Letters to the Editor

Years of Life Lost to Death

A Comprehensive Analysis of Mortality in Germany Conducted as Part of the BURDEN 2020 Project

by Dr. rer. pol. Annelene Wengler, Dr. rer. med. Alexander Rommel, Dr. PH Dietrich Plaß, Heike Gruhl, Janko Leddin, Dr. med. Thomas Ziese, and Dr. rer. pol. Elena von der Lippe

and

The COVID-19 Disease Burden in Germany in 2020

Years of Life Lost to Death and Disease Over the Course of the Pandemic

by Dr. rer. med. Alexander Rommel, Dr. rer. pol. Elena von der Lippe, Dr. PH Dietrich Plaß, Dr. med. Thomas Ziese, Michaela Diercke M.Sc., Dr. rer. nat. Matthias an der Heiden, Dr. med. Sebastian Haller, and Dr. rer. pol. Annelene Wengler

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Counterintuitive Results

The authors report that 11.6 million years of life were lost to death in Germany in 2017 (1). This is somewhat surprising. One would spontaneously assume that an infinite number of years of life are lost due to the sum of all deaths. The methodological background is that the authors correlate every death with the number of years of life that a person of a corresponding age can still expect under favorable conditions. The favorable-condition residual life expectancies are determined as a best-of from age-specific mortality rates in the individual federal states of Germany. Since there is no mortality without death, this is to a degree a case of the dog chasing its tail.

What applies to death from any cause also applies, to a lesser extent, to years of life lost (YLL) as a result of certain causes of death: contrary to what one might assume, the reported 1 710 791 YLL due to ischemic heart disease do not represent the life-years that would be gained if coronary heart disease (CHD) would be eliminated as a cause of death. In a logically consistent manner, residual life expectancies would have to be used from a life table that has been adjusted for CHD as a possible cause of death. The corresponding life tables are known as “cause-elimination life tables” (2).

If one gradually eliminates all causes of death, the residual life expectancy becomes infinitely large according to intuition. As compared to the method adapted by Wengler et al. (1) in the

Global Burden of Disease Study, the procedure is more robust, since the dependency of the residual life expectancy on the (more or less arbitrary) choice of the subregions considered for the best-of determination (districts, spatial planning regions, federal states?) is no longer applicable.

Regardless of the preferred method, one aspect should not be left unmentioned: quantitative statements on the potential for prevention implicitly use a problematic assumption, namely independence for causes of death. In fact, a potentially life-shortening disease rarely comes alone.

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Mortality, Burden of Disease, Life Expectancy, and Methodology

To the important work by Rommel et al. (1), I would like to add a methodological aspect and place the results in a broader context. The loss of life span determined using the YLL formula in the article (1) is only valid if the number of attributable premature deaths is measured (2). However, this number must not be less than the number of attributable excess deaths (2): “in times of especially increased mortality [. . .], the excess mortality exceeded the reported deaths from COVID-19” (1).

Despite this potential underestimation of the YLL, the results of Rommel et al. (1) show that SARS-CoV-2 in Germany has so far had a small impact on life expectancy. At the beginning of 2020, there were around 83 million people in

Germany with an average residual life expectancy of around 37 years. The YLL = 303 608 ascribed by the authors to COVID-19 means a loss of life expectancy of around 0.01% for these people, corresponding to around 1.5 days. According to *Figure 2* of the article (1), the loss for men between the ages of 60 and 69 is approximately 750 years/100 000, i.e., approximately 3 days.

Such context (i.e., ~1.5 days and ~3 days) is important to explicitly reiterate to prevent misinterpretation of the larger numbers reported by the authors. They report: “On average, each patient who died [of COVID-19] lost 9.6 years of life” (1). This “residual life expectancy by age of death” (1) is only to be interpreted as an intermediate calculation step, since the deceased have no residual life expectancy.

According to ongoing analyses (3), an increase in the number of deaths in Germany by 5% in 2020 and the influence of SARS-CoV-2 on mortality are statistically confirmed despite massive countermeasures. The YLL associated with this undisputed SARS-CoV-2 effect should be better used—as the authors themselves suggest—for “effects [...] on public health” (1), i.e. with respect to a population at risk, rather than to deaths.

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Inadequate Explanation

The analysis by the Robert Koch Institute (RKI) on deaths due to COVID-19 in Germany (until 18 January, 2021) (1) shows an average residual life expectancy for people who have died from the disease of 11.0 and 8.1 years for men and women, respectively. For this purpose, the authors use “the highest empirically derived age-specific residual life expectancy among all the German Federal States” based on the life tables 2016/2018. They do not explicitly correct for previous illnesses.

