

Beverage Specific Effect of Alcohol on Pancreatitis Mortality in Russia

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Summary – Pancreatitis is a major public health problem with high associated economic costs. The incidence of pancreatitis has increased in many European countries in recent decade. There is evidence that beverage preference may have modifying influence on pancreatitis risk independently of the amount of alcohol consumed. The aim of this study was to examine the relation between the consumption of different beverage types and pancreatitis mortality rates in Russia. Method: Time-series analytical modeling techniques (ARIMA) were used to examine the relation between the sale of different alcoholic beverages (vodka, wine, beer) and age-standardized male and female pancreatitis mortality data for the period 1970–2005. Results: The analysis suggests that of the three beverages, vodka alone was associated with pancreatitis mortality. The estimated effects of vodka sales on the pancreatitis mortality rate are clearly statistically significant for both sexes: a 1 liter increase in vodka sales would result in a 10.3% increase in the male pancreatitis mortality rate and in 3.2% increase in female mortality rate. 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.

Key words: pancreatitis mortality, beverage-specific alcohol sale, ARIMA time series analysis, Russia, 1970–2005.

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INTRODUCTION

Pancreatitis is a major public health problem with high associated economic costs.¹ The incidence of pancreatitis has increased in many European countries in recent decades.^{2,3} Increase of acute pancreatitis over time was greater in the younger age group which probably represents an increase in alcoholic pancreatitis, as acute pancreatitis among young people is more commonly alcohol related.⁴ The incidence of acute pancreatitis varies considerably throughout the region and tended to be highest in Scandinavia and Eastern Europe.^{3,5} The reasons for geographic differences in incidence of pancreatitis are still poorly understood and are most likely due to the differences in risk factors, including alcohol consumption.⁵ Since an association between alcohol abuse and pancreatitis was reported by Friedreich,⁶ many studies have confirmed that excessive alcohol consumption is a major risk factor for both acute and chronic pancreatitis.^{1,7-9} The strong support for a close link between alcohol and pancreatitis comes from the individual level studies.^{4,10} Using data on 17905 men and women who participated in the Copenhagen City Heart Study Kristiansen et al. reported that a high alcohol intake is associated with a high risk of pancreatitis.¹¹ Hazard ratios associated with drinking 1-6, 7-13, 14-20, 21-34, 35-48, and >48 drinks/week were 1.1, 1.2, 1.3, 1.3, 2.6, 3.0 respectively, compared with 0 drinks/week. A recent systematic review and meta-analysis of epidemiologic studies on alcohol consumption and pancreatitis published between 1980 and 2008 reported a monotonic and approximately exponential dose-response relationship between average volume of alcohol consumption and the risk of pancreatitis.¹² The risk curve between alcohol consumption and pancreatitis was relatively flat at low levels of alcohol consumption and increased markedly with increasing levels of consumption. Individuals consuming 36 grams of alcohol daily, had a relative risk of 1.2 (95% CI: 1.2-1.3), compared with non-drinkers. Whereas those with a daily alcohol intake of 96 grams, had a four-fold increased risk of pancreatitis (RR=4.2; CI: 3.1-5.7), relative to non-drinkers. This study also provided evidence supporting the existence of a threshold effect (about 4 drinks daily) between alcohol consumption and the risk of pancreatitis.¹² Collectively, these findings suggest that the total amount of alcohol consumed is a critical factor in producing chronic alcohol-induced pancreatic damage.

There is, however, evidence that pattern of drinking and beverage preference may have a modifying influence on pancreatitis risk independently of the amount of alcohol consumed. A follow-up study from Sweden revealed a dose-response association between the amount of spirits consumed on a single occasion and the risk of acute pancreatitis.¹³ After multivariate adjustments, there was a 52% (95% CI: 1.1-2.1) in-

creased risk of acute pancreatitis for every increment of five standard drinks of spirits consumed on a single occasion. Similarly, Nakamura et al. reported that higher risk for chronic pancreatitis in alcohol-dependent men was associated with drinking spirits rather than lower-alcohol beverages.¹⁴ In contrast, Gerloft et al. found that beer dose-dependently increases basal amylase secretion of rat pancreatic acinal cells, while wine and hard liquor had no effect on amylase secretion neither diluted to the ethanol concentration of beer nor undiluted.¹⁵ It seems that the risk of alcohol-induced pancreatitis differ by beverage type, in such manner, that particularly spirits, but also beer consumption has stronger effects than does wine drinking.

