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Spatial variation of male alcohol-related mortality in Belarus and Lithuania

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Background: Numerous studies have addressed the problem of hazardous alcohol consumption, alcohol-related causes of death and their relationship to persisting excess male mortality in the countries of the former USSR. Yet relatively little is known about the geographical patterns of alcohol-related mortality within these countries and the cross-border continuities of such patterns. This study aims at identifying the spatial distribution and the cross-border patterns of adult male mortality from alcohol poisonings and liver cirrhosis in Belarus and Lithuania. **Methods**: We use cause-specific mortality data for 2003–2007. We employ spatial econometric techniques to detect 'hot spots' of alcohol-related mortality across the combined territory of the two countries. **Results**: Specific patterns associated with extremely high rates of mortality from alcohol poisoning can be observed in Belarus, particularly in the areas bordering Russia and Lithuania. Meanwhile, patterns of alcohol-induced liver disease dominate in Lithuania, and continue across the border from eastern Lithuania into north-western Belarus. **Conclusions**: The districts located along the Belarusian–Lithuanian border appear to be especially problematic, as they suffer from an enormous burden of alcohol consumption. The situation is particularly severe on the Belarusian side, where there are extremely high levels of mortality from both alcohol poisoning and liver cirrhosis. These areas should be considered primary targets for antialcohol policies.

Introduction

Alcohol is known to be largely responsible for excessive male mortality in the countries of the former USSR (FSU).[1–3] The persisting overall disadvantage in life expectancy is closely related to excess male mortality at adult ages stemming from prevailing specific patterns of excessive alcohol consumption (binge drinking). Thus, these countries have a huge burden of alcohol-related mortality at working ages.[4–9] Previous studies have shown that significant mortality fluctuations during the Soviet and post-Soviet periods were attributable to sudden changes in alcohol consumption and the effects of anti-alcohol policies.[1,4,5,6] Gorbachev's anti-alcohol campaign launched in the mid-1980s was indicative: as a result of the short-term reduction in alcohol consumption in response to the campaign, male adult mortality decreased markedly.[7] Likewise, the unprecedented mortality growth that occurred in the FSU in the early 1990s is believed to be strongly associated with the rapid increase in alcohol intake.[8,9] A very recent study has suggested that alcohol is an important factor in regional mortality variation within Belarus.[10]

In this article, we focus on two neighbouring countries with many shared historic and sociocultural characteristics: Belarus and Lithuania. Their common history dates back to the 13th century, when the modern territories of the two countries formed the Grand Duchy of Lithuania. In 1569, the duchy was united in a federative state with Poland (Polish-Lithuanian Commonwealth). In the late 18th century, the territories came under the control of the Russian Empire. After WWI, Lithuania re-established its independence, whereas Belarus became a part of the USSR in 1922. During the interwar period (1918–1940), the region, consisting of eastern Lithuania (including the capital Vilnius) and north-western Belarus, was under the control of Poland. Between 1945 and 1991, both countries were republics of the USSR.

Before the dissolution of the USSR, Belarus and Lithuania had very similar unfavourable mortality trends.[11] In both countries, changes in overall male mortality have been strongly related to trends in causes of death directly linked to excessive alcohol consumption, such as cirrhosis of the liver and other liver diseases, as well as alcohol poisoning (figure 1).

Since the early 2000s, however, this link has weakened. Meanwhile, the trends in the two main components—liver cirrhosis and other liver diseases on the one hand and alcohol poisoning on the other—differed in the two countries. It has been suggested that a striking increase in the consumption of alcoholic beverages was responsible for the enormous growth in mortality due to alcohol-related liver diseases observed in Lithuania in 2000–2007.[4] Recent trends in mortality from accidental poisoning by alcohol diverge markedly in Belarus and in Lithuania. In the 1980s, male adult mortality from this cause was somewhat higher in Lithuania. Due to more unfavourable alcohol consumption trends in the 1990s and 2000s, mortality from alcohol poisoning was about three times higher in Belarus than in Lithuania. This can be explained by shifts towards particularly hazardous forms of alcohol consumption, as well as by increasing consumption of poor quality homemade alcohols and dangerous ethanol-containing substances.[15]

