Stockholm Research Reports in Demography | no 2021:17

Excess mortality and COVID-19 in Sweden in 2020:

A demographic account

Martin Kolk, Sven Drefahl, Matthew Wallace and Gunnar Andersson

ISSN 2002-617X | Department of Sociology

Stockholm University

Demography Unit

Excess mortality and COVID-19 in Sweden in 2020: A demographic account

Martin Kolk[1,2], Sven Drefahl[1], Matthew Wallace[1] and Gunnar Andersson[1]

[1]Demography Unit, Department of Sociology, Stockholm University, Stockholm, Sweden

[2]Institue for Future Studies, Stockholm, Sweden

Abstract

In this study, we provide an account of mortality levels in Sweden during 2020, with a focus both on excess mortality and mortality due to COVID-19 deaths. We present various measures of life expectancy of women and men based on age-specific death rates during 2020. Our measures of excess mortality are based on comparisons with benchmarks based on a previous mortality forecast for 2020 by Statistics Sweden and the observed mortality rates during an average of 2017-2019. We present data on regional and seasonal variation in excess mortality as well as estimates of Years of Potential Life lost due to COVID-19. We decompose the excess mortality in 2020 into what can be explained by COVID-19 and changes in mortality by other causes. We also provide some estimates on the impact of the excess mortality in 2020 on the remaining life expectancy for different cohorts of Swedish women and men. We demonstrate that the impact of COVID-19 mortality was concentrated to higher ages and among men in particular. Some younger age groups rather experienced a negative excess mortality. The mortality situation during 2020 pushed life expectancy back to levels previously observed during 2018 for women and 2017 for men.

Keywords: excess mortality, mortality, life expectancy, COVID-19, Sweden

Stockholm Research Reports in Demography 2021:17

ISSN 2002-617X

1. Introduction

In early 2020 COVID-19 spread across the globe, and in March 2020 it reached Sweden. For much of the remaining year, Sweden witnessed elevated mortality due to deaths associated with COVID-19. Here, we assess the extent of this observed excess mortality in 2020. We provide a comprehensive breakdown of mortality due to COVID-19 as well as overall excess mortality in Sweden by age, sex, calendar time, and region. We contrast the observed mortality in 2020 with recent, pre-pandemic mortality patterns and official pre-pandemic mortality forecasts for 2020.

In a very short time, researchers produced an extensive body of research on various aspects of the COVID-19 pandemic and its consequences. Demographers produced estimates of the impact of COVID-19 on mortality in countries such as the United States (Andrasfay and Goldman 2021; Goldstein and Lee 2020), England and Wales (Aburto et al. 2021a) and Spain (Trias-Llimós, Riffe and Bilal 2020). A comparative study by Aburto et al. (2021b) presented life expectancy estimates for 2020 for 29 countries, with mortality rates from 2019 used as a benchmark. A few countries had similar to lower mortality in 2020 compared to 2019 (including Sweden's Nordic counterparts Denmark, Finland and Norway). Nevertheless, most countries witnessed excess mortality, with a decline in life expectancy of up to 1.5 years and larger declines for men than for women. With this benchmark, Sweden had a slightly higher excess mortality than the median of countries in the study. This was partly due to an unusually pronounced mortality reduction in Sweden in 2019. A study by Pifarré i Arolas et al. (2021) instead used the metric of Years of Life lost in 2020 for 81 countries. Sweden, like many other high-income countries had a high concentration of mortality at older ages, with fewer years of life lost than if deaths had occurred at younger ages. Islam et al. (2021) estimates total excess mortality for 29 high-income countries in 2020, and also find that Sweden ranked in the middle of the 29 countries.

Some researchers have extolled the advantages of using excess mortality as a summary measure of the pandemic's effects in terms of elevated mortality. This is a relatively simple and objective measure that is particularly appropriate when making comparisons of mortality differentials between countries (Beaney et al. 2020; Modig, Ahlbom and Matthews 2020). The measure is particularly suitable for countries that lack a high-quality registration of causes of death. The latter, of course, does not apply to Sweden, a country for which death registration is of high-quality and complete. Yet, even for Sweden, it is of interest to investigate the extent of excess mortality as a summary measure of various negative and possible positive effects of the COVID-19 pandemic on mortality patterns, not least to be able to place findings in the context of wider work.

Several studies from Sweden have examined patterns in COVID-19-related mortality based on individual-level data on observed deaths and causes of deaths during the early parts of 2020. They show increased mortality, notably among the socio-economically disadvantaged (Drefahl et al. 2020), those in crowded and multigenerational households (Brandén et al. 2020) and migrants (Aradhya et al. 2020; Rostila et al. 2021). Similar studies on mortality among the foreign-born have been conducted in Norway (Indseth et al. 2020) and Belgium (Vanthomme et al. 2021). Calderón-Larrañaga et al. (2020) show that mortality in Stockholm was elevated in areas with lower incomes and/or in areas with more migrants. Modig, Ahlbom and Ebeling (2021) investigated how mortality varied over different weeks during the year, with data up to week 33 (early August), revealing the magnitude of excess mortality during the 2020 spring peak in Swedish mortality. Modig et al. (2021) then went on to show strongly elevated mortality among men and women living in elderly care in Sweden.

Our study differs from previous studies on excess mortality in several ways. One important difference is that we primarily use forecasted mortality rates for 2020, which were produced by Statistics Sweden prior to the pandemic, as our baseline, instead of observed mortality rates from previous years (e.g. Aburto et al. 2021b; Islam et al. 2021). This has two advantages. First, it accounts for the secular trend of falling mortality that is one of the most robust demographic findings of a century or more (Drefahl, Ahlbom and Modig 2014). Using a pre-pandemic average of mortality rates as a benchmark would otherwise overestimate the mortality that had occurred in the absence of COVID-19. Secondly, the forecast is based on the Lee-Carter method for extrapolation (described in Statistics Sweden 2018) based on data for a longer time period which produces rates that are more stable than those derived from shorter extrapolation windows. Additionally, we further break down the excess mortality by region of residence in Sweden, by calendar-year month, and detailed ages of women and men, including statistics on the amount of deaths that can be directly attributed to COVID-19. To our knowledge, such a comprehensive review of the excess mortality for a national population in 2020 has not been produced before, although similar statistics will likely be produced for other countries in the future.

2. Results

2.1 Changes in life expectancy and number of deaths

Life expectancy has increased steadily over the past hundred years for women and men in Sweden. However, the increase in the most recent decades was somewhat slower in Sweden than in many other countries in Europe. This was mainly due to a comparatively slower decline in mortality at the very highest ages, in contrast with other life expectancy leaders (Drefahl, Ahlbom and Modig 2014). However, mortality for older men, and at younger ages for both women and men, is still lower in Sweden than in most other countries (Drefahl, Ahlbom and Modig 2014). In 2019, an unusually sharp reduction in mortality was noted in Sweden. Life expectancy then increased by 0.56 years for men and 0.48 years for women compared to 2018, instead of around 0.1-0.2 years which had been the average increase per observed year in recent decades.

Following this positive development, 2020 was the first year in a long time with a substantive decline in life expectancy. Life expectancy then decreased by 0.69 years for men and 0.40 years for women compared to 2019. In Statistics Sweden's previous population forecast for 2020, with assumptions made in the absence of any pandemic, 2020 life expectancy was estimated to be 0.78 years (men) and 0.43 years (women) higher than what was actually observed. Statistics Sweden's forecast of life expectancy for 2020 was then only marginally higher than what had been observed for 2019.

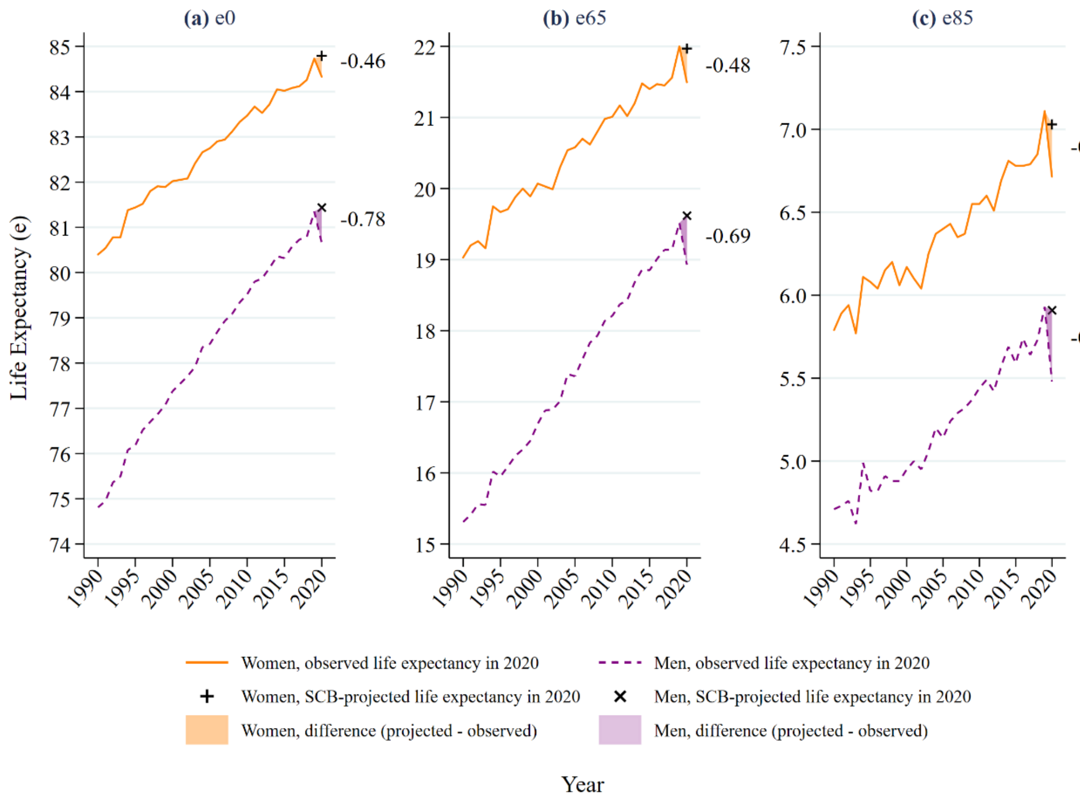
The decrease in life expectancy in 2020 was of course due to the impact of COVID-19, and in the rest of our study we demonstrate how this decrease can be explained by changes in mortality in (i) different age groups, (ii) different months of the year, and (iii) different regions of Sweden. We also show how these changes can be explained directly by registered COVID-19 deaths and any remaining excess or under-mortality in other causes of death in different age groups.

