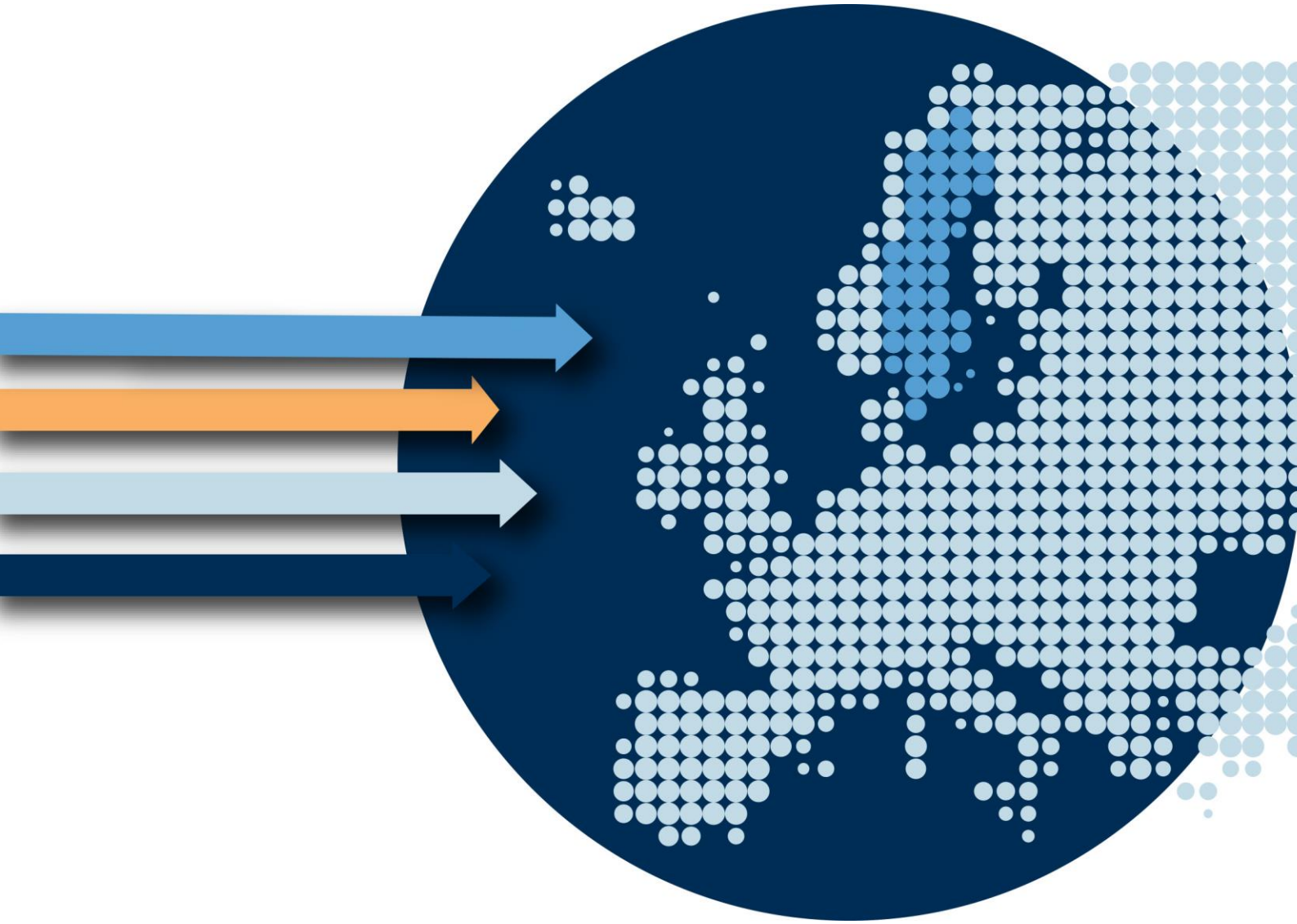
DISEASE BURDEN ASSOCIATED WITH COVID-19 IN SWEDEN – QALYS LOST DUE TO EXCESS MORTALITY



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Executive Summary

Sweden is among the countries with the highest COVID-19 death rates, as measured in terms of deaths with a COVID-19 diagnosis per million people. The number of cases, however, does not always serve as the best way to measure the burden of a disease as it does not take lost life-years, or the quality of life-years into consideration. Health economists therefore use the concept of Quality-Adjusted Life-Years (QALYs) to estimate the burden of diseases and injuries. The objective of this study is to estimate the disease burden of COVID-19 in Sweden in terms of QALYs lost during the first half of 2020.

The excess mortality during the first six months of 2020 was calculated and multiplied by the number of discounted QALYs lost. Excess mortality was calculated as the difference between observed mortality from the date of the first reported COVID-19 death (March,11) until June 30, 2020 compared to the average mortality for the same period in 2015-2019. The number of discounted QALYs lost was calculated using a standard approach, based upon national survival statistics, quality-of-life data from a previous study (IHE Report 2020:7), and a 3% discount rate.

The excess mortality during the first half year of 2020 was 5,310 deaths, which is consistent with the reporting from Folkhälsomyndigheten (5,467 deaths). Most deaths observed were among the elderly population, those 70 years or older. The excess mortality generated a total loss of 32,082 QALYs, which can be compared to the total QALY loss due to fatal road traffic accidents during an entire year (5,048 QALYs), due the last severe seasonal flue in 2018 (8,851 QALYs) and due to COVID-19 worry in April only (39,209 QALYs).

