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Covid-19 Caused Lifetime Loss Estimation From Excess Mortality Data

Research report

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Abstract

A statistical method was implemented in order to estimate the average remaining period of life for deceased covid-19 patients if they would not have been infected by SARS-Cov-2. The method is based on the dependence between the covid-19 caused average lifetime shortage and the course of excess mortality during and after a severe covid-19 mortality occurrence. Excess mortality curves were calculated for various average life shortenings and compared to excess mortality data from various countries. Regarding to the ordinary natural fluctuations in mortality as well as to the magnitude of real covid-19 occurrences, this method is currently limited to an average lifetime shortage up to about 1 year, for countries where the covid-19 mortality maximum is comparable with the ordinary mortality, or shorter at lower relative covid-19 mortality maxima. The results are indicating that the average lifetime shortage for covid-19 fatal cases is at least about 1 year, likely more.

1 Introduction

Regarding to covid-19 fatal cases, whose majority already had suffered from serious preliminary diseases, there is a discussion if in most of these cases not covid-19 but the preliminary disease might have been the reason for these deaths. This theory is rather common among coronavirus sceptics, at least in Germany, where it has become common in tv and other media to use expressions like "died associated with covid-19" or similar, instead of "died from covid-19". In contrast to the imagination that covid-19 might usually not be the main cause of death, various forensic medical experts, who have made autopsies of people who had died associated with covid-19, evaluated the great majority of covid-19 fatalities as having died from covid-19 [aezei-2020, burkhardt-2020, fett-2020, lung-2020, bdp-2020, schwennicke-2020, hohmann-2020, mueller-2020, sbhh-2020]. A few statements affecting the potential survival periods if not having died from covid-19 are ranging between 8 months or less and up to 10 years on the average [focus-2020, schwennicke-2020].

In order to achieve additional evidence about the potential lifetime decrease caused by fatal covid-19 diseases, the influence of the potential lifetime decrease on the shape of the excess mortality curve was calculated by a model, and the results were compared to excess mortality courses of various countries.

2 Results from Covid-19 fatal cases autopsies

At the beginning of the covid-19 pandemy, in Germany only a small fraction of the covid-19 fatal cases were autopsied, except of the covid-19 fatal cases in Hamburg, where the autopsy rate was about 100 %. After a substantial number of such autopsies, the leading forensic medical expert in Hamburg, Klaus Pueschel, had claimed, that all of the examined cases had suffered from serious diseases and would have died within the same year [schwennicke-2020, focus-2020], with an average potential survival time of 8 months or lower [schwennicke-2020], and that a substantial number of covid-19 fatal cases had died by other diseases they had suffered from [mueller-2020]. These and similar statements had soon been instrumentalized by various opponents of the anti-covid-19 measures in order to downplay the seriousness of the covid-19 pandemy.

Meanwhile more and more other forensic medical experts autopsied covid-19 fatal cases. The results of these autopsies are giving evidence that in the great majority of the covid-19 fatal cases the covid-19 disease clearly had been the root cause of death. The fraction of covid-19 related fatal cases (in Germany, if nothing else is denoted) where covid-19 had been the primary cause of death is stated as:

- 61 of 65 cases (=94 %) [aezei-2020]
- 85...90 % [burkhardt-2020]
- 82 % of 154 cases [fett-2020, lung-2020]
- 86 % of 154 cases [bdp-2020, schwennicke-2020]
- >3/4 of 154 cases died directly from covid-19, 8 % died from something else [hohmann-2020]
- 8 of 14 cases [mueller-2020]
- 332 of 384 cases (= 86 %) in Austria [mueller-2020]
- 382 of 423 (= 90 %) in Hamburg [sbhh-2020]

3 Modelling the shapes of excess mortality curves

3.1 Model description

Every day there is a certain number N_0 of people who die for various reasons. In the great majority, the reason is an enhanced morbidity, caused by an acute or chronic disease, or, off course, the natural decay of old age. As a basic guideline, it is assumed that at every day there is a certain number $N_{0,vuln}$ of especially vulnerable people, forming a group whose members would die at the same day if suffering from covid-19, or will survive for a certain, but unknown average potential survival period $t_{av,srv}$, if not infected with SARS-Cov-2. The number of people of one of the said groups N_{srv}, which have survived for a certain time t_{srv}, will follow a certain distribution, which shape is unknown and which therefore is assumed to be a simple exponential decay function, which, for now, is supposed to be a passable approach to the actual conditions:

$$N_{srv}(t) = N_{0,vuln} * \exp(-k_1 * t) \qquad (3.1)$$

k_1 : determining factor for the resulting average potential survival period $t_{av,srv}$.
t : time

To calculate the daily number of deaths during a certain interval, for every day of this interval the numbers of deaths for this day and the following days is calculated using the differentials of equation (3.1), and all deaths which are calculated for a given day of this interval, and, if present, the corresponding covid-19 deaths, are summarized to the total number of deaths at this day.

As long as there are no covid-19 fatalities, the resulting daily mortality rate will be N_0, if $N_{0,vuln}$ is set to be equal to N_0. For a day where there are N_{cfc} covid-19 caused fatal cases, the $N_{0,vuln}$ value is set to be the difference between N_0 and N_{cfc}:

$$N_{0,vuln}(t) = N_0 - N_{cfc}(t) \qquad (3.2)$$

At any constant $N_{cfc}(t)$ over a long period, there would be an approach to a condition where the covid-19 and non-covid-19 mortality will fully compensate each other and the resulting death rate will approach N_0. To obtain informations about the average potential survival period $t_{av,srv}$ an outbreak of covid-19 death numbers, arising from and returning to a comparably low covid-19 death number and represented as a peak in the $N_{cfc}(t)$ diagram, will be a suitable occurance. Such an occurrence is more or less present in most of the covid-19 fatal case number courses of the different countries in spring 2020, when in almost every country the covid-19 case numbers increased exponentially and, by countermeasures, were rapidly pushed down again to comparably low levels in many of these countries.

Supposed that the average potential survival period $t_{av,srv}$ is zero, which would mean that all people who died from covid-19 would have been died at the same day anyway, the number of covid-19 deaths naturally will remain constant at N_0. For all $t_{av,srv}$ greater than 0, during the covid-19 outbreak a part of the future mortality will be shifted to earlier dates, which will result in a certain amount of excess mortality followed by an analogous shortfall mortality. With increasing $t_{av,srv}$ the excess mortality curve will more and more approach the covid-19 mortality curve, whereas the following shortfall mortality curve will become more pronounced first and then become longer and flatter. The shape of the mortality curve, in comparison to the covid-19 mortality curve, will be characteristic for a given $t_{av,srv}$, which makes it possible to estimate $t_{av,srv}$, provided that an appropriate covid-19 mortality course is existing for the given country.

Because actual courses of mortality are shaped by various fluctuations, which can cover a less pronounced excess or shortfall mortality, a perceptible covid-19 induced excess mortality characteristic can only be achieved after a very significant covid-19 outbreak. To supply the model with such outbreak data, it could be simulated by an appropriate mathematical function, e.g. a parametered positive part of a sinus function. As an alternative, available numbers of an existing covid-19 outbreak can be used, which has been chosen, to obtain an input closer to reality.

The model calculations were performed with the covid-19 fatal case numbers from Belgium in 2020, because of the large proportion between covid-19 deaths and non-covid deaths, which is an important precondition to get a pronounced shortfall mortality course which can be identified even at long average potential survival periods. The daily fatality number of Belgium is alternating in a yearly period, similar to the mortality course in many other countries, which is less important for the modelling results and was therefore neglected. Instead, a constant normal mortality of 300/day was set as the model baseline, which roughly corresponds to the actual average death numbers in Belgium (see fig. 3-1) and makes it easier to identify the results displayed in the diagrams.

