Mortality in Norway and Sweden during the COVID-19 pandemic 2020 – 22: A comparative study

Per-Henrik Zahl, Örjan Hemström, Rune Johansen, Svenn-Erik Mamelund

PII: S1876-0341(23)00371-4

DOI: https://doi.org/10.1016/j.jiph.2023.10.033

Reference: JIPH2273

To appear in: *Journal of Infection and Public Health*

Received date: 19 May 2023
Revised date: 31 August 2023
Accepted date: 29 October 2023

Please cite this article as: Per-Henrik Zahl, Örjan Hemström, Rune Johansen and Svenn-Erik Mamelund, Mortality in Norway and Sweden during the COVID-19 pandemic 2020 – 22: A comparative study, *Journal of Infection and Public Health,* (2023) doi:https://doi.org/10.1016/j.jiph.2023.10.033

Mortality in Norway and Sweden during the COVID-19 pandemic 2020 – 22: A comparative study

Per-Henrik Zahl[1]

Örjan Hemström[2,3]

Rune Johansen[1]

Svenn-Erik Mamelund[4]

Correspondence

per-henrik.zahl@fhi.no

[1]Norwegian Institute of Public Health,

Division of Mental and Physical Health

Oslo, Norway

[2]Social Statistics and Analysis

Population and Living Conditions

Statistics Sweden

Solna, Sweden

[3]Public Health Agency of Sweden

Solna, Sweden

[4]Centre for Research on Pandemics & Society, Oslo Metropolitan University, Norway

Summary

Background: Norway and Sweden picked two different ways to mitigate the dissemination of the SARS-CoV-2 virus. Norway introduced the strictest lockdown in Europe with strict border controls and intense virus tracking of all local outbreaks while Sweden did not. That resulted in 477 COVID-19 deaths (Norway) and 9737 (Sweden) in 2020, respectively.

Methods: Weekly number of COVID-19 related deaths and total deaths for 2020-22 were collected as well as weekly number of deaths for 2015-19 which were used as controls when calculating excess mortality. During the first 12-18 months with high rate of virus transmission in the society, excess mortality rates were used as substitute for COVID-19 deaths. When excess mortality rates later turned negative because of mortality displacement, COVID-19 deaths adjusted for bias due to overreporting were used.

Results There were 17521 COVID-19 deaths in Sweden and 4272 in Norway in the study period. The rate ratio (RR) of COVID-19 related deaths in Sweden vs. Norway to the end of week 43, 2022, was 2.11 (95% CI 2.05-2.19). RR of COVID-19 related deaths vs. excess number of deaths were 2.5 (Sweden) and 1.3 (Norway), respectively. RR of COVID-19 deaths in Sweden vs. Norway after adjusting for mortality displacement and lockdown, was 1.35 (95% CI 1.31-1.39), corresponding to saving 2025 life in Norway. If including all deaths in 2022, RR=1.28 (95% CI 1.24-1.31).

Conclusions Both COVID-19 related mortality and excess mortality rates are biased estimates. When adjusting for bias, mortality differences declined over time to about 30% higher mortality in Sweden after 30 months with pandemics and at the cost of 12 million € per prevented death in Norway.

Funding None

Introduction

Norway and Sweden are two neighbouring countries with very similar public health care systems, genetically very similar populations, and individuals who are exposed to similar risk factors for most diseases. For the last 100 years, life expectancies as well as cause-specific mortality rates have been very similar (except for the classification of accidents and intoxications).[1] Mortality of heart and vascular diseases are 30% higher in Sweden (but death of acute infarct is almost identical) and Norway has about 4% higher cancer mortality. Norway also has 50-60% higher mortality of COPD and other respiratory diseases (probably because of differences in smoking prevalence).[2] In the last decade, total mortality in both countries have dropped 10% and the mortality difference between countries is about 1-2%.[2]

When the first cases of SARS-CoV-2 infections and the COVID-19 diseases appeared late in February 2020, Norway and Sweden chose two very different approaches to mitigate the spread of the virus. Norway introduced very strict lockdowns from March 12, lasting for about 15 months, and local outbreaks were immediately mitigated. In contrast, Sweden did not introduce lockdowns but asked people to take personal responsibility to mitigate the spread of COVID-19 disease.[3] The policies were not only different, but they were the strictest (Norway) and least strict (Sweden) in Western-Europe.

At the end of the summer of 2021, 87% of the Norwegian population had received one dose of vaccine and 57% were fully vaccinated, and one year later, 75% were fully vaccinated. In Sweden, 82% of the Swedish population had received one dose and 56% were fully vaccinated, and one year later 74% of the populations were fully vaccinated. Vaccination coverage per dose was in other words similar in the two countries. Norway used only mRNA vaccines, while Sweden offered the AstraZeneca vaccines frequently to people aged 65 years and above.[4]

Deaths of COVID-19 is the ultimate outcome for comparing the two different methods (lockdowns and vaccinations) to mitigate the spread of the SARS-CoV-2 virus. The cause-specific death rate of COVID-19 is, however, depending on the frequency of testing for SARS-CoV-2 and differences in traditions of writing death certificates. Thus, cause-specific mortality of COVID-19 is probably not comparable over time and across countries.

