Suicidology Online 2011; 2:67-74.

Suicidology Online
open access journal
www.suicidology-online.com
ISSN 2078-5488

Original Research

Alcohol consumption and suicide rates in Russia

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Submitted to SOL: 19th May 2011; accepted: 19th September 2011; published: 14th November 2011

***Abstract*:** Background: Suicide is one of the main causes of premature mortality in Russia, brining considerable losses of human lives. There is strong evidence of a crucial role of alcohol in the explanation of the high suicide rate and its profound fluctuations over the past decades in this country. 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 overall level of alcohol consumption was significantly associated with both male and female suicide rates. The estimates of the age specific models for men were positive and ranged from 0.029 (75+ age group) to 0.084 (30-44 age group). The estimates for women were positive for the age groups 15-29 (0.036), 30-44 (0.033), 45-59 (0.022) and 60-74 (0.008). 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 Russia during recent decades. Aim: To estimate the aggregate level effect of alcohol on suicide rates in Russia.

Key words: alcohol, suicide, ARIMA time series analysis, Russia, 1980–2005.

Suicide is one of the main causes of premature mortality in Russia, brining considerable losses of human lives (Mäkinen, 2000; Nemtsov, 2003; Pridemore & Spivak, 2003). The age-standardized suicide rate for 2005 was 32.2 per 100.000 residents, which was two times higher than the European Union average (Razvodovsky, 2008). High suicide rates in this country and its profound fluctuations over the past decades have attracted considerable interest (Wasserman, Värnik & Eklund, 1994; Värnik, Wasserman, Dankowicz & Eklund, 1998; Mäkinen, 2006). There is strong evidence of a crucial role of alcohol in explanation of this phenomenon (Wasserman, Värnik & Eklund, 1994; Lester, 1998; Nemtsov, 2003; Pridemore, 2006). Several studies highlighted a significant aggregate level association between alcohol and suicide in Russia. In his time series analysis data for the period 1965-99 Nemtsov (2003) has reported that a 1-litre increase in alcohol consumption is expected to increase suicide rates by 12% for the total population (13% for men and 6% for women). A more recent update suggests that 1 litre increase in per capita consumption is associated with an increase in overall suicide rates by 7.2% (8% for male and 4.3% for female) (Landberg, 2008). Another study has highlighted a close cross-sectional link between alcohol and suicide in Russian regions during the mid-1990s (Pridemore, 2006).

Several researchers have focused on the role of drinking culture as a possible explanation of the extremely high suicide rates in Russia (Pridemore & Chamlin, 2006; Razvodovsky, 2009a). The distinctive traits of the Russian drinking culture are the heavy episodic (binge) drinking pattern, the preference for distilled spirits, and sociocultural tolerance for heavy drinking (Nemtsov & Razvodovsky, 2008). A world wide assessment of drinking patterns showed that Russia and former Soviet republics had the most hazardous patterns of drinking (Rehm, Taylor & Patra, 2006). The findings suggest that binge drinking and suicide mortality are positively related phenomena in Russia. In their time series analysis Pridemore and Chamlin (2006) found a positive association between alcohol-related mortality and suicide in Russia between 1956 and 2002. The results from another study based on Russian data from 1956 to 2005 showed a positive association between fatal alcohol poisoning (as a proxy for binge drinking) and the suicide rate (Razvodovsky, 2009b). In a recent time series analysis Stickley, Jukkala & Norström (2011) concluded that binge drinking was significantly associated with the occurrence of suicide

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ISSN 2078-5488

in Russia and the magnitude of the relation is the same across the course of the later-tsarist, Soviet, and post-Soviet periods. Collectively this evidence provides additional support for the hypothesis that an unfavorable mixture of higher overall levels of alcohol consumption and a binge drinking pattern are a major risk factor for suicide mortality in Russia.

A potential limitation of previous Russian time-series studies of the relationship between alcohol and suicide mortality is that they have relied upon either indirect indicators of alcohol consumption (alcohol-related mortality), or indirect estimates of overall levels of alcohol consumption. However, the fact that Russian estimates based upon the ratio of blood alcohol concentration (BAC) between BAC-positive and BAC-negative cases of violent deaths, as recorded by regional bureau of forensic services, implies that the alcohol effect estimates might be spurious (Razvodovsky, 2010). In particular, the regression equation that reflects the relationship between the ratio of BAC-positive and BAC-negative cases of violent deaths and the level of alcohol consumption was calculated using statistics from Moscow, obtained during a relatively short period of time (1983–1986). Furthermore, the reliability of total consumption estimates may be questioned since other sources of unrecorded consumption, with the exception of samogon (self-distilled Vodka), were ignored (Nemtsov, 2000). Therefore, we assume that the incidence rate of alcohol psychoses may better capture the aggregate level of alcohol consumption than official sales statistics and previous expert estimation. This assumption is consistent with the findings, which suggest that the incidence rate of alcohol psychoses is among the most consistent predictors of the rate of alcohol-related problems in Russia (Nemtsov & Razvodovsky, 2008).