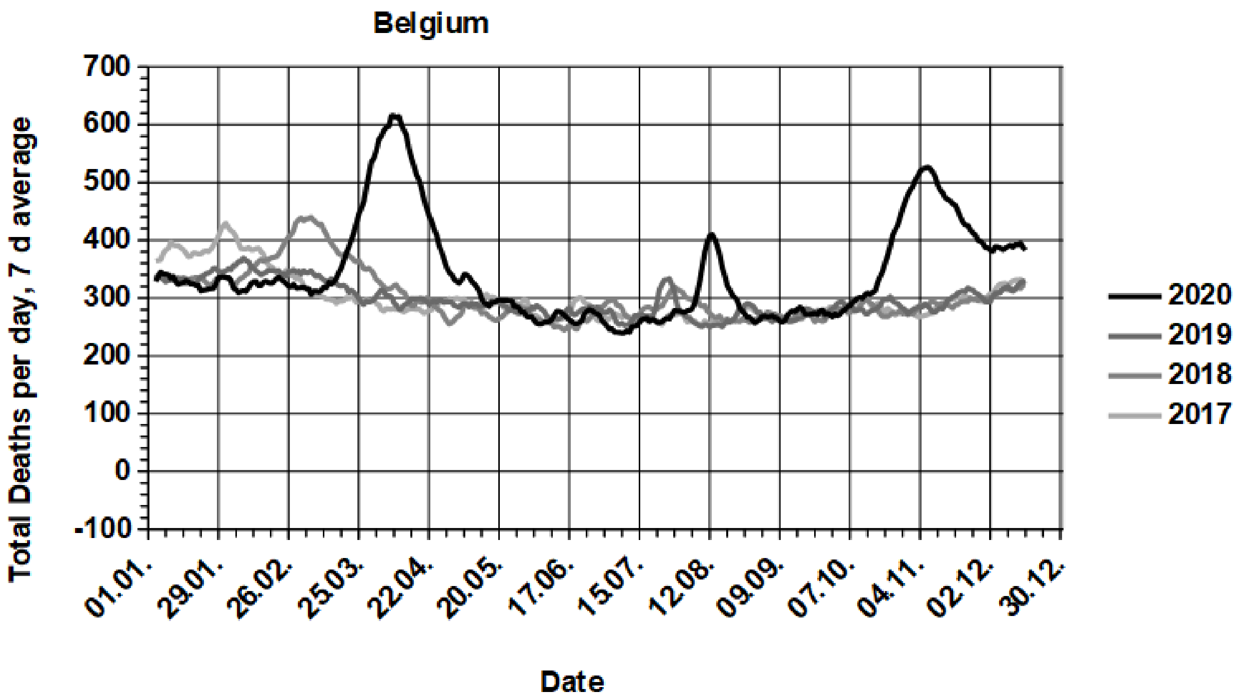

Fig. 3-1: Mortality in Belgium during the years 2017 to 2020, as 7-day floating average values (from 3 days before to 3 days after the corresponding date), to reduce short-period fluctuations (basic data from [github-2021-mt])

During the first months of the years displayed, a more or less pronounced excess mortality can be identified, probably caused by seasonal flu outbreaks of different intensity. During the summer months, smaller peaks indicate an increased mortality, probably induced by high ambious temperatures, which is rather common and is present also for 2020, with an extraordinary intensity, but not caused by covid-19 mortality, which had been much lower at that time. The large peaks in March/April and November 2020, however, appeared simultaneously with serious covid-19 outbreaks.

3.2 Modelled excess mortalities for various average potential survival periods

Based on a "normal" mortality of constant 300/day and covid-19 mortality data of Belgium [github-2021-cv], excess mortality curves were calculated for average potential survival periods of 2, 5, 10, 20, 50, 100, 200 and 400 days for the covid-19 fatal cases. The shapes of the corresponding modelled excess mortality curves are shown in Fig. 3-2 to 3-9. Caused by mathematical and capacity reasons, the present model version is limited to an average potential survival period ranging from 2 days to 400 days, and therefore can not be tested at the 0 days value. Anyhow, the obtained shapes of the modelled excess mortality are in full compliance with the shapes theoretically expected.

In said diagrams, the red line indicates the number of covid-19 fatal cases, which have been extracted from [github-2021-cv] and transformed to 7-day floating averages, whereas the blue line represents the number of non-covid deaths, denoted as "other deaths". The sum of covid-19 caused deaths and non-covid deaths, denoted as "all deaths" and represented by the black line, indicates the modelled total number of deaths, and its deviation from the 300/day baseline is roughly representing the excess mortality course to be expected for actual potential survival periods which correspond to the referring model parameter.

It shall be considered that the second covid-19 outbreak has not yet ended. It shall be remarked, too, that around day 175 there is a negligible but prominent irregularity in the course of the covid-19 death curve, which is originated from a short series of negative fatal case numbers, which supposedly have been reported in order to perform a retrospective data correction.

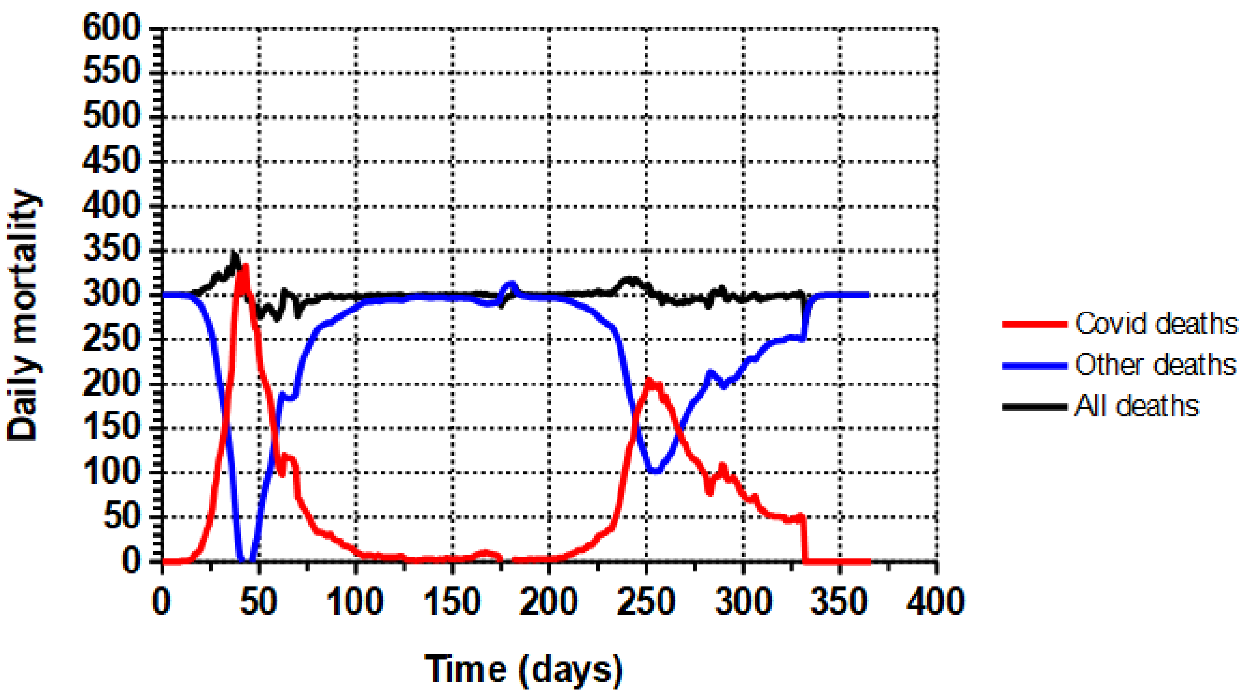

Fig. 3-2: Covid-19 excess mortality in Belgium, calculated for an average potential survival period for the covid-19 fatal cases of 2 days

