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EVOLUTION OF SEX GAP IN LIFE EXPECTANCY ACROSS HIGH-INCOME COUNTRIES: UNIVERSAL PATTERNS AND COUNTRY-SPECIFIC ATTRIBUTES

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EVOLUTION OF SEX GAP IN LIFE EXPECTANCY ACROSS HIGH-INCOME COUNTRIES: UNIVERSAL PATTERNS AND COUNTRY-SPECIFIC ATTRIBUTES[2]

The sex gap in life expectancy (LE) at birth is currently narrowing in all high-income countries. Previous research on Western European and English-speaking (WE&ES) countries suggested that smoking-related mortality at ages 50+ was largely responsible for both widening and subsequent narrowing of the gap. However, countries of Central and Eastern Europe (CEE) have had particularly high excess male mortality at young and middle ages that couldn`t be fully attributed to the smoking-related causes.

We use the Human Mortality Database to examine the patterns and time trends in male/female differences in LE across 41 high-income countries and 7 country groups from 1959 until the latest available year. Contour decomposition is applied to estimate the contribution of different ages to the maximum sex gap and its change ever since.

While the UK was the first country to reach the peak in the sex gap in 1969, Greece did it half a century later, in 2009. The largest male disadvantage in LE was observed in Russia in 2005 (13.7 years), Israel had a peak in 1999 with just 4.4 years. There is a persistent difference between countries and particularly country groups in the age-specific contribution to the maximum sex gap. In WE&ES countries ages older than 50 play the major role in determining the sex gap while CEE countries have high excess male mortality in young and middle ages (20-50). The narrowing of the sex gap in CEE countries hasn`t substantially changed the age contribution. Mortality at ages younger than 50 still plays an important role in determining the sex gap in LE in these countries.

Differences in the sex gap between countries add a new dimension to a previously established East-West mortality divide. Country specifics must be taken into account to develop public health policies aimed at reducing sex mortality inequalities.

JEL Classification: J10, J11, I14, N32, N34.

Keywords: sex gap in life expectancy, gender differences in health, mortality, decomposition.

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Introduction

Nowadays women live longer than men in all the countries of the world (United Nations 2019). However, the female advantage in mortality is a relatively new phenomenon that emerged in the last 150 years over the course of epidemiological transition (Omran 1971). The shift from the prevalence of infectious and parasitic diseases to the dominance of cardiovascular and other non-communicable diseases alongside the reduction of maternal mortality has led to higher gains in female life expectancy (LE) (Beltrán-Sánchez, Finch, and Crimmins 2015). The widening of the sex gap in LE became particularly pronounced after World War I in most of the high-income countries (Luy 2003). Ruth Bonita defines the changes in sex gap in life expectancy as "the gender transition" and distinguishes three stages: 1) similarity of male and female life expectancies, 2) increasing sex gap in LE due to firstly reduction of maternal mortality and subsequent higher rates of mortality improvements at middle and older ages in females compared to males, 3) narrowing of the sex gap as a result of females reaching the limits of mortality reduction (Bonita 1998).

Although there is a certain biological basis to the female advantage in mortality, time trends and country-specific variations in the sex gap in LE are largely determined by the differences in behavioural risk factors (Austad 2006; Carey and Lopreato 1995; Case and Paxson 2005; Eskes and Haanen 2007; Lang, Arnold, and Kupfer 1994; Luy 2003; Nathanson 1984; Rogers et al. 2010; Waldron 1976, 1983, 1985; Waldron and Johnston 1976; Wingard 1984; Zarulli et al. 2018). Social and behavioural factors that determine higher male mortality include first of all smoking (Huxley and Woodward 2011; McCartney et al. 2011; Östergren and Martikainen 2020; Preston and Wang 2006; Waldron 1986; Wensink et al. 2020), but also dangerous alcohol consumption (Kossova, Kossova, and Sheluntcova 2020; Rehm et al. 2007, 2009; Trias-Llimós and Janssen 2018), unbalanced diet (Rørholm Pedersen et al. 2016), reckless behaviour resulting in death from external causes (McKee and Shkolnikov 2001; Sorenson 2011), stress (Pietilä and Rytkönen 2008a), insufficient use of medical services (Galdas, Cheater, and Marshall 2005; Green and Pope 1999) and, probably treatment compliance but the evidence is still controversial (DiMatteo 2004).

Most of the studies of the sex differences in LE focus on Western European and English-speaking countries and attribute widening and narrowing of the sex gap to changes in mortality at ages 50+ due to smoking-related causes. Even when researchers show that there is "no common pattern of change in the sex gap in life expectancy" (Gjonca et al. 2005), the non-conforming countries are usually treated as outliers. Beltrán-Sánchez et al. (2015) has shown that sex differences in mortality started to grow in birth cohorts born after 1880 using data for 10

Western European countries, Australia, Canada, and the USA. He argued that "excess adult male mortality is *clearly* rooted in specific age groups, 50–70". At the beginning of the 20th century higher infant boys mortality also played an important role in determining the level of sex differences in LE, and excess male deaths at ages 60+ became the predominant later (Zarulli, Kashnitsky, and Vaupel 2021). Preston and Wang (2006) used USA data to show that sex differences in mortality at ages 50-84 changed on a cohort basis and correspond to changes in cohort smoking patterns. In Western European and English-speaking countries smoking is responsible for up to 50% of the sex gap at ages 50-85 between 1950 and 2015 (Wensink et al. 2020). The narrowing of the gap in G7 countries (except Japan) in the 20th century happened due to converging mortality at ages 55-75 from cardiovascular diseases and external causes (Trovato and Heyen 2006). However, research on early stages of the sex gap narrowing (Trovato and Lalu 1996) showed that changes in the probability of death in ages 25-59 explain the most variation in changes of sex differences in LE in 33 countries. Narrowing of the sex gap in LE can also happen because of differently shaped survival curves of men and women. Glei and Horiuchi (Glei and Horiuchi 2007) showed that due to the more rectangular shape of the female survival curve the same rate of improvement will result in smaller gains in LE in women compared to men resulting in narrowing of the gap. Cui, Canudas-Romo, and Booth (2019) further show that more dispersed male death distribution usually contributes towards the narrowing of the gap.

In Western European and English-speaking countries smoking-related mortality at ages older than 50 has played a crucial role in determining the rise and fall of the sex gap in mortality. However, countries of Eastern Europe, especially former USSR ones, had unique trends in mortality for decades, diverging from the rest of the developed world (Vallin and Meslé 2004). After decades of stagnation Russia and other Former Soviet Union (FSU) countries entered a period of massive fluctuations in mortality that spanned from the mid-1980s to the 21st century. Those fluctuations in mortality can to a large extent be explained by changes in alcohol consumption (Leon et al. 2010; Shkolnikov, McKee, and Leon 2001). Stress due to social and economic changes of the 1990s also affected mortality, especially for men, since "in situations of acute social and economic transition they, especially if single, are more vulnerable than women" (Walberg et al. 1998). In 2002 alcohol-attributable mortality accounted for over a third of all deaths at age 20-44 for men and 19.9% of deaths for women (Rehm et al. 2007). Only since 2003, LE improvement in Russia became statistically independent of alcohol consumption (Danilova et al. 2020). Enormous male excess mortality results in one of the biggest sex gaps in the world. Despite the extreme importance of the issue, we found no studies that have specifically addressed the peculiarity of the sex gap in Eastern Europe compared to the other countries.

In this paper, we question the uniformity of the pattern of the sex gap change over time. First, we investigate countries' diversity in the timing and magnitude of the maximum sex gap in LE, second, we show that age groups contribution to the maximum sex gap noticeably differs between country groups, and finally, we indicate that the established age contribution pattern is stable over time.

Data and methods

We use complete life tables and population exposures from the Human Mortality Database (HMD 2021) for 41 high-income countries with reliable vital statistics for the period since 1959 (first year of data for FSU countries) onwards. We group all countries under the study into 7 groups based on their geopolitical position (Table 1). The countries within groups have similar (but, of course, not identical) demographic histories and similar levels of mortality.

Table 1. Country groups under the study and data availability

Former Soviet Union	Belarus Estonia	Latvia Lithuania	Russia Ukraine
Central and Eastern Europe	Bulgaria Croatia (2001+) Czech Republic	Germany, East Hungary Poland	Slovakia Slovenia (1983+)
Asia	Hong Kong (1986+) Israel (1983+)	Japan Republic of Korea (2003+)	Taiwan (1970+)
Western Europe	Austria Belgium France	Germany, West Luxembourg (1960+)	Netherlands Switzerland
English-speaking	Australia Canada	Ireland New Zealand	UK USA
Southern Europe	Greece (1981+) Italy	Portugal	Spain
Northern Europe	Denmark Finland	Iceland Norway	Sweden

Note: data availability is shown for countries with time series beginning after 1959

The sex gap in LE for groups of countries was calculated as a difference between weighted by the population mean LE at birth of women and men. HMD exposure-to-risk data was used for weighting.