SARS-CoV-2 infections are related with increased mortality of other diseases for at least 12 months after the initial infection.[5] Deaths many weeks or months after a COVID-19 disease is not easily linked to an infection with SARS-CoV-2, especially not when the disease is related with multiple other non-communicable causes of death. This problem is very similar to studying deaths under and after an influenza pandemic.[6] It is standard practice to calculate

excess mortality during the influenza season to get a more comprehensive picture of the influenza mortality rather than only studying influenza and pneumonia deaths.[6]

The aim is to compare the number of COVID-19 deaths in Norway and Sweden during the pandemic. In particular, we compare excess mortality within a country to cause-specific COVID-19 mortality rates using high quality causes of death registries.

Methods

All deaths from 2015 to 2022 (until week 43 in 2022) were collected by Statistics Norway and Statistics Sweden, respectively. Data were aggregated by sex, 1-year age groups and by week of deaths for each year.

COVID-19 deaths, here called *COVID-19 related deaths* (defined as COVID-19 as either underlying or contributing causes of death on the death certificates), by sex and by week for the period 2020 to 2022 were recorded by the Norwegian Institute of Public Health (Norway) and the National Board of Health and Welfare (Sweden). COVID-19 related deaths are the numbers usually used in media. Diagnosis coding for COVID-19 is complicated, in part because the World Health Organization (WHO) initially created two diagnosis codes for COVID-19. The WHO's codes are as follows: U07.1 – COVID-19, virus identified (lab confirmed), and U07.2 – COVID-19, virus not identified (clinically diagnosed). Then in 2021, WHO introduced U09.9 – post COVID-19 condition, unspecified, U10.9 –multisystem inflammatory syndrome related with COVID-19, unspecified, and U12.9 – COVID-19 vaccines causing adverse effects in therapeutic use, unspecified.[7]

Because COVID-19 related deaths are including many cases with COVID-19 as only contributing cause of death (but not as underlying cause of death), COVID-19 related deaths overestimate the number of individuals that actually die of COVID-19. The COVID-19 mortality rate defined as the underlying cause of death is here denoted by κ.

It is an empirical experience that influenza is underreported as an underlying cause of death,[6] and it may also be the case for COVID-19 too. Many therefore calculate the excess mortality rate ν when studying mortality of COVID-19 and ν is defined as

$$\nu = \lambda - \mu. \quad (1)$$

Here λ is the observed mortality rate and μ is the expected mortality rate.[8,9] This definition was initially defined for closed cohorts and supposed to never become negative.[9] When the excess mortality method is applied on period data, the excess mortality is supposed to randomly vary around zero. When ν is outside the 95 percent confidence interval, the terms significant (positive) excess mortality (higher than expected mortality) or significant negative excess mortality (lower than expected mortality) are being used.

Thus, ν is supposed to be larger than κ when ν is used to imitate deaths of influenza and probably for COVID-19 too. If ν is smaller than κ, this can be by random or because of incorrectly modelling μ. The first can be tested using statistics. If ν is negative, for example during a strict lockdown, one can assume that the μ being used is invalid because strict lockdowns reduce the mortality of many causes of deaths.

A conservative approach is not to overestimate ν by underestimating μ. Here, μ is calculated as the mean number of deaths in the period 2015-19 divided by the population in 2019. The

mean number of deaths in the period 2015-19 was used and not the extremely low number in 2019.

The cumulative excess in number of deaths from week 1 in 2020 until week 43 in 2022, is calculated by subtracting the weekly mean number of deaths in 2015-19 from the observed number of deaths per week from the start of 2020 and accumulate over time. The cumulative excess numbers were adjusted for population increases after 2019, and calculation was stopped at week 43 because then the influenza season started. Note there is no modelling of declining mortality trend, that might increase the excess rate.

In 2019, Sweden observed a very strong decline in the number of deaths, and an increase in life expectancy by 0.5 years.[10] This can partly be explained by relatively high influenza-related mortality rates in 2014-2015, 2015-2016, 2016-17 and in 2017-18 among old and frail individuals,[11] which was followed by exceptionally low mortality lasting from the summer of 2018 until week 11 in 2020. This phenomenon is called *mortality displacement* - the occurrence of deaths at an earlier time than they would have otherwise occurred, meaning deaths are displaced from the future into the present. Because of this, a "new" population of vulnerable persons had been built up by March 2020 in Sweden, contributing to relatively more deaths among old people in the early phases of the COVID-19 pandemic. This phenomenon is called *dry tinder effect*. When there is an initial dry tinder effect, all excess incidence increases should be calculated as COVID-19 deaths, we think.

Note that strong lockdowns may prevent many deaths among older and frail individuals while still some die of COVID-19, leading to negative excess mortality rates.[10] During strong lockdowns with negative excess mortality rates, COVID-19 related deaths were used.

Also note that during a long pandemic, mortality displacement may occur, leading to negative excess mortality rates, even though individuals still die of COVID-19. This is because during the pandemic, the expected mortality μ drops. When the excess mortality rate turns negative during the pandemic (because of mortality displacement), COVID-19 related deaths adjusted by multiplying with the ratio of the (excess deaths)/(COVID-19 related deaths) at the start of the pandemic was used. Here we assume that the bias in the COVID-19 related death rate (compared to κ) is as in the start of the pandemics where the bias is (excess deaths)/(COVID-19 related deaths). The reason for this bias is that during the COVID-19 pandemic, extensive testing and using COVID-19 related deaths leads to overestimation of κ.

Figures and rates were aggregated using Microsoft Excel and Stata/SE 15.0 was used to calculate rate ratios (RR). The age groups 0-79, 80-89 and 90+ were used because then there is a similar number of deaths in each group. The analyses are adjusted for both mortality displacement and dry tinder effects. Comparing Norway and Sweden is a natural experiment.