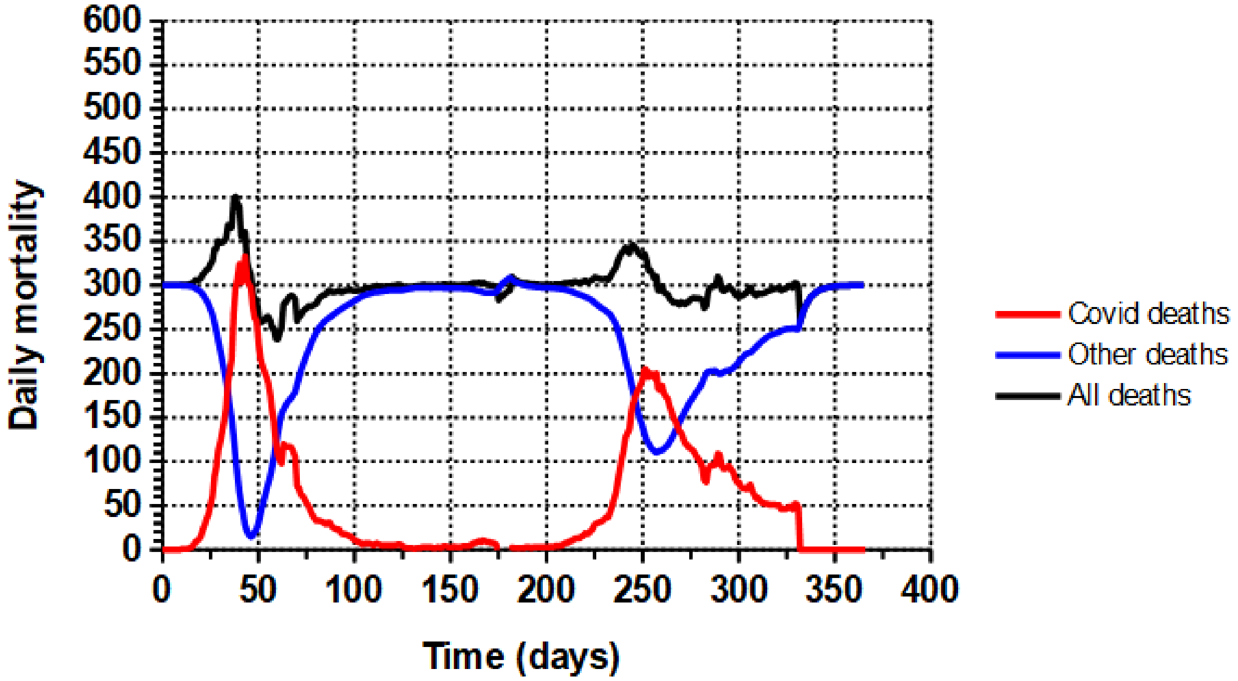

Fig. 3-3: Covid-19 excess mortality in Belgium, calculated for an average potential survival period for the covid-19 fatal cases of 5 days

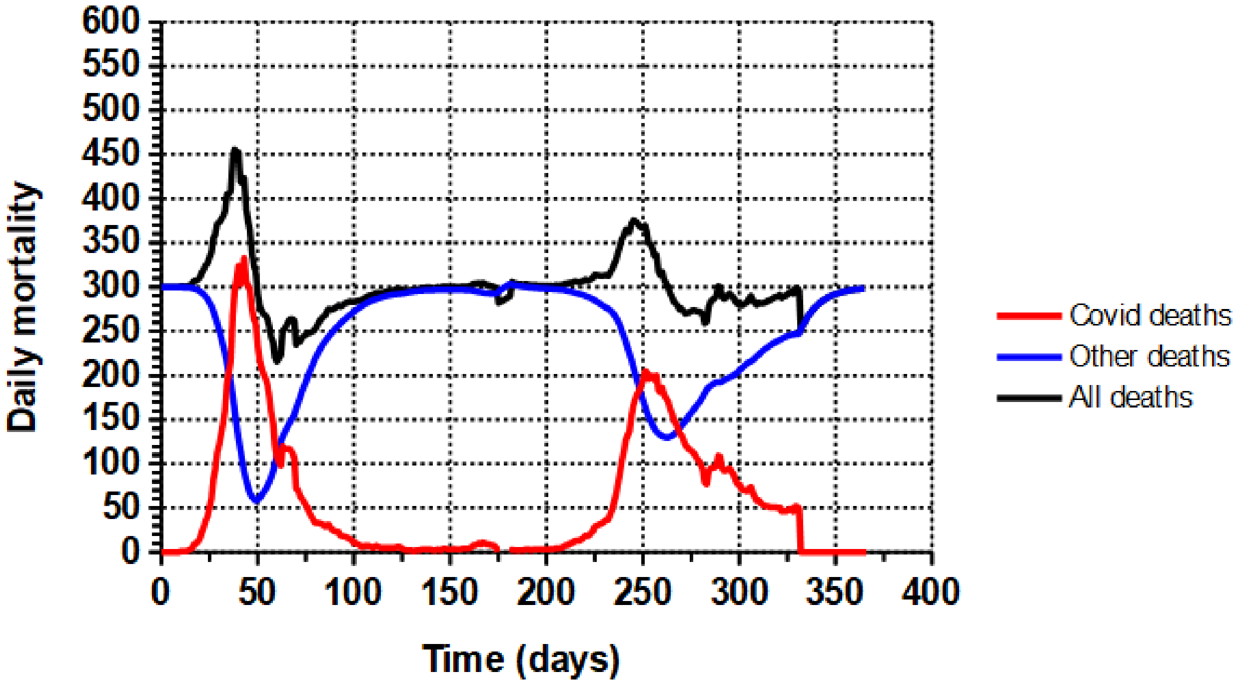

Fig. 3-4: Covid-19 excess mortality in Belgium, calculated for an average potential survival period for the covid-19 fatal cases of 10 days

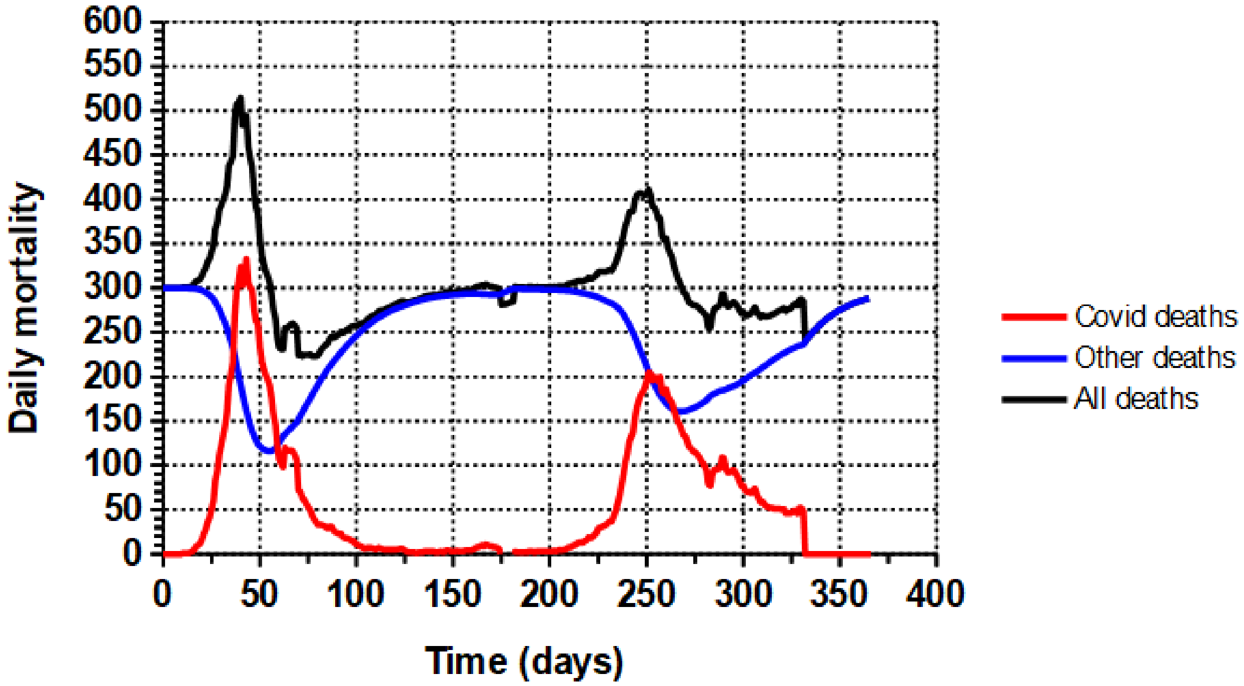

Fig. 3-5: Covid-19 excess mortality in Belgium, calculated for an average potential survival period for the covid-19 fatal cases of 20 days

