



Surveillance of mortality related to the COVID-19 epidemic in Denmark

Memo from the SSI on the surveillance methods applied and the interpretation of collected data

In this memo, we describe the various methods applied by the SSI to monitor COVID-19-related mortality in Denmark.

How COVID-19-related deaths are registered in Denmark

To ensure near-real-time monitoring of COVID-19-related deaths, the SSI uses the deaths recorded daily by the Central Office of the Civil Registration (CPR) Registry in combination with COVID-19 test results. By definition, all daily deaths for which a positive COVID-19 PCR test was recorded within the 30 days leading up to the date of death are counted as COVID-19 deaths. The same method is used to monitor other respiratory infections, e.g., influenza and pneumococci. Since the beginning of the epidemic, continuous monitoring of 30-day COVID-19 deaths has formed part of the assessment of the burden and severity of the epidemic, along with COVID-19 case numbers and the number of people admitted to hospital with COVID-19.

One considerable advantage of using the 30-day COVID-19 death figure is that it may be retrieved automatically from national Danish registers, and it is therefore available here and now. That explains why this figure is an important part of our monitoring of the evolution of the COVID-19 epidemic.

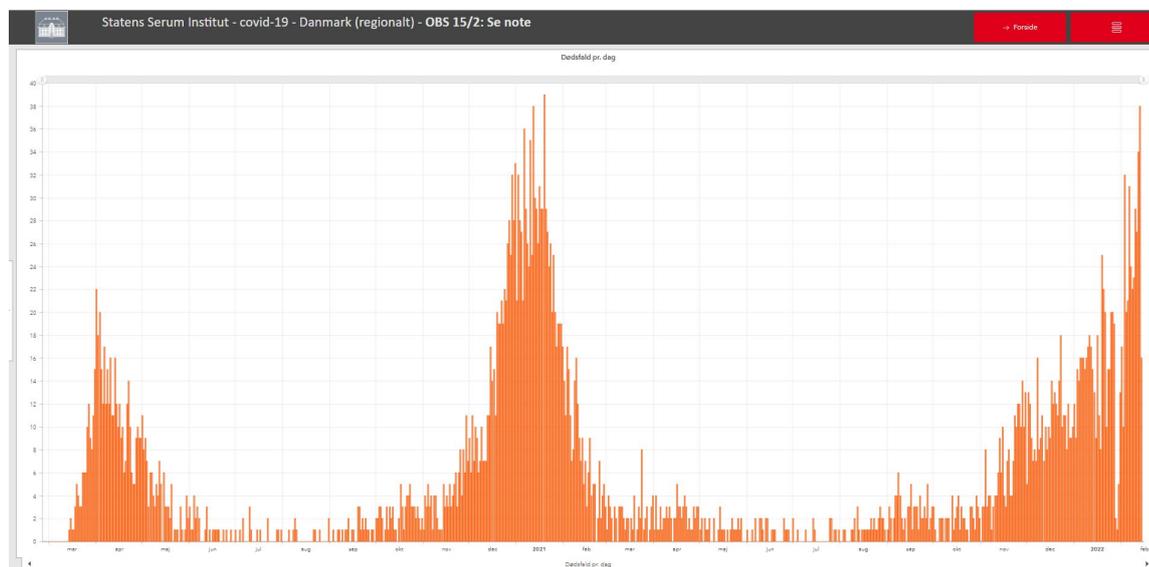
A drawback of the method is that in some cases deaths will be misclassified as COVID-19 deaths even though the cause of death is, in fact, not COVID-19-related. This may be the case if someone who has recently become infected with COVID-19 happens to die in a traffic accident. In this case, the person dies “with” COVID-19 not “due to” COVID-19. Therefore, the number of COVID-19 deaths gets overestimated by the recorded figures.

Furthermore, some degree of underestimation of the number of COVID-19 deaths will occur because deaths registered more than 30 days after a COVID-19-positive test are not counted in the statistics even though deaths occurring more than 30 days after the latest test may, in fact, have been caused by COVID-19. Thus, the 30-day COVID-19 death figure represents a trade-off when used for surveillance purposes. As the figure does not provide the full picture of COVID-19 mortality, it is used in conjunction with other measures.

The evolution of 30-day COVID-19 deaths in Denmark since the onset of the epidemic in early March 2020 is shown in Figure 1, based on the SSI’s COVID-19 dashboard.



