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Spatial patterns of male alcohol-related mortality in Belarus, Lithuania, Poland and Russia

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Abstract

Introduction and Aims. *Eastern Europe is known to suffer from a large burden of alcohol-related mortality. However, persisting unfavourable conditions at the national level mask variation at the sub-national level. We aim to explore spatial patterns of cause-specific mortality across four post-communist countries: Belarus, Lithuania, Poland and Russia (European part).* ***Design and Methods.*** *We use official mortality data routinely collected over 1179 districts and cities. The analysis refers to males aged 20–64 years and covers the period 2006–2014. Mortality variation is mainly assessed by means of the standardised mortality ratio.* Getis-Ord Gi* statistic *is employed to detect hot and cold spots of alcohol-related mortality.* ***Results.*** *Alcohol-related mortality exhibits a gradient from very high levels in northwestern Russia to low levels in southern Poland. Spatial transitions from higher to lower mortality are not explicitly demarcated by national boundaries. Within these countries, hot spots of alcohol-related mortality dominate the territories of northwestern and western Russia, eastern and northwestern Belarus, southeastern Lithuania, and eastern and central Poland.* ***Discussion and Conclusions.*** *The observed mortality gradient is likely associated with the spread of alcohol epidemics from the European part of Russia to the other countries, which appears to have started more than a century ago. Contemporary socioeconomic and demographic factors should be taken into account when developing anti-alcohol policies. The same is true for the peculiarities of culture, norms, traditions and behavioural patterns observed in specific geographical areas of the four countries. Reducing alcohol-related harm in the areas identified as hot spots should be prioritised.* [Grigoriev P, Jasilionis D, Klüsener S, Timonin S, Andreev E, Meslé F, Vallin J. Spatial patterns of male alcohol-related mortality in Belarus, Lithuania, Poland and Russia. *Drug Alcohol Rev* 2020;39:835–845]

Key words: alcohol-related mortality, spatial patterns, post-communist countries.

Introduction

For many years, mortality trends in Eastern Europe, and especially in the countries of the former Union of Soviet Socialist Republics, have been largely determined by male premature mortality. Numerous studies have addressed the problem of excessive adult mortality and have identified alcohol consumption as the primary contributor to these trends [1–8]. However, the accumulated evidence supporting this relationship is mainly based on national-level data or data on large regions within a single country [9,10]. Relatively little is known about variations in alcohol-related mortality across smaller geographical units, and especially about spatial mortality patterns extending beyond national boundaries [11–14].

We aim to explore spatial patterns of male alcohol-related mortality at the district level across four post-communist countries: Belarus, Lithuania, Poland and Russia (European part). What does spatial variation in mortality look like, both across the combined observation areas of the four countries and within each country? Does the spatial clustering of alcohol-related mortality extend beyond national borders? What are the potential explanations for the observed patterns? To our knowledge, this is the first study on alcohol-related harm in the region that addresses these kinds of questions.

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The countries chosen for our analysis provide a fascinating context for research, as they have a common past, and yet remain quite distinct. Appendix S1 (Territories of Belarus, Lithuania, Poland, and European Russia in 1900 and 1930) compares the territories of these countries at the beginning of the 20th century with their contemporary national borders. At the end of the 17th century, Belarus, Lithuania, a large part of modern Poland and some parts of Russia were included in the Great Duchy of Lithuania. At the end of the 18th century, all or large shares of the territories of modern Belarus, Lithuania and Poland fell under the control of the Russian Empire. Some parts of modern Poland remained or became part of Prussia or Austria. Poland and Lithuania were independent states during the whole inter-war period, whereas the independent Belarusian People's Republic existed only from 1918 to 1919. Between 1920 and 1939, western Belarus and the southeastern part of Lithuania (former Vilno gubernia) were incorporated into Poland, while the remaining territory of modern Belarus and the Russian Federation became republics of the newly formed Union of Soviet Socialist Republics (USSR). As a result of World War II, Lithuania and the western part of Belarus were incorporated into the USSR. Poland "moved" westward by (re-)claiming territories that had been part of the German Empire. Following the fall of the communist regimes and the dissolution of the USSR in 1991, Lithuania and Belarus regained their independence, while the Russian Federation formed a new, independent state. Poland remained independent and started to seek closer ties with Western Europe. Overall, the political and economic trajectories of the four countries have differed substantially over the last decades. Since 2004, Lithuania and Poland have been members of the European Union with liberal political regimes and free market economies. By contrast, Belarus and Russia have autocratic and centralised political systems. However, while Russia underwent massive privatisation and a transition toward a free market economy, Belarus has preserved many features of the Soviet political and economic model [15]. After the collapse of the USSR the mortality trends of Belarus, Lithuania and Russia have been diverging. These tendencies are thought to be largely attributable to the different paths of political and socioeconomic transformation adopted by these countries [15]. Previous research has also highlighted the importance of complex historical and political factors in the development of mortality trends in Eastern European countries; and, in the case of the Baltic States, the benefits of renewed independence and EU membership [16].