While a recent report by the World Health Organization (WHO) indicates a notable divergence in the levels and the patterns of alcohol consumption between Belarus and Lithuania, in 1990 both the overall per capita consumption of pure ethanol and the composition of consumed alcoholic beverages (predominantly spirits) were very similar in the two countries. At present, in Lithuania roughly one-half of the total amount of pure ethanol consumed is in the form of beer, and only one-third is in the form of spirits; whereas in Belarus one-half of the total amount of pure ethanol consumed is in the form of spirits, and about one-sixth is in the form of beer.[16] Nevertheless, in terms of health consequences, the WHO assigns both countries to the highest YLL category, a mortality measure reflecting alcohol-attributable years of human life lost. This assessment is consistent with reports of marked behavioural similarities between Belarusian and Lithuanian males. In both

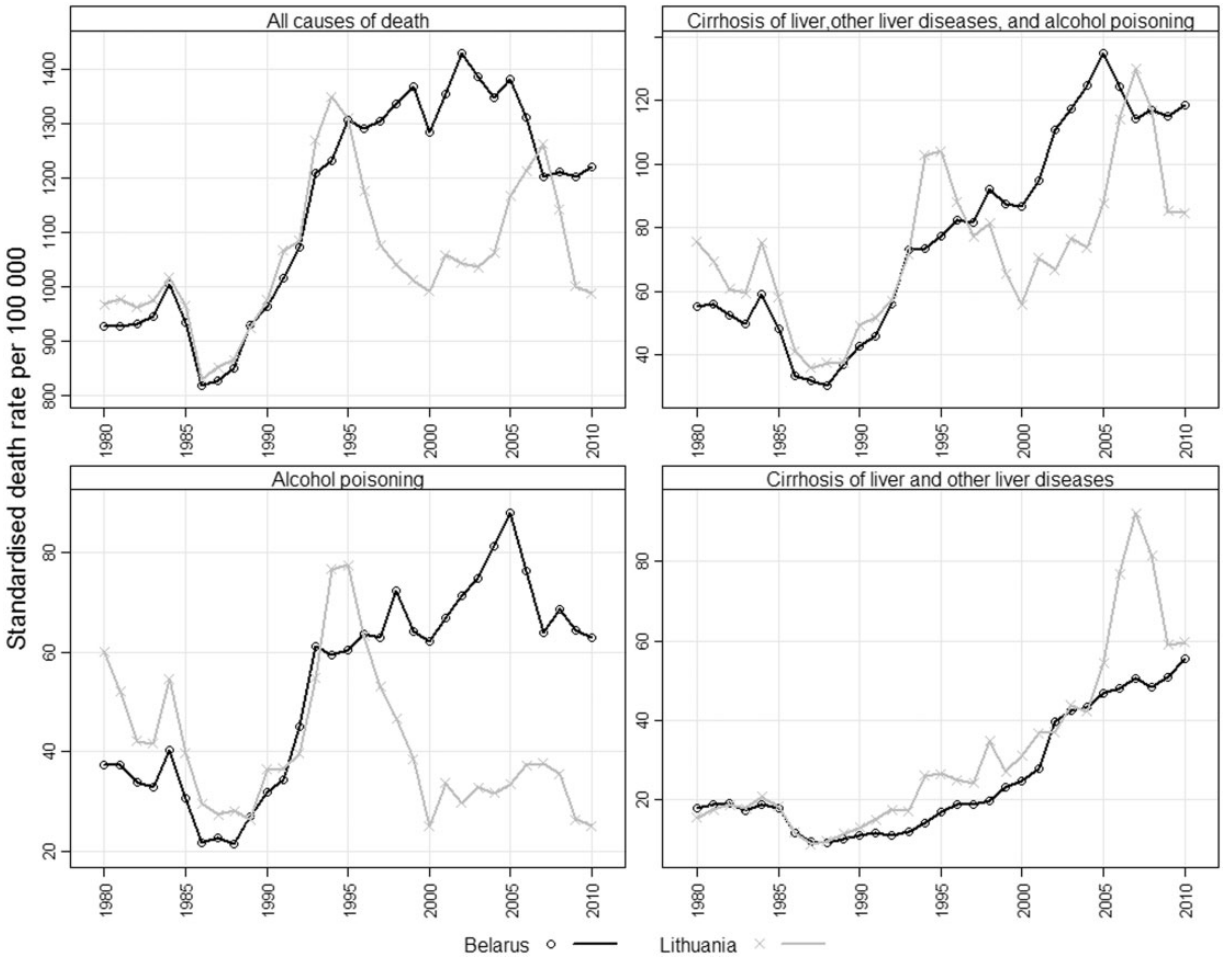

Figure 1 Standardised death rates (per 100 000) from selected causes of death in Belarus and Lithuania; males ages 20–64; 1980–2010 Belarus – reconstructed data by causes of death[12]; Lithuania – for 1980–1999, reconstructed data by causes of death[13]; for 2000–2010[14].

countries about one-half of all men engage in heavy episodic drinking, and male drinkers consume more than 30 litres of pure alcohol per year.[16]

To our knowledge, this study is the first to analyze cross-country spatial patterns of alcohol-related mortality in the countries of the former USSR. Elsewhere in the world, using spatial analysis to study alcohol-related phenomena is also uncommon,[17] although there are few exceptions.[18] Geographic information system (GIS) tools can be effective in studying and addressing alcohol-related health problems. Our aim in this article is to explore and detect within-country and cross-country spatial clusters of elevated alcohol-related mortality in Belarus and in Lithuania. This kind of analysis is important for at least two reasons. First and foremost, identifying 'hot spots' of alcohol-related mortality facilitates the development of