Figure 1. Evolution of 30-day COVID-19 deaths in Denmark since the beginning of the epidemic in March 2020. From the SSI's COVID-19 dashboard (updated 16 February 2022).



Officially registered COVID-19 deaths in the Danish Causes of Death Registry

All deaths in Denmark are registered in the Causes of Death Registry, administered by the Danish Health Data Authority (HDA). Deaths are registered on a Cause of Death Certificate based on specific medical assessment of the cause of death. Even so, the figures carry some measure of uncertainty as it may be difficult to accurately identify the primary cause of a death. Frequently, several causes contribute to death, particularly if the deceased person already had one or more underlying diseases which is often the case with rising age. In these cases, COVID-19 will often have played an important part in the death, but the relative importance of COVID-19 and the other diseases may be difficult to assess. Therefore, the notification of the primary and any contributory causes of death is often based, in part, on the physician's judgement.

The completed cause of death certificates are sent to the Danish Health Data Authority (HDA) for validation, after which each death is registered in the Causes of Death Registry. The process typically takes a few weeks, but may in some cases take longer to complete.

The HDA figures describing COVID-19 deaths are in some cases more accurate than the automated register data extractions, but, in contrast, these data are available almost immediately. To ensure near-real-time registration, 30-day COVID-19 death figures have been used since the beginning of the epidemic, thereby providing important information about its evolution.

Increasing share of deaths “with” COVID-19 after the spreading of the Omicron variant

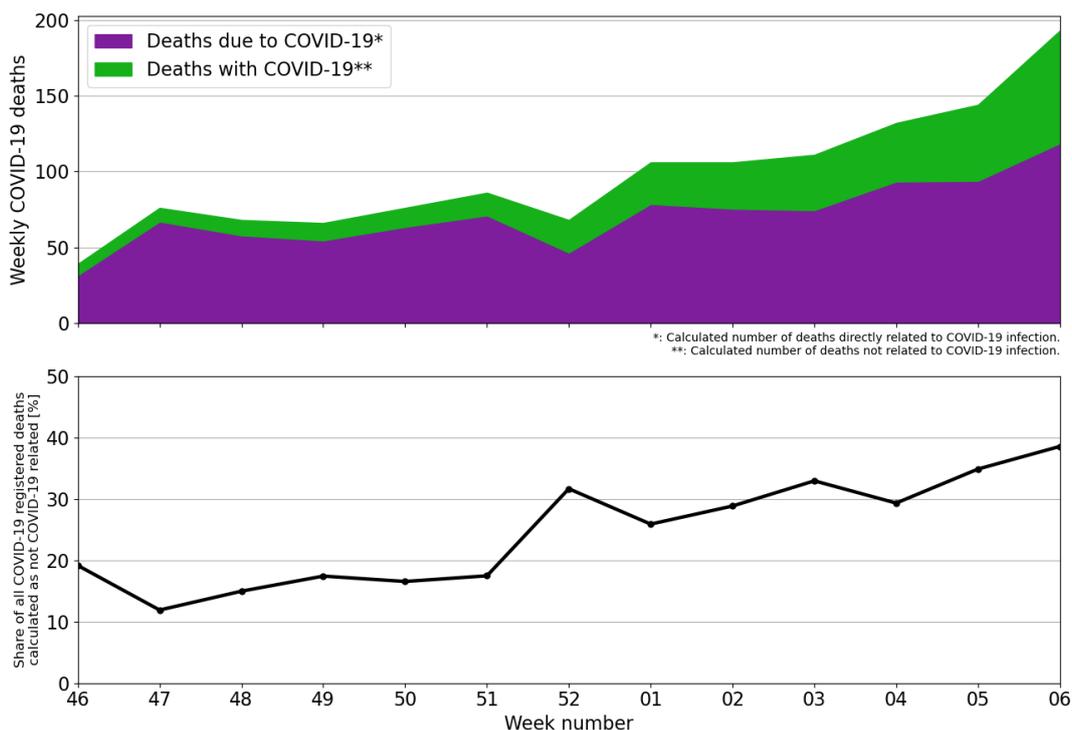


However, the character of COVID-19 infectivity and morbidity have changed during the spread of the new Omicron variant and the advancement of booster vaccination efforts in Denmark as from late 2021. As the population has experienced a rise in cases, many of which are less serious than previously, a rise is also seen in the proportion of deaths that are incorrectly recorded as having occurred “due to” COVID-19 rather than “with” COVID-19. Therefore, the daily figures describing 30-day COVID-19 deaths will become less accurate than previously.