This study aims to extend the existing knowledge of alcohol-related mortality in these countries in two ways. First, we focus on the possible historical origins of the current alcohol epidemics in this region. We do so by identifying specific spatial patterns of alcohol-related mortality across the four countries. For this we investigate whether historical boundaries are relevant for understanding present-day patterns, and perform cross-border comparisons of alcohol-related mortality trends. Second, we also seek to identify the best- and worst-performing geographical entities across the whole study area, as well as within each country. Such analyses may be expected to facilitate the development of area-specific alcohol policies, while taking into account the potential influence of the historical context on contemporary drinking patterns and alcohol-related mortality.

Methods

Data

For our analyses, we rely on original mortality data that have been routinely collected by the National Committee of Statistics of Belarus (Belstat), Statistics Lithuania, Statistics Poland and the Federal State Statistics of Russia (Rosstat). These data include information on deaths by medical cause, by sex and by five-year age groups at the district level. The obtained cause-specific mortality data are classified in accordance to the International Statistical Classification of Diseases and Related Health Problems, 10th Revision (ICD-10). For Lithuania, Poland and Russia, we use data classified by the three-digit ICD-10 items, while for Belarus, we rely on the abridged Belarusian version of ICD-10 consisting of 277 items. The causes of death considered in the analysis include either causes explicitly attributable to alcohol [alcohol abuse (F10 in the ICD-10), accidental poisoning by alcohol (X45) or alcoholic liver cirrhosis (K70)], or causes highly correlated with alcohol consumption [non-alcoholic liver cirrhosis (K74) and external causes of deaths (V01-Y98)] [17]. Other important medical conditions correlated with alcohol, such as heart (I00-I52) and cerebrovascular (I60-I69) diseases, are also considered, but are not covered by the main analysis.

As population exposures (denominator), we use official data for the mid-year population by sex and five-year age groups (Belarus and Poland), as well as data from the 2010 population census (Russia). In the case of Lithuania, both the death and the population counts come from a *census-linked* dataset compiled from individual records [14]. We focus on the male population aged 20–64 years, as they represent the main population group affected by alcohol-related mortality [3].

Figure 1. *Administrative division of Belarus, Lithuania, Poland and Russia (European part). Source: Prepared by the authors. Base maps [20,22].*

Our analysis refers to the periods 2008–2012 (Belarus and Russia), 2006–2010 (Poland) and 2011–2014 (Lithuania). The mortality estimates are calculated on the basis of data pooled over the respective time periods, which helps to ensure the robustness of the region-specific mortality rates.

Mortality measures

The raw data allow us to estimate for each territorial unit: (i) the standardised death rate (SDR); and (ii) the standardised mortality ratio (SMR):

$$\mathrm{SDR}^{ij} = \sum_x \frac{D^{ij}{}_x}{E^i{}_x} \cdot w^s{}_x,$$

where D_x^{ij} is the number of deaths at age x from cause j in area i, E_x^i is population exposure at age x in area i, and w_x^s is a vector of weights (proportions) in the European population standard [18].

$$\mathrm{SMR}^{ij} = \frac{D_{\mathrm{obs}}^{ij}}{D_{\mathrm{exp}}^{ij}} = \frac{D_{\mathrm{obs}}{}^{ij}}{\sum_x \left(M_x^{Sj} E_x^i\right)}$$

where D_{obs}^{ij} and D_{exp}^{ij} are the total number of observed and expected deaths from cause j in area i, E_x^i is population exposure at age x in area i, while M_x^{sj} denotes age-specific mortality rates from cause j in the population chosen as the standard.

We calculate SMRs for the combined territory of the four countries, with M_x^{sj} representing the average mortality rates across Belarus, Lithuania, Poland and European Russia; as well as for each country individually, with the national M_x^{sj} serving as the reference. An SMR below one implies that mortality is lower than the average mortality level observed in our total sample, whereas an SMR above one implies that mortality is higher.

In order to measure the degree of inequality in mortality from selected causes across the four countries, we apply the Theil measure [19]. It allows us to

