EAST-WEST AND GENDER MORTALITY GAPS IN EUROPE'S ELDERLY POPULATION DURING THE COVID-19 PERIOD

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Abstract
This study examines changes in old-age mortality in Europe during the COVID-19 pandemic period, focusing on two critical disparities: the East-West mortality gap and the gender mortality gap. Motivated by long-term variations in mortality rates across European regions and between sexes, this research aims to clarify how these inequalities changed during the pandemic. By addressing the interplay between regional and gender-based disparities, the study contributes to a deeper understanding of the pandemic's effects on vulnerable populations, particularly the elderly. Factor and cluster analyses were employed to categorise European countries into clusters for comparison of mortality trends and to evaluate the persistence of the East-West gradient. The research on mortality gaps utilises a quantitative approach, analysing data from the Human Mortality Database and Eurostat for the years 2019–2022. Annual weighted and unweighted mean differences in life expectancy at age 65 were calculated to assess changes during the pandemic. Gender-specific differences were examined alongside regional disparities to highlight the compounded impacts of the pandemic on old-age populations. The study reveals that during the COVID-19 pandemic, the East-West mortality gap among the elderly widened. Before the pandemic, the life expectancy difference at age 65 between Eastern and Western Europe was 4.44 years for men and 3.24 years for women. By 2022, this gap widened to 6.02 years for men and 4.75 years for women. Western European countries showed signs of recovery in 2022, whereas Eastern European countries experienced prolonged declines in life expectancy. Gender disparities remained relatively stable during the pandemic, with differences of approximately 4.4 years in Eastern Europe and 3.2 years in Western Europe. The findings underscore the pandemic's role in amplifying regional inequalities while maintaining gender disparities. This study provides novel insights into the compounded impacts of the COVID-19

pandemic on old-age mortality in Europe, emphasising the interplay between regional and gender gaps. It contributes to the literature by demonstrating how crises, such as pandemics, can exacerbate existing inequalities. The findings have significant implications for public health policies, highlighting the need for targeted interventions to address regional disparities and support ageing populations in vulnerable regions.

Key words
life expectancy at age 65, East-West mortality gap, gender mortality gap, COVID-19, European countries

INTRODUCTION

The COVID-19 pandemic significantly altered long-term mortality trends in Europe. Even before its outbreak, despite general improvements in mortality during the second half of the 20th century, specific convergent and divergent trends were observed. These were particularly observable between traditional democratic countries and states of the socialist bloc ("East-West mortality gap") and between sexes ("gender mortality gap"). Differences in political and healthcare systems, behavioural factors (e.g., smoking habits or alcohol consumption), and environmental conditions (e.g., air pollution) have notably influenced the East-West mortality gap (Tleshova et al. 2025; Janssen 2020; Velkova et al. 1997; Bobak and Marmot 1996). Since the turn of the millennium, mortality in post-socialist regions has decreased, narrowing the East-West mortality gap (Velkova et al. 1997; Meslé 2004; Leon 2011). The gender gap reflects stable differences in life expectancy between men and women, shaped by biological, socioeconomic, cultural, and behavioural factors (OECD 2023; Dahlgren and Whitehead 1991; Allel et al. 2021).

As the pandemic has affected many dimensions of human life, including health and the economy, Schöley et al. suggested that the homogeneous mortality perceptions of Europe were disrupted by the different impacts of the pandemic on populations, depending on their age-sex structure, vaccination coverage, or health system capacity (Schöley et al. 2022). Regarding the gender mortality gap during the COVID-19 pandemic, Beegle et al. expected it to increase in 2020, particularly in high-income countries, such as the Netherlands, Switzerland, or Canada (Beegle et al. 2024). In general, the progress in gender equalisation observed in 2010–2019 has slowed or even reversed in many countries in the years that followed (Pinho-Gomes et al. 2022).