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Foreword

The Swedish Institute for Health Economics (IHE) has performed a study of the disease burden of COVID-19 in Sweden in terms of QALYs lost during the first half of 2020. The study shows that the excess mortality resulted in a total loss of 32,082 QALYs. This study presents a first and preliminary estimate of the disease burden in Sweden. Further research is needed to get a complete picture of the total impact of COVID-19.

Lund, October 2020

Peter Lindgren
Managing Director

1. Background

Unlike many other countries, Sweden did not introduce a national lock down to suppress COVID-19. Instead, different types of mitigation strategies were implemented, such as recommending limitations for social gatherings and travelling. Since the outbreak of the COVID-19 pandemic in Sweden in late March 2020, the Swedish Public Health Agency (Folkhälsomyndigheten, FHM) has reported 5,846 deaths, 2,580 cases with intensive care and 86,505 diagnosed individuals as of September 14 (1). Sweden is among the countries with the highest COVID-19 death rates, as measured in terms of deaths with a COVID-19 diagnosis per million people (2, 3). The number of cases, however, does not always serve as the best way to measure the burden of a disease as it does not take lost life-years, or the quality of life-years into consideration. Health economists therefore use the concept of Quality-Adjusted Life-Years (QALYs) to estimate the burden of diseases and injuries. A QALY is a measure that expresses health loss as function of time (measured in years) and quality of life, QoL, (measured on a scale from 0 to 1 based on surveys or interviews), making it possible to compare the burden of different illnesses.

1.1 Objective

The objective of this study is to estimate the disease burden of COVID-19 in Sweden in terms of QALYs lost during the first half of 2020.

2. Methods

2.1 Quality-Adjusted Life-Years (QALYs)

A quality-adjusted life-year (QALY) is the standard outcome measure in most health economic analyses. The measure can be used to measure various types of health losses, from e.g. temporary pain to a fatal disease, and thus allows for comparison across these different types of health losses. QALYs are calculated by multiplying the time in a specific health state with the QoL in that health state. Time is expressed in years, while QoL is expressed on a scale from 0 (representing death) to 1 (representing full health). One QALY is equal to one year of full health. Quality of life is measured using direct methods – the visual analogue scale (VAS), standard gamble (SG), time trade off (TTO) – or indirect methods like the EQ-5D questionnaire.

2.2 QALYs Lost Due to Premature Death

The amount of QALYs lost due to premature death is calculated using a standard approach (4-6). First, the number of expected life-years lost is calculated based on survival statistics for the general population (7). Secondly, these life-years lost are multiplied by the QoL according to population norms (8). Thirdly, the QALYs lost are discounted to account for the lower value of future QALYs lost as compared to QALYs lost in the present. A 3% discount rate is applied in accordance with guidelines from the Swedish Dental and Pharmaceuticals Benefits Agency (Tandvårds-och läkemedelsförmånsverket, TLV) (9).

2.3 Excess Mortality

Excess mortality is defined by the World Health Organization (WHO) as “mortality above what would be expected based on the non-crisis mortality rate in the population of interest. Excess mortality is thus mortality that is attributable to the crisis conditions. It can be expressed as a rate (the difference between observed and non-crisis mortality rates), or as a total number of excess deaths” (10). The reason for calculating the excess mortality is that the reported cases could be under- or overestimated. For example, there may be deaths that should have been attributed to COVID-19 but went undetected because of a lack of testing. There also may be deaths due to other causes that were incorrectly attributed to COVID-19. Moreover, the crisis may lead to more or less deaths due to other causes. For example, social distancing may reduce the number of road traffic injuries or influenza infections. Here, we calculate excess mortality as the difference between the observed mortality in the first half year of 2020 (January-June) compared to the average mortality in 2015-2019.

3. Results

3.1 Excess Mortality COVID-19

Figure 1 shows the observed number of deaths during the first six months of 2020 in Sweden. Starting in March 2020 (corresponding to the outbreak of COVID-19 in Sweden), excess mortality was observed compared to the average number of deaths in 2015-2019. The first death due to COVID-19 in Sweden as reported by the FHM on March 11. Since that time, 31,966 all-cause-deaths were observed in Sweden, corresponding to an excess mortality of 5,310 deaths (31,966 in 2020 – 26,656 in 2015-2019) (11). This figure is consistent with the FHM's reporting of 5,467 COVID-19 deaths for that same period (March 11-June 30) (1).

