pattern that was hazardous according to the AUDIT definition [35]. Most importantly, 64.2% of men and 18.1% of women reported that they drink 5 or more standard drinks at one occasion.

It should be noted that the oldest age groups of both men and women did not experience a sharp fluctuations in their suicide rates during the anti-alcohol campaign, while increases and decreases in suicide rates for working-age males were more pronounced during the 1980s and 1990s. We also found that the relationship between overall alcohol consumption and suicide rates was stronger for working-age males. In principle, it's not surprisingly, given that the previous studies identified an unhealthy lifestyle among middle-age working class males with the high level of alcohol consumption. It was shown, for example, that 69.5% males age group 40-49 drink 5 or more standard drinks at one occasion and 24.4% drinks 10 or more standard drinks at one occasion [36].

It is of interest to compare our findings with results for other countries. The estimate for Belarus (7.4% for men and 3.6% for women) is markedly larger than the estimate observed for countries with less hazardous drinking pattern (southern and mid-Europe), and similar to those observed in countries with more detrimental drinking pattern (northern Europe, Russia). Regarding the AAF estimates, the Belarusian male AAF of 63% markedly less than estimates for Russia (75%) [19]. Collectively, these findings adds to the growing evidence that the binge drinking pattern (i.e. excessive consumption of alcohol in the form of spirits) results in quicker and deeper level of intoxication, increasing the propensity for auto destructive behavior. This may be especially true, as the level of per capita vodka sale in Belarus seems to be a better predictor of suicide rate than the overall level of alcohol sale [37].

Before concluding, it is necessary to say something about the potential limitations of this study. First, we relied on estimated overall level of alcohol consumption across the period. However, the accuracy of 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 [38]. This represents an essential drawback of such methods, because many other factors influence the level of alcohol-related problems [26]. Further, there may also have been potential problems with the suicide mortality data we used. However, earlier study has confirmed the reliability of the statistics on violent death for the Soviet period [39]. In the post-Soviet period virtually all deaths from external causes are subjected to forensic autopsies, which include BAC inspection and histological examination of organs [40]. Finally, there was also the risk of omitted variable bias in this work.

In conclusion, this study replicates previous findings that suggested a close link between alcohol and suicide at the aggregate level. The outcome of this study also support the hypothesis that suicide and alcohol closely connected in culture with prevailing intoxication-oriented drinking pattern and adds to growing body of evidence that a substantial proportion of suicides in Belarus are due to acute effect of binge drinking. The results of present study, as well as findings from other settings indicate that a restrictive alcohol policy can be considered as an effective measure of suicide prevention in countries where rates of both alcohol consumption and suicide are high.

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