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Weekly Actuarial Insights on Covid-19 in Germany

Report per 25-February-2021

Deloitte Actuarial and Insurance Services

Overview Covid-19 in Germany

Table 1 displays the weekly overview of the current number of confirmed infection cases, recovered patients and deaths due to Covid-19 in Germany as per official statistics of Robert-Koch-Institut.

Table 1. Weekly Overview Covid-19

25-February-2021	Confirmed Infections			Recoveries			Deaths		
Age	M	F	Total	M	F	Total	M	F	Total
0-4	22,862	21,339	44,201	21,179	19,879	41,058	1	3	4
5-14	70,505	64,659	135,164	66,949	61,494	128,443	3	2	5
15-34	347,275	353,575	700,850	331,245	338,028	669,273	51	30	81
35-59	435,021	487,409	922,430	411,252	464,461	875,713	1,559	661	2,220
60-79	185,814	189,256	375,070	162,966	172,474	335,440	12,244	6,389	18,633
80+	82,016	164,953	246,969	55,789	130,022	185,811	21,771	26,804	48,575
All	1,143,493	1,281,191	2,424,684	1,049,380	1,186,358	2,235,738	35,629	33,889	69,518

Mortality Rate

Many insurance stakeholders are concerned with the expected increase of the mortality rates of the German population due to the Covid-19 pandemic. We calculate in this document the mortality rate since the beginning of the epidemic with the ultimate goal of estimating the excess mortality during a 1-year period.

Robert-Koch-Institut reports the number of deaths caused by Covid-19 daily. When interpreting these figures, please note that there is a lag in the reporting of deaths. In each daily report, a significant number of deaths reported on that day actually occurred prior to the date reported, in some cases even weeks before. Due to this lag daily reports from Robert-Koch-Institut underestimate the true number of deaths on that day.

Covid-19 mortality rate is calculated by dividing the number of deaths by the number of infected persons. Among all infected persons until 25-February-2021, there are cases for which the ultimate outcome of the infection is not yet known. For that reason we have derived the following method to obtain a more accurate estimator of the Covid-19 mortality rate.

1. We start with the number of reported cases four weeks ago. This is the base number, which we use to compute the mortality rate. This number includes all reported infection cases from January until four weeks ago.
2. We then follow the infection cases from 1. and track whether they have ended as recoveries or deaths.
3. The mortality rate is then obtained by dividing the number of deaths from 2. by the total number of infections from 1.
4. As more than 99,9% of all reported cases result in either death or recovery within four weeks, our estimate does not make any assumptions regarding the outcome of the current unresolved cases.

In Table 2 we calculate the mortality rate according to this method. In this table 28-January-2021 is the date from which we start tracking the infected, i.e. four weeks prior to 25-February-2021.

Table 2. Estimate Mortality Rates

28-January-2021	Confirmed Infections			Deaths			Mortality Rate		
Age	M	F	Total	M	F	Total	M	F	Total
0-4	19,960	18,738	38,698	1	3	4	0.0%	0.0%	0.0%
05-14	64,209	59,066	123,275	2	2	4	0.0%	0.0%	0.0%
15-34	319,162	325,730	644,892	50	29	79	0.0%	0.0%	0.0%
35-59	396,194	446,925	843,119	1,491	625	2,116	0.4%	0.1%	0.3%
60-79	168,282	171,907	340,189	11,687	6,059	17,746	6.9%	3.5%	5.2%
80+	74,173	150,575	224,748	20,597	25,474	46,071	27.8%	16.9%	20.5%
All	1,041,980	1,172,941	2,214,921	33,828	32,192	66,020	3.2%	2.7%	3.0%

The current epidemiological estimates of the true prevalence of the contagion indicate that the number of infected is 2.5 to six times[1] higher than officially reported case numbers. This factor should be considered when assessing the true mortality rate. The range for the Covid-19 mortality rate is hence between 0.5% and 1.19% of infected persons after considering the estimate of the true number of infections (2.5 to six times larger than the number of infections in Table 2).

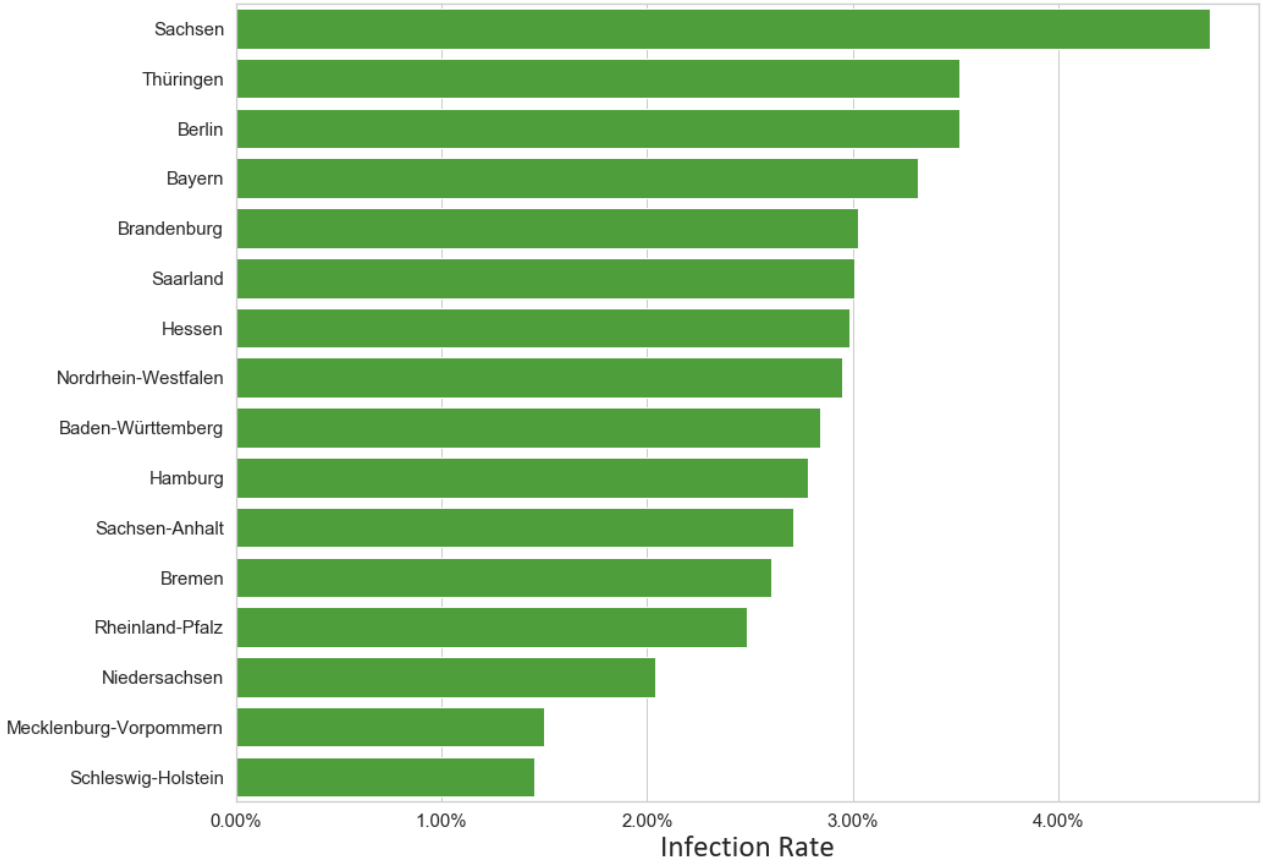
We do not expect the true number of infections in Germany to be reliably calculated in the near future, although mass antibody screening is becoming a more realistic future scenario. In a future report, we will attempt to assess the true mortality rate by deriving further assumptions about the unconfirmed infections using data from Germany and other countries.