The maximum sex gap in LE was decomposed using a stepwise replacement algorithm (Andreev, Shkolnikov, and Begun 2002) using DemoDecomp3 R package. Decomposition of changes in sex gap into initial and trend component was done using contour decomposition algorithm (Jdanov et al. 2017) with R scripts from Max Planck Institute for Demographic Research Technical Report (Jdanov and Shkolnikov 2014). We decomposed changes in the sex

[3] https://cran.r-project.org/package=DemoDecomp

gap from the onset of sustained decline till the last available year. The date of onset of sustained decline in sex gap in LE at birth (LE) was taken from (Glei and Horiuchi 2007) or added following the same principle. The year of onset is the first year when (i) observed and 5-year mean sex gap is smaller than in a previous year, (ii) the level of 5-year mean sex gap was not later exceeded, (iii) the decline in sex gap was not interrupted by an increase of more than 0.25 years (for both observed and 5-year mean gap) or a sustained increase for 3 or more years (Glei and Horiuchi 2007).

Results

Timing of the maximum sex gap in life expectancy

The sex gap in LE at birth is now declining in all high-income countries. Taiwan (2015), Hong Kong (2012) and Belarus (2012) were the last three countries to join the trend of narrowing sex differences in mortality. But the current identical trend does not imply that there is an identical level of sex differences or there was identical history (figure 1). English-speaking countries were the first ones to reach a peak at the sex gap (7.36 years in 1975) and to achieve a sustained decline in it in 1978 (table 1). However, this pattern is far from being universal. Northern European and Western European countries followed this pattern shortly after, but the other countries had a growing male disadvantage for another 10 and even 20 years.

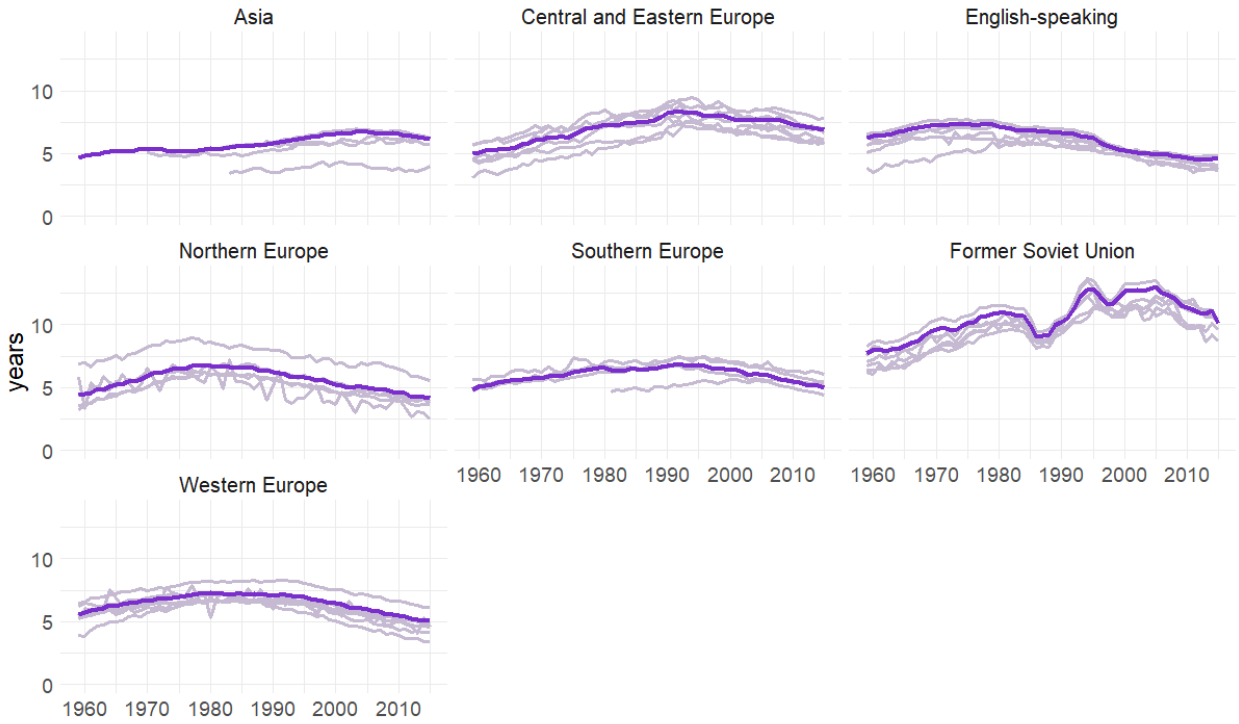

Figure 1. Change in sex gap in life expectancy at births.

Note: Weighted averages for groups of countries are shown in a bold purple line.

Among English-speaking countries, only Ireland has a slightly different dynamics of sex gap change reaching sustained decline only in 2001 but maintaining quite a low level of sex gap since the 1960s. In Northern Europe, Finland has higher levels of sex gap but follows the same pattern of change as the other countries in this group. Among western European countries France has a higher level of sex gap which is probably due to the remarkably high LE of French women and not because of the higher mortality of French men. Southern Europe is a heterogenous group: Italy behaves like Western European countries, Spain and Portugal lag and reaches max sex gap only in the mid-1990s, and Greece following a specific path with a generally very low gap but with late onset of its sustained decline (2010). Asian countries do not have a pronounced rise in the sex gap, the growth is quite slow and only stops in the 2000s. Israel is different: it has the lowest maximum gap of all countries (4.37 years) that started to narrow further in 2003. All these groups of countries have different timing of the maximum sex gap in LE but similar levels that do not exceed 8.5 years and for most countries is 6-7 years.

The situation is rather different for Central and Eastern European (CEE) countries and FSU states. CEE countries experienced a peak in the sex gap in the early 1990s which is not that unusual, but the level of the gap was and is substantially higher with a maximum gap of up to 9.46 years (Hungary). FSU countries are by far the leaders in the magnitude of the sex gap with an average gap of more than 13 years that they have reached later than all the other countries. All the groups of countries except FSU overlap in the magnitude of the sex gap, there are no definite cutlines between groups. FSU countries are very distinct: they all have a maximum gap of more than 11 years, and no other country gets even close. One other characteristic of FSU countries is major fluctuations in the sex gap in the 1980s-1990s that cannot be explained by cohort differences in smoking levels usually used to explain the rise in the sex gap.

Table 2. Maximum sex gap in LE in groups of countries, year of maximum sex gap, and the onset of sustained decline

Group	**Maximum value** (country-specific max-min range)	**Year of max gap**	**Onset of sustained decline**
Former Soviet Union	**13.04** (11.93-13.68)	**2005**	**2006**
Central and Eastern Europe	**8.39** (7.26-9.46)	**1992**	**1993**
English-speaking countries	**7.36** (5.9-7.74)	**1975**	**1978**
Western Europe	**7.26** (6.71-8.31)	**1980**	**1983**
Asia	**6.75** (4.37-6.96)	**2004**	**2005**
Southern Europe	**6.85** (5.75-7.5)	**1992**	**1994**
Northern Europe	**6.77** (6.23-9)	**1979**	**1980**

Notes: the year of onset is the first year when (i) observed and 5-year mean sex gap is smaller than in a previous year, (ii) the level of smoothed sex gap was not later exceeded, (iii) the decline in sex gap was not interrupted by an increase of more than 0.25 years (for both

observed and smoothed gap) or a sustained increase for 3 or more years (Glei and Horiuchi 2007).

Changes in the sex gap in western European and English-speaking countries happened alongside continuous growth of LE of both men and women. The reason behind such high sex gaps in CEE and FSU countries is not a slower rate of improvement of LE of men compared to women but long stagnation and even decline in male LE in the 1960s-1990s (fig.2). In CEE countries the sex gap started to decline as soon as both male and female LE begin to grow at the beginning of the 1990s and the same is true for FSU countries 15 years later.