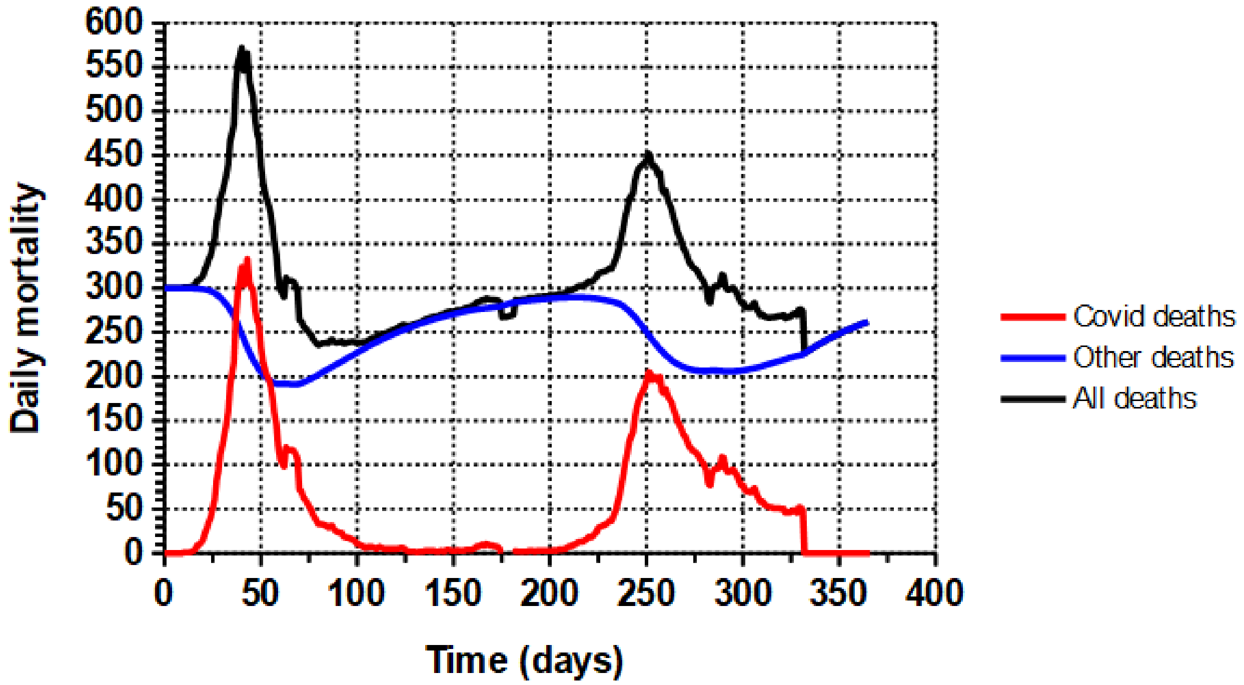

Fig. 3-6: Covid-19 excess mortality in Belgium, calculated for an average potential survival period for the covid-19 fatal cases of 50 days

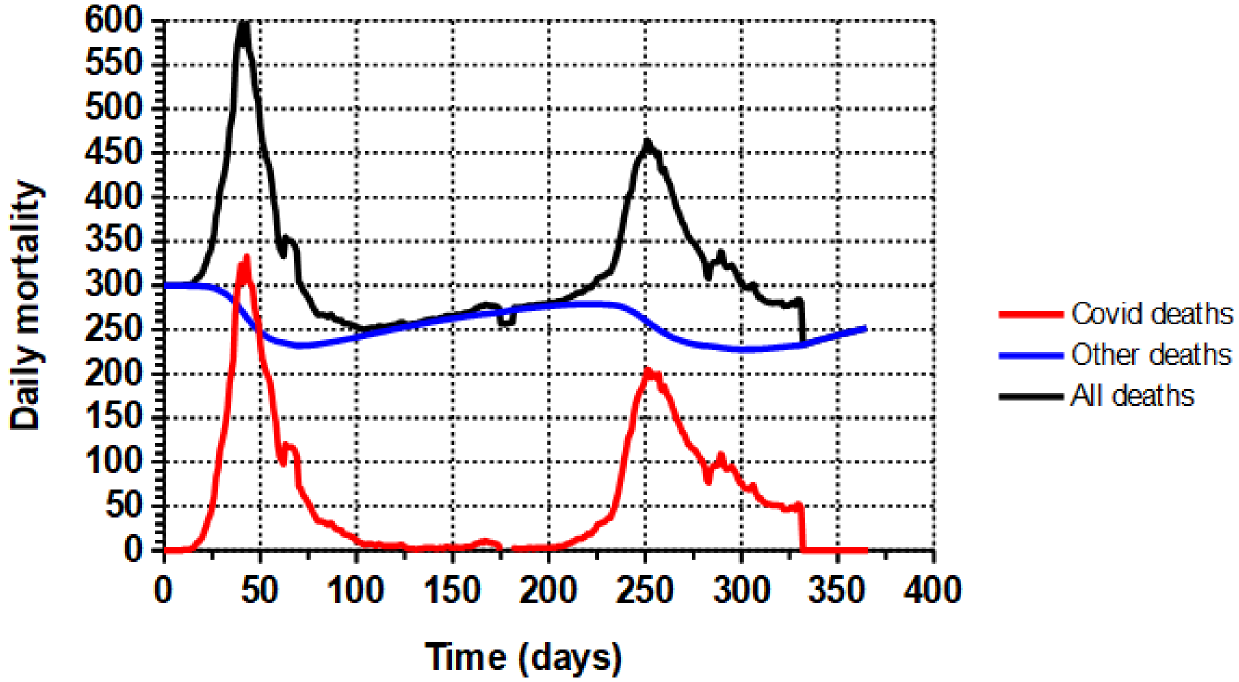

Fig. 3-7: Covid-19 excess mortality in Belgium, calculated for an average potential survival period for the covid-19 fatal cases of 100 days

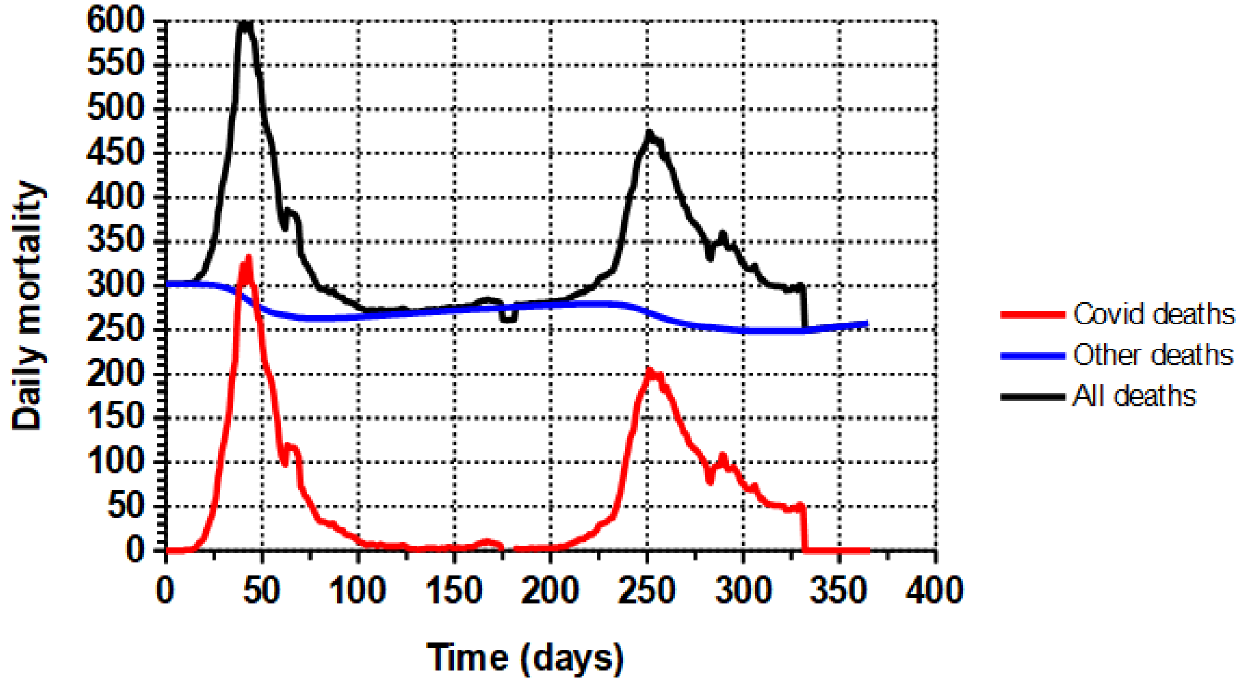

Fig. 3-8: Covid-19 excess mortality in Belgium, calculated for an average potential survival period for the covid-19 fatal cases of 200 days