Despite a growing body of research documenting the impact of the COVID-19 pandemic on life expectancy and excess mortality in Europe, most studies focus on the total population or on life expectancy at birth, and rarely systematically examine higher-age mortality, particularly in relation to long-standing East–West differentials. Moreover, there is a lack of empirical work that jointly quantifies both the East–West mortality gap and the gender gap at higher age within a unified

analytical framework, while explicitly linking pandemic-period developments to pre-pandemic convergence or divergence trends.

OBJECTIVES

The study is focused on two main aims. The first objective is to assess the persistence of the East-West mortality gap in Europe, particularly among the elderly population. The second aim is to examine mortality gaps (the gender gap and the supposed East-West gap) among European countries during the COVID-19 pandemic and to investigate how the pre-pandemic mortality trends were affected during the pandemic years.

In contrast to previous studies on this issue, which employed basic comparisons of mortality indicators between groups of countries or sexes (Velkova et al. 1997), the present study applies a unified, yet straightforward quantitative framework that jointly captures East-West and gender mortality gaps at age 65 using weighted and unweighted mean differences between empirically derived country clusters. By tracing these gaps from pre-pandemic years through 2020–2022, it uniquely shows how, during the COVID-19 pandemic, long-standing mortality inequalities among Europe's elderly population were reshaped.

THEORETICAL FRAMEWORK

The East–West mortality gap can be understood through the lens of fundamental cause theory (Link and Phelan, 1995). It emphasises that, above all, socio-economic resources and institutional capacities shape long-term health outcomes. During COVID-19, countries with stronger structures recovered faster, while those constrained by historical and systemic inequalities continued to experience elevated mortality, highlighting the role of deep structural determinants beyond individual behaviours.

This study builds upon existing research on mortality disparities in Europe, focusing on the interplay between regional inequalities and gender differences. It incorporates established theories on socio-political, behavioural, and environmental determinants of mortality trends (Bobak and Marmot 1996; Meslé et al. 2002; Pinho-Gomes et al. 2022). These studies agree on the existence of the East-West mortality gradient in Europe, supposing convergence over the latest decades before the COVID-19 pandemic (Shkolnikov et al. 2024; Velkova et al. 1997; Meslé et al. 2002; Leon 2011)as well as a narrowing of the gender mortality differences (Pinho-Gomes et al. 2022).Additionally, it integrates recent findings on the impacts of the COVID-19 pandemic on vulnerable populations, emphasising the compounded effects of health crises on pre-existing disparities (Schöley et al. 2022; Bambra et al. 2020; Igari 2023). Generally, it could be assumed that a pandemic or any health crisis leads to an increase in mortality inequalities (Shkolnikov et

al. 2024). Specifically, during the COVID-19 pandemic, a greater mortality excess was observed in Eastern Europe and the Baltic countries, where pre-pandemic mortality was also traditionally higher. This trend is often associated with higher levels of poverty or income inequality and lower vaccination rates in those affected countries (Pizzato et al. 2024). There were also differences in the pandemic burden and population vulnerability (Igari 2023). The increase in mortality differences was driven primarily by the second pandemic year, 2021 (Igari 2023; Shkolnikov et al. 2024). Analyses suggest that the stringency of pandemic control measures played only a minor role in explaining regional mortality differences; instead, trust in government and in the measures, and thus compliance with them, as well as, above all, the use of vaccination in 2021, emerge as key factors (Shkolnikov et al. 2024). Also, the health system's capacities and overload in relation to the timing of the spread of infection played an important role (Igari 2023).

Particular aspects may be discussed related to gender-specific impacts of the COVID-19 pandemic. Both sexes are assumed to be influenced by different factors, but potentially with similar resulting effects on mortality increase (Pinho-Gomes et al. 2022; Pinho-Gomes et al. 2023). During the first pandemic year, globally, in high-income countries, the excess mortality was much higher for men than for women, likely due to the accumulation of gendered advantages for women (lower infection fatality risk, different occupational exposure, better access to care). In 2021, sex ratios of excess mortality fell, probably reflecting vaccine rollout and the earlier depletion of the most vulnerable groups (Beegle et al. 2024).