The previously stable trend of declining mortality over many decades makes it useful to primarily rely on the death rates that Statistics Sweden had forecasted for 2020 when making comparisons against an alternative scenario without COVID-19 in order to investigate the excess mortality in 2020. Less attention is given to the comparison of mortality during 2020 with an average value of observed mortality for the years 2017–2019, as these years together represent a period with higher mortality than what should have been realistically expected for 2020.

Table 1: Life expectancy at birth, age 65, and age 85 in Sweden, for 2019, 2020, and the forecast for 2020

Life expectancy	2020 observed	2019 observed	2020 minus 2019	2020 forecast	2020 observed minus 2020 forecast
Women					
From birth (e0)	84.33	84.73	-0.40	84.79	-0.46
From 65 (e65)	21.50	22.00	-0.50	21.97	-0.48
From 85 (e85)	6.72	7.11	-0.40	7.03	-0.32
Men					
From birth (e0)	80.66	81.35	-0.69	81.44	-0.78
From 65 (e65)	18.93	19.52	-0.59	19.62	-0.69
From 85 (e85)	5.48	5.93	-0.45	5.91	-0.43

Figure 1: Life expectancy at birth, age 65, and age 85 in Sweden, for 1990-2020, and the forecast for 2020



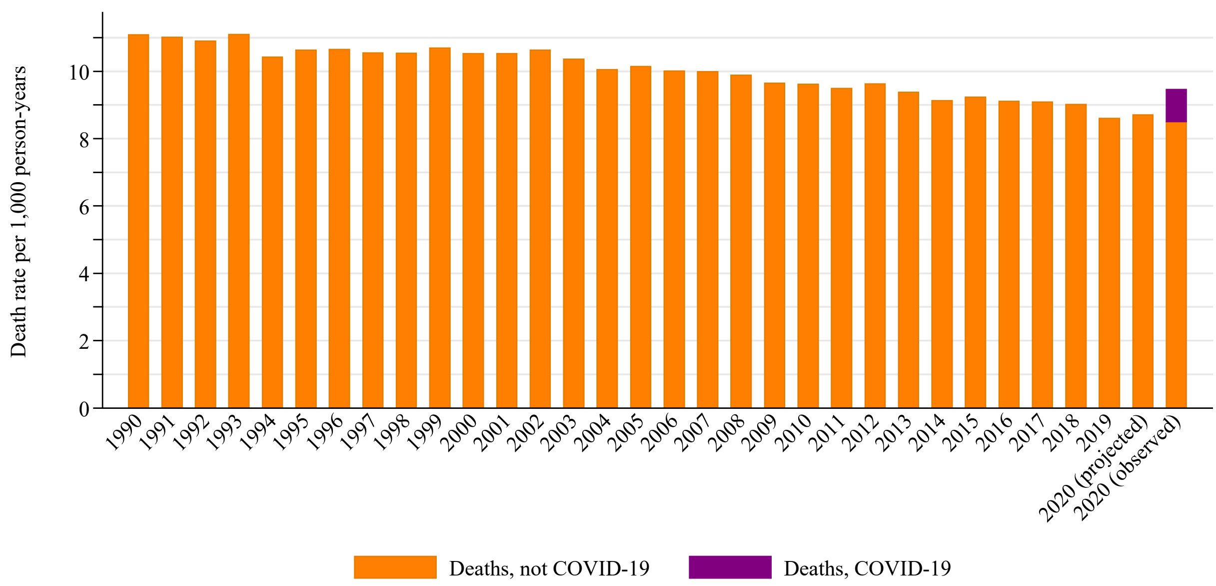
In Table 1 and Figure 1, we initially show the development over time of the remaining life expectancy for women and men at birth, at age 65 and age 85. Life expectancy at birth was 84.33 years for women and 80.66 years for men in 2020, which is 0.46 and 0.78 years lower than Statistics Sweden's forecasted values of 84.79 and 81.44 years for the same year. The difference in the remaining life expectancy at age 65 was about the same size, while it was slightly lower if measured at age 85. Life expectancy for women in 2020 was slightly higher than what was observed for 2018 (see Figure 1). For men, life expectancy in 2020 was slightly lower than what was measured for 2017 (also see Figure 1). The mortality patterns in 2020 thus corresponded approximately to what had already prevailed for men in 2017 and for women in 2018.

In Figure 2, we show crude death rates calculated as the number of deceased persons in Sweden per calendar year during 1990-2020 in relation to the size of the population in each year. The figure includes the mortality per 1,000 individuals in 2020, including the portion that was due to COVID-19 mortality. The latter is based on data on COVID-19 deaths provided by the Swedish Public Health Agency.

Figure 2 shows the same declining trend in overall mortality over time as in Figure 1. However, these death rates are the product of two counteracting forces, the effects of declining mortality in each age group and the slow aging of the Swedish population. Thus, crude death rates per 1,000 individuals in the population is affected by changes in population size through childbirth and migration and also by changes in population age structure through variations in cohort sizes among the elderly. In the short-term, however, changes in the populations structure are small and comparisons of crude rates remain valid. For 2020, the crude death rate was 8.6 percent higher than what had been forecasted by Statistics Sweden, 10.0 percent higher than what was observed for 2019, and 4.9 percent higher than what was observed for 2018. If we remove the number of deaths associated with COVID-19 from the total, crude mortality was instead 2.3 percent lower than what had been forecasted by Statistics Sweden. However, such a figure makes little sense as the number of non-COVID-19 deaths is not un-related to those related to COVID-19.

The impact of COVID-19 played a slightly greater role in the development of the crude death rate during 2020 (Figure 2) than on the expected life expectancy (Figure 1). This is because deaths in COVID-19 occur at relatively old ages and thus do not affect remaining life expectancy as much as the number of deaths itself.

Figure 2: Death rates per 1,000 inhabitants in Sweden, 1990-2020, and the 2020 forecast



In the rest of our study, we focus primarily on analyzes of changes in age-specific death rates, as well as of calculations of the remaining life expectancy that is based on those death rates. A major advantage of measures such as life expectancy at different ages is that they measure mortality that is independent of the age structure of a population, which is important when comparing mortality measures for different years and countries. As a final contribution, we also present some cohort measurements of mortality. Based on historical data and Statistics Sweden's forecast for the death rates of different birth cohorts, we estimate how many years COVID-19 have shortened the life expectancy of different cohorts of now living women and men.

2.2 Age-specific death rates

In Table 2, we present the number of deaths in different age groups during 2020. We show separately the number of deaths in COVID-19 and all deaths combined in the different age groups. At ages below 30, the number of deaths in COVID-19 is very small (8 for women and 14 for men). The number of deaths is, expectedly, highest in the older ages, this applies both to deaths in COVID-19 and other mortality. The total number of COVID-19-related deaths was 9816 during the year, compared with 98124 deaths in total, which means that deaths with COVID-19 correspond to 10.0 percent of all deaths during 2020. COVID-19 deaths were even more strongly concentrated to the older ages than what is the case for deaths in general. The proportion of deaths from COVID-19 was higher among men than for women in all age groups from age 40 onwards.

Table 2: Number of deaths in different age groups in Sweden, all-cause mortality and COVID-19 mortality, 2020

	Women			**Men**		
Age group	Deaths, COVID-19	Deaths, all causes	Deaths from COVID-19 as a % of all deaths	Deaths, COVID-19	Deaths, all causes	Deaths from COVID-19 as a % of all deaths
0-29	8	348	2.3	14	786	1.8
30-34	8	126	6.3	6	241	2.5
35-39	5	157	3.2	6	221	2.7
40-44	9	208	4.3	14	308	4.5
45-49	12	327	3.7	27	497	5.4
50-54	17	541	3.1	61	881	6.9
55-59	35	846	4.1	99	1458	6.8
60-64	53	1340	4.0	134	2170	6.2
65-69	106	2199	4.8	278	3461	8.0
70-74	267	4021	6.6	523	5692	9.2
75-79	482	5723	8.4	782	7699	10.2
80-84	774	7469	10.4	1104	8639	12.8
85-89	1153	9716	11.9	1118	8750	12.8
90-94	1041	9806	10.6	801	6270	12.8
95-99	484	4912	9.9	276	2065	13.4
100+	90	1004	9.0	29	243	11.9
In total	**4544**	**48743**	**9.3**	**5272**	**49381**	**10.7**

