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A tale of three pandemics: Impacts on life expectancy and lifespan inequality

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Abstract

This study aims to provide a comparative analysis of the impacts of three significant pandemics – the 1918-19 influenza pandemic, the HIV/AIDS epidemic, and the COVID-19 pandemic – on life expectancy and lifespan inequality. Using cause-eliminated life tables and the Theil Index, we examine changes in life expectancy and lifespan inequality globally. The findings reveal that each pandemic uniquely altered demographic patterns. The 1918 influenza pandemic caused the sharpest immediate reductions in life expectancy, particularly affecting young adults, and led to a significant rise in lifespan inequality. In contrast, the HIV/AIDS epidemic had a more gradual and enduring impact, disproportionately affecting young and middle-aged adults in its early stages and exacerbating health disparities, especially in regions with limited access to antiretroviral therapy. COVID-19 primarily impacted older populations, resulting in smaller reductions in life expectancy compared to the 1918 influenza but with a distinctive decrease in lifespan inequality due to concentrated mortality among older adults. Furthermore, gender-specific effects varied across the pandemics. While the 1918 influenza pandemic and COVID-19 showed relatively uniform impacts across genders, HIV/AIDS revealed pronounced disparities, with women experiencing greater reductions in life expectancy and heightened lifespan inequality. By examining the unique mortality patterns and impacts of these pandemics, this study provides valuable insights to policymakers, emphasizing the need for tailored public health strategies to address inequalities and improve resilience in future global health crises.

Keywords

Life Expectancy

Lifespan Inequality

1918 Influenza

HIV/AIDS

COVID-19

Pandemics

JEL Classification

I14

I18

J18

1. Introduction

Health crises, such as the recent COVID-19 pandemic (2020-2021), the ‘influenza pandemic’ (1918-1919) – also known as the “mother of all pandemics” (Taubenberger and Morens 2006) – and the HIV/AIDS pandemic (1990-), have caused extensive morbidity and mortality throughout human history. For instance, the influenza epidemic of 1918, which emerged immediately after World War I, is one of the deadliest pandemics in history, claiming an estimated 50 to 100 million lives worldwide (Johnson & Mueller, 2002). It had an unusual age distribution, with high mortality among young adults, which challenged existing understandings of infectious disease dynamics. This pandemic spread rapidly, affecting nearly every region of the world within a relatively short period. In contrast, the HIV/AIDS pandemic, which began in the early 1980s, unfolded differently. While HIV spread more gradually than the influenza virus, it had a deeply transformative and long-lasting impact and has caused over 40 million deaths worldwide (UNAIDS, 2020). Unlike the influenza pandemic, which had a rapid onset and short duration, HIV became a chronic global health crisis, disproportionately affecting sub-Saharan Africa and other marginalised populations (Moyo et al., 2023). It primarily reduced life expectancy in regions with inadequate healthcare infrastructure, exacerbating existing health disparities (Asghari et al., 2018; Marty et al., 2021; Tian et al., 2023). However, the advent of antiretroviral therapies (ART) in the mid-1990s helped to stabilize and even improve life expectancy among those living with HIV, though the virus remains a major public health issue in many parts of the world (Oguntibeju, 2012; Ghosh, 2023). The COVID-19 pandemic, which began in December 2019, has had profound and lasting effects on global health, surpassing any event experienced in the past half-century, including wars and natural disasters. The World Health Organization declared an end to the global coronavirus emergency in 2023, having recorded nearly 7 million deaths attributed to the virus (De Cock et al., 2021).

A growing body of literature highlights that pandemics can affect countries differently. For instance, Furceri et al., (2022) show that past pandemics have had a substantial impact on income inequality, and early evidence suggests that the distributional consequences of the COVID-19 pandemic could have been substantial (Wildman, 2021; Su et al., 2022; Tan et al., 2021; Demenech et al., 2020). Additionally, due to increases in mortality worldwide, pandemics directly and indirectly cause stagnation or declines in life expectancy. For example, life expectancy at birth decreased significantly during the influenza pandemic in 1918 (Grove and Hetzel, 1968; Noymer and Garenne, 2000; Sawchuk, 2009). Furthermore, the COVID-19 pandemic has had a profound impact on life expectancy, significantly altering demographic

trends and exacerbating existing disparities across various racial, ethnic, and socioeconomic groups (Huang et al., 2023; Kuehn, 2022; Schöley et al., 2022; Aburto et al., 2021). In the context of HIV/AIDS, research by Aburto et al., (2021) highlighted that life expectancy reductions in the United States differed between racial groups during the period from 1980 to 2000, with more significant impacts on black individuals compared to white individuals. Additionally, the HIV/AIDS pandemic exacerbated lifespan inequality during this time. Further analysis by Dorling et al. (2005) revealed that the global difference in life expectancy was significantly larger than the differences within the UK during the early 2000s. This gap would have widened even further if the effects of AIDS were considered. HIV/AIDS plays a major role in exacerbating the differences in life expectancy between regions such as Africa and North America (Dorling et al., 2005).

In this context, our study focuses on variation in age at death or lifespan inequality, offering a comparative analysis of the three pandemics in a global context. While examining life expectancy is important, we argue that a more comprehensive understanding arises from exploring lifespan inequality, which provides deeper insights into the full distribution of the impacts of pandemics on the age-at-death distribution, because lifespan inequality, like life expectancy, serves as a critical measure of mortality patterns and population health. Lifespan inequality captures the variation in when individuals die, which may reflect broader social and health inequalities. Moreover, understanding lifespan inequality is essential at both the individual (micro) and population (macro) levels, as it reveals disparities in health outcomes and mortality risks (Wijesinghe et al, 2024).

At the individual level, lifespan variation recognises the unpredictability of when death might occur, emphasizing personal risk. This uncertainty can have profound psychological and economic consequences. Edwards (2013) suggests that because people are generally risk averse, they are willing to trade potential additional years of life for greater certainty regarding their lifespan. When lifespan inequality diverges across socioeconomic groups, it highlights an often-overlooked dimension of inequality: those from more privileged backgrounds are able to plan their lives more effectively, while individuals from disadvantaged groups face heightened unpredictability about their survival. This uncertainty influences key life decisions, such as education, employment, and retirement planning (Brown et al, 2012). For individuals with greater uncertainty, planning for the future becomes a more complex and stressful process.

At the population level, lifespan inequality reveals the overall heterogeneity in health within a society. A high degree of inequality suggests that different segments of the population

are experiencing very different health outcomes. This information is crucial for designing effective public policies, including healthcare provision, insurance and pension systems, and equitable social safety nets. Rising lifespan inequality among disadvantaged groups indicates that members of these groups are leading increasingly diverse life courses, reflecting deeper social inequalities. For example, growing inequality in lifespan can parallel increasing inequality in other areas, such as access to education, employment, and family life (Brown et al, 2012).

In the context of pandemics, lifespan inequality tends to magnify existing health inequalities, with disadvantaged populations experiencing higher mortality rates and greater vulnerability to early and midlife mortality (McGowan and Bamba,2022). Therefore, monitoring lifespan inequality can serve as an early warning system for detecting adverse mortality trends, particularly in the aftermath of global health crises. However, the discussion of lifespan inequality in the context of health crises has received limited attention from scholars. For instance, Yadav and Yadav (2023) and Aburto et al. (2021) examined the effects of COVID-19 on life expectancy and lifespan inequality in India and in England and Wales, respectively. Additionally, Aburto et al. (2021) discussed Black-White disparities in life expectancy and lifespan inequality in the US due to HIV/AIDS, highlighting the ongoing impact of health crises. Expanding upon this limited base, the current study aims to conduct a comparative analysis of the effects of the 1918 influenza, HIV/AIDS, and COVID-19 on life expectancy and lifespan inequality. By analyzing the disparate effects of pandemics on lifespan inequality in particular, we attempt to fill a critical gap in the understanding of public health crises. These three health crises highlight the persistent obstacles encountered by global health systems and the significant disparities that exist within and between countries. Consequently, this study makes a significant contribution to the historical documentation of these events and offers invaluable insights to policymakers and public health officials. By doing so, it aspires to inform strategies that could alleviate the adverse impacts of future pandemics on lifespan inequality.

The remainder of the paper is organized as follows. Section 2 describes the data and provides a brief explanation of the methods. Section 3 presents the results and discussion. The final section concludes.

2. Data and Methods

We utilized various sources to obtain life tables and cause-of-death data covering the total population, males and females. The first part, focusing on the 1918-1919 influenza pandemic, primarily draws on data from the Human Mortality Database (HMD), which provides coverage

for 11 countries during those years (Appendix, Table A1). Additionally, the number of deaths attributed to the influenza was gathered from different statistical yearbooks of the respective countries. Influenza pandemic mortality data were reported in irregular age groups across different countries, necessitating harmonization for consistency. Using a Penalized Composite Link Model (PCLM), we estimated death counts for each year of age from 0 to 110 based on the grouped data, ensuring robust and comparable age-specific mortality trends critical for demographic analyses (Rizzi et al., 2019, Aburto et al., 2021). The PCLM was independently applied to each combination of country, sex, and year.

