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Have regional inequalities in life expectancy widened within the European Union between 1991 and 2008?

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Abstract

Background

Health inequalities have widened within and between many European countries over recent decades, but Europe-wide trends at the sub-national scale have been largely overlooked. For regions across the European Union (EU), we assess how geographical inequalities (i.e., between regions) and sociospatial inequalities (i.e., between regions grouped by an area-level measure of average household income) in male and female life expectancy have changed between 1991 and 2008.

Methods

Household income, life expectancy at birth and population count data were obtained for 129 regions (level 2 Nomenclature of Statistical Territorial Units, 'NUTS') in 13 European countries with 1991-2008 data (2008 population = 272 million). We assessed temporal changes in the range of life expectancies, for all regions and for Western and Eastern European regions separately.

Results

Between 1991 and 2008 the geographical range of life expectancies found among European regions remained relatively constant, with the exception of life expectancy among Eastern European males, for whom the range widened by 2.8 years. Sociospatial inequalities in life expectancy (1999 to 2008 data only) remained constant for all regions combined and for Western Europe, but more than doubled in size for Eastern European males. For Eastern European females, life expectancy was unrelated to regional household income.

Conclusions

Regional life expectancy inequalities in the EU have not narrowed over two decades, despite efforts to reduce them. Household income differences may partly explain these inequalities, although the extent differs by sex and Eastern/Western context. As inequalities transcend national borders, reduction efforts may require EU-wide coordination in addition to national efforts.

Keywords

Europe, Life expectancy, health inequalities, socioeconomic, EU, temporal, geographical.

Introduction

Substantial geographical disparities in health are evident at multiple scales, including between neighbourhoods (1), cities (2), regions (3-5), countries (6) and continents (7). Documenting these differences and their development over time is an important first step in ascertaining and addressing their underlying causes.

Within Europe, studies of geographical inequalities in health have mostly compared regions within single countries (8-10) or have compared nations (11-13). Leon (13) compared life expectancy trajectories from 1970 to 2009 between 22 European countries and found little closure of the health gap in the last two decades, as most countries experienced similar rates of improvement. Nonetheless, analysis at the country level can obscure finer-resolution differences in health, and may cause researchers to over-state the importance of national-level factors in determining health inequalities(13-15).

Geographical health inequalities often reflect underlying spatial differences in socioeconomic conditions; areas with wealthier populations tend to be healthier. This relationship is usually assumed to be driven by individual-level associations – that is, a primarily compositional rather than contextual effect(16). However, area-level socioeconomic circumstances have also been independently related to health inequalities, using multilevel techniques that allow the simultaneous investigation of individual- and higher-level effects(17, 18). In many European countries socioeconomic health inequalities at the individual level have widened in recent decades(12, 19-23), but whether this widening is also found at the area-level has been little studied. Addressing the inequitable distribution of health will require an understanding of its determinants – the circumstances in which people grow, live, work and age – as well as

recognition that these conditions are themselves generated and perpetuated by the wider socioeconomic, political and environmental context(24).

In the 1990s, Shaw et al. (14) pooled data from the then 15 Member States of the European Union (EU) and compared their 160 regions. The mortality rate difference between the most and least healthy regions grew by 11% between 1990 and 1994. In this study we utilise a further 14 years of data, analyse males and females separately and add a socioeconomic dimension. Our study groups sub-national regions by measures of health (life expectancy) and socioeconomic status (household income) rather than by national boundaries as in most international studies. Specifically we assess how inequalities in life expectancy, at the sub-national level, have changed in the EU between 1991 and 2008. Inclusion of Eastern as well as Western European regions offers the opportunity to assess whether the well-documented East-West health divide, typically a nationally-reported phenomenon, persists at the sub-national level.

Methods

Geographical units

The European 'Nomenclature of Statistical Territorial Units' (NUTS) classification was established to make cross-border comparisons feasible. The 2006 NUTS level 2 geography was obtained(25), as these were the smallest units for which comparable data were available over time (average population 2.1 million for the NUTS2 regions in our study).

Health and population data

Life expectancy at birth was chosen as the health outcome to minimise errors from international differences in diagnostic and coding practices. Life expectancy is typically higher for females than males, therefore sex-specific life expectancy at birth and population data were downloaded for as many NUTS2 regions and years as available(26).

Socioeconomic data

Income is closely related to mortality(20), hence we obtained regional average household income data as our area-level measure of socioeconomic status(26). Average primary income for private households is estimated using Purchasing Power Consumption Standard¹ units (PPCS) per capita, which allows for meaningful comparison between countries.

Data availability

To account for occasional missing values we calculated three-year moving averages, such that each year was given the average value of itself and the preceding and subsequent years. Some non-mainland regions were atypical of their countries or had very small populations which gave rise to missing or unreliable data². These regions were therefore excluded. The resulting dataset contained continuous life expectancy and population data from 1991 to 2008, and household income data from 1999 to 2008, for 129 NUTS2 regions within 13 countries. Eight of these countries (96 regions) were Western European (Austria, Belgium, Spain, Finland, France, Italy, Portugal, and Sweden) and five (33 regions) were Eastern European (Czech Republic, Estonia, Hungary, Lithuania, and Poland).