The level of alcohol consumption in Russia is among the highest in the world with an annual sales rate about 10 liters of pure alcohol per capita, while independent estimates show a figure as high as 17 litres.^{16,17} The distinctive trait of Russian drinking culture is a high overall level of alcohol consumption and the heavy episodic (binge) drinking pattern of strong spirits (vodka), leading to an increase in deaths from alcohol poisoning and cardiovascular diseases.^{18–23} 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 sale and pancreatitis mortality at the aggregate level. In this study we will test the hypothesis of beverage-specific effect on pancreatitis mortality by analyzing Russian time series data between 1970 and 2005.

METHODS

Data

The data on age-adjusted sex-specific pancreatitis 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-9 codes 577.0 (acute pancreatitis) – 577.1 (chronic pancreatitis) and with ICD-10 codes K 85 (acute pancreatitis) – K 86.0/86.1 (chronic pancreatitis).

The data on per capita beverage-specific alcohol sales (vodka, wine, beer in liters of pure alcohol) were taken from Rosstat's annual reports.

Statistical analysis

To examine the relation between changes in the consumption of different types of alcoholic beverages and pancreatitis mortality across the study period a time-series analysis was performed using the statistical package »Statistica«. The dependent variable was the annual pancreatitis 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.²⁴ 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 'pre-whitening'. This is subsequently followed by an inspection of the cross-correlation function in order to estimate the association between the two pre-whitened time series. It was Box and Jenkins 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.²⁵ We used this model specification to estimate the relationship between the time series pancreatitis mortality and alcohol consumption rates in this paper. In line with previous aggregate studies²⁶⁻²⁸ we estimated semi-logarithmic models with logged output. The following model was estimated:

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

where ∇ means that the series is differenced, M is pancreatitis mortality rates, a indicates the possible trend in pancreatitis 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 pancreatitis mortality rates associated with a 1-litre increase in alcohol sales is given by the expression: $(\exp(\beta_1) - 1) * 100$.

RESULTS

According to official statistics, the male pancreatitis mortality rate increased 5.6 times (from 21.4 to 120.1 per 1000.000 of population) and female mortality rate increased 3.8 times (from 11.2 to 42.9 per 1.000.000 of population) in Russia from 1970

to 2005. Across the whole period the male pancreatitis mortality rate was 2.2 times higher than the female rate (56.3 vs. 25.6 per 1 000.000) with a rate ratio of 1.9 in 1970 increasing to 2.8 by the 2005. For both sexes, the time series pancreatitis mortality rates fluctuated greatly over the period: decreased markedly between 1984–1988, then started on an upward trend from 1988–1989, before increasing substantially during 1992 to 1994 (by 72.3% and 29.6% for men and women respectively). From 1995–1998 there was a fall in the rates before they again jumping dramatically between 1998 and 2005 (by 84.3% and 46.4% for men and women respectively). Although the trends in pancreatitis mortality rates are rather similar over time series for both sexes, the male pancreatitis mortality rate tends to fluctuated across time series to a much greater extent than the female rate. The average per capita alcohol sales figure was 8.2 liters with vodka being the drink overwhelmingly consumed. However, these mean figures mask differing trends among the beverages across the period. While there has been a slight drop in vodka sales from 4.84 liters in 1970 to 3.88 liters in 2005 and wine sales have remained at roughly the same level there has been a sharp growth in beer sales – especially in recent years. Between 1998 and 2005 the per capita sales figure for beer rose from 1.16 to 3.08 liters. It is also worth noting that beverage sales have experienced sharp fluctuations across the period. Thus, a brief Andropov's anti-alcohol campaign in the early 1980s resulted in a decline in vodka sales. An especially sharp fall was recorded in vodka and wine sales in 1985–1987 that coincided with Mikhail Gorbachev's anti-alcohol campaign. Similarly, the collapse of the Soviet Union and the ending of the state's alcohol monopoly in the early 1990s were accompanied by a sharp rise in vodka sales.

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 pre-whitening the cross-correlations between alcohol consumption and the pancreatitis mortality time series were inspected. This showed that there was a statistically significant cross-correlation between total per capita alcohol/vodka sales consumption and pancreatitis mortality for males and females at lag zero (Table 1). At the same time, there was no cross-correlation between the level of wine/beer sales and homicide rates.