In present study we will further test the hypothesis of the close aggregate level link between alcohol and suicide in Russia using data on sex- and age-specific suicide rates and indirect estimates of overall levels of alcohol consumption based on the incidence rate of alcohol psychoses from 1980 to 2005.

Methods

Data

The data on age-adjusted sex- and age-specific suicide mortality rates per 100,000 of the population were taken from the Russian State Statistical Committee (ROSSTAT). The ROSSTAT's cause of death classification has undergone several changes in recent 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. From 1989-1998 ROSSTAT used a coding scheme that was based on ICD-9. From 1999 a new coding system based on ICD-10 was introduced. ROSSTAT issued a table of correspondence between its classification system and ICD-9 and ICD-10 and it has been claimed that the Russian system of coding was and is compatible with the ICD. For example ROSSTAT's (fromer Goscomstat) code 173 (1989-1998) "suicide and self-inflicted injury) corresponds with ICD-9 code E 950.0-E 959.9 and code 249 (since 1999) corresponds with ICD-10 code X 60.0-X 84.9. The overall level of alcohol consumption in Russia has been estimated using the indirect method (Razvodovsky, 2010).

Statistical analysis

To examine the relation between changes in the overall alcohol consumption and suicide mortality across the study period a time-series analysis was performed using the statistical package Statistica (Statsoft GmbH, Hamburg). 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 [17]. 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:

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

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 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 rates and overall alcohol consumption in this paper. In line with previous aggregate studies (Norström & Rossov, 1999; Ramstedt, 2001) we estimated semi-logarithmic models with logged output. The following model was estimated:

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

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.

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Table 1. Estimated effects (bivariate ARIMA model) of total alcohol consumption per capita on suicide rates and alcohol attributable fraction (AAF).

Age group	Males				Females			
[years]	Model	Estim.	p	AAF	Model	Estim.	p	AAF
15-29	1,1,0*	0.070	0.000	0.610	1,1,0	0.036	0.000	0.390
30-44	0,1,1	0.084	0.000	0.680	0,1,1	0.033	0.018	0.360
45-59	0,1,1	0.079	0.000	0.660	0,1,1	0.022	0.023	0.260
60-74	1,1,0	0.044	0.000	0.450	1,1,0	0.008	0.025	0.100
75+	0,1,1	0.029	0.038	0.330	0,1,1	0.010	0.381	-
total	1,1,0	0.070	0.000	0.610	1,1,0	0.032	0.000	0.350

*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.

The percentage increase in suicide mortality rates associated with a 1-litre increase in alcohol consumption is given by the expression: (exp(β1)-1)*100.

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 (Norström & Rossov, 1999). 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 (Norström, 2006).

Results

Sex-specific suicide rates yield patterns that vary little from each other over time Figures 1-2. The time series fluctuated over the period: it dropped sharply in 1984-1986, than increased substantially from 1991 to 1994 (especially for working-age men). This increase was followed by a steep decline between 1995 and 1998, with a new increase emerging in 1999. 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 rate of suicide increased for both sexes during the transition, but it appears that males were more adversely affected during this period. In general, the male suicide rate tends to fluctuated across time series to a much greater extent than the female rate. It should be also emphasized that working-age males showed a greater decrease in suicide mortality in the mid-1980s and a subsequent increase in the early 1990s. The graphical evidence also suggests that the trends for suicide and alcohol consumption are rather similar over the time series for both sexes.

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 Table 1. Overall alcohol consumption is significantly associated with both male and female (except for the female 75+ age groups) suicide rates. The estimated effects of alcohol consumption on the age-specific suicide rate for men ranged from 0.029 (75+ age group) to 0.084 (30-44 age group) and for women from 0.008 (60-74 age group) to 0.036 (15-29 age group). Gender and age-specific AAF estimates are presented in Table 1. The estimates for females (35%) were lower than the estimates for males (61%). The estimated AAF for men ranged from 33% (75+ age group) to 68% (30-44 age group) and for women from 10% (60-74 age group) to 39% (15-29 age group).