¹ An artificial currency unit obtained by the conversion of the income parameters of private households with specific purchasing power standards for final consumption expenditure.

² Åland (Finland: FI20); Ceuta, Melilla and the Canary Islands (Spain: ES63, ES64, ES70); French overseas territories (FR91, FR92, FR93, FR94); and Madeira and the Azores (Portugal: PT30, PT20)

Analyses

We analysed 'geographical' and 'socio-spatial' inequalities in life expectancy between groups of European regions. 'Geographical' inequalities refer to differences in life expectancy between regions grouped by their life expectancy. 'Socio-spatial' inequalities describe differences in life expectancy between regions grouped by their mean household income. Regions were aggregated into deciles based upon either (a) life expectancy or (b) household income for each year, so that each decile contained approximately the same number of people. Population-weighted average life expectancy was calculated for each decile by multiplying each region's life expectancy by its population, summing these across the decile then dividing by the decile's total population. We define inequalities as the difference between the most extreme groups in each year – i.e., the shortest and longest lived deciles of regions, or those with the smallest or largest mean household incomes. In doing so we are assessing the change in the *range* of life expectancy over time, rather than tracking the life expectancy changes for set groups of regions. Differences were calculated in both absolute (years) and relative (%) terms. However, as the relative results closely mirrored the absolute ones, we present only absolute inequalities here.

Results

Geographical inequalities in life expectancy

Between 1991 and 2008 regional life expectancy increased by an average of 4.6 years for males (range 0.1 to 6.5) and 3.6 years for females (range 1.2 to 5.3; Figure 1). Male life expectancy gains were lowest in Lithuania (a single NUTS2 region, with an increase of only 0.1 years) and highest in parts of Italy and France. For females the lowest life expectancy gains also occurred in Lithuania, and the greatest improvements occurred in parts of Poland, France and Portugal.

Eastern European regions dominated the lowest deciles of male and female life expectancy throughout the time period, and regions with the highest life expectancy were in France, Spain, Italy and Sweden (Figure 2). Life expectancy rankings remained relatively stable over time: regions experiencing high or low life expectancies at the start tended to maintain their position.

Figure 1. Life expectancy change between 1991 and 2008 for EU NUTS2 regions, separately for males (top) and females (bottom).

Footnote: Data sources: NUTS2 and country boundary data: GISCO (25); Life expectancy: derived from Eurostat(26) data.