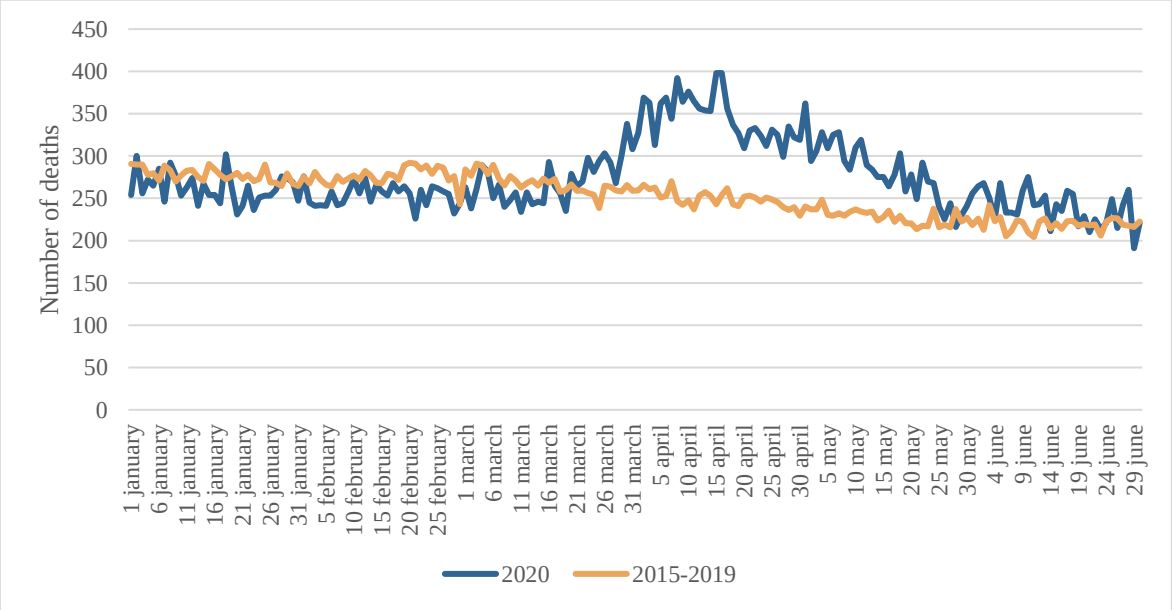

Figure 1. *Number of deaths between January and June 2020 and 2015-2019 (average number)*

Figure 2 shows the observed number of deaths during the first six months of 2018 in Sweden, which was the last year with a more severe seasonal flu. During the period when the FHM reported excess mortality in 2018 (week 3-15, January 15-April 15), there were in total 26,045 deaths as compared to an average number of 24,606 deaths in 2015-2017 (11), resulting in an excess mortality of 1,439 deaths.

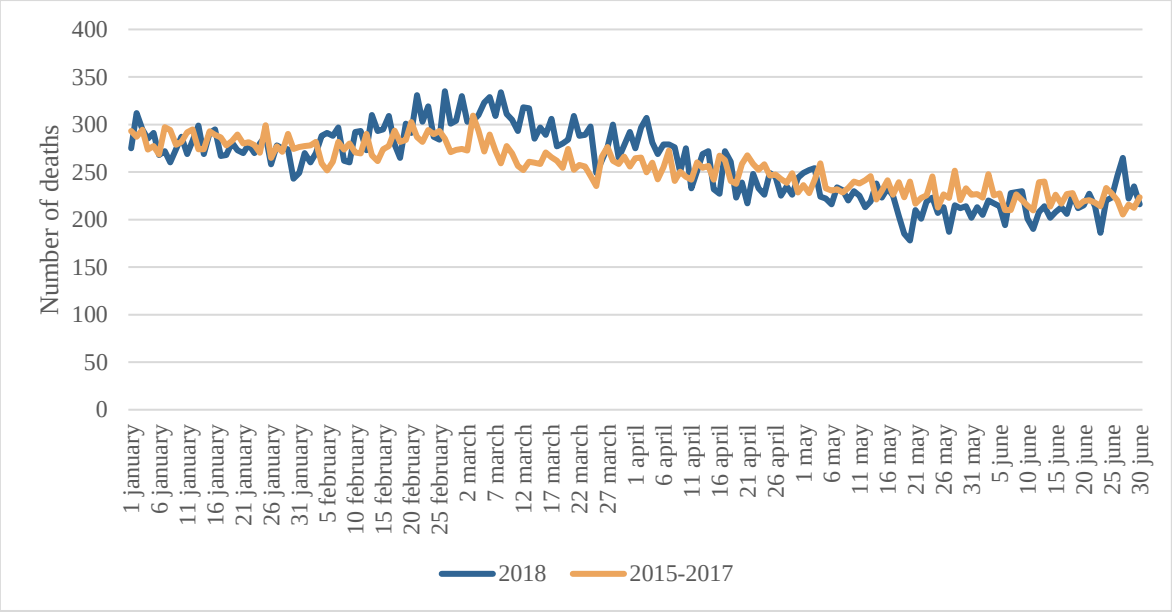

Figure 2. *Number of deaths between January and June 2018 and 2015-2017 (average number)*

Figure 3 characterizes the excess mortality resulting from the seasonal flu of 2018 and the COVID-19 pandemic of 2020. The number of deaths is presented stratified by age as reported by the FHM (1, 12). Most deaths observed are among the elderly population, those 70 years or older.

