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Research paper

Trends in life expectancy and healthy life years at birth and age 65 in the UK, 2008–2016, and other countries of the EU28: An observational cross-sectional study

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ABSTRACT

Background: As society ages, promoting the health of the extra years of life is of paramount importance for health, social care and pension provision. Increases in life expectancy in the UK and elsewhere have slowed in recent years, but the reasons for this are unclear. No formal comparison of trends in healthy life years between the UK and the other countries of the EU28 in recent times has been published. These countries are geographically proximate, and share many social, cultural and demographic properties, making them interesting and useful comparators, especially as the UK prepared to leave the European Union in 2020.

Methods: We calculated sex-specific healthy life years (HLY), unhealthy life years (ULY), mild and severe ULY at birth and age 65 using life tables and age-specific prevalence of activity limitation amongst the EU28 between 2008 and 2016 from EuroHex. Trends in life expectancy, HLY, ULY and proportion of life spent healthy (HLY%) were compared. We then decomposed HLY temporal changes into relative effects of changes in healthy life and mortality, by age group.

Findings: Life expectancy at birth, and age 65, in the UK were increasing rapidly in 2008 but slowed around 2011. Germany, Portugal and France showed evidence of a similar slowing. HLY at birth in the UK decreased, whereas it increased in most EU28 countries. The UK experienced a period of absolute expansion of unhealthy life in both sexes. The reduction in HLY at birth in the UK was mainly attributable to increases in unhealthy life in younger age groups.

Interpretation: The UK's performance relative to the other countries of the EU28 was poor after 2011, combining static life expectancy and reductions in healthy life years. These trends suggest that the UK government's Ageing Society Grand Challenge (to increase the healthy life expectancy by five years by 2035) will be difficult to attain.

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1. Introduction

Life expectancy (LE) in the UK increased significantly over recent decades but the increase has recently slowed [1,2]. Reasons underlying this are not fully understood, but may include cuts to public spending on health and social care under austerity, increasing mortality rates from seasonal influenza combined with more frequent extremes of temperature, a larger proportion of the population in the 'susceptible' group of older, frail people [3–5], and a higher mortality rate amongst the working age population [6]. A slowing in the rate of increase in LE has also been seen in the US and a few European countries (France, Germany, Sweden, the Netherlands) since 2011 [2,7]. Given that other countries in the EU have already achieved higher LE than the UK, it seems unlikely that the deceleration in the UK is due to being close to the natural maximal lifespan of human beings [8].

Given the ageing of populations worldwide, the need to ensure that the extra years of life are lived in good health is of vital importance to ensure adequate health, social care and pension provision. The concept of healthy life expectancy is therefore of interest to health and economy stakeholders. This indicator has been in use for several years, but differing definitions of 'disability' and calculation methods have hampered between-country comparisons [9]. Since 2005, the EU has reported healthy life years (HLY), a disability-free life expectancy based on the Statistics on Income and Living

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Research in Context

Evidence before this study

Data from Public Health England and the Organisation for Economic Cooperation and Development (OECD) and others have published evidence that the rate of increase in life expectancy in several developed countries worldwide has slowed in recent years, including in the UK. In addition, Sir Michael Marmot conducted a report into health inequalities in England, published in 2010, and recently updated in 2020, which highlighted stalling life expectancy increases and widening health inequalities. Narrative reviews of healthy life expectancy trends for countries with appropriate data have been published, but quantitative analyses of trends in healthy life years (HLY) have not. Disparities in health expectancies between countries have, therefore, not been scrutinised in detail.

Added value of this study

Our findings compare the performance of the UK, over the post-financial crisis period, to the other countries of the EU28, and decompose the changes seen into the effects of mortality and disability. We are therefore able to compare directly trends in life expectancy and healthy life years between countries, and to provide a deeper understanding of the drivers of the changes seen. We report that, after 2011, the UK performed poorly, in almost all measures, compared to the EU28.

Implications of all the available evidence

Our work highlights and quantifies the substantial disparities in health and life expectancy between the UK and its nearest neighbours, adding to the pool of evidence showing that the UK is in need of considerable change in health and social care policy to address these failings. Although the time period of analysis preceded the COVID-19 pandemic, our findings provide a benchmark when assessing the effect of the pandemic on the health and life expectancies of European countries who have been differentially impacted.

Conditions (EU-SILC) annual survey, with improved harmonisation and therefore comparability since 2008 [10]. It is important to track trends in LE and HLY to ensure policy reforms aimed at shortening and delaying the time spent in ill health/dependence (termed 'compression of morbidity/disability') [11], and avoiding the converse, i.e. an increase in the years lived in ill health/dependence ('expansion of morbidity/disability') [12].

Although there have been a number of analyses comparing trends in LE with those of the EU and other high-income OECD countries [2,6,7], to date there have been no quantitative analyses of trends in HLY. This study aimed to compare trends in LE and HLY between the UK and the other countries of the EU28 using harmonised data in order to identify important differences, and to provide a benchmark of the UK's performance before the COVID-19 pandemic and prior to leaving the European Union in early 2020.

2. Methods

2.1. Data source

Full life tables for all countries of the EU28 between 2008 and 2016 were available from the EuroHex website (www.eurohex.eu) (except for Croatia whose data were only available from 2010). Results from the EU-SILC annual survey of non-institutionalised persons of 16 years and older were downloaded from the same source for all EU28 countries over the same period [10]. Healthy life was defined using the survey question PH030, 'For at least the last 6 months have you been limited in activities people usually do, because of a health problem?' with responses: 1) yes, strongly limited, 2) yes, limited or 3) not limited. We downloaded the proportions of participants in each response category by 5-year age band and sex.