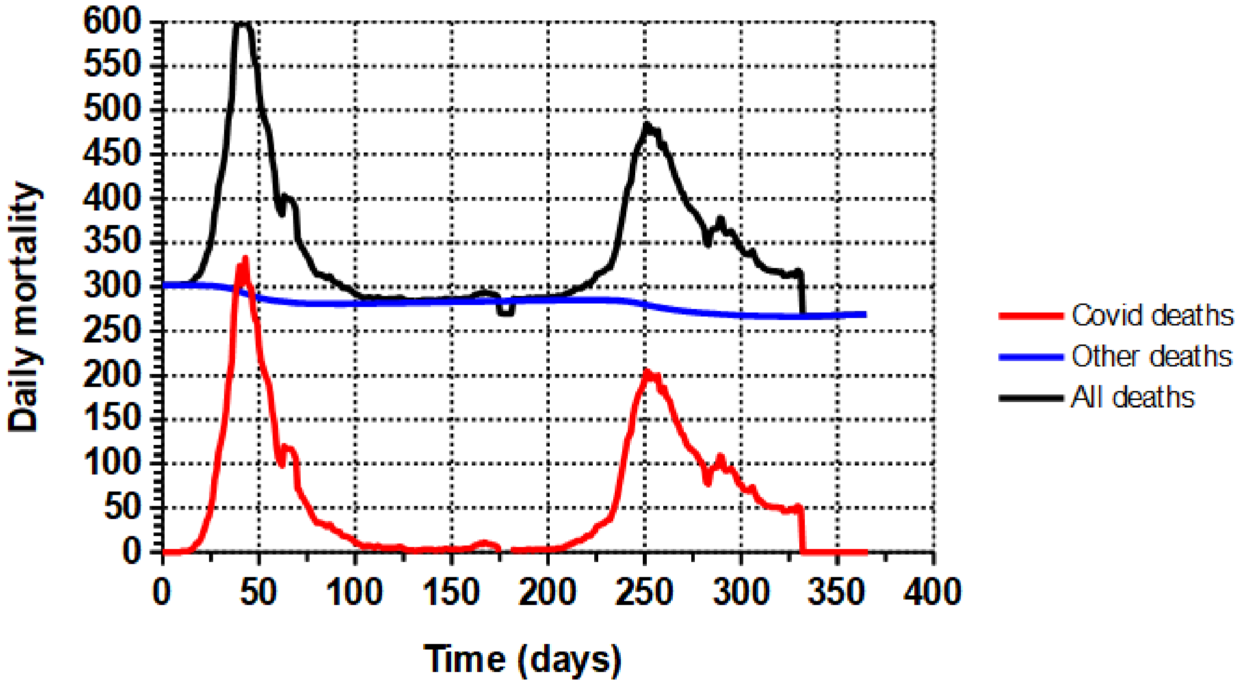

Fig. 3-9: Covid-19 excess mortality in Belgium, calculated for an average potential survival period for the covid-19 fatal cases of 400 days

As expected, the excess mortality effects are little pregnant at very short average potential survival periods. With increasing duration of the average potential survival period, the calculated excess mortality curve approaches the covid-19 fatal case curve, whereas the shortfall mortality course, which appears subsequently, changes from short, pronounced shortfalls to longer and less pronounced ones.

Looking on Fig. 3-1, it can be estimated that during summer the actual mortality numbers in Belgium usually are fluctuating by about 25 around the average. Regarding also the subsequent shortfalls in Fig. 3-8 and 3-9, it can be concluded that the highest average potential survival period which would cause a subsequent shortfall which can surely be distinguished from fluctuations and yearly alternations will be somewhere between 200 days and 400 days. Therefore, upgrading the model calculation table to higher values would be of theoretical interest only, but without practical use.

4 Excess mortality in different countries

For a series of countries, mortality data could be investigated. For a part of these countries, the available data are convenient for constructing appropriate excess mortality curves, like that shown in Fig. 3-1. So far, such convenient data was found for Belgium, Sweden, Switzerland, Germany, Denmark, Netherlands, United Kingdom and Portugal [github-2021-mt].

Figures 4-1 to 4-8 are showing the mortality courses of 2020 and some of the past years (black and grey lines), as well as the excess mortality (blue line), which represents the difference between the mortality in 2020 and the average mortality of the years before. This excess mortality (and shortfall mortality, too, if noticeable) can directly be compared with the reported covid-19 mortality [github-2021-cv] (red line).

The underlying total mortality values from [github-2021-mt] were processed from the basic data, which were available in steps of either 1 day or 1 week. In case of daily values, the floating average values over 7 days (from 3 days before to 3 days after) are displayed instead of the original values. In case of weekly values, the original values are displayed. The covid-19 mortality data from [github-2021-cv] are all available in daily steps and are displayed as 7-day floating averages.

The meaning of the legend items of the diagrams is:

- ExMort2020: Excess mortality in 2020
- CovMort2020: Covid-19 mortality in 2020
- 2020 ... 2015: Total mortality in the years 2020 and previous

In Belgium, Sweden and Switzerland (fig. 4-1 to 4-3) the course of the excess mortality strongly corresponds to the covid-19 mortality, except of the relative mortality shortfall before the first outbreak, which is obviously caused by substantial flue mortalities in previous years, and a pronounced mortality peak in summer in Belgium, which might have been caused by a heat period. After the decline of the first outbreak, a shortfall mortality can not be identified with certainty, because it is too moderate to be clearly distinguished from the random fluctuations.

All the above said seems to be valid for Germany and Denmark (fig. 4-4 to 4-5), too. However, the excess mortality in these countries is comparably low, and therefore a valid conclusion from a subsequent shortfall mortality is not possible for longer average potential survival periods than about 10 days.