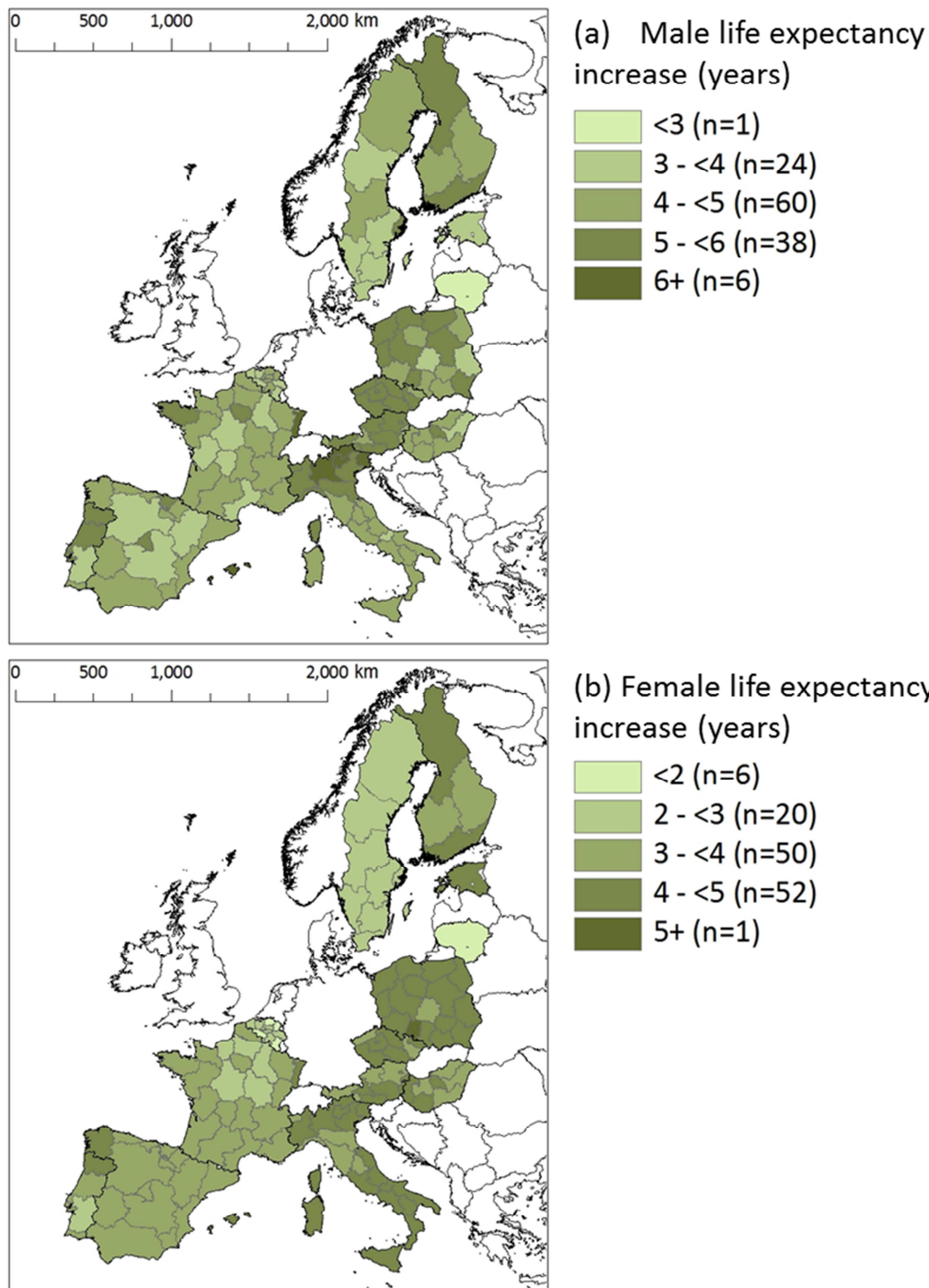
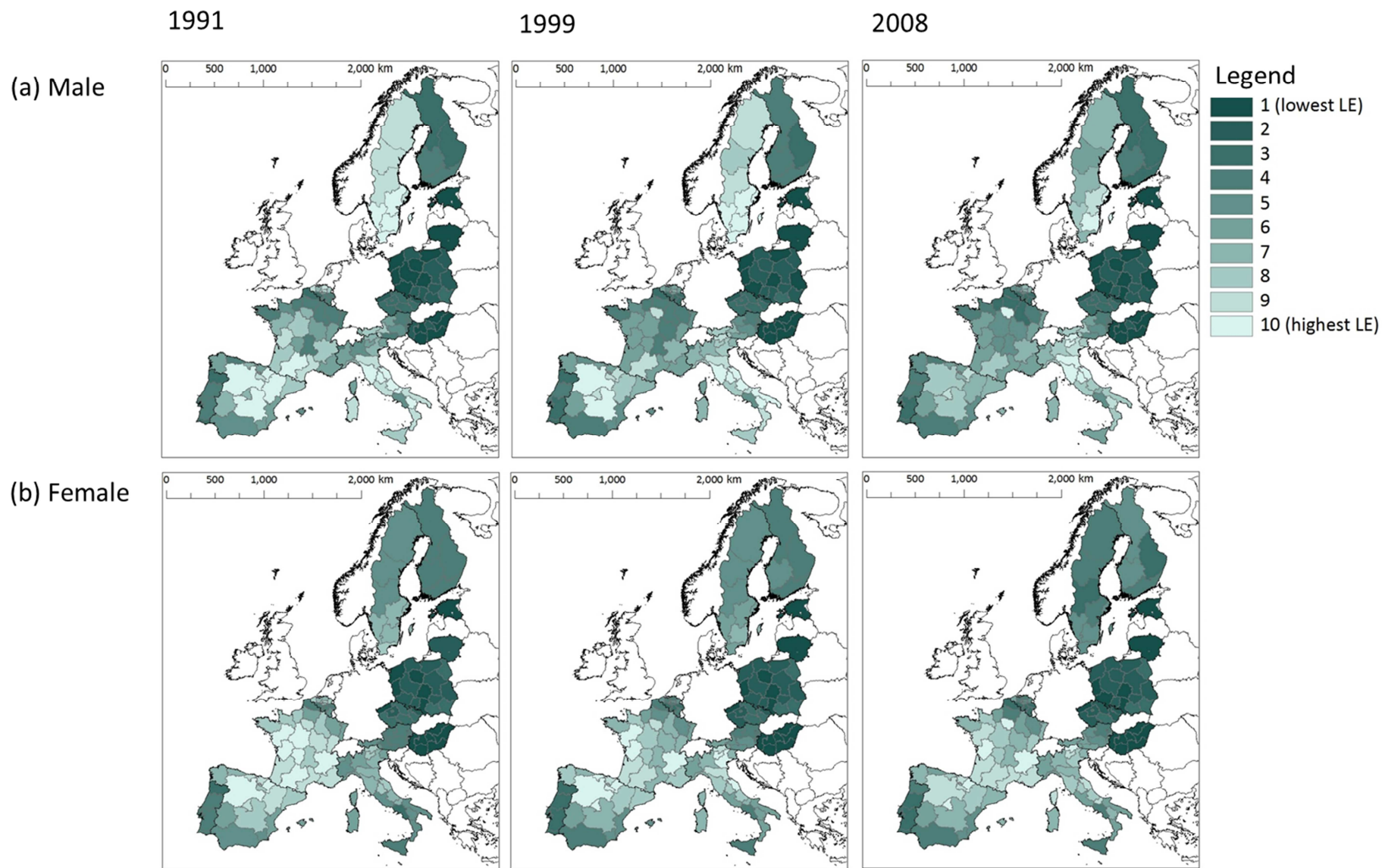


Figure 2. NUTS2 regions grouped by life expectancy (LE) deciles for (a) males and (b) females in 1991, 1999 and 2008.
 Footnote: Data sources: NUTS2 and country boundary data: GISCO (25); Life expectancy: derived from Eurostat(26) data.