2.2. Statistical analysis

Sex and age specific HLY at birth, and age 65, for each country of the EU28 were estimated using the Sullivan method [13] with healthy defined as without any limitation. To calculate HLY at birth, we approximated the proportion of respondents with any limitation (i.e. those who answered 'yes, limited' or 'yes, very limited') aged 15 and under using the EuroStat method (i.e. the proportion at age 15 was assumed the same as at 16–19, and below age 15 to be half that proportion, with 0% of people assigned any limitation at birth) [14]. We also estimated years with severely ill-health (sevULY) based on participants who answered 'Yes, strongly limited'. Mild ULY was calculated similarly using the proportion of respondents who reported 'yes, limited'. The proportion of remaining life expectancy that was healthy (HLY%) was estimated as HLY%=HLY/LE. We calculated 95% confidence intervals for all health expectancies (and HLY%) at ages above age 15 by standard methods [15].

Country and sex-specific trends in LE and HLY were plotted, and where non-linearity was suspected, change-point linear analyses were implemented and compared to simple linear models using automated single knot placement and adjusted R^2 values [16].

Absolute expansion of unhealthy life was assumed where the simple linear model gradient of LE was significantly greater than that of HLY, and absolute compression of unhealthy life was defined as the converse. Relative expansion or compression of unhealthy life were defined as overlapping LE and HLY gradients alongside reducing, or increasing HLY% gradient, respectively, and dynamic equilibrium as significantly increasing ULY but stable or reducing severe ULY, i.e. where more years are being lived with ill-health, but the relative severity is reducing [17].

For countries with reductions in HLY between 2008 and 2016, and those with the greatest gains, we used an extension of the Arriaga decomposition technique [18] to examine the extent to which changes in HLY between 2008 and 2016 for each country were driven firstly by changes in mortality or the prevalence of unhealthy life, and secondly by specific age groups [19]. Prevalence of unhealthy life in the EU-SILC survey varies over time, therefore we tested the validity of our decomposition conclusions by repeating the analysis using 2009 and 2015 to ensure that our results were not unique to the specific combination of years chosen. All analyses were conducted in R version 6•3•2 [20] including segmented linear analyses with package 'segmented' [21].

3. Results

3.1. Trends in LE at birth and age 65 2008–2016

In 2008, life expectancy at birth was highest for French women (84.8 years) and Swedish men (79.2 years) (Figs. 1,2). The countries with the lowest LE at birth were Lithuania and Bulgaria (for men, 65.9 years and women, 77.0 years, respectively). LE in the UK in 2008 was the seventeenth highest in women (81.8 years) and tenth highest in men (77.7 years). By 2016, the highest LE for men was recorded in Italy (81.0 years) and for women, in Spain (86.3 years) and the lowest in Lithuania and Bulgaria (for men 69.1 years, and women 78.5 years, respectively). The UK remained tenth and seventeenth highest LE at birth in 2016 in men and women, respectively (Figs. 1,2). In most countries, LE at birth increased steadily between 2008 and 2016, with the exceptions of UK and Germany, where modelling suggested

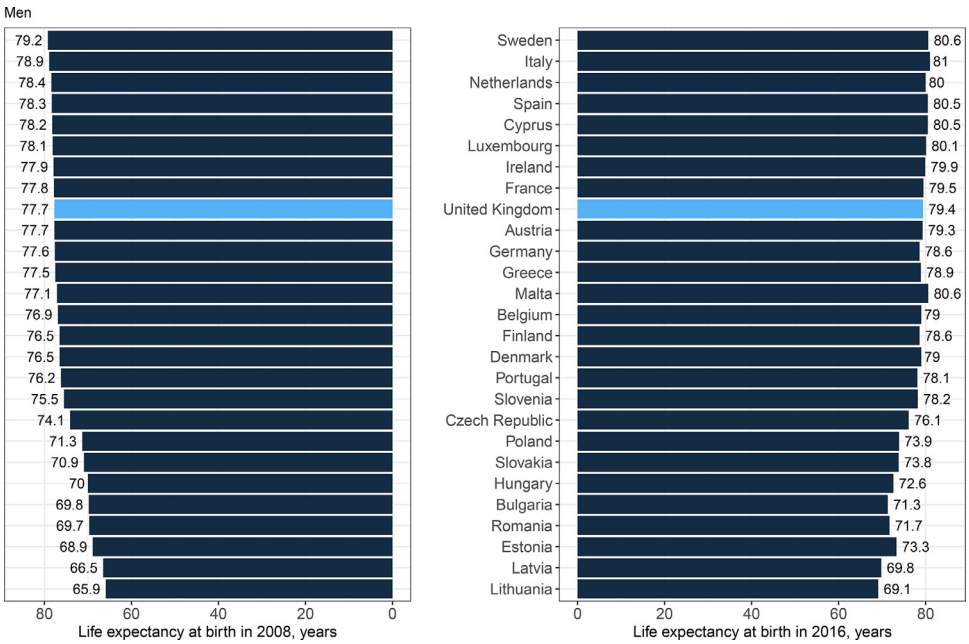

Fig. 1. Comparison of life expectancy at birth for men in the EU or UK in 2008 and 2016, ranked by 2008 values.

that the speed of increase reduced mid-way through the period (Fig. 3, Supplementary Figures 1,2). In the UK, modelling suggested that LE at birth for both sexes increased until around 2011, with no significant increase beyond this point (Supplementary Figure 2, Supplementary Table 1). The same pattern as the UK was observed for men's LE at birth in Germany until 2012 (Supplementary Figure 2). Moreover, the gradient of UK LE at birth was one of the steepest increases before 2011, but then dropped below all other countries (Fig. 2). Many countries saw a drop in LE at birth around 2015, which has been previously attributed to the combination of a severe influenza season in most high-income countries, and abnormally hot summer weather [22,23].

Modelling also suggested that the increase in UK men's LE at age 65 slowed significantly around 2011 (Supplementary Figures 3,4, Supplementary Table 2). In 2008 the UK had the eighth highest LE at age 65 for men (17.6 years), and the sixteenth highest for women (20.2 years), but by 2018 both had dropped down one place (women, seventeenth with 21.1 years, men to ninth with 18.8 years). Germany and Portugal also saw a deceleration in the LE increases at age 65 during the period (Supplementary Figure 3), whereas all other countries saw predominantly linear increases (Supplementary Figure 5).