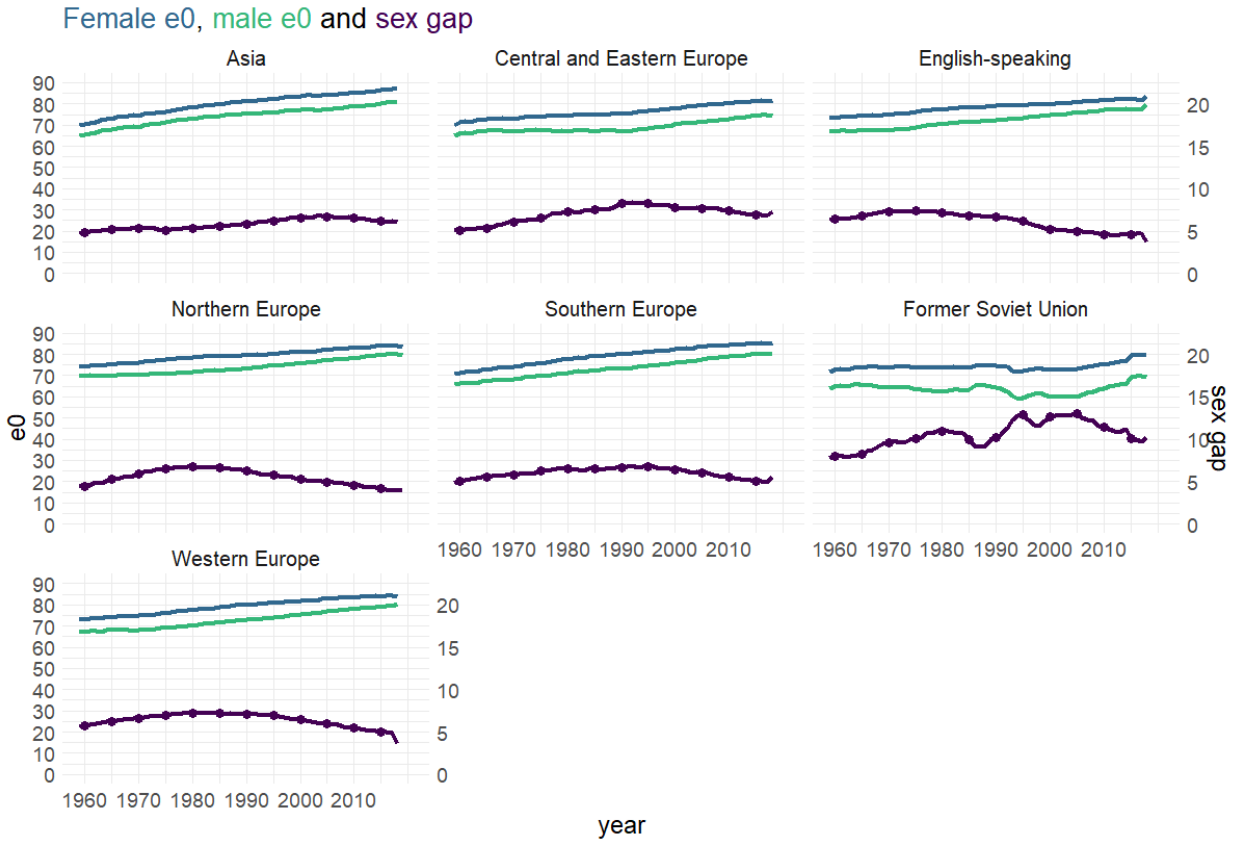

Fig. 2. Trends in male and female life expectancy at birth (LE– left scale) and sex gap in life expectancy (right scale), by country groups, in years.

So, although the sex gap in LE is narrowing in all high-income countries, there is a lot of variability in the year that narrowing started and the level it started from. CEE and FSU countries have the biggest maximum sex gap that widened during stagnation and deterioration in LE.

Age-specific contribution to the maximum sex gap

The contribution of age groups to the sex gap in LE differs in different countries. Here we decomposed the largest sex gap in LE for every country to see the age structure of the biggest mortality disparity. Of course, the composition of the sex gap depends not just on the country specifics but also on the time of the maximum sex gap. Countries that had the peak earlier (in the

1970s and 1980s) – English-speaking, Western, and Northern European – have a relatively large contribution of infant and child mortality to an overall gap (fig. 3). CEE and FSU countries despite having a max sex gap relatively late have a substantial contribution of early adult mortality (ages 20-44) that contributes up to 4.86 years to an overall gap (Russia). Most countries have a similar share of ages 45-69 – around 40-50% of the total gap, the exceptions are Japan (36.6%), Hong Kong (36.1%) and Switzerland (37.7%) that have a smaller contribution of this age group mostly balanced by a higher share of the age group 70+.

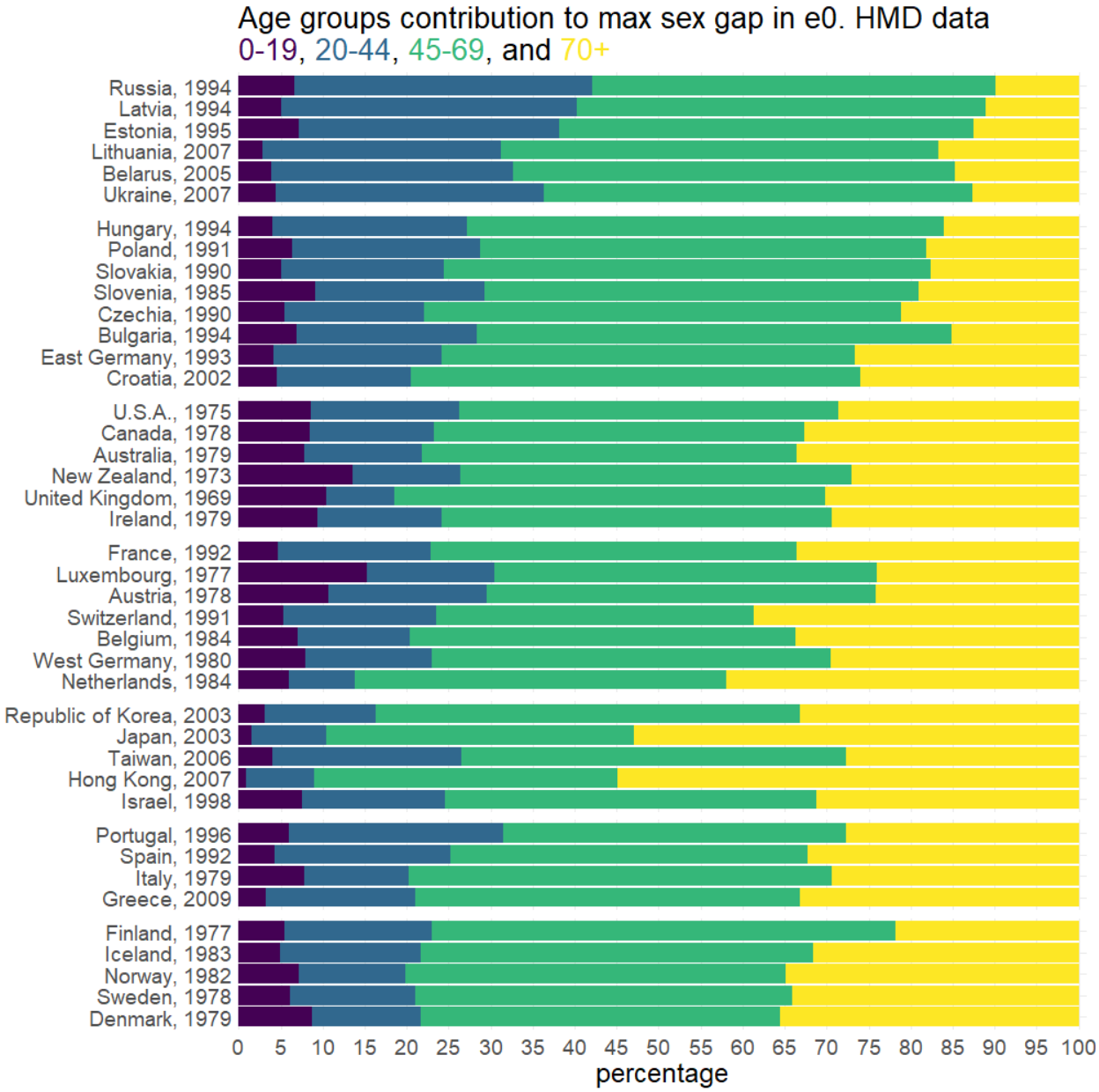

Fig. 3. Age groups contribution to the maximum sex gap in life expectancy at birth.

Note: Groups of countries are ordered from the biggest maximum gap on top to the smallest maximum gap at the bottom. Countries within groups are ordered in the same way.

CEE and FSU countries with the largest maximum sex gap have a relatively small contribution of mortality differences at older ages – less than 20% for all countries except Croatia (26%), Czech Republic (21.1%) and East Germany (26.6%). No country from the other groups has a share of this age group of less than 20% no matter the timing of the max sex gap. For example, the United Kingdom that was the first country to reach its peak in the sex gap in 1969 has a contribution of 30.2% for ages 70+. Even though there are relatively few deaths at younger ages in general, these deaths can seriously affect LE because of how many person-years are getting lost. The reduction of mortality in these ages should be a priority for national policymakers.