Average life expectancies for regions in the shortest- and longest-lived deciles each year, and the absolute gap between them, are shown in Figure 3. In most cases life expectancy increased steadily over time, and the trajectories were roughly parallel. Consequently there were no marked changes in absolute inequalities over the 18 years, except for the 2.8 year widening seen for males in Eastern European regions (Fig. 3c). Much of this widening occurred in the early 1990s and mid-2000s, with almost a decade of stability in between. This illustrates the inherent limitations of calculating change between relatively arbitrary start and end points without reference to the intervening period.

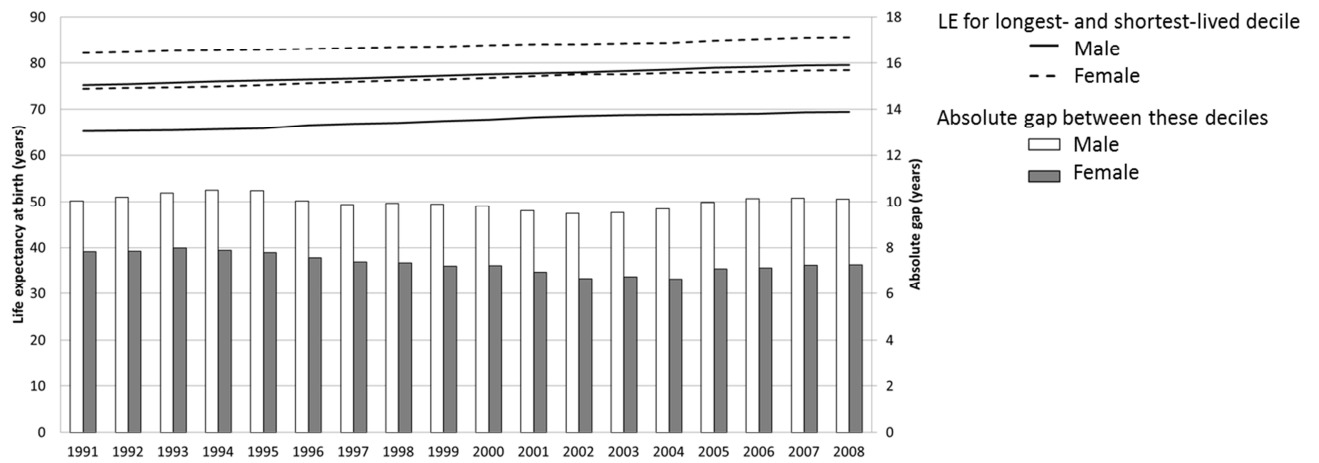
Apart from Eastern European males, the other sex and national groupings showed no clear trend over time (Figure 3). The ranges of life expectancies observed for each of these groupings changed by less than a year between 1991 and 2008. Given the small size of these changes, and the influence of the start and end points that were imposed by data availability, these findings cannot be considered as indicative of long-term trends. Only for male life expectancies in Eastern European regions were the smallest and largest gaps found at the start and end of the study period, respectively, suggesting overall widening over time.

To assess whether the patterns were contingent on the regions included we compared trends observed over the latter half of the study period with those obtained from a separate set of regions for which 2001 to 2008 data were available. These comprised 91 regions from 6 countries: Germany, UK, Ireland, Latvia, the Netherlands and Slovakia. For these regions, the change in absolute inequalities in male and female life expectancy over the same period

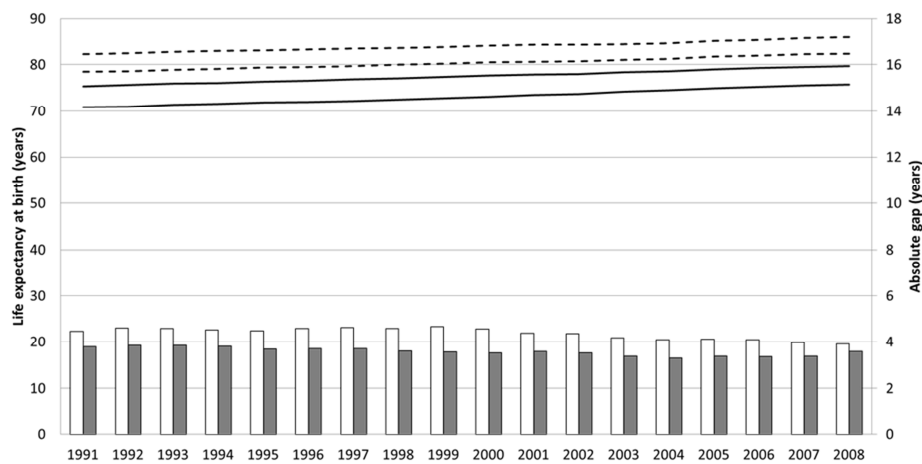
differed by no more than 0.2 years compared with the original results (both correlation coefficients = 0.9).

Figure 3. Average life expectancy at birth ('LE', population-weighted average, years) for regions in the shortest- and longest-lived deciles each year between 1991 and 2008, and the absolute gap between them. Male and female data shown separately for (a) all regions, (b) Western European regions and (c) Eastern European regions.