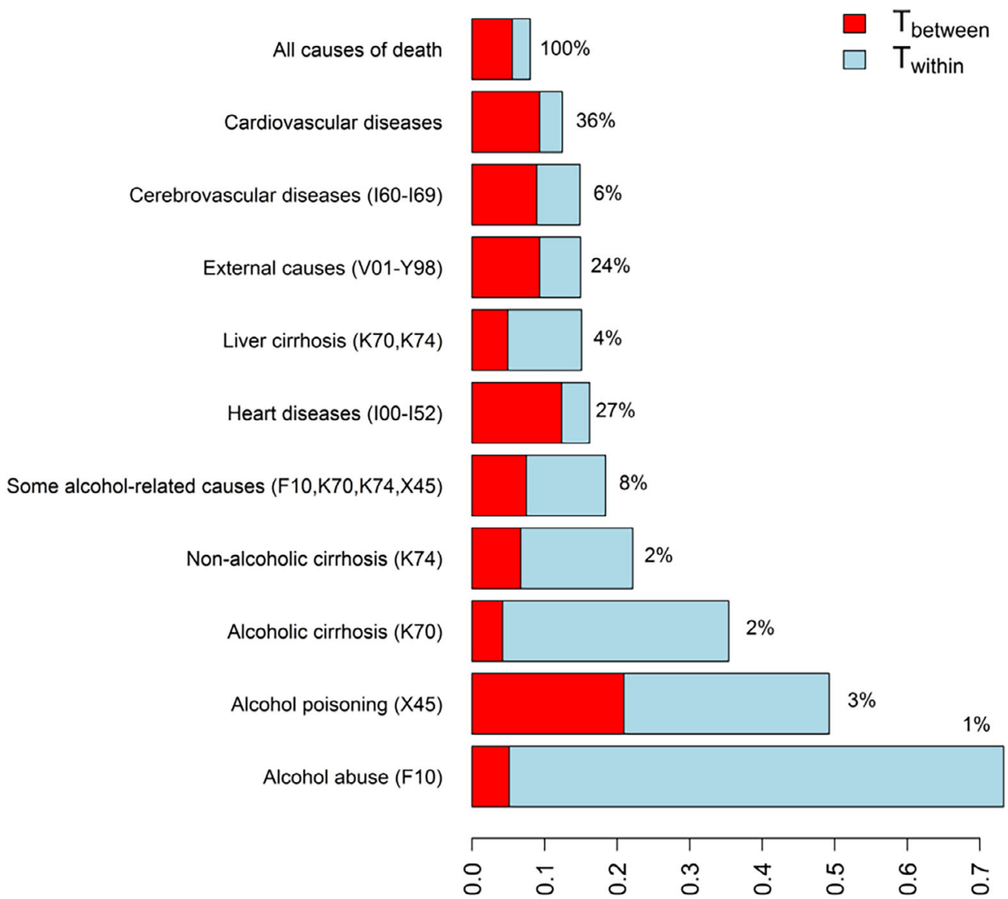

Figure 2. *Theil index decomposed into* between *and* within *components by selected causes of death, combined territory of Belarus, Lithuania, Poland and European Russia; males, 20–64 years. Note: Values next to horizontal bars show the shares in total mortality.*

decompose the variance across all 1179 regions into its between- and within-country components (T_B and T_w) and, further, into the contribution of each country to these components:

$$T = T_B + T_W$$

$$T_B = \sum_{g=1}^{\omega} s_g \ln\left(\frac{n}{n_g s_g}\right); T_W = \sum_{g=1}^{\omega} s_g \sum_{i \in g} s_{i,g} \ln\left(n_g s_{i,g}\right)$$

$$s_g = \frac{\sum_{i \in g} y_{i,g}}{\sum_{i}^{n} y_i}; \; s_{i,g} = \frac{y_{i,g}}{\sum_{i=1}^{n_g} y_{i,g}}$$

where n is the number of observations i, y is mortality by specific causes and g is the group variable (country).

Mortality maps

Mortality maps have been produced on the basis of shapefiles that were either downloaded for free from the DIVA-GIS website [20] (Belarus and Lithuania) or obtained elsewhere [21,22] (Poland and Russia). These shapefiles were modified to conform to the current administrative division and to match the raw data.

For Russia, we focus on only four selected economic regions located in the European part of Russia: central, northwestern, central Black Earth and Kaliningrad (23 oblasts including Moscow and St. Petersburg). Of the 1179 territorial units (districts, cities and towns) covered by our analysis, 609 are located in European Russia, 131 in Belarus, 60 in Lithuania and 379 in Poland (Figure 1).

Our mortality maps are categorised using *quintile* classification. In order to identify statistically significant *hot* and *cold* spots of alcohol-related mortality, we rely on the *Getis-Ord Gi* statistic* [23]. Like other, alternative methods of spatial cluster detection [11,24,25], the Gi* involves the conceptualisation of spatial relationships. Here, we relied on the frequently used *first-order queen* definition of neighbourhood, according to which districts that share at least one common border point are considered neighbours. All spatial data operations, as well as all spatial analyses, were performed using *ArcGIS* software.