Suicidology Online 2011; 2:67-74.

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Figure 1. Trends in per capita alcohol consumption and suicide rates for men in Russia 1980-2005.

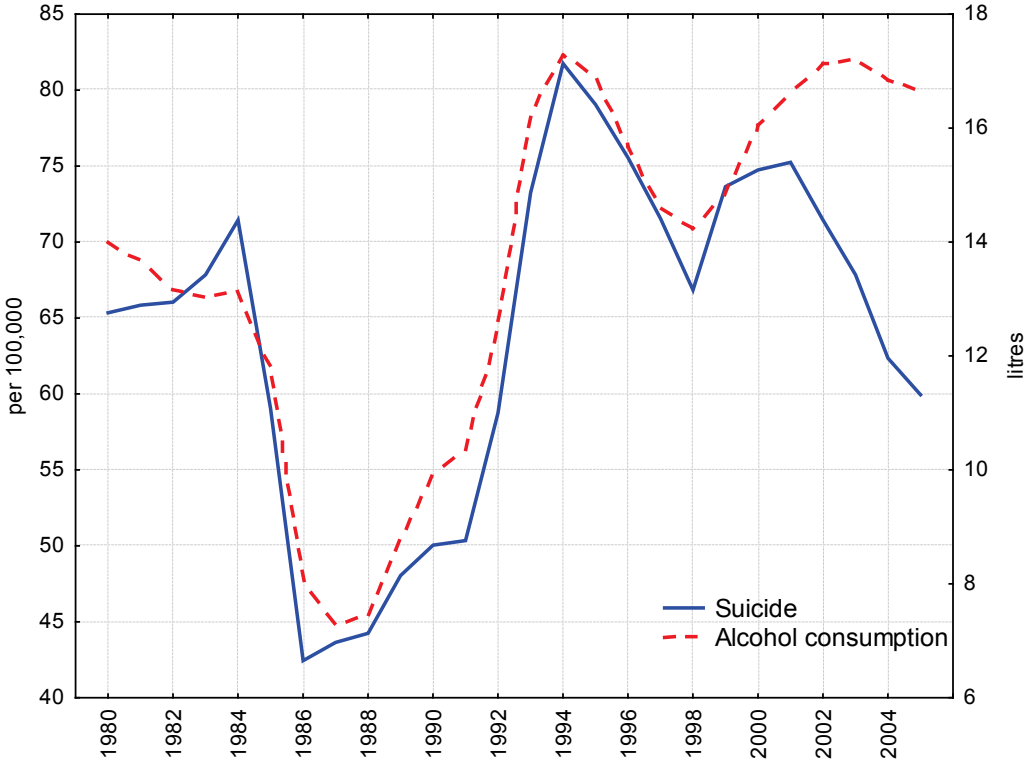
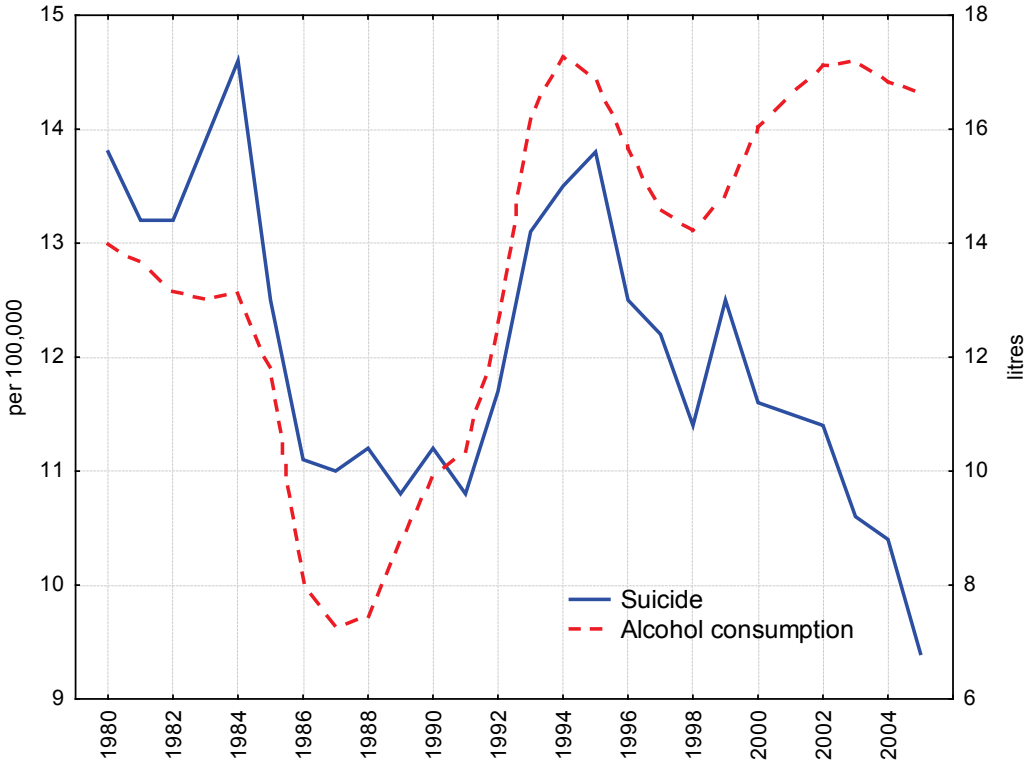