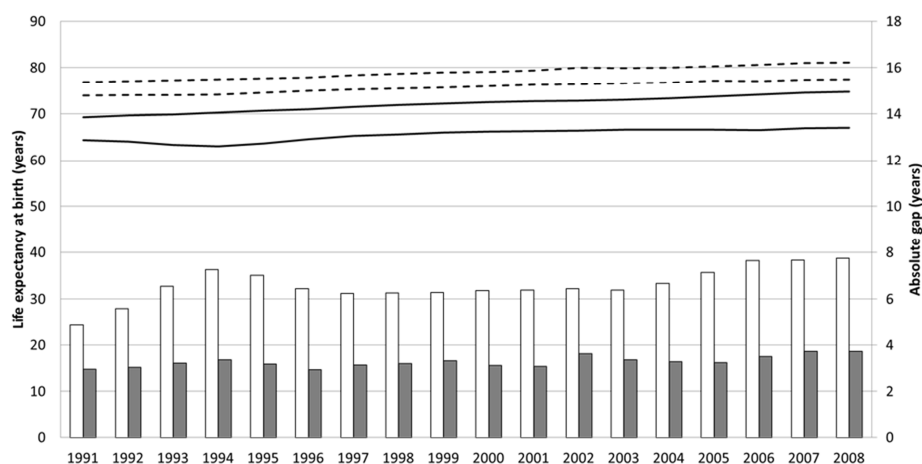
(a) All regions



(b) Western European regions



(c) Eastern European regions



Sociospatial inequalities in life expectancy

The absolute gap in average household income between the highest- and lowest-income deciles increased between 1999 and 2008, for all regions combined and for the Eastern and Western European subsets. In Eastern Europe the gap widened by 45% over the period, compared with 15% in Western Europe and 14% for all regions combined.

Life expectancies in the lowest- and highest-income deciles each year increased steadily over time in all regions (Fig. 4a) and Western Europe (Fig. 4b). Hence, there was very little change in these absolute gaps between 1999 and 2008 (all less than 0.5 years).

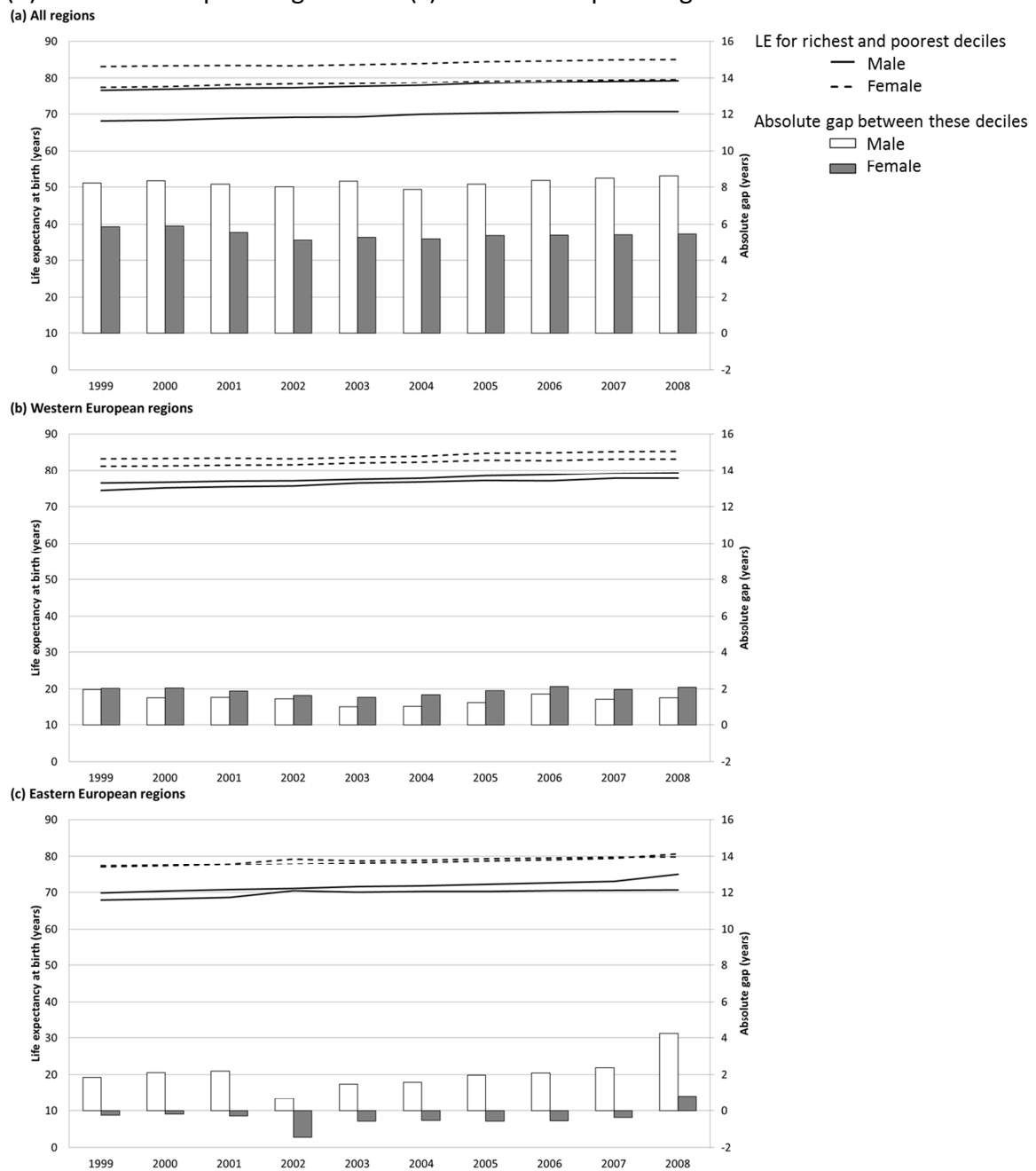
For Eastern European regions, however, sociospatial inequalities in life expectancy showed different patterns (Fig. 4c). Life expectancies for males in the lowest-income Eastern European regions each year almost stagnated after 2002, increasing by an average of only 15 days each year (compared with 135 days per year for males in the lowest-income Western European regions). As male life expectancies in the highest-income Eastern European regions increased at a faster rate over time, the gap in 2008 (4.2 years) was more than double that in 1999 (1.8 years).