Results

In 2019, the median age was 39.8 years (Norway) and 41.1 years (Sweden). Expected lifetimes were 84.7 (Norwegian women), 81.2 (Norwegian men), 84.7 (Swedish women) and 81.3 (Swedish men). Number of physicians per 100 000 individuals were 505 (Norway) and 430 (Sweden), and corresponding number of nurses were 1650 (Norway) and 1150 (Sweden), respectively. The number of hospital beds per 100 000 were 320 (Norway) and 270 (Sweden). Gross domestic product (GDP) per capita adjusted for purchasing power parity prices (PPP)

were 66 830 US dollar (Norway) and 55 820 (Sweden). Health care expenses as proportion of GDP were 9% (Norway) and 11% (Sweden).[12-15]

In Table 1, number of deaths, exposure years and total mortality rate per 100 000 person-years with 95% percent confidence intervals (95% CI) by country, sex, and age groups for the period 2015-19, for 2020, 2021 and for the first 43 weeks in 2022 are presented.

In Table 2, absolute mortality differences and mortality rate ratios for the excess mortality rates by country and sex for 2020, 2021, and for the first 43 weeks in 2022 are presented.

Excess mortality rates and COVID-19 related mortality rates are compared in Table 3 by sex and years. Excess mortality rates follow the trends for the COVID-19 related death rates, and the excess rates are smaller than the COVID-19 related deaths rates, except for Norwegian men in 2022. The discrepancies in rates are much larger for women than for men, especially for Swedish women in 2021.

Figure 1 presents number of COVID-19 related deaths for Norway and Sweden as recorded by the causes of deaths registries and used in scientific publications of the COVID-19 deaths during the pandemic[11,16,17] and in media.[18] Note that the population is about twice as large in Sweden as in Norway. Sweden experienced a wave of COVID-19 deaths in the spring 2020 and another wave starting in the fall 2020 and ending in March 2021. Because of the lockdown, there were no corresponding strong waves in Norway. Number of COVID-19 related deaths in Norway were 477 (2020), 966 (2021), and 2829 (first 43 weeks in 2022); the sum is 4272. The number of COVID-19 as the underlying cause of death wase 3576 (414 in 2020 and 303 first 26 weeks in 2021). Corresponding number of COVID-19 related deaths in Sweden were 9737 (2020), 5062 (2021), and 2722 (first 43 weeks in 2022); the sum is 17521. In Sweden, 11.7% of the covid deaths occurred in the age group under 80 years, while in Norway, the corresponding proportion was 17.1%. The RR of COVID-19 related deaths in Sweden vs. Norway is 2.11 (95% CI 2.05-2.19).

In 2020, the proportions of U07.2 diagnoses compared to the sum of U07.1 and U07.2 were 2.6% (Norway) and 4.5% (Sweden), respectively. The next year the proportions were 0.5% (Norway) and 0.7% (Sweden).

Cumulative number of excess deaths by year and by country are given in Figure 2a (Norway) and 2b (Sweden). In Norway, the excess number was -439 (2020), -1138 (first 26 weeks in 2021), 2022 (last 26 weeks in 2021), and 2948 (until week 43 in 2022); the sum is 3393. Excess number of deaths in Sweden were 8089 (2020), -600 (2021), and -363 (to week 43 in 2022); the sum is 7126. RR of COVID-19 related deaths to excess number of deaths were 2.5 (Sweden) and 1.3 (Norway), respectively.

To calculate the number of COVID-19 deaths in Norway, we used COVID-19 deaths for the period when the excess mortality is negative, i.e. all of 2020 and first 26 weeks in 2021. In this period there were 817 COVID-19 deaths. From week 27 in 2021 until week 43 in 2022, the excess number of deaths were 1138+884+2948=4970. The estimated number of COVID-19 deaths in Norway is 817+4970=5787.

In Sweden, the excess mortality was positive from week 11 (2020) to week 5 (2021) when it became negative. The cumulative excess deaths were 1055+8029+1036=10120. In the same period the COVID-19 related deaths were 11748. From week 5 in 2021 until the end of the

study period, there were 5793 COVID-19 related deaths in Sweden. When the excess mortality is negative after week 4 in 2021 and there was no lockdown in Sweden, and still many people died of COVID-19, using excess mortality here is not justified. The ratio of (excess deaths)/(COVID-19 related deaths)=10120/11748=0.86. We suggest using 86% of the COVID-19 related deaths in Sweden after week 4 in 2021 as the number of COVID-19 deaths in this period. Then there is 10120+5793x0.86=15102 COVID-19 deaths in Sweden.

The RR of COVID-19 deaths in Sweden compared to Norway is calculated as (15102/10521556)/(5787/5425270)=1.35 (95% CI: 1.31-1.39, P<0.0001), corresponding to 3915 more deaths in Sweden or Norway saved 2025 life by their strategy.

If including deaths during the last 9 weeks of 2022 (1222 in Sweden and 1207 in Norway, the RR would be (15856/10521556)/(6405/5425270) = 1.28 (95% CI: 1.24-1.31, P<0.0001). During the first 18 weeks in 2023, there 14684 deaths in Norway compared to 15504 in same period in 2022, indicating that the strong excess mortality in Norway was disappearing because of mortality displacement.