The HIV/AIDS data covers 200 countries from 1990 to 2019 (Appendix, Table A1), with death data obtained from the Global Burden of Disease Study (GBD). GBD is the most comprehensive observational epidemiological study globally, offering detailed data on mortality and morbidity from major diseases, injuries, and risk factors at global, regional, and national levels from 1990 to the present (Global Burden of Disease Study, 2021).

COVID-19 death data for 2020 and 2021 were obtained from COVerAGE-DB, a global demographic database tracking COVID-19 cases, deaths, tests, and vaccines (Riffe et al., 2021). The sample includes data from 45 countries in 2020 (see Appendix, Table A1). In both years, the dataset spans at least until December 1st, ensuring that almost the full impact of the pandemic during 2020 and 2021 is likely captured. For both analyses of HIV/AIDS and COVID-19, population data and country life tables were sourced from the United Nations' World Population Prospects 2024 (United Nations, Department of Economic and Social Affairs, Population Division, 2024).

Demographic and statistical techniques

This study employs the life table and cause-eliminated life table methods to estimate changes in life expectancy and lifespan inequality caused by the 1918 influenza, HIV/AIDS, and COVID-19. The first step in this approach is calculating the probabilities of survival (${}_n p_x$) from the all-cause abridged life tables. The formula for this calculation is as follows:

$${}_n P_x = 1 - {}_n q_x \quad (1)$$

where x is the exact age, n is the number of years in the age interval, and (${}_n p_x$) is the probability of dying between the beginning of an age interval and before reaching the end of that age interval. Then, the probability of death, eliminating the i_{th} cause (${}_n q_{x1}^{(-i)}$) was estimated by:

$${}_n q_{x1}^{(-i)} = 1 - {}_n p_x \left(\frac{{}_n D_x - {}_n D_x^i}{{}_n D_x} \right) \quad (2)$$

Where ${}_nD_x$ is the number of deaths in the age interval x to $x + n$ for all causes, and ${}_nD_x^i$ is the number of deaths in the age interval x to $x + n$ attributable to the i_{th} cause of death.

Next, the number of person-years lived ${}_nL_{x1}^{(-i)}$ in the age interval x to $x + n$ was estimated for ages 0, 1, 5, 10, ..., 100 using the formula:

$${}_nL_{x1}^{(-i)} = (n - {}_n f_x) \cdot l_x^{(-i)} + [n l_x \cdot l_{x+n}^{(-i)}] \quad (3)$$

where $n=1$ for $x = 0$, $n= 4$ for $x = 1$, and $n = 5$ for $x = 5, 10 \dots, 100$, and ${}_n l_x$ the number of individuals from the original life table who survive to the beginning of each age interval, $l_x^{(-i)}$ denotes the number of survivors from the life table after eliminating deaths due to the i_{th} cause (influenza, HIV/AIDS, or COVID-19), L_x is the number of person-years lived within a specific age interval x from the original life table, and ${}_n f_x$ represents the force of mortality (probability of death) for the age interval and is estimated from the all-cause life table as follows:

$${}_n f_x = \frac{n \cdot l_x - n L_x}{l_x - l_{x+n}} \quad (4)$$

The last step is to calculate the number of person-years lived after the exact age x ($T_x^{(-i)}$) by:

$$T_x^{(-i)} = L_x^{(-i)} + L_{x+1}^{(-i)} + \dots + L_{110+}^{(-i)} \quad (5)$$

Finally, the cause-eliminated life expectancy ($e_x^{(-i)}$) is calculated as follows:

$$e_x^{(-i)} = \frac{T_x^{(-i)}}{l_x^{(-i)}} \quad (6)$$

Subsequently, the contribution of a disease (in this case, the 1918 Influenza pandemic, HIV/AIDS, or COVID-19) to the change in life expectancy for a particular year can be quantified by calculating the difference between the cause-eliminated life expectancy ($e_x^{(-i)}$) and the observed life expectancy e_x in that same year. This difference provides a clear measure of the disease's impact on life expectancy by isolating its effect from other causes of death.

Lifespan inequality measurement – Theil index

Several studies, including Kannisto (2000), Shkolnikov et al. (2003), Vaupel et al. (2011), Wilmoth and Horiuchi (1999), and van Raalte and Caswell (2013), have explored indicators of lifespan inequality, highlighting strong associations among different metrics. In this study, we choose the Theil Index to measure lifespan inequality, as it is more responsive to variations across the full age-at-death distribution. Unlike the Gini index, which emphasises central tendencies,

the Theil index's sensitivity to variations across the full age-at-death distribution provides a nuanced view of lifespan inequality, particularly in the context of pandemics characterized by age-specific mortality patterns. We calculate lifespan inequality for the total population and separately for males and females. The Theil index for lifespan inequality, which is denoted as T_a , can be calculated as follows:

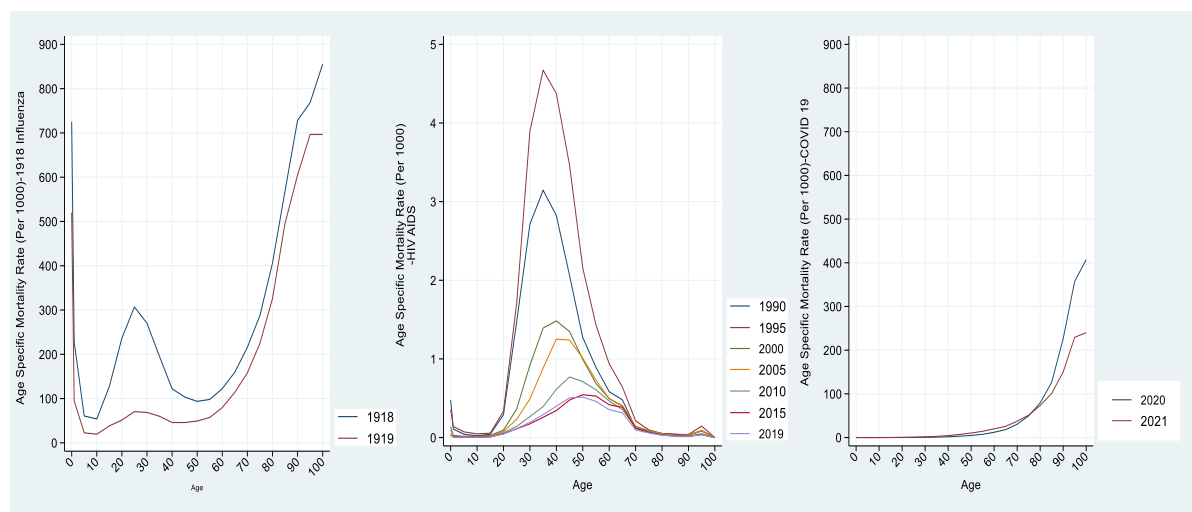
$$T_a = \frac{1}{l_a} \sum_{x=a}^{\omega} d_x \left(\frac{\alpha_x}{\mu_a} \right) \log \left(\frac{\alpha_x}{\mu_a} \right) \quad (7)$$

where a and ω are the youngest and oldest age intervals taken from a given life table, l_x is the radix of the population μ_a is the average age at death of the population, and d_x and α_x are the life table number of deaths and the average age at death in the age interval x to $x+5$, respectively.

3. Results and Discussion

To illustrate the differences in mortality patterns among those three pandemics, we first use the age-specific mortality distributions in the USA as an example. Figure 1 shows the age-specific 1918-19 influenza, HIV/AIDS, and COVID-19 mortality distribution (per 1000 population). Due to HIV/AIDS mortality rates being much lower overall, a different y-axis scale is used in the middle panel to improve visibility.

Figure 1: Age-Specific Mortality Distribution in 1918 Influenza, HIV/AIDS and COVID-19