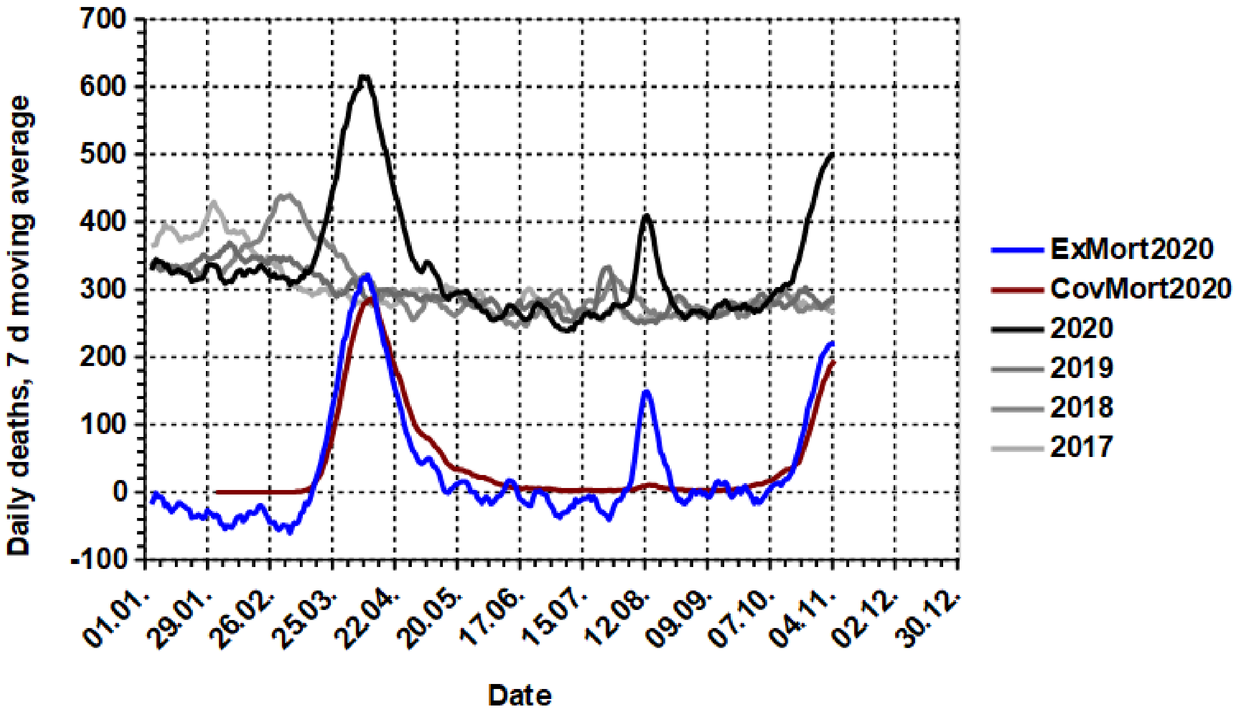

Fig. 4-1: Mortality and excess mortality data of Belgium, compared to covid-19 mortality during 2020

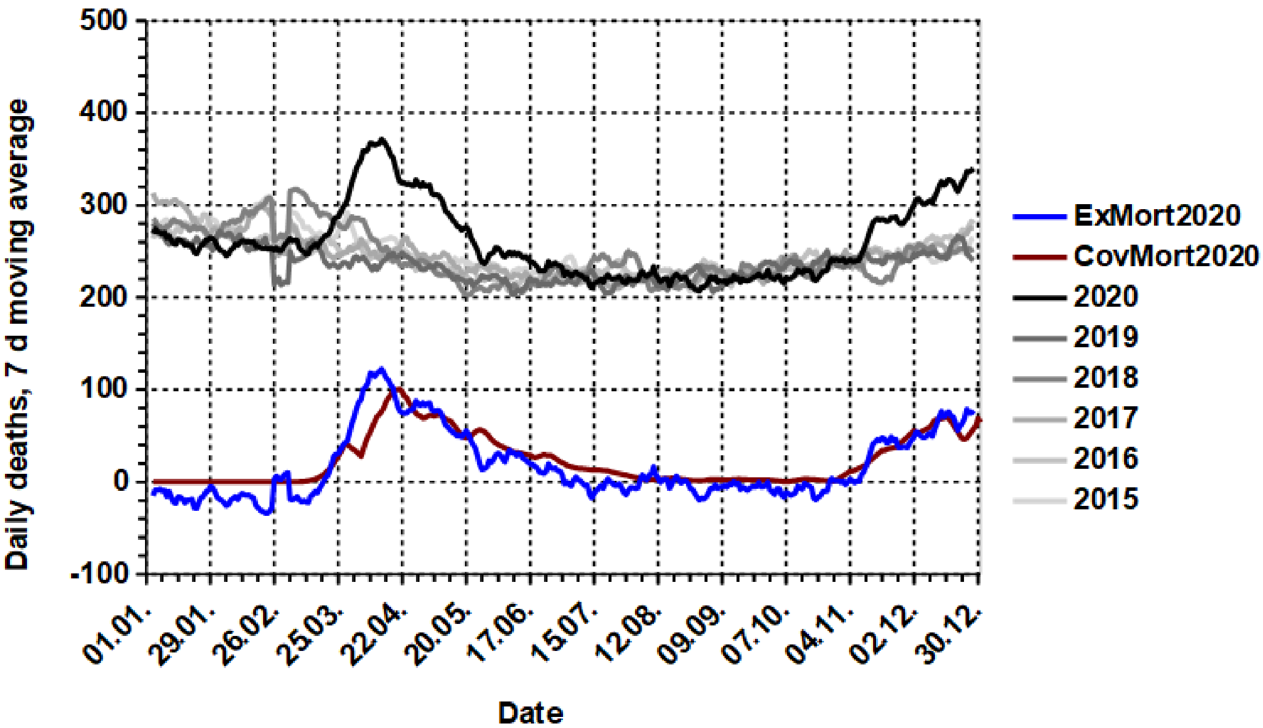

Fig. 4-2: Mortality and excess mortality data of Sweden, compared to covid-19 mortality during 2020

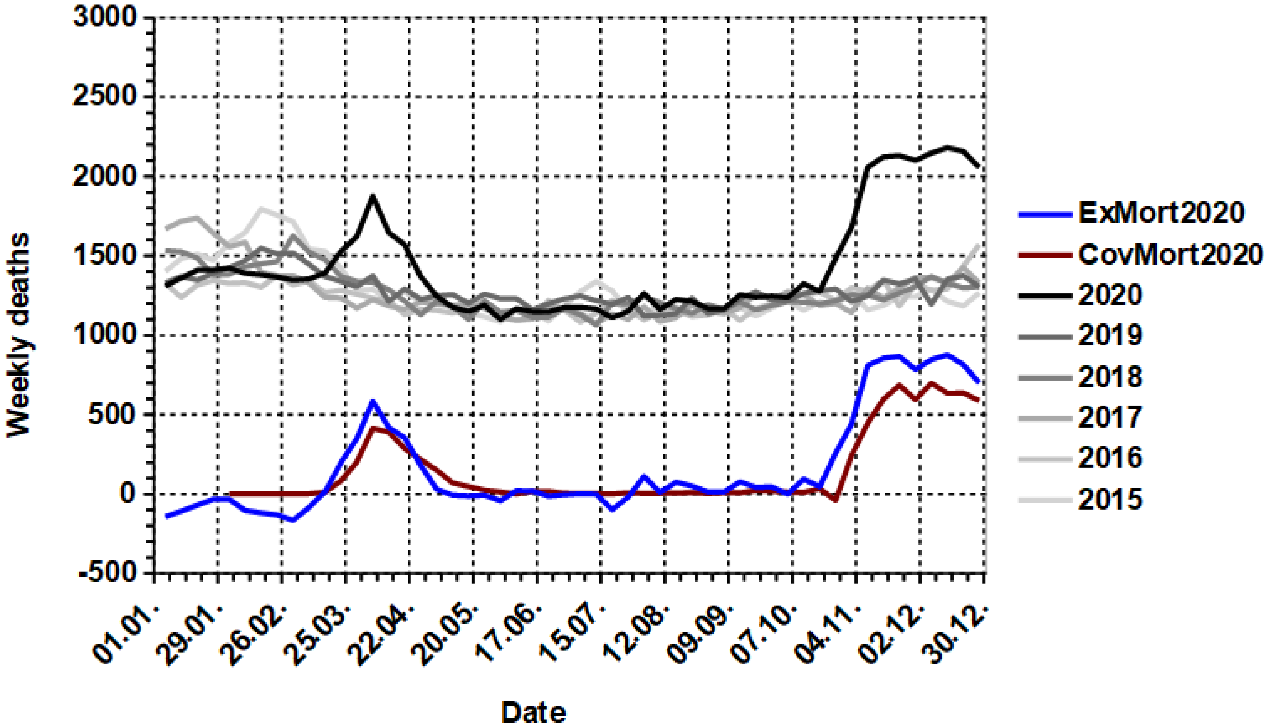

Fig. 4-3: Mortality and excess mortality data of Switzerland, compared to covid-19 mortality during 2020