Discussion

Both COVID-19 related deaths and excess deaths yield biased estimates of the real number of COVID-19 deaths in Norway and Sweden. Mortality displacement, dry tinder effect and using COVID-19 related deaths all introduces bias. Here we try to adjust for these sources of bias. In 2022 (30 months after the pandemic started), the cumulative mortality of COVID-19 was about 35% higher in Sweden than in Norway; i.e., 3915 of 15102 COVID-19 deaths in Sweden could have been prevented, if there had been a lockdown as in Norway until population were vaccinated (or 2025 more deaths would have occurred in Norway). At the end of 2022 (33 months after the pandemic started) COVID-19 mortality was still 28% higher in Sweden.

This study is a natural experiment of the effect of a very strict lockdown in Norway to mitigate the spread of SARS-CoV-2 virus: border controls, each time an individual was diagnosed with COVID-19, there were local lockdowns and tracking of virus. In contrast, Sweden did not close borders, did not track virus when virus was detected, schools closing and working from home were not mandatory. Norway opened after about 15 months when most old and adult people were vaccinated. Note that we study the simultaneous effect of both a stricter lockdown and vaccination before the virus were widely disseminated in the population

The Swedish strategy on mitigating the COVID-19 disease received international attention and criticism, notably because the reported COVID-19 mortality rates in Sweden in the beginning were much higher than in comparable countries such as Finland, Norway and Denmark. The similarity of Norway and Sweden with regard to COVID-19 risk factors, socioeconomics and demographics, life expectancy and comorbidity, governmental and administrative systems, health care service, education and other potential confounding variables[12-15] indeed provide an interesting case study to explore how the more intense mitigation measures in Norway and the less intense measures in Sweden contributed to the countries' mortality patterns.

The cost of the Norwegian lockdown is calculated to be about 270 billion Norwegian crowns (corresponding to 25 billion €), or about 4600 € per citizen.[19] It can be questioned if this was

justified when it did not prevent more than 2025 COVID-19 deaths (12 million € per prevented death, and only delayed the pandemic by slightly more than a year.

Using negative excess mortality rates when many individuals die of COVID-19 is obviously not justified. During the lockdown, excess rates in Norway were negative (and much more negative for women than for men). Only countries with very strict lockdowns reported initially negative excess rates.[16-18] From the summer of 2021 and onwards, the cumulative excess mortality is about the same as COVID-19 deaths in the Causes of Death Registry in Norway. Any delayed death due to mitigation of COVID-19 and other infections is captured by the excess mortality method. In Sweden excess mortality rates and COVID-19 death rates were very similar in 2020 but diverged in the following years. Negative excess rates after the initial pandemic peak have not been reported. Summing excess mortality rates for the complete study period in Sweden only catches half of the COVID-19 deaths.

COVID-19 related deaths may be recorded differently in Norway and Sweden. Sweden collected COVID-19 deaths in two different agencies (the Public Health Agency of Sweden and the National Board of Health and Welfare). The latter recorded COVID-19 related deaths, but validation studies of patient journals indicated that 15% of the reported COVID-19 deaths probably were not related to the virus.[20] There was a significant 23% drop in death of lung diseases from 5073 in 2019 to 3885 in 2021 (European short list code J09-J18 and J40-J47) and 13% significant drop from 6032 in 2019 to 5276 in 2021 for Alzheimer and other dementia diseases (European short list code F00-F09) in Sweden, indicating that there is a mortality displacement.[21] Only Norway has published COVID-19 deaths based on underlying causes of death.

The strength of this study is the quality of the data (using high quality register data covering the complete populations) and using time varying cumulative excess mortality rates.

By using time-varying excess mortality rates and comparing to COVID-19 death rates, one may adjust for mortality displacement. Our method to adjust for mortality displacement is intuitive. Here the peak of the excess mortality comes simultaneously with the peak of the Covid-19 pandemic. However, the absolute differences between the two curves depends on the level of the dry tinder effect, the level of the mortality displacement and the frequency of testing for the virus. The latter you can estimate and adjust for, while there is no method to calculate and adjust for the dry tinder effect and mortality displacement. We have argued that both effects should be completely incorporated in the calculations. However, when comparing estimates in Norway and Sweden, one must have in mind that the estimated RR would probably have been different if the pandemic had arrived at another time.

Furthermore, this analysis does not rely on statical modelling involving multiple assumptions. Calculations are transparent. Statistical modelling has so far focused on extrapolating the trends before 2020.[16-18] We show that the change in expected mortality and excess mortality after 12-18 months with high mortality of COVID-19, primarily depends on what happened after 2020 (mortality displacement).

Mutations of virus during the follow-up may confound the analyses. It is generally assumed that new mutations were less fatal, but more contagious.[22,23] Our MRR estimates relies on an intricate interaction between the number of individuals been infected and natural immunity to COVID-19 in the population. If for example the delta virus infected less people and were

more fatal in 2020, infection with omicron in 2021 may affect more people, but the case fatality rate was lower, and this may yield a higher excess mortality as well as lower.

Another limitation is deaths of influenza. In Norway, there were hardly any influenza recorded during the first 15 months of the pandemic and not in Sweden either.[24] First in week 48 of 2021 did the number of patients admitted to hospitals because of influenza pass 5 per week in Norway, but hardly any deaths were observed during the study period.[25]

Role of funding source: None

Contributors

All authors conceived the study and contributed to the design and statistical approach. PHZ supervised the study. All authors have full access to the data and contributed to the analyses. All authors contributed to interpretation of the results. PHZ wrote the original draft, which was reviewed and edited by ÖH, RJ and SEM. All authors approved the final manuscript and accepted responsibility for the decision to submit for publication.