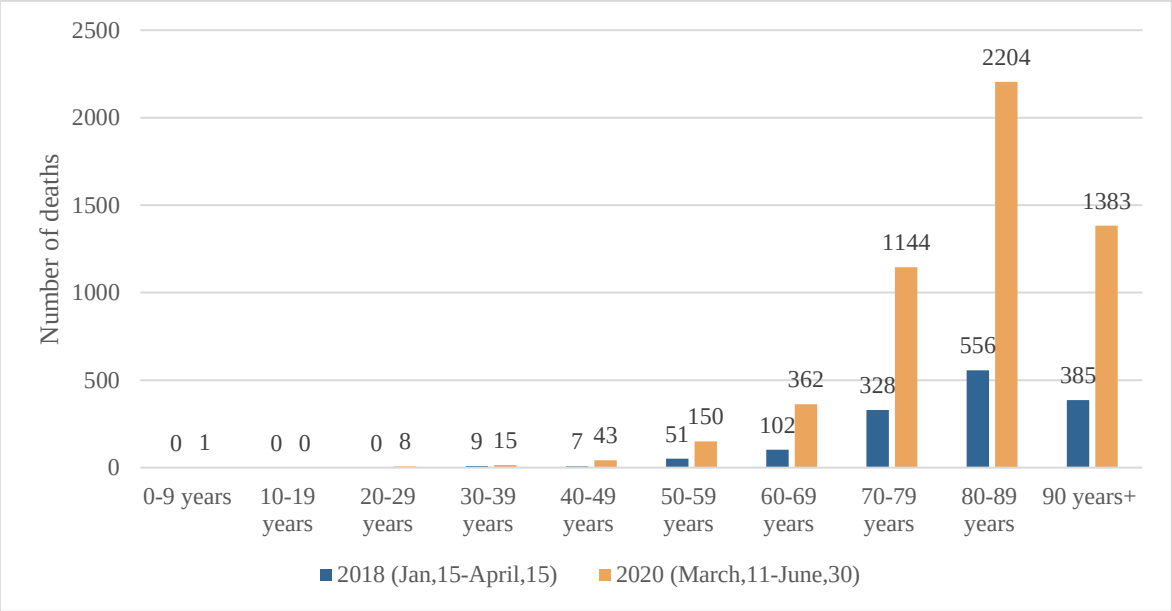

Figure 3. *Excess mortality during seasonal flu 2018 and COVID-19 2020 by age based on age distribution for reported deaths by the FHM (Folkhälsomyndigheten)*

3.2 QALYs Lost per Premature Death

The QoL of the Swedish population (population norm) has been estimated in several studies over time (Figure 4) (8, 13-16). Most were performed to monitor public health in specific regions. Quality of life is measured using the EQ-5D questionnaire. This questionnaire includes five questions on current health in different domains (mobility, selfcare, usual activities, pain/discomfort, and anxiety/depression) that can be used to generate an index based on TTO, and a VAS question where the respondent rates current health from 0 (worst possible health) to 100 (best possible health). Consistent with what is usually found, VAS generates a lower QoL compared to the EQ-5D index. However, while VAS shows a decrease in QoL between 2012 and February 2020, the EQ-5D-5L index appears to show a slight increase in QoL during the same period. This is probably due to the transition to the EQ-5D-5L (i.e. where each domain has five levels) in 2017, which has been found to generate higher QoL (17) compared to the EQ-5D-3L (i.e. where each domain has three levels) used in previous measurements. Both the EQ-5D index and VAS show a reduced QoL in April 2020, i.e. during the outbreak of COVID-19 in Sweden. There is, however, a steeper decline in QoL when measured using VAS, suggesting that this instrument is more sensitive to the non-health related changes (e.g. economic worry) in QoL following the outbreak of the COVID-19 pandemic.

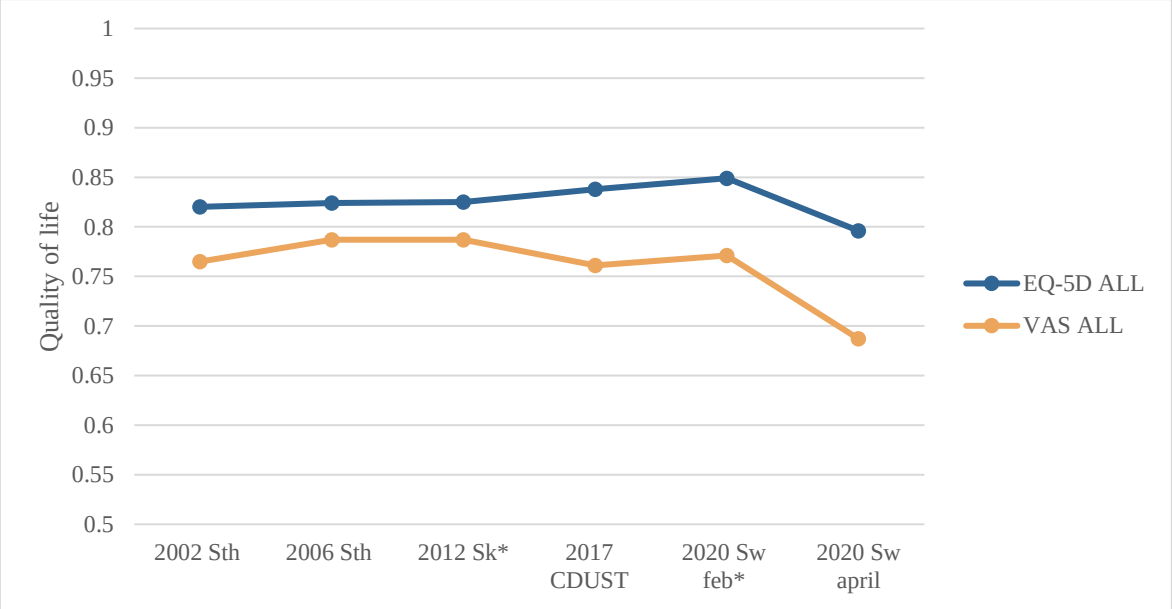

Figure 4. *Quality of life in Sweden over time (Sth=Stockholm, Sk=Skåne, CDUST=Uppsala, Sörmland, Västmanland, Värmland och Örebro, Sw=Sweden).*

*Estimated value on VAS for 2012 Sk (based on 2006 relation EQ-5D/VAS) and EQ-5D for 2020 Sw feb (based on 2017 relation EQ-5D/VAS).