In general, gender differences in mortality during the pandemic are assumed to be driven primarily by a combination of biological factors, social roles, inequalities, and other health determinants. While analyses of biological (genetic, hormonal, etc.) factors show rather inconclusive results, apparent gender diversity has been documented, stemming from gender differences in multimorbidity, in health-related behaviours (e.g., smoking, alcohol overuse, use of preventive tools), or in the structure of employment (Lemarchand et al. 2025).

DATA AND METHODS

The analysis involves three particular steps. The first two steps aim to classify the European countries into several groups with similar mortality conditions. This enables us to compare the studied mortality gaps not only among nations but also between and within groups of countries at a comparable level of demographic development. Additionally, this part of the analysis enables evaluation of the persistence of the East-West mortality gap and the differences between post-communist countries and other European countries. The third step is a crucial part of the analysis, focusing on quantifying the mortality gaps themselves.

The first step involves applying factor analysis to pre-pandemic life expectancy values (life expectancy at age 65 for men and women in 2017, 2018, and 2019) to aggregate them into factors that cover the 35 European countries studied (Table S1 in the Supplement). The calculated factor scores are then used as input variables in the second step's cluster analysis, enabling a multivariate classification of the countries studied. In this second analytical step, groups of countries with the most similar pre-pandemic mortality characteristics are identified. As there are no extreme observations in the dataset, the Euclidean distance was used in the hierarchical procedure and the average linkage method of clustering. In line with the objective of assessing whether a traditional East-West mortality pattern persists in Europe, we retained two dominant clusters encompassing most European countries for further analyses. If it were confirmed that the two dominant clusters do not correspond to the traditional East-West differences, then this would reflect a violation of this pattern in Europe. As will be seen from the description of the results, a small third cluster was formed based on the analysed data, including only two countries with specific developments. This remained part of the descriptive analysis but was not used to study the East-West mortality gap, as it brings together countries that currently deviate from this East-West distribution in their values and trends.

The third step was analysing mortality gaps and the changes observed during the pandemic period, with a focus on older ages. To estimate both the East-West gap (differences between the clusters of countries) and the gender gap, and to present them in a complex manner, we used a measure based on the mean difference in life expectancy at age 65 between and within the clusters of countries. For the analysis, two forms of the mean difference are proposed: the population-unweighted form (which reflects heterogeneity among countries) and the weighted form (which reflects heterogeneity among inhabitants in the studied countries). The weight is the population size at age 65 and over as of July 1 in each year of analysis (see Data availability for details) for each country, published by Eurostat (Eurostat 2024).

For analysis of the East-West gap (gap between the clusters of countries), the mean difference measure (MD) could be defined as:

$$MD^{E-W}{}_{e65} = \sum_{ij}(w_i \times w_j) \times \frac{(e65_i - e65_j)}{[(w_i \times w_j) \times (I \times J)]}$$

or

$$MD^{E-W}{}_{\Delta e65} = \sum_{ij}(w_i \times w_j) \times \frac{(\Delta e65_i - \Delta e65_j)}{[(w_i \times w_j) \times (I \times J)]}$$

where *e65* represents life expectancy values at age 65 and *Δe65* their annual differences, *i* and *j* represent countries in the particular clusters, *i = 1, .., I* and *j = 1, .., J*; *I* and *J* are the total numbers of countries in both the clusters, *I x J* is the number of studied inter-country differences. *wi* is the weight of the *i*-th observation, where *wi* = number of males or females aged 65 and older in country *i* or *wi = 1* in the population-unweighted approach. The calculation was done separately for males and females. Regardless of the direction of subtraction, we maintain the established term East-West gap.