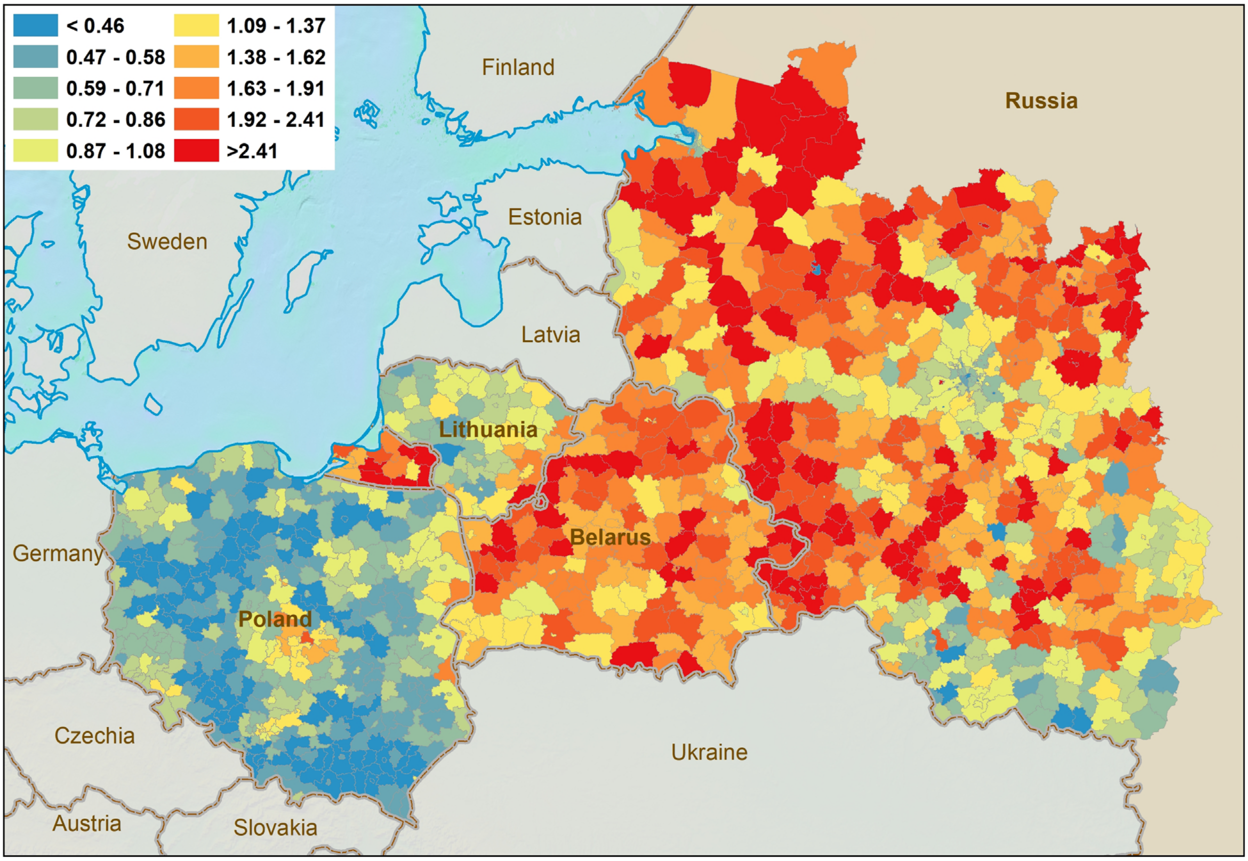

Figure 3. *Standardised mortality ratios across the combined territory of Belarus, Lithuania, Poland and European Russia; males 20–64 years, selected alcohol-related causes (F10, K70, K74, X45). Source: Own calculations. Base maps [20,22]. Note: Standardised mortality ratio value of 1.0 marks the average for all four countries.*

Results

Variation in cause-specific mortality

Descriptive statistics reflecting differences in mortality levels across the territorial units of the four countries are provided in Table A1. On average, districts and cities of Poland report the lowest mortality levels. All-cause mortality among men aged 20–64 years in Poland is roughly one-half lower than among their counterparts in Belarus and European Russia, and is one-third lower than among men in this age group in Lithuania. This apparent advantage of Poland is not, however, found for specific causes of death, such as alcohol abuse and liver cirrhosis.

Figure 2 depicts the Theil index by selected causes of death, decomposed into *between-* and *within-country* components. The further decomposition into country-specific components appears in Appendix S2. In interpreting the outcomes, it is important to note that there is a negative relationship between the degree to which a specific cause of death contributes to the overall number of deaths and the degree of spatial variance observed across our study area. Causes of death that make up a small share of the total number of mortality events tend to exhibit higher degrees of spatial variation. A partial explanation for this pattern is that these causes of death show higher random variation because the number of cause-specific deaths occurring in each region is small. But this pattern may also stem from real variation, with some causes of death being more clustered in specific areas.

However, even if we keep this potential limitation in mind, the Theil analysis still appears to show that the within-country dimension of variation is particularly relevant for causes of death that are closely linked to alcohol. This pattern is also visible for a rather large group of alcohol-related causes of death ('Selected alcohol-related deaths') that accounts for 8% of all death events. For this group we still obtain a higher within-country variation share than is observed for deaths that are not directly related to alcohol consumption. The latter include cerebrovascular diseases with an overall share of 6%. Also for cardiovascular diseases, heart diseases and external causes, between-country variation dominates. When we look at country-specific contributions, we see that Poland has