To calculate the loss in QALYs for a premature death, we use the QoL estimated using VAS in February 2020 (8) as this is the most recent measure of QoL and the measure is available for different age groups. As VAS generates lower QoL compared to the EQ-5D index, we also performed a sensitivity analysis using the VAS measurement from February 2020, adjusted according to the ratio between the EQ-5D index and the VAS score in 2017 (14) (0.838/0.761 = 1.101)[1]. A comparison of this score to the EQ-5D index in 2012 (15) and 2006 (16) for different age groups (Figure 5), suggests a higher QoL in February 2020 for those who are 45 years or older. This may reflect a real change in QoL or the impact of using the EQ-5D-5L instead of the EQ-5D-3L.

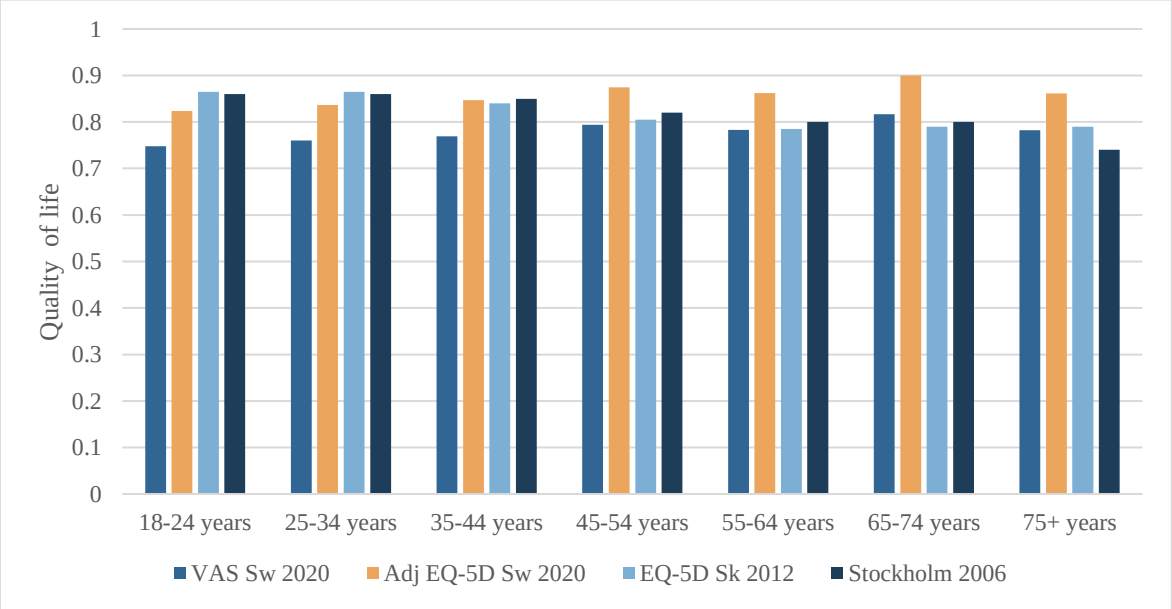

Figure 5. *Quality of life by age (Sw=Sweden, Sk=Skåne)*

*Adj EQ-5D = VAS 2020 * (EQ-5D index 2017/VAS 2017)

The mean number of QALYs lost per premature death is calculated by multiplying the expected number of remaining life-years with the QoL and discounting using a rate of 3%. The result shows that the mean number of QALYs lost per premature death decreases with age (Figure 6). A premature death for a child between 0 and 9 years old translates to a loss of around 25 QALYs, whereas a premature death for an individual aged 90 years or older results in a loss of around 3 QALYs.

[1] The EQ-5D index was not elicited from the February 2020 measurement (the one shown in Figure 5 is estimated) and the 2017 EQ-5D index measurement was not subdivided into different age groups.