Similarly, the gender gap was calculated as the mean difference in life expectancy at age 65 for females and males ($e65^{females}$ and $e65^{males}$) in particular clusters, in the same manner, we analysed also the mean difference of the annual changes of the life expectancy gender gap:

$$MD^{G}{}_{i} = \sum_{i}(e65^{females}{}_{i} - e65^{males}{}_{i})/I$$

or

$$MD^{\Delta G}{}_{i} = \sum_{i}\Delta(e65^{females}{}_{i} - e65^{males}{}_{i})/I$$

for the unweighted form

and

$$MD^{G}{}_{i} = \sum_{i} w_{i}^{females+males} \times (e65^{females}{}_{i} - e65^{males}{}_{i})/\sum_{i} w_{i}^{females+males}$$

or

$$MD^{\Delta G}{}_{i} = \sum_{i} w_{i}^{females+males} \times (\Delta(e65^{females}{}_{i} - e65^{males}{}_{i}))/\sum_{i} w_{i}^{females+males}$$

for the weighted form for the cluster *i*. The calculation was done separately for particular groups of countries (clusters).

We do not use the absolute (or square) value of the difference in the numerator of the proposed measure, allowing negative differences to contribute to a decrease in the calculated gap. While the analysis based on annual values of the examined indicators allows for a description of the development of the East–West and gender mortality gaps, the analysis based on annual changes in the indicators will make it possible to better track the evolution of both gaps and, above all, to capture the periods when long-term trends began to change. The use of weighted and unweighted differences enables a more detailed examination of regional and gender inequalities compared to previous approaches. However, since the primary purpose of the article is to identify differences among European countries in the analysed mortality gaps, the following text will focus on interpreting unweighted indicators. However, in presenting the results, the weighted form, which maps

the differences between inhabitants of individual clusters, is also included for comparison. As will be seen in the following text, the basic trends of both indicator types are essentially identical. The analysis was performed using both Excel and SAS software, version 9.4.

The crucial data – life expectancy at age 65 for men and women – was taken from the Human Mortality Database (Max Planck Institute for Demographic Research (Germany), University of California, Berkeley (USA), and French Institute for Demographic Studies (France) n.d.)or the World Population Prospects database (United Nations, Department of Economic and Social Affairs, Population Division 2022). Countries with fewer than 1 million inhabitants were excluded from the analysis because of the high variability in their mortality trends, which makes it challenging to distinguish systematic patterns from random fluctuations.

The analysis comprises three pre-pandemic years (2017, 2018, and 2019) and three pandemic years (2020, 2021, and 2022); the complete input data are provided in Supplementary Table S1.

RESULTS AND DISCUSSION

The clusters formed using the cluster analysis (Figure 1; for more details, see Supplementary Table S1 and Figure S1) almost precisely reflect the distinction between post-communist countries and traditional European economies. Western, Northern, and Southern European countries were combined into a single cluster. Most of the post-communist countries formed a second cluster. There were only a few exceptions – Slovenia, which was based on the pre-pandemic (2017–2019) life expectancy values added to the first cluster of countries, and an independent cluster containing North Macedonia and Bosnia and Herzegovina. The last two mentioned countries do not fit into either of the previous two clusters; their demographic situations and development are unique within Europe. Although both countries merit attention in demographic research, in line with the focus of this paper, they will be excluded from further analysis, and the focus will be on the two presented clusters. Their composition reflects the persistent East-West mortality gap in Europe. However, it is worth noting that pre-pandemic developments foreshadowed a possible loosening of this East-West gradient, as seen in the case of Slovenia. In the following analysis, in accordance with the paper's issue, the first cluster will be labelled "West," and the second, comprising Central and Eastern European countries, will be labelled, for simplicity, as "East."

Figure 1 illustrates not only the clusters (distinguished by colour) but, above all, the development of mortality in European countries from 2019 to 2022, based on life expectancy at age 65. Clearly, in both studied groups of countries (East and West), the pandemic period brought visible changes in mortality levels. Trajectories show that most countries experienced a leftward shift (decrease in life expectancy,

as represented by the male values in Figure 1) and an upward trend (increasing gender differences) during the pandemic. In other words, the pandemic's onset worsened (decreased) life expectancy in all the studied countries (accompanied by a slight increase in the gender gap). The East cluster experienced a more pronounced change in mortality, with a notable decrease in life expectancy and a widening gender gap, resulting in greater variability across European countries. In the West cluster, the end of most trajectories (arrows) in 2022 is more favourable than the initial year (dots), indicating recovery or improvement since 2019. In the East cluster, the most recent studied year was less favourable than the pre-pandemic period, showing no full recovery until 2022.