3.2. HLY trends 2008–2016

The highest HLY at birth in 2008 was seen in Sweden for men (69.4 years) and Malta for women (72.1 years), and in 2016 was highest in Sweden for both sexes (men 73.1 years, women 73.4 years) (Figs. 4,5). HLY for UK women was the third highest in 2008 (66.3 years) but fell to 14th highest by 2016 (63.1 years) (Fig. 5). UK men had the fourth highest HLY at birth in 2008 (65.0 years) but the 11th

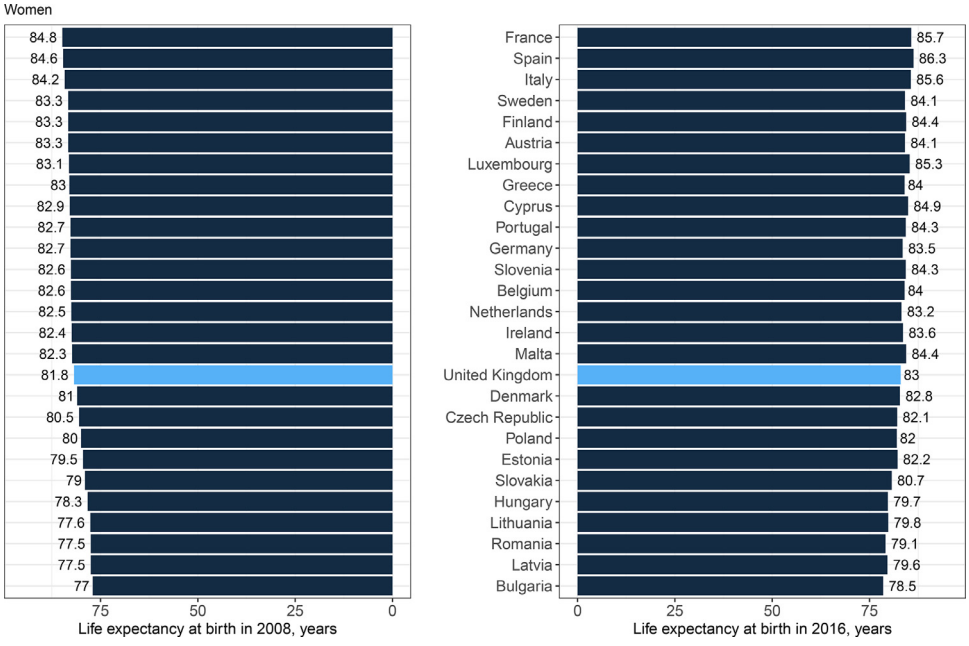

Fig. 2. Comparison of life expectancy at birth for women in the EU or UK in 2008 and 2016, ranked by 2008 values.

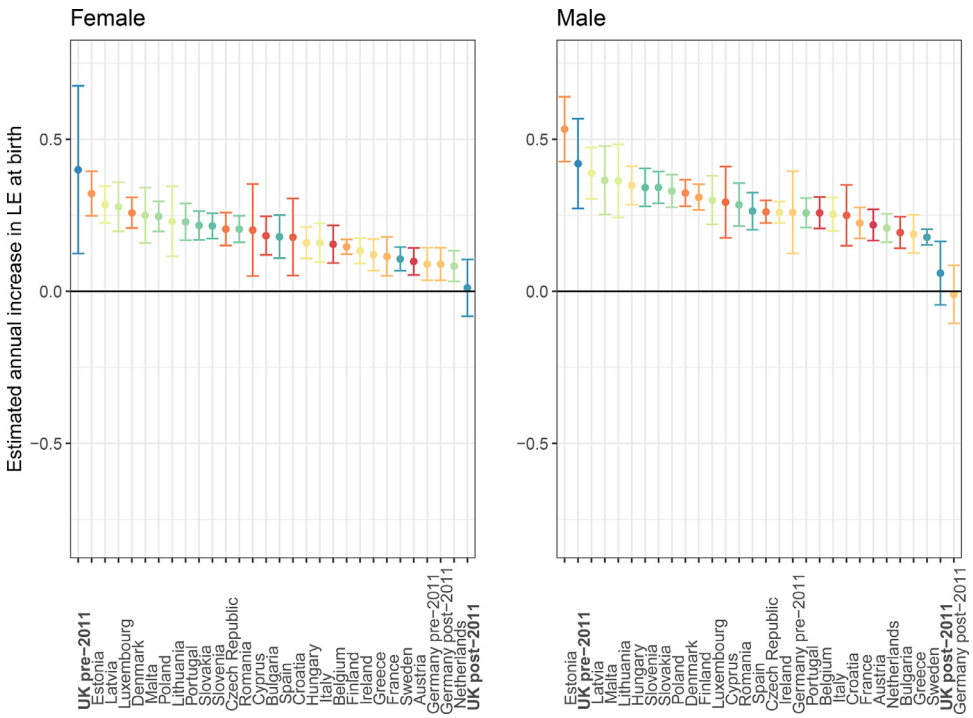

Fig. 3. Estimated simple linear model gradient of life expectancy at birth in the UK before and after 2011 compared to the other countries of the EU28 between 2008 and 2016. Those countries whose gradient changed significantly are represented by their pre- and post-changepoint gradients.

highest in 2016 (63.1 years) (Fig. 4). Whereas HLY for women in the UK dropped linearly, at a rate of −0•40 (95% CI −0•34, −0•47) years per year, for men HLY remained stable until around 2011 when it began to descend at a similar rate to women (−0•40, 95% CI −0•30, −0•50 years per year)(Supplementary Figure 6).

Although trends in HLY at birth were more variable than trends in LE over the same period, the UK was in the minority of countries where HLY at birth was lower at the end than the start of the period (Fig. 6, Supplementary Figure 6). There was also evidence of a substantial reduction in HLY at birth in Austria, Greece and Luxembourg. We investigated these trends further by examining trends in mild ULY and severe ULY (Supplementary Figure 7). Only for Austria could the increase in ULY be clearly attributed to an increase in mild ULY, in the UK, Greece and Luxembourg trends in mild and severe ULY were similar (Supplementary Figure 7).