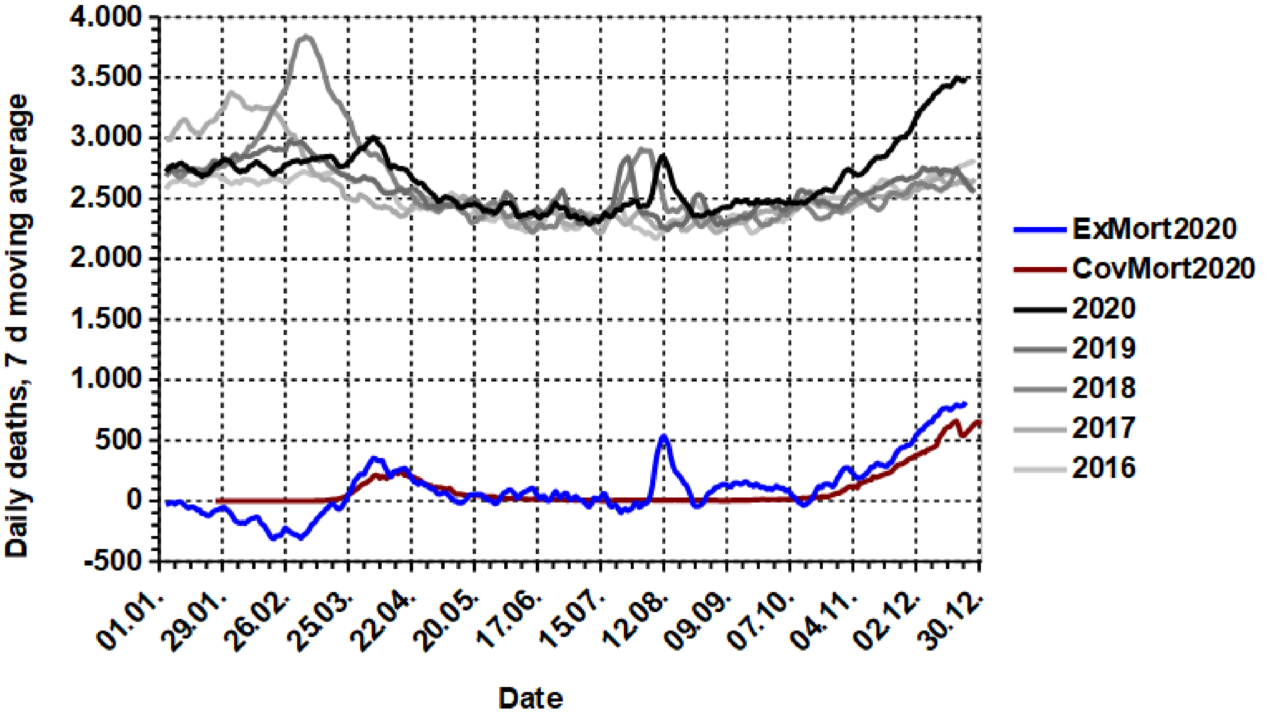

Fig. 4-4: Mortality and excess mortality data of Germany, compared to covid-19 mortality during 2020

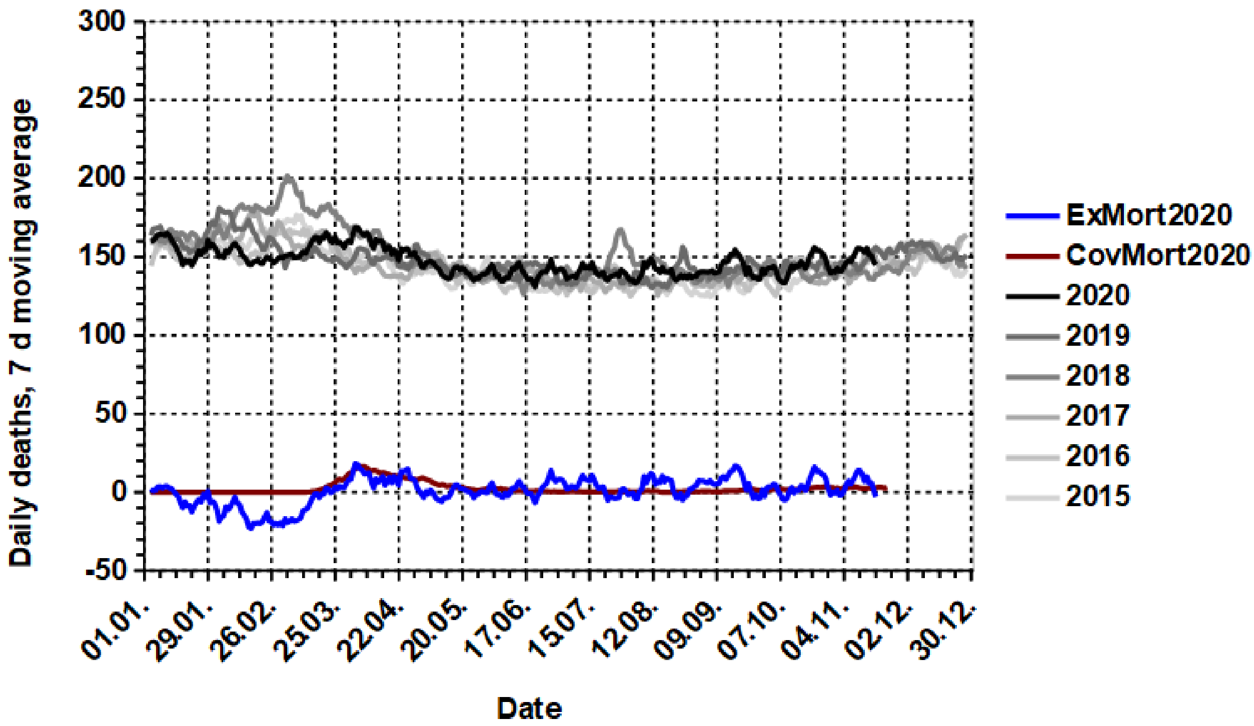

Fig. 4-5: Mortality and excess mortality data of Denmark, compared to covid-19 mortality during 2020

For both the Netherlands and the United Kingdom (fig. 4-6 to 4-7), the excess mortality at the first covid-19 outbreak is much higher than the confirmed covid-19 mortality. This might have been caused by a serious fraction of covid-19 induced deaths which have not been confirmed as such, or by an increase of non-covid-19 deaths induced by an overburdened healthcare system which could have leaded to a lack of medical effectivity and performance.

For both countries no shortfall mortality after the first covid-19 outbreak can be observed.