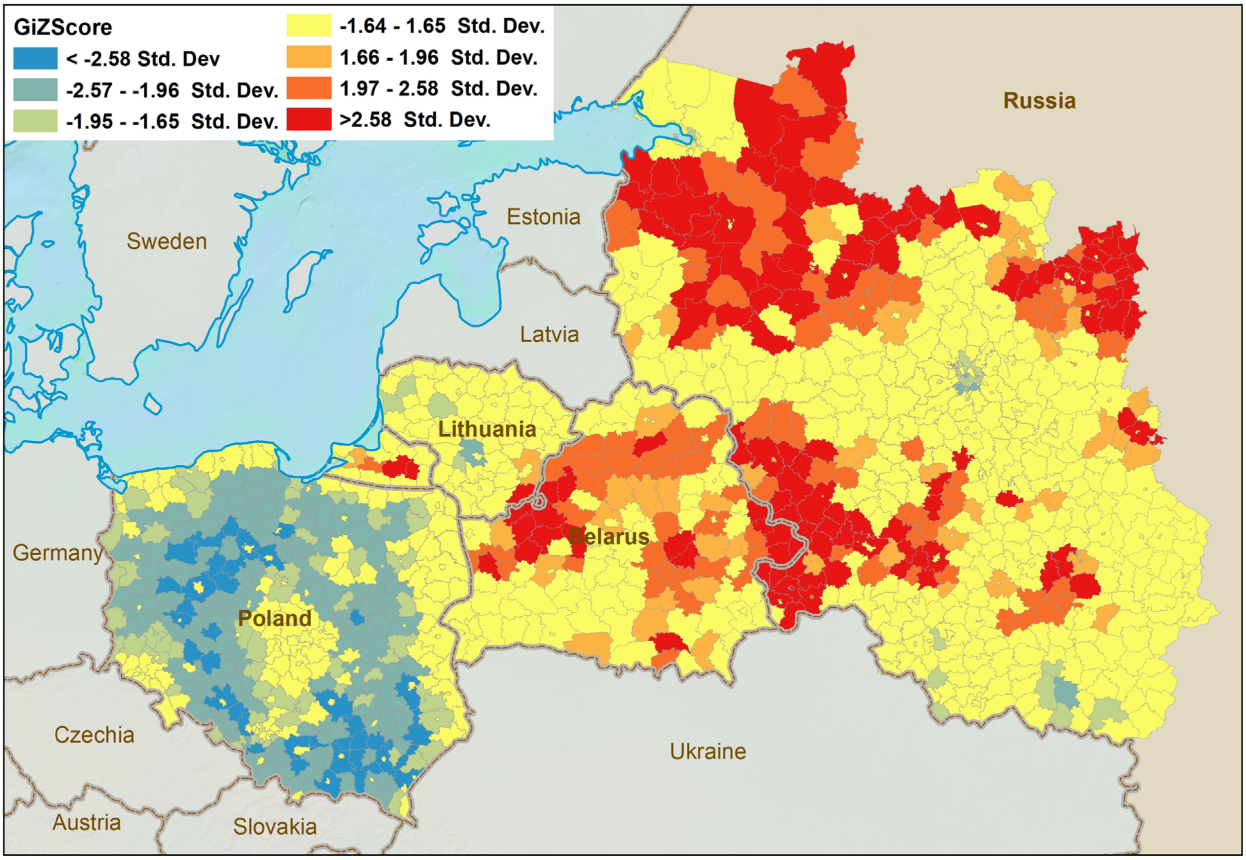

Figure 4. *Spatial clusters of mortality from selected alcohol-related causes (F10, K70, K74, X45); combined territory of Belarus, Lithuania, Poland and European Russia; males 20–64 years. Source: Own calculations. Base maps [20,22]. Note: Calculated on the basis of standardised mortality ratios presented in Figure 3.*

a relatively large contribution to the total within-country variation T_w for alcohol-related causes compared to other causes of death (Table S2.2, Appendix S2). Russia contributes the largest (around 80%) share to the overall T_w for the selected causes of death. This contribution is considerably larger than would be expected based on the share of observations in Russia (52%) in the total number of observations.

Mortality maps

Figure 3 depicts a map of mortality from selected alcohol-related causes of death (F10, K70, K74, X45) across the combined territories of Belarus, Lithuania, Poland and European Russia. The territorial units are categorised into deciles according to the SMR value.

Among these countries, Russia exhibits the largest local disparities: alcohol-related mortality varies from very high levels in the northwest and west to low levels in the capital and surrounding districts, St Petersburg and the Black Earth region (south). In Poland, most of the districts fall into the lowest SMR category. However, the districts located in central Poland around Łódź and several eastern districts bordering Belarus exhibit high levels of alcohol-related mortality. In terms of within-country variation, Belarus appears to be more homogenous than the other countries, as in almost all districts of Belarus, alcohol-related mortality exceeds the average mortality level estimated for the four countries.