Source: Authors' calculations

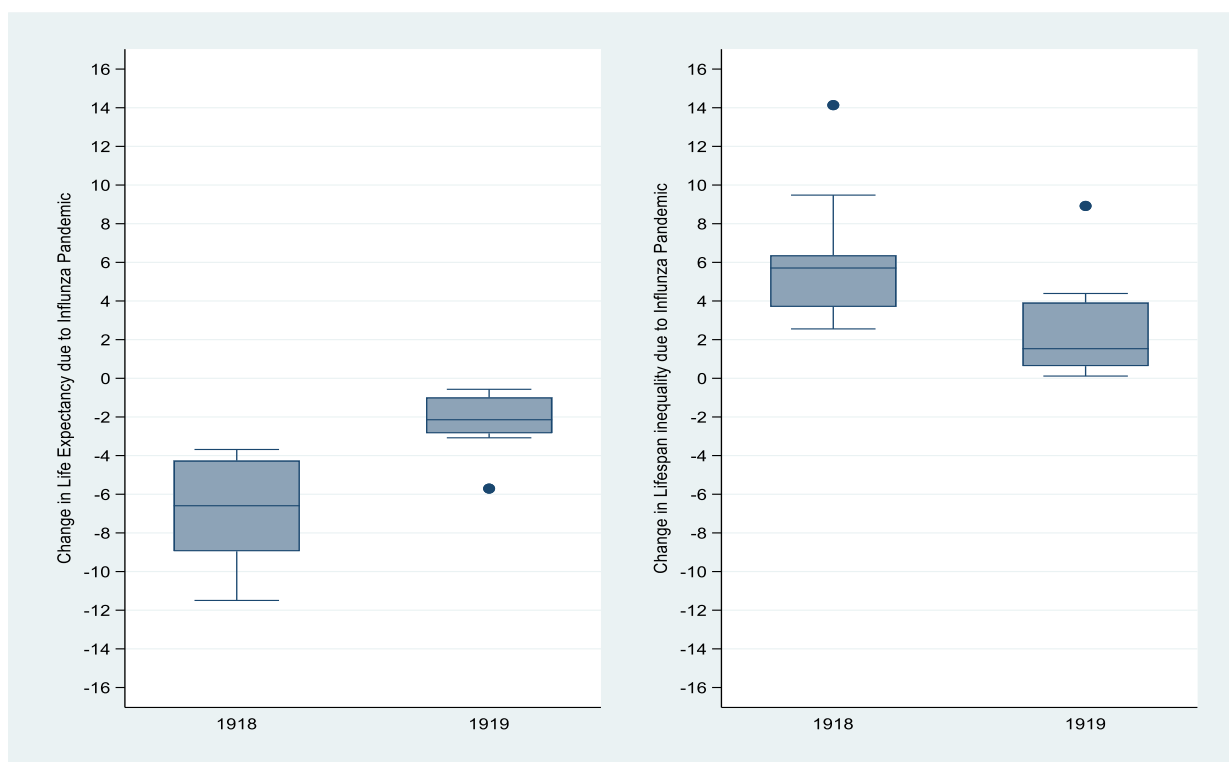
According to Figure 1, the 1918-1919 influenza pandemic displays a unique "W-shaped" curve, with high mortality rates among infants, young adults (ages 20-40), and the elderly, especially in 1918. This contrasts sharply with HIV/AIDS, which shows a peak in mortality among young and middle-aged adults (ages 30-50), with significantly lower overall rates and minimal impact on children and the elderly. In comparison, COVID-19 mortality follows an

exponential pattern, with very low rates in younger populations but a steep rise among older adults, particularly those aged 60 and above, with the highest rates in the elderly (ages 80+). Unlike influenza and HIV/AIDS, COVID-19 mortality is concentrated in older age groups, though the rates were slightly lower in 2021 compared to 2020. These differences highlight how each disease disproportionately affected different segments of the population, with influenza severely impacting the young and elderly, HIV/AIDS affecting younger and middle-aged adults, and COVID-19 predominantly impacting the elderly.

Impacts of Pandemics on Life Expectancy and Lifespan Inequality

Figure 2 illustrates the changes in life expectancy and lifespan inequality due to the 1918 influenza pandemic in the years 1918 and 1919, based on data from 11 countries. This was calculated by comparing life expectancy and lifespan inequality under two scenarios: one including all causes of death, and the other excluding deaths specifically attributed to the 1918 influenza pandemic, separately for each country in the sample (see Appendix, Tables A2 and A3). Each boxplot shows the distribution of the change in life expectancy (or lifespan inequality) across all countries in the sample.

Figure 2: Influenza Pandemic 1918 impacts on life expectancy and lifespan inequality



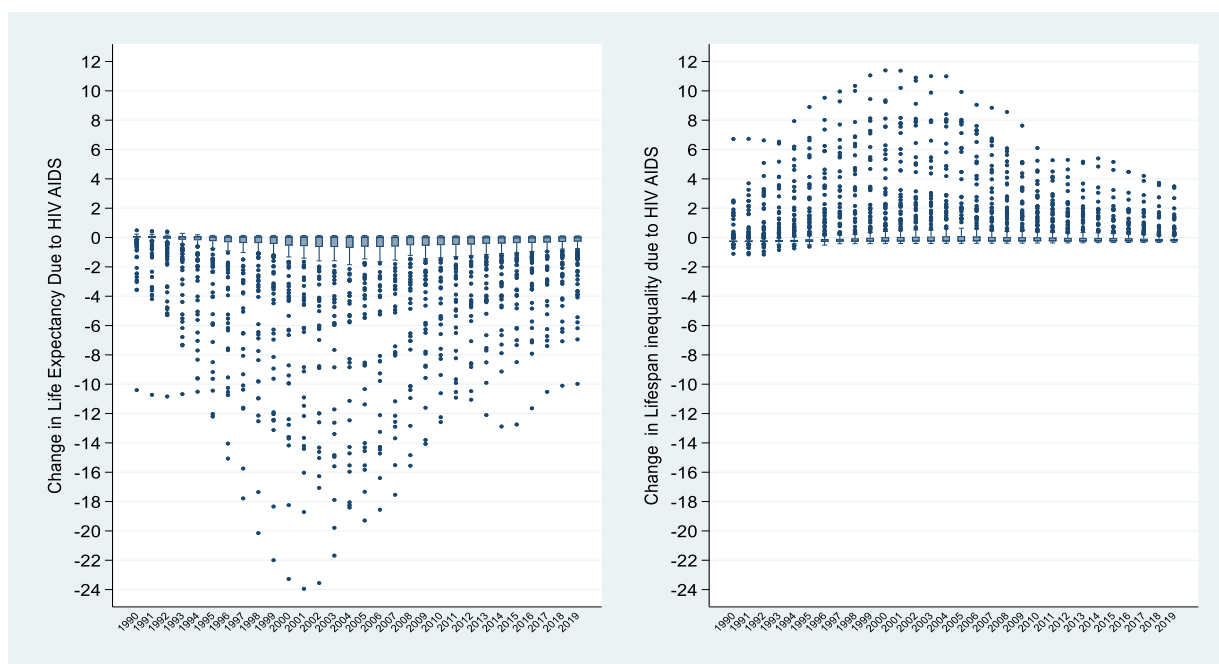
Source: Authors' calculations

The pandemic caused a significant drop in life expectancy and a sharp increase in lifespan inequality. In 1918, the mean decrease in life expectancy was 6.79 years. This suggests a severe and consistent impact across countries, with some variation in extreme cases. For instance, the US appears as an outlier, with a much larger drop of 11.49 years placing it well outside the interquartile range for that year and experiencing a notably different impact on life expectancy and lifespan inequality. Despite this variation, the relatively low standard deviation and moderate interquartile range (see Appendix, Table A6) suggest that the reduction in life expectancy was broadly similar across countries. In 1919, the impact on life expectancy was much less, with a mean decrease of 2.20 years. Although the US experienced a drop of 5.71 years, this value does not stand out to the same degree as an outlier compared to 1918. Comparing the distributions in 1918 and 1919, a *t*-test confirms that the difference in mean impact of the pandemic was smaller in 1919 than in 1918 ($p < 0.001$).

The 1918 influenza pandemic's distinctive age-dependent mortality pattern, characterized by high risk among young adults (20–34 years) and comparatively lower risk for infants and those aged over 35 (van Wijhe et al., 2018), contributed to a marked increase in lifespan inequality, as evidenced by a mean increase of 6.13 units. Erkoreka's (2010) study also underscores this heightened vulnerability of young adults during the pandemic across Europe, including Italy and Spain. In 1919, lifespan inequality was less impacted, with a mean increase of 2.62, with a slightly higher interquartile range of 3.28 (see Appendix, Table A6). Again, the difference between the two years was statistically significant ($p = 0.012$). This suggests a major shift in the distribution of ages at death during the peak year of the pandemic, followed by some recovery in inequality in the subsequent year. A Kolmogorov-Smirnov test reveals that the lifespan inequality distribution in 1919 was notably different between 1919 and the peak pandemic year of 1918, likely reflecting a gradual return of age-at-death patterns toward typical levels ($p = 0.023$).

Figure 3 illustrates the impact of the HIV/AIDS pandemic on life expectancy and lifespan inequality for each year from 1990 to 2019, based on data from 200 countries. This was calculated by comparing life expectancy and lifespan inequality under two scenarios: one including all causes of death, and the other excluding deaths specifically attributed to HIV/AIDS, separately for each country in the sample (the underlying data can be provided upon request).

Figure 3: HIV AIDS impacts on life expectancy and lifespan inequality



Source: Authors' calculations

Each boxplot in Figure 3 shows the distribution of the change in life expectancy (or lifespan inequality) across all countries in the sample. In 1990, the mean decrease in life expectancy due to HIV/AIDS was approximately 0.16 years for the total population, with a median of around 0.07. The high standard deviation and interquartile range (IQR) highlight the significant variation in life expectancy reductions, reflecting differences in epidemic intensity across countries (see Appendix, Table A7). The substantial number of extreme outliers represent countries, particularly in Sub-Saharan Africa, with notably higher mortality rates among young adults.

By 2008, partial recovery in life expectancy is observed, with the mean life expectancy loss due to HIV/AIDS reducing to 0.94 years. The narrower box plot for life expectancy and narrower range of outliers show decreasing variability in mortality distributions due to HIV/AIDS. The reduction in standard deviation and IQR (see Appendix, Table A7) reflects a shift towards a more uniform experience across countries. In 2018, life expectancy loss due to HIV/AIDS had further declined to approximately 0.48 years.