Narrowing of the sex gap.

The narrowing of the sex gap in different countries is happening due to changes in mortality in different age groups. We used contour decomposition to show the change in age groups contribution to the sex gap in LE at birth between the year preceding the onset of sustained decline in the gap (the maximum gap before the sustained decline) and the last available year. We did not use the year with the maximum sex gap as an initial year of decomposition because the trend might have been unstable, and the goal was to show changes in age groups contribution during the narrowing of the gap. Results for selected countries are shown in figure 4, other results can be found in appendix 2.

English-speaking countries and countries from Western, Southern, and Northern Europe show a substantial change in sex gap level partly due to a longer period of narrowing. These countries started with a clearly 2-peaked distribution of age groups contribution but managed to minimize sex differences in infant mortality with time. The majority of the reduction happened in ages older than 45 years, the contribution of young adult ages was very low to begin with, and during the narrowing became almost non-existing. There is a certain shift to older ages in contribution, but it is important to notice that these countries started with older ages contributing a lot to the sex gap even in the 1970s, so the shift is not that dramatic. In the UK, for example, the biggest contributors to the sex gap in 1973 were ages 65-74, in 2018 it is 70-79, and in France it is still 65-74 years in 2018 as it was in 1992. Although there is a small structural change in the ages contributing to the sex gap, these countries managed to substantially lower the contribution of all age groups up to 85-90 years. There is yet no improvement in the oldest ages. The picture is dramatically different for CEE and FSU countries and much younger ages contribute to the initial and final sex gap in LE. In Russia, in 2005 the biggest contributor was the age group 50-59 and in 2014 it is 55-64. There is little reduction in the contribution of ages older than 75 and although mortality of young males was reduced significantly ages 20-44 still

account for more than 30% of an overall gap (3.47 years out of 11.2 total). In Poland, there was almost no change in the contribution of ages younger than 35. In Asian countries, there has been a small change in the sex gap since the onset of sustained decline, and it follows the same pattern as in other countries: reduction of contribution in all age groups, a slight shift to older ages, almost no change at the very old ages.

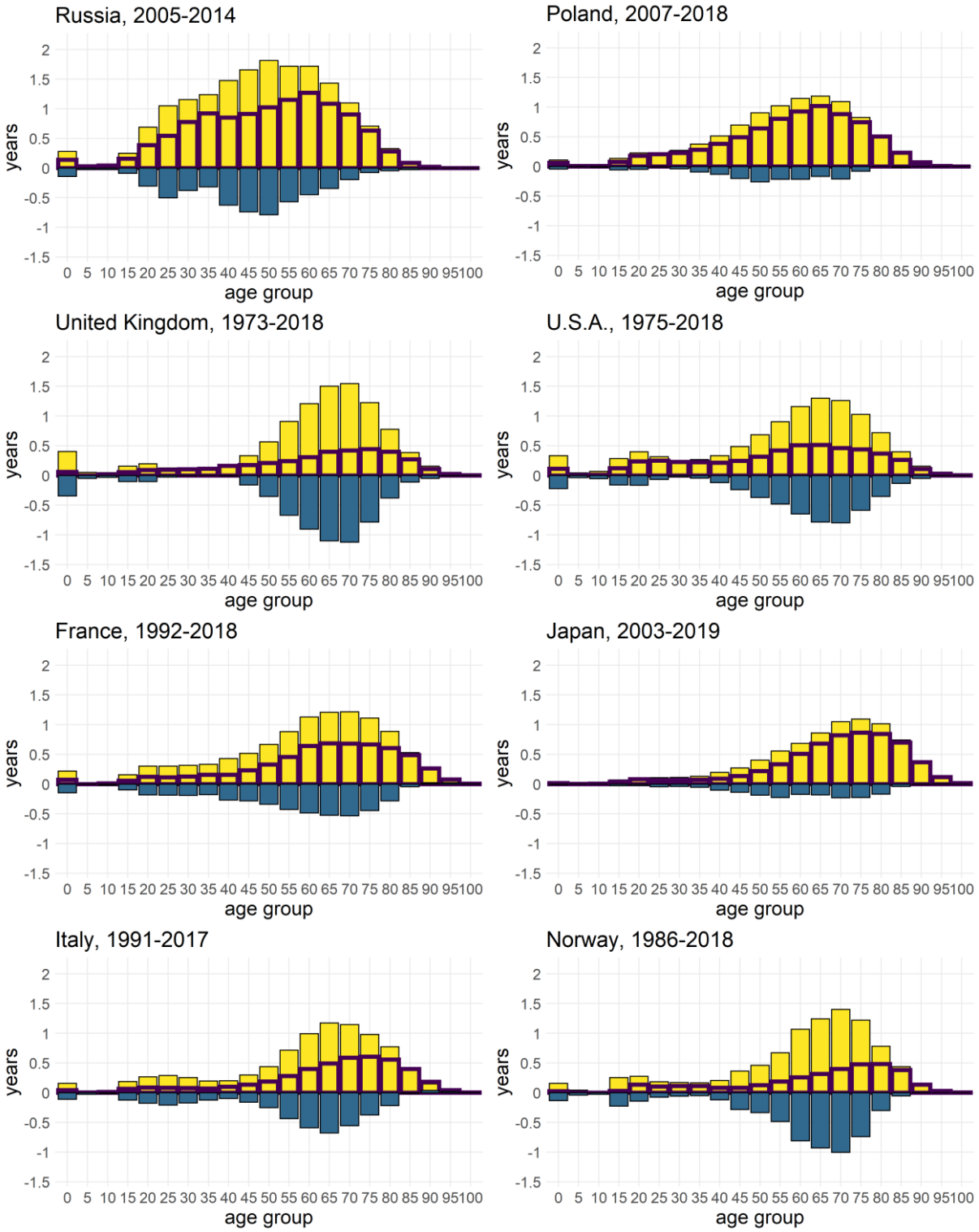

Fig. 4. Contour decomposition of changes in the sex gap in LE at birth.

Note: Yellow bars – contribution of age groups to the initial sex gap (first year in the title), blue bars – the trend of change in the contribution of age groups, purple line bars – contribution of age groups to the final sex gap.

Discussion

In this study, we showed that the sex gap in LE differs a lot between countries and country groups. Although there are some general trends and all HMD countries are currently experiencing a decline in sex mortality differences, the magnitude, and the timing of the maximum sex gap in LE, as well as age groups contribution to it, varies between country groups. Changes in the sex gap in LE do not follow one universal pattern – sex gap changes reflect country history, gender roles in society and gender health attitudes. FSU countries are unquestionable "leaders" in the level of the maximum sex gap in LE (13 years), and countries of Central and Eastern Europe have second largest sex gap (8.4 years). In Asian countries and in Northern Europe the maximum sex gap did not exceed 6.8 years. The start of sustained decline in the sex gap varies by almost 40 years with United Kingdom being a pioneer (1974) and Taiwan joining the global trend in 2015.

The rise in the sex gap in LE is often attributed to males' earlier uptake of smoking, and the following narrowing is the result of women catching up. Pampel (2002) reviews several studies (mostly done on USA data) on smoking contribution to sex differences in mortality and concludes that "cigarette smoking represents a major source of the difference in mortality between men and women" (p. 81). Waldron (1993) attributes the narrowing of the sex gap to an increase in female lung cancer mortality along with a "variety of additional factors" based on data from 23 developed countries. Eastern European countries - Poland, Hungary, Yugoslavia, and Bulgaria were included in the analysis together with Western European countries, Anglophone countries, and Japan. Eastern European countries did not have the same trends in male/female deaths rates ratio and sex differences in mortality from lung cancer as countries of Northern Europe and English-speaking countries, but the article focused on the countries that have already experienced narrowing of the gap. Preston and Wang (2006) showed that in the United States sex differences in cohort smoking patterns correspond well to sex differences in mortality. In Russia, the difference in smoking prevalence between men and women decreases since at least 1996 (Shkolnikov et al. 2020), during the time of rising and decrease in sex gap in LE. Representative data on cohort smoking patterns for Russia, unfortunately, does not exist. The key component of sex gap attribution to smoking-related mortality is the age structure of male/female mortality difference. The negative impact of smoking needs to accumulate, and it manifests itself in ages older than 50. Mortality before that age can hardly be attributed to

smoking alone. Our research shows that in FSU countries and CEE countries up to 40% of the maximum sex gap in LE is attributed to mortality differences at ages younger than 45, before consequences of the excess male smoking start to show.

