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The Effect of Beverage Type on Alcoholism Mortality in Russia

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Abstract

Background: Alcohol is increasingly implicated in the mortality crisis observed in Russia since the collapse of the communist system. Objective: The aim of this study was to examine the relation between the consumption of different beverage types and alcoholism mortality rates in Russia. Method: Age-standardized male and female alcoholism mortality data for the period 1970-2005 and data on beverage-specific alcohol sales were obtained from Russian State Statistical Committee. Time-series analytical modeling techniques (ARIMA) were used to examine the relation between the sales of different alcoholic beverages (vodka, wine, beer) and alcoholism mortality rates. **Results:** Vodka consumption as measured by sale was significantly associated with both male and female alcoholism mortality rates. The consumption of beer and wine were not associated with alcoholism mortality rates. Conclusions: The findings from this study suggest that public health efforts should focus on both reducing overall consumption and changing beverage preference away from distilled spirits in order to reduce alcohol-related mortality rates in Russia.

Keywords: Alcoholism; Mortality; Beverage-specific alcohol sales; ARIMA time series analysis; Russia; 1970-2005

Introduction

The harmful use of alcohol was identified as one of the major contributing factor to mortality globally [1]. Alcohol consumption caused a considerable disease burden in Europe: 6,1% of all the deaths could be attributed to this factor, with most of the burden in Eastern European region [2,3]. Its contribution is especially striking in Russia, where alcohol may be responsible for more than 30% of all deaths [4], while a case-control study in Izhevsk suggests that 43% of all deaths of male in the 25-54 years age range were attributed to hazardous drinking [5]. A more recent study in the Siberian city of Barnaul based on proxy information on alcohol consumption and other lifestyle factors from families of adults who died in 1990-2001 showed that alcohol was responsible for 59% of all male and 33% of all female deaths at ages 15-54 years [6]. Collectively, this research evidence suggests that alcohol is a major contributor to premature deaths toll in Russia. Alcohol is also increasingly implicated in the massive fluctuations in Russian mortality over the past several decades, but the nature of this phenomenon is still poorly understood by a research community.

The most important cause of the health burden in Europe is alcohol dependence (alcoholism), accounting for more than 70% of the overall alcohol-attributable net mortality before age 65 [2]. Alcohol dependence is a maladaptive pattern of alcohol misuse, defined as a cluster of physiological, behavioral, and cognitive phenomena in which the use of alcohol takes on a much higher priority for a given individual than other behaviors that once had greater value, is one of the most severe consequences of problem drinking (ICD-10). Russia has the highest prevalence of alcoholism in Europe, which may be explained by high overall population drinking and prevalence of irregular heavy drinking episodes (binge drinking) [7,8]. Binge drinking is usually defined as the consumption of ten or more standard drinks on a single occasion [9]. Overall, in 2005 close to 11 million people in Russia suffered from alcohol dependence [2].

There is evidence that spirits preference is associated with a quicker and deeper level of intoxication, increasing the risk of alcohol-related health outcomes. In particular, Baltieri et al. [10] reported that spirit drinkers demonstrated higher severity of alcohol dependence and craving for alcohol, more frequent history of treatment for alcoholism,

lower adherence to the treatment and high aspartate aminotransferase (AST) serum levels and Mean Corpuscular Volume (MCV) that the beer drinkers. Also, Wilhelm et al. [11] highlighted those alcohol dependent individuals who prefer spirits have more hippocampal damage, in term of loss of volume, than beer drinkers. In line with these pieces of evidence, we assume that occasional heavy drinking of vodka in Russia should result in a positive association between vodka sales and alcoholism mortality at the aggregate level. In this study we will test the hypothesis of beverage-specific effect on alcoholism mortality by analyzing Russian's time series data between 1970 and 2005.

Methods

Data

The data on age-adjusted sex-specific alcoholism mortality rates per 1000.000 of the population are 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 is compatible with ICD codes. The data on per capita beverage-specific alcohol sales (vodka, wine, beer in liters of pure alcohol) were taken from Rosstat's annual reports.

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Statistical analysis

To examine the relation between changes in the consumption of different types of alcoholic beverage and alcoholism mortality across the study period a time-series analysis was performed using the statistical package "Statistica". The dependent variables were the annual alcoholism mortality and the independent variables were aggregate beverage-specific alcohol sales. 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 [12,13]. 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:

$$\overline{V}x_t = x_t - x_{t-1}$$

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 [12] who first proposed this particular method for undertaking a time series analysis and it is commonly referred to as ARIMA modeling. We used this model specification to estimate the relationship between the time series alcoholism mortality and alcohol consumption rates in this paper. In line with previous aggregate studies [13-16] we estimated semi-logarithmic models 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 alcoholism mortality rates, a indicates the possible trend in alcoholism mortality due to other factors than those included in the model, A is the beverage-specific alcohol sales, β is the estimated regression parameter, and N is the noise term. The percentage increase in alcoholism mortality rate rates associated with a 1-litre increase in alcohol consumption is given by the expression: $(\exp(\beta_1)-1)\cdot 100$. 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.