Figure 2. Trends in per capita alcohol consumption and suicide rates for women in Russia 1980-2005.



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Discussion

The changes in suicide trends during the periods of the Russian's modern history suggest that the phenomenon of suicide should be analysed in relation to the socioeconomic context. There is evidence that the suicide mortality trends in Russia were influenced by the three major factors: the long-standing mortality crisis that began in the USSR in the 1960s, Gorbachev's anti-alcohol campaign during 1985-1988, and the severe socioeconomic crisis imposed by rapid societal transformation in the early 1990s. A fairly close aggregate-level match between alcohol consumption and suicide mortality during the Gorbachev's anti-alcohol campaigns may be used as evidence for the hypothesis suggesting that alcohol is responsible for a substantial number of suicide deaths in Russia.

On the other hand, several researchers argue that alcohol unlikely provides the universal explanation for the mortality fluctuations during 1980s in Russia (Wasserman, Värnik & Eklund, 1994). They suggest that the decrease in suicide mortality rate in Russia 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. One can argue, however, that social changes should also have resulted in an increased anomie, which according to Durkheim, is associated with a high suicide rate (Durkheim, 1966). In addition, Nemtsov has highlighted that in Russia the number of BAC-positive suicides decreased by 55 per cent, while the number of BAC-negative suicides did not change substantially during Gorbachev's Perestroika (Nemtsov, 2003). He argues that "so-called national optimism was more likely a projection of the emotions of the more intelligent sections of the population (including scientists) than of the Russian population as a whole". Moreover, it has been shown that the oldest age groups of both men and women did not experience a reduction in their suicide rates during the anti-alcohol campaign, while working-age males faced the greater decreases in suicide mortality in the mid-1980s and the subsequent increases in the late 1980s and yearly 1990s (Pridemore & Spivak, 2003).

There is strong evidence of a key role of alcohol in explaining of Russian suicide mortality crisis in the early-1990s. In his well designed study Mäkinen (2000) has reported that alcohol consumption was a powerful predictor of suicide rates in the group of "high-suicide, unequal sex distribution" Eastern Bloc countries (including Russia) witch experienced a large drop in suicide rates in 1985-1989, especially for middle-age males, followed by a large general increase in 1989-1993 (Mäkinen, 2000). Similarly, it was shown that the pattern of the age-specific distribution of suicides and fatal alcohol poisonings coincided during the anti-alcohol campaign and nearly coincided during the transition (Nemtsov, 2003). Generally, this evidence supports the hypothesis that the increase in alcohol consumption was the main determinant of suicide mortality crisis in Russia in the early-1990s.

One of the most interesting features of the suicide mortality crisis in Russia in the early-1990s is the gender difference in spite of the fact that men and women share the same socio-economic circumstances. It seems that males were most vulnerable to the stressful experience resulting from abrupt socioeconomic changes, political instability, unemployment and impoverishment. This disproportionately affects the working-age male population because their work and family roles rendered them more vulnerable to socioeconomic disruption (Cornia & Poniccia, 2000; Gavrilova, Semyonova, Evdokushkina, Gavrilov, 2000). Several studies have suggested that men in Russia, as a result of traditional masculine norms, are more prone to respond to stressful situations with maladaptive behavior such as increased alcohol consumption, while women have a more adaptive stress response. Based on interviews conducted with a stratified random sample of 1190 Muscovites Jukkala and coauthors concluded that experiencing several kinds of economic problems is positively related to the risk of binge drinking among men (Yukkala, Mäkinen, Kislitsyna & Ferlander, 2008). In contrast, women seemed less likely to binge drink when experiencing economic problems. Cockerham *et al* found that psychological distress promotes frequent drinking in Russia among men, but not among women, even though women reported significantly more distress (Cockerham, Hinote & Abbot, 2006).