area-specific anti-alcohol measures, and greater efficiency in the allocation of resources. Second, studying similarities and differences in alcohol-related mortality patterns in neighbouring countries helps us generate hypotheses regarding the impact of common historical and sociocultural contexts on contemporary drinking patterns.

Data and methods

In our analysis, we rely on original data obtained from the National Committee of Statistics of Belarus (Belstat) and Statistics Lithuania, including data on deaths by medical causes and mid-year population by sex and 5-year age groups at the district level. In both countries, the causes of death are based on the 10th revision of International Statistical Classification of Diseases and Related Health Problems, the ICD-10. For Lithuania, we use data classified by the three-digit ICD-10 items. For Belarus, we use data classified in accordance with the abridged Belarusian version of the ICD-10 consisting of 277 items. The analysis focuses on the male population aged 20–64, and refers to the period 2003–2007.

Given the potential problems related to the quality of death registration at the district level, the accurate estimation of alcohol-attributable mortality is a difficult task. To avoid potential distortions due to specifics of registration and the possible misclassification of causes of death, we deal exclusively with two large, well-defined groups of causes of death which are known to be directly linked to alcohol: (i) cirrhosis of the liver and other liver diseases and (ii) accidental poisoning by alcohol.[3,15,19] The first category corresponds to items 186 and 187 of the abridged version of the ICD-10 used in Belarus; and items K70, and K74 of the three-digit ICD-10 list. The second category corresponds to item 269 of the Belarusian classification and item X45 of the ICD-10. We deliberately combine all liver pathologies in a single group based on the assumption that they are largely induced by excessive alcohol intake, although they might not be registered as such (cirrhosis of the liver caused by alcohol might sometimes be registered as 'cirrhosis of the liver', and not as 'alcoholic liver cirrhosis').