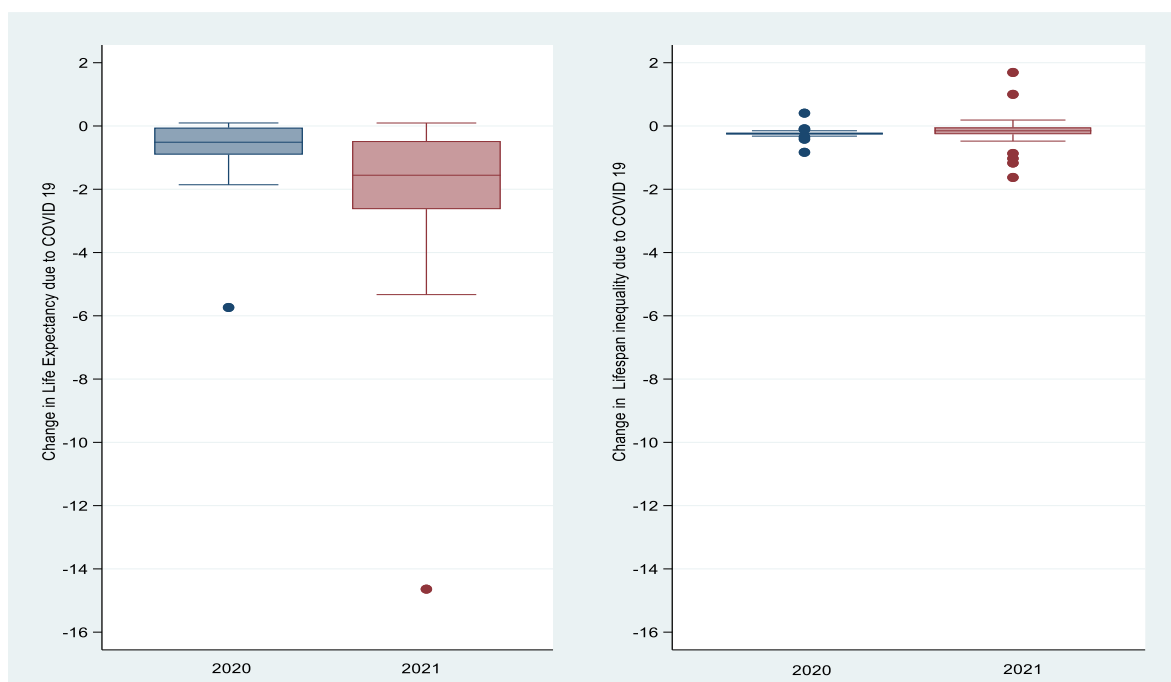
In 1990, the increase in lifespan inequality due to HIV/AIDS was significantly elevated, with a mean of 0.13 and a median of 0.27. By 1999, the increase in lifespan inequality due to HIV/AIDS had increased to a mean of 0.38 and a median 0.24. However, starting in the mid-2000s, there is a noticeable decline in the impact of HIV/AIDS on life expectancy and lifespan

inequality. This demonstrates the beneficial effects of enhanced prevention efforts and greater access to antiretroviral therapy (ART). For example, in sub-Saharan Africa, ART has played a transformative role in decreasing HIV-related mortality and morbidity (Burger et al., 2022). According to their findings, free ART contributed to a 27% reduction in annual mortality and a 36% decrease in poor health reports among black Africans aged 25-49 in South Africa. Globally, ART scale-up averted an estimated 4.2 million deaths in low- and middle-income countries from 2002 to 2012 (Ford et al., 2013), and studies report that HIV-related mortality rates dropped by over 58% across multiple locations following ART introduction (Reniers et al., 2014).

However, despite the increased availability of ART, there remains substantial variation in the impact of HIV/AIDS on life expectancy and lifespan inequality due to differing levels of treatment access, healthcare resources, and risk factors (Asghari et al., 2018; Marty et al., 2021; Tian et al., 2023). This persistent variability is especially evident in high-prevalence regions such as Sub-Saharan Africa, South and Southeast Asia, and the Caribbean, with countries like Botswana, Eswatini, Kenya, South Africa, Zambia, Zimbabwe, Mozambique, Malawi, and Namibia frequently appearing as outliers (Figure 3). By 2018, the impacts of HIV/AIDS on life expectancy and lifespan inequality are noticeably less than in 1990, as demonstrated by the box plots in Figure 3. This visual observation is further supported by the results of a Kolmogorov-Smirnov test, which reveals a significant difference in the distributions of lifespan inequality between 1990 and 2018 ($p < 0.001$).

Figure 4 depicts the effects of the COVID-19 pandemic on life expectancy and lifespan inequality for 2020 and 2021, based on data from 45 countries. This was calculated by comparing life expectancy and lifespan inequality under two scenarios: one including all causes of death, and the other excluding deaths specifically attributed to COVID-19, separately for each country in the sample (see Appendix, Table A4 and A5). Each boxplot shows the distribution of the change in life expectancy (or lifespan inequality) across all countries in the sample.

Figure 4: COVID-19 impacts on life expectancy and lifespan inequality



Source: Authors' calculations

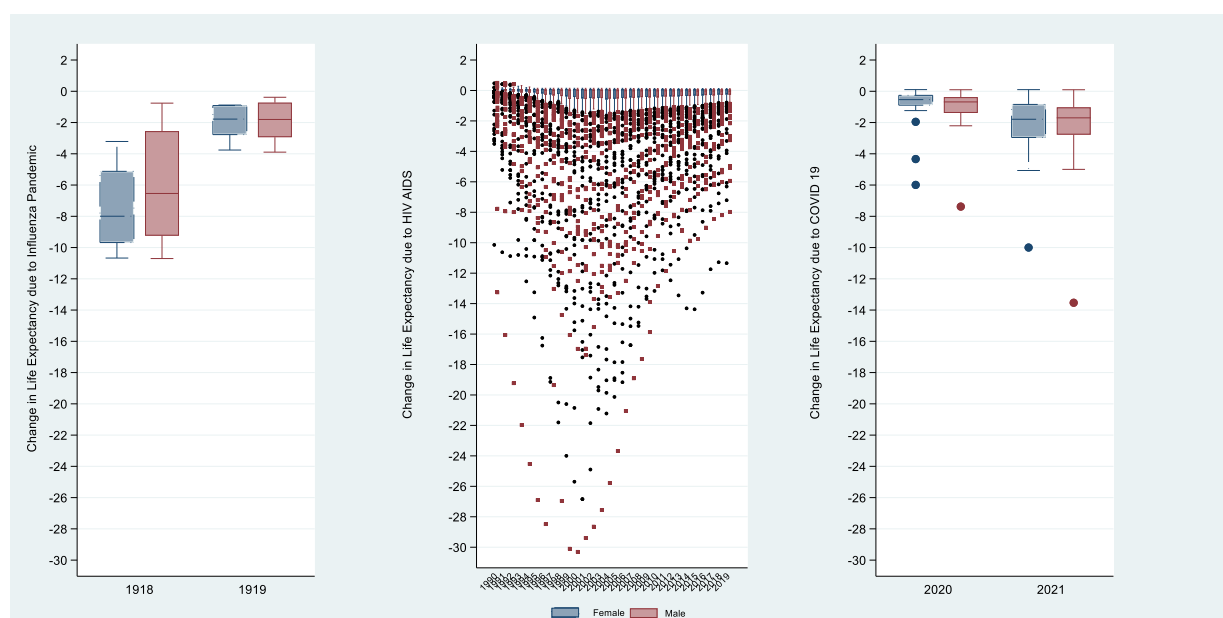
In the first year of the COVID-19 pandemic (2020), the mean decrease in life expectancy for the total population was 0.65 years, with a median of 0.51. The standard deviation of 0.92 and interquartile range (IQR) of 0.85 indicate notable variability across countries. The box plot in Figure 4 highlights the substantial spread of life expectancy changes, indicating that different countries faced distinct pandemic-related challenges. In 2021, life expectancy loss increased sharply, with the mean reduction reaching 1.95 years with a median of 1.56. The standard deviation rose to 2.37, and the IQR expanded to 2.15, underscoring even greater disparities as some countries continued to struggle with COVID-19's impact. Some nations, such as South Korea, New Zealand, and Thailand, experienced relatively less impact due to strong pandemic responses, including effective leadership, communication, community engagement, and robust public health infrastructure (Chen & Assefa, 2021). In contrast, countries like the United States, Italy, and Brazil, which faced challenges in these areas, experienced more significant mortality increases (Chen & Assefa, 2021). A Kolmogorov-Smirnov test confirms a significant difference in the distributions of the impact of COVID-19 on life expectancy between 2020 and 2021 ($p < 0.001$). An outlier in the life expectancy box plot for both years is Peru which, by 2022, had around 6,500 COVID-19 deaths per million people, the highest rate worldwide (World Bank, 2023). Despite immediate measures such as lockdowns, social distancing, and business closures, Peru's underfunded healthcare system and lack of essential resources including ICU capacity

contributed to its high mortality rate (Olivera, 2021). Historical underinvestment in public health in Peru further compounded these challenges (ECLAC, 2019).