The specification of the bivariate ARIMA model and outcome of the analyses are presented in Table 2 and 3. According to the results, alcohol consumption showed a statistically significant association with both male and female pancreatitis mortality rates, implying that a 1-litre increase in per capita alcohol sale is associated with an increase in male mortality of 4.2% and female mortality of 1.8%. The analysis also suggests that, of the three beverages, vodka alone was associated with pancreatitis mortality in Russia (Table 4). The estimated effects of vodka sales on the pancreatitis

Table 1. Descriptive statistics, Russia 1970–2005

	Mean	Std. Dev.
Total alcohol sales (liters)	8.18	2.03
Vodka sales (liters)	4.44	1.15
Wine sales (liters)	2.39	0.99
Beer sales (liters)	1.33	0.58
Pancreatitis mortality rate males (per 1,000,000)	56.31	24.93
Pancreatitis mortality rate females (per 1,000,000)	25.55	7.10

Table 2. The results of cross-correlation analysis between pre-whitened time series for males. Effects of beverage specific alcohol sales per capita on pancreatitis mortality rate.

Lag	Alcohol sale		Vodka sale		Wine sale		Beer sale	
	r	SE	r	SE	r	SE	r	SE
-3	-0.026	0.177	-0.058	0.177	-0.117	0.177	0.032	0.177
-2	-0.027	0.174	0.191	0.174	-0.239	0.174	0.045	0.174
-1	0.089	0.172	0.310	0.172	-0.132	0.172	0.115	0.172
0	0.634	0.169	0.548	0.167	-0.056	0.169	0.123	0.169
1	0.231	0.172	0.342	0.172	0.266	0.172	0.225	0.172
2	0.111	0.174	0.287	0.174	0.154	0.174	0.042	0.174
3	0.168	0.177	0.145	0.177	0.158	0.177	0.025	0.177

Table 3. The results of cross-correlation analysis between pre-whitened time series for females. Effects of beverage specific alcohol sales per capita on pancreatitis mortality rate.

Lag	Alcohol sale		Vodka sale		Wine sale		Beer sale	
	r	SE	r	SE	r	SE	r	SE
-3	0.158	0.177	0.165	0.177	-0.182	0.174	0.125	0.177
-2	0.055	0.174	0.165	0.174	-0.081	0.174	0.053	0.174
-1	0.291	0.172	0.214	0.172	0.115	0.172	0.164	0.172
0	0.416	0.169	0.314	0.169	0.139	0.169	0.170	0.169
1	0.071	0.172	0.164	0.172	0.072	0.172	0.162	0.172
2	0.018	0.174	0.142	0.174	0.015	0.174	0.110	0.174
3	0.058	0.177	0.061	0.177	0.081	0.177	0.005	0.177

Table 4. Estimated effects of beverage specific alcohol sales on pancreatitis mortality rates.

Parameter	Total alcohol sale			Vodka sale		
	model	estim.	p	model	estim.	p
Pancreatitis mortality males	0.1.0*	0.042	0.017	0.1.0	0.103	0.000
Pancreatitis mortality females	0.1.0	0.018	0.048	0.1.0	0.032	0.045

* 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.

mortality rate are clearly statistically significant for both sexes: a 1 liter increase in vodka sales would result in a 10.3% increase in the male pancreatitis mortality rate and in 3.2% increase in female pancreatitis mortality rate.

DISCUSSION

According to the results of time-series analysis there was a positive and statistically significant effect of per capita vodka sales on pancreatitis mortality in Russia. The effects of drinking spirits may also be exacerbated by the way they are drunk, such as heavy episodic drinking pattern, which is widespread. Moreover, this pattern of consuming alcohol is much more frequent when drinking spirits than when drinking other types of beverages, among both men and women in Russia.²⁹ The strong aggregate level association between vodka sales and pancreatitis mortality rate in Russia might be an outcome of a preference for spirits among heavy drinkers.¹⁹ These findings provide indirect support for the binge drinking hypothesis, suggested that episodic heavy drinking of spirits is an important determinant of pancreatitis mortality in Russia.