Some distinct patterns are observed in the districts situated near national borders. In terms of their levels of alcohol-related mortality, the districts located along the border between Belarus and Russia are so similar that the national border is hardly visible. The same pattern is found in the districts located along the Belarusian-Lithuanian border. We also note that the change in the alcohol-related mortality regime observed at the Belarusian-Poland border is not as pronounced as the shift seen at the border between the Kaliningrad oblast of Russia and Lithuania, as well as between the Kaliningrad oblast and Poland. Looking at the spatial pattern as a whole, we find that alcohol-related mortality reaches very high levels in the northwest and west of

Russia, and very low levels in the south of Poland. This mortality gradient is even more noticeable when we consider mortality from external causes of death (Appendix S3). Another important observation is that in all four countries, the big cities tend to have lower alcohol-related mortality than the surrounding districts. Finally, we also observe a striking resemblance between the geographic patterns of alcohol-related mortality, mortality due to external causes, and even total mortality (Figure 3 and Appendix S3).

Figure 4 depicts the GiZ score calculated on the basis of the data presented in Figure 3. It is divided into seven categories. The middle category (−1.65 to 1.65 SD) should be interpreted as the absence of statistically significant clusters of mortality. The remaining categories represent either hot (statistically significant positive *z*-scores) or cold (negative *z*-scores) spots. A higher *z*-score is associated with a more intense clustering of hot and cold spots.

The major hot spots of alcohol-related mortality are located in the northwest of Russia, as well as along the Belarusian-Russian and Belarusian-Lithuanian borders. Mortality in the districts located at the Belarusian-Polish border does not deviate from the global mean measured for the combined territory of the four countries.

Because of the substantial differences in mortality levels between the four countries, the spatial analysis based on the combined territory masks substantial variation within each country. Therefore, we performed an additional within-country analysis that compares alcohol-related mortality in each region to the corresponding national average. This approach generated more visible country-specific hot and cold spots of alcohol-related mortality (Appendix S4). Most of the territory of the Russian oblasts of Leningrad, Novgorod, Smolensk and Bryansk are covered by clusters of elevated alcohol-related mortality. At the same time, districts located in the central Black Earth region (Voronezh, Lipetsk and Kursk oblasts), as well as in the Moscow oblast, form large clusters of low mortality. In Belarus, most of the hot spots are located along the border with Lithuania, whereas the cold spots are located in the southwestern part of the country, close to the Polish border. In Lithuania, almost all of the districts located near the national border with Belarus exhibit alcohol-related mortality levels that are significantly higher than the average national level. Finally, a very intense clustering of hot spots can be observed in central Poland around Łódź, as well as in the districts located along the border to Belarus.

Discussion

We analysed spatial patterns of alcohol-related mortality across four post-communist countries. Building on our previous studies that examined the spatial distribution of alcohol-related mortality in the region [13,14], the present contribution extends the geographical coverage of the analysis to European Russia and Poland, refers to more recent periods, and considers more causes of death. In line with previously reported findings [13,14], our analysis uncovered systematic variation in alcohol-related mortality among men in Belarus, Lithuania, Poland and European Russia. We found that premature male alcohol-related mortality tends to vary over the study area, from very high levels in the northwest and west of Russia, to very low levels in the south of Poland. Although overall mortality levels differ considerably between the four countries, we showed that shifts from *higher* to *lower* levels of alcohol-related mortality are not clearly demarcated by national borders. In particular, we observed that the districts located on either side of the border between Belarus and Russia exhibit very similar mortality patterns. Moreover, the results of our Theil analysis provided support for the view that the within-country dimension of variation is particularly relevant for alcohol-related deaths.

We assumed that the spatial distribution of alcohol-related mortality in the four neighbouring countries has historical roots. This hypothesis could be supported by comparing contemporary patterns with those observed in the past. Unfortunately, the evidence confirming this link based on historical mortality data is very scarce, especially for this region of Europe. A notable exception is the study by Andreev *et al.*, who estimated mortality attributable to drunkenness in the Russian Empire at the end of 19th century [26]. At that time, the European part of Tsarist Russia included 50 Russian and non-Russian (Belarus, Moldova, Ukraine, the Baltic countries) provinces. According to the rough estimates for the period 1870–1894, alcohol-related mortality in the Russian provinces was seven times higher than in the Belarusian provinces, six times higher than in the Ukrainian provinces and 16 times higher than in the other non-Russian provinces [26]. However, over time, the *alcohol epidemics* spread from the European part of Russia to the other countries of the region. The mortality gradient across the territories of our four countries observed today likely reflects the traces of a spatial diffusion process of alcohol consumption patterns initiated more than a century ago.