Turning to the impact on lifespan inequality, the mean change in lifespan inequality in 2020 was a decrease of 0.24, with a median decrease of 0.25. Thus, unlike the other two pandemics, lifespan inequality did not increase substantially, likely due to the more uniform impact of COVID-19 on older age groups' mortality. By 2021, the mean change in lifespan inequality adjusted slightly to -0.16, with a median close to -0.15 (see Appendix, Table A8). The box plot for 2021 shows that while the overall change in lifespan inequality remained modest, some countries experienced more pronounced disparities in age-at-death patterns. For example, in Belgium (an outlier in Figure 4), the majority of deaths occurred among those aged 64 and older, with nearly half of deaths concentrated among those aged 84 and above (Peeters et al., 2021). Similarly, Brazil recorded the highest death rate among those over 60 (Azevedo e Silva et al., 2021). Comparing the distributions of lifespan inequality change due to COVID-19 between 2020 and 2021, a Kolmogorov-Smirnov test confirms a significant distributional change between 2020 and 2021 ($p=0.001$).

Figure 5 illustrates the impacts of all three pandemics on life expectancy changes separately by gender, showing how each event led to life expectancy reductions with varying severity between males and females.

Figure 5: Pandemic impacts on life expectancy, by gender

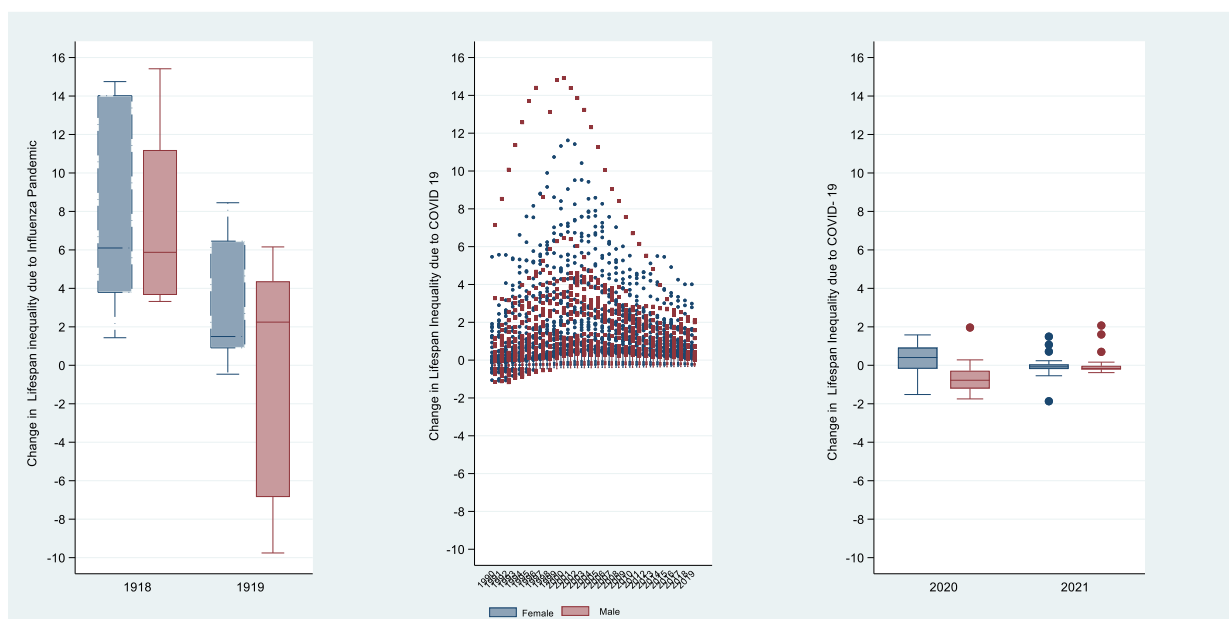


Source: Authors' calculations

When comparing the impacts of the influenza pandemic, HIV and COVID-19, on life expectancy across genders, females experienced a mean life expectancy loss of 4.75 years

compared to 4.01 years for males in the influenza pandemic in 1918. Although the female mean is slightly higher, a *t*-test ($p = 0.5801$) and Kolmogorov-Smirnov test ($p = 0.617$) show that these differences are not statistically significant. Our findings are consistent with empirical studies (e.g., Sawchuk, 2009; Paskoff & Sattenspiel, 2019) that found no significant differences in mortality based on sex during the 1918 influenza pandemic. In contrast, research from the United States highlights a notable impact, showing that women lost much of their mortality advantage over men, a trend that persisted until the 1930s (Noymer & Garenne, 2000). In COVID-19, the mean loss of life expectancy was 1.48 years for females and 1.61 years for males. This similarity is confirmed by the *t*-test ($p=0.365$) and Kolmogorov-Smirnov test ($p=0.318$), indicating no significant gender-based differences in either the average loss or the overall distribution. Although some countries, such as Peru, Brazil, and Israel, appeared as outliers regarding female life expectancy loss in 2020, by 2021, only Peru remained an outlier. For males, Peru stood out as an outlier in both years. Considering HIV/AIDS, the mean life expectancy loss for females was -0.84 years, compared to -0.66 years for males. Both the *t*-test ($p=0.001$) and the Kolmogorov-Smirnov test ($p<0.001$) highlight significant differences in the averages and distribution, indicating distinct gender-specific patterns. These results are consistent with global epidemiological evidence showing that women bear a disproportionately higher burden of HIV in terms of infection rates, mortality, and broader health impacts (Wang et al., 2016; UNAIDS, 2017; Girum et al., 2018).

Figure 6: Pandemic impacts on lifespan inequality, by gender



Source: Authors' calculations

A t -test ($p=0.438$) and Kolmogorov-Smirnov test ($p = 0.905$) indicate no statistically significant differences in mean values or distribution shapes, suggesting that lifespan inequality was not substantially different between genders in the case of the 1918 influenza. In contrast, COVID-19 exhibits significant gender disparities, with males showing a mean lifespan inequality decrease of 0.34 years compared to an *increase* of 0.13 years for females. A t -test ($p = 0.0002$) and KS test ($p < 0.0001$) confirm statistically significant differences in both the mean and distribution between the genders. The results of our analysis align with existing empirical studies on COVID-19 mortality. According to Mamlook et al. (2020) and Hu et al. (2021), males have been more susceptible to severe disease and death from COVID-19 than females. This is further supported by Yanez et al. (2020), who found that mortality rates were 77% higher in men than in women, especially among older adults. HIV shows the most striking gender disparity, with females experiencing a mean lifespan inequality change of 0.14 years compared to 0.02 years for males. A t -test ($p < 0.0001$) and Kolmogorov-Smirnov test ($p < 0.0001$) reveal highly statistically significant differences in both magnitude and distribution, indicating distinct gender-specific patterns of lifespan inequality in the case of HIV. These findings align with broader epidemiological evidence showing that women, particularly in younger age groups, bear a disproportionately high burden of HIV. Of the 1 million AIDS-related deaths in 2017, women accounted for a larger share (UNAIDS, 2017). In Ethiopia specifically, 57% of AIDS-related deaths were among females (Ethiopian Public Health Institute, 2017). Moreover, AIDS-related illnesses remain the leading cause of death among women of reproductive age (15–49 years) globally (UNAIDS, 2017) and the second leading cause of death for young women aged 15–24 years in Africa (Wang et al., 2016).

4. Conclusion

This study examined the impact of three major pandemics: the 1918 influenza pandemic, the HIV/AIDS epidemic, and the COVID-19 pandemic, on life expectancy and lifespan inequality. By utilizing standard and cause-eliminated life tables, we quantified the changes in life expectancy associated with each pandemic, capturing changes in life expectancy and lifespan variability due to the unique mortality patterns of each pandemic.

We found that the 1918 influenza pandemic, HIV/AIDS epidemic, and COVID-19 pandemic all caused reductions in life expectancy, but their impacts differed in magnitude and dynamics over time. The 1918 influenza pandemic led to the most significant and immediate reductions, with life expectancy dropping sharply during its peak. COVID-19 also caused substantial reductions, concentrated among older populations, with losses increasing in 2021

compared to 2020. In contrast, the HIV/AIDS epidemic, though spanning decades, had a much smaller impact on life expectancy, with reductions peaking in the early 2000s. Notably, the HIV/AIDS epidemic revealed significant gender disparities, with women experiencing more pronounced reductions in life expectancy than men. By contrast, the impacts of the 1918 influenza and COVID-19 pandemics were more uniform across genders.

We also found that lifespan inequality showed divergent patterns across the three pandemics. Both the 1918 influenza pandemic and HIV/AIDS epidemic increased lifespan inequality significantly, but through different mechanisms. The 1918 influenza pandemic caused a sharp rise in inequality due to high mortality among younger adults, while HIV/AIDS, concentrated among young and middle-aged adults in its early stages, led to a more gradual increase over time. Conversely, the COVID-19 pandemic uniquely decreased lifespan inequality on average, as its mortality concentration among older adults smoothed age-at-death distributions. Our analysis highlights notable gender disparities in lifespan inequality across the three pandemics. While the 1918 influenza showed no significant gender differences in lifespan inequality, COVID-19 and HIV/AIDS both exhibit pronounced disparities. COVID-19 disproportionately affected males, while HIV/AIDS had a greater impact on females.