FSU and CEE countries have experienced stagnation in life expectancy since the beginning of 1960s to the end of 1980s. This stagnation can be attributed to a multitude of factors including medical care, diet, alcohol consumption, and social environment (Bobak and Marmot 1996). Health crisis was particularly prominent for men, whose life expectancy even deteriorated during this period. Excess male mortality in FSU and CEE countries is a topic of numerous papers (Danilova et al. 2020; Ezzati et al. 2015; Grigoriev et al. 2020; Grigoriev and Andreev 2015; Keenan et al. 2015; Leon et al. 2007, 2010, 2011; Rehm et al. 2007) that signify the crucial role of alcohol in high mortality in general and especially in high mortality from cardiovascular diseases. Changes in alcohol consumption in the end of 20th century played a major role in mortality fluctuations in Russia and other FSU countries. Increase in life expectancy in 1985-1987 and the decline that followed can to a big extent be explained by Gorbachev's anti-alcohol campaign and its termination (Shkolnikov and Nemtsov 1997). In Russia LE and level of level alcohol consumption (measured by prevalence of deaths from acute alcohol poisonings) were strongly negatively correlated during the period of mortality fluctuations from 1984 to 2003 (Danilova et al. 2020). Differences in alcohol consumption can also explain smaller sex gap in CEE countries compared to FSU states. Comparison of alcohol contribution to premature mortality in new (Czech Republic, Hungary, Lithuania, Poland) and old EU states showed that although new EU members have higher rates of alcohol-attributable mortality in men compared with the old EU countries, it is still considerably lower than in Russia (Rehm et al. 2007). There is a spatial gradient of male alcohol-attributable mortality from very high levels in north-western Russia to low levels in southern Poland (Grigoriev et al. 2020). Most CEE countries have traditionally less detrimental practice of drinking compared to FSU countries: for example, higher preference of beer over spirits (Czech Republic) or less common consumption of large amounts of alcohol in one day (Poland) (Rehm et al. 2007).

Whether smoking-related or alcohol-related mortality contribute more to the sex gap is up to debate. In a paper published in 2011 (McCartney et al. 2011) smoking-attributable mortality was shown to contribute more to an overall sex gap than alcohol-attributable mortality, but in this research ischaemic heart disease was placed into the category “smoking-attributable mortality” although alcohol consumption plays an important role in cardiovascular disease development (Ezzati et al. 2015; Iakunchykova et al. 2020; Nilssen et al. 2005).

Russia has by far the largest sex gap in mortality. There is a major gender difference in alcohol consumption in Russia (Bobrova et al. 2010): men drink more, more often, have a

stronger preference for spirits and other strong beverages. Qualitative research in Saint-Petersburg (Pietilä and Rytkönen 2008b) showed that male drinking is seeing as something normal and expected while female drinking is seeing as highly unusual and undesired: women are not expected to drink recreationally and only drink for special occasions. Research done on data from regions of the Russian Federation showed that alcohol consumption has a significant influence on the sex gap in LE (Kossova et al. 2020). Alcohol has an especially strong influence on premature mortality (Rehm et al. 2007), as excess alcohol consumption can lead to acute cardiac events, and it also increases risks of mortality from external causes. It is highly plausible to suggest that higher alcohol consumption among males plays a key role in defining the sex gap in mortality in Eastern European and FSU countries, especially influencing sex differences in mortality in young and middle ages.

Most of the existing research on causes and age patterns of sex differences in mortality use data on high-income Western European countries and the USA, that have similar patterns in LE dynamics. The countries that do not correspond to these patterns are often left aside. There is substantial influence of country's history and traditional behaviour, including gender roles, on the specificity of the sex gap in LE in the country, and study of country-specific age patterns and causes contributing to the sex gap is crucial for its narrowing and improvement of health and longevity for both men and women. While in Western European and English-speaking countries sex gap changed during continuous growth in LE of both men and women, many CEE and FSU countries experienced stagnation in mortality and even worsening of LE. CEE and FSU countries have historically had huge male excess mortality in young and middle ages, and the pattern is still unchanged. The narrowing of the sex gap in LE in these countries does not dramatically change an overall age groups contribution, and ages younger than 50 still play a crucial role in determining an overall gap. Although recently mortality at all ages was reduced and LE has grown – there must be a serious change in behaviours and health attitudes of people in order to achieve levels of the gap that are now can be found in many European countries. Only attention to detail and specific histories of each country can lead to the development of proper public health measures that will benefit everyone.

Study limitations

This research uses data only on 41 countries with reliable vital statistics which is of course not enough to describe the worldwide diversity in sex gap changes. Time-series length varies for different countries and makes it difficult to compare them for long periods of time. For most countries, time series are not long enough to pinpoint the beginning of the sex gap growth.

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Appendix

Appendix 1. Maximum sex gap in LE since 1946

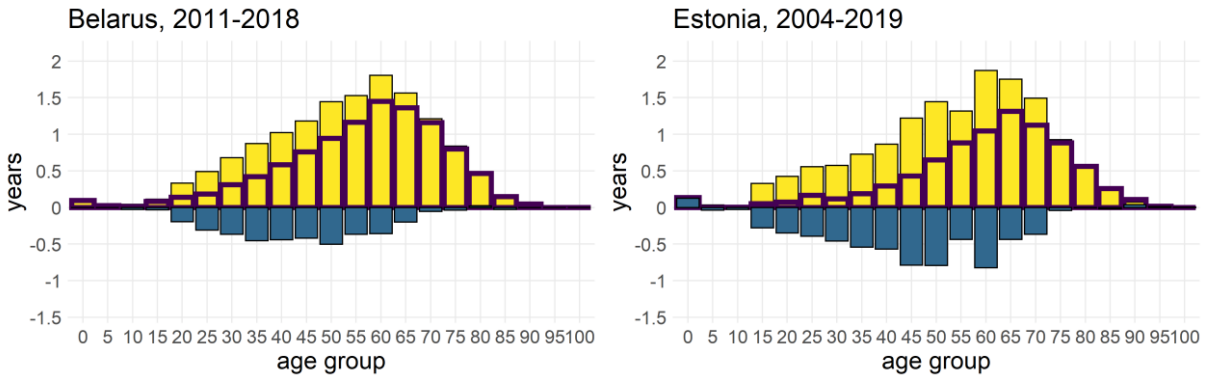
Country/group	Max gap	Year	Contribution of age groups to the max gap, %				Onset of sustained decline
			0-19	20-44	45-69	70+	
Former Soviet Union							
Belarus	12.24	2005	3.9	28.8	52.6	14.7	2012
Estonia	12.73	1995	7.2	31	49.3	12.6	2005
Latvia	13.53	1994	5.1	35.2	48.6	11.1	1995
Lithuania	12.68	2007	2.8	28.5	52.1	16.7	2008
Russia	13.68	1994	6.6	35.5	48	9.9	2006
Ukraine	11.93	2007	4.4	32	51	12.6	2008
Central and Eastern Europe							
Bulgaria	7.58	1994	6.9	21.5	56.5	15.2	1996
Croatia	7.26	2002	4.5	16	53.4	26	2004*
Czech Republic	7.87	1990	5.4	16.6	56.9	21.1	1991
Germany, East	7.52	1993	4.2	20	49.2	26.6	1995
Hungary	9.46	1994	4	23.2	56.8	16	1995
Poland	9.24	1991	6.3	22.4	53.1	18.1	2008
Slovakia	8.86	1990	5.1	19.3	58	17.6	2001
Slovenia	8.25	1985	9.1	20.2	51.7	19.1	2007^
English-speaking countries							
Australia	7.14	1979	7.9	13.9	44.7	33.6	1981
Canada	7.41	1978	8.4	14.9	44.1	32.6	1979
Ireland	5.9	1979	9.3	14.8	46.5	29.3	2001
New Zealand	6.7	1973	13.5	12.8	46.7	27	1980
United Kingdom	6.31	1969	10.4	8.1	51.3	30.2	1974
U.S.A.	7.74	1975	8.6	17.6	45.2	28.6	1976
Western Europe							
Austria	7.21	1978	10.7	18.8	46.4	24.1	1983
Belgium	6.83	1984	7	13.4	46	33.7	1996
France	8.31	1992	4.6	18.2	43.7	33.5	1993
Luxembourg	7.84	1977	15.3	15.1	45.6	24	1978^**
Netherlands	6.71	1984	5.9	7.8	44.3	41.9	1983
Switzerland	6.98	1991	5.3	18.2	37.7	38.7	1992