Figure 4c reveals little difference in female life expectancies between Eastern European regions with the lowest and highest average incomes. Females in the lowest-income decile had marginally *higher* life expectancy (average 0.5 years) than those in the highest-income

decile for nine of the ten years. The life expectancy trajectories of the other eight deciles (not shown) were similarly erratic, suggesting a degree of noise in these data. We explored the possibility that membership of the household income deciles was highly unstable, as this could be symptomatic of data quality issues, but this was not found to be the case.

Sociospatial inequalities in life expectancy averaged 84% and 78% of the Europe-wide geographical life expectancy gap for males and females, respectively (correlation coefficients between income and life expectancy each year all > 0.73 , $p < 0.0001$). In Western European regions income and life expectancy were less correlated: coefficients ranged 0.21 to 0.36 for males ($p < 0.05$) and 0.16 to 0.23 for females (half significant at $p < 0.05$). In Eastern European regions we found good correlations for male life expectancy (coefficients 0.47 to 0.54, $p < 0.01$) but no relationship for females (0.04 to 0.26, $p > 0.10$).

Figure 4. Average life expectancy at birth ('LE', population-weighted average, years) for regions in the lowest- and highest-income deciles each year between 1999 and 2008, and the absolute gap between them. Male and female data shown separately for (a) all regions, (b) Western European regions and (c) Eastern European regions.



Discussion

In most regions of Europe life expectancy increased steadily between 1991 and 2008.

Geographical inequalities – the life expectancy gaps between the shortest- and longest-lived regions each year – have remained relatively constant for all sex and national groupings apart from males in Eastern Europe. Among this group the range of male life expectancies widened by almost three years across the period. Since 1989 Eastern European countries have experienced radical social and economic reforms following the transition from communism to capitalism. It has been postulated that the transition had a disproportionate effect on the health of working-age males(15, 27). Our findings suggest that this health legacy persisted into the 2000s. Following the accession of Eastern European countries to the EU in 2004, and the resulting opportunities for economic migration to the west, it is possible that health-selective migration may act to maintain or widen the gap further.

The well-documented and persistent ‘East-West health divide’(15, 28, 29) is apparent from our analyses, as the shortest- and longest-lived deciles comprised only Eastern and Western European regions, respectively. At the sub-national level we found no indication that the East-West health divide changed substantially between 1991 and 2008, in contrast to the work of Vågerö(15) who reports a continued widening since the 1960s (at the national level). However, our sample excluded non-EU Eastern European nations – some of whom experienced worsening life expectancy between 1990 and 2005(15). Life expectancies in Eastern European EU nations have recently been improving at the same rate as in Western

Europe(13), suggesting it may be difficult to close this health gap. Identifying the key drivers of the geographical inequalities is an important first step in this regard.

We investigated the contribution of between-region household income differences to the geographical inequalities in life expectancy observed. In the Europe-wide analysis the sociospatial inequality accounted for most of the geographical difference: i.e., the lowest- and highest-income regions were often also the shortest- and longest-lived, respectively. At the finer resolution afforded by the Eastern and Western European analyses, however, we found some decoupling between life expectancy and regional socioeconomic status. In the most extreme case regional household income was unrelated to female life expectancy in Eastern Europe. In Slovakia Rosicova et al.(30) also found socioeconomic differentials in regional mortality for males but not females, using education, employment and income indicators. Given the substantial economic upheaval experienced in Eastern Europe in recent decades it is feasible that the key determinants of population health in these regions, and their relevance for male and female health, differ from those in Western Europe.

Widening individual-level social inequalities in mortality over time have previously been reported for most of the countries in our analysis(11, 12, 19-23, 31-36). As found for geographic inequalities we found widening sociospatial inequality in life expectancy only for Eastern European males, whereas the gaps for the other groupings remained constant. The stability of these regional inequalities is surprising in the context of the widening income differences observed within each population group over time. The widening inequality in

male life expectancy in Eastern Europe may relate to the steeper rate at which the income gap has widened over time in these regions.