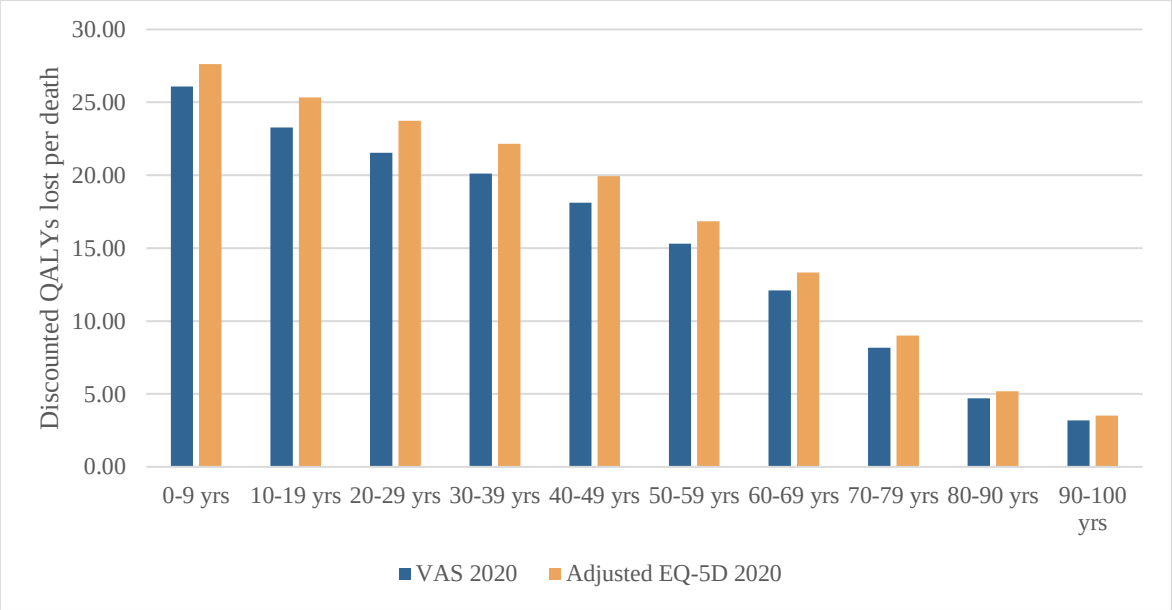

Figure 6. *Discounted number of QALYs lost per premature death by age*

3.3 Total QALY Loss for COVID-19 Mortality

The excess mortality during the first half year of 2020 generated a total loss of 32,082 QALYs based on VAS measurement in February 2020 (35,323 QALYs based on adjusted EQ-5D), which was primarily caused by deaths among the older population. This can be compared to the loss due to COVID-19 worry (e.g., worry about the economy, social isolation, or getting ill) in the general population that amounts to 39,209[2] QALYs for April alone (1 month) (8), primarily comprised of worry among the younger part of the population (Figure 7). To gain additional perspective as to the QALY loss due to COVID-19 mortality (4 months), this loss can be compared to road traffic fatalities (12 months) (18) or the mortality of last severe seasonal flu in 2018 (3 months) (Figure 8).

[2] The total QALY-loss in this report is 39,209 QALYs. The total QALY-loss in the original report (IHE Report 2020:7) is 41,729 QALYs. The difference is due to different age intervals used in the calculations.

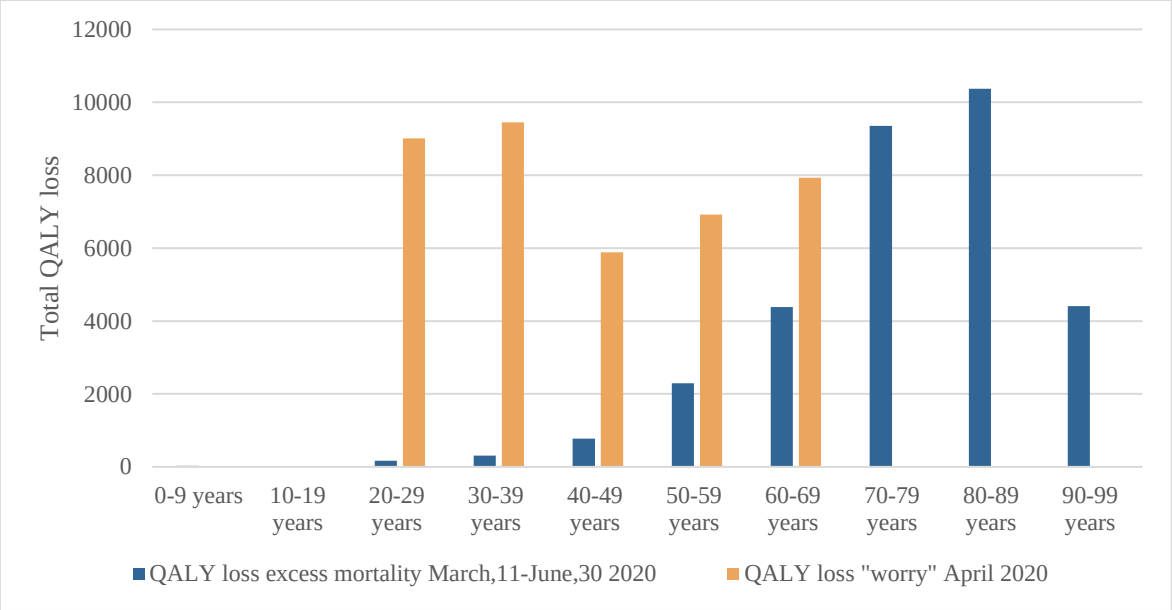

Figure 7. *Total QALY loss by age due to excess mortality March,11-June,30 2020 and worry related to COVID-19 in April 2020*