To assess the proportion of persons registered by surveillance who happened to die “with” COVID-19 rather than “due to” COVID-19, the SSI in collaboration with the PandemiX Centre at Roskilde University (RUC) have performed some probability calculations based on the weekly number of deaths and the incidence of COVID-19 community transmission. The analysis presupposes that all individuals in the group have the same probability of testing positive and the same probability of dying during the course of the period - or, as a minimum, that the two figures are independent. Younger (0-39-year-olds), e.g., have approx. 20% probability of testing positive in the period and a very limited probability of death, whereas elderly people (65+ years) only have approx. 2.5% probability of testing positive but a markedly higher risk of death. Therefore, the analysis needs to be conducted separately for each age group. For practical reasons, we selected the age groups 0-19, 20-39, 40-59, 60-69, 70-79 and 80+ years for the analysis. The age-specific 30-day incidence of having a positive COVID-19 test was collected from the SSI’s weekly reports as were the weekly age-specific data on the number of deaths among test-positive persons. The total number of weekly age-specific deaths was collected from the SSI’s contribution to the EuroMOMO mortality monitoring system, and we employ the standard EuroMOMO method to adjust for lag in the registration of deaths. Additional details about the methods used and about our interpretations may be ordered from the SSI and from the PandemiX Centre at Roskilde University.

Calculations show that, by the end of Week 6 in 2022, nearly 40% of all deaths that occurred within 30 days after a COVID-19-positive PCR test were deaths “with” COVID-19 not “due to” COVID-19, Figure 2. Before the spreading of the Omicron variant, this share was only 10%-20%. Thus, the 30-day COVID-19 death figure increasingly overestimates the number of deaths “due to” COVID-19, whereas the true number of COVID-19 deaths is only increasing slightly despite surging COVID-19 case numbers caused by community transmission with the Omicron variant.

Figure 2. Probability calculation of the weekly number of deaths “with” and “due to” COVID-19 (top panel), and the share of deaths not related to COVID-19 (bottom panel), from Week 46 2021 to Week 6 2022. The calculation was made by the PandemiX Centre, RUC and EuroMOMO, SSI.



COVID-19 mortality validated by death certificates

A review of COVID-19 deaths based on death certificates registered in the Danish Causes of Death Registry shows a similar picture of an increasing proportion of deaths “with” COVID-19, not “due to” COVID-19, since the beginning of 2022. The review includes deaths for which the death certificate stated one of the following ICD-10 diagnostic codes as the cause of death: a) COVID-19 infection with no details about localisation; b) COVID-19 severe acute respiratory syndrome; c) Corona virus infection, unspecified; d) Covid-19, Virus identified, and e) COVID-19, Virus not identified.

As shown in Figure 3, the proportion of all 30-day COVID-19 deaths (the red line) assessed to have occurred “with” COVID-19 has followed an increasing trend since early 2022. In contrast, the number of deaths occurring “due to” COVID-19 has remained largely stable. Even so, some uncertainty exists around the past few weeks as a considerable share of death certificates are still lacking.

Before the spread of the Omicron variant, a generally high level of agreement was noted between 30-day COVID-19 deaths and deaths recorded in the Causes of Death Registry, Figure 4. This does no longer apply so well, however, for the period January-February 2022, when Denmark has witnessed another comprehensive wave of COVID-19 infection, particularly among elderly citizens.

Therefore, in the present situation with high transmission levels of the Omicron variant, it is important to also consider the death figures published by the Causes of Death Registry when assessing the burden and severity of the COVID-19 epidemic.

Figure 3. Deaths “due to” and “with” COVID-19 based on death certificates, from Week 51 2021 to Week 6 2022, compared with 30-day COVID-19 deaths (red line). Reports from the Danish Causes of Death Registry (CDR), the Danish Health Data Authority and the SSI.