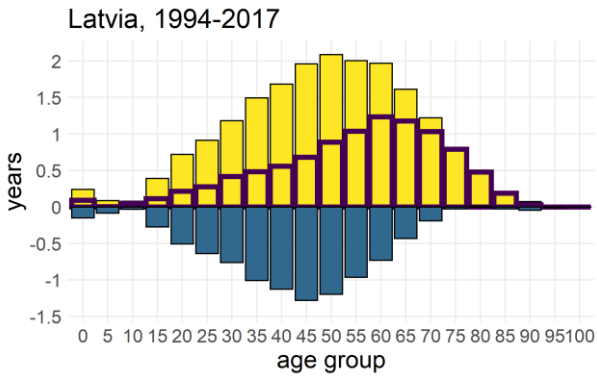
West Germany	6.75	1980	7.9	15.1	47.5	29.5	1981
Asia							
Hong Kong	6.24	2007	0.9	8.1	36.1	54.9	2012^
Israel	4.37	1998	7.5	17.1	44.2	31.2	2003
Japan	6.92	2003	1.5	8.9	36.6	53	2004
Republic of Korea	6.96	2003	3.1	13.2	50.6	33.1	2004*
Taiwan	6.44	2006	4.1	22.4	45.8	27.7	2015
Southern Europe							
Greece	5.75	2009	3.2	17.9	45.8	33.2	2010
Italy	6.76	1979	7.8	12.5	50.4	29.3	1992
Portugal	7.5	1996	5.9	25.5	40.8	27.7	1997
Spain	7.4	1992	4.3	20.9	42.6	32.2	1997
Northern Europe							
Iceland	7.21	1983	4.9	16.8	46.8	31.6	1984
Denmark	6.21	1979	8.7	12.9	42.8	35.5	1982
Finland	9	1977	5.4	17.5	55.3	21.8	1978
Norway	6.89	1982	7.2	12.7	45.3	34.8	1987
Sweden	6.23	1978	6.2	14.9	44.9	34.1	1980

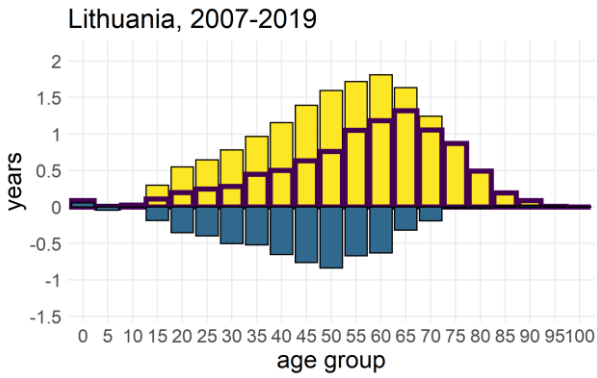
Notes: the year of onset is the first year when (i) observed and 5-year mean sex gap is smaller than in a previous year, (ii) the level of smoothed sex gap was not later exceeded, (iii) the decline in sex gap was not interrupted by an increase of more than 0.25 years (for both observed and smoothed gap) or a sustained increase for 3 or more years (Glei and Horiuchi 2007).
*- short data series
^ – fluctuating value of sex gap, the onset is unclear
** - only rules (i) and (ii) applied

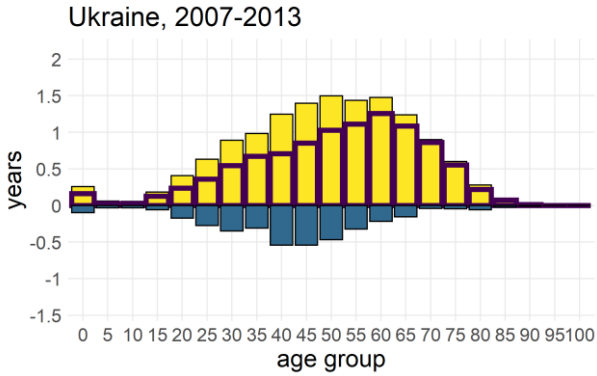
Appendix 2. Contour decomposition of the change in the sex gap in life expectancy at birth. Yellow bars – contribution of age groups to the initial sex gap (first year in the title), blue bars – the trend of change in the contribution of age groups, purple line bars – contribution of age groups to the final sex gap.