The selected causes are known to be sensitive indicators of alcohol consumption, and were strongly correlated to overall mortality in the former USSR.[1,7] Using direct standardisation by age (with the European population standard by the WHO, 1976), we calculated cause-specific age-standardised death rates (SDRs). To reduce random variations due to small death numbers, the SDRs were calculated from pooled data on deaths and population exposure over 5 years (2003–2007).

Figure 2 Territorial division of Belarus and Lithuania: districts and major cities
Base maps[20], 1930 national borders (=)[21]

To produce mortality maps, we used shape files for Belarus and Lithuania which are downloadable for free from the DIVA-GIS website.[20] These shapes were first modified in accordance with the contemporary administrative division, re-projected (World Miller Cylindrical projection), and then merged. The map of the territorial divisions of the two countries is shown in figure 2. In total, 189 territorial units (131 in Belarus and 58 in Lithuania) are used in the analysis.

To detect the clusters of elevated mortality, we relied on the local indicators of spatial association (LISA).[22,23] The LISA were used to identify statistically significant clusters (or hot spots). The most useful output of the LISA is the so-called LISA cluster map, in which there are five categories coded in accordance with the type of spatial autocorrelation. The high–high (high rates: high neighbours) and low–low (low rates: low neighbours) locations represent statistically significant local spatial clusters of high and low mortality, respectively. High–low and low–high locations are spatial outliers. Spatial autocorrelation which is statistically not significant is labelled *not significant.* To obtain the LISA, it was first necessary to define the spatial neighbourhood structure. Here we relied on *the first-order queen* structure, which assumes that the districts that share a border are neighbours. The advantages and limitations of using LISA statistics in analysis of spatial clusters of alcohol-related mortality are discussed elsewhere.[17]

Results

Spatial patterns of alcohol-related mortality

Figure 3 depicts spatial patterns of mortality from the selected alcohol-related causes across the entire territory of Belarus and Lithuania. In addition, the map on SDRs from all causes of death is presented to illustrate differences in overall mortality between the two countries. Male adult mortality is higher in Belarus than in Lithuania, and almost all of the districts with the highest mortality levels are located in Belarus. At the same time, in both countries the cities and towns (shown as circles on the map) exhibit quite similar mortality levels. Almost all of them fall into the lowest SDR category.

The spatial distribution of total mortality from the selected alcohol-related causes combined (liver cirrhosis, alcoholic liver disease and alcohol poisoning) looks more clustered than mortality from all causes of death. In Belarus, large areas of elevated mortality appear along the border with Lithuania (north-west), and also along the border with Russia (north and east of Belarus). In Lithuania, most of the districts with high mortality are located along the border with Belarus and in the north-western part of the country. Looking at each of the two alcohol-related causes of death suggests that high mortality from alcohol poisoning is most common in Belarus (particularly in the districts along the Lithuanian and Russian borders) and in a few districts of Lithuania close to the Belarusian border, while high mortality from liver cirrhosis and liver disease is concentrated in the north-western districts of Lithuania and in certain oblasts of Belarus along the border to Lithuania.

'Hot spots' of alcohol-related mortality

The results of the analysis of local autocorrelation are presented in figure 4. Here we are particularly interested in the areas labelled as the high-high clusters—i.e., the locations where districts with high SDR values are surrounded by neighbours which also have high SDRs. All of the clusters of elevated mortality from all causes of death are located in Belarus. The large low–low cluster is located