[1] Ifo Schnelldienst Digital, 12/2020, 12th October, 2020

Regional Distribution

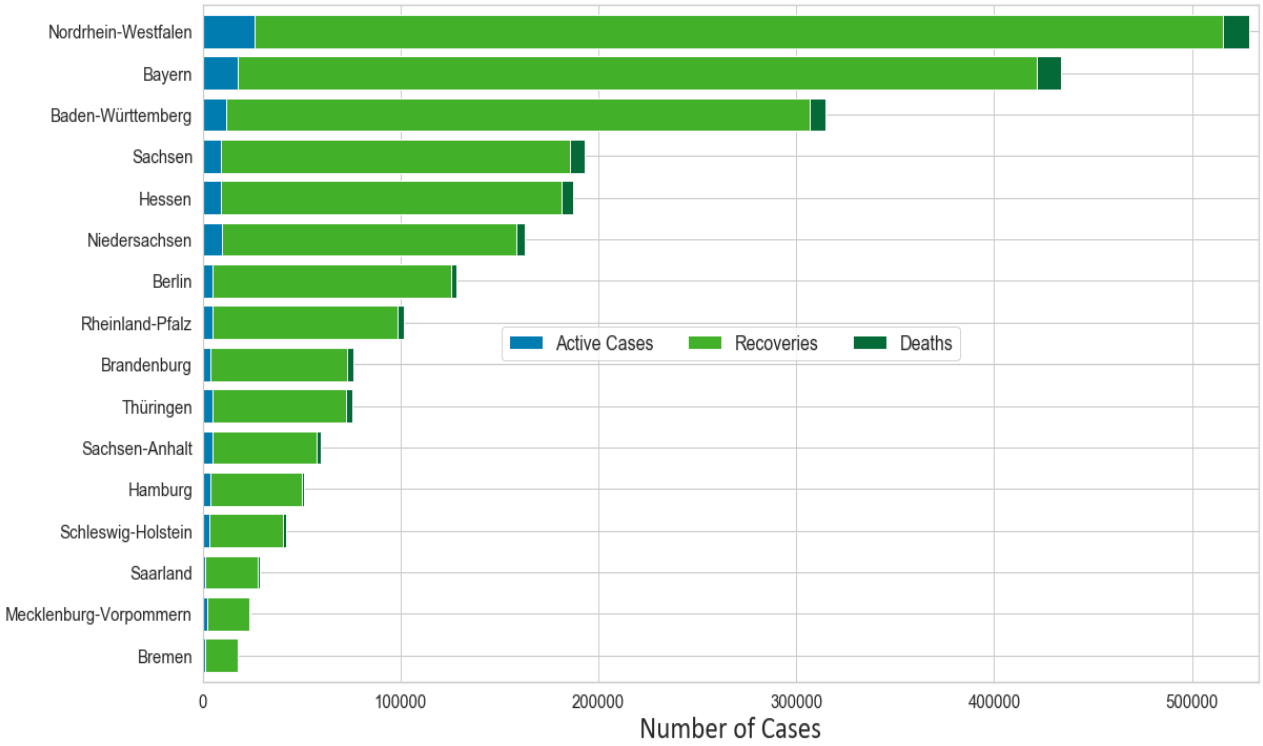
The infection rates in the federal states display a sizeable variance as demonstrated in Figure 1. The infection rate shows the ratio between the number of confirmed infections and the total population in the federal state as at 25-February-2021.

Figure 1. Covid-19 Infection Rates per Federal State



The same geographical variance is observable in Figure 2 where we split the total number of Covid-19 cases into recoveries, deaths and active cases (infected, outcome unknown). Figure 2 also refers to 25-February-2021.

Figure 2. Active Cases, Recoveries and Deaths per Federal State



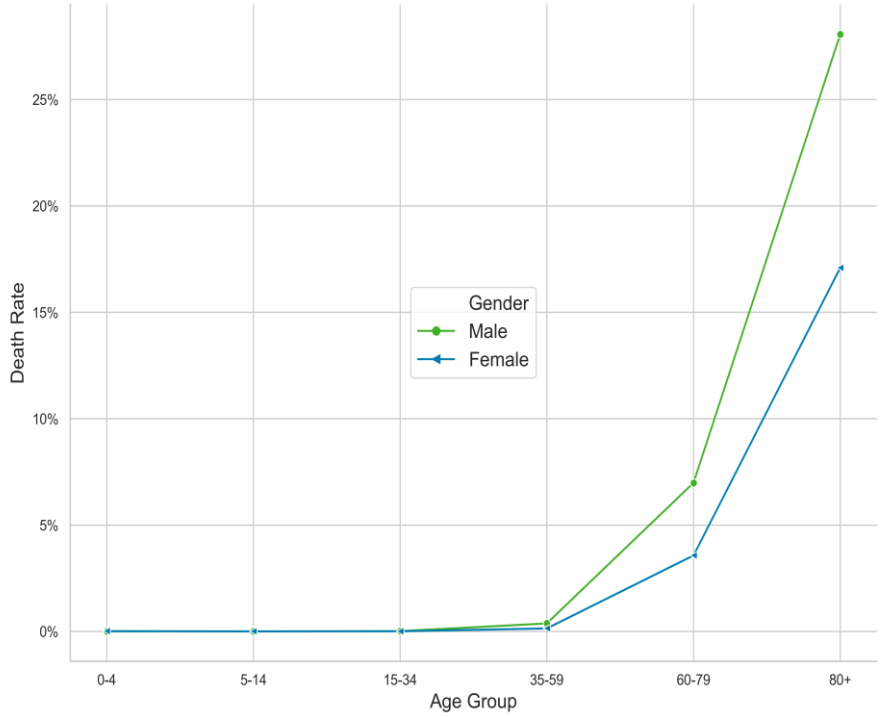
Impact of Gender

Initial reports from Wuhan, China indicated a significantly higher mortality for men infected with Covid-19. The underlying data confirms that this is also the case in Germany, as demonstrated in Table 2.

We further considered the relative infection rates of men and women. Over all ages, the average infection rate for men in Germany is 2.77%, whereas the average infection rate for females is slightly higher at 3.03%. The mortality rate – defined as the number of deaths among all infected persons – is significantly higher in men, which is in line with observations in other countries.

Figure 3 shows the mortality rate calculated for different age brackets per 25-February-2021. Again, here we emphasize that the true number of infections is likely to be between 2.5 and six times higher, so that the true mortality rate is likely to be correspondingly lower.

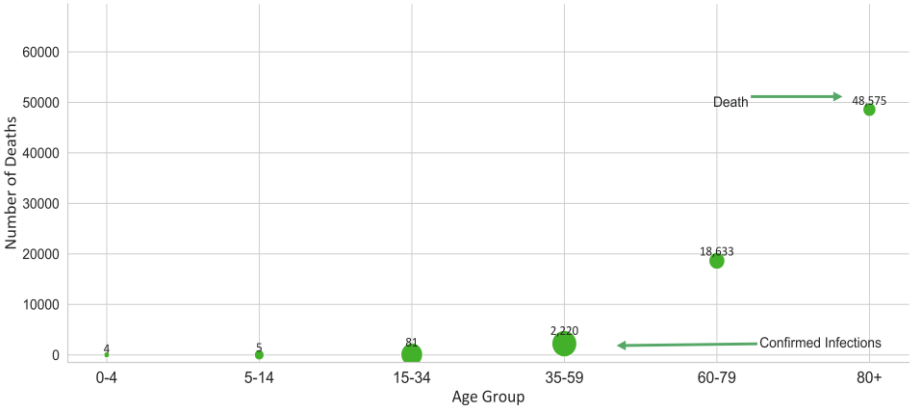
Figure 3. Covid-19 Mortality Rate (as % of Infected) by Gender



Impact of Age

As seen in other countries, for example Italy and China, the outcome of a Covid-19 infection is highly correlated with the age of the infected. In Figure 3 above one can clearly see the impact of age on mortality rate. Figure 4 displays the number of deaths and the corresponding infection numbers (denoted with the size of a bubble) per age bracket.