The UK was in the group of countries whose HLY at age 65 remained largely the same across the period (Supplementary Figure 8), although there was some evidence of an increase in UK HLY at age 65 towards the end of the period (Supplementary Figure 9).

The proportion of remaining life at birth spent healthy (HLY% at birth) in the UK decreased linearly between 2008 and 2016 (Supplementary Figure 10), as in most EU28 countries (Supplementary Figure

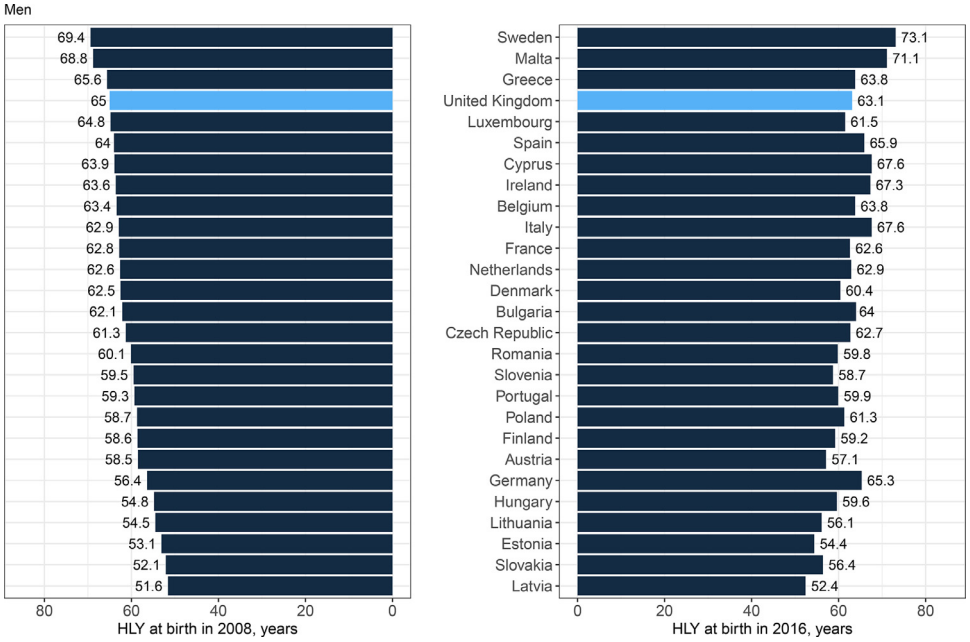

Fig. 4. Comparison of Healthy Life Years (HLY) at birth in EU and UK men in 2008 and 2016, ranked by 2008 values.

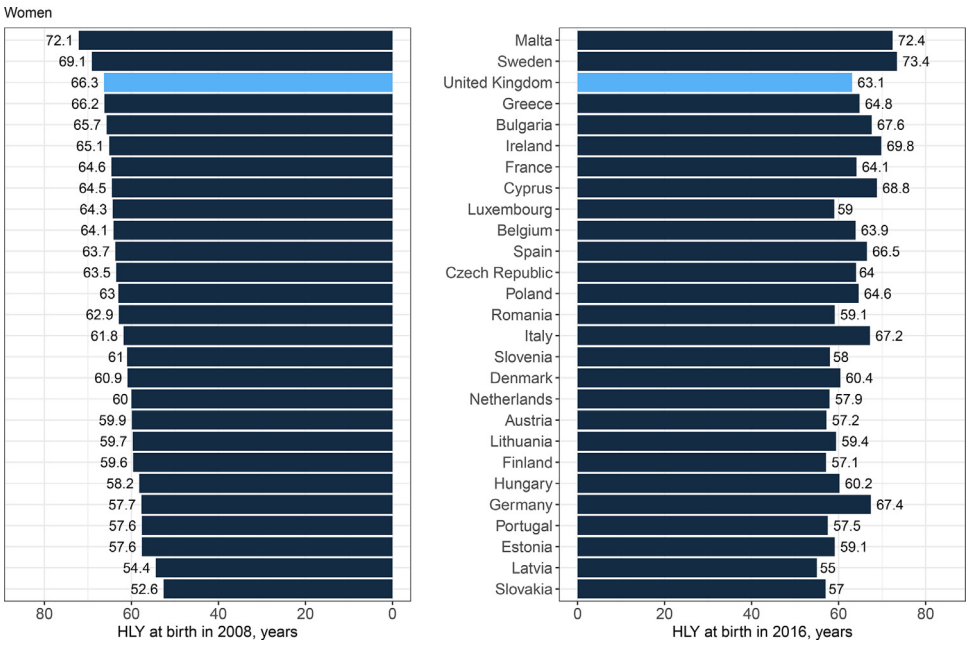

Fig. 5. Comparison of Healthy Life Years (HLY) at birth in EU and UK women in 2008 and 2016, ranked by 2008 values.

11). The theoretical goal for all countries is a large LE combined with a large HLY%. When we directly compared the absolute values of these parameters in 2016, countries that performed well in both dimensions (defined arbitrarily as above the sex-specific 80th centiles for both) in both sexes were Malta and Cyprus (Fig. 7). When linear gradients of these dimensions were compared, analogous to comparing speed of 'improvement' of each country, again Malta appeared to perform well for men and women (Supplementary Figure 12). Under both scenarios, the UK was not amongst the 'high-performing' countries, appearing in the bottom-left quadrant of both plots. Other countries in this quadrant included Austria, Greece, France, and the Netherlands.

As the number of HLY was decreasing, our analyses suggested that the UK was in a period of absolute expansion of morbidity between 2008 and 2016, as were Luxembourg, Greece, Estonia, Denmark and Austria (Fig. 8). HLY in Greece and Luxembourg also declined, but, unlike the UK, LE in those countries increased at a steady rate. Although from our analyses, Denmark, Estonia and Austria appeared to experience a period of absolute expansion of unhealthy life like the UK, they also experienced dynamic equilibrium, meaning unhealthy life was expanding but the severity of unhealthy life was not.