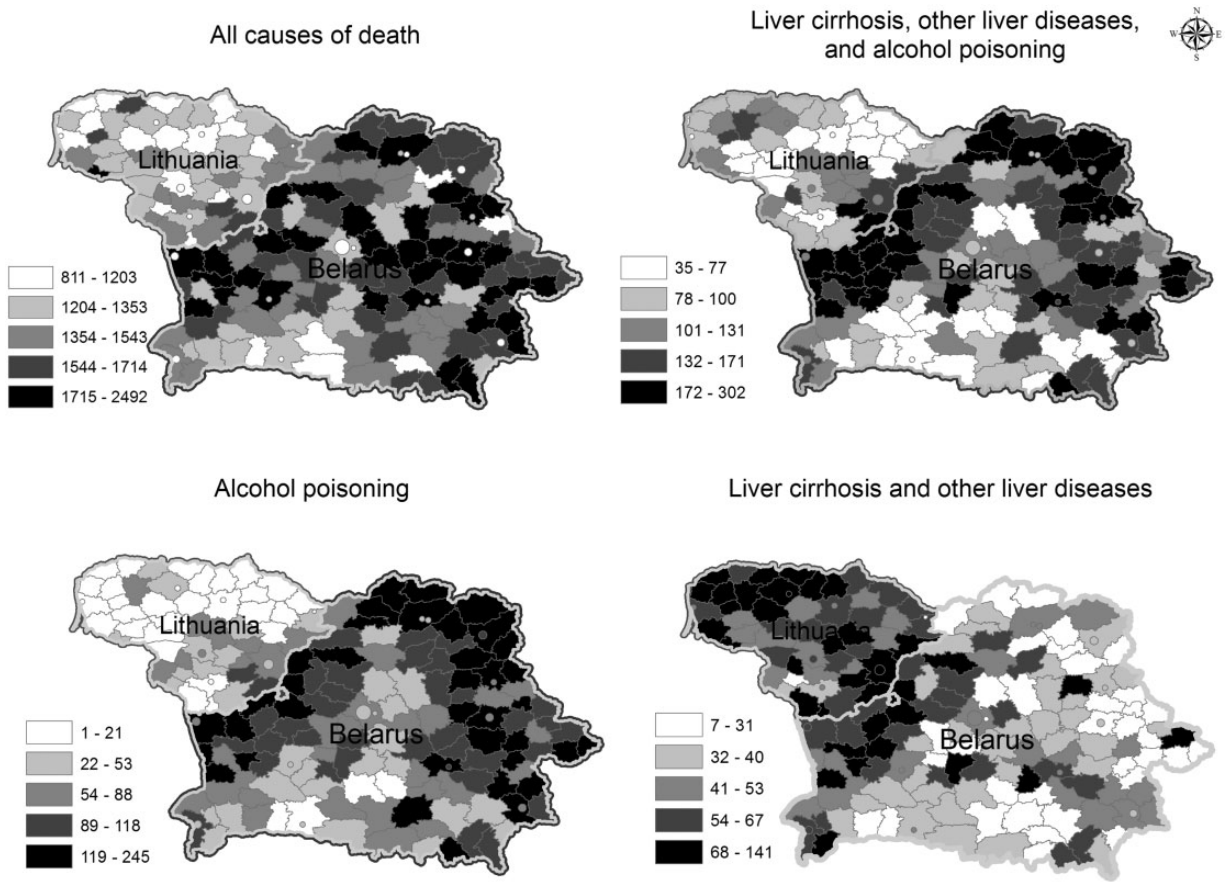

Figure 3 SDRs (per 100 000) from selected alcohol-related causes of death on the combined territory of Belarus and Lithuania; males ages 20–64; 2003–2007
The quintile method of classification was used to produce mortality maps

in Lithuania. Three small high-low clusters—i.e., areas where districts with high mortality are surrounded by districts with low mortality, relative to the mortality levels of all of the districts in both countries—are also found in Lithuania. The largest cluster of mortality due to all alcohol-related causes of death is located on the Belarusian–Lithuanian border. Most of the districts in this cluster are in Belarus. Meanwhile, we can see two distinct patterns for alcohol poisoning and alcohol-related liver diseases. Elevated mortality from alcohol poisoning is concentrated in the north and the east of Belarus, and also along the Belarusian border with Lithuania. The hot spots of mortality from alcohol-related liver diseases (liver cirrhosis and alcoholic liver disease) are in the north-west of Lithuania and along both sides of the Belarusian–Lithuanian border. It is interesting to note that the national border divides the latter cluster into two almost equal parts, as roughly one-half of the districts which form this cluster are in Belarus, and the other half are in Lithuania.