Another potential factor contributing to the increase in mortality in 2022 in the East cluster may be the onset of the Russian–Ukrainian armed conflict, which may give rise to further changes in mortality patterns that warrant more detailed analysis once sufficient post-conflict data become available.

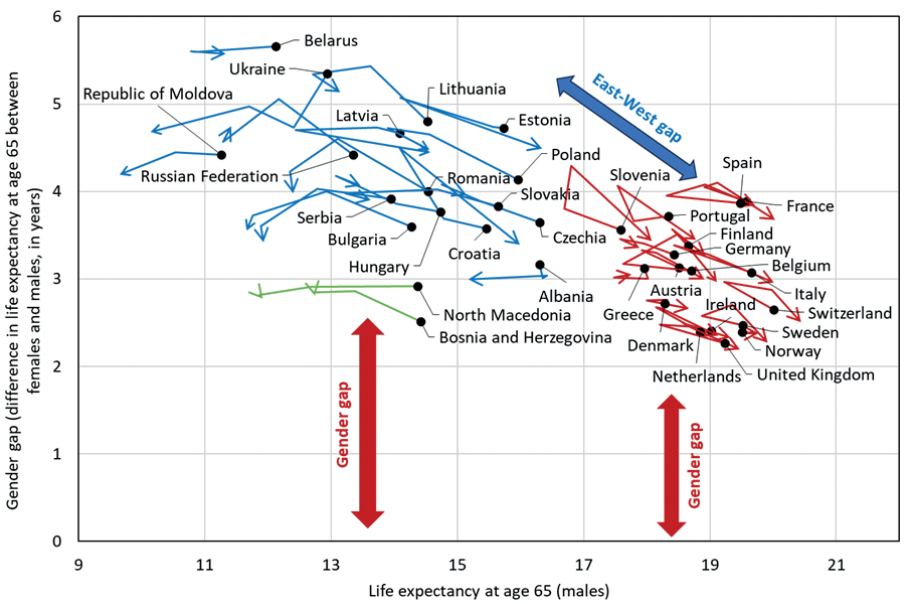

Fig. 1 Visualisation of the East-West mortality gap and gender mortality gap: trajectories of European countries according to the gender gap in life expectancy at age 65 (y-axis) and male life expectancy at age 65 (x-axis), 2019, 2020, 2021 and 2022

Notes: Colours – classification of the countries according to the results of the cluster analysis (see Supplementary Figure S1) into West cluster (red), East cluster (blue), and residual cluster (green). Dots correspond to the initial mortality situation (2019) and start particular country-specific trajectories. Arrows represent the last year under observation (2022).

Source: United Nations, Department of Economic and Social Affairs, Population Division 2022; Max Planck Institute for Demographic Research (Germany), University of California, Berkeley (USA), and French Institute for Demographic Studies (France) n.d.; Eurostat 2024

The simple quantitative expression of the East-West gap or the gender gap proposed above aims to evaluate the changes in these gaps during the pandemic directly in numerical terms. We focus specifically on the differences between countries (e.g., the unweighted measures) in the text; weighted differences between the clusters and sexes are usually more pronounced than country-based differences. The main trends, however, are the same. The results for both (weighted and unweighted) measures are shown in Figure 2.