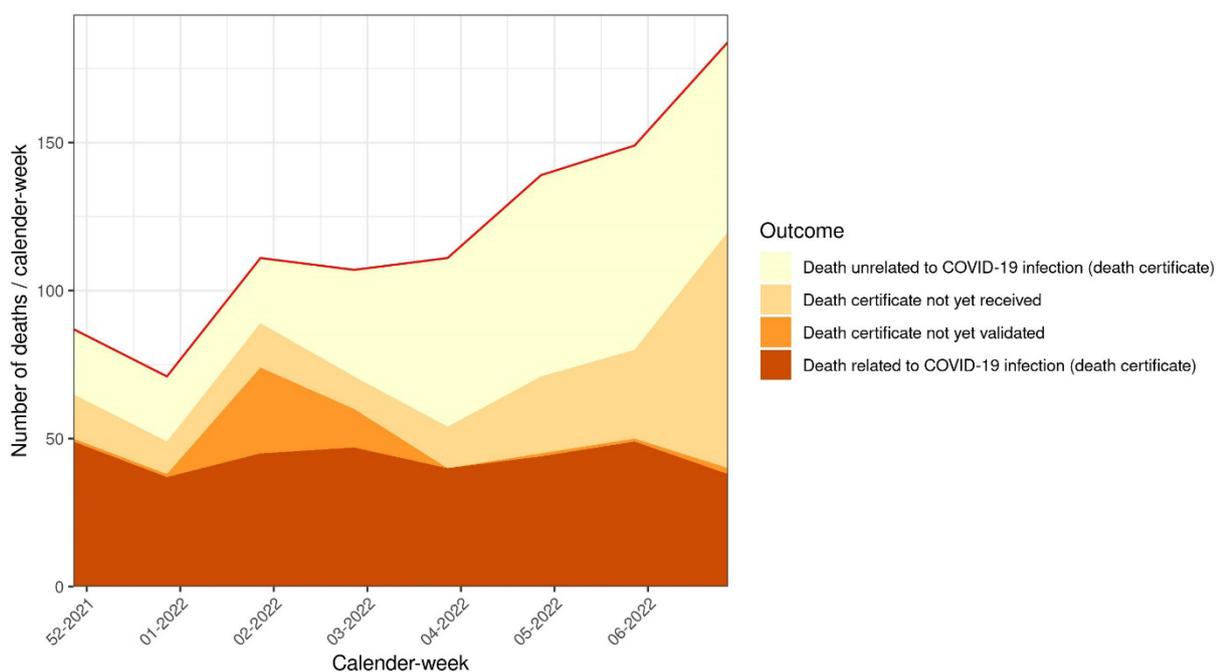
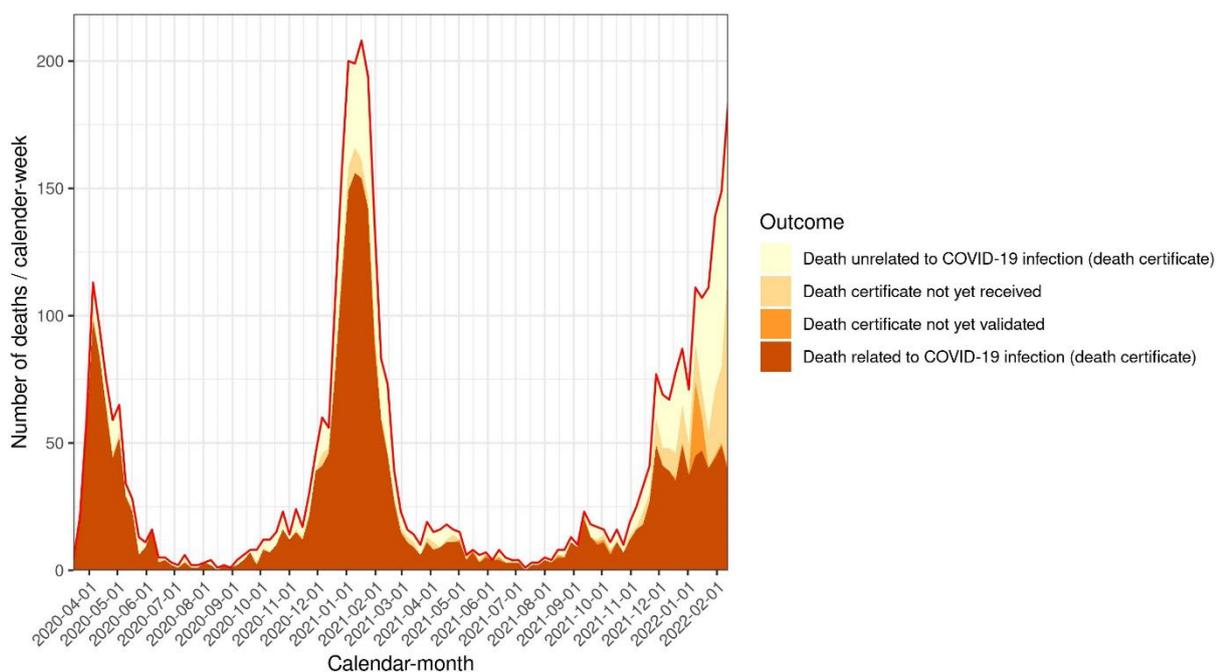