These findings provide important insights for future pandemics. The demographic age group most affected will play a critical role in determining the impacts on life expectancy and lifespan inequality. Pandemics that disproportionately affect younger populations are likely to cause sharp reductions in life expectancy and significant increases in lifespan inequality, as seen during the 1918 influenza pandemic. Conversely, pandemics that primarily affect older populations, such as COVID-19, may result in smaller reductions in life expectancy and potential decreases in lifespan inequality, as mortality is concentrated among those already near the end of the life course.

Our findings highlight the need for tailored, evidence-based policy responses. Policies for future pandemics must prioritize demographic-specific interventions. For pandemics like the 1918 influenza, which heavily affected younger adults, strategies should focus on vaccination, health education, and rapid deployment of medical resources to protect this demographic group. In contrast, pandemics such as COVID-19, which disproportionately impact older populations, demand robust investments in geriatric healthcare, long-term care facilities, and preventive measures like vaccines designed for older age groups. The findings also emphasize the critical role of addressing gender disparities in healthcare during pandemics. The pronounced impacts of the HIV/AIDS epidemic on women highlight the need for gender-sensitive healthcare programs.

Finally, preparedness strategies should incorporate lessons from these historical pandemics. Enhanced surveillance systems, demographic-specific public health responses, and continuous monitoring of health inequalities trends can guide future interventions.

Even though our study offers valuable insights into three different pandemics, there are some limitations. A primary limitation of this study is the lack of reliable, age- and sex-specific mortality data for a wider selection of countries, particularly for the 1918 influenza pandemic. Incomplete or inconsistent records from this period hinder the precision of mortality estimates and limit the ability to fully assess the age and gender impacts. For HIV/AIDS and COVID-19, more detailed data are available, but regional discrepancies in data collection quality and completeness may still present challenges.

Our research also points to opportunities for future research, which should focus on deepening our understanding of how pandemics differentially impact life expectancy and lifespan inequality across various demographic groups and socioeconomic settings. Key areas include examining age-specific mortality patterns and the extent to which these shifts contribute to lifespan inequality, especially in contexts where healthcare access is limited. Additionally, research could further explore the role of gender disparities in mortality during pandemics, as well as the long-term socioeconomic effects of these gendered impacts on health and mortality. Comparative studies across countries and regions would also provide insights into how differences in healthcare infrastructure, policy responses, and social determinants influence outcomes, helping to identify best practices for mitigating mortality impacts. It is also crucial to consider not only the direct effects of pandemics on life expectancy and lifespan inequality but also their long-term, indirect impacts. These indirect effects include disruptions to essential healthcare services, increases in mental health issues, widening health disparities, and economic losses. Future research should also focus on evaluating these indirect effects at the subnational level, with particular attention to the collateral damage to healthcare systems, the surge in mental health challenges, and the growing burden of non-communicable diseases associated with pandemics. By understanding these indirect effects and their long-term consequences, policymakers can design interventions that are not only immediate but also sustainable, ensuring that public health systems are better prepared to address the multifaceted challenges posed by future pandemics.

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Appendix

Table A1: Country List

1918 Influenza Pandemic

Total Population Male /Female

Denmark	Denmark
England	England
Finland	
Italy	Italy
Netherland	Netherland
Norway	Norway
Scotland	
Spain	
Sweden	Sweden
Switzerland	
USA	USA

HIV AIDS Pandemic

Afghanistan	Denmark	Liberia	Saint Kitts and Nevis
Albania	Djibouti	Libya	Saint Lucia
Algeria	Dominica	Lithuania	Samoa
American Samoa	Dominican Republic	Luxembourg	San Marino
Andorra	Ecuador	Madagascar	Sao Tome and Principe
Angola	Egypt	Malawi	Saudi Arabia
Antigua and Barbuda	El Salvador	Malaysia	Senegal
Argentina	Equatorial Guinea	Maldives	Serbia
Armenia	Eritrea	Mali	Seychelles
Australia	Estonia	Malta	Sierra Leone
Austria	Eswatini	Marshall Islands	Singapore
Azerbaijan	Ethiopia	Mauritania	Slovakia
Bahamas	Fiji	Mauritius	Slovenia
Bahrain	Finland	Mexico	Solomon Islands
Bangladesh	France	Micronesia	Somalia
Barbados	Gabon	Monaco	South Africa
Belarus	Gambia	Mongolia	South Sudan
Belgium	Georgia	Montenegro	Spain
Belize	Germany	Morocco	Sri Lanka
Benin	Ghana	Mozambique	State of Palestine
Bermuda	Greece	Myanmar	Sudan
Bhutan	Greenland	Namibia	Suriname
Bolivia	Grenada	Nauru	Sweden
Bosnia and Herzegovina	Guam	Nepal	Switzerland

Botswana	Guatemala	Netherlands	Syrian Arab Republic
Brazil	Guinea	New Zealand	Tajikistan
British Virgin Islands	Guinea-Bissau	Nicaragua	Thailand
Brunei Darussalam	Guyana	Niger	Timor-Leste
Bulgaria	Haiti	Nigeria	Togo
Burkina Faso	Honduras	Niue	Tokelau
Burundi	Hungary	North Macedonia	Tonga
		Northern Mariana Islands	
Cabo Verde	Iceland	Norway	Trinidad and Tobago
Cambodia	India	Oman	Tunisia
Cameroon	Indonesia	Pakistan	Türkiye
Canada	Iran		Turkmenistan
Central African Republic	Iraq	Palau	Tuvalu
Chad	Ireland	Panama	Uganda
Chile	Israel	Papua New Guinea	Ukraine
China	Italy	Paraguay	United Arab Emirates
Taiwan	Jamaica	Peru	United Kingdom
Colombia	Japan	Philippines	Tanzania
Comoros	Jordan	Poland	USA
Congo	Kazakhstan	Portugal	Uruguay
Cook Islands	Kenya	Puerto Rico	Uzbekistan
Costa Rica	Kiribati	Qatar	Vanuatu
Croatia	Kuwait	Republic of Korea	Venezuela
Cuba	Kyrgyzstan	Moldova	Viet Nam
	Lao People's Democratic Republic		
Cyprus	Latvia	Romania	Yemen
Czechia		Russian Federation	Zambia
Dem. People's Republic of Korea	Latvia	Rwanda	Zimbabwe
Democratic Republic of the Congo	Lesotho		

COVID-19 Pandemic

Total Population	Female /Male
Afghanistan	
Argentina	Argentina
Australia	Australia
Austria	Austria
Belgium	Belgium
Brazil	Brazil
Bulgaria	Bulgaria
Chile	Chile
Colombia	Colombia

Czechia	Czechia
Denmark	
Finland	
France	France
Georgia	
Germany	Germany
Greece	Greece
Guatemala	Guatemala
Hiti	
Hungary	Hungary
Indonesia	
Italy	Italy
Jamaica	
Japan	Japan
Lithuania	
Mexico	
Moldova	Moldova
Nepal	
Netherland	
New Zealand	New Zealand
Norway	Norway
Paraguay	Paraguay
Peru	Peru
Philippines	Philippines
Portugal	Portugal
Puerto Rico	Puerto Rico
Slovakia	Slovakia
Slovenia	Slovenia
Spain	Spain
Sweden	
Switzerland	
Taiwan	
Togo	Togo
UK	UK
Ukraine	Ukraine
USA	USA

Table A2: Life Expectancy Changes - Influenza Pandemic

Country	Total Population				Female Population				Male Population			
	1918		1919		1918		1919		1918		1919	
	Life Expectancy (All-cause death)	Life Expectancy (Cause Elimination -Influenza Death)	Life Expectancy (All-cause death)	Life Expectancy (Cause Elimination -Influenza Death)	Life Expectancy (All-cause death)	Life Expectancy (Cause Elimination -Influenza Death)	Life Expectancy (All-cause death)	Life Expectancy (Cause Elimination -Influenza Death)	Life Expectancy (All-cause death)	Life Expectancy (Cause Elimination -Influenza Death)	Life Expectancy (All-cause death)	Life Expectancy (Cause Elimination -Influenza Death)
Denmark	56.22	63.77	56.88	59.96	57.28	60.49	57.71	58.62	55.14	55.89	56.08	56.45
England	40.9	44.58	54.08	55.87	50.25	55.37	56.61	58.39	33.39	35.93	51.55	53.31
Finland	32.85	42.81	36.32	47.01								
Italy	25.82	41.7	31.68	42.61	28.34	36.33	44.88	45.98	23.52	27.67	38.62	39.35
Netherland	47.63	51.89	54.78	55.35	67.97	75.23	70.19	71.07	59.75	66.29	61.99	62.77
Norway	50.32	59.78	56.79	59.64	52.06	61.74	58.09	60.86	48.55	57.79	55.47	58.41
Scotland	48.87	52.68	50.80	53.07								
Spain	30.36	36.95	40.95	41.94								
Sweden	49.72	58.67	56.42	58.84	51.36	60.21	57.89	60.34	48.1	57.12	54.97	57.60
Switzerland	46.3	54.83	55.08	56.28								
USA	46.73	58.22	58.65	62.52	53.64	61.70	59.61	63.68	49.49	57.75	59.22	61.65