The increased demand for alcohol in Russia in the early-1990s is often attributed to psychosocial distress resulting from the "shock therapy" economic reform and sudden collapse of the Soviet paternalist system (Leon & Shkolnikov, 1998; Cornia & Poniccia, 2000; Gavrilova, Semyonova, Evdokushkina, Gavrilov, 2000; Andreeva, Ermakov & Brenner, 2008). This demand was met by factors that increased supply. Following the repeal of the state alcohol monopoly in January 1992, the alcohol market fragmented, including many private producers and importers which were operating without a license or registration (Nemtsov & Razvodovsky, 2008). The country was practically flooded by a wave of homemade, counterfeit, and imported alcohol, mainly spirits (Nemtsov, 2000). The negative outcomes of an increase of alcohol consumption during this period included a sharp rise in suicide mortality. Several factors including better regulation of the alcohol

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market resulted in a relative increase in price for alcohol compared to food products and impoverishment. A decrease in the purchasing capacity of the population due to unpaid or delayed salaries was behind the decrease in alcohol consumption after 1994 (Nemtsov & Razvodovsky, 2008).

It is important to point out, that the magnitude of the bivariate association between alcohol and suicide rates for men is substantially greater than for women. This means that alcohol-related suicide is mainly a male phenomenon, as was shown in previous studies. For example, Wasserman and coauthors estimated for the former USSR that the attributable fraction of alcohol for male suicides (more than 70%) exceeded considerably that for females (24%) (Wasserman, Värnik & Eklund, 1994). A more recent estimate suggests that alcohol may be responsible for 70.3% of male suicides and 51.1% of female suicides (Landberg, 2008). Beverage preference and harmful drinking patterns might be responsible for the gender difference in suicide rates as vodka continues to be the drink of choice for the majority of men in Russia, while women not only drink less than men, but those who do drink, consume vodka less frequently than men. Indeed, according to a population survey 44% of men and only 6% women reported that they drink an equivalent of 25 centiliters of vodka or more at one occasion (Bobak, McKee, Rose & Marmot, 1999). According to a more recent study 28% of men and 4% of women consume at least 200g (more than 86g of pure alcohol) on one occasion at least once every 2-3 weeks (Pomerleau, McKee, Rose, Haerpfer, Rotman & Tumanov, 2008). Furthermore, the results of the population survey carried out in Archangelsk suggest that 61.9% of male and 25.7% of female industrial workers had a consumption pattern that was hazardous according to the AUDIT definition (Averina, Nilssen, Brenn, Brox, Kalinin & Arkhipovsky, 2003).

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 surprising, given that the previous studies identified an unhealthy lifestyle among middle-age working class Russian males with the high level of alcohol consumption (Cockerham, 2000). An analysis of drinking by male age groups indicates that the frequency increases steadily to a peak between ages 30-39, before decreasing slightly in the 40-44 and 45-49 year-old and declines from age 50 significantly (Cockerham, 2000). Correspondingly, a recent study based on the data from the Russian Longitudinal Monitoring Survey (RLMS) showed that frequent, heavy drinking was significantly more common among men aged 40-59 years than in their older and younger conuterparts (Perlman, 2010).

Before concluding, it is necessary to say something about the potential limitations of this study. In particular, 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. 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, earlier study has confirmed the reliability of the statistics on violent death for the Soviet period (Wasserman & Värnik, 1994). In the post-Soviet period virtually all deaths from external causes are subjectd to forensic autopsies, which include BAC inspection and histological examination of organs (Stickley, Leinsalu, Andreew, Razvodovsky, Vagero, McKee, 2007). Finally, the present analysis is based on fairly short time series and this implies caution in the interpretation of findings.

In conclusion, the present study replicates previous findings suggesting close aggregate level association between alcohol and suicide in Russia. The outcome of this study also provides indirect support for the hypothesis that alcohol played a crucial role in the fluctuation in suicide mortality rate in Russia during recent decades. The finding from this study indicates 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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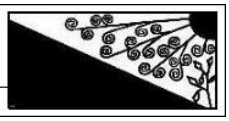

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