Spatial inequalities in mortality in Russia before and during the COVID-19 pandemic: a district-level analysis

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Background

A substantial body of research has demonstrated significant fluctuations in life expectancy trends in Russia and other Eastern and Central European countries during the late 20th and early 21st centuries. (Field 1995; Shkolnikov et al. 1996, 2004; Shkolnikov and Cornia 2000; Meslé 2004). The researchers identified several factors that may have contributed to these trends, including the role of hazardous alcohol consumption and other risky behaviors, significant socio-economic changes, including privatization, and other factors (Leon et. al 2007; Grigoriev et al. 2010). The relatively recent studies indicated a consistent growth in life expectancy in Russia between 2004 and 2019 (Shkolnikov et al., 2013; Shkolnikov et al., 2019). However, the advent of the global pandemic led to a significant decline in this trend, with a considerable number of additional deaths occurring in 2020 and 2021 (Shkolnikov et al., 2024).

A number of studies have investigated these changes and geographical patterns of mortality in Russia at the regional level. As demonstrated by Shkolnikov and Vassin (2002), the implementation of anti-alcohol measures during the 1980s led to an increase in life expectancy in Russia, particularly among men. However, it remained relatively low in comparison to other developed countries. While regional variation in life expectancy narrowed, significant differences persisted, with mortality in men aged 45-74 and women above 60 being key factors. Furthermore, the pattern of life expectancy improvement from the northeast to the southwest in European Russia was identified. The study conducted by Vallin and colleagues (2005) also revealed mortality patterns in Russia, which exhibited a stark contrast between the south-west and north-east of European Russia, as well as between European Russia and Siberia. Another consequence of their research is the demonstration of a significant divergence in patterns of mortality and their correlation with geographic regions. The 1988-89 period serves as a baseline for the observation of trends from 1969-1994. As Timonin and colleagues (2017) have demonstrated, life expectancy in Russia has increased in the period from 2004 to 2014. However, the trends observed across regions have varied. While disparities in life expectancy between regions have decreased slightly, with convergence at younger ages and divergence at older ages, cardiovascular diseases and external causes have been identified as key factors. Furthermore, major cities like Moscow and Saint Petersburg have demonstrated the greatest improvements in mortality.

Later study by Timonin and colleagues (2020), the first one using district-level data (for one point in time), revealed that the previous studies on this topic, which relied on data for the highest level of administrative division in Russia, tended to mask important variations in mortality within the regions. In addition, it showed high

disproportions in life expectancy of Russian districts. The lowest life expectancy is found in shrinking areas of the Far East and Northwest, while the highest levels are in districts around Moscow, Saint Petersburg, and science cities, suggesting that national mortality rates could improve by addressing these disparities.

A broader international study by Grigoriev and colleagues (2020) examined spatial patterns of alcohol-related mortality across Belarus, Lithuania, Poland, and European Russia. The findings revealed a gradient from high mortality in northwestern Russia to lower levels in southern Poland. The highest concentrations of alcohol-related mortality are observed in northwestern Russia, eastern Belarus, southeastern Lithuania, and central Poland. This suggests that alcohol epidemics spread from Russia over the last century and that local socioeconomic, cultural, and behavioral factors in these regions should be prioritized in anti-alcohol policies. A further study by Schur and colleagues (2021) on city-level data demonstrated that, despite overall improvements in mortality rates between 2000 and 2010, disparities in life expectancy (LE) widened between the most developed areas, represented by larger cities, and the least developed areas, represented by smaller cities and rural regions.

There is a paucity of knowledge regarding the geographical distribution of inequalities in mortality within Russia and the manner in which they have changed over time. Nevertheless, it is essential to examine granular data in order to more accurately estimate the spatial inequalities and overall trends in the broader area (Danilova et al., 2021). The present study seeks to address this gap by examining changes in spatial inequalities in cause-specific mortality between three time points: 2001–2003, 2009–2011, and 2020–2021, using anonymized death records for districts.

Data & Methods

We analyzed data on deaths categorized by sex, age, district and cause of death for the periods 2001–2003, 2009–2011, and 2020–2021, using anonymized vital registration records provided by the Russian State Statistical Service (Rosstat). The list of causes included in the analysis are: HIV and tuberculosis, cancer, cardiovascular diseases, diseases of the respiratory system, alcohol-related causes and external causes. The data were carefully checked and corrected to ensure their full comparability in time. In total, 2264 districts were included in the analysis covering the territory of Russia, as defined by the Russian constitution before 2014. Population figures were drawn from the national censuses of 2002, 2010, and 2021.

For each district, we calculated sex- and cause-specific age-standardized death rates (SDRs), using direct standardization based on the 2013 European standard population. This allowed us to ensure that our results were consistent with international studies. SDRs were computed for the total population and for the middle-aged populations who are known to have been experiencing a substantial burden of excess mortality in Russia. To minimize the impact of yearly fluctuations, especially in areas with smaller populations, we aggregated death data over three-year spans around each census, providing more stable and reliable results. Bayesian methods are also used to access district mortality curves to overcome this problem.