Results

According to official statistics, the male alcoholism mortality rates increased 1.6 times (from 44.0 to 72.3 per 1000.000 of population) and female mortality rates increased 2.3 times (from 7.5 to 17.5 per 1.000.000 of population) in Russia from 1970 to 2005. Across the whole period the male alcoholism mortality rate was 4.8 times higher than the female rates (51.3 vs. 10.8 per 1 000.000) with a rates ratio of 5.9 in 1970 decreasing to 2.8 by the 2005. The trends in the sex-specific alcoholism mortality rates are displayed in Figure 1. As can be seen, the pattern of alcoholism mortality for men and women was uniform. For both sexes the time series alcoholism mortality rates fluctuated greatly over the period: decreased from 1972 to 1976, increased from 1976 to 1981, decreased markedly from 1981 to 1983 (by 15.0% and 21.5% for men and women respectively), dropped sharply between 1984-1988 (4 times for men and 3.3 times for women), than started on an upward trend from 1988-1989, before jumping dramatically during 1992 to 1995 (4.9 times for men and 5.9 times for women). From 1995-1998 there was a fall in the rates before they again rising between 1998 and 2003 and then started to decrease in the most recent years.

The graphical evidence suggests that the temporal pattern of Russian alcoholism mortality for males and females fits closely with changes in vodka sales per capita (Figures 2 and 3). 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. After prewhitening the cross-correlations between beverage-specific alcohol sales and alcoholism mortality time series were inspected. This indicated that there was a statistically significant cross-correlation between total per capita alcohol sales, vodka and beer sales and alcoholism mortality for males and females at lag zero (Tables 1 and 2). At the same time, there was no cross-correlation between the level of wine sales and alcoholism mortality rates.

The specification of the bivariate ARIMA model and outcome of the analyses are presented in Table 3. According to the results, total alcohol sales is a statistically significant associated with both male and female alcoholism mortality rates, implying that a 1-litre increase in per capita alcohol sale is associated with an increase in male mortality of 15.4% and female mortality of 17.2%. The analysis also suggests that of the three beverages vodka alone was associated with alcoholism mortality in Russia. The estimated effects of vodka sales on the alcoholism mortality rate are clearly statistically significant for both sexes: a 1 liter increase in vodka sale would result in a 24.2% increase in the male alcoholism mortality rates and in 27.4% increase in female mortality rates. The association between beer sale per capita and alcoholism rates was also positive for both sexes, but statistically not significant

Discussion

It is widely accepted that the level of spirits consumption is an important determinant of alcohol-related mortality in a population [2]. This is particularly true in relation to Russia where Gorbachev's anti-alcohol campaign was associated with a rapid reduction in the level of both vodka consumption and alcoholism mortality, while increasing consumption in the transition period has been linked to dramatic rise in mortality rates. A fairly close aggregate-level match between vodka consumption and alcoholism mortality during the Andropov's (in the early 1980s) and Gorbachev's (1985-1988) anti-alcohol campaigns may be use as evidence for the hypothesis suggesting that a restrictive alcohol policy can be considered as an effective measure of alcohol-related mortality prevention.

The increase in vodka consumption has contributed to the dramatic rise in alcoholism deaths between 1992 and 1995. The increase of alcohol consumption in this period was to a great extent due to increase of alcohol availability following the repeal of the state alcohol monopoly in January 1992 [15].