The residual life expectancy of patients who died of COVID-19 still appears to be relatively high. The median age of persons who died of COVID-19 until 29 December 2020 was 84 years (2). The life tables 2016/2018 reveal a residual life expectancy in the general population of only 6.0 years for men, and of 7.0 years for women.

Earlier situation reports from the RKI show that the median age of the COVID-19 deaths is close to the average age. In the last situation report of which I am aware with both reported parameters (13 September, 2020) (3), the average and median ages of deceased cases were 81 and 82 years, respectively. Thus, an asymmetrical distribution of years of life lost to COVID-19 does not seem to be a crucial reason for the differences in residual life expectancy between the median age and the average of all deaths recorded in the study.

Further, “the highest empirically derived age-specific residual life expectancy among all the German Federal States” seems to

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explain only a small part of the differences in residual life expectancy. According to the life tables 2017/2019, the difference in residual life expectancy for 80-year-olds between the national average and the federal state with the highest residual life expectancy for men and women is only 0.25 and 0.47 years, respectively.

A plausible explanation to be considered is that a (too) crude division of deaths into 10-year groups may have been used as a basis for calculating the average residual life expectancy (the use of 10-year groups is implied, for example, in *eFigure 2* of the article).

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Overestimated Numbers

Rommel et al. report that in 2020, persons who died of COVID-19 in Germany lost 9.6 years of life on average (1). This number is an overestimate:

For each deceased person, the authors equate the years of life lost with the residual life expectancy that average persons of the respective age have according to the period life tables. This approach ignores the fact that persons who died of COVID-19 are in a significantly worse state of health than average persons of the same age. Assuming that 28.7% of the deceased are nursing home residents (2), and the residual life expectancy after admission to a nursing home is a maximum of 1 year, i.e. 0.5 years for an average home resident (3), this results in an estimated loss of life years of only 7.0 years ($0.287 \times 0.5 + 0.713 \times 9.6$). This estimate is still too high for

three reasons: not all those who died of/with COVID-19 were reported to the Robert Koch Institute (RKI) by the nursing homes. Clients of outpatient care services are not taken into account. Even deceased persons without outpatient/inpatient care may often have had pre-existing conditions and thus a reduced life expectancy.

Taking into account the rapid aging of the society, there was a reduced mortality in Germany during the first wave of SARS-CoV-2, as compared to the corresponding period of 2016–2019; our own (still unpublished) analyses also show this for the entire year 2020. This indicates that the number of years of life lost may be lower than the estimated number given above.

The authors clearly state that pre-existing conditions were not taken into account. However, the media reports do not mention this limitation at all (*Süddeutsche Zeitung*) or mention it only

marginally (*Welt, Spiegel*), thus failing to convey the limitations of this approach to the reader.

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Methodological Error

Rommel et al. (1) suggest that people who died of COVID-19 lost 9.6 years of life. As the median age of COVID-19 deaths is 84 years, they supposedly would have reached 94 years of age if the disease had been prevented. It would be astonishing if specifically people with COVID-19 would have had such an above-average life expectancy. Where is the error?

The authors use the methodology of the Global Burden of Disease (GBD) study (2), but without a reference value. The GBD study calculates how many years of life are lost due to death for 359 diseases. For this, the age at death of the affected person is subtracted from the average residual life expectancy of their peers. In Germany, 80-year-old men have a residual life expectancy of 8.1 years (3). There is no point in calculating this number for a single disease without reference to the general population and other causes of death. For this reason, years of life lost per 100 000 inhabitants/year in the GBD study are comparatively reported for many diseases.

Lower respiratory tract infections lead to a global loss of 1 524 years of life/100 000 inhabitants/year. If the 305 641 years of life lost due to COVID-19 are calculated for the population, there were 368 years of life lost/100 000 inhabitants due to COVID-19 in 2020 in Germany. This corresponds to about 25% of the total loss due to lower respiratory infections. For all causes of death, the GBD study shows a loss of 32 797 years of life/100 000 inhabitants / year; in other words, almost 100 times greater than the loss due to COVID-19.

The comorbidity of those who died of COVID-19 is also not taken into account. The years of life are calculated from the

average residual life expectancy without taking into account the state of health. Many people who died of COVID-19 have a reduced life expectancy due to comorbidities. Therefore, the average value for the age group cannot be assumed. Social status is also missing: a low social status is associated with an increased risk of dying from COVID-19 and an overall lower life expectancy.

In the end, the authors themselves put it into perspective by stating that “the COVID-19 pandemic in Germany had reached the approximate level of severity of a severe influenza wave”.