Table A3: Lifespan Inequality Changes - Influenza Pandemic

Country	Total Population				Female Population				Male Population			
	1918		1919		1918		1919		1918		1919	
	Theil Index (All-cause death)	Theil Index (Cause Elimination - Influenza Death)	Theil Index (All-cause death)	Theil Index (Cause Elimination - Influenza Death)	Theil Index (All-cause death)	Theil Index (Cause Elimination - Influenza Death)	Theil Index (All-cause death)	Theil Index (Cause Elimination - Influenza Death)	Theil Index (All-cause death)	Theil Index (Cause Elimination - Influenza Death)	Theil Index (All-cause death)	Theil Index (Cause Elimination - Influenza Death)
Denmark	17.62	15.07	17.91	17.23	16.50	15.07	16.77	17.23	18.73	15.07	18.99	17.23
England	29.88	23.92	19.63	15.72	24.66	20.86	17.92	17.01	32.47	31.04	21.28	20.36
Finland	35.13	31.43	33.44	29.60	Data not available							
Italy	53.53	44.05	36.11	32.39	53.41	42.25	34.35	30.71	52.99	44.43	37.58	33.72
Netherland	26.97	24.07	20.95	20.83	26.06	12.04	19.84	13.39	27.91	15.88	22.04	16.68
Norway	21.04	15.23	17.01	15.47	20.00	13.91	16.00	14.50	22.02	13.60	17.96	13.54
Scotland	25.45	19.74	23.70	19.31	Data not available							
Spain	49.63	43.27	37.53	37.17	Data not available							
Sweden	21.48	15.81	17.80	17.17	20.52	14.73	16.49	15.16	22.34	16.77	19.02	20.77
Switzerland	22.29	17.13	16.93	16.24	Data not available							
USA	60.45	46.32	48.95	40.03	57.63	42.89	45.22	36.77	63.13	49.66	52.83	43.44

Table A4: Life Expectancy Changes – COVID-19

Country	Total Population				Female Population				Male Population			
	2020	2021		2020	2021		2020	2021				
	Life Expectancy (All-cause death)	Life Expectancy (Cause Elimination - COVID)	Life Expectancy (All-cause death)	Life Expectancy - (Cause Elimination - COVID)	Life Expectancy (All-cause death)	Life Expectancy (Cause Elimination - COVID)	Life Expectancy (All-cause death)	Life Expectancy (Cause Elimination - COVID)	Life Expectancy (All-cause death)	Life Expectancy (Cause Elimination - COVID)	Life Expectancy (All-cause death)	Life Expectancy (Cause Elimination - COVID)
Afghanistan	62.58	62.6	61.98	62.14	Data not available							
Argentina	75.89	77.31	75.39	79.55	79.28	75.6	78.65	82.23	72.55	74.22	72.18	75.6
Australia	84.32	84.26	84.53	84.53	85.72	83.16	85.84	85.82	82.89	82.83	83.17	83.16
Austria	81.5	82.09	81.58	83.29	83.91	80.44	84.08	85.52	79.05	79.71	79.04	80.44
Belgium	80.79	81.37	81.88	83.16	83.05	81.02	84.3	84.92	78.52	79.91	79.43	81.02
Brazil	74.01	75.25	72.75	77.48	77.37	73.26	76.01	80.09	70.7	72.31	69.56	73.26
Bulgaria	73.65	74.33	71.8	74.61	77.51	71	76.01	79.01	77.51	78.95	68.44	71
Chile	79.38	80.71	78.94	82.41	82.04	79.39	81.44	84.41	76.74	78.35	76.47	79.39
Colombia	74.77	76.42	72.83	78.16	78.14	73.69	76.44	80.71	71.54	73.62	69.4	73.69
Czechia	78.57	79.35	77.73	80.58	81.54	76.98	80.89	83.26	75.63	76.16	74.67	76.98
Denmark	81.54	81.64	81.38	81.74	Data not available							
Finland	81.87	81.91	82.04	82.27	Data not available							
France	82.21	83.14	82.5	84.71	85.17	81.13	85.49	87.43	79.17	80.36	79.43	81.13
Georgia	72.77	73.26	71.69	74.19	Data not available							
Germany	81.15	81.49	80.63	81.63	83.65	78.94	83.22	84.06	78.66	79.03	78.08	78.94
Greece	80.91	81.22	80.11	81.11	83.54	79	82.85	84.62	78.38	78.73	77.49	79
Guatemala	71.8	72.77	69.24	71.77	75.55	68.37	72.65	74.6	68.26	69.55	66	68.37
Hiti	64.05	63.98	63.19	63.17	Data not available							
Hungary	75.73	76.36	74.53	77.79	79.03	73.88	77.92	80.88	72.32	73	71.1	73.88

Indonesia	68.81	68.85	67.57	68.05	Data not available							
Italy	82.4	83	82.85	84.81	84.69	82.38	85.1	86.57	80.04	81.09	80.52	82.38
Jamaica	71.87	71.92	70.5	71.57	Data not available							
Japan	84.69	84.59	84.78	84.79	87.72	81.82	87.73	87.69	81.61	81.53	81.8	81.82
Lithuania	75.07	75.52	73.72	75.53	Data not available							
Mexico	70.13	71.99	70.21	71.83	Data not available							
Moldova	70.17	70.91	68.85	71.25	74.85	65.95	73.55	76.44	65.69	66.3	64.44	65.95
Nepal	69.25	69.26	68.45	69.05	Data not available							
Netherland	81.64	82.1	81.69	81.69	Data not available							
New Zealand	82.74	82.65	82.45	82.36	84.57	80.66	84.32	84.42	80.88	80.97	80.58	80.66
Norway	83.2	83.14	83.23	83.31	84.88	81.69	84.88	84.99	81.47	81.48	81.56	81.69
Paraguay	73.18	73.88	70.26	74.16	76.16	71.21	73.38	77.96	70.4	71.21	67.43	71.21
Peru	73.67	79.4	72.38	87.02	76.82	83.65	74.75	84.75	70.81	78.19	70.12	83.65
Philippines	72.12	72.25	69.27	70.02	74	67.77	71.48	72.19	70.24	70.42	67.17	67.77
Portugal	81.05	81.43	81.04	82.41	83.98	78.91	84.08	85.24	77.95	78.47	77.85	78.91
Puerto Rico	78.04	78.55	80.16	81.56	82.59	77.12	84.52	85.85	73.64	74.29	75.86	77.12
Slovakia	77.01	77.46	74.91	77.74	80.36	73.72	78.43	81.06	73.6	74.14	71.49	73.72
Slovenia	80.44	81.37	80.69	83.32	83.31	79.43	83.84	86.26	77.63	78.71	77.65	79.43
Spain	82.29	83.19	83.01	84.95	85.01	81.83	85.77	87.33	79.55	80.81	80.21	81.83
Sweden	82.43	83.02	82.98	84.39	Data not available							
Switzerland	83.07	83.77	83.99	85.31	Data not available							
Taiwan	80.89	80.8	81.01	80.96	Data not available							
Togo	61.04	60.95	61.62	61.55	61.58	60.8	62.39	62.34	60.49	60.41	60.85	60.8
UK	80.43	81.6	80.74	83.73	82.45	81.12	82.77	85.34	78.43	80.56	78.72	81.12
Ukraine	72.57	72.85	71.62	73.18	77.37	67.56	76.7	78.49	67.59	68.02	66.53	67.56
USA	77.41	78.57	77.2	78.84	80.31	77.15	80.24	81.7	74.64	75.88	74.3	77.15

Table A5: Lifespan inequality changes – COVID-19

Country	Total Population				Female Population				Male Population			
	2020		2021		2020		2021		2020		2021	
	Theil Index (All-cause death)	Theil Index (Cause Elimination - COVID)	Theil Index (All-cause death)	Theil Index - (Cause Elimination - COVID)	Theil Index (All-cause death)	Theil Index (Cause Elimination - COVID)	Theil Index (All-cause death)	Theil Index - (Cause Elimination - COVID)	Theil Index (All-cause death)	Theil Index (Cause Elimination - COVID)	Theil Index (All-cause death)	Theil Index - (Cause Elimination - COVID)
Afghanistan	9.83	10.15	10.06	10.21	Data not available							
Argentina	3.18	3.33	3.19	3.06	3.36	2.95	2.84	2.68	2.81	3.47	3.37	3.3
Australia	1.34	1.61	1.28	1.54	1.44	1.49	1.16	1.43	1.22	1.71	1.36	1.63
Austria	1.63	1.89	1.68	1.85	1.85	1.59	1.33	1.52	1.33	2.11	1.93	2.12
Belgium	1.72	2.55	1.79	3.41	1.89	2.75	1.51	3.38	1.47	2.09	1.97	2.13
Brazil	3.91	4.32	4.05	5.08	4.65	4.82	3.24	3.79	3.01	4.76	4.71	4.54
Bulgaria	2.56	2.78	2.62	2.68	2.07	2.31	3.24	3.24	2.07	2.14	2.83	2.92
Chile	2.34	2.5	2.45	2.4	2.65	2.09	2.09	2.03	1.93	2.74	2.72	2.7
Colombia	3.72	3.87	4.06	3.88	4.39	3.07	3.16	2.97	2.91	4.45	4.8	4.7
Czechia	1.73	1.98	1.79	1.96	1.93	1.64	1.45	1.59	1.37	2.19	1.98	2.17
Denmark	1.64	1.9	1.53	1.78	Data not available							
Finland	1.74	2	2	1.82	Data not available							
France	1.92	2.15	1.92	2.06	2.2	1.75	1.52	1.65	1.53	2.42	2.2	2.4
Georgia	2.84	3.08	2.88	3.13	Data not available							
Germany	1.76	2.02	1.79	2.01	1.95	1.74	1.49	1.72	1.47	2.19	1.99	2.2
Greece	1.8	1.98	1.83	2.7	2.09	1.61	1.47	1.24	1.45	2.28	2.13	2.21
Guatemala	5.29	5.4	5.25	5.21	5.91	4.65	4.48	4.44	4.53	5.97	5.9	5.93
Hiti	9.58	9.9	9.77	10.09	Data not available							
Hungary	2.12	2.34	2.2	2.25	2.34	1.93	1.86	1.88	1.7	2.57	2.34	2.39
Indonesia	4.8	5.05	4.91	5.19	Data not available							