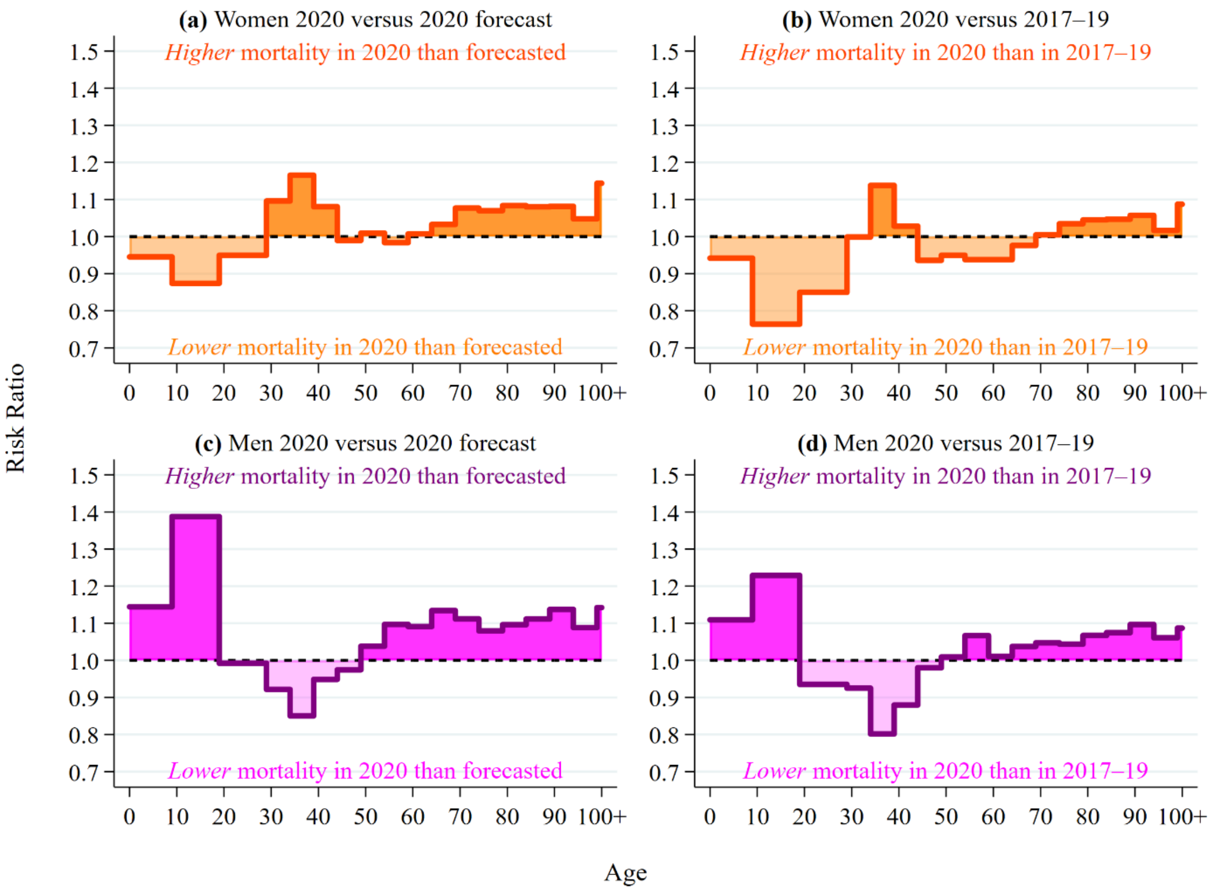
In Figure 3, we present the age-specific death rates for women and men in 2020, which show the risk of dying during this year for individuals in different age groups. The figure has an exponential scale (the distance between two scale lines in the figure corresponds to a 10-fold increase in the death rate) to better show-case the patterns and large differences in the risk of dying by age. The figure clearly shows how both COVID-19-related mortality and mortality in general increase very sharply with increasing age. For example, the age-specific death rate for men aged 40–44 years was 0.000043 deaths per person-year in COVID-19 and 0.000954 deaths per person-year for total mortality, for women aged 60–64 years they were 0.00019 and 0.00472 deaths per person-year, and for men aged 85–89 years they were 0.017 and 0.136 deaths per person-year. The figure also shows that the share of COVID-19 deaths on the total mortality is not the same across all ages but lowest at young ages and highest around ages 80–90.

Figure 3: Age-specific death rates, in 5-year age groups in 2020 in Sweden, for all-cause and COVID-19 mortality

In Figure 4, we compare the actual age-specific death rates for women and men in 2020 with the age-specific death rates that Statistics Sweden adopted in its latest forecast for 2020, and with the average value of the observed death rates for 2017–2019. We report the relative deviations, i.e., the difference in percent between the death rates as they appear in Figure 3 and those expected for 2020 in different age groups. At older ages, with significantly more deaths than at younger ages, an excess mortality rate of 10 percent leads to significantly more additional deaths than a corresponding relative excess mortality at younger ages. It appears that the observed mortality was higher than expected for men in all age groups from 50 years and above and for women in slightly older ages. The relative excess mortality among the elderly was higher among men than women. The excess mortality was higher if one prioritizes Statistics Sweden's forecast as a benchmark than if one makes the comparison based on the average value of 2017–2019. With Statistics Sweden's forecast as the comparison, the relative excess mortality among men aged 50 and above was just over 10 percent, among post-retirement aged women it was just under 10 percent.

For younger age groups, we find both excess and under-mortality in 2020. The percentage variation between different years can be greater here as the number of deaths are fewer. For men aged 30–49, we find reduced mortality in 2020, which could be explained by changing behaviors in connection with various measures that may have reduced different types of risky behavior. However, for younger women, excess mortality is observed also at these ages. In the very young ages, we also see some variation in relative excess and under-mortality, with opposite patterns for males and females. For the very youngest age groups, COVID-19 deaths are very few (Table 2), and the differences seen in Figure 4 are therefore due to variation in other types of deaths than those from COVID-19. Mortality at these ages is generally so low that even a small number of deaths can cause percentage changes in comparisons like ours.

Figure 4: Relative difference in observed mortality 2020 compared with the 2020 forecast, and the average of 2017–2019, for different age groups of women and men in Sweden



2.3 Seasonal variation in mortality

In Figure 5, we show how mortality developed over the months during 2020. Specifically, we show the monthly death rate per 1,000 person-years in four broad age categories (0–29, 30–64, 65–84 and 85+). We compare the death rates per month in 2020 (the solid orange line) with the observed average death rates per month for the averaged years 2017–2019 (the dashed orange line). Here, unfortunately we are unable to make comparisons to any forecasts as Statistics Sweden does not produce any such monthly forecasts. The shaded areas represent differences between these two rates. Dark orange indicates that mortality was *higher* in a given month in 2020 than in the 2017–19 average; light orange indicates that mortality was *lower* in a given month in 2020 than in the 2017–19 average. The purple line shows the death rate per 1,000 person-years from COVID-19. Note the differences in scale across the age-specific panels. Here, at least visually, we can only make comparisons *within* the four panels, rather than *across* the panels.

Figure 5: Death rates by month during 2020, by age group in Sweden, for the average of 2017–2019 and observed in 2020: all-cause and COVID-19 deaths

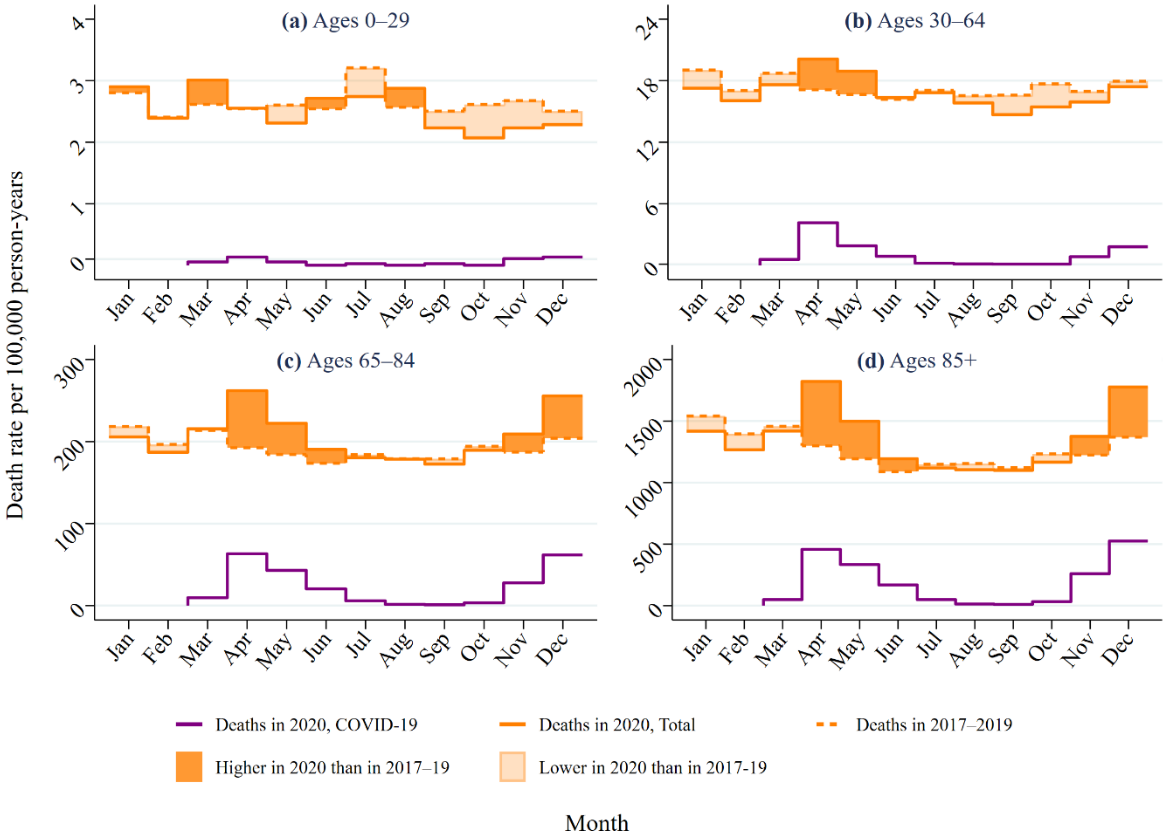


Figure 5 shows that the impact of COVID-19 on total mortality in Sweden in 2020 can be seen clearly in the months of April, May (i.e. the peak of the first wave of the pandemic in Sweden), November, and December (i.e. the start of the second wave), especially in age groups 65–84 and 85+. Expectedly, the trends in excess mortality in 2020 compared to the 2017–19 average closely track the fluctuations that we observe in mortality from COVID-19. That is to say, larger blocks of dark orange, indicating an excess mortality in 2020, correspond with higher mortality rates from COVID-19. For the age groups 65–84 and 85+, we observe a similar – if not greater impact – of COVID-19 mortality on overall mortality in the second wave as compared to the first one. This can be seen in both the magnitude of the mortality rate from COVID-19 and in the magnitude of the overall excess mortality in 2020. For the age group 30–64, however, the mortality rate from COVID-19 was instead lower during the end of 2020 than in spring 2020. As such, we only find a COVID-19 driven excess mortality in this age group in April and May. We can only speculate given the limits of our data, but one partial explanation could be related to hospital treatments of COVID-19 becoming more effective over the year (National Board of Health and Welfare 2020b). In the youngest age group (0–29) we find more fluctuation in excess mortality, including in months where COVID-19 mortality was actually lowest (e.g. June and August). The number of COVID-19 deaths in this age group is so small, and the age range covers such different ages of mortality, which may explain why the pattern differs from other age groups.

2.4 Regional differences in mortality changes

Figure 6a and Figure 6b show the impact of mortality from COVID-19 at the regional level to investigate whether or not COVID-19 had a similar, or differential, impact across counties in Sweden.

Figure 6a shows the change in life expectancy at birth (e_0) between 2020 and the 2017–2019 average (i.e., e_0 in 2020 minus e_0 for the average of years 2017–19) for women (panel a) and men (panel b) in Sweden's twenty one counties. Here, a three-year reference period is necessary to obtain more stable comparisons when analyzing regions with significantly fewer inhabitants than for, say, the whole population of Sweden. There was also no forecast at the county level done by Statistics Sweden. Our 3-year average is based on a higher mortality baseline than the forecast, illustrating the differences between the two approaches (and the advantages of using a good forecast as a comparison). Within both of the panels, the counties are ordered from most negatively impacted by COVID-19 (top) to least – or not at all – impacted by COVID-19 (bottom). As an additional comparator for the counties, we included the same metric for all of Sweden.