Figure 4. Infections and Number of Deaths per Age Group

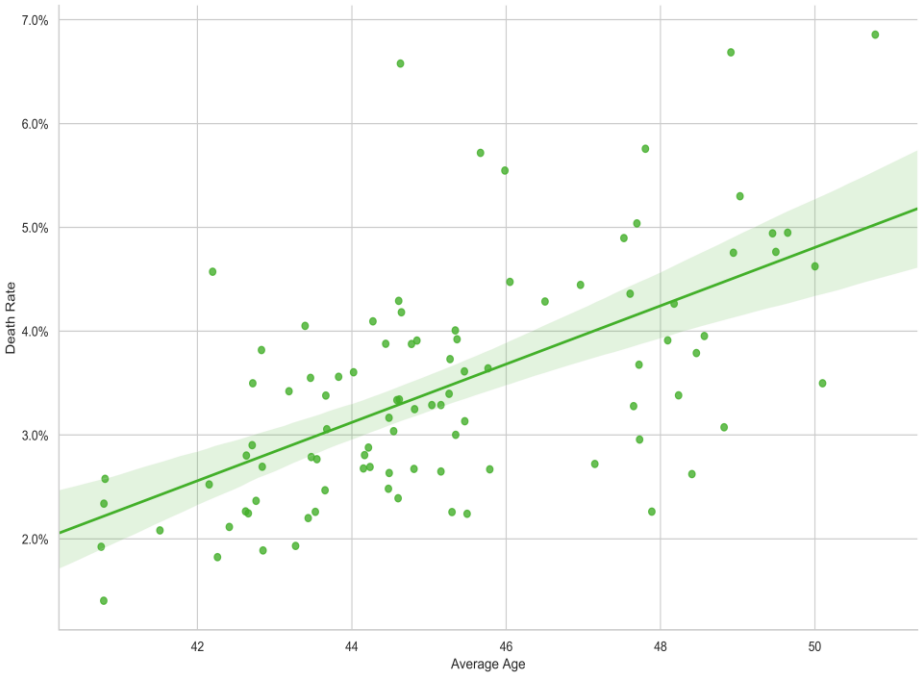


Confirmed Infections are represented by the size of a bubble. The position of the bubble corresponds to the number of deaths per age group (vertical axis).

We further analyzed the data based on municipal districts (*Landkreise*). We observe a positive correlation between average age and mortality rate in each district. We compared the infection rates of the districts and noted that different districts in Germany find themselves in a different stage in the cycle of the disease.

In many municipal districts, the number of deaths is too small to be statistically evaluated. When we focus however only on the districts in the highest quartile with respect to the infection rate, we notice a positive correlation between the average age and the Covid-19 mortality rate.

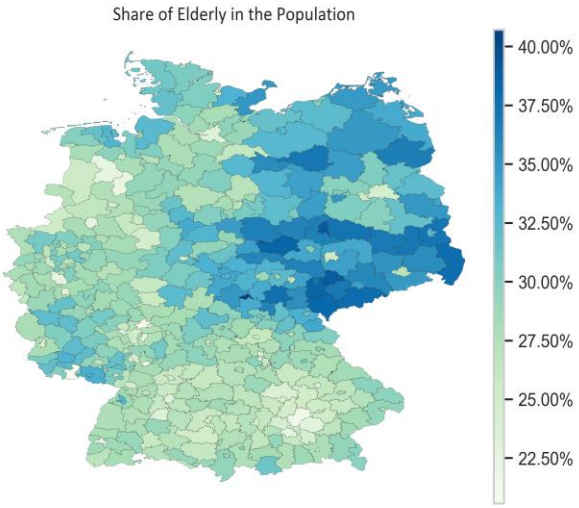
Figure 5. Covid-19 Mortality Rate (as % of Infected) by Average Age



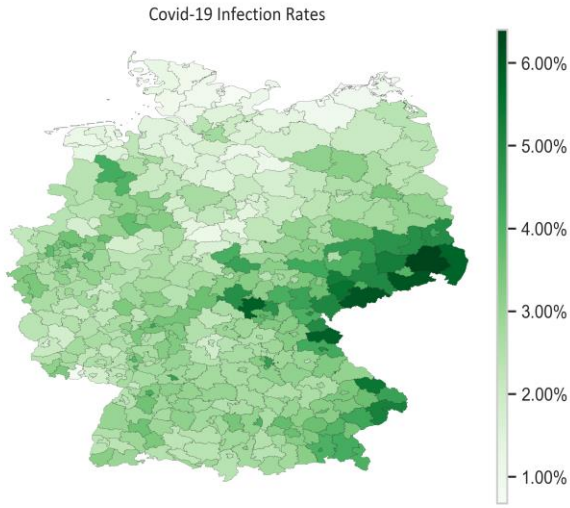
Since the number of deaths per district and the differences in the average age among districts are rather small numbers, this statistic is naturally prone to high uncertainty.

In the next step we analyzed the correlation between average age and infection rate per municipal district. Figure 6 (left) shows the proportion of elderly (people aged over 60) in different municipal districts in Germany. We note that the eastern part of Germany has a much higher percentage of elderly than the southern or western parts. In Figure 6 (right) the infection rates are displayed. Comparing both maps, we conclude that the infection rate does not appear to be correlated to the prevalence of elderly people in a municipal district.

Figure 6. Elderly People (60+ Years) and Covid-19 Infection Rates



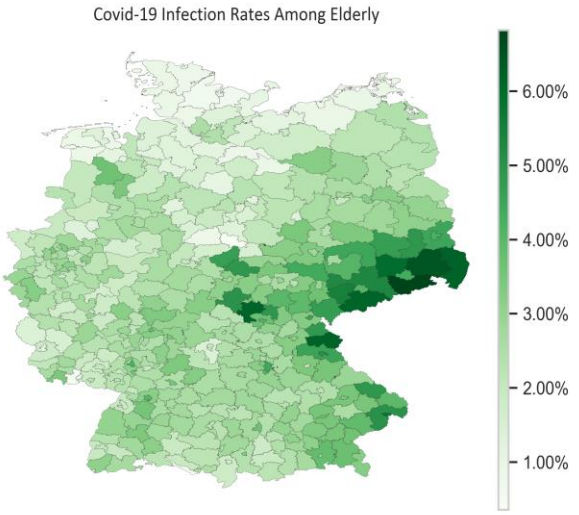
Source: Statistisches Bundesamt and Robert-Koch-Institut



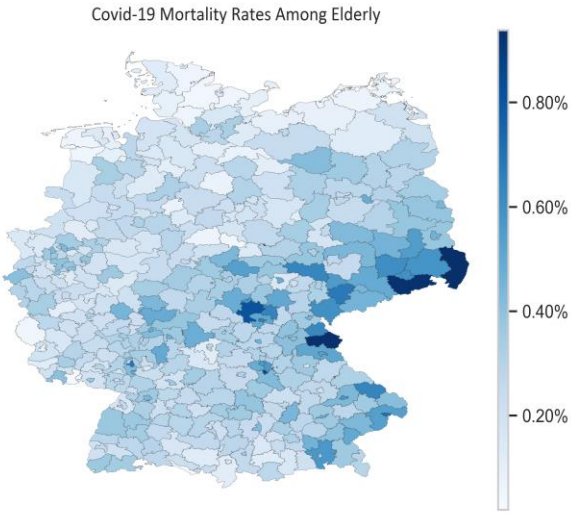
Source: Statistisches Bundesamt and Robert-Koch-Institut

Next, we explored whether the infection and mortality rates among elderly people deviate from the total population. Both maps in Figure 7 indicate that the infection rates in the elderly correspond well to the infection rate in the general population.