Studies from many countries have shown an inverse relationship between alcohol prices and alcohol drinking and concluded that affordability of alcohol is one of the most important predictor of alcohol-related mortality [16-18]. The results from ecological regression suggest that lower vodka prices were associated with statistically significant increase in Russian total mortality [19]. It is obvious, therefore, that the increase in heavy drinking in Russia during transition, which triggered the dramatic rise in alcoholism mortality, resulted also from an increase in the affordability of vodka. With price liberalization in 1992, vodka became much more affordable because of a sharp drop in the price of vodka relative to those of other goods and alcoholic beverages including beer [20]. By 1995, the real price of vodka fell to its lowest point, after which point the real vodka price recovered until 1999, and then the affordability trend turned down again [21]. The relative fall in price for vodka explains an apparent paradox – an
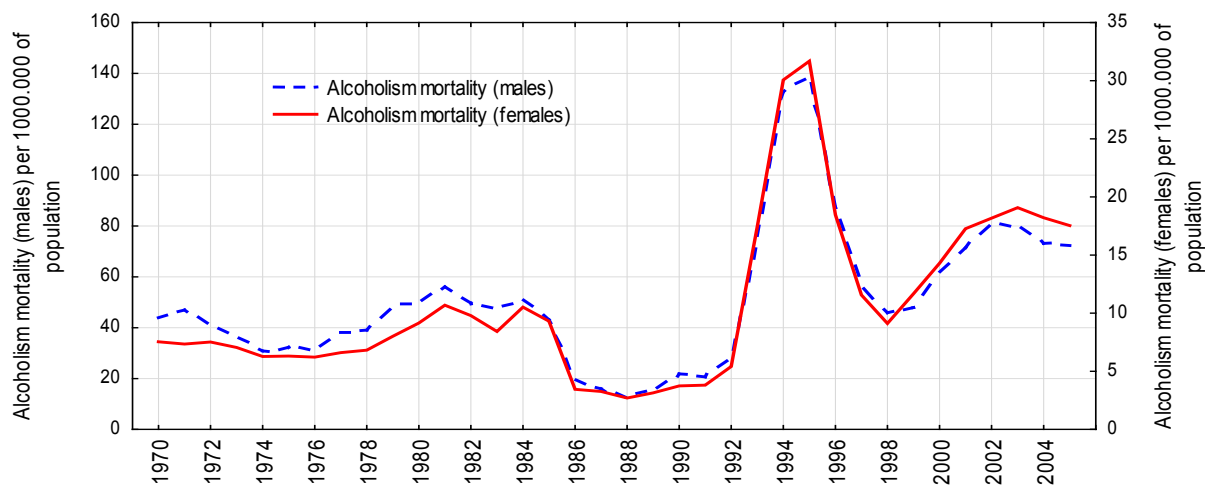
Figure 1: Trends in male and female alcoholism mortality rates in Russia between 1970 and 2005
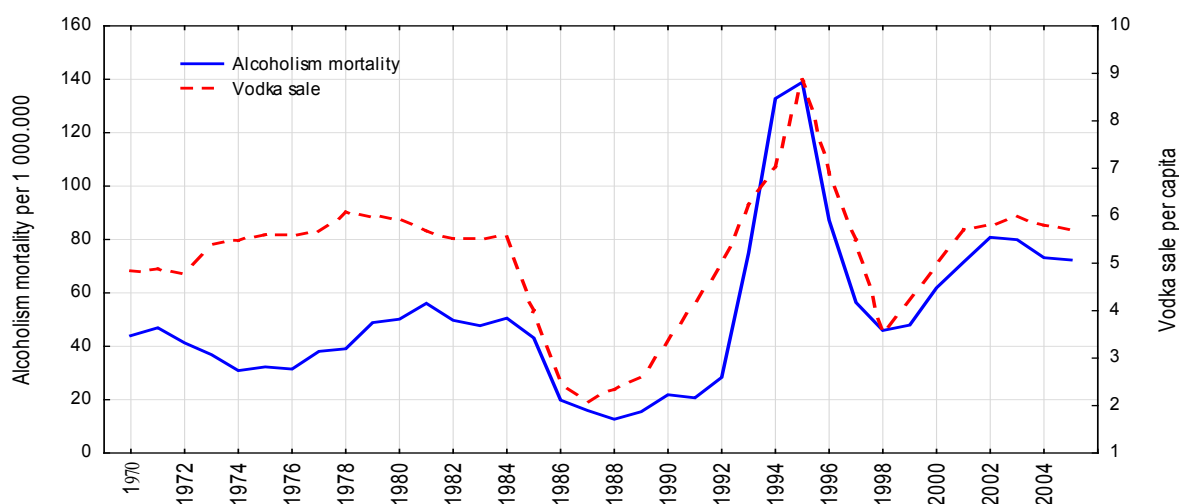