Former Soviet Union

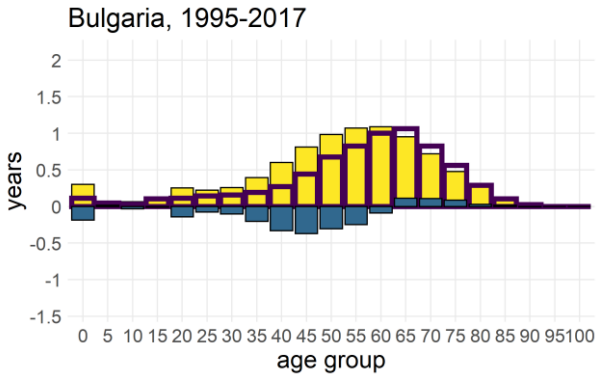


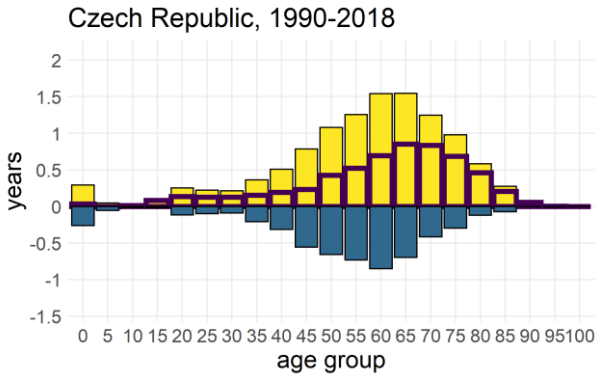


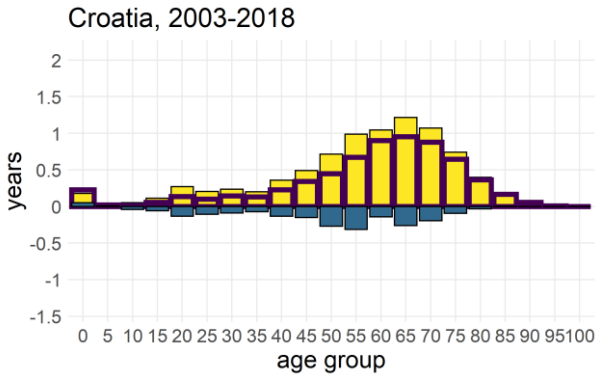


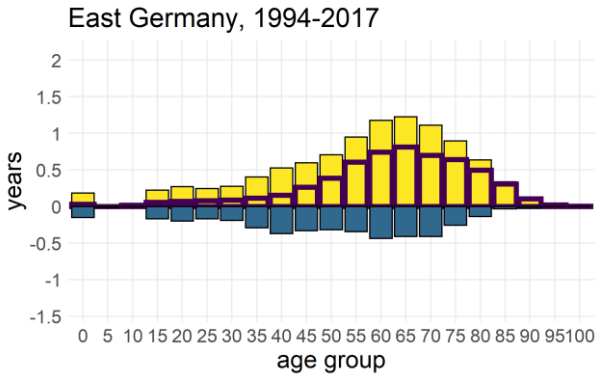


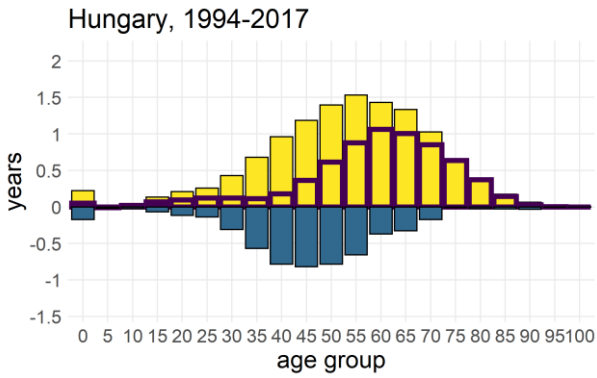
Central and Eastern European countries

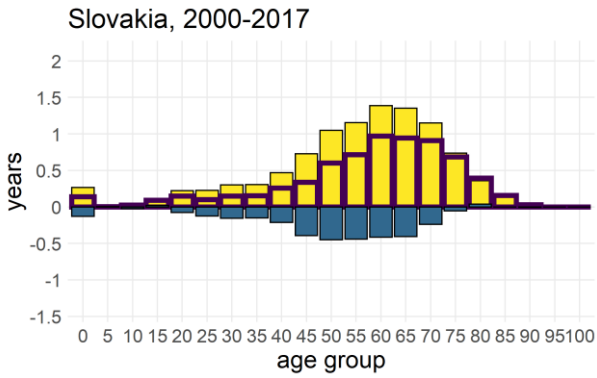


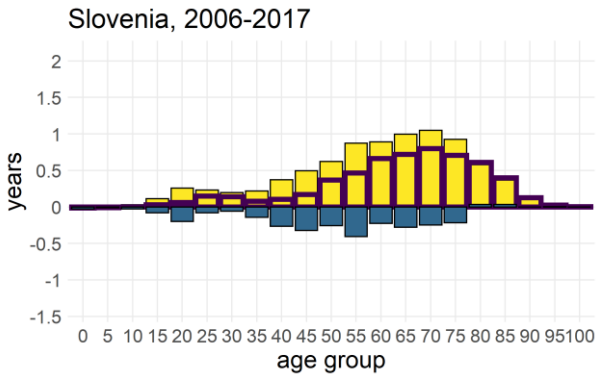




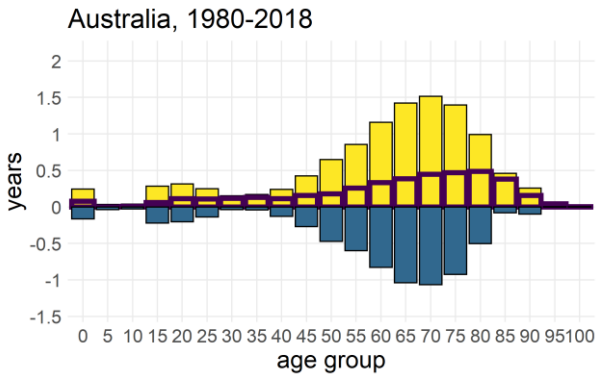


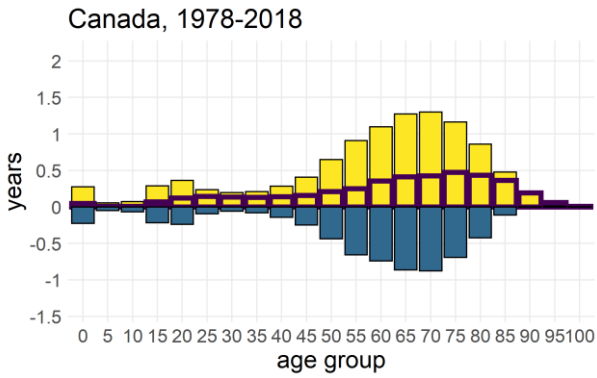


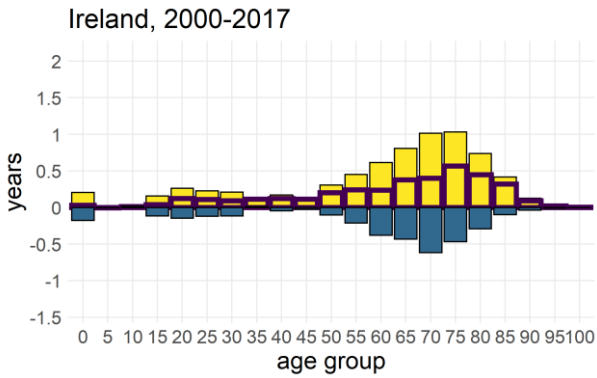


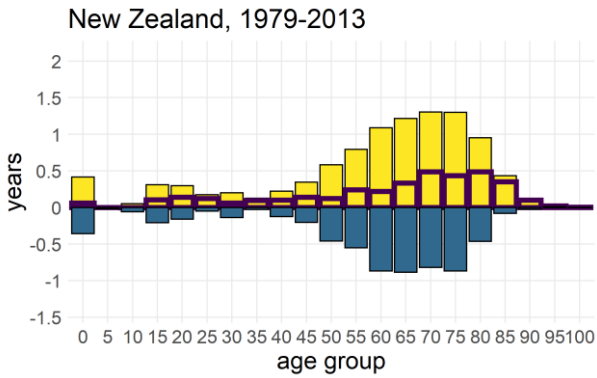


English-speaking countries

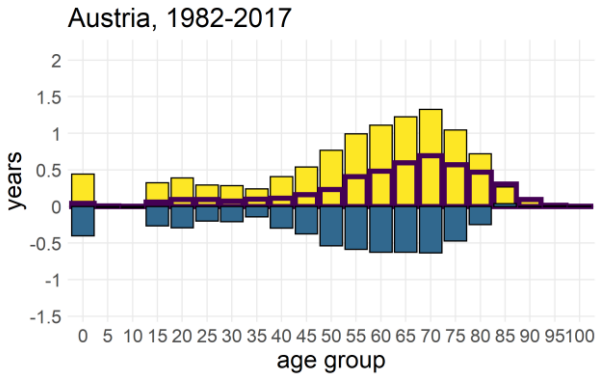


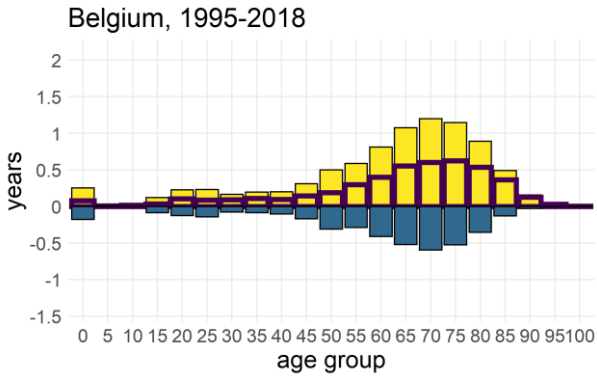


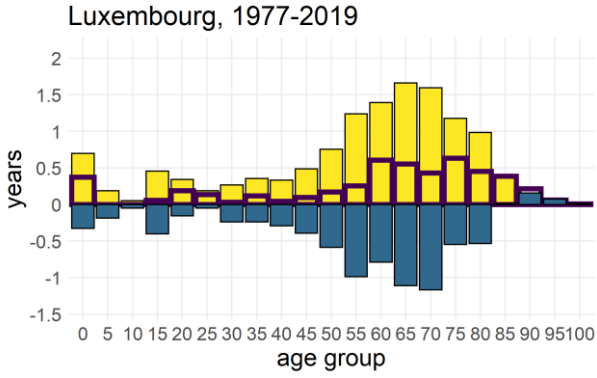


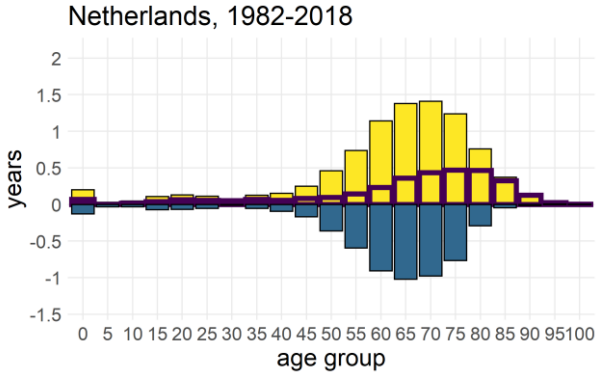


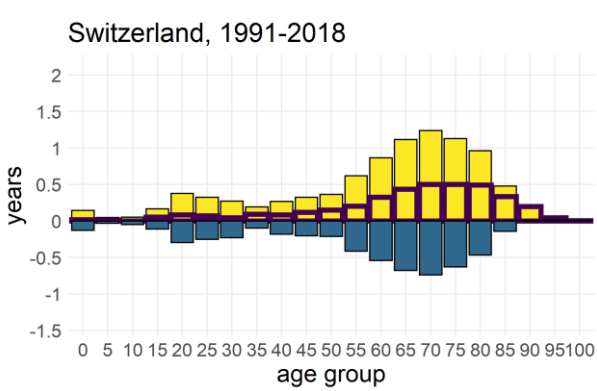
Western Europe