Figure 7. Infection and Mortality Rates Among Elderly People (60+ Years)



Source: Statistisches Bundesamt and Robert-Koch-Institut



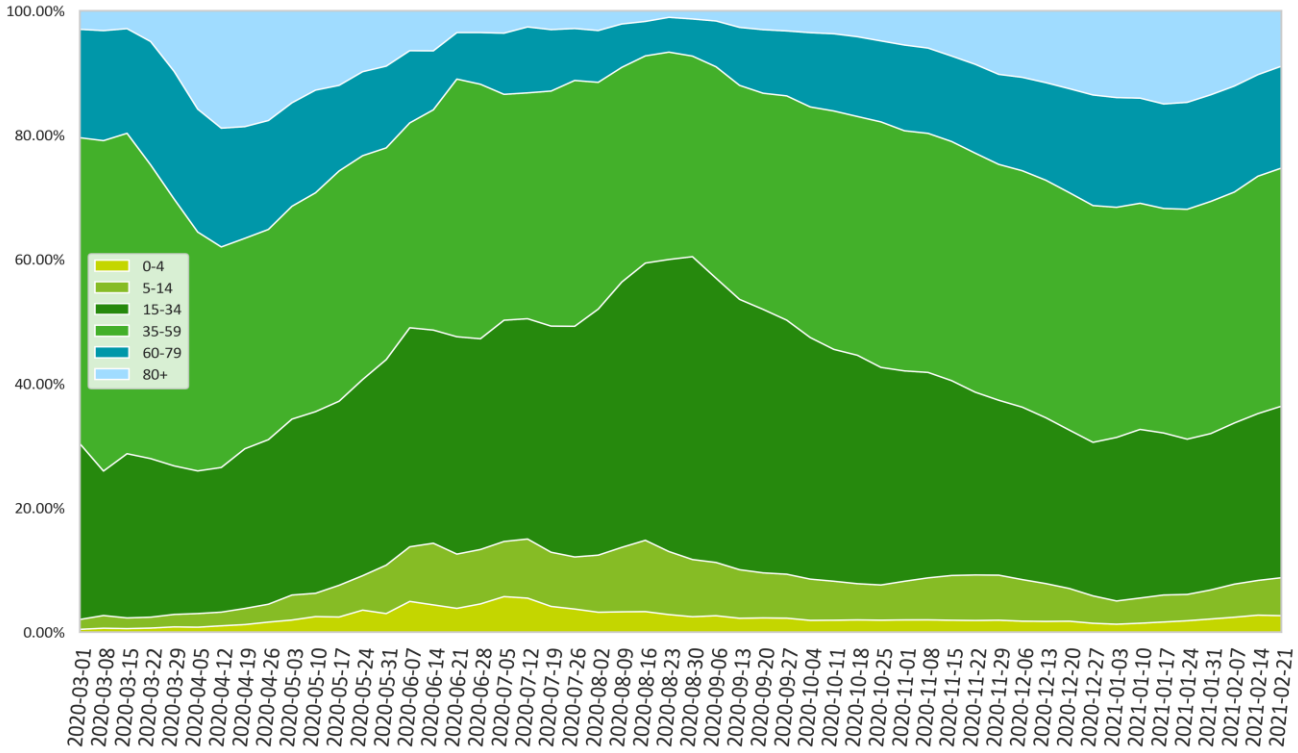
Source: Statistisches Bundesamt and Robert-Koch-Institut

We conclude that at this stage of the contagion specific events (visits to hotspots in e.g. Austria and Italy, carnival) seem to determine the spread of the disease, not the average age of the population in a municipal district.

As the time passes the virus distribution among different age groups changes as well. Comparing the new infection at the height of the contagion in April with the new

infections in the summer 2020 we clearly observe that the proportion of younger people among the new infections has increased significantly. As a lower percentage of older people became infected, the mortality rate for the total population of Germany decreased significantly since the height of the infection in April 2020.

Figure 8. Percentage Distribution of Weekly New Covid-19 Cases Across Age Groups



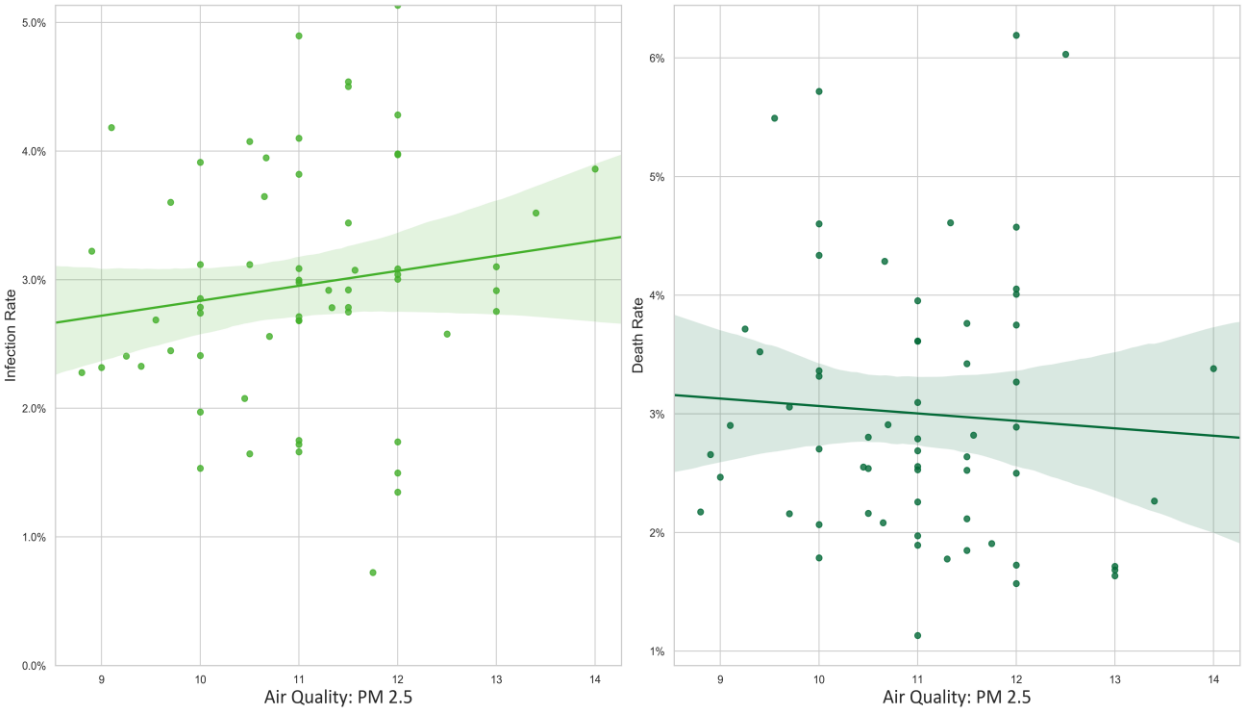
Impact of Air Pollution

Some reports and articles[2] covering Covid-19 indicated that air quality might correlate to the incidences and severity of Covid-19.