Data sharing

Aggregated data from the Statistics Norway, Statistics Sweden, Norwegian Institute of Public Health and Socialstyrelsen are publicly available. Aggregated data and analytical code (including adjustments for population growth) are available on request to the corresponding author.

Declaration of interests

We declare no competing interests.

Figure legends

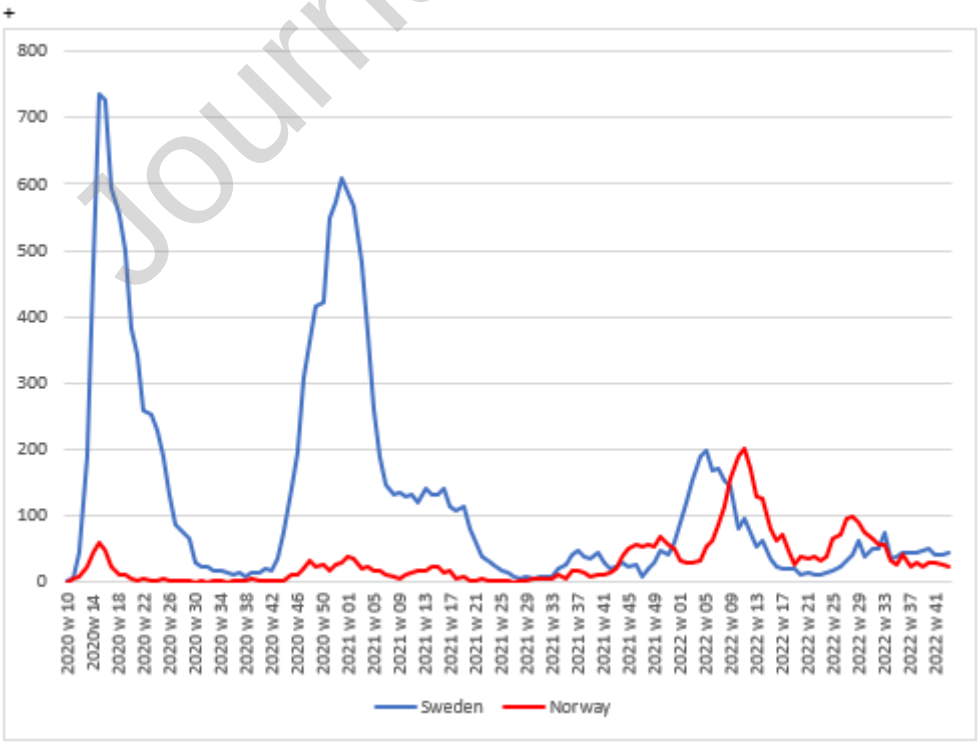

Figure 1. Number of COVID-19 related deaths in Norway (red line) and Sweden (blue line) by weeks. The rate ratio of COVID-19 related deaths in Sweden vs. Norway is calculated as (17521/10521556)/(4272/5425270) =2.11 (95% CI 2.05-2.19, P<0.0001).