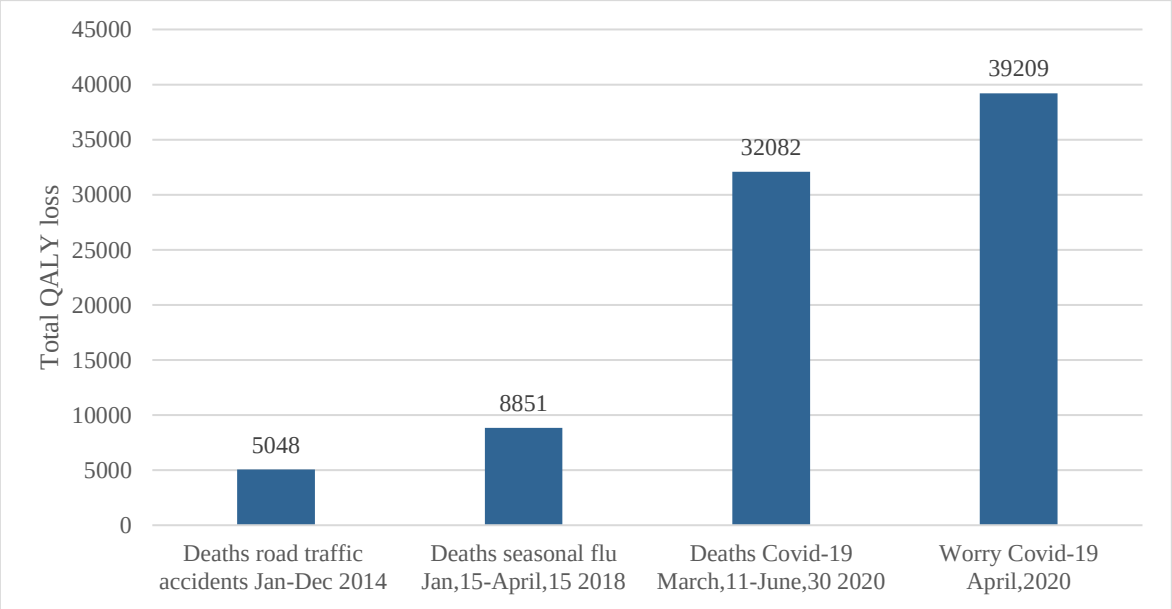

Figure 8. *Total QALY loss due to COVID-19 deaths compared to other causes*

3.4 Net Health Analysis

Net health analysis is a method that aims to estimate the net health impact of an intervention by taking both the direct and indirect health impacts into account (19-21).

The direct health impact includes the estimated impact on mortality or morbidity from the intervention. This is most often expected to result in a reduction of mortality or morbidity for the outcome targeted by the intervention. However, the intervention could also increase or lower risk by altering the behaviour of individuals. A typical example of this is seat belts in cars which may lead to increased driving speeds because of an increased sense of security. Mitigation interventions aimed at COVID-19 could for example lead to a decrease in risk of road traffic accidents (due to less travelling) or increase risk of psychological illness (due to less socializing and more unemployment). Although these impacts are increasingly acknowledged by authorities (22-24), the data is currently insufficient to determine the size and scope of these impacts.

The indirect health impact includes the estimated impact on mortality (or morbidity) when less income is available for reducing other health risks. The assumption is that spending on health and safety increases with income, and when income is reduced due to spending on a new intervention, there is less money available for spending on other types of goods and services that can increase health and safety. For an intervention to result in a positive net health benefit, the spending on a new intervention must be predicted to save more lives than the death it is predicted to cause by reducing the income available.

The maximum intervention cost per life saved that would assure that more lives are saved than lost is derived by dividing the Value of a Statistical Life (VSL) by the marginal propensity to spend on goods and services that reduces the risk of death. The current VSL as applied by the Swedish Transport Agency is SEK41.5 million (25). Based on a previous net health analysis, the marginal propensity to spend on risk-reducing goods and services is 18% (19, 20), resulting in a threshold (or maximum intervention cost) of SEK 231 million (41.5/0.18). If the intervention cost is less per life saved, the net health impact is expected to be positive.

The current estimate by the National Institute of Economic Research (NIER/Konjunkturinstitutet) is that GDP will be reduced by 7% during 2020 (26). This corresponds to a loss of around SEK350 billion (7% x annual GDP of SEK5,000 billion (27)) and would cause an indirect health impact of around 1,500 deaths (SEK350 billion/SEK231 million). This means that the direct health impact, i.e. avoided deaths due to COVID-19, must be higher than 1,500 deaths for the net health impact to be positive.

4. Discussion

This study has estimated the disease burden from COVID-19 during the first six months of 2020 in terms of the total number of QALYs lost due to excess mortality. The results show a total loss of 32,082 QALYs, primarily attributable to death among those over 70 years old. This is, however, only part of the story of the total impact of COVID-19 on the QALYs lost in Sweden during the pandemic. As shown in a study performed by IHE in collaboration with researchers at the University of Southern California (8), there has been a loss in quality-of-life among the broader Swedish population that amounts to 39,209[3] for the month of April alone (8). The loss was primarily found among the Swedish workforce, and worry about the economy appears to have been a major driver. However, the study design did not allow us to untangle the separate impact of different possible explanations (worry about the economy, worry about health, social isolation etc.) and future research is needed to establish this. Nevertheless, the two studies taken together conclude that the COVID-19 pandemic and mitigation response strategy have so far resulted in an estimated total loss of 71,291 QALYs in Sweden.

The QALY loss in this study should be considered as a lower estimate of the real total disease burden which also includes QALYs lost due to morbidity caused by COVID-19, QALYs lost due to delayed health care (e.g., postponed surgical procedures) and QALYs lost due to COVID-19-related worry before and after April 2020. Moreover, there may be additional QALYs lost in the long run associated with a potential second wave of COVID-19, and also morbidity and mortality as a consequence of social isolation and economic recession. Previous research has shown that reductions in GDP are associated with an increase in mortality (28).