We have collected the data on the presence of the so-called 2.5mm particles in German cities from the Federal Statistical Office. No comparable data exists for non-urban districts, so our data is limited to about 60 out of 400 municipal districts.

The data pool is therefore small and caution is advised when drawing statistical inference from the graphs in Figure 9.

Figure 9. Air Quality and Covid-19 Infection and Mortality Rates



The existing data does not suggest that the level of air pollution has an impact on the infection rate or the mortality rate in Germany. This may change as the pandemic progresses.

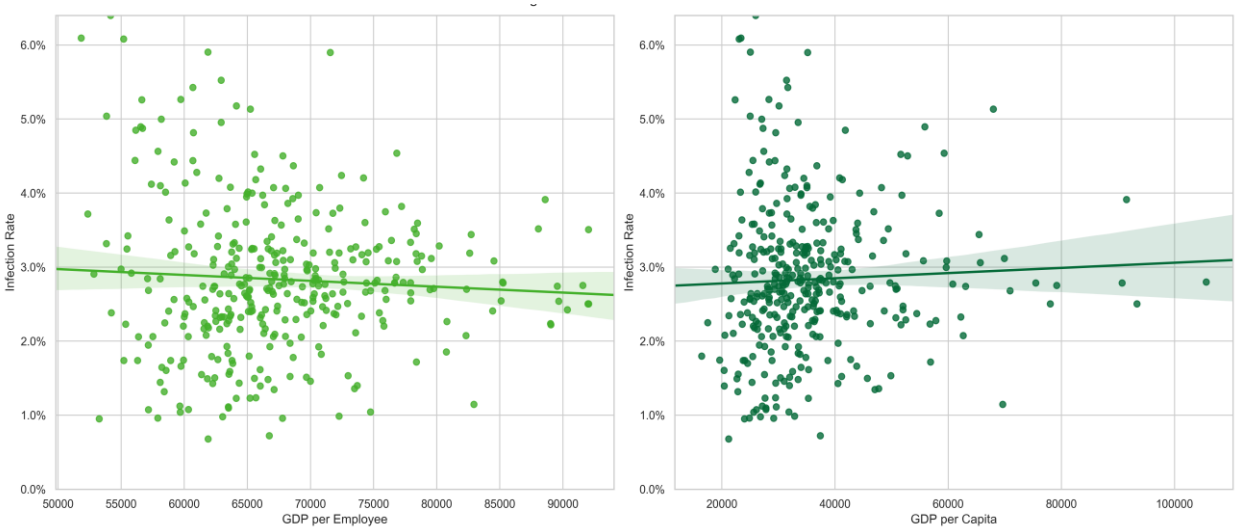
[2] Exposure to air pollution and Covid-19 mortality in the United States. Wu, Nethery, Sabath, Braun, Dominici, medRxiv 2020.04.05.20054502. "Results**:** We found that an increase of only 1 µg/m^3 in PM2.5 is associated with a 8% increase in the COVID-19 death rate, 95% confidence interval (CI) (2%, 15%)."

Impact of GDP Per Capita

This section details our analysis of the correlation between the GDP per capita and the population infection rates per municipal district. We have collected data detailing the GDP per Capita as well as the GDP per Employee for each district in Germany (in 2017). Our hypothesis was that districts that are more affluent were more likely to have been exposed to the pandemic hotspots, resulting in higher infection rates.

The GDP per Capita in some municipal districts is extremely high (e.g. in Wolfsburg), overly affecting the correlation analysis. Therefore, we have excluded the top 5% (20) of districts from our analysis. The figures below are based on the remaining 95% of the municipal districts.

Figure 10. GDP per Capita in Districts and Covid-19



The trend in Figure 10 shows disappearing or weakly positive correlation between infection rate and the GDP per Capita (and the GDP per Employee). That contrasts starkly with the strong positive correlation between infection rate and GDP per Capital (and the GDP per Employee) we had been consistently observing before December 2020, indicating that the Corona virus has spread from the more affluent regions (South and West Germany) into the less affluent regions of Germany (East Germany) in the last months.

Comparison with Seasonal Influenza Mortality

In this section, we consider the severity of Covid-19 in comparison to the seasonal flu.

Table 3. Comparison of Covid-19 and Influenza Number of Deaths

Disease	Covid-19	Flu 19/20	Flu 18/19	Flu 17/18	Flu 17/16
Deaths	69,519	434	954	1,674	722

Table 3 shows the number of clinically confirmed Covid-19 related death cases from February 2020 to the present. We can see that the current number of deaths due to Covid-19 is much larger than the number of flu deaths over the last four flu seasons combined.

For seasonal flu the true mortality is likely to be higher than the officially confirmed numbers. Nevertheless, although Germany has a relatively low Covid-19 mortality rate, it is clear that Covid-19 is much deadlier than the seasonal flu.

In connection with influenza, Robert-Koch-Institut calculates the seasonal excess mortality reported in Table 4. According to the methodology used here, there is excess mortality if the actual mortality in a season exceeds the estimated base mortality[3].

The reported numbers show that annual variation of mortality is still higher than the number of Covid-19 related deaths in Germany. On the other hand there is no statistical consistency between flu related deaths and excess mortality.

Table 4. Seasonal Confirmed Influenza Deaths and Excess Mortality

Flu Season	Confirmed Deaths	Excess Mortality
19/20	434	N/A
18/19	954	N/A
17/18	1,674	25,100
16/17	722	22,900
15/16	237	0
14/15	274	21,300
13/14	23	0
12/13	196	20,600
11/12	14	2,500
10/11	165	0
09/10	258	0
08/09	10	18,700

Even after taking all the uncertainties regarding their respective mortality rates into account, the Covid-19 mortality rate in Germany appears to be much higher than the flu mortality rate, even in comparison to the most severe years such as the 2017/2018 flu season.

Annual variation in number of deaths during the influenza seasons is higher than the 2020 increase of mortality due to Covid-19. It is however not clear that seasonal influenza causes the increase in mortality.

[3] The base mortality is calculated by removing the expected influenza impact and adding a safety margin.

Comparison with 1918 Influenza

The influenza of 1918 and 1919 was one of the deadliest pandemics in history. Caused by a more virulent influenza virus mutation and diffused along rail and sea routes during the First World War, it reached its climax in autumn of 1918. As we have seen, the influenza mortality in the last years was lower that Covid-19 mortality in 2020. Our next question is how Covid-19 compares to the deadly influenza from a century ago.

Unfortunately, no reliable data for 1918 mortality within the area of modern Germany exists. For many other European and American countries, a comparison between 1918 influenza and Covid-19 is however possible.

In this section, mortality rate refers to the annual deaths as % of total population.

Italy

Italy was strongly affected by both Covid-19 and 1918 influenza. Reliable mortality data are available for both diseases. Italy hence serves as a showcase for comparing the excess mortality due to these two pandemics.