Discussion

Data quality

Before discussing the results of this study, it is necessary to address the issues related to the quality and the reliability of death registration. There is some evidence suggesting that the quality of cause-of-death statistics in Belarus and Lithuania is satisfactory. According to Anderson and Silver[24] mortality data in the countries of the European part of the former USSR 'are generally reliable, especially at the working ages'. The WHO assigns Belarus to the category of countries with cause-specific mortality data of medium quality, and Lithuania to the category of countries with mortality data of high quality.[25] According to Stickley and colleagues[3] the quality of registration of death from accidental poisoning by alcohol in some countries of the former USSR (including Belarus and Lithuania) is sufficient for making correct analyses and inter-country comparisons. We cannot exclude the possibility of variation in coding practices and in the interpretation of medical rules between Belarus and Lithuania and within each of these countries. However, we believe that such variation would not have a significant influence on our findings, as we have chosen to deal with well-defined medical conditions. Moreover, since during the analyzed period both countries used causes of death based on the ICD-10, the mortality statistics are likely to be comparable. Finally, our analysis is restricted to males of active adult ages, a population group for whom cause-of-death statistics are generally reliable. As the deaths which occur in this population group are considered premature, the deceased are very often (always in cases of alcohol poisoning) subject to autopsies. Thus, these deaths are more likely than other deaths to be registered correctly. Original statistical tables for Belarus provided the data on the number of deaths from a specific cause of death certified by autopsies. We found that all of the cases (100 per cent) of male deaths from accidental poisoning by alcohol which occurred in Belarus in 2003–2007 were registered on the basis of autopsies. Over the 5-year period, the share of male deaths (all ages) from cirrhosis of the liver and other liver diseases confirmed by autopsies ranged from 41 to 42% (Brest, Vitebsk, Minsk and Mogilev oblast) to 66% in the capital, Minsk. Presumably, this share would have been much higher if it had been calculated for working-age males only, but the available data did not allow us to see the actual percentages. There was a similar requirement that an autopsy be performed in cases of poisoning or