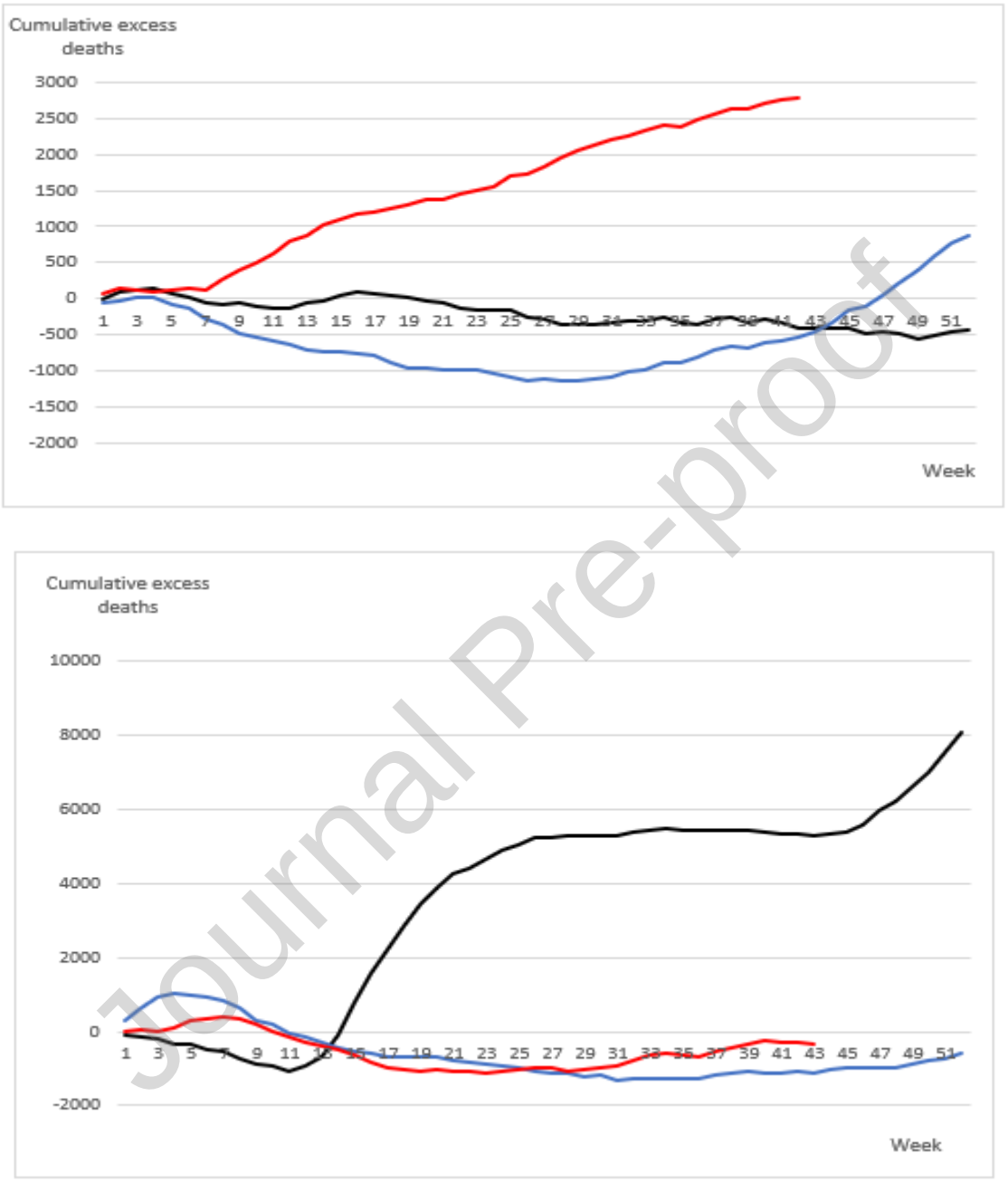

Figure 2. Cumulative excess deaths in Norway (fig 2a) and Sweden (fig 2b) by weeks for 2020 (black line), 2021 (blue line) and first 43 weeks in 2022 (red line).

References

1. Waaler HT, Dødelighetsforskjeller mellom Norge og Sverige. Kunnskapssenteret. Rapport 3-2005. Oslo: Norwegian Institute of Public Health, 2005. ISSN electronic: 1503-9544.

2. Raknes G, Strøm MS. Dødsårsaker i Sverige og Noreg 2010-20. Folkehelseinstitutt, Oslo: 2021. https://www.fhi.no/hn/helseregistre-og-registre/dodsarsaksregisteret/dodsarsaker-i-sverige-og-noreg-20102020/ Accessed May 10, 2023
3. Askim J, Bergström T. Between lockdowns and calm downs. Comparing the COVID-19 responses of Norway and Sweden. Local Government Studies. 2022; 48: 291-311.
4. Islind AS, Óskarsdóttir M, Cot C, Cacciapaglia G, Sannino F. The quantification of vaccine uptake in the Nordic countries and impact on key indicators of COVID-19 severity and healthcare stress level via age range comparative analysis. Sci Rep. 2022; 12: 16891.
5. Uusküla A, Jürgenson T, Pisarev H, Kolde R, Meister T, Tusler A, Suija K, Kalda R, Piirsoo M, Fisher K. Long-term mortality following SARS-CoV-2 infection: A national cohort study from Estonia. Lancet Reg Health Eur 2022; 18: 100394.
6. Nielsen J, Vestergaard LS, Richter L, Schmid D, Bustos N, et al. European all-cause excess and influenza-attributable mortality in the 2017/18 season: should the burden of influenza B be reconsidered? Clin Microbiol Infect 2019; 25: 1266-76.
7. WHO. Emergency use ICD codes for COVID-19 disease outbreak. Geneva: World Health Organization, 2022. https://www.who.int/standards/classifications/classification-ofdiseases/emergency-use-icd-codes-for-covid-19-disease-outbreak Accessed March 10, 2023.
8. Andersen PK, Væth M. Simple parametric and non-parametric models for excess and relative mortality. Biometrics 1989; 45: 523-35.
9. Zahl P-H. A linear non-parametric regression model for the excess hazard. Scan J Stat 1996; 23: 353-64.
10. Juul FE, Jodal HC, Barua I, Refsum E, Olsvik Ø, et al. Mortality in Norway and Sweden during the COVID-19 pandemic. Sc J Publ Health 2022; 50: 38-45.
11. Rizzi S, Søgaard J, Vaupel JW. High excess deaths in Sweden during the first wave of COVID-19: Policy deficiencies or 'dry tinder'? Scand J Public Health 2022; 50: 33-37.
12. Pedersen AG and Ellingsen CL. Data quality in the Causes of Death Registry. Tidsskr Nor Legeforen 2015;135: 768-70.
13. Brooke HL, Talback M, Hornblad J, et al. The Swedish cause of death register. Eur J Epidemiol 2017; 32: 765-73.
14. Six questions about Swedish healthcare. Article number 2017-9-8. Socialstyrelsen, Stockholm, 2017.
15. Nordic Health & Welfare Statistics – Homepage, www.nhwstat.org/
16. Wang H, Paulson KR, Pease SA, et al. Estimating excess mortality due to the COVID-19 pandemic: a systematic analysis of COVID-19-related mortality, 2020–21. Lancet 2022; 399: 1513–36.
17. Keep KP, Björk J, Kontis V, Parks RM, Bæk KT, Emilsson L, Lallukka T. Estimates of excess mortality for the five Nordic countries during the COVID-19 pandemic 2020−2021. Int J Epidemiol 2022; 51: 1722–32.
18. Tracking covid-19 excess deaths across counties. The Economist, Oct 20th, 2021. https://www.economist.com/graphic-detail/coronavirus-excess-deaths-tracker Accessed May 10, 2023.