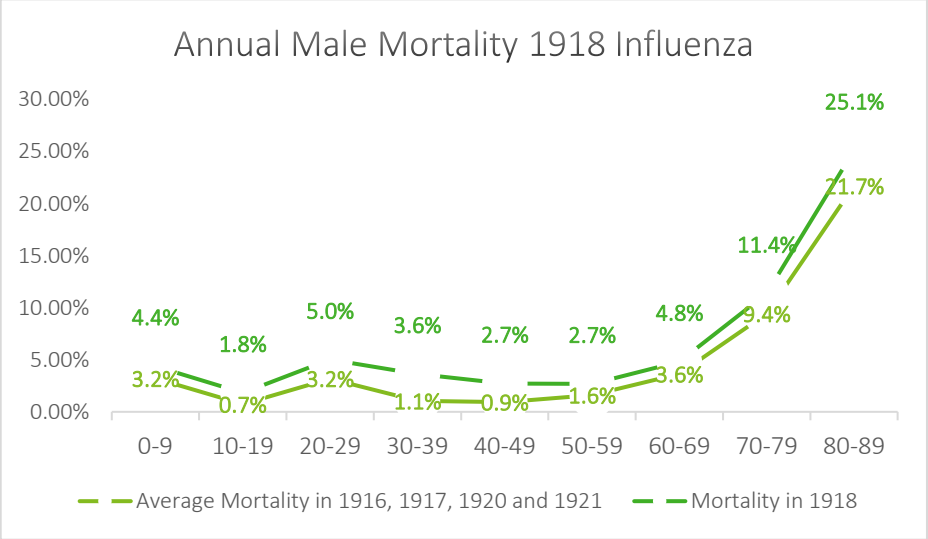
The excess mortality from 1918 influenza is derived from the data in the Human Mortality Database. For the expected mortality without the influenza effect, we use the mortality rates in years 1916, 1917, 1920 and 1921. We omit 1919 since the influenza virus was still active in the beginning of 1919.

We compare separately men and women. For men caution is needed when interpreting the figures: The war-related increase of mortality for young men (particularly those in the age group 20-29) in 1916 and 1917 distorts the analysis. For women on the other hand the increase in mortality is primarily caused by influenza. The female mortality prior to 1918 and after 1919 is comparable.

For a comparable figure of mortality in Italy in 2020, we started with the official data on the number of deaths until 15 May 2020. The annual mortality 2020 is obtained by extrapolating the mortality until the end of the year. In other words, we assume that the mortality in the first 4.5 months of 2020 will persist until the end of 2020. As benchmark for expected mortality in 2020 we use the exact mortality data from 2016, 2017 and 2018.

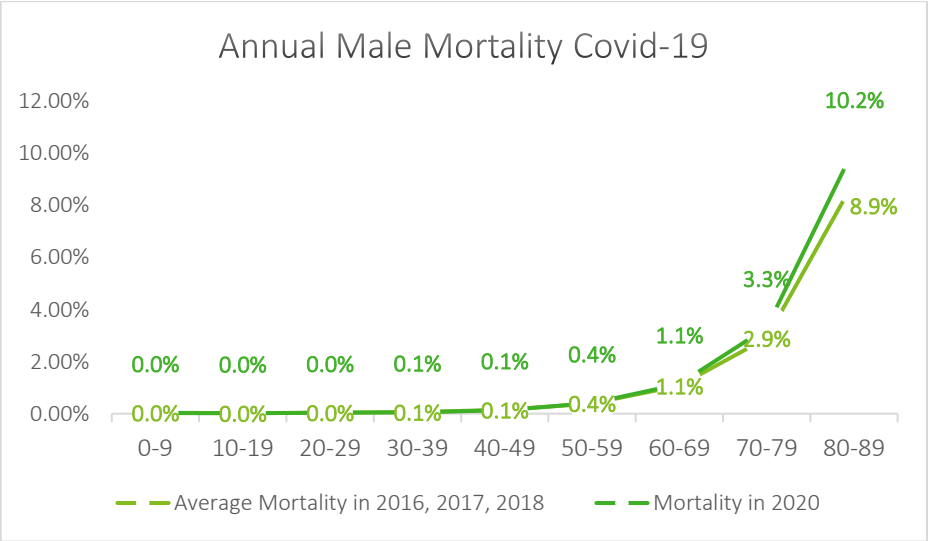
Looking at the graphs in Figure 11 to Figure 14 we conclude that the mortality impact of Covid-19 in Italy is by no means comparable to the extreme effect of the 1918 influenza. Only for very old people – as already discussed in the section on the impact of age on Covid-19 mortality – do we observe a somehow comparable increase of mortality.

Figure 11. Male Mortality Italy 1918



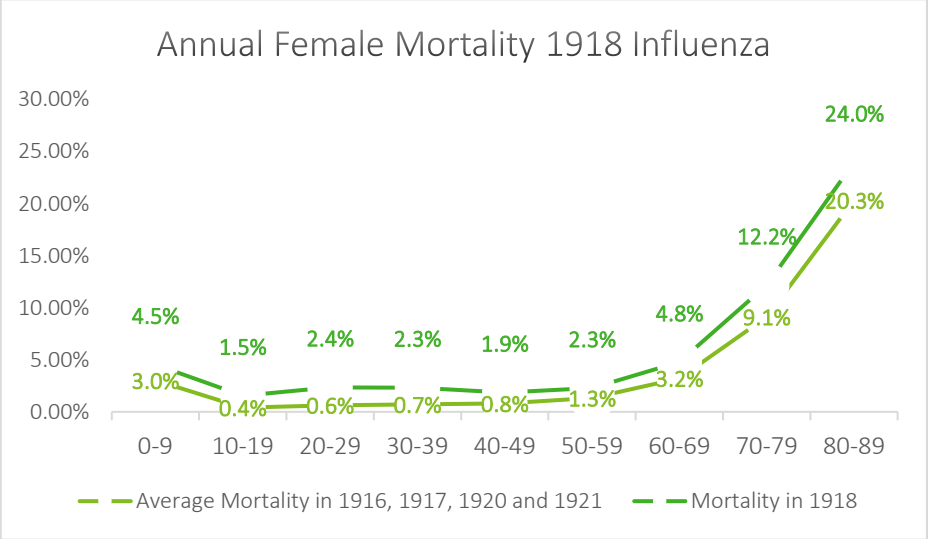
1918 Influenza caused an enormous increase in mortality across all age groups. The figures for younger men (in age group 20-29 and partially 30-39) are distorted by the war-related deaths in 1916-1917.

Figure 12. Male Mortality Italy 2020



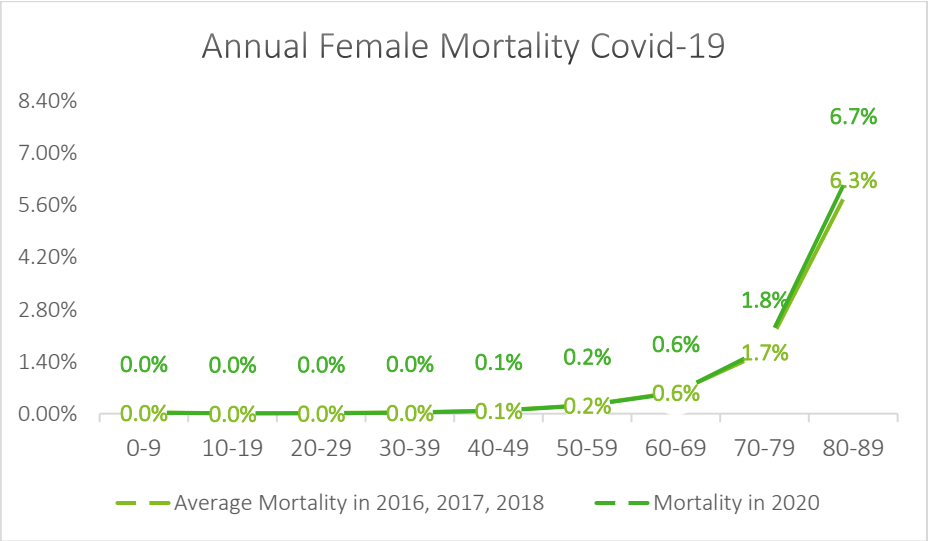
In 2020 the mortality among men younger than 50 is lower than the average in years 2016-2018. But for men older than 80 the proportional increase of the mortality is similar to the increase in 1918 (from 8.9% to 10.2%, increase by 14%).