It should, however, be noted that the excess mortality reported in this study may be followed by a mortality deficit. In August 2020, the observed mortality in Sweden was actually lower (6,712 deaths) compared to the average for the same month in 2015-2019 (6,832 deaths) (11). A similar development has also been found in Belgium (29). This is according to expectations as the deaths mainly occurred in older individuals with a high level of comorbidity (30) who may have died later for other reasons if they would not have been infected by Covid-19. For the same reason, excess mortality during a seasonal flu is usually followed by a period of mortality deficit (31). The WHO has also recently found a correlation between mild seasonal flu and a high excess mortality during Covid-19, and this may be part of the explanation behind the high death toll due to Covid-19 in Sweden according to the FHM (32).

[3] The total QALY-loss in this report is 39,209 QALYs. The total QALY-loss in the original report (IHE Report 2020:7) is 41,729 QALYs. The difference is due to different age intervals used in the calculations.

Quality of life was derived from a VAS measurement in 2020 (8). A limitation with VAS is that it is not preference-based, i.e. it does not require the respondent to make a trade off in terms of risk or life-years, and therefore tends to result in lower estimates compared to SG and TTO. However, the VAS instrument may be more responsive compared to the indirect measurement of QoL using the EQ-5D. The EQ-5D instrument is designed to capture the QoL in five health-related dimensions, while VAS is designed to rate health on a scale from "worst possible" to "best possible". As shown in this study, the EQ-5D showed a slight increase in the overall QoL between 2012 and February 2020, while VAS showed a slight decrease. Also, the reduction in QoL during the height of the pandemic (April 2020) was larger when measured using VAS. These results are in line with previous research (33), and suggest that VAS may be more responsive to changes in non-health related quality of life. The widening gap between VAS and EQ-5D after the introduction of the EQ-5D-5L also suggest that the 5-level version differs even more from VAS. There is an ongoing debate regarding the future use of the EQ-5D measure (34), and future research may be needed to identify its short-comings and the potential use of alternatives.

It is important to note that this study is a description of the disease burden and not an evaluation of the corresponding mitigation strategies. Nothing can be said about the appropriate level or type of interventions used in response to the pandemic based on this study, because this would require an estimate of the counterfactual situation, i.e. what would be the outcome without the interventions. The outcome of different strategies has been estimated in for example Norway (23) and the US (35). However, none of these studies estimated the QALYs lost as a consequence of the impact of the mitigation/suppression strategies on the social and economic life of the population (e.g. worry about the future economic situation, depression due to social isolation etc.). To ensure that the net outcome of mitigation/suppression strategies for society is positive, future research is needed to provide a more complete picture of the QALYs lost during the pandemic in order to achieve more appropriate trade-offs across alternative strategies included in future economic evaluations.

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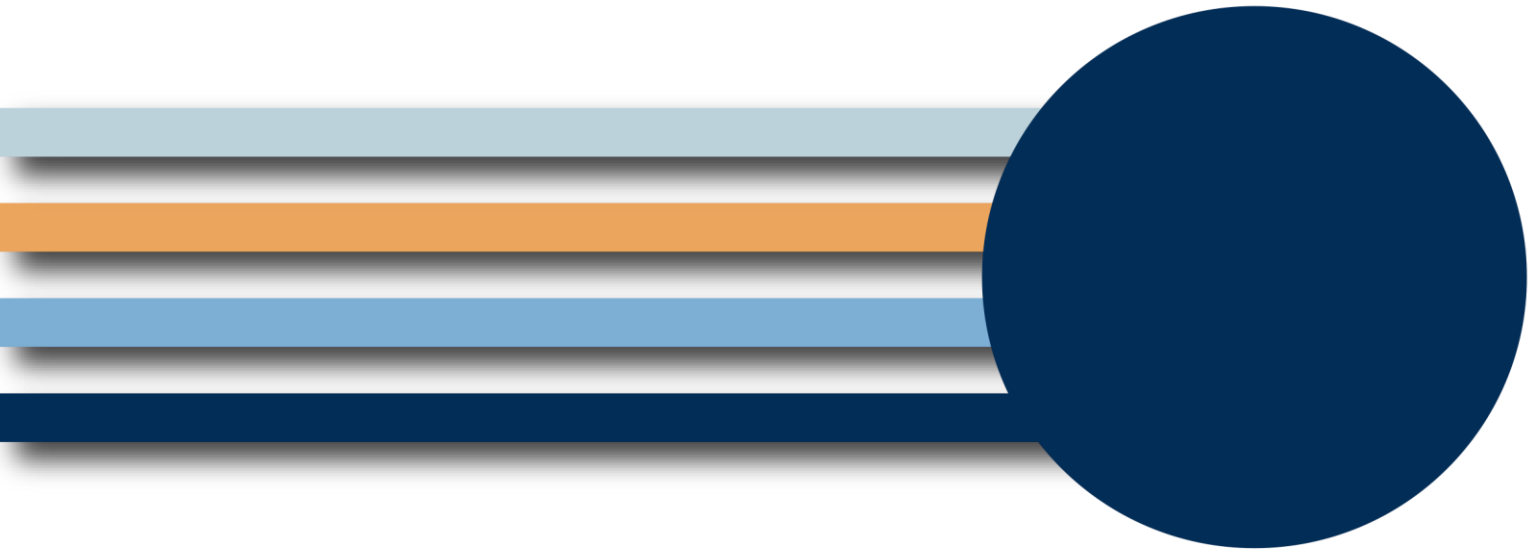

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