Figure 4. Deaths “due to” and “with” COVID-19 based on death certificates, from March 2020 to February 2022, compared with 30 COVID-19 deaths (red line). Reports from the Danish Causes of Death Registry (CDR), the Danish Health Data Authority and the SSI.



Overall excess mortality is another measure of the severity of the COVID-19 epidemic



An additional and very robust measure used to gauge COVID-19-related mortality is analyses of total excess mortality in the population. This method is independent of testing activity, diagnostic codes, etc. The SSI operates the EuroMOMO mortality monitoring programme, which presents estimates of weekly excess mortality in Denmark and 26 other European countries.

Excess mortality figures show that in the last weeks of 2021, Denmark witnessed excess mortality among elderly people aged 75 years or more. This excess mortality was particularly pronounced from Week 49 2021 to Week 1 2022. From Week 2 2022 and onwards, the excess mortality has followed a declining trend in all age groups and is now approaching normal level, shown in Figure 5 and Figure 6. However, an early preliminary signal of an increasing excess mortality is again seen in Week 6 2022 among elderly aged 85 years and more. These most recent data should however be interpreted cautiously.

For more information about monitoring of mortality in Denmark, please see the SSI's website: <https://www.ssi.dk/sygdomme-beredskab-og-forskning/sygdomsovervaagning/d/overvaagning-af-doedelighed>

You may also read more about monitoring of mortality in Europe at the website of EuroMOMO: <https://www.euromomo.eu/>

Figure 5. Total weekly all-cause mortality in Denmark for all ages, 2021 through early February 2022. From EuroMOMO, SSI.