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In Reply:

We are grateful for the constructive reactions to our contributions (1, 2) and would like to take the opportunity to address specific points. It should be noted that the feedback almost exclusively related to the article on COVID-19 (2). The only exception are the statements on the “cause-deleted life expectancies” in the following paragraph. The other statements do not necessarily reflect the opinion of all co-authors of the first article (1). In our COVID-19 article (2), we calculated the years of life lost to health impairments as the sum of the years lived with disability (YLD) and the years of life lost to death (YLL), which results in the disability-adjusted life years (DALY). The letters to the editor and, hence, our answers refer exclusively to the years of life lost due to death (YLL).

Taking into account pre-existing conditions—The YLL exemplary provide the life span at the population level that is lost due to specific causes of death. As in the Global Burden of Disease (GBD) study, pre-existing conditions of the deceased were not considered specifically in our analysis. The underlying statistical residual life expectancy at the time of death, however, includes both healthy and ill people as a cross-section of the population. In the framework of burden of disease calculations, the residual life expectancy, from a statistical point of view, represents the average life expectancy that can be achieved at each respective age. This is different from other morbidity-adjusted concepts such as “healthy life expectancy” or “cause-deleted life expectancies”. These concepts describe the residual life expectancy under the given health conditions. However, they do not

quantify the total loss measured in terms of the life span achievable in the general population. Accordingly, the assumption that the residual life expectancy is primarily based on the life expectancy of healthy people is not correct. Regardless of the cause of death, persons who die are on average sicker than those who survive. As far as we know, the assumption that persons who have died of COVID-19 are generally in a poorer health state than other deceased has not been empirically proven. Furthermore, as a disease-comparing system, burden of disease calculations apply a uniform standard to all causes of death.

Comparison with other diseases and cause of death statistics—Comparing our figures directly with those from the GBD study is not suitable as we have partly chosen a different methodological approach in our study, for good reasons. Also, a comparison with worldwide figures, as suggested in one of the letters, is not indicated due to strong variations in the occurrence of infections. In our article, we used the five most important causes of death as well as lower respiratory infections from the year 2017 for comparison. According to this, the loss in terms of life span was less for lower respiratory tract infections in 2017 than for COVID-19 in 2020. As data for 2020 was still lacking, a different reporting year had to be used provisionally in order to relate the level of COVID-19 mortality to other causes of death. While in the reported cases COVID-19 is recorded as a relevant cause of death in the causal chain, the cause of death statistics only show one underlying cause of death. As mentioned in the letters, however, death often has several causes. In addition to a promptly available one, we would therefore also welcome the development of a multi-causal cause of death statistics. Only such a database would allow for a thorough and timely comparison of diseases and causes of deaths and taking account of comorbidities in the event of death.

Excess mortality from COVID-19—In order to evaluate the level of COVID-19 mortality, while taking demographic aging into account, we analyzed the all-cause mortality in 2020 in the Supplementary Material section of our article. Excess mortality can be observed during the pandemic, especially during the second wave, which corresponds to the number of reported COVID-19 deaths. This observation could be complemented by an analysis of the cause of death statistics in order to understand,

for example, changes due to the measures taken to control the COVID-19 pandemic. However, these data are not yet available for 2020.

Mean loss of life time—The mean of 9.6 years of life lost applies to all persons who died of COVID-19 and not to the heavily populated groups of persons over 80. As described, 11.0% of the deaths and 29.0% of the years of life lost due to death can be attributed to the group of persons under 70 years of age. Younger persons who died have a stronger impact and influence the mean value of the YLL. The median age of those who died of COVID-19 is therefore not suitable for assessing the significance of this indicator. According to the Destatis life tables 2016/2018, the residual life expectancy of a 60-year-old person is 25.0 years on average; of an 80-year-old, 9.9 years; and of a 90-year-old, 4.6 years. Even though the achievable life span does not decrease linearly with age (because healthier people tend to live longer), the mean residual life expectancy for very old people (90 years and older) is well below 9.6 years.

Since all deceased could potentially have lived longer, we believe it is correct to determine the YLL for all deceased. In our view, it is not valid to derive the potential shortening of the overall population's life span from this, as was suggested in one of the letters to the editor. This holds true since the overall living population does not suffer any direct loss of life due to the COVID-19 mortality. Other pandemic effects, such as a reduction in overall life expectancy, can also only be analyzed with comprehensive and updated data on overall mortality. DOI: 10.3238/arztebl.m2021.0244

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Conflict of interest statement

The authors of all contributions declare that no conflict of interest exists.