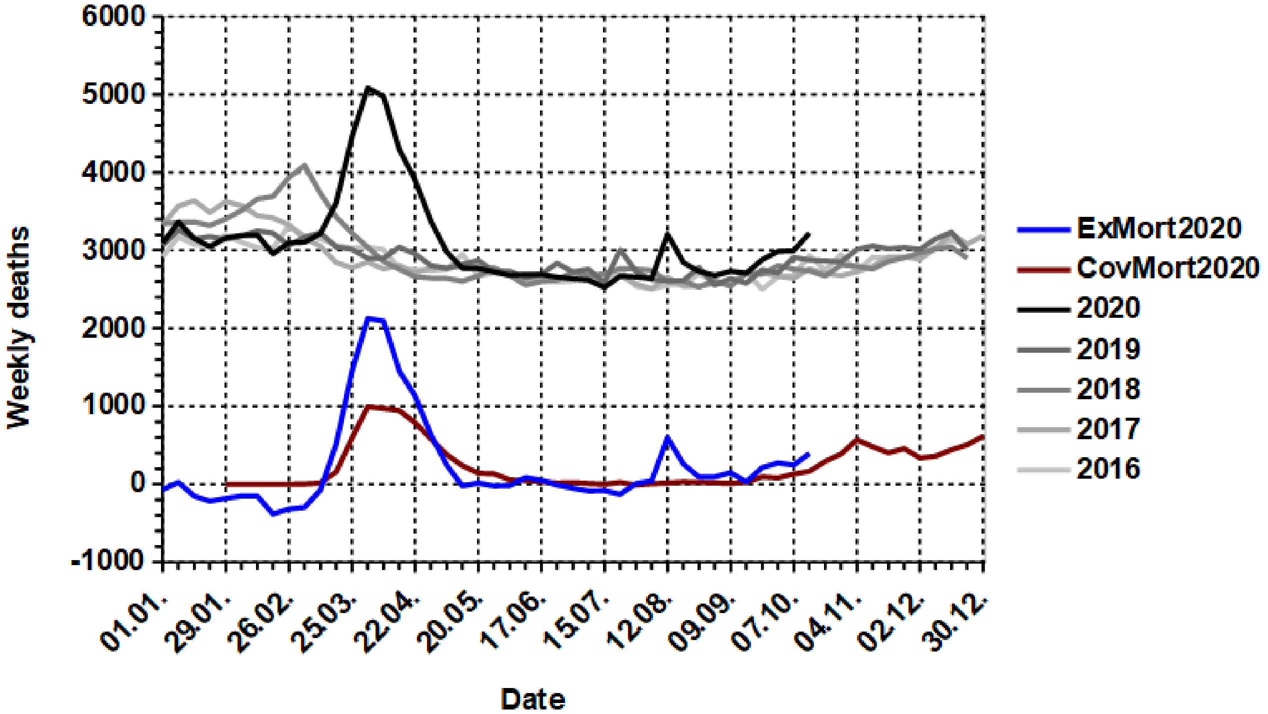

Fig. 4-6: Mortality and excess mortality data of the Netherlands, compared to covid-19 mortality during 2020

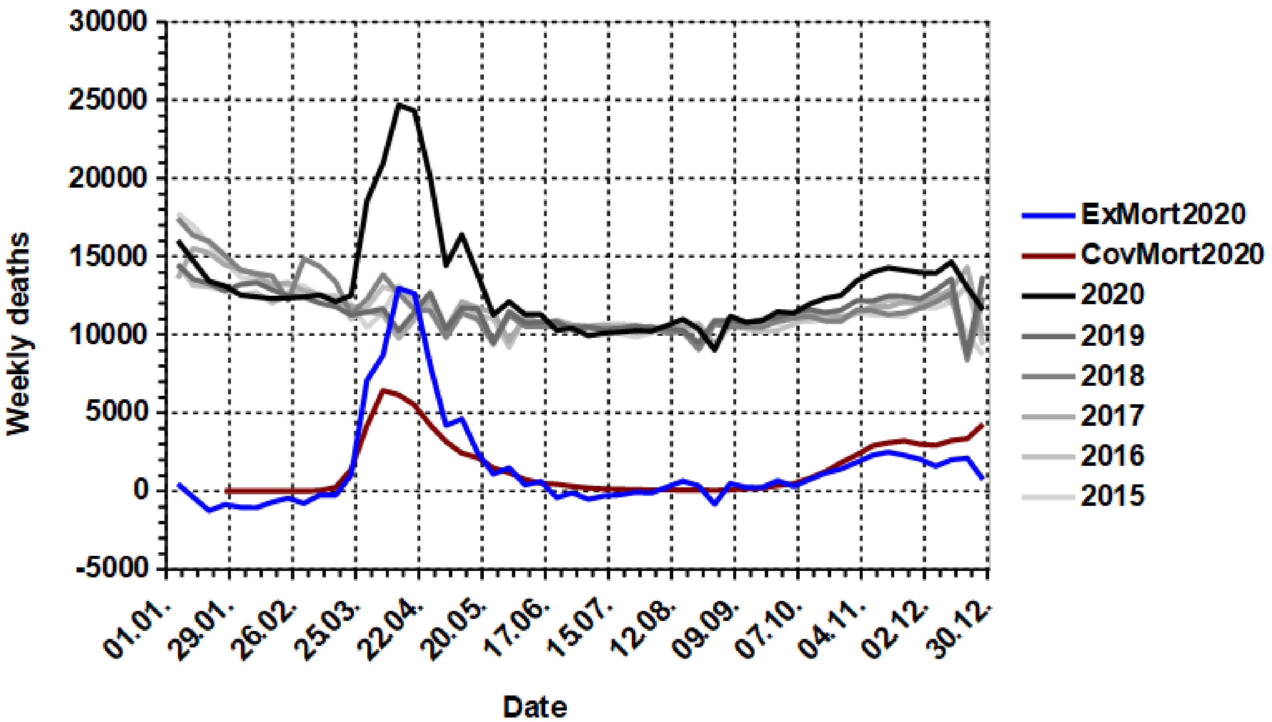

Fig. 4-7: Mortality and excess mortality data of the United Kingdom, compared to covid-19 mortality during 2020

The mortality courses of Portugal (fig. 4-8) are characterized by a series of more or less pronounced excess mortality peaks during summer, whereas the covid-19 mortality seems to be moderate during the displayed interval.

Also for Portugal, no shortfall mortality after the first covid-19 outbreak can be observed.

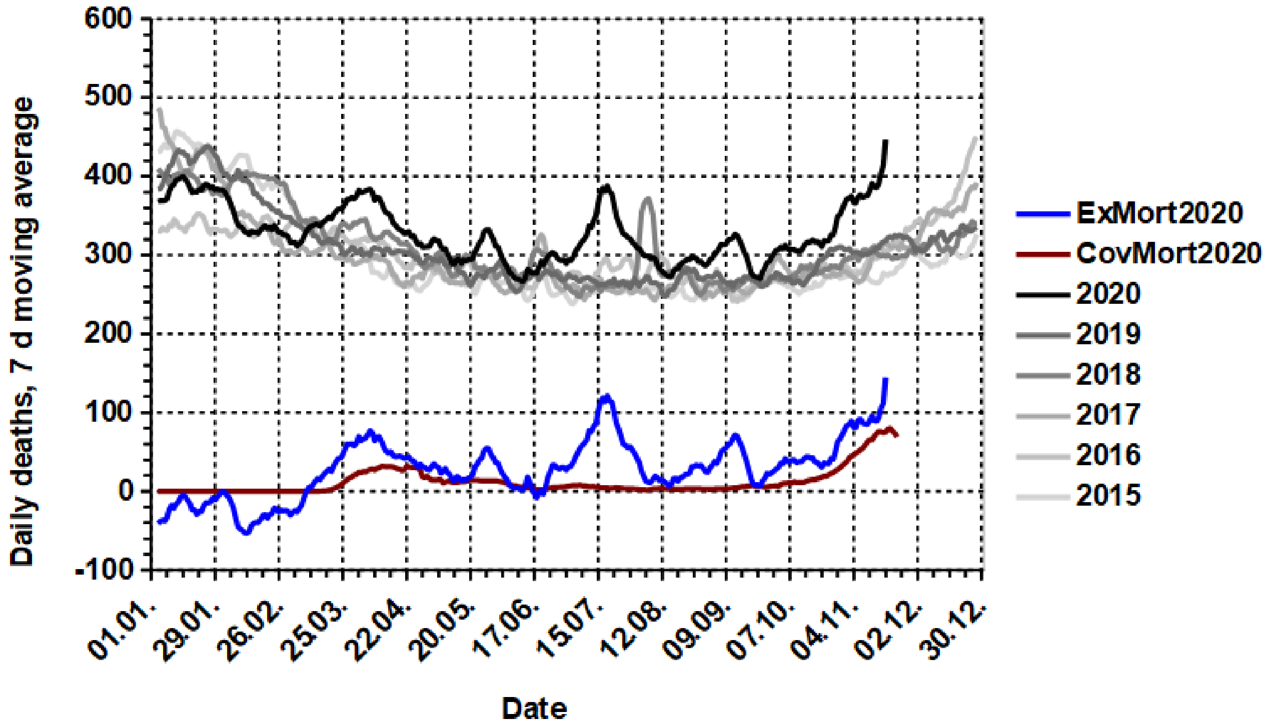

Fig. 4-8: Mortality and excess mortality data of Portugal, compared to covid-19 mortality during 2020

5 Conclusions

The excess mortality courses, in relation to the corresponding covid-19 mortality courses, compared to the results of the modelled scenarios, clearly indicate that the people who have died in correlation to a covid-19 disease would have survived for a substantial average period of about one year or longer, if not having been infected with SARS-Cov-2. This result is verifying the results of various autopsies, that in most of the fatal cases covid-19 had been the primary cause of death.

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