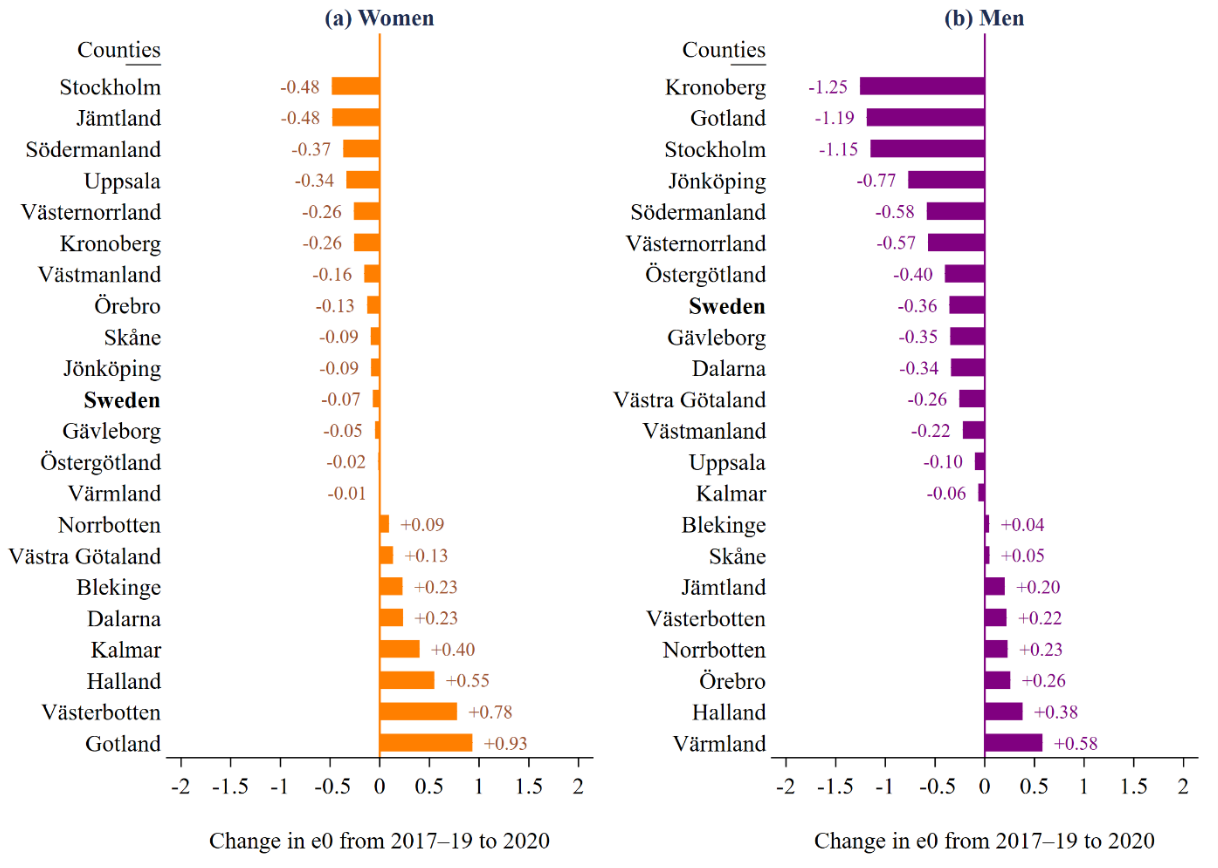
At the *country-level*, e_0 in 2020 in Sweden was 0.07 years shorter among women and 0.36 years shorter among men as compared to the 2017–2019 average. At the *county-level*, we document substantial geographical variation in the impact of COVID-19, in which the impact is much greater, or indeed much less, than this total population average effect. We also find a significant amount of within-county variation by sex. However, we highlight those counties where the direction of the effect for men and women is similar.

Among men, fourteen counties experienced a decline in e_0 in 2020 relative to 2017–19; seven experienced an increase. This ranged from a decrease of 1.25 years in Kronoberg to an increase of 0.58 years in Värmland. Among women, twelve counties experienced a decline in e_0; nine experienced an increase. This ranged from a decrease of 0.48 years in Stockholm to an increase of 0.93 years in Gotland. For both sexes, Stockholm, Västernorrland, Kronoberg, and Södermanland were some of the worst affected counties, with male and female e_0 declining in 2020 compared to 2017–19. Halland and Västerbotten were some of the least affected counties, with male and female e_0 increasing in 2020 compared to 2017–19. As alluded to, however, the direction of the impact upon male and female e_0 was not always the same. The clearest example is Gotland; male e_0 declined by 1.19 years (rendering it one of the worst affected counties for men), female e_0 rose by 0.93 years (rendering it the least affected counties for women). There were three other such county cases where female e_0 increased when male e0 decreased: Kalmar, Dalarna, and Västra Götaland. Conversely, there were four county cases where male e_0

increased when female e_0 decreased: Skåne, Jämtland, Örebro, and Värmland. It is unclear, and beyond the scope of this study, exactly why COVID-19 mortality had a differential impact upon men and women in the same county. This may represent noise in the estimates (certainly for some of the smaller counties, including Gotland) or county-sex-specific COVID-19 risk factors.

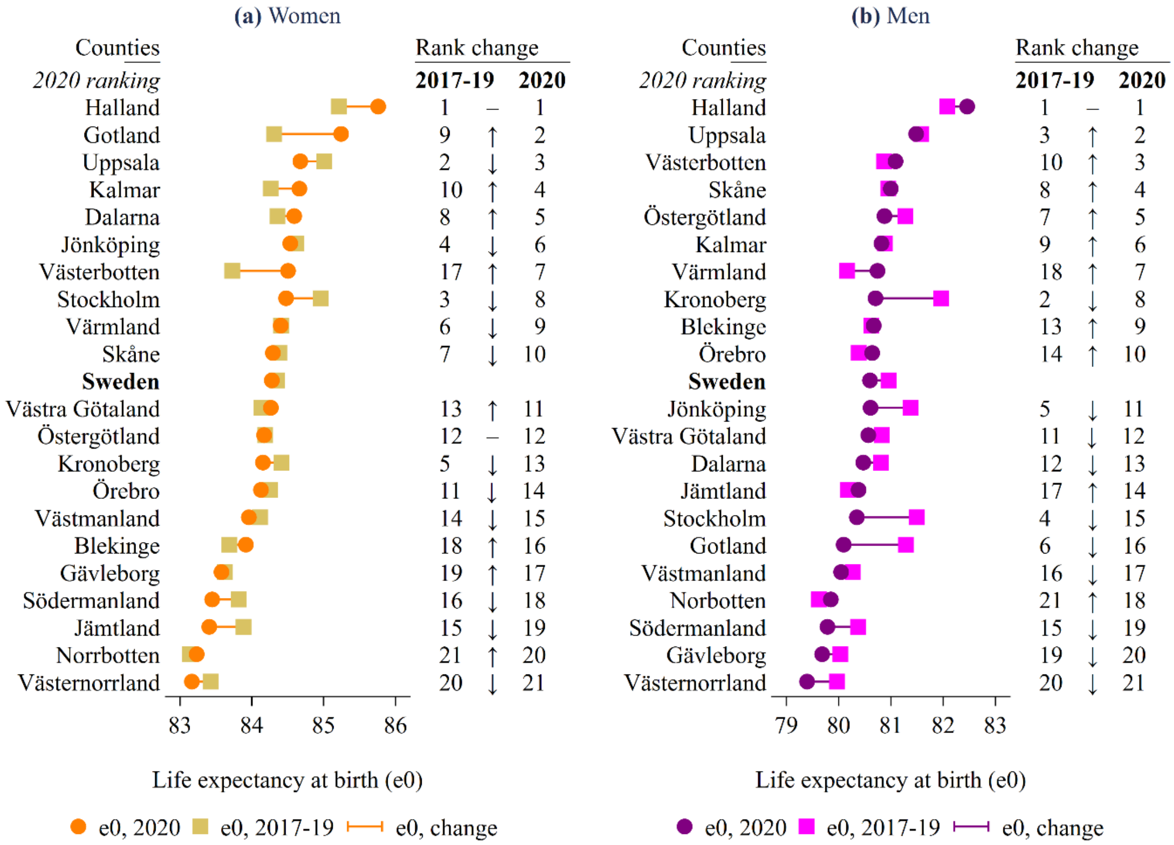
Figure 6b instead plots and ranks counties by their e0 in 2020, placing the magnitude of the losses or gains from Figure 6a into a wider perspective. Counties are ordered from highest e0 in 2020 (top) to lowest e0 in 2020 (bottom) for women (a) and men (b). As we can see, for both male and female e0, Halland retains its position as the Sweden's most longevous county. This is unsurprising given that Figure 6a indicates an increase in e_0 between 2020 and 2017–19 of 0.55 among women and 0.38 among men. Uppsala also retains its position as one of Sweden's most longevous counties despite a 0.38 decrease in e_0 among women and 0.10 decrease among men. The rank change for Stockholm, previously one of Sweden's most longevous counties in 2017–19, is stark. Female e_0 falls from 3rd to 8th place; male e_0 from 4th to 15th place. We also find that some counties rise in these mortality rankings. Most notably, Västerbotten, formerly 17th for female e_0 and 10th for male e_0 rises to 7th among the former and 3rd among the latter. This is due to increases in e_0 of 0.78 among women and 0.22 among men in 2020 relative to 2017–19. Most clear from this figure is the disproportionate impact of COVID-19 in Stockholm County in 2020.

Figure 6a: Life expectancy (e_0) at birth in different regions of Sweden for 2017–2019 and 2020: Change in life expectancy



Overall, the decline in life expectancy was most evident in Stockholm, its neighboring counties, in Småland, and the southern parts of the Norrland coast. The regions least affected are found in western and southern Sweden and in upper Norrland. The pattern does not follow a clear pattern based on population density or urbanization, though while the largest impact was observed in the largest city of Sweden, other large cities did not have an unusually large mortality change.