3.3. Decomposition of HLY changes between 2008 and 2016

We used decomposition to assess the relative contributions of mortality and disability effects in different age groups to the declines in HLY at birth between 2008 and 2016 in the UK. To assess whether there were common patterns, we repeated the decomposition analyses for Austria, Greece and Luxemburg (countries that also saw declines in HLY at birth over the same period), and, for contrast, Germany and Italy (countries having the highest gains in HLY at birth). For the four countries that saw declines in HLY at birth between 2008 and 2016 (Austria, Greece, Luxemburg, UK) there were broad similarities in the relative contribution of mortality and unhealthy life (Fig. 9). At younger ages, mortality reduced, but the effect of this was less than that of an increase in the prevalence of disability (grey bars

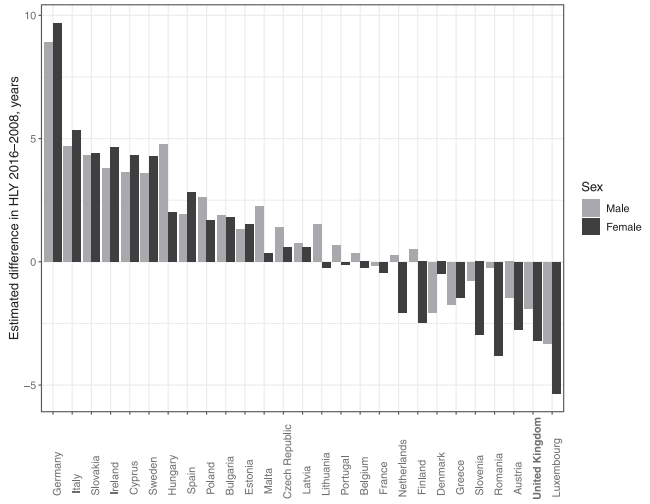

Fig. 6. Sex-specific change in HLY at birth between 2008 and 2016 for all countries of the EU28. Croatia omitted due to missing data before 2010.

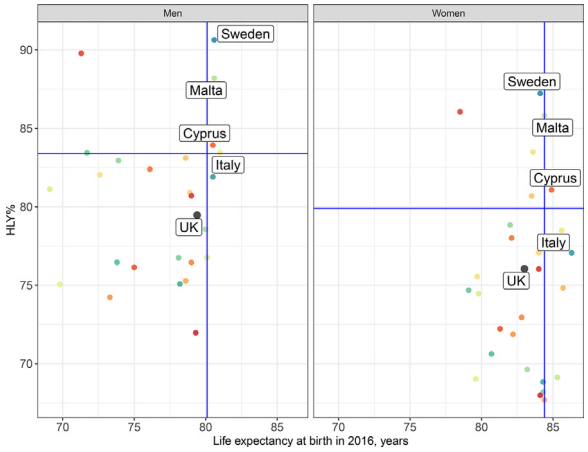

Fig. 7. Life expectancy and HLY proportion at birth in 2016 in all countries of the EU28. Blue lines indicate sex-specific 80th percentiles for each dimension.