Figure 2: Trends in male alcoholism mortality rate (right scale) and vodka sales per capita (left scale) in Russia between 1970 and 2005
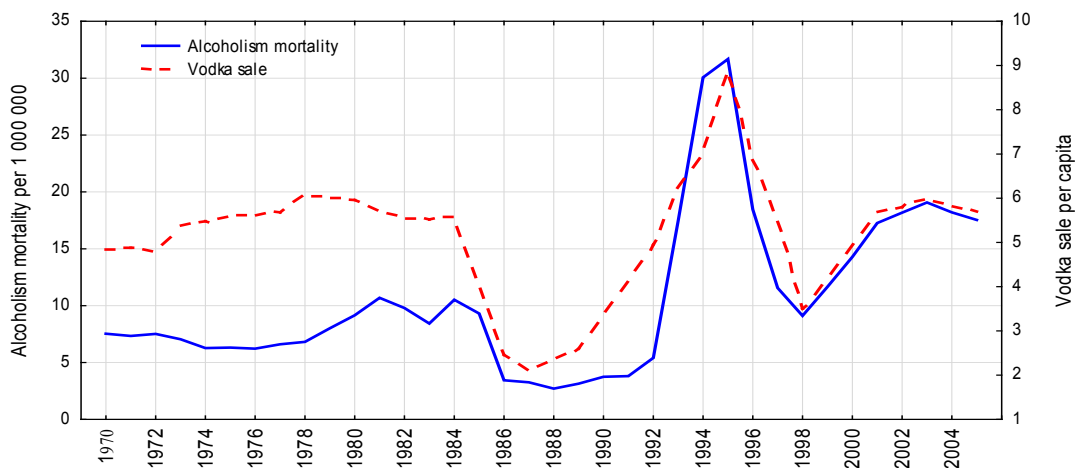

Figure 3: Trends in female alcoholism mortality rate (right scale) and vodka sales per capita (left scale) in Russia between 1970 and 2005

	Alcohol sale		Vodka sale		Wine sale		Beer sale	
Lag	r	SE	r	SE	r	SE	r	SE
-3	0.125	0.177	0.071	0.177	0.129	0.177	0.124	0.177
-2	0.065	0.174	0.152	0.174	0.214	0.174	0.252	0.174
-1	0,220	0.172	0.066	0.172	0.167	0.172	0.153	0.172
0	0.601	0.169	0.651	0.167	0.216	0.169	0.321	0.169
1	0.136	0.172	0.036	0.172	0.115	0.172	0.137	0.172
2	0.057	0.174	0.0 51	0.174	0.134	0.174	0.029	0.174
3	0.093	0.177	0.037	0.177	0.105	0.177	0.075	0.177

Table 1: The results of cross-correlation analysis between prewhitened time series for males. Effects of beverage specific alcohol sale per capita on alcoholism mortality rate

	Alcohol sale		Vodka sale		Wine sale		Beer sale	
Lag	r	SE	r	SE	r	SE	r	SE
-3	0.067	0.177	0.048	0.177	0.123	0.174	0.115	0.177
-2	0.083	0.174	0.117	0.174	0.152	0.174	0.135	0.174
-1	0.131	0.172	0.224	0.172	0.155	0.172	0.215	0.172
0	0.623	0.169	0.673	0.169	0.147	0.169	0.412	0.169
1	0.214	0.172	0.018	0.172	0.202	0.172	0.221	0.172
2	0.013	0.174	0.124	0.174	0.237	0.174	0.058	0.174
3	0.124	0.177	0.078	0.177	0.132	0.177	0.039	0.177

Table 2: The results of cross-correlation analysis between prewhitened time series for females. Effects of beverage specific alcohol sale per capita on alcoholism mortality rate

Parameter	Total alcohol sale		Vodka sale		Wine sale		Beer sale	
	model	estimated	model	estimated	model	estimated	model	estimated
mortality males	0.1.0	0.154*	0.1.0	0.242*	0.1.0	0.083	0.1.0	0.356
mortality females	0.1.0	0.172*	0.1.0	0.274*	0.1.0	0.106	0.1.0	0.396

Table 3: Estimated effects of beverage specific alcohol sale on alcoholism mortality rates

*p<0.001
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.

increase in alcohol consumption against a background of economic crisis.

It seems plausible that mortality crisis in the mid-1990s was to a great extent due to changed alcohol consumption structure, when 80% of all alcohol in Russia was consumed in the form of spirits [22]. In 2003, according to official alcohol sales figured, strong beverages accounted for 41,2% of the total consumption [23]. The declining quality of vodka also is an important factor in alcoholism mortality crisis during this period. According to the data from the State Statistics Service, 21.6% to 45.1% of vodka sold during that period did not meet quality standards [15].

Some put forward the "demographic echo" or "catching-up" hypothesis suggesting that excess deaths in the early of 1990s are the deaths of alcohol dependent individuals, whose lives were saved during the anti-alcohol campaign [24-28]. The Russian alcoholism mortality crisis in the mid-1990s could therefore be the combined results of increase in availability/affordability of vodka, deterioration of his quality, change in alcohol consumption structure, lagged "catch-up" mortality and reversion of the long-run trend.