Our work has methodological implications. The fluctuations in narrowing and widening we observed over time highlighted the need for a fine temporal resolution when studying how health inequalities have changed over time. Indeed, if restricted to between 1991 and 1994 our analysis would reveal a slight widening of the geographical inequality in Western Europe: corresponding with the widening gap in all-cause mortality reported by Shaw et al.(14) (for the regions of 15 Western European countries between 1990 and 1994). Thus, trends identified for short time periods may have limited generalisability to longer periods.

Our study had limitations. First, the data were collected by 13 separate national administrations, and while Eurostat strives to ensure their reliability and comparability some inconsistencies may persist. Second, the NUTS2 regions varied substantially in population size in some cases, which may have affected the original life expectancy data and our calculations based on them. We omitted regions with the smallest populations and unstable life expectancy estimates, and used population-weighted averaging techniques and deciles to ameliorate these issues. Third, countries with many regions may have dominated decile trends and downweighted the contribution of single-region countries. The single-region countries in this study consisted of the Baltic States of Lithuania and Estonia: nations that have experienced particularly poor health and turbulent changes in life expectancy in recent decades(13). Fourth, we were unable to test whether the findings were sensitive to

the measure of socioeconomic status used, due to a lack of indicators with comparable spatial and temporal coverage. Finally, due to data availability our analysis ended in 2008, at the start of the global economic crisis. As the crisis will undoubtedly have more severe socioeconomic and health effects in some regions and countries than in others(15) it is vital that these are investigated once data become available.

While the imperative to reduce health inequalities is widely acknowledged there has been uneven progress across Europe to address the problem(37, 38). Reducing these inequalities is likely to require EU-wide coordination in addition to national efforts. The EU's Joint Action on Health Inequalities project, initiated in 2011, could provide a good baseline, through encouraging knowledge transfer, improved access to structural funds, and EU-wide policy-making. The EU's response to the recent financial crisis illustrates the feasibility of coordinating EU-wide fiscal and policy action when political will exists.

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Conflicts of Interest

None declared.

Key points

- A geographical focus has been largely absent from Europe-wide health inequalities work, although spatial determinants of health are likely to be important.
- Regional life expectancy inequalities in the EU have not narrowed over recent decades, despite efforts to reduce them. Inequalities have widened for males in Eastern Europe.
- Household income differences may partly explain the inequalities, although not for females in Eastern Europe.
- As health inequalities in Europe transcend national borders, efforts to reduce them may require EU-wide coordination in addition to national efforts.

References

1. Hanlon P, Walsh D, Whyte B. Let Glasgow Flourish. Glasgow: Glasgow Centre for Population Health, Accessed 15th June 2012 from http://www.gcph.co.uk/assets/0000/0377/LetGlasgowFlourish_full.pdf2006.
2. Gray L, Merlo J, Mindell J, Hallqvist J, Tafforeau J, O'Reilly D, et al. International differences in self-reported health measures in 33 major metropolitan areas in Europe. *Eur J Public Health*. 2012;22(1):40-7.
3. Singh GK, Siahpush M. Widening socioeconomic inequalities in US life expectancy, 1980-2000. *Int J Epidemiol*. 2006;35(4):969-79.
4. Pearce J, Dorling D. Increasing geographical inequalities in health in New Zealand, 1980-2001. *Int J Epidemiol*. 2006;35(3):597-603.
5. Bonneux LG, Huisman CC, de Beer JA. Mortality in 272 European regions, 2002-2004. An update. *Eur J Epidemiol*. 2010 Feb;25(2):77-85.
6. Mackenbach JP, Stirbu I, Roskam AJR, Schaap MM, Menvielle G, Leinsalu M, et al. Socioeconomic inequalities in health in 22 European countries. *N Engl J Med*. 2008;358(23):2468-81.
7. Dorling D, Shaw M, Smith GD. HIV and global health - Global inequality of life expectancy due to AIDS. *BMJ*. 2006 Mar 18;332(7542):662-4.
8. Leyland AH, Dundas R, McLoone P, Boddy FA. Cause-specific inequalities in mortality in Scotland: two decades of change. A population-based study. *BMC Public Health*. 2007;7:11.
9. Dzurova D. Mortality differentials in the Czech Republic during the post-1989 socio-political transformation. *Health Place*. 2000;6(4):351-62.
10. Razum O, Altenhoener T, Breckenkamp J, Voigtlaender S. Social epidemiology after the German reunification: East vs. West or poor vs. rich? *Int J Public Health*. 2008;53(1):13-22.
11. Leinsalu M, Stirbu I, Vågerö D, Kalèdienè R, Kovács K, Wojtyniak B, et al. Educational inequalities in mortality in four Eastern European countries: divergence in trends during the post-communist transition from 1990 to 2000. *Int J Epidemiol*. 2009;38(2):512-25.
12. Shkolnikov VM, Andreev EM, Jdanov DA, Jasilionis D, Kravdal Ø, Vågerö D, et al. Increasing absolute mortality disparities by education in Finland, Norway and Sweden, 1971 - 2000. *J Epidemiol Community Health*. 2011.
13. Leon DA. Trends in European life expectancy: a salutary view. *Int J Epidemiol*. 2011;40(2):271-7.
14. Shaw M, Orford S, Brimblecombe N, Dorling D. Widening inequality in mortality between 160 regions of 15 European countries in the early 1990s. *Soc Sci Med*. 2000;50:1047-58.
15. Vågerö D. The East–West Health Divide in Europe: Growing and Shifting Eastwards. *European Review*. 2010;18(01):23-34.
16. Kunst A. Socioeconomic inequalities in health in Central and Eastern Europe: synthesis of results of eight new studies. *Int J Public Health*. 2009;54(4):197-200.
17. Fone D, Dunstan F, Lloyd K, Williams G, Watkins J, Palmer S. Does social cohesion modify the association between area income deprivation and mental health? A multilevel analysis. *Int J Epidemiol*. 2007;36(2):338-45.