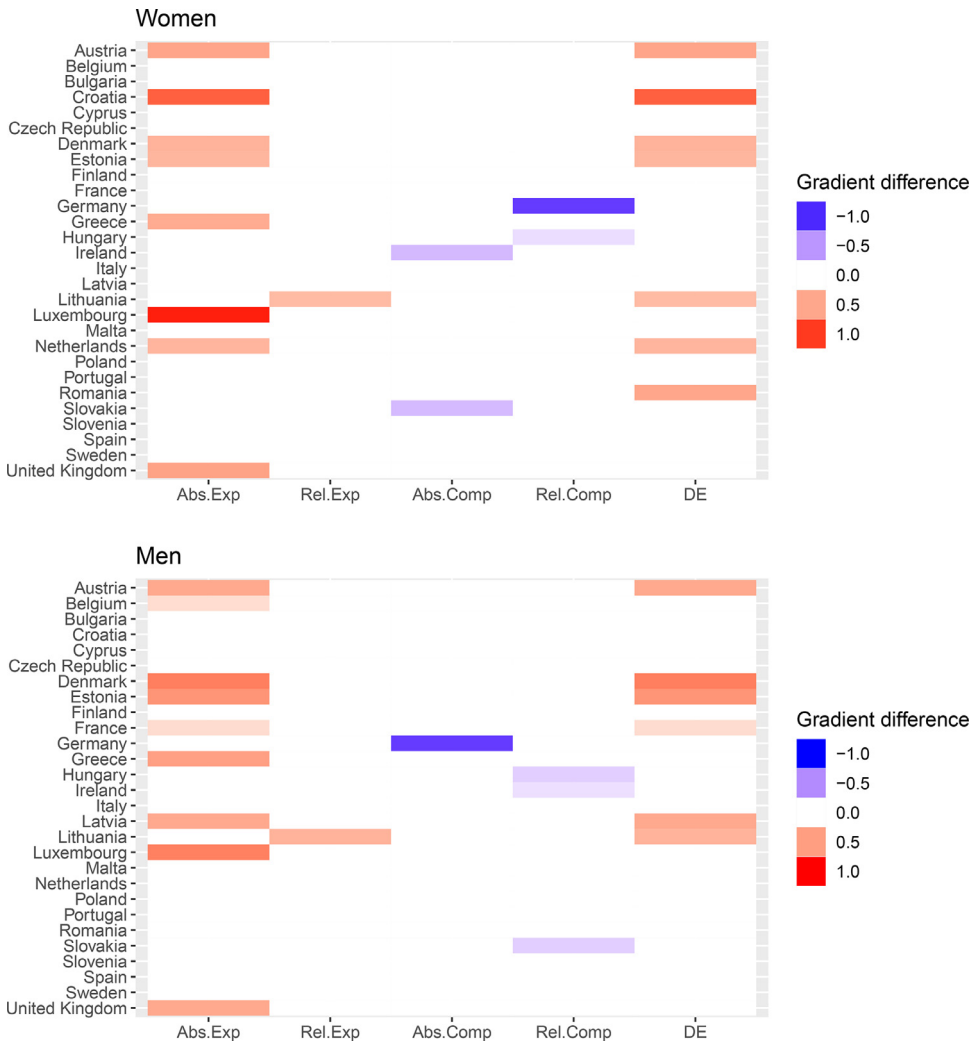

Fig. 8. Presence of absolute (Abs.) or relative (Rel.) compression (Comp) or expansion (Exp) of disability, or dynamic equilibrium (DE), for males and females of each country of the EU28 for the period 2008 to 2016. Simple linear gradients in LE and HLY over the study period were estimated (with 95% CI) for each country and compared. Red boxes indicate that LE gradient was significantly greater than HLY gradient, and blue indicates the opposite. Dynamic equilibrium was noted where 95% CI of LE and HLY gradients overlapped, ULY was increasing but severe ULY was not.

extend further downwards than black bars extend upwards). However, for the UK from age 55 (men) and ages 65–84 (women), and in the 75–84 years age group in Greece and Luxembourg, reductions in mortality contributed more than increases in unhealthy life (upward black bars larger than downward grey bars). Indeed the prevalence of unhealthy life in UK women aged 85+ reduced over the period (leading to grey bars above zero), as it did in this age group for women in Greece and Luxembourg, and for men in Austria and Greece. Decomposition analyses were repeated comparing 2009 with 2015 to account for the annual variability in disability prevalence in some countries. Patterns of mortality and disability changes were similar, suggesting that our results are robust to specific choice of comparator years (data not shown). Italy and Germany both saw increases in HLY at birth between 2008 and 2016 (Supplementary Figure 6). In both, for all age groups except the oldest, reductions in unhealthy life were of greater consequence than mortality changes, and this relative importance of unhealthy life changes tended to increase across the life-course.

4. Discussion

Our study is the first to provide quantitative analyses to compare trends in life expectancy and HLY between the UK and the rest of the EU28, over a nine-year period from 2008 to 2016. Our results show that the majority of EU28 countries saw linear increases in LE, and a substantial number increases in HLY at birth between 2008 and 2016. However, from around 2011, UK LE increases at birth stalled, and HLY fell sharply, leading to a steady reduction in the proportion of remaining life spent healthy for both males and females. A sharp rise in the number of years spent with severe unhealthy life in UK females also occurred around 2011. Only three other countries of the EU28, Austria, Greece, and Luxembourg, had a significant decline in HLY over the period, but, unlike the UK, LE continued to increase in these countries. However, the common factor in the decline in HLY in all four countries was a greater increase in the prevalence of unhealthy life, particularly at younger ages, than reduction in mortality.

Our results are in line with previous work that identified a slowing of UK increases in LE in recent years [2,6,7,22]. Declines in old age mortality stalled in the Netherlands, Denmark and Norway during the 1980s and 1990s [24], and more recent stalling of LE increases have been reported in other high-income countries [25,26]. Given the similarity across many countries, it is unlikely that the UK's stalling LE can be fully attributed to adverse consequences of political economic austerity, as not all countries pursued such strident policies following the global economic crisis in 2008, but it is likely to have