19. von Brasch T, Cappelen Å, Holden S, Lindstrøm EL, Skretting J. COVID-19, tapt verdiskaping og finanspolitikkens rolle - Utredning for Koronakommisjonen. Report 2022/15. Oslo, Norway: Statistics Norway, 2022.
20. Kalischer Wellander B, Lötval J. God samstämmighet mellan olika svenska mått på avlidna i covid-19. Läkartidningen 2021: 118; 21120.
21. Socialstyrelsen. Causes of Death Registry. https://www.socialstyrelsen.se/statistik-och-data/register/dodsorsaksregistret/ Accessed May 10, 2023
22. Callaway E- Beyond Omicron: what's next for COVID's viral evolution. Nature 2021; 600: 204-7.
23. Adjei S, Hong K, Molinari NM, Bull-Otterson L, Ajani UA, et al. Mortality Risk Among Patients Hospitalized Primarily for COVID-19 During the Omicron and Delta Variant Pandemic Periods — United States, April 2020–June 2022. CDC. Morbidity and Mortality Weekly Report (MMWR). 2022; 71; 1182-9.
24. https://vgrfokus.se/2021/11/viktigt-med-hog-vaccinationstackning-mot-influensa-under-pandemin/ Accessed May 10, 2023.
25. https://www.fhi.no/contentassets/9e3ffd797020455da9bede9a50070e4c/vedlegg/2021-51-og-52-influensaovervaking-2021-2022-uke-51-og-52.pdf Accessed May 10, 2023.

Table 1. Number of all-cause deaths, exposure years and mortality rates (MR) per 100 000 with 95% confidence intervals (CI) by country, sex and age groups for the full calendar year of the period 2015-19, 2020 and 2021 and for the first 43 weeks in 2022.

		2015-19				**2020**				**2021**				**2022***			
		Deaths	Exp. years	MR	95% CI	Deaths	Exp. years	MR	95% CI	Deaths	Exp. years	MR	95% CI	Deaths	Exp. years	MR	95% CI
Norway	Men																
	Age 0-79 years	50 858	12 807 058	397	394 to 401	10 290	2 616 128	393	386 to 401	10 585	2 625 419	403	396 to 411	9257	2 640 685	351	343 to 358
	Age 80-89 years	32 212	357 176	9019	8920 to 9118	6456	77 011	8383	8180 to 8590	6631	79 887	8300	8102 to 8503	5917	82 317	7188	7006 to 7374
	Age ≥ 90 years	15 851	62 275	25 450	25 060 to 25 850	3262	13 423	24 300	23 470 to 25 150	3362	13 953	24 100	23 290 to 24 920	3181	14 330	22 200	21 430 to 22 980
	Women																
	Age 0-79 years	35 172	12 344 684	285	282 to 288	7119	2 520 742	282	276 to 289	7413	2 529 543	293	286 to 300	6470	2 544 292	254	248 to 261
	Age 80-89 years	35 160	531 298	6618	6549 to 6687	6744	108 469	6217	6070 to 6368	7042	110 422	6377	6229 to 6528	5910	111 418	5304	5170 to 5441
	Age ≥ 90 years	34 498	159 444	21 640	21 410 to 21 870	6705	31 807	21 080	20 580 to 21 590	6969	32 145	21 680	21 170 to 22 190	6046	32 228	18 760	18 290 to 19 240
Sweden	Men																
	Age 0-79 years	105 686	24 349 323	434	431 to 437	22 686	5 001 981	454	448 to 460	22 097	5 030 959	439	433 to 445	18 274	5 056 099	361	356 to 367
	Age 80-89 years	75 807	869 303	8720	8658 to 8783	17 273	190 634	9061	8926 to 9197	15 994	198 524	8056	7932 to 8182	13 459	210 551	6392	6285 to 6501

Age ≥ 90 years	41 711	146 601	28 450	28 180 to 28 730	9422	30 232	31 170	30 540 to 31 800	9422	31 224	30 180	29 570 to 30 790	6624	31 674	20 910	20 410 to 21 420
Women																
Age 0-79 years	73 171	23 595 210	310	308 to 312	15 248	4 833 594	316	311 to 321	15 005	4 861 733	309	304 to 314	12 846	4 883 110	263	259 to 268
Age 80-89 years	79 042	1 221 554	6471	6426 to 6516	16 681	253 770	6573	6474 to 6674	15 336	259 808	5903	5810 to 5997	13 211	269 733	4898	4815 to 4982
Age ≥ 90 years	79 395	341 195	23 270	23 110 to 23 430	16 814	69 084	24 340	23 970 to 24 710	15 133	70 078	21 590	21 250 to 21 940	9960	70 389	14 150	13 870 to 14 430

*Only the first 43 weeks in 2022

Table 2. Absolute mortality differences and mortality rate ratios (MRR) for the excess all-cause mortality rates by country and sex for the full calendar years of 2020 and 2021 and for the first 43 weeks in 2022 when using the incidence in period 2015-19 as the reference.