18. Chaix B, Rosvall M, Merlo J. Neighborhood Socioeconomic Deprivation and Residential Instability: Effects on Incidence of Ischemic Heart Disease and Survival After Myocardial Infarction. *Epidemiology*. 2007;18(1):104-11.
19. Mackenbach JP, Bos V, Andersen O, Cardano M, Costa G, Harding S, et al. Widening socioeconomic inequalities in mortality in six Western European countries. *Int J Epidemiol*. 2003;32(5):830-7.
20. Martikainen P, Makela P, Koskinen S, Valkonen T. Income differences in mortality: a register-based follow-up study of three million men and women. *Int J Epidemiol*. 2001;30(6):1397-405.
21. Valkonen T, Martikainen P, Jalovaara M, Koskinen S, Martelin T, Makela P. Changes in socioeconomic inequalities in mortality during an economic boom and recession among middle-aged men and women in Finland. *Eur J Public Health*. 2000;10(4):274-80.
22. Regidor E, Gutierrezfisac JL, Rodriguez C. Increased socioeconomic differences in mortality in 8 Spanish provinces. *Soc Sci Med*. 1995;41(6):801-7.
23. Marang-van de Mheen PJ, Smith GD, Hart CL, Gunning-Schepers LJ. Socioeconomic differentials in mortality among men within Great Britain: time trends and contributory causes. *J Epidemiol Community Health*. 1998;52(4):214-8.
24. Commission on Social Determinants of Health. Closing the gap in a generation. Geneva: World Health Organization 2008.
25. Eurostat GISCO. Administrative boundaries of NUTS 2006. http://epp.eurostat.ec.europa.eu/cache/GISCO/geodatafiles/NUTS_2006_03M_SH.zip. Luxembourg: Eurostat GISCO - European Commission; 2006.
26. Eurostat. New Cronos (Data downloaded: 25 April 2012). Manchester: ESDS International, University of Manchester; 2012.
27. Gleit DA, Horiuchi S. The narrowing sex differential in life expectancy in high-income populations: Effects of differences in the age pattern of mortality. *Popul Studies*. 2007;61(2):141-59.
28. Bobak M, Marmot M. East-West mortality divide and its potential explanations: proposed research agenda. *BMJ*. 1996;312(7028):421-5.
29. Forster DP, Józán P. Health in Eastern Europe. *Lancet*. 1990;335:458-60.
30. Rosicova K, Geckova A, Dijk J, Rosic M, Zezula I, Groothoff J. Socioeconomic indicators and ethnicity as determinants of regional mortality rates in Slovakia. *International Journal of Public Health*. 2009;54(4):274-82.
31. Strand BH, Groholt E-K, Steingrimsdottir OA, Blakely T, Graff-Iversen S, Naess O. Educational inequalities in mortality over four decades in Norway: prospective study of middle aged men and women followed for cause specific mortality, 1960-2000. *BMJ*. 2010;340:c654.
32. Diderichsen F, Hallqvist J. Trends in occupational mortality among middle-aged men in Sweden 1961-1990. *Int J Epidemiol*. 1997 Aug;26(4):782-7.
33. Leclerc A, Chastang JF, Menvielle G, Luce D. Socioeconomic inequalities in premature mortality in France: Have they widened in recent decades? *Soc Sci Med*. 2006;62(8):2035-45.
34. Leinsalu M, Vågerö D, Kunst AE. Estonia 1989-2000: enormous increase in mortality differences by education. *Int J Epidemiol*. 2003;32(6):1081-7.
35. Shkolnikov VM, Andreev EM, Jasilionis D, Leinsalu M, Antonova OI, McKee M. The changing relation between education and life expectancy in central and eastern Europe in the 1990s. *J Epidemiol Community Health*. 2006;60(10):875-81.

36. Kolodziej H, Lopuszanska M, Bielicki T, Jankowska EA. Social inequality in premature mortality among Polish urban adults during economic transition. *Am J Hum Biol.* 2007;19(6):878-85.
37. Whitehead M. Diffusion of ideas on social inequalities in health: A European perspective. *Milbank Q.* 1998;76(3):469-92.
38. Marmot M. Interim first report on social determinants of health and the health divide in the WHO European Region – Executive summary. *European Social Determinants and Health Divide Review.* Geneva: World Health Organization Europe 2010.