Figure 6b: Life expectancy (e_0) at birth in different regions of Sweden for 2017–2019 and 2020: Ranking of counties by life expectancy

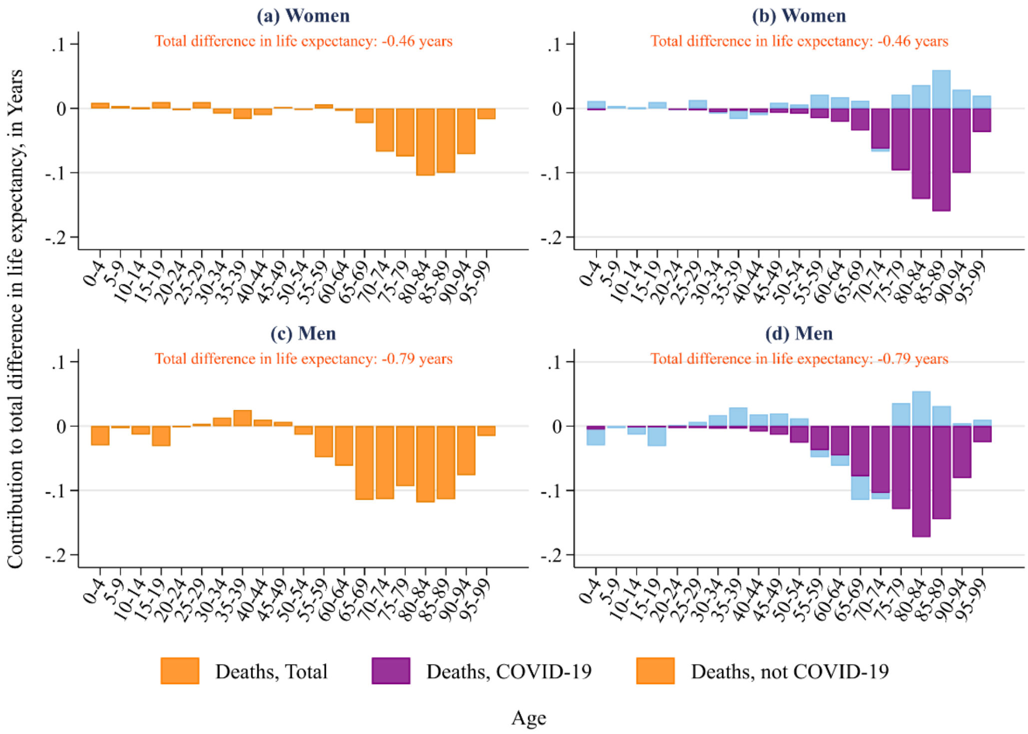


2.5 The impact of age-specific changes in mortality

In panels a and c of Figure 7, we present the break-down of the total difference in life expectancy between what was observed for 2020 and what was forecasted in Statistics Sweden's forecast for the same year by the contributions from different age groups. We show here the positive or negative contributions to the reduced life expectancy in 2020 (0.79 years for men and 0.46 years for women) from mortality changes in different five-year age groups of women and men. It is clear that in principle the entire decline in life expectancy in 2020 was due to increased mortality for men older than 55 years and women older than 70. For men, we note a positive contribution to life expectancy due to mortality reductions among younger adults. A negative minor contribution from increased mortality among boys can probably be related to random variation between different years, as opposed to COVID-19. For women, we see few deviations in mortality in addition to the clear deviations that can be observed for the older age groups.

In panels b and d of Figure 7, we make the same breakdown of differences in life expectancy, but with a separate account of the contributions from COVID-19-related mortality and other mortality. The contributions from COVID-19 are always negative, while the contributions from other mortality can be both negative or positive. The sum of the various bars gives the total difference in life expectancy compared to what was forecasted by Statistics Sweden for the same year.

Figure 7: Decomposition of difference in life expectancy in Sweden in 2020 compared to the forecast for 2020 (in years), with positive and negative contributions from mortality changes in different age groups. Decomposition of all-cause mortality in panel a and c, and decomposition by type of mortality in panel b and d.

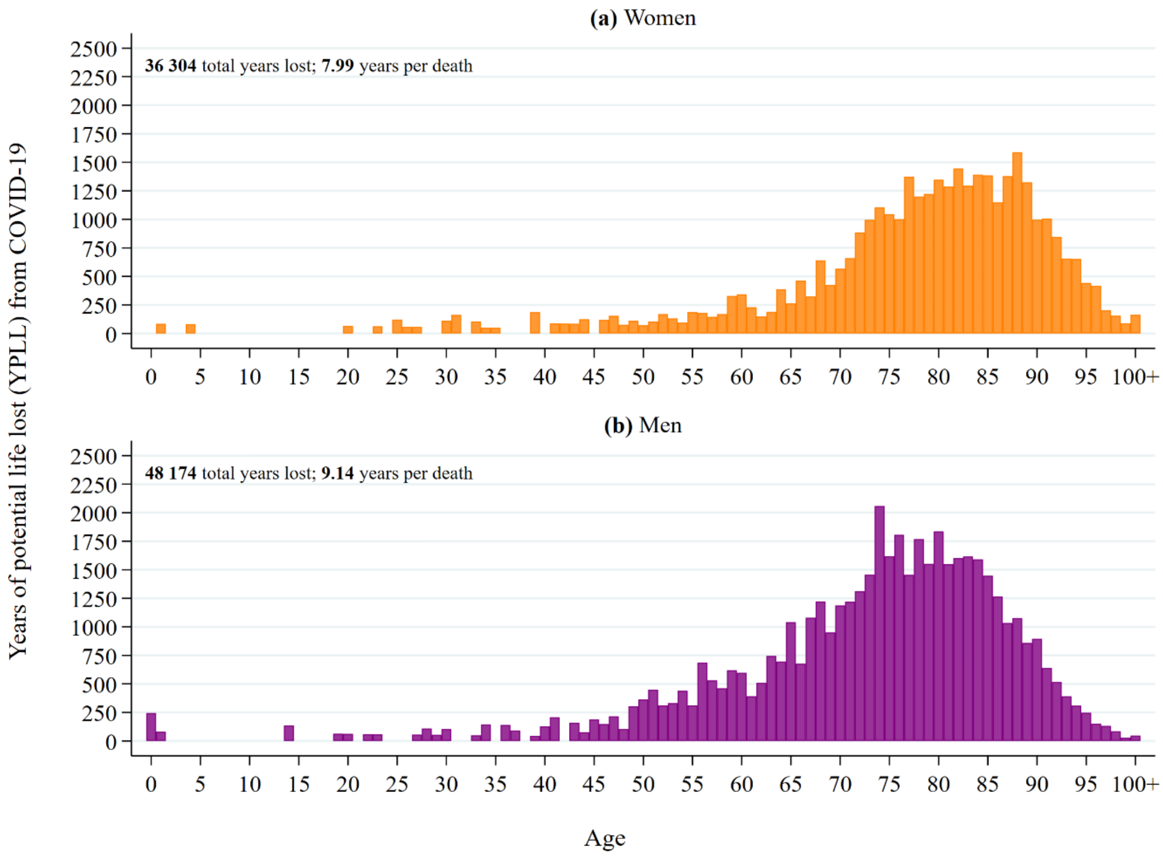


The direct contributions from COVID-19-related mortality can mainly be attributed to increased mortality in the older ages. For mortality that cannot be related to COVID-19, we see that such mortality has mainly been lower than expected. However, it is complicated to divide up different causes of death in this way because people who died in COVID-19 could not die of other causes during the year. However, some of the abnormalities with reduced mortality in causes of death other than COVID-19 could be attributed to various behavioral changes, for example, related to fewer traffic accidents or reduced incidence of other infectious diseases than COVID-19.

However, we can still state that we do not see any increased mortality from causes other than COVID-19 in 2020, which indicates that possible displacement effects in healthcare do not (yet) seem to have affected mortality significantly (Sprung et al. 2020). A possible underreporting of COVID-19-related deaths (see appendix) can also not contribute to the patterns we observe for other types of mortality in Figure 7.

In Figure 8, we present the 'years of potential life lost' (YPLL) due to deaths from COVID-19 in 2020. This metric provides an alternative view, placing greater importance on the time lost as opposed to only the number of deaths. The time lost is based upon the difference between the age at death and the maximum potential lifespan of a person at that age (and the summation of the differences). To illustrate, a female who dies at birth is assumed to have lost a potential 84.79 years of life (as per Figure 1); a 65-year-old man who dies is assumed to have lost a potential 19.62 years of life (as per Figure 1). YPLL places greater weight upon deaths that occur at younger ages, but crucially acknowledges that all deaths imply some loss of life (Gardner and Sanborn 1990; Martinez et al. 2019). This is relevant given that some policy responses have been framed around the argument that COVID-19 mortality is mostly affecting people who, even in the absence of COVID-19, would have died (from something else) soon after anyway (Pifarré i Arolas et al. 2021).

Figure 8: Years of potential life lost (YPLL) attributed to deaths in COVID-19 in 2020, for women and men in Sweden by one-year age groups



As Figure 8 shows, COVID-19 can be linked to 48,174 lost life years for men and 36,304 lost years for women in Sweden. This corresponds to an average of 9.14 years lost per male death from COVID-19 and 7.99 years per female death from COVID-19. Regarding the distribution of the years lost, if we adopt the age groups defined in previous analyses, we can say that men aged 0–29, 30–64, 65–84, and 85+ accounted for 2%, 20%, 60%, and 18% of YPLL respectively. Among women, the same age groups accounted for around 1%, 12%, 52%, and 35% of YPLL respectively. Thus, we can see that more potential years were lost at younger ages among men. Indeed, a fifth of all YPLL among men were concentrated between ages 30 and 64 (mostly at the upper end of this range). This is a not an insignificant share given the lower death rates relative to older ages. Yet, despite the greater weights placed upon young deaths, 78% of all male YPLL and 87% of all female YPLL were still based in age groups 65+. From a public health standpoint, these results provide an aggregated statistic on how much life has been cut short in Sweden by COVID-19.

2.6 Impact on mortality on cohort life expectancy

In Table 3, we show an estimate of how the excess mortality in 2020 can be assumed to have affected the remaining life expectancy for people in Sweden who were alive at different ages at the beginning of 2020. We use a so-called cohort life expectancy table and assumptions about future mortality patterns derived from Statistics Sweden's population forecast for 2021 and onwards. With this method, we estimate how much the increased mortality in 2020 (compared with the forecast for 2020) affected the actual remaining life expectancy for people of different ages. That is, Table 3 shows the effects of COVID-19 mortality on remaining life expectancy in an approach that is not based on assumptions about a synthetic cohort for a single calendar year.