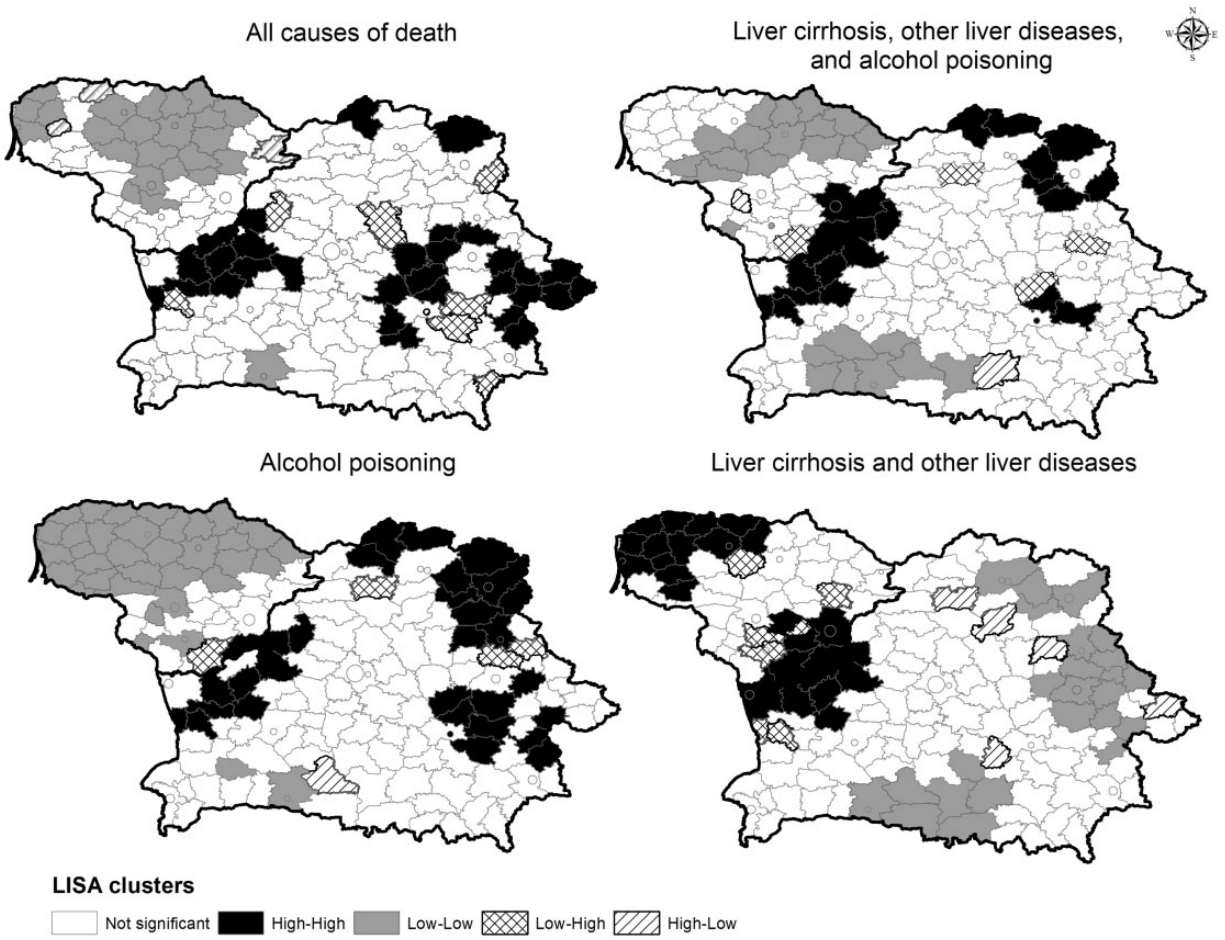

Figure 4 LISA cluster maps of mortality from selected alcohol-related causes of death on the combined territory of Belarus and Lithuania; males ages 20–64; 2003–2007
Calculations were performed using GeoDa™, p=0.05, 9,999 permutations

other forms of external death in Lithuania. Compared to other European countries (including Belarus), Lithuania had higher overall autopsy rates (28–31%) in 2003–2007[26].

Main findings

In this study, we performed an analysis of spatial variation in alcohol-related mortality across the regional units in Belarus and Lithuania. The two major alcohol-related causes of death, alcohol poisoning and liver cirrhosis, were deliberately chosen to enable us to examine the geographical similarities and dissimilarities in alcohol consumption and its health impacts. Previous research has shown that mortality from accidental poisoning by alcohol is associated with particularly dangerous consumption patterns, such as heavy episodic consumption of vodka, ethanol-containing substances, or surrogates;[3] whereas mortality from alcohol-related liver diseases is largely attributable to the long-term consequences of high alcohol consumption.[19,27] The results of our analysis point to the existence of differences in drinking patterns between Belarus and Lithuania. More hazardous forms of alcohol consumption strongly correlated with accidental poisoning by alcohol (including illegal or homemade alcohol) seem to be more prevalent in Belarus, particularly in the regions bordering Russia and Lithuania. Binge drinking of spirits is known to be common practice in Belarus.[28] By contrast, the consumption patterns in Lithuania are characterised by higher rates of consumption of beer and other light alcoholic beverages, such as cider and cocktails; and lower rates of consumption of non-beverage alcohol and ethanol-containing substances.[16] In Lithuania, beer consumption rates (expressed as the amount of pure alcohol consumed per capita) have been systematically higher than the corresponding rates for spirits since the end of the 1990s.[16] In 2000–2006, there was a marked increase in the consumption of beer and light alcohol beverages in Lithuania: in just 6 years beer consumption grew by 50%, whereas consumption of the group of beverages including sparkling wines and cider increased almost 3-fold.[29] This shift occurred despite the simultaneous (2-fold) increase in the consumption of spirits.[29] At the same time, beer consumption rates remained well below spirit consumption rates in Belarus.[15] In Lithuania, it is possible that a sudden increase in the availability of relatively cheap alcohol following the decrease in excise taxes in 1999, the liberalisation of alcohol control (of sales hours and advertisements) rules in 2001, and the elimination of import taxes for EU-manufactured alcohol after Lithuania joined the EU in 2004 may have contributed to the 'epidemic' of deaths due to alcohol-related liver diseases in 2000–2007. This can be interpreted as a lagged effect which mostly affected people with a history of excessive alcohol consumption who had already been suffering from liver diseases during the previous years or decades.