It should be emphasized that the results suggest a fairly quick response of pancreatitis mortality rates to changes in vodka sale. The instantaneous response of mortality rates from chronic alcohol-related diseases seems quite surprising when considering the long latency period at the individual level.²⁶ There are several reasonable explanations for this seeming inconsistency. It is well recognized, that pancreatitis mortality is the classical indicator of harmful effect of chronic heavy drinking (chronic pancreatitis) and also associated with episodic heavy drinking (acute pancreatitis), thus reflecting the acute and chronic consequences of heavy drinking.^{7,30} Therefore, the contemporaneous association between the two variables may support

the point that substantial proportion of pancreatitis deaths in Russia are due to acute effect of binge drinking. Further, Norström and Skog argue that in a population there exists a reservoir of heavy drinkers who are near the critical threshold-value for dying from chronic alcohol-related consequences.²⁶ In case when these high risk individuals increase alcohol consumption during a given year, they will exceed the threshold value and die from alcohol-related diseases. This is the reason why the immediate impact on chronic alcohol related mortality can be registered from marked changes in aggregate consumption.

It is important to point out, that the size of the bivariate association between vodka sale and pancreatitis mortality for men is substantially greater than for women. Beverage preference and harmful drinking pattern might be responsible for the gender difference in pancreatitis mortality rate as vodka continue to be the drinking of choice for the majority of men in Russia, while women not only drink less often than men, but those who do drink, consume vodka less frequently than men. Indeed, according to population survey 44% of men and only 6% women reported that they drink an equivalent of 25 cl of vodka or more at one occasion.³¹ According to a more recent study 28% of men and 4% of women consume at least 200g (86+ g of pure alcohol) on one occasion at least once every 2–3 weeks.³²

Before concluding, several potential limitations of this study must be mentioned. In particular, there was the risk of omitted variable bias in this work. It should be acknowledged that other risk factors such as diet and smoking also affect the mortality rate from pancreatitis.^{9,33–35} However, there is no compelling epidemiological evidence of rapid changes in the dietary and smoking patterns among Russian men and women that could have translated into substantial fluctuations in pancreatitis mortality rate in the last decades. Therefore, the controlling for the impact of these risk factors would not have modified our results.

In conclusion, the present study suggests that pancreatitis mortality tends to be more responsive to changes in spirits consumption per capita than to the wine or beer consumption. Assuming that drinking vodka is usually associated with intoxication episodes, these findings provide indirect evidence that that substantial proportion of pancreatitis deaths in Russia are due to acute effect of binge drinking. The findings from the present study have important implications as regards alcohol policy in Russia suggesting that any attempts to reduce overall consumption should also be linked with efforts through differential taxation to shift the beverage preference away from spirits.

UTJECAJ RAZLIČITIH VRSTA ALKOHOLA NA SMRTNOST OD PANKREATITISA U RUSIJI

Sažetak – Pankreatitis je značajan javno-zdravstveni problem povezan s visokim troškovima liječenja. Učestalost pankreatitisa u mnogim europskim zemljama je tijekom prošlog desetljeća narasla. Postoje dokazi da izbor pića može imati modificirajući učinak na pankreatitis, neovisno o količini konzumiranog alkohola. Cilj ove studije bio je ispitati povezanost konzumacije različitih tipova pića i mortaliteta uzrokovanog pankreatisom u Rusiji. Metoda: Analitički model vremenskih serija (ARIMA) korišten je da se utvrdi odnos između prodaje različitih alkoholnih pića (votka, vino, pivo) i podataka o mortalitetu od pankreatitisa u standardiziranoj muško-ženskoj populaciji u periodu od 1970–2005. Rezultati: Rezultati sugeriraju da je od tri ispitivana pića samo votka bila povezana s mortalitetom od pankreatitisa. Učinak prodaje votke na mortalitet od pankreatitisa je statistički značajan kod oba spola: porast prodaje votke od 1 litre godišnje rezultira povećanjem muškog mortaliteta od pankreatitisa za 10,33% i ženskog mortaliteta od pankreatitisa za 3,2%. Zaključak: Nalazi ove studije sugeriraju da bi trebalo usmjeriti javno-zdravstvene napore i na smanjivanje opće potrošnje i na promjenu preferencije alkoholnih pića u smislu izbjegavanja destiliranih pića, s ciljem smanjivanja mortaliteta od pankreatitisa u Rusiji.

Cljučne riječi: mortalitet od pankreatitisa, prodaja alkohola ovisno o vrstu pića, ARIMA analiza vremenskih serija, Rusija, 1970–2005

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