Figure 13. Female Mortality Italy 1918



The increase of mortality of younger women is enormous, three to four times more women the age of 40 died than expected. Another perspective: Almost every 40th woman between 20 and 40 died in 1918.

Figure 14. Female Mortality Italy 2020



For all women younger than 70 the mortality in 2020 is even slightly lower than in 2016-2018. The mortality increase for women older than 70 is moderate compared to 1918.

Comparison with Italy

As Italy was strongly affected by Covid-19 at a much earlier point in time than Germany, we considered the impact of Covid-19 in Italy. We consider it a suitable comparison as Italy has a comparably well-developed health system. There is clear evidence of an increased mortality rate associated with lack of containment. We have performed an ad hoc, comparative analysis of the two countries per 17 April 2020.

Regions in Northern Italy were most severely affected by Covid-19, prior to lockdown and stay-at home orders issued by the Italian Government on 9 March 2020. Already at that point, the increase in total mortality in these regions started to be noticeable.

Table 5 displays the figures from the period 1 March to 17 April 2020, just short of 7 weeks. We start with, per age group, the expected total deaths in Germany and in Italy. We have produced these values by using our own mortality prediction models, which were trained on historical mortality data until 2017 for nine countries.

In Table 5 we compare the expected deaths with the officially reported Covid-19 deaths. We are aware that some of the Covid-19 deaths may be part of the expected deaths. By this we mean people who have died of other causes but were also tested positive on Covid-19. On the other hand, we also reckon that the number of deaths which are not attributed to Covid-19, but which are nevertheless causally related to it, further complicate the estimate. Please see the focus topic Bergamo for further insights on this point.

Table 5. Comparison of Reported Covid-19 Mortality in Germany and Italy in the Period 1 Mar 2020 – 17 Apr 2020

1 Mar-17 Apr	Mortality in Germany			Mortality in Italy		
Age	Expected	Covid-19	Increase	Expected	Covid-19	Increase
0-4	421	1	0.2%	397	2	0.5%
5-14	80	0	0.0%	64	0	0.0%
15-34	962	7	0.7%	538	48	8.9%
35-59	11,040	173	1.6%	5,444	993	18.2%
60-79	45,585	1,327	2.9%	24,352	8,663	35.6%
80+	72,581	2,596	3.6%	60,562	10,862	17.9%
Total	130,669	4,104	3.1%	91,358	20,568	22.5%

The discrepancy between the mortality increases in Germany and Italy is large for all age groups. The most likely explanation for this discrepancy is that no exponential increase of infection cases has happened in Germany comparable to the one in Northern Italy.

Bergamo

In 2019, the overall annual mortality rate in Italy was 1.09%. This is in line with comparable industrialized countries with an aging population. The journalists of L'Eco di Bergamo have examined the Covid-19 impact in the Bergamo region in Lombardy. This is one of the areas hardest hit by the virus, even in comparison with the rest of the world.

We could certify that their assumptions about the expected mortality in March 2020 are in line with what our models predict. They have compared these expected mortalities with the actual deaths recorded in March and derived the true death toll of the disruption caused by the Covid-19.

Table 6. Excess Mortality in Bergamo in March 2020

Bergamo province	Expected	Actual	Covid-19 official	Excess	Increase
Deaths	900	5,400	2,060	2,440	600%

It is important to bear in mind that this has happened against the backdrop of an unhindered spread of the contagion for an extended period of time. Furthermore, as the lethality and infectivity of Covid-19 were still not as well understood as they are today, some practical decisions appear to have contributed to an increase of the mortality (like quarantining milder cases in nursery homes, hence aggravating the spread of the contagion in the vulnerable population). The situation is not comparable to the whole of Italy and much less to Germany, where early steps were taken to prevent such a rapid spread of the disease.

A similar pattern of increased mortality has been reported from other hotspots like Madrid or New York City. However, a preliminary analysis of German mortality data until 3 May 2020 by Federal Statistical Office has shown – if anything – just a very moderate increase of mortality by the end of March and the beginning of April compared to the usual seasonal mortality trends.

The development in Bergamo is nevertheless important for mortality modelling. Although a collapse of health systems causing the magnitude of excess deaths as observed in Bergamo, is unlikely to happen in other developed countries, there are two important insights from these figures:

- In regions in the world with weaker health systems, Covid-19 is likely to increase mortality for an extended period in a similar way to Bergamo's experience rather than following Germany's pattern.

- The curve of infection numbers may become flattened in many countries. However, the number of deaths exceeding the expected mortality will be observable, albeit for many countries spread over a number of weeks. This will need to be considered in future mortality models.

Special Focus New York

Our next focus is one of the largest Covid-19 hotspots, New York City and more broadly New York State. They should serve as an example of the extent of excess mortality rates, which could have affected other regions including Germany, had they not implemented early containment and lockdown measures.

For an assessment of the excess mortality rates, we have analyzed weekly counts of deaths from National Center for Health Statistics for the last six years.[4] Data for 2020 is available until June 6 (week 23).

The annual estimates of resident population stem from US Census Bureau.

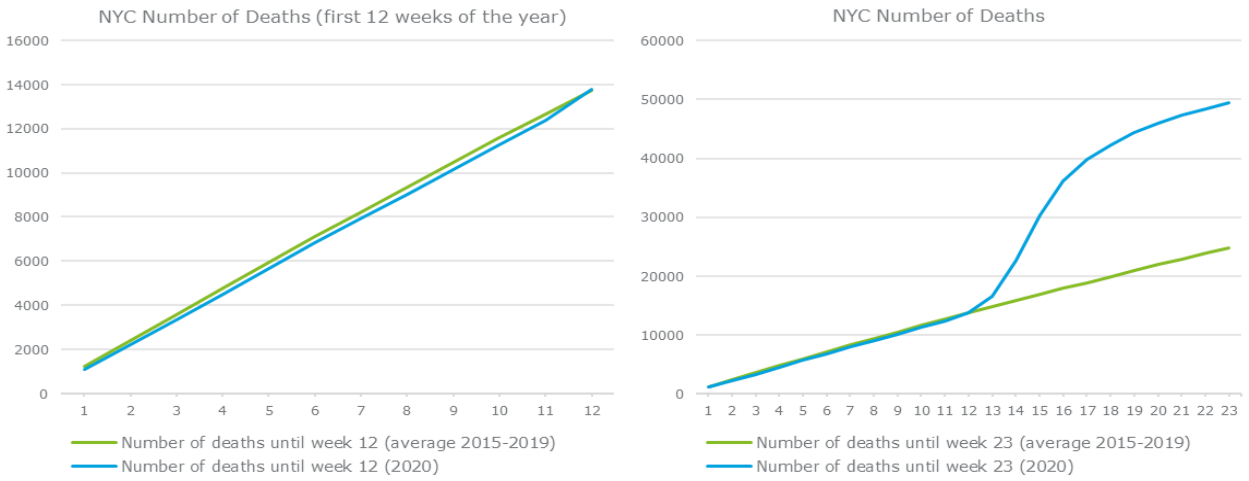
New York City

In New York City, the average annual mortality rate for the period 2015-2019 is 0.64%. There is no much variation in the annual mortality rates in these five years. Since the Ney York City population is comparably young, this is a much lower figure than the average for industrial countries.