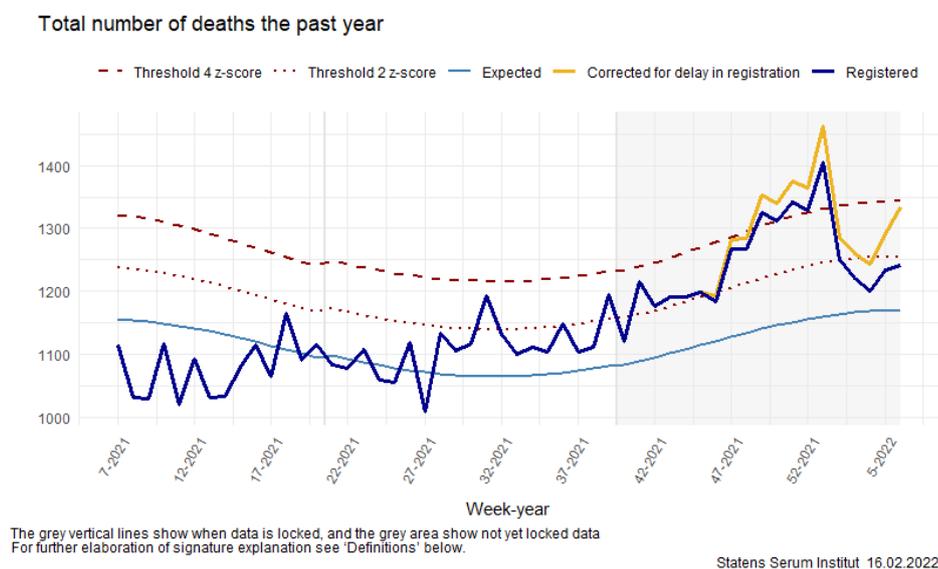
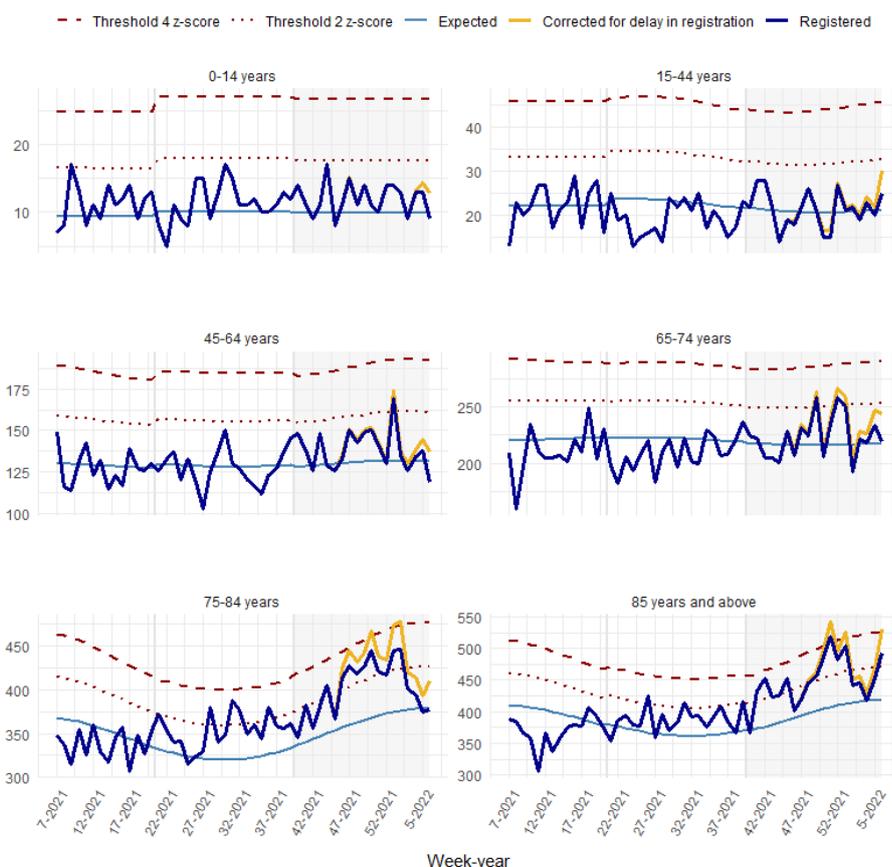


Figure 6. Total weekly all-cause mortality in Denmark by age group, 2021 through early February 2022. From EuroMOMO, SSI.



Total number of deaths the past year, divided into age groups



The grey vertical lines show when data is locked, and the grey area show not yet locked data. For further elaboration of signature explanation see 'Definitions' below.

Statens Serum Institut 16.02.2022

Summary

Assessing population mortality changes will always be associated with some measure of uncertainty. Various surveillance methods are used, each of which has advantages and drawbacks.

Until December 2021, the automated register data extractions of 30-day COVID-19 deaths have provided a fairly accurate picture, which has informed us of the burden and severity of the COVID-19 epidemic on a daily basis.

However, as the character of COVID-19 transmission and morbidity has changed following the spread of the Omicron variant and as vaccine-induced immunity has increased in the population in Denmark since late 2021, it has become increasingly important to also take into account the reports from the Causes of Death Registry as these afford us an opportunity to assess more accurately how many deaths are, in fact, due to COVID-19.

Vaccine immunity is less effective in protecting against COVID-19 infection than in protecting against severe disease and death. Therefore, a considerable increase has been observed in recent months in case numbers, but not in the number of COVID-19 patients admitted to hospital or the number of deaths. The data from the Causes of Death Registry presented here seem to confirm the calculated proportions of deaths "due to" and "with" COVID-19, based on probability calculations provided by the PandemiX Centre at Roskilde University and the SSI.



That the actual COVID-19-related mortality in Denmark in recent weeks - after the shift to the Omicron variant - has not been increasing but rather been declining or at least stabilized is confirmed by excess mortality figures from EuroMOMO, SSI.

The SSI will continue monitoring COVID-19-related mortality in Denmark using the methods described.

Statens Serum Institut, 17 February 2022