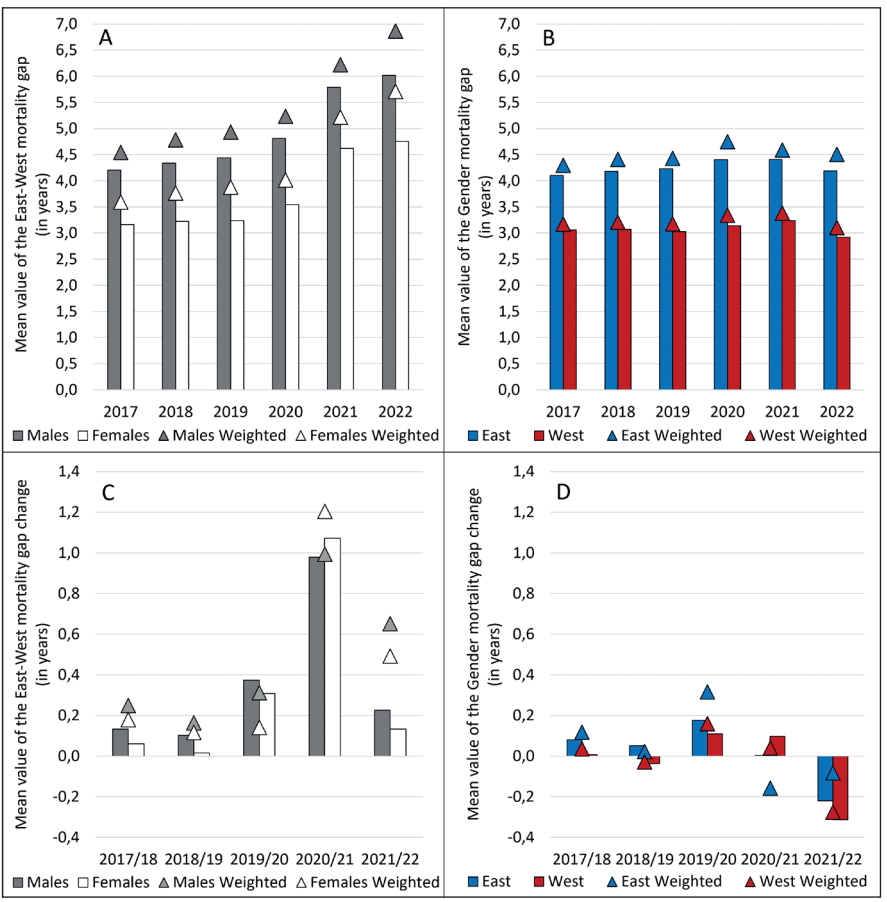

Fig. 2 Mean difference of the East-West mortality gap (A) and the gender mortality gap (B) based on life expectancy at age 65, unweighted and population-weighted, 2017–2022 (in years, upper panels), the mean difference of the East-West mortality gap (C) and the gender mortality gap (D) based on annual changes in life expectancy at age 65, unweighted and population-weighted, 2017–2022 (in years, lower panels)

Source: United Nations, Department of Economic and Social Affairs, Population Division 2022; Max Planck Institute for Demographic Research (Germany), University of California, Berkeley (USA), and French Institute for Demographic Studies (France) n.d.; Eurostat 2024

According to the results in Figure 2, before the onset of the pandemic (2017, 2018, and 2019), the mean difference (MD) in life expectancy at age 65 between the countries in the East and West clusters was above 3 years for females and more than 4 years for males (Figure 2, panel A). Before the pandemic, the East-West gap had already slightly increased, especially for males; therefore, the pandemic did not alter this trend. Above all, in the second pandemic year (2021), the East-West gap rose exceptionally, by about a year for both sexes (Figure 2, panel C). In 2021, the mean difference in life expectancy at age 65 between the East and West clusters was 5.79 years for males and 4.62 years for females (values for the unweighted measures are presented in the text unless otherwise specified). There was also a slight increase in 2022. The East-West gap increased to 6.02 years for males and 4.75 years for females. In other words, the first year of the pandemic (2020) already saw an increase in mortality differences in Europe; however, this change was not fundamental, as practically all countries were negatively affected by the pandemic, with the degree of impact varying. In contrast, the second year of the pandemic (2021) saw a much greater shift towards heterogeneity in Europe, as a significant portion of the countries in the West cluster experienced an improvement in mortality rates, while most countries in the East cluster continued to decline in life expectancy.