		2020 vs. 2015-19				**2021 vs. 2015-19**				**2022* vs. 2015-19**			
		Difference	95% CI	MRR	95% CI	Difference	95% CI	MRR	95% CI	Difference	95% CI	MRR	95% CI
Norway													
	Men	-7.42	-18.7 to 3.87 P=0.20	0.99	0.98 to 1.01 P=0.20	3.85	-7.43 to 15.1 P=0.50	1.01	0.99 to 1.02 P=0.50	64.7	53.4 to 76.1 P<0.0001	1.09	1.07 to 1.10 P<0.0001
	Women	-3.11	-4.29 to -1.93 P<0.0001	0.96	0.95 to 0.98 P<0.0001	-7.12	-18.9 to 4.68 P=0.24	0.99	0.98 to 1.01 P=0.24	25.4	13.6 to 37.2 P<0.0001	1.03	1.02 to 1.05 P<0.0001
Sweden													
	Men	65.5	56.6 to 74.4 P<0.0001	1.07	1.06 to 1.09 P<0.0001	-3.65	-5.16 to 12.5 P=0.42	1.00	0.99 to 1.01 P=0.41	-4.50	-13.3 to 4.28 P=0.32	0.99	0.98 to 1.00 P=0.31
	Women	24.7	15.6 to 33.8 P<0.0001	1.03	1.02 to 1.04 P<0.0001	-44.7	-53.7 to -36.6 P<0.0001	0.95	0.94 to 0.96 P<0.0001	-79.8	-88.7 to -70.8	0.91	0.90 to 0.92 P<0.0001

*Only the first 43 weeks in 2022

Table 3. Excess all-cause mortality rates (per 100 000 with 95% confidence intervals) and Covid-19 related mortality rates (per 100 000 with 95% confidence intervals) by country and sex for the full calendar years of 2020 and 2021 and for the first 43 weeks in 2022 using data in Figures 1-2 (mean weekly number of deaths in the period 2015-19 divided by the population in 2019 as the reference). Cause-specific mortality of covid-19 are based on registrations of covid-19 infections as underlying cause of deaths or contributing causes of deaths.

	2020					**2021**					**2022***				
	Excess mortality	95% CI	Covid-19 Deaths	Covid-19 mortality	95% CI	Excess mortality	95% CI	Covid-19 deaths	Covid-19 mortality	95% CI	Excess mortality	95% CI	Covid-19 deaths	Covid-19 mortality	95% CI
Norway															

	Men	-2.0	-2.6 to -1.5	251	9.3	8.2 to 10.5	16.5	15.0 to 18.1	552	20.3	18.6 to 22.1	76.3	72.7 to 80.0	1556*	68.7	65.4 to 72.2
	Women	-14.5	-16.0 to -13.1	226	8.5	7.4 to 9.7	16.3	14.8 to 17.9	414	15.6	14.0 to 17.1	47.8	45.0 to 50.8	1273*	57.3	54.2 to 60.5
	Sum	-8.2	-9.0 to -7.4	477	8.9	8.1 to 9.7	16.4	15.3 to 17.5	966	17.9	16.8 to 19.1	62.2	60.0 to 64.5	2829*	63.1	60.8 to 65.4
Sweden																
	Men	91.4	88.9 to 94.1	5069	97.1	94.4 to 99.8	30.0	28.6 to 31.5	3106	59.0	57.0 to 61.2	-10.2	-11.1 to -9.4	1574	35.9	34.2 to 37.8
	Women	64.3	62.1 to 66.5	4372	84.8	82.3 to 87.4	-42.0	-43.8 to -40	2213	42.6	40.9 to 44.4	4.2	3.6 to 4.8	1168	27.0	25.5 to 28.6
	Sum	77.3	75.6 to 79	9441	93.8	92.1 to 95.7	-5.7	-6.2 to -5.3	5319	48.4	47.1 to 49.8	-4.2	-4.6 to -3.8	2742*	31.5	30.3 to 32.7

*First 43 weeks in 2022 only.

Research in context

Evidence before this study

Comparing COVID-19 mortality in Norway and Sweden is of great interest because Norway introduced a very strict lockdown lasting until the population was fully vaccinated while Sweden did not. Norway and Sweden are countries with very similar public health care systems, genetically very similar populations, and individuals who are exposed to similar risk factors for most diseases. Comparing mortality is a natural experiment.

Official number of COVID-19 related deaths for the period 2020-22 were 18295 (Sweden) and 4896 (Norway). Sweden has twice as many citizens and COVID-19 mortality rate is twice as high as in Norway. In contrast, cumulative excess mortality rates are very similar for the period. However, excess mortality rates are negative in about half of the 3-year study period for both countries.

We searched OVID for articles published in English from March 1, 2020, to April 1, 2023, using the following search terms: (“COVID” OR “coronavirus”) AND (“excess mortality” OR “COVID mortality*“) AND (“Norway” OR “Sweden”). The search identified 51 articles, 13 of which reported primary data on COVID-19 related deaths or excess mortality, but no articles compared countries for the period 2020-22.

We did not find any articles discussing the validity of the official vital COVID-19 statistics. We found two reports in Norwegian and Swedish, respectively, studying overreporting when comparing to standard methods used in the national causes of death registries. Excess mortality rates varied with the study period and the choice of model for calculation expected mortality in the absence of COVID-19 pandemic.

Added value of this study

COVID-19 related mortality and excess mortality are both two biased estimates and the biases vary over time. Mortality displacement is a serious problem after 12-18 months with pandemics; the excess mortality becomes negative even though many still die of COVID-19. Strict lockdowns also generate problems when calculating excess mortality, excess mortality becomes negative.

This study suggests an intuitive method to calculate and compare COVID-19 mortality in Norway and Sweden adjusted for mortality displacement and bias in official number of COVID-19 deaths over a 3-year period.

Implications of all the available evidence

Comparison of COVID-19 deaths and excess mortality between countries when the validity of official COVID-19 death statistics is not comparable is a questionable practice. Comparison of excess mortality rates is confounded by length of the study period, mortality displacement, how strict lockdowns were imposed and probably also of vaccines.

Declaration of Competing Interest

The authors have no competing interests to declare