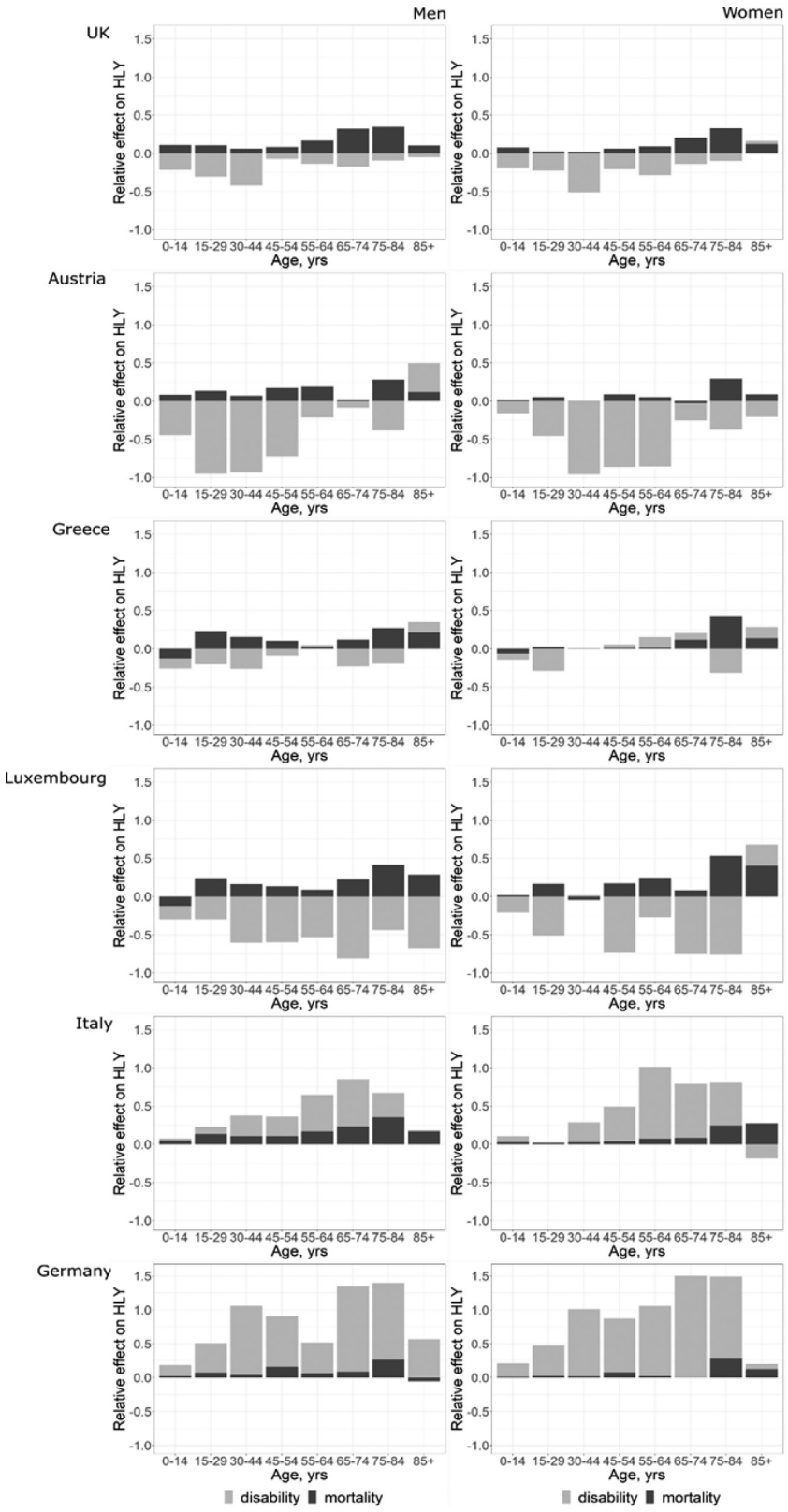

Fig. 9. Contribution of mortality and unhealthy life (reductions above zero, increases below zero) on changes in HLY at birth between 2008 and 2016, by gender for Austria, Luxemburg, UK (where HLY declined) and Germany and Italy (where HLY increased the most).

been a contributing factor. In Australia, the period before LE slowed was characterised by lower mortality compared to Western Europe and the USA, and was attributed to lower prevalence of smoking and obesity-related diseases and fewer traffic-related deaths [26]. The subsequent slowing of LE improvement in Australia was attributed to worsening dietary quality leading to increased prevalence of overweight and obesity and thereby, to an increase in cardiovascular disease [6]. The data available for use in the present study were not

sufficient to incorporate analyses into these hypotheses for the UK. Although a number of previous studies have presented comparative trends in LE, including between European countries, the only comparisons of trends in HLY have been qualitative in nature [17]. Our present study adds to this by applying robust quantitative methods to decompose changes in HLY across Europe. The time period chosen for study began during the global financial crisis in 2008. Due to data availability, it was not possible to select a more recent epoch, however the effects of the financial crisis were, as the name suggests, global. Therefore, cross-country comparisons at this time are valid, as all were suffering some level of financial downturn.

In 2008, the UK government commissioned Sir Michael Marmot to undertake a review of life expectancy and health inequalities in England. The resulting report, 'Fair Society, Healthy Lives' was published in 2010 [27]. A series of evidence-based recommendations for reducing health inequalities were advocated and many were taken up in subsequent years by local governments and other organisations. An update to this report was published in 2020, highlighting regressive policies and practices by central government, which had led to stalling of increases in LE and widening inequality [3]. Although the current study could not identify health inequalities within the countries of interest using the data sources available, the direction and timing of the changes reported match those of the Marmot review. The review postulated that reductions in the increase in LE were probably partially associated with increased mortality rates from seasonal influenza, and increases in social, economic and political inequalities over ten years of austerity-led policies.

The UK government has committed to achieving its 'Ageing Society Grand Challenge', whereby it aims, through targeted funding and policies, to add five healthy years of life to the average UK lifespan by 2035 and to reduce health inequalities. Other countries have incorporated improvement in healthy life years into government targets, in both health and pension policy domains. In particular, the Estonian Ministry of Social Affairs altered national health plan policy in light of worse-than-expected HLY analyses, and HLY form an important part of their sustainable development strategy. Sustainability of the Estonian pension system is being improved through prioritisation of HLY in order to increase the length of people's working lives, thus postponing retirement. HLY is also used to monitor progress in key European policies on health such as the 2000 Lisbon strategy.

Although similarities were found in LE and HLY trends between the UK and other EU28 countries, no other country saw a combined slowing of the increase in LE at birth and age 65 alongside reducing HLY and HLY%. The resultant classification of the state of health in the UK between 2008 and 2016 was one of 'absolute expansion of unhealthy life', meaning more years would be lived with some level of long-standing disability, in both sexes. Other countries that saw a period of absolute expansion were Luxembourg, Greece, Estonia, Denmark and Austria, but in all LE grew steadily throughout the period. There was some evidence that unhealthy life in Estonia, Denmark and Austria was becoming relatively less severe, despite expanding, which was not the case in the UK. Few countries showed evidence of compression of unhealthy life (Slovakia, Germany, Ireland and Hungary).

In 2020 the UK began to suffer its first cases of the COVID-19 viral pandemic. At the time of writing the second wave of infections was underway, and all countries were implementing different healthcare and fiscal policies to mitigate the worst effects of the disease and the repercussions of necessary public health interventions. How the pandemic will affect trends in LE and HLY is unknown, but it is expected that some penalty in LE will be evident, especially for older age groups, and HLY may reduce due to cases of 'Long COVID' [28].

5. Strengths and limitations

The strength of our study lies in the use of a very large and comprehensive survey on healthy life (measured using activity limitation) across the whole population of the countries of interest, over a wide multi-year timespan. Undertaking a quantitative analysis of the trends is also a strength, although the relative shortness of the time period did not allow more formal time series analyses. Other limitations relate to missing data, the self-report nature of the underlying activity limitation data, and the still incomplete harmonisation of the EU-SILC question. Data for Croatia were missing prior to 2010, though we do not feel this omission to be influential in the context of our results and conclusions. Perhaps more importantly the EU-SILC survey that provides the activity limitation data, is only undertaken for individuals aged 16 years and over. To calculate HLY at birth therefore assumptions need to be made about the prevalence for those aged 0–15 years. We used standard Eurostat assumptions about the prevalence of disability in persons under 16 years of age [14]. Trends for HLY at age 65 are unaffected by these assumptions, and those from birth are unlikely to have been substantially affected since disability in this younger age group is comparatively rare. Data on activity limitation were self-reported, which could have potentially introduced a source of bias, however such data have been shown to be closely associated with morbidity and mortality [29]. Also, we report trends in HLY and compare these between countries rather than directly comparing point estimates of HLY. In addition, although harmonisation of the EU-SILC question between European countries was improved in 2008, it remains sub-optimal and further changes in the question may have been implemented in individual countries over the period of analysis. We make no assumptions about future rankings of EU countries based on the metrics described here, as regression to the mean would likely lead to large variability in rank confidence intervals.