The development of the gender gap (Figure 2, panels B and D) remained relatively constant over the period under review. Still, the gap was approximately one year higher in the East cluster (gender gap exceeded four years) than in the West cluster (with a gender mortality gap of about three years). In the first two years of the pandemic (2020 and 2021), the gender gap increased slightly, reaching its maximum. In the Eastern cluster, it was 4.41 years, while in the Western cluster, it reached 3.14 and 3.24 years. In contrast to the East-West gap, the gender gap in 2022 decreased in both clusters, returning to pre-pandemic values (4.19 and 2.92 years in the East and West clusters, respectively).

DISCUSSION

Given that life expectancy gains before the pandemic were increasingly driven by reductions in mortality at older ages, particularly in Western Europe (Jasilionis et al. 2023; Schöley et al. 2022), it could be expected that the COVID-19 shock disproportionately reversed these improvements among the elderly and thereby reinforced the long-standing East–West mortality gap at age 65. Furthermore, because both male and female mortality at older ages were strongly and simultaneously affected by COVID-19, we hypothesised that the pandemic primarily amplified regional (East–West) inequalities in old-age mortality, while leaving the relative magnitude of the gender mortality gap at age 65 broadly stable within each macro-region.

Europe was divided in terms of mortality already before the onset of the COVID-19 pandemic (Debón et al. 2017; Meslé et al. 2002; Shkolnikov et al. 2024; Vågerö 2010). Carracedo et al. identified the East-West mortality gradient (gap) for the population aged 65 and older; however, in contrast to our results, their study (covering years 1990–2012) placed Slovenia into the Eastern cluster (Carracedo et al. 2018). Previous studies have highlighted that economic conditions, alcohol consumption, and smoking habits are critical determinants of mortality differences between Western and Eastern Europe, with the behavioural factors reinforcing the long-standing East-West mortality gap (Bobak and Marmot 1996; Meslé et al. 2002). Bobak and Marmot also discussed the effect of pollution, health behaviours, or social environment (Bobak and Marmot 1996).

The gender mortality gap in the pre-pandemic years (2010–2019) was reported to be decreasing (Pinho-Gomes et al. 2022). According to our results, only the West cluster showed a slight decrease in the gender gap value just before the onset of the pandemic. In the East cluster, its values were increasing slightly. The East-West differences in the gender gap could, among other factors, be related to gender disparities in particular spheres of life (work participation, political and economic power). It has been demonstrated that these factors affect not only sex-specific life expectancies but also health disparities (Leão et al. 2024; Ningsih et al. 2024).

Our findings confirm previous conclusions about the significant impact of the COVID-19 pandemic period on long-term mortality trends and on changes in the distribution of mortality levels in Europe. During the pandemic period, the mortality gap between Western and Eastern Europe widened to a level not observed in over 20 years (Shkolnikov et al. 2024). Huang et al. also confirm that 17 out of 27 European countries would have experienced an increase in life expectancy at age 65 in 2020 if the COVID-19 pandemic had not occurred (Huang et al. 2023).

Our study emphasises the pronounced regional divergence between Eastern and Western Europe, particularly in the second pandemic year, highlighting the pandemic's disproportionate impact on Eastern countries. Among the relevant factors are higher poverty levels and inequalities in society, in general, a higher pandemic burden in vulnerable populations (Pizzato et al. 2024; Igari 2023). Bambra et al. emphasised the importance of policy responses during the pandemic, particularly at its outset, when adequate protection against the virus was not yet available (Bambra et al. 2020). Regulation enforcement, vaccination coverage, as well as trust in science and government, or individual behaviour, may also contribute to the observed differences in mortality between countries (Shkolnikov et al. 2024; Ylli et al. 2022). However, the effective implementation of regulations in most Eastern European societies is expected to be constrained by past experiences with authoritarian regimes, during which many people may remain more sceptical of government regulations (Miller et al. 2004; Tleshova et

al. 2025). This is also related to the effectiveness of vaccination implementation – vaccination coverage rates are lower in Eastern Europe (Ylli et al. 2022). It can be assumed that vaccination coverage contributed to the East-West mortality differences, which peaked in 2021, rather than specifically at the outset of the pandemic.