Assuming the mortality rate of the first 23 weeks in 2020 will continue through 2020, we estimate the annual mortality rate to become 1.30%. This is an increase of 0.66%. Even assuming no excess mortality until the end of 2020, New York City annual mortality rate will increase by more than 0.15%, which is considered a pandemic mortality increase in the Solvency II standard formula.

In the first 12 weeks of 2020, the number of deaths was slightly below the average of the last five years, see Figure 15. This is a normal annual variance and likely due to the severe impact of seasonal flu in the previous years. Since week 13 (the second half of March) however, there is a dramatic increase in the number of deaths in 2020.

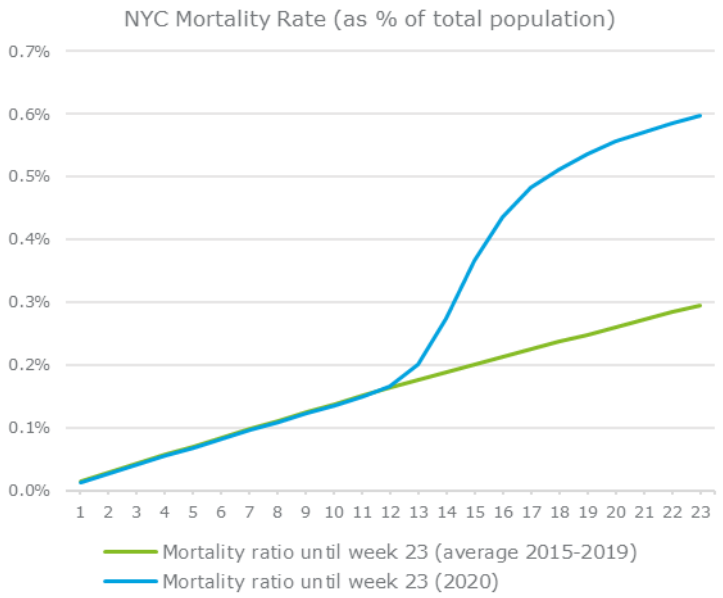
Figure 15: New York City Number of Deaths



[4] Data for 2019 and 2020 are provisional and may be incomplete because of the lag in time between when the death occurred and when the death certificate is completed, submitted and processed.

The same enormous increase can be observed looking at the mortality rates as percentage of the total resident population in New York City Figure 16.

Figure 16. New York City Cumulative Mortality Rate



Comparing weeks with the highest mortality in the years 2015-2019 with the year 2020 in Table 7 we see that Covid-19 caused many more deaths than any other cause.

Table 7. Five Worst Weeks in New York City

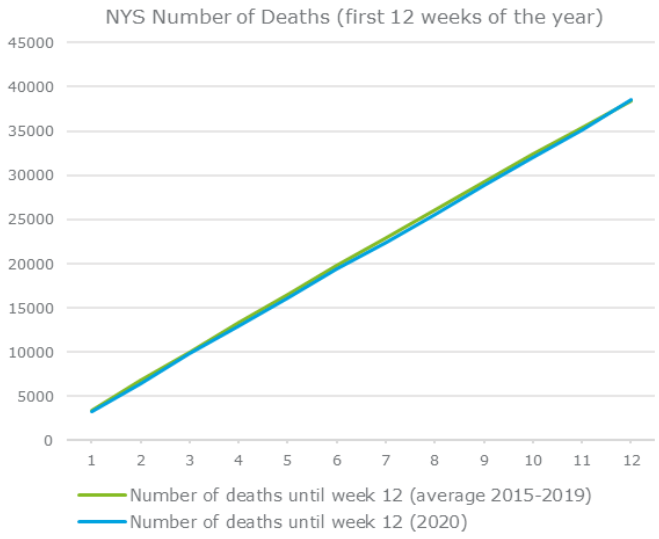
Period	Number of Deaths				
2015-2019	1,351	1,331	1,279	1,277	1,254
2020	7,719	6,070	5,712	3,816	2,781

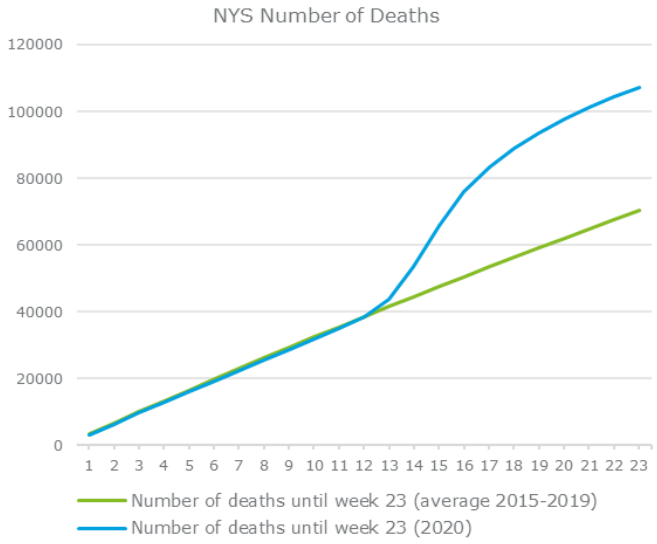
New York State

In New York State, which includes besides New York City a vast area with smaller urban centers, the increase of mortality rate was lower than in New York City. The average over years 2015-2019 is 0.78% and in 2020, it is 1.21%. It gives an increase of 0.42%.

The pattern of mortality increase starting from week 13 is very similar to New York City as can be observed in Figure 17.

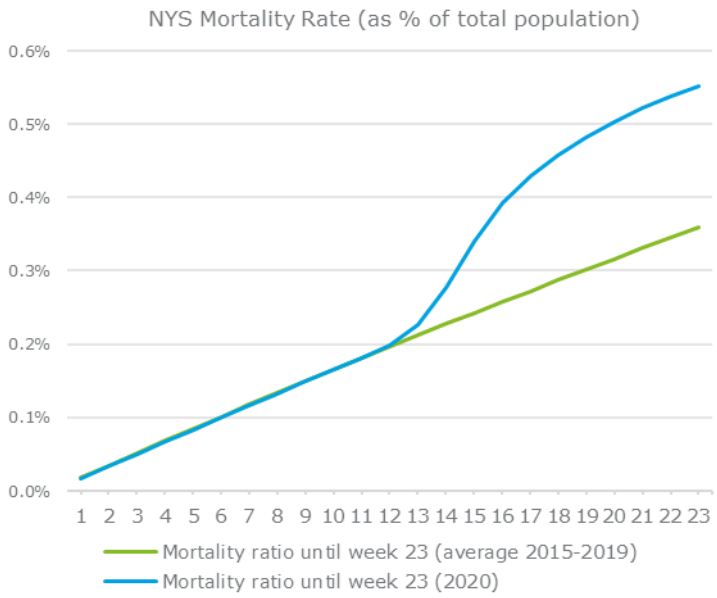
Figure 17. New York State Number of Deaths





Similarly, the mortality rates as % of the total resident population increase dramatically in Figure 18, albeit not as strongly as in New York City.

Figure 18. New York State Mortality Ratio



We close our analysis of New York State by displaying the difference between five years with the highest mortality in Table 8.

Table 8. Five Worst Weeks in New York State

Period	Number of deaths				
2015-2019	3,783	3,637	3,542	3,440	3,419
2020	12,317	10,077	9,712	7,359	5,416

Sources:

- Robert-Koch-Institut
- Statistisches Bundesamt
- UrbiStat
- Statista
- Human Mortality Database
- Ministero della Salute, Italy
- L'Eco di Bergamo and InTwig
- US National Center for Health Statistics
- US Census Bureau
- A neural network model for expected mortality modelling in 2019-2020 developed within German Actuarial Association and improved internally

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