These comparisons provide interesting areas for future research and policy scrutiny to understand macro-level cross-sectional and longitudinal differences in population ageing between and within countries.

Contributors

CW and CJ initiated the study. All analysis and drafting were performed by CW who is guarantor of the analysis. All authors contributed to the framing of the analytical conclusions, editing of the paper, and have seen and approved the final manuscript version.

Data sharing statement

Data are publicly-available from EuroHex (http://www.eurohex.eu/).

Declaration of Competing Interest

Dr Welsh has nothing to disclose. Dr Jagger has nothing to disclose. Dr Matthews has nothing to disclose.

Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.lanepe.2020.100023.

References

[1] Public Health England. A review of recent trends in mortality in England. 2018 https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/827518/Recent_trends_in_mortality_in_England.pdf.

[2] Marshall L, Finch D, Cairncross L, Bibby J. Mortality and life expectancy trends in the UK: stalling progress. 2019 https://www.health.org.uk/sites/default/files/upload/publications/2019/HL04_Mortality-trends-in-the-UK.pdf.
[3] Marmot M, Allen J, Boyce T, Goldblatt P, Morrison J. Health equity in England : the marmot review 10 years on. London.
[4] Christiensen K, Doblhammer G, Rau R, Vaupel JW. Ageing populations: the challenges ahead. NIH Public Access 2009;374:1196–208.
[5] Papanicolas I, Mossialos E, Gundersen A, Woskie L, Jha AK. Performance of UK national health service compared with other high income countries: observational study. BMJ 2019;367:1–12.
[6] Leon DA, Jdanov DA, Shkolnikov VM. Trends in life expectancy and age-specific mortality in England and Wales, 1970–2016, in comparison with a set of 22 high-income countries: an analysis of vital statistics data. Lancet Public Health 2019;4:e575–82.
[7] Raleigh VS. Trends in life expectancy in EU and other OECD countries. OECD Health Working Papershttps://doi.org/. doi: 10.1787/223159ab-en.
[8] Dong X, Milholland B, Vijg J. Evidence for a limit to human lifespan. Nature 2016;538:257–9.
[9] Bogaert P, van Oyen H, Beluche I, Cambois E, Robine JM. The use of the global activity limitation Indicator and healthy life years by member states and the European commission. Arch Public Health 2018;76:1–7.
[10] Eurostat. EU statistics on income and living conditions (EU-SILC) methodology - data quality. Eurostat statistics explained. 2020 https://ec.europa.eu/eurostat/statistics-explained/index.php/EU_statistics_on_income_and_living_conditions_(EU-SILC)_methodology_–_data_quality.
[11] Fries J. Aging, natural death, and the compression of morbidity. N Engl J Med 1980;303:130–5.
[12] Kramer M. The rising pandemic of mental disorders and associated chronic diseases and disabilities. Acta Psychiatr Scand 1980;62:382–97.
[13] Sullivan DF. A single index of mortality and morbidity. HSMHA Health Rep 1971;86:347–54.
[14] Eurostat. Healthy life years expectancy disability-free life expectancy – DFLE method. 2013 http://epp.eurostat.ec.europa.eu/cache/ITY_SDDS/Annexes/hlth_hlye_esms_an1.pdf.
[15] Hughes I, Hase T. Measurements and their uncertainties. a practical guide to modern error. Oxford : New York: Oxford University Press; 2010.
[16] Muggeo VMR. Estimating regression models with unknown break-points. Stat Med 2003;22:3055–71.
[17] Jagger C, Robine J, Crimmins E, Saito Y, van Oyen H, Tiene de Carvalho Yokota R. International handbook of health expectancies. Springer; 2020.
[18] Arriaga E. Measuring and explaining the change in life expectancies. Demography 1984;21:83–96.
[19] van Raalte A, Nepomuceno M. Decomposing gaps in healthy life expectancy. International handbook of health expectancies. Springer; 2020.
[20] R Core Team. R: a language and environment for statistical computing. R foundation for statistical computing. 2015 http://www.r-project.org/.
[21] Muggeo V.M.R. segmented: an R package to fit regression models with broken-line relationships. 2008;: 20–5.
[22] Debón A, Chaves L, Haberman S, Villa F. Characterization of between-group inequality of longevity in European Union countries. Insur: Math Econ 2017;75:151–65.
[23] Hiam L, Dorling D, Harrison D, McKee M. What caused the spike in mortality in England and Wales in january 2015? J R Soc Med 2017;110:131–7.
[24] Janssen F, Mackenbach JP, Kunst AE. Trends in old-age mortality in seven European countries, 1950-1999. J Clin Epidemiol 2004;57:203–16.
[25] Fenton L, Minton J, Ramsay J, et al. Recent adverse mortality trends in Scotland: comparison with other high-income countries. BMJ Open 2019;9:1–9.
[26] Lopez AD, Adair T. Slower increase in life expectancy in Australia than in other high income countries: the contributions of age and cause of death. Med J Aust 2019;210:403–9.
[27] Marmot M, Bell R. Fair society, healthy lives (Full report). Public Health 2012;126:S4–10.
[28] Azarpazhooh MR, Morovatdar N, Avan A, et al. COVID-19 pandemic and burden of non-communicable diseases: an ecological study on data of 185 countries. Journal of Stroke and Cerebrovasc Dis 2020;29:1–9.
[29] Berger N, van Oyen H, Cambois E, et al. Assessing the validity of the global activity limitation indicator in fourteen European countries. BMC Med Res Method 2015;15. doi: 10.1186/1471-2288-15-1.