Italy	1.45	1.7	1.49	1.64	0.01	1.44	1.22	1.4	1.63	1.86	1.67	1.84
Jamaica	3.53	3.79	3.71	3.65	Data not available							
Japan	1.54	1.79	1.43	1.69	0.01	1.53	1.19	1.47	1.68	1.94	1.54	1.8
Lithuania	2.55	2.81	2.65	2.77	Data not available							
Mexico	4.22	4.31	4.16	4.24	Data not available							
Moldova	3.39	3.6	3.4	3.56	3.76	2.85	2.69	2.68	2.68	4.03	3.77	4.02
Nepal	5.36	5.64	5.51	5.5	Data not available							
Netherland	1.55	1.82	1.55	1.84	Data not available							
New Zealand	1.97	2.23	2.07	2.33	3.36	1.94	3.53	2.03	4.44	2.48	4.64	2.58
Norway	1.45	1.74	1.4	1.67	1.21	1.52	1.19	1.46	1.63	1.91	1.55	1.82
Paraguay	4.4	4.6	4.29	4.19	4.92	3.96	3.64	3.4	3.76	5.09	4.81	4.75
Peru	3.52	3.11	3.75	2.06	3.91	2.72	3.29	2.22	3.02	3.04	4.14	2.54
Philippines	4.69	4.95	4.71	4.9	5.12	4.43	4.19	4.38	4.17	5.37	5.12	5.33
Portugal	1.7	1.95	1.72	1.83	1.33	1.6	1.37	1.52	1.97	2.21	1.96	2.17
Puerto Rico	3.67	3.84	3.06	3.04	4.24	3.09	2.37	2.32	2.93	4.39	3.6	3.62
Slovakia	2.24	2.49	2.3	2.43	2.52	2.02	1.85	1.92	1.78	2.76	2.54	2.7
Slovenia	1.54	1.78	1.61	1.73	1.77	1.4	1.24	1.34	1.17	2.01	1.81	1.99
Spain	1.52	1.73	1.54	1.63	1.71	1.46	1.25	1.35	1.23	1.9	1.72	1.89
Sweden	1.48	1.74	1.17	1.65	Data not available							
Switzerland	1.55	1.81	1.4	1.65	Data not available							
Taiwan	2.14	2.39	2.11	2.35	Data not available							
Togo	11.44	11.78	11.02	11.36	11.6	11.6	10.74	11.08	11.25	11.95	11.28	11.62
UK	1.97	2.16	3.04	2.04	3.44	1.86	1.73	1.73	2.4	2.12	3.35	3.57
Ukraine	3	3.24	2.03	3.2	3.39	2.46	2.29	2.36	2.21	3.57	2.28	2.37
USA	2.98	3.16	3.12	3.2	3.08	2.58	2.54	2.62	1.68	3.31	3.28	3.39

Table A6: Summary Statistics – 1918 Influenza Pandemic

Year	Changes in Life Expectancy-Total Population				Changes in Lifespan Inequality-Total Population			
	Mean	Median	SD	IQR	Mean	Median	SD	IQR
1918	-6.79	-6.59	0.80	4.69	6.13	5.71	3.25	2.67
1919	-2.20	0.43	1.42	1.86	2.62	1.53	2.67	3.28
	Changes in Life Expectancy-Female				Changes in Lifespan Inequality-Female			
	Mean	Median	SD	IQR	Mean	Median	SD	IQR
	-4.75	-3.49	3.48	5.86	5.63	4.80	4.91	6.50
	Changes in Life Expectancy-Male				Changes in Lifespan Inequality-Male			
	Mean	Median	SD	IQR	Mean	Median	SD	IQR
	-4.01	-2.79	3.49	4.90	3.92	3.85	6.48	3.61

Table A7: Summary Statistics – HIV/AIDS Pandemic

HIV -Life Expectancy -Total Population					HIV -Lifespan inequality -Total Population				
Year	Mean	Median	SD	IQR	Year	Mean	Median	SD	IQR
1990	-0.16	0.07	0.95	0.09	1990	-0.13	-0.27	0.69	0.1
1991	-0.22	0.06	1.07	0.12	1991	-0.08	-0.27	0.79	0.1
1992	-0.33	0.06	1.28	0.16	1992	-0.02	-0.26	0.92	0.09
1993	-0.43	0.05	1.49	0.22	1993	0.04	-0.25	1.05	0.11
1994	-0.55	0.04	1.77	0.27	1994	0.11	-0.25	1.21	0.13
1995	-0.68	0.03	2.07	0.33	1995	0.18	-0.25	1.36	0.16
1996	-0.79	0.03	2.36	0.4	1996	0.24	-0.25	1.5	0.18
1997	-0.88	0.03	2.63	0.45	1997	0.29	-0.24	1.62	0.19
1998	-0.98	0.03	2.9	0.46	1998	0.33	-0.25	1.72	0.22
1999	-1.04	0.02	3.09	0.52	1999	0.38	-0.24	1.8	0.26
2000	-1.17	0.01	3.3	0.62	2000	0.42	-0.24	1.87	0.3
2001	-1.23	0.01	3.46	0.67	2001	0.43	-0.24	1.88	0.31
2002	-1.25	0.02	3.47	0.72	2002	0.45	-0.24	1.93	0.32
2003	-1.24	0.01	3.53	0.73	2003	0.44	-0.23	1.89	0.33
2004	-1.26	0.01	3.46	0.78	2004	0.42	-0.23	1.84	0.36
2005	-1.21	0.01	3.33	0.7	2005	0.39	-0.22	1.73	0.37
2006	-1.13	0	3.11	0.71	2006	0.34	-0.22	1.58	0.34
2007	-1.04	-0.01	2.86	0.69	2007	0.29	-0.22	1.44	0.31
2008	-0.94	-0.01	2.56	0.6	2008	0.24	-0.22	1.3	0.29
2009	-0.85	-0.02	2.3	0.63	2009	0.19	-0.21	1.14	0.29
2010	-0.79	-0.02	2.1	0.6	2010	0.15	-0.21	1.01	0.27
2011	-0.74	-0.02	1.94	0.58	2011	0.12	-0.22	0.91	0.26
2012	-0.68	-0.02	1.84	0.55	2012	0.09	-0.22	0.85	0.24
2013	-0.65	-0.03	1.76	0.5	2013	0.06	-0.22	0.8	0.24
2014	-0.62	-0.03	1.69	0.48	2014	0.05	-0.21	0.77	0.23
2015	-0.59	-0.04	1.62	0.46	2015	0.03	-0.21	0.73	0.23
2016	-0.55	-0.03	1.52	0.44	2016	0	-0.21	0.67	0.21
2017	-0.51	-0.03	1.43	0.41	2017	-0.02	-0.21	0.62	0.19
2018	-0.47	-0.02	1.33	0.38	2018	-0.04	-0.22	0.56	0.17
Changes in Life Expectancy-Female					Changes in Lifespan Inequality-Female				
Mean	Median	SD	IQR		Mean	Median	SD	IQR	
-0.84	0.05	2.68	0.33		0.14	-0.26	1.23	0.15	
Changes in Life Expectancy-Male					Changes in Lifespan Inequality-Male				
Mean	Median	SD	IQR		Mean	Median	SD	IQR	
-0.66	0.00	2.24	0.41		0.02	-0.25	1.00	0.15	

Table A8: Summary Statistics - COVID-19 Pandemic

Year	Changes in Life Expectancy-Total Population				Changes in Lifespan Inequality-Total Population			
	Mean	Median	SD	IQR	Mean	Median	SD	IQR
2020	-0.65	-0.51	0.92	0.85	-0.24	-0.25	0.14	0.05
2021	-1.94	-1.55	2.37	2.15	-0.16	-0.15	0.48	0.21
	Changes in Life Expectancy-Female				Changes in Lifespan Inequality-Female			
	Mean	Median	SD	IQR	Mean	Median	SD	IQR
	-1.48	-0.87	1.79	1.68	0.13	0.01	0.68	0.67
	Changes in Life Expectancy-Male				Changes in Lifespan Inequality-Male			
	Mean	Median	SD	IQR	Mean	Median	SD	IQR
	-1.61	-1.26	2.02	1.59	-0.34	-0.24	0.70	0.69