We show that the impact was relatively limited for 55- and 65-year-olds, but note that the effects were greater for people who were 85 years and older. At the age of 95, the average remaining life expectancy is relatively short (slightly more than 3 years for women and a little less than 3 years for men); the increased mortality in 2020 meant that the more than 5,000 women in those ages were estimated to have their lives shortened by an average of 21 days. The corresponding figure for male 95-year-olds is 24 days. For 85-year-olds, the shortening can be calculated at 16 days on average for women and 27 days for men. For 75-year-olds, the reduction is estimated at 7 days on average for women and 11 days for men. For 65-year-old men, it is estimated at 9 days. For 65-year-old women and 55-year-old men and women, the average reduction in life expectancy is estimated as less than a few days. In our calculations, we have only considered the effects of the excess mortality in 2020, while more long-term effects of COVID-19 on mortality remain to be studied.

Table 3: Change in remaining life expectancy due to mortality changes at different ages during 2020, based on cohort life tables. Difference between the impact of observed and forecasted mortality for 2020

Sex	Remaining life expectancy / Number of people in life	Turned 55 years old in 2020	Turned 65 years old in 2020	Turned 75 years old in 2020	Turned 85 years old in 2020	Turned 95 years old in 2020
Women	Remaining life expectancy (years) with forecasted death rates	33.58	23.66	14.72	7.46	3.21
	Remaining life expectancy (years) with deaths observed	33.58	23.65	14.70	7.42	3.15
Men	Remaining life expectancy (years) with forecasted death rates	31.38	21.55	12.91	6.28	2.71
	Remaining life expectancy (years) with deaths observed	31.37	21.53	12.88	6.20	2.64
		Age 55	Age 65	Age 75	Age 85	Age 95
Women	Population, end of 2019	68 104	54 350	54 018	16 221	1 956
Men	Population, end of 2019	69 700	53 745	51 059	23 265	5 361

3. Summary

In our study, we have examined the impact of the COVID-19 pandemic on mortality patterns in Sweden during the calendar year 2020. We found that the pandemic reversed recent gains in life expectancy to levels last observed during the years 2017–2018. It is otherwise unusual for life expectancy to fall to any significant extent between calendar years. A significant decline in life expectancy for both sexes had not been observed in Sweden since 1968, when the decline was also less strong than in 2020.

The increased mortality in Sweden in 2020 was concentrated at older ages, while some younger age groups instead had lower mortality than expected. Men were hit harder than women. The fact that mortality increases were so concentrated to older ages means that their impact on various age-adjusted mortality measures, such as remaining life expectancy, is smaller than for the deviations in the number of actual deaths. However, 2020 was indeed an unusual mortality context as the COVID-19 pandemic led to 7,752 more deaths than what had been forecasted for this year. Mortality was highest in April and December in 2020.

Our study is limited to quantifying the influence of the pandemic during 2020. However, mortality associated with COVID-19 was also significant during the first part of 2021 (Public Health Agency 2021b). As a consequence, Sweden will likely experience excess mortality in 2021 too. Furthermore, we currently lack knowledge about the possible long-term impact of COVID-19 on the population's health and mortality. Our aggregated data also does not allow us to examine socioeconomic differences in outcomes, or differences between the native and immigrant population.

Like most other high-income countries, Sweden saw a tangible influence of COVID-19 on excess mortality during 2020 (Aburto et al. 2021b; Pifarré i Arolas et al. 2021). As in other countries, the impact was highest at the older ages, and among men (Aburto et al. 2021b; Islam et al. 2021). If compared to the mortality of 2019, the excess mortality in Sweden during 2020 was slightly above the average for other countries with comparable data and certainly above the levels observed for the other Nordic countries (Aburto et al. 2021b; Islam et al. 2021). Explaining differences and similarities in mortality between Sweden and other countries is an important task for future research. The ranking changes somewhat if one accounts for the fact that the mortality reduction in Sweden in 2019 had been stronger than in other countries in Europe. Like in many other high-income contexts the excess mortality in Sweden during 2020 was particularly high in metropolitan areas (e.g. Quast et al. 2020), with elevated mortality mainly observed for the Stockholm region. We also found some other regional patterns, where the west and south of Sweden were hit less hard by COCID-19 in 2020.

COVID-19 will continue to have an impact on different aspects of Sweden's demographic dynamics also in the next few years, but the long-term effects on age structure and population size will probably be relatively limited because the actual mortality change have been at play at such advanced ages. The extent to whether the indirect effects of COVID-19 will (continue to) spill over to other demographic processes such as those related to childbearing and international and domestic migration remains to be seen.

The possibility that additional countries produce data like those presented in our study will facilitate further comparisons of mortality patterns where adjustments for the effects of different population age structures are made.

4. Data and method

4. 1 Data

Our analyzes are based on information from two different data sources. Our measures involving the number of deaths and the population in different subgroups are based on data from Statistics Sweden's (SCB) population statistics, where we ordered data on deaths and population size at the county and monthly level for years 2017–2020. We supplemented this with data from Statistics Sweden's population forecast for 2020 and onwards (Statistics Sweden 2020). These data are available to download freely from Statistics Sweden’s data repository website.

Data on COVID-19-related deaths have been provided by the Swedish Public Health Agency and are based on their collection of data on diseases as covered by the Swedish Communicable Diseases Act, SmiNet (National Board of Health and Welfare 2020a; Public Health Agency 2021a). The reporting of such deaths is based on individuals who had received a positive test result on COVID-19. This information has since been combined with statistics on all deceased individuals from the Swedish Tax Agency's register, which serves as a basis for the population register. If a person dies within 30 days after a positive laboratory-confirmed case, he or she is counted as deceased with COVID-19. Some sorting is done by individuals with causes of death that were clearly unrelated to COVID-19 (for example traffic accidents), but as a rule, data on causes of death are not used in this data source. Individuals who had died more than 30 days after any last confirmed COVID-19 test, or who had never tested positive for COVID-19 are not included in the material. The Public Health Agency assesses that this produces some unreported cases for people who had actually died from COVID-19 but who had not been registered with a positive test (Public Health Agency 2021a).

The definition of the number of COVID-19-related deaths therefore differs somewhat from the cause of death-based statistics provided by the National Board of Health and Welfare. We have had access to both of these data sources and evaluate the differences briefly in our appendix. In summary, there are strengths and weaknesses with both sources, but overall they are in broad agreement and would produce similar results at the level of detail presented in this study.

When we in our study report on non-COVID-19-related deaths, we do this by subtracting the COVID-19 deaths within a certain population group from the total number of deaths for the same group.

4. 2 Method

With the help of data from the Swedish Public Health Agency and Statistics Sweden, we have based our analyzes on the observed number of deaths and population size for each age in 2020. We have received comparable data from Statistics Sweden for 2017–2019. We have created life tables based on data for 2020 and the average of those three preceding years. We have also used age-specific death rates from Statistics Sweden's forecast for 2020. We have used period-based life tables for most of our calculations. For our calculations with five-year age groups, we have used the weighted average of the death risks in one-year age groups. Our life tables use 100 years as the highest age category.

For our decomposition of the changed life expectancy, we have used a method introduced by Arriaga (1984) where ${}_n\triangle_x$ is the contribution to the difference in life expectancy between population *1* and *2* from all-cause mortality in age group x to $x + n$. The method is based on the conventional life table functions l_x, T_x , and ${}_nL_x$.

$$(1)\quad {}_n\triangle_x = \frac{l_x^1}{l_0^1} \cdot \left(\frac{{}_nL_x^2}{l_x^2} - \frac{{}_nL_x^1}{l_x^1} \right) + \frac{T_{x+n}^2}{l_0^1} \cdot \left(\frac{l_x^1}{l_x^2} - \frac{l_{x+n}^1}{l_{x+n}^2} \right)$$

We expand the decomposition with:

$$(2)\quad {}_n\triangle_x^i = {}_n\triangle_x \cdot \frac{{}_nR_x^i(2) \cdot {}_nm_x\,(2) - {}_nR_x^i(1) \cdot {}_nm_x\,(1)}{{}_nm_x\,(2) - {}_nm_x\,(1)}$$

where the ${}_n\triangle_x^i$ is the contribution to the difference in life expectancy for the cause of death i in age group x to x + n, and the contribution this cause of death gives to the difference in life expectancy between the two populations. ${}_nm_x(1)$ and ${}_nm_x(2)$ is the death rate for age group x to $x + n$ and and ${}_nR_x^i(1)$ and ${}_nR_x^i(2)$ is the proportion of deaths from cause of death i for age group x to $x + n$ in the two populations. As described in the first equation, ${}_n\triangle_x$ is the difference in mortality from all causes of death in age group x to $x + n$.

In Figure 8, we use the method Years of Potential Life Lost (YPLL). YPLL is calculated according to equation 3 below, where d_x is the number of deaths at age x (in our case COVID-19 deaths 2020), and e_x the remaining life expectancy at age x (in our case according to Statistics Sweden's forecast), which is summed up over all ages. Limitations and the implicit and explicit assumptions of this method are described by Gardner and Sanborn (1990) (1990). The method intends to quantify at the population level the extent of a change that negatively affects mortality.

$$(3)\ YPLL = \sum_x^{\infty} d_x * e_x$$

For our cohort life expectancy table, we used the death rates for 2020, linked to the population projection for 2020–2070 (Statistics Sweden, 2020b). We show life expectancy for men and women who had reached ages 55, 65, 75, 85, and 95 in 2020. Table 3 is based on the population size of people in those ages at the end of 2019.

5. Acknowledgements

We are grateful for financial support from the from the Swedish Public Health Authority which partially financed the study, as well as support from Swedish Research Council for Health, Working Life, and Welfare (FORTE) for a project with ageing research, grant number 2016-07115. The funders of the study had no role in the study design, data analysis, data interpretation, or writing of the report. The authors received funding from the Swedish Public Health Authority in early 2021 with a free and open mandate to write a (Swedish language) report on excess mortality in Sweden.

References

Aburto, Jose Manuel, Ridhi Kashyap, Jonas Schöley, Colin Angus, John Ermisch, Melinda C. Mills, and Jennifer Beam Dowd. 2021a. "Estimating the burden of the COVID-19 pandemic on mortality, life expectancy and lifespan inequality in England and Wales: a population-level analysis." *Journal of Epidemiology and Community Health*:jech-2020-215505.