A comparison of the results of this study with the available historical data suggests that mortality patterns in the four countries have persisted over time. For example, the territories of the central Black Earth region (Kursk and Voronezh oblast) had the lowest levels of alcohol-related mortality in European Russia in the 19th century, and they still do today. Conversely, alcohol-related mortality levels in the Novgorod, Smolensk, Tver' and Vladimir oblasts were high in the past, and still remain above the country average [26]. A number of other observations point to the relevance of the historic context in shaping contemporary mortality patterns. For example, the districts of Belarus (northwest) and Lithuania (southeast) form a cross-border cluster of alcohol mortality that used to belong to the Vilno gubernia in the Russian Empire, and then, until 1939, to Poland. This observation was first made by our previous study based on mortality data for earlier years [13]. Another example is a mortality hot spot found in areas of eastern Poland, which belonged to Russia as part of Congress Poland during extended periods of the 19th century and the early 20th century. Conversely, cold spots of alcohol-related mortality were detected in southern parts of Poland bordering Slovakia (Lesser Poland) that once belonged to Austria; as well as in northern parts of Poland that belonged with a Polish-dominated population to the German Empire for extended periods prior to 1945 and were not subject to major population displacements after World War II (Greater Poland). All of these observations suggest that historical and sociocultural factors may have influenced the formation and the evolution of regional patterns of alcohol consumption, and that these patterns may have been transferred across generations through cultural norms and social interactions. Likewise, the results of a recent study on the historical persistence of alcohol-induced mortality in Russia indicate that the hazardous drinking patterns that emerged and crystallised during the early stages of modernisation and urbanisation have indeed been very persistent [27].

The turbulent historical events experienced by the four countries have inevitably affected the ethnic composition of their contemporary populations. However, the relationships between ethnic background and alcohol-related mortality are not straightforward. For example, the higher levels of alcohol-related mortality in the regions with larger shares of Polish minorities reported for Lithuania coincides with the observation that the Polish ethnic group also exhibits the highest alcohol-related mortality levels in the country [14]. The disadvantage of Polish males relative to Lithuanian males remains significant even after compositional differences, including education and urban–rural place of residence, are taken into account [14]. This is a striking finding given that Poland has much lower alcohol-related mortality than Lithuania. At the same time, a large cluster of low mortality from external causes of death and alcohol-related mortality has been identified in southwestern Belarus along the border to Poland and Ukraine [28].

It is likely that differences in socioeconomic conditions, in conjunction with selective migration from peripheral to core regions, contribute to regional disparities in alcohol mortality. This hypothesis is supported by the observation that in all four countries, the big cities, and especially the capitals, tend to have lower mortality than other areas. Elevated mortality in the highly industrialised areas of Poland points to the possible impact of deindustrialisation. A recent study has demonstrated the growing advantage of Moscow and St. Petersburg over the other Russian regions, most likely due to socioeconomic factors [29]. Other best-practice areas in Russia with high life expectancy levels are science cities and cities with a special regime (often related to the defence/applied industries) [30].

Our study confirms that there has been an intense clustering of extremely high levels of premature alcohol-related mortality in the northwest of the European part of Russia, which is also known as the *big triangle*. This label was applied to these regions because they are situated among the major centres of labour migration: Moscow, St. Petersburg and the Baltic States. Compared to the central Black Earth region, these territories have historically had very unfavourable agricultural conditions, which led to large waves of out-migration during the Soviet era. The less developed eastern regions of Belarus have also experienced large-scale depopulation. Since the Soviet era, the most hazardous forms of alcohol consumption in the region have been known to occur in rural areas [31]. This phenomenon has been explained by the specific social environments of rural areas: that is, by the lack of future prospects, entertainment opportunities and medical services and, possibly, by the selective out-migration of healthier and more ambitious individuals [32,33].

In addition to living standards and the social environment, other factors could explain the higher mortality in peripheral regions. We cannot exclude the possibility that the populations living in geographical proximity to the national borders are more likely to be exposed to the production and cross-border smuggling of illegal alcohol [34]. This issue is especially relevant for the people living near the open border between Belarus and Russia. According to the official statistics for Belarus, the supply of illegal alcohol entering the country has been rising since 2010, and alcohol smuggled from Russia accounts for about 90% of illegal alcohol in Belarus. In 2017, more than 550 000 L of alcoholic beverages and spirits valued more than 2.2 million US dollars were seized from illegal circulation by Belarusian authorities [35]. Similarly, there is some evidence that substantial quantities of cheaper and/or counterfeit alcoholic beverages are being smuggled from Belarus and Russia into Lithuania [36]. This evidence indicates that policies aimed at controlling the illegal alcohol trade are needed, and serves as a warning that straightforward increases in taxes and sales restrictions for legal alcohol may not be effective in reducing alcohol-related mortality.

Limitations and implications for future research

Several issues have to be taken into account when interpreting the results of the present study. The first is the regional variation in diagnostics and coding practices of causes of death both between and within countries. Some inconsistencies in the registration of causes of death can be deduced from the descriptive statistics presented in Table A1. For example, when compared to mortality patterns in Russia, it appears that mortality from alcoholic liver cirrhosis (K70) across the districts of Belarus is too low, whereas mortality from non-alcoholic liver cirrhosis (K74) is too high. However, when K70 and K74 are combined into one category, hardly any differences between the two countries can be observed. Another illustrative example is that the level of mortality from alcohol abuse (F10) in Poland is found to be similar to the level in Russia, and to be six times higher than the level in Lithuania. These findings are implausible given that Poland has much lower levels of mortality from other causes of death. The relatively low levels of mortality from accidental poisoning by alcohol recorded in Poland might be attributed to under-coding. This is suspected to be the case in some Western European countries as well [37]. Combining specific alcohol-related causes in a single category mitigates the problem of data comparability and allows us to make more robust statistical inferences. However, it does not rule out the possibility that deaths explicitly attributable to alcohol are misclassified elsewhere. There is some evidence suggesting that deaths from accidental poisoning by alcohol and chronic alcoholism could be reported as ischemic heart disease, likely due to the stigmatisation of alcohol-related deaths [38]. Nevertheless, it has been argued that the potential misclassification of acute alcohol poisoning is insufficient to attenuate the strong association reported between heavy drinking and cardiovascular mortality [39].