An increase in mortality from liver cirrhosis has been also observed in Russia.[30] In the past, the trends in mortality from cirrhosis were very similar to the trends in mortality from accidental alcohol poisoning. However, in recent years a notable decrease in mortality from accidental alcohol poisoning was accompanied by persistently high mortality rates from liver cirrhosis. It has been suggested that there might be a reduction in the prevalence of the most hazardous forms of drinking associated with alcohol poisoning.[30] Meanwhile, the overall level of alcohol consumption in Russia remains high, which may be expected to result in chronic damage to the liver, as well as to the pancreas, the heart and other organs.[31]

The cross-border cluster (which includes districts of Belarus and Lithuania along the border, as well as the northern and north-eastern districts of Belarus) can be considered the most problematic area, as it suffers from an enormous burden of excessive alcohol consumption. The situation is especially severe on the Belarusian side of this cluster, where high levels of both alcohol poisoning and liver cirrhosis are observed. These districts in particular should be targeted by anti-alcohol policies in the two countries. It is also possible that the production and cross-border smuggling of illegal alcohol (due to higher prices in Lithuania) contribute to excess alcohol-related mortality in this cross-border cluster.[32] Therefore, a closer collaboration of the two countries in combating the illegal cross-border trade of alcohol (produced both legally and illegally) may be an effective strategy for reducing the burden of alcohol in this region. Finally, the fact that similar anti-alcohol measures introduced in 2008–2009 in Lithuania and in 2011 in Belarus were followed by substantial declines in alcohol-related mortality in both countries suggests that the collaboration and co-ordination of policies in this area could have positive effects.

In addition to studying the spatial patterns of alcohol-related mortality in Belarus and Lithuania, it is important that we seek to explain their origins. It is unclear why the detected clusters of elevated alcohol-related mortality are mainly located along the Belarusian–Lithuanian and Belarusian–Russian borders. These spatial patterns suggest that common sociocultural and historical factors may be important in this context, as Belarus and Lithuania, and especially the cross-border region exhibiting a distinct pattern of alcohol-related mortality, have historical ties. The current cross-border patterns might be also explained by the spatial diffusion process. It has been suggested that the effects of harmful alcohol consumption have spread from the European part of Russia to the other countries of the region over time.[33] These explanations and the emergence of specific geographical patterns of alcohol-related mortality in the regions should be examined in future studies using historical data. For more comprehensive evidence on mortality effects of individual and area-specific variables, microdata with a hierarchical multilevel structure are needed.

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Conflicts of interest: None declared.

Key points

- *What was already known?*
- In Belarus and Lithuania, excessive alcohol consumption among adults males is a major public health threat.
- Despite extensive research, very little is known about geographical patterns of alcohol-related mortality in the region.

- *What does this paper add?*
- This study is the first analysis dealing with cross-country spatial patterns of alcohol-related mortality in the countries of the former USSR.
- While extremely high rates of mortality from alcohol poisoning are more widespread in Belarus, high rates of mortality from alcohol-induced liver disease are more common in Lithuania.
- There is a clear Belarusian–Lithuanian cross-border area with elevated alcohol-related mortality. This area should be considered a primary target for in-depth investigation and anti-alcohol policies in both countries.

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