In contrast to some previous studies (Pinho-Gomes et al. 2022), the gender gap remained nearly stable across the above-analysed countries in the years preceding the pandemic. Moreover, we confirmed the East-West gradient in the gender mortality differences; the gender differences in life expectancy at the age of 65 in the Eastern cluster (a difference of about four years in favour of women) are approximately one year higher compared to the West (females' life expectancy at age 65 is about three years longer than that of males).

The COVID-19 pandemic had only a slight impact on the stable development of the gender gap in Europe; the general East-West pattern of the gender gap remained stable. The proven stability of the gender gap during the pandemic years may be surprising, as crises typically exacerbate socioeconomic or other inequalities in society (Bambra et al. 2020). Some studies from the COVID-19 pandemic show that men were at greater risk of serious complications or death from infection, which may have temporarily widened the gender gap. Indeed, only a small change is evident during the first year of the pandemic, particularly in the East cluster. On the other hand, women faced greater economic uncertainty, including job loss and lower income, on average (Pinho-Gomes et al. 2022).

Despite the long-term East-West mortality gradient (Shkolnikov et al. 2024; Meslé et al. 2002; Vågerö 2010), we confirmed that mortality levels in some Central European countries were similar to those in the West cluster before the onset of the pandemic. Despite these similarities, the general pattern of the East-West mortality gap not only persists, but it is also reflected in the observed pandemic mortality development. Our study shows that the long-standing East–West mortality gap at age 65 widened markedly during the pandemic, as Western European countries began to recover by 2021 while most Eastern countries continued to experience declines in life expectancy. At the same time, it confirms that the gender mortality gap at older ages remained relatively stable within both regions, with women maintaining an advantage of about four years in the East and three years in the West.

Limitations of this study

This study benefits from robust data availability and quality, given its focus on developed European countries. However, some of the latest data had to be replaced with older datasets due to gaps in availability, which may slightly affect the precision of results for certain countries. Additionally, reporting inconsistencies

during the pandemic and variations in data-collection methodologies could impact the accuracy of statistics in specific regions. Summary indicators used in the analysis, while effective for identifying broad trends, cannot fully capture the complexity of underlying social, cultural, or healthcare factors.

A key limitation of our approach is that using only two main clusters necessarily simplifies the diversity of mortality patterns across Europe, and excluding countries with populations below one million, while reducing random fluctuations, may also omit potentially relevant small-state trajectories. The relatively short time frame of the study – covering three pre-pandemic and three pandemic years – limits its ability to reflect long-term historical and socio-economic developments that shape mortality trends. Therefore, the findings should be viewed as a foundational quantitative overview, providing a guide for more detailed and country-specific analyses in future research.

CONCLUSIONS

The observed East-West mortality gap mirrors global patterns of health inequality, in which socio-economic disparities and lifestyle and structural differences remain critical determinants. The widening of the East-West mortality gap during the pandemic cannot be understood as a temporary deviation, but as a manifestation of long-term accumulated structural inequalities in health. It also reflects broader global challenges in addressing health crises and highlights the importance of international cooperation in mitigating disparities. In Eastern Europe, the persistent East-West mortality gap underscores the need for better-targeted health interventions and information campaigns that go beyond individual behaviour change. Such efforts should focus on prevention, lifestyle-related risk factors, and vaccination coverage, while simultaneously addressing underlying socio-economic and structural determinants of health.

The simplicity of the presented method, as well as the focus on confirmed mortality disparities in Europe, may help policymakers assess the fulfilment of Agenda 2030 for Sustainable Development Goal 10 to reduce inequities within and between countries, and set realistic and efficient goals for the upcoming years.

Our findings contribute to the existing body of literature by offering a nuanced perspective on mortality trends during the COVID-19 pandemic in Europe. It highlights regional divergence, with Eastern Europe experiencing a sharper decline and a slower recovery compared to Western Europe. This divergence highlights the need for targeted health interventions, improved healthcare infrastructure, the promotion of preventive measures, increased vaccination coverage, and the reduction of socioeconomic inequalities.

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