Another potential data quality issue concerns the population denominators used to calculate death rates. It is possible that a proportion of the population officially reported for the regions was de facto residing elsewhere. However, we believe that this problem was to a large extent mitigated by using the population census data (Russia) and census-linked data (Lithuania), as well as by pooling the data over five-year time periods (Belarus and Poland). In addition, Lithuania improved its migration statistics in 2009 by introducing a special tax for those individuals who failed to report departures to other countries [40]. Finally, the analyses presented in this paper enabled us to offer only tentative explanations regarding the origin of the observed geographical patterns. The proposed hypotheses need to be tested more specifically in future studies by linking mortality data with area-level contextual variables, and by applying spatial regression models. More comprehensive analyses should eventually involve using micro-data and multilevel modelling. Some steps in this direction have already been taken [14].

Conclusion

The observed cross-border continuities and patterns (hot spots) of elevated alcohol-related mortality confirm that harmful alcohol consumption is a deep-rooted problem in the region. The observed striking resemblance of cross-country and within-country geographical patterns of mortality due to directly alcohol-related, external and total adult mortality once again confirms the role of alcohol in the continuing crisis in premature mortality. We identified important similarities and disparities in the scale of alcohol-related burdens across the four countries selected for this study. Most of the Lithuanian and Polish regions seem to be less affected by alcohol epidemics, while large parts of Belarus and Russia report extreme levels of alcohol-related mortality. Evidence of cross-border continuities of elevated alcohol-related mortality between neighbouring regions of Belarus and Russia and between Belarus and Lithuania suggests that these patterns have historical roots dating back to the Russian Empire and to the more recent period of Soviet rule. Although such relationships are not straightforward, there is clearly a need for more in-depth studies that go beyond investigations of nation-specific and contemporary socioeconomic or socio-demographic contexts. These findings indicate that a broader perspective on the peculiarities of these cross-border areas should be adopted when developing national or even cross-border strategies and interventions. Our observation that within-country variation in alcohol-related deaths is highly relevant supports the view that anti-alcohol policies should have an explicit regional dimension, with a strong focus on hot spots.

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Conflict of Interest

The authors have no conflicts of interest.

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APPENDIX

Table A1 *Mean and standard deviation of the standardised death (per 100 000) from selected causes of death across territorial units of Belarus, Lithuania, Poland and European Russia; males, ages 20–64 years*

	Belarus		Lithuania		Russia		Poland	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
All causes combined	1394.8	211.1	969.7	170.8	1549.4	386.5	683.7	101.1
Cardiovascular diseases causes (I00-I99)	512.7	83.7	308.5	59.6	611.9	169.9	201.5	37.1
Heart diseases (I00-I52)	400.4	71.7	250.8	50.8	487.5	149.4	126.4	28.4
Alcoholic cardiomyopathy (I42.6)	12.3	13.1	—	—	69.5	69.4	—	—
Cerebrovascular diseases (I60-I69)	95.2	26.6	47.0	18.1	109.5	40.7	38.1	11.3
External causes (V01-Y98)	417.7	104.2	267.6	67.4	398.9	146.8	131.0	32.7
Accidental poisoning by alcohol (X45)	79.8	31.2	18.0	17.1	53.1	44.0	9.20	9.10
Liver cirrhosis (K70,K74)	46.6	15.9	50.5	17.4	64.7	33.9	29.9	10.9
Alcoholic liver cirrhosis (K70)	14.9	11.6	29.9	13.8	26.8	26.9	14.5	7.0
Non-alcoholic liver cirrhosis (K74)	32.6	12.9	19.5	10.0	38.0	24.3	15.4	7.1
Alcohol abuse (F10)	23.1	19.1	2.0	3.1	13.0	25.9	12.8	10.3
Selected alcohol-related causes combined (F10, K70, K74, X45)	148.3	43.3	72.1	29.1	130.8	69.8	51.90	22.40
Number of observations	*131*		*60*		*609*		*379*	

Supporting Information

Additional Supporting Information may be found in the online version of this article at the publisher's website:

Appendix S1. Territories of Belarus, Lithuania, Poland, and European Russia in 1900 and 1930.

Appendix S2. Decomposition of Theil index into country-specific components by selected causes of death.

Appendix S3. SMR across the combined territory of Belarus, Lithuania, Poland, and European Russia; males 20–64.

Appendix S4. Spatial clusters of mortality from selected alcohol-related causes (F10, K70, K74, X45); Belarus, Lithuania, Poland, and European Russia; males, ages 20–64.