To investigate mortality inequalities, we employed two key regression-based metrics: the slope index of inequality (SII) and the relative index of inequality (RII). The SII measures the absolute gap in death rates between the most and least disadvantaged groups, giving insight into the scale of inequality in terms of real mortality differences. In contrast, the RII assesses proportional inequality by calculating how the mortality rate of disadvantaged groups compares to that of the more affluent, highlighting relative disparities. These indices allowed us to capture both absolute and relative inequalities in mortality, offering a nuanced perspective on health disparities across districts.

Districts were then ranked according to their SDRs and divided into ten population percentile groups. Each group represented 10% of the total population, providing a granular view of mortality patterns across the nation.

Expected findings

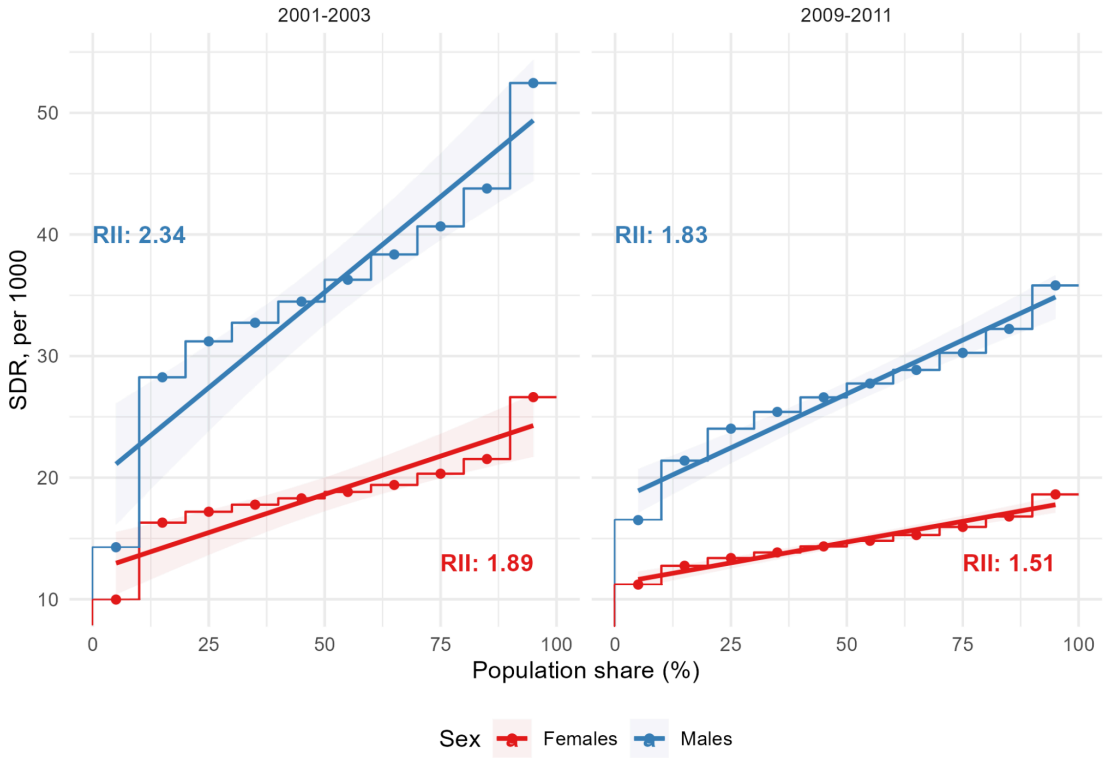

Figure 1. Regression line depicting the Standardized Death Rate (SDR) for all causes and all ages across ten district groups, segmented by sex and time period.

Historically, mortality inequalities in Russia have been more pronounced among men, driven by factors such as higher rates of hazardous alcohol consumption, risky behaviors, and external causes including accidents and violence. The relative index of inequality (RII) for males, which was 2.34 during the period 2001-2003, decreased to 1.83 during the period 2009-2011. This indicates a reduction in mortality inequality, although it remained substantially higher than that of females. For women, the RII decreased from 1.89 to 1.51 over the same period, indicating a comparable but less pronounced improvement. These figures indicate that, prior to the advent of the pandemic, both sexes

exhibited a reduction in mortality inequalities; however, men continued to experience greater disparities. This pattern of inequality reduction prior to the pandemic is likely to reflect improvements in healthcare access and the success of public health interventions, particularly in addressing external causes and alcohol-related mortality.

It is anticipated that the study will demonstrate that while life expectancy has improved overall, mortality rates related to cardiovascular diseases and alcohol-related causes will continue to contribute to disparities. It is anticipated that major urban centers, such as Moscow and Saint Petersburg, will demonstrate the most significant reductions in mortality rates, which may further accentuate the existing disparities between urban and rural or less developed areas. This nuanced understanding of health disparities will provide a detailed account of how mortality inequalities have evolved across Russia's regions and time periods.

Furthermore, the study is expected to elucidate the manner in which pre-existing disparities in mortality rates influenced the impact of the COVID-19 pandemic on excess mortality rates across different districts in Russia. The disparate baseline conditions, established over decades of mortality inequality, are likely to have exacerbated the differences in how regions experienced excess mortality during the pandemic. Consequently, the study may demonstrate that the pandemic further widened existing health disparities, with disadvantaged districts bearing the brunt of the pandemic's toll. This finding would emphasize the necessity for targeted public health interventions in these vulnerable regions to mitigate future health crises.

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