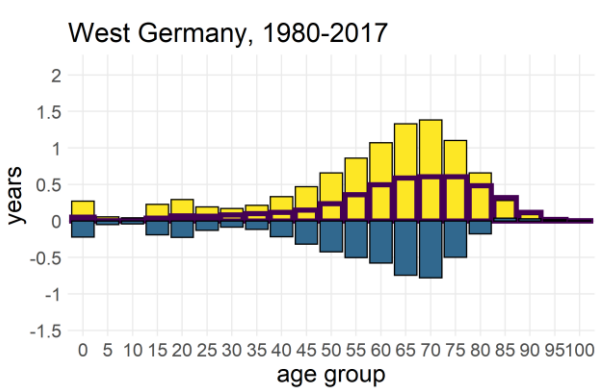




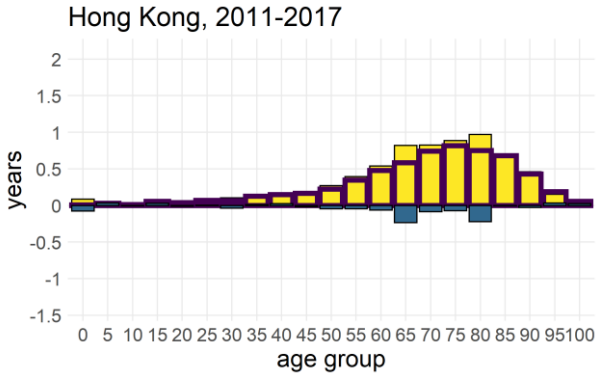


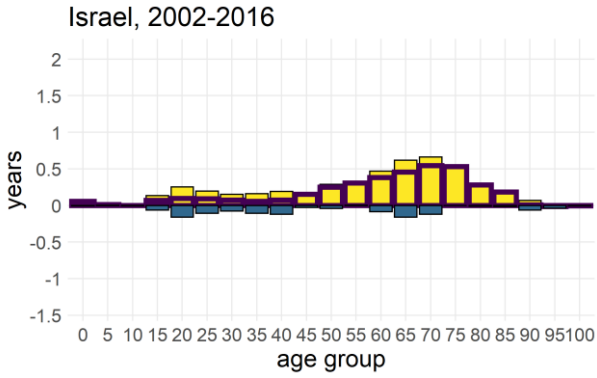


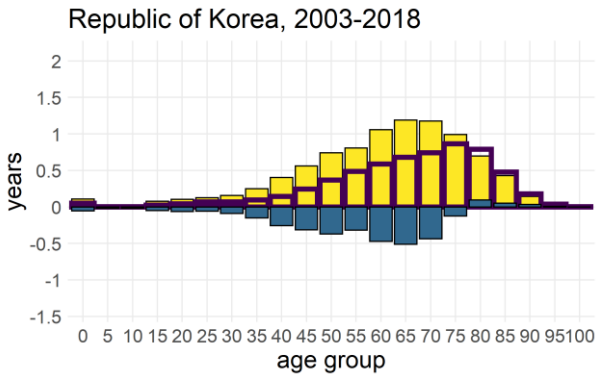


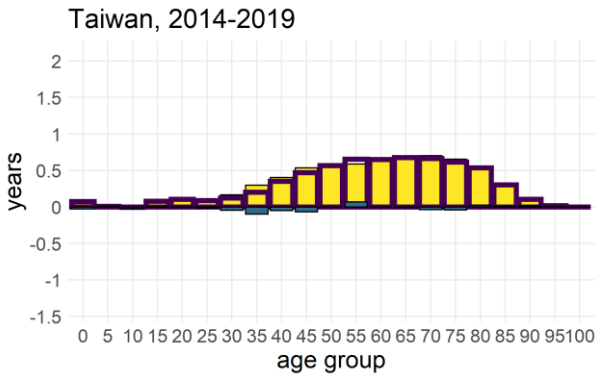


Asia

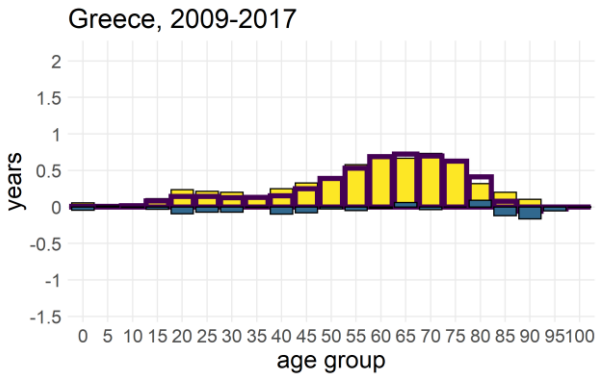


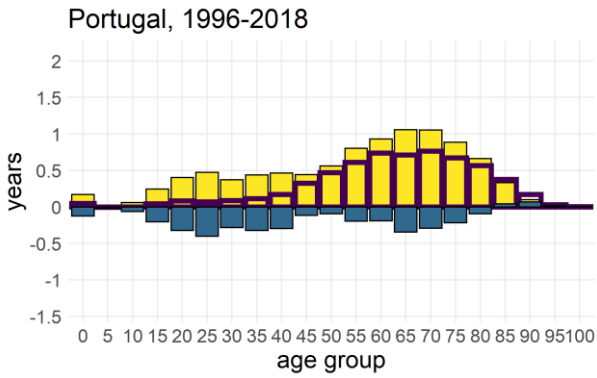


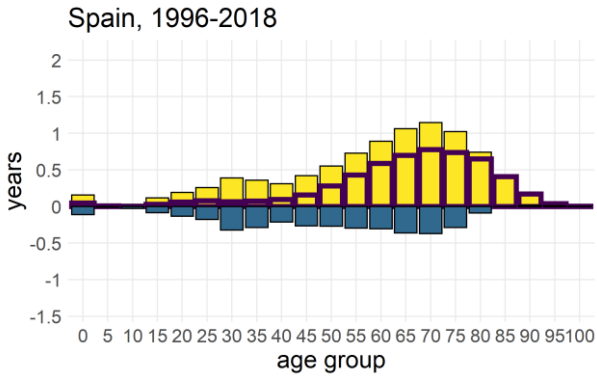




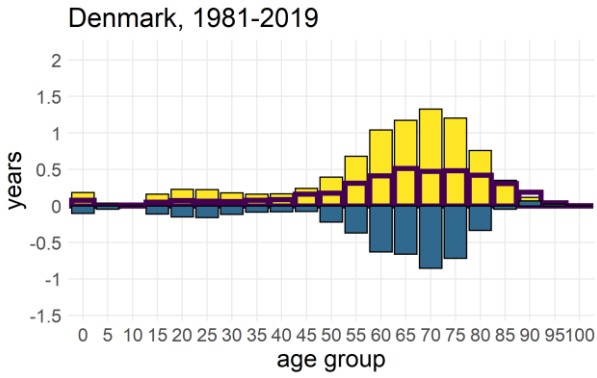
Southern Europe

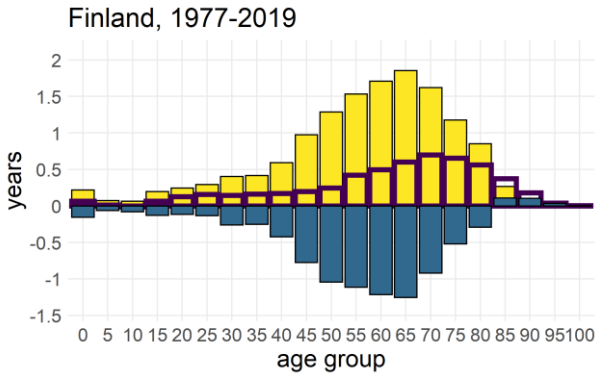


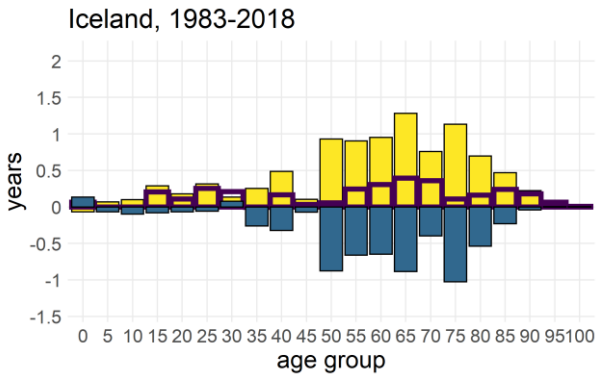


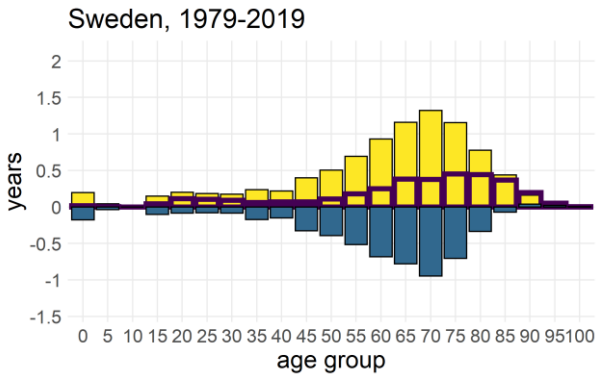


Northern Europe






Iceland, 1983-2018
years
2
1.5
1
0.5
0
-0.5
-1
-1.5
0 5 10 15 20 25 30 35 40 45 50 55 60 65 70 75 80 85 90 95100
age group


Sweden, 1979-2019
years
2
1.5
1
0.5
0
-0.5
-1
-1.5
0 5 10 15 20 25 30 35 40 45 50 55 60 65 70 75 80 85 90 95100
age group