Aburto, Jose Manuel, Jonas Scholey, Luyin Zhang, Ilya Kashnitsky, Charles Rahal, Trifon Missov, Melinda C. Mills, Jennifer Beam Dowd, and Ridhi Kashyap. 2021b. "Recent Gains in Life Expectancy Reversed by the COVID-19 Pandemic." *medRxiv*:2021.03.02.21252772.

Andrasfay, Theresa, and Noreen Goldman. 2021. "Reductions in 2020 US life expectancy due to COVID-19 and the disproportionate impact on the Black and Latino populations." *Proceedings of the National Academy of Sciences* 118(5):e2014746118.

Aradhya, Siddartha, Maria Brandén, Sven Drefahl, Ognjen Obućina, Gunnar Andersson, Mikael Rostila, Eleonora Mussino, and Sol P. Juárez. 2020. "Lack of acculturation does not explain excess COVID-19 mortality among immigrants. A population-based cohort study." *Stockholm Research Reports in Demography* 2020:44.

Arriaga, Eduardo E. 1984. "Measuring and Explaining the Change in Life Expectancies." *Demography* 21(1):83-96.

Beaney, Thomas, Jonathan M Clarke, Vageesh Jain, Amelia Kataria Golestaneh, Gemma Lyons, David Salman, and Azeem Majeed. 2020. "Excess mortality: the gold standard in measuring the impact of COVID-19 worldwide?" *Journal of the Royal Society of Medicine* 113(9):329-34.

Brandén, Maria, Siddartha Aradhya, Martin Kolk, Juho Härkönen, Sven Drefahl, Bo Malmberg, Mikael Rostila, Agneta Cederström, Gunnar Andersson, and Eleonora Mussino. 2020. "Residential context and COVID-19 mortality among adults aged 70 years and older in Stockholm: a population-based, observational study using individual-level data." *The Lancet healthy longevity* 1(2):e80-e88.

Calderón-Larrañaga, Amaia, Davide L. Vetrano, Debora Rizzuto, Tom Bellander, Laura Fratiglioni, and Serhiy Dekhtyar. 2020. "High excess mortality in areas with young and socially vulnerable populations during the COVID-19 outbreak in Stockholm Region, Sweden." *BMJ Global Health* 5(10):e003595.

Drefahl, Sven, Anders Ahlbom, and Karin Modig. 2014. "Losing ground-Swedish life expectancy in a comparative perspective." *PloS one* 9(2):e88357.

Drefahl, Sven, Wallace Matthew, Mussino Eleonora, Aradhya Siddartha, Kolk Martin, Brandén Maria, Malmberg Bo, and Andersson Gunnar. 2020. "A population-based cohort study of socio-demographic risk factors for COVID-19 deaths in Sweden." *Nature Communications* 11(5097).

Gardner, John W, and Jill S Sanborn. 1990. "Years of potential life lost (YPLL)—what does it measure?" *Epidemiology*:322-29.

Goldstein, Joshua R., and Ronald D. Lee. 2020. "Demographic perspectives on the mortality of COVID-19 and other epidemics." *Proceedings of the National Academy of Sciences* 117(36):22035.

Indseth, Thor, Mari Grøsland, Trude Arnesen, Katrine Skyrud, Hilde Kløvstad, Veneti Lamprini, Kjetil Telle, and Marte Kjøllesdal. 2020. "COVID-19 among immigrants in Norway, notified infections, related hospitalizations and associated mortality: A register-based study." *Scandinavian Journal of Public Health*:1403494820984026.

Islam, Nazrul, Vladimir M. Shkolnikov, Rolando J. Acosta, Ilya Klimkin, Ichiro Kawachi, Rafael A. Irizarry, Gianfranco Alicandro, Kamlesh Khunti, Tom Yates, Dmitri A.

Jdanov, Martin White, Sarah Lewington, and Ben Lacey. 2021. "Excess deaths associated with covid-19 pandemic in 2020: age and sex disaggregated time series analysis in 29 high income countries." *BMJ* 373:n1137.
Martinez, Ramon, Patricia Soliz, Roberta Caixeta, and Pedro Ordunez. 2019. "Reflection on modern methods: years of life lost due to premature mortality—a versatile and comprehensive measure for monitoring non-communicable disease mortality." *international Journal of epidemiology* 48(4):1367-76.
Modig, K, A Ahlbom, and A Matthews. 2020. "Total mortalitet bättre vid jämförelser än död i covid-19." *Läkartidningen* 21-22(117:F3XL).
Modig, Karin , Anders Ahlbom, Mats Lambe, and Marcus Ebeling. 2021. "Excess mortality for men and women above age 70 according to level of care during the first wave of COVID-19 pandemic in Sweden: a population-based study." *The Lancet Regional Health – Europe* i tryck.
Modig, Karin, Anders Ahlbom, and Marcus Ebeling. 2021. "Excess mortality from COVID-19: weekly excess death rates by age and sex for Sweden and its most affected region." *European Journal of Public Health* 31(1):17-22.
National Board of Health and Welfare. 2020a. "Beskrivning av datakällor för avlidna i covid-19 [description of data sources for covid-19 deaths]." (Dnr. 6.7-14923/2020).
—. 2020b. "Halvering av andelen döda bland dem som sjukhusvårdats för covid-19 [50% decrease in deaths among those hospitalized for covid 19]." *Pressmedelande* https://www.socialstyrelsen.se/om-socialstyrelsen/pressrum/press/halvering-av-andelen-doda-bland-dem-som-sjukhusvardats-for-covid-19/ [downloaded 2021-03-07].
—. 2021. "Jämförelse av Socialstyrelsens och Folkhälsomyndigetens statistik över avlidna i covid-19 under april och december [comparision of the National Board of Health and Welfare's, and the Public Helath Agency's statistics on covid-19 deaths]." Dnr: 6.7-7387/2021.
Pifarré i Arolas, Héctor, Enrique Acosta, Guillem López-Casasnovas, Adeline Lo, Catia Nicodemo, Tim Riffe, and Mikko Myrskylä. 2021. "Years of life lost to COVID-19 in 81 countries." *Scientific reports* 11(1):3504.
Public Health Agency. 2021a. "Beskrivning av datakällor för övervakning av covid-19 [description av data sources for monitoring covid-19]." https://www.folkhalsomyndigheten.se/globalassets/statistik-uppfoljning/smittsamma-sjukdomar/veckorapporter-covid-19/2020/overvakningssystem-for-covid-19-v4.pdf [downloaded 2021-03-06]:1-7.
—. 2021b. "Veckorapport om covid-19, vecka 8 [Weekly report of covid-19, week 8]." https://www.folkhalsomyndigheten.se/globalassets/statistik-uppfoljning/smittsamma-sjukdomar/veckorapporter-covid-19/2021/covid-19-veckorapport-2021-vecka-8.pdf [downloaded 2021-03-09].
Quast, Troy, Ross Andel, Sean Gregory, and Eric A. Storch. 2020. "Years of life lost associated with COVID-19 deaths in the United States." *Journal of Public Health* 42(4):717-22.
Rostila, Mikael, Agneta Cederström, Matthew Wallace, Maria Brandén, Bo Malmberg, and Gunnar Andersson. 2021 "Disparities in COVID-19 deaths by country of birth in Stockholm, Sweden: A total population based cohort study." *American Journal of Epidemiology* 12(ahead of print):kwab057.
Sprung, Charles L., Gavin M. Joynt, Michael D. Christian, Robert D. Truog, Jordi Rello, and Joseph L. Nates. 2020. "Adult ICU Triage During the Coronavirus Disease 2019 Pandemic: Who Will Live and Who Will Die? Recommendations to Improve Survival." *Critical care medicine* 48(8):1196-202.

Statistics Sweden. 2018. "Sveriges framtida befolkning 2018–2070 [the future population of Sweden 2020–2070]." *Demografiska rapporter* 2018:1.

—. 2020. "Sveriges framtida befolkning 2020–2070 [the future population of Sweden 2020–2070]." *Statistiska meddelanden* BE 18 SM 2001.

Trias-Llimós, Sergi, Tim Riffe, and Usama Bilal. 2020. "Monitoring life expectancy levels during the COVID-19 pandemic: Example of the unequal impact of the first wave on Spanish regions." *PloS one* 15(11):e0241952.

Supplemental materials

Comparisons between different measures of COVID-19 mortality

Our analysis is based on four different mortality statistics: the observed deaths during the average of 2017–2019, the number of deaths in 2020, the number of deaths according to Statistics Sweden's forecast for 2020, and deaths related to COVID-19 from the Swedish Public Health Agency's monitoring system SmiNet. The National Board of Health and Welfare (*Socialstyrelsen*) produces official statistics on causes of death that can also be used to estimate mortality in COVID-19. With the help of microdata on deaths in Sweden, delivered by the National Board of Health and Welfare we have been able to make supplementary estimates of what mortality looked like during different months of 2020 based on data from different sources. We have made a comparison of mortality rates for April and December, which were the two months hardest hit by elevated mortality in 2020.

The Public Health Agency's estimates of deaths are linked to testing (Public Health Agency 2021a), with a higher frequency of tests during late 2020 than in the spring the same year. This could have led to some under-reporting of COVID-19 when tests were less frequent at the beginning of the year and a possible over-reporting of COVID-19 when tests were executed more extensively at the end of the same year (because people with other causes of death who also had a positive covid-19 test may then have been included in the SmiNet statistics). The Public Health Agency (2021a) has previously described differences in the reporting of deaths in different data sources. The National Board of Health and Welfare (2021) states that at the end of 2020, slightly more COVID-19 deaths were reported in the Public Health Agency than in the National Board of Health and Welfare statistics.