There are several potential factors behind the decrease in vodka consumption and alcoholism mortality rates between 1995 and 1998. They include better regulation of the alcohol market that may have resulted in a relative increase in prices for vodka compared to those for food products [21,29]. In this period the government affected the alcohol market through a struggle against production of illegal vodka. Thus, only in 1995, agencies of the Ministry of Internal Affairs closed more than 2.300 underground workshops producing contra factual

vodka [20]. It also appears likely that changes in the structure of alcohol consumption (switch from predominant consumption of spirits to the consumption of beer) have had a positive impact on bringing down the death rate from alcoholism in Russia between 1995 and 1998. Another possible factor in the decrease in alcohol consumption was impoverishment and decrease in the purchasing capacity of the population due to unpaid or delayed salaries [15,30-32]. An important factor in the decrease in mortality from alcoholism that began in 1995 may have been the excess deaths in the cohort of alcoholics in previous years. The subsequent rise in vodka sale and alcoholism mortality rates from 1998 may be associated with the increase in affordability of vodka [7].

The results of present study are important because despite the growing literature on alcohol and mortality in Russia there has been no prior time-series analysis of beverage-specific effect of alcohol sales on alcoholism mortality in the country. According to the results of time-series analysis there was a positive and statistically significant effect of per capita alcohol sales and vodka sales on alcoholism mortality in Russia. These findings clearly indicate that population drinking and alcohol-related mortality is positively related phenomena in Russia. It is important to point out, that the size of the bivariate association between alcohol consumption and alcoholism mortality rates for women is higher than for men. It seems plausible that women are more sensitive to an increased risk of alcohol-related mortality even at the relatively low levels of alcohol consumption. More specifically, women appear to suffer alcohol-related physical and psychical illnesses at lower levels of exposure to alcohol and to a greater degree than men. Further, there are some indications that Russian women are drinking more

now which are likely to be a factor in the narrowing of the male-female alcohol-related mortality rates ratio [33,34]. In his recent study, based on the results of RLMS Perlman [25] highlighted that frequent heavy drinking almost doubled among women between 1994 and 2004.

Before concluding, several potential limitations of this study must be mentioned. In particular, some researchers argue that alcohol unlikely provide the universal explanation for the mortality fluctuations during 1980s in Russia [26]. They believe that the decrease in 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 [35-37]. However, in his seminal work Nemtsov [4] argue that "so-called national optimism was more likely a projection of the emotions of the more intelligent sections of the population than of the Russian population as a whole".

Further, there was the risk of omitted variable bias in this work. While some experts have underlined the importance of binge drinking as the main reason for the alcohol-related mortality crisis in Russia in the 1990s, other has called attention to the effect of the psychosocial distress of economic and political reforms [27,38,39]. The collapse of the USSR in 1991 and growth of consumer prices in 1992 were followed by declining of living standards majority of population. However, close aggregate level association between alcohol consumption and alcoholism mortality rates strongly supports an alcohol- related hypothesis and suggests that rather that playing major causal role; psychosocial distress may represent a confounding factor [40].

Finally, it is likely that increase in alcoholism mortality in Russia in the mid-1990s is a consequence of deterioration in the quality of health care system, following the collapse of Soviet Union in late 1991. As command economy collapsed, the public health system faced a financial crisis. Left without proper funding, health care system was unable to maintain needed level of medical care [24]. A process of destruction of the narcological service that began in 1989 continued in the early 1990s [20]. Furthermore, in 1991 the Law on the Militia has been adopted, which called for the closing of all Medical-Labor clinics by June 1994 [21]. As a result, up to 150.000 of the most advanced alcoholics were released. However, the importance of these factors is clearly modest compared to alcohol, thus limiting their potential influence.

Conclusion

In conclusion, this is the first time-series analysis of beverage-specific alcohol sales and alcoholism mortality rates in Russia, which has shown that alcoholism mortality tend to be more responsive to changes in vodka sales per capita than to the wine or beer sales. The outcomes of this study provide indirect support for the hypothesis that unfavorable mixture of higher level of vodka consumption and binge drinking pattern is a major risk factor for alcoholism mortality in Russia. The results from present study also suggest a close aggregate-level link between alcohol availability and alcoholism mortality and support the idea that high availability of alcohol is associated with increasing in binge drinking and that heavy drinkers are sensitive to availability of alcohol.

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