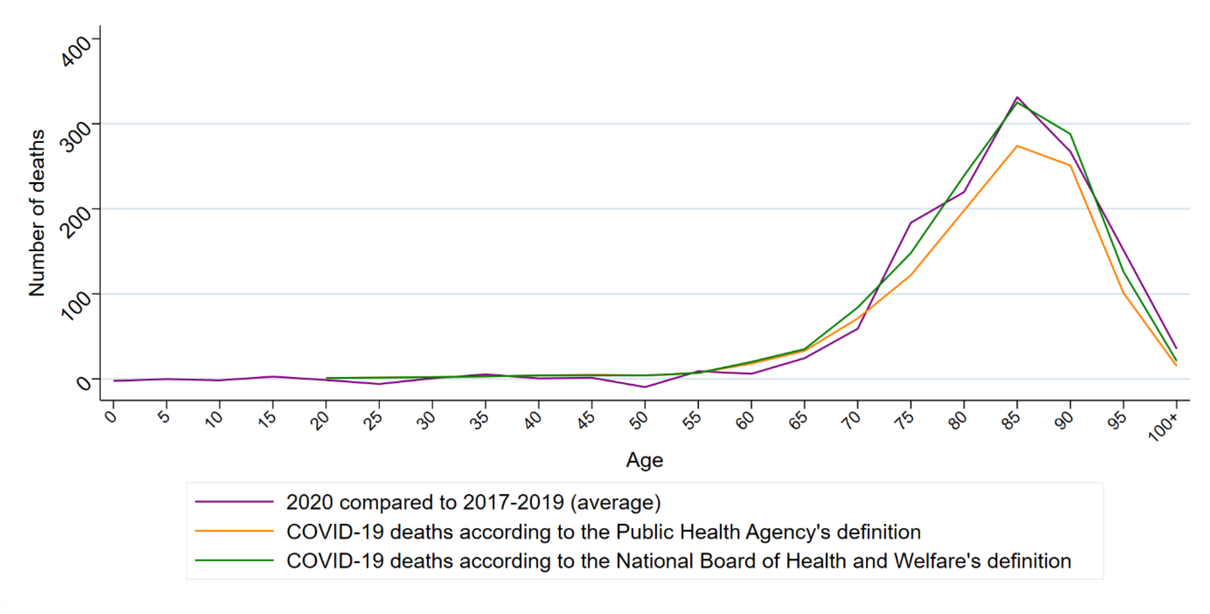
In Figure A1, we show the excess mortality in 2020 during a spring month and a winter month with high mortality in 2020 compared with the COVID-19-registered mortality based on data from the Public Health Agency's SmiNet data and the National Board of Health and Welfare, respectively, for different age groups. In general, we see that the different mortality measures correspond quite well. For April, the Swedish Public Health Agency's definition is slightly below the definition based on causes of death and also below our measure based on excess mortality. This probably reflects that SmiNet to some extent underestimated COVID-19 mortality during the beginning of the epidemic due to lower testing (Public Health Agency, 2021a). The total number of deaths in COVID-19 for 2020 based on data from SmiNet is 9816, while it amounts to 10256 based on our summary of data from the cause of death register.

For December, we see an opposite pattern where the number of COVID-19 deaths according to the Swedish Public Health Agency's definition is slightly higher than when COVID-19 deaths were defined according to registered causes of death. For women in December, both data sources' measures of COVID-19 mortality exceed our measure of excess mortality. For men in April, we see some excess mortality at ages 70–79 that is not visible in data on COVID-19 deaths from the Swedish Public Health Agency or the National Board of Health and Welfare. Our data do not allow us to examine in more detail why the different data sources have some minor deviations from each other over the year.

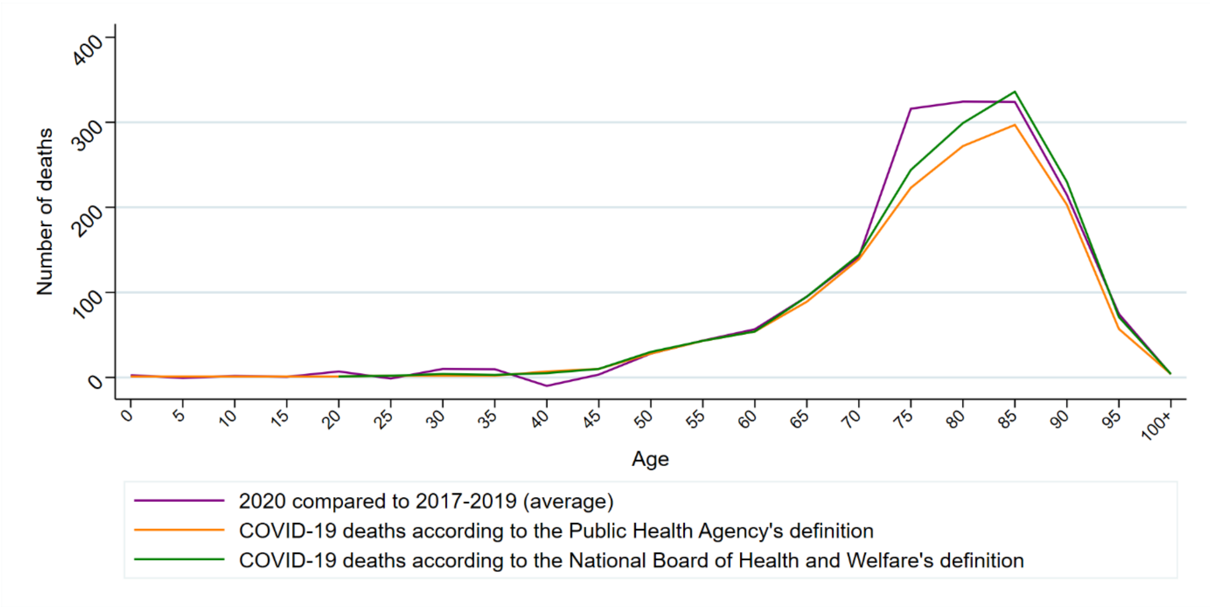
Overall, however, we note that COVID-19 deaths according to both the Public Health Agency's and the National Board of Health and Welfare's definitions correspond well with our measures of excess mortality in 2020. We assess that our study describes the patterns of COVID-19 mortality during the year reasonably well.

Figure A1: Number of deaths in April and December 2020 for men and women in different age groups. Excess mortality compared to 2017–2019, COVID-19 deaths according to the Public Health Agency's SmiNet, and COVID-19 deaths according to the cause-of-death register of the National Board of Health and Welfare

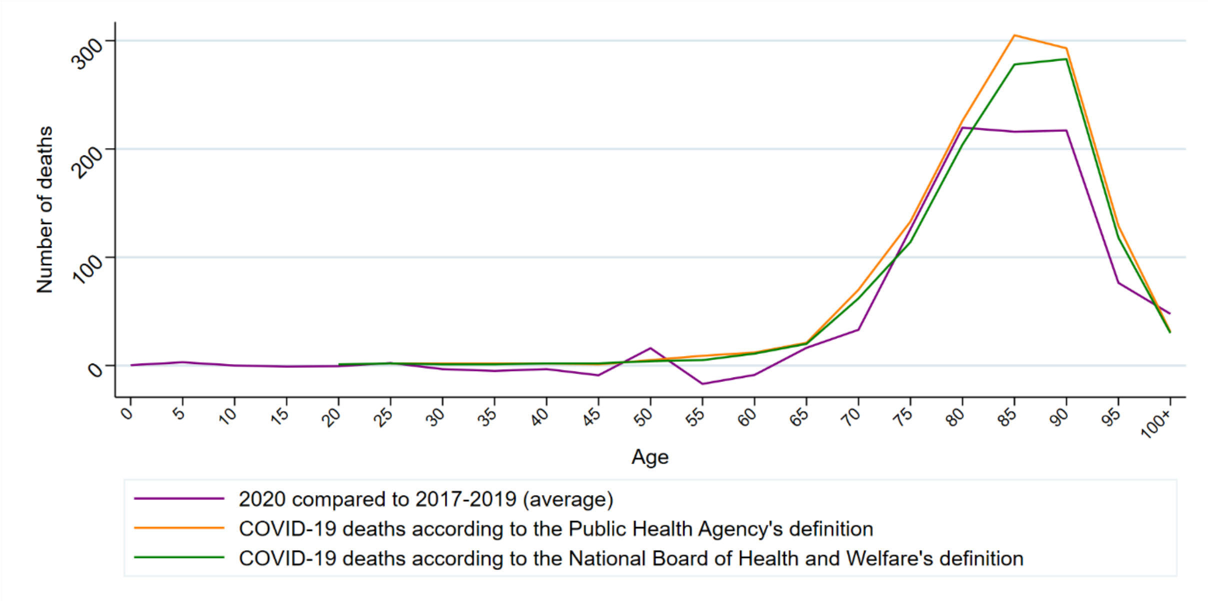
A1a: Women in April



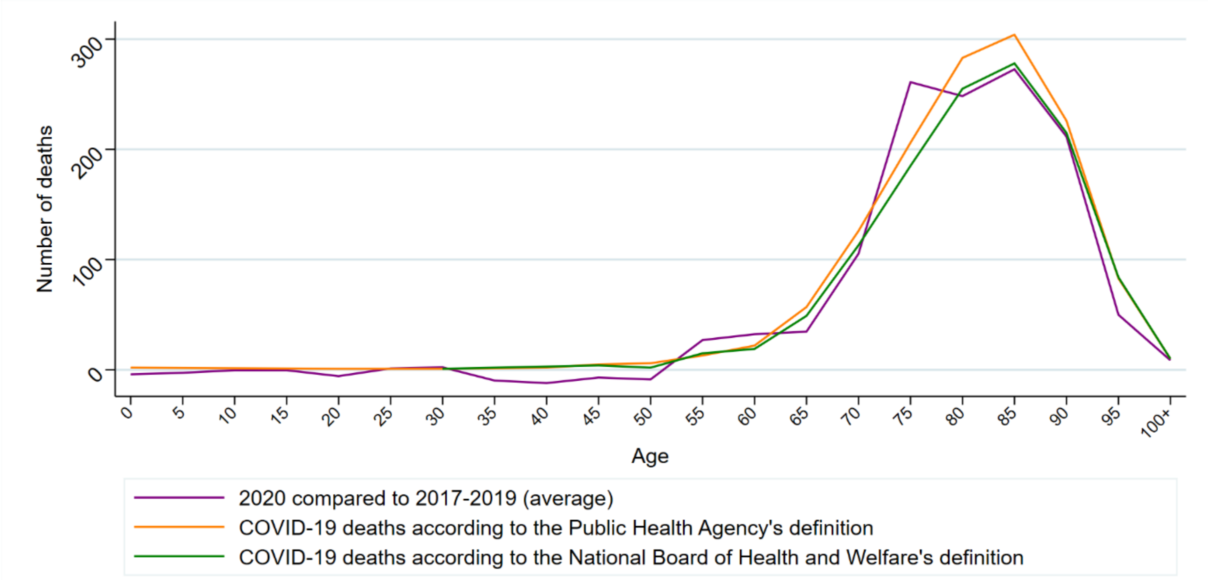
A1b: Men in April



A1c: Women in December



A1d: Men in December



Stockholm Research Reports in Demography
Stockholm University,
106 91 Stockholm,
Sweden
www.su.se | info@su.se | ISSN 2002-617X

Stockholm University
Demography Unit