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The Hammer vs Mitigation—A comparative retrospective register study of the Swedish and Danish national responses to the COVID-19 pandemic in 2020

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In the efforts to dampen the COVID-19 pandemic, governments are compelled to outweigh disease control efforts to the possible negative consequences of closing large parts of society. Although Denmark and Sweden are alike in political organization and health care, national responses to the 2020 COVID-19 epidemic differed noticeably. Denmark initiated a hard lock down followed by an outbreak control strategy (the so-called "hammer and dance" strategy), while Sweden's strategy was based on advising on social distancing, while keeping society open (a so-called mitigative strategy). The objective of this study is to describe national epidemic control strategies in Denmark and Sweden in 2020, and compare the epidemic dynamics in the two countries, with respect to number of COVID-19 cases, admissions to intensive care and mortality. Data on epidemic control efforts and COVID-associated morbidity/mortality were downloaded from official government and epidemic surveillance webpages and comparatively described using basic statistics. Overall, we found "the hammer" resulted in better epidemic control during 2020 with less COVID-19-associated admissions to intensive care and lower mortality.

Key words: COVID-19; epidemiology; pandemic; SARS-CoV-2; virology.

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The SARS-coronavirus 2 (SARS-CoV-2) most likely crossed from bats to humans in November 2019 [1]. Human-to-human transmission among citizens in Wuhan, China, was evident by December 2019. Because of the high infectivity and asymptomatic/pre-symptomatic spread of the virus, initial containment strategies failed and WHO declared the COVID-19 outbreak a Public Health Emergency of International Concern (PHEIC) by January 30, 2020. Today (early January 2021), 88.5 million people have been infected worldwide and 1.9 million with fatal outcome. Disease burden and control measures largely depend on national strategies for disease control and prevention, which again reflect socio-economic resources and organization. Scandinavian countries have strong historical, political, and linguistic ties. Sweden and Denmark are neighboring nations, alike with respect to population, political organizations, and healthcare systems. However, because of constitutional differences in the governments' authorization to restrict personal freedom rights, the national responses to the COVID-19 epidemic have differed substantially between the two countries.

In March 2020, Denmark followed the strategy of many other European countries and imposed a four-week national lockdown in order to control the epidemic and avoid overwhelming of the healthcare system. The lockdown was possible because extensive changes to the legislation around epidemic diseases were adopted by the Danish parliament, provisionally empowering the Minister of Heath to bypass basic constitutional rights in pandemic times. The strategy has been nicknamed

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"the hammer and the dance" because of the strong initial nationwide response to the pandemic followed by handling of local outbreaks. Sweden, on the other hand, was not able to bypass basic rights and thus adopted a less restrictive strategy, based on social distancing while keeping the society open, a so-called mitigative strategy.

OBJECTIVES

In the following, we describe the differences in responses to the pandemic in Denmark and Sweden with respect to different aspects of society and discuss how this may have affected the national courses of the epidemic with respect to number of cases infected with SARS-CoV-2, admissions to intensive care units and mortality.

MATERIALS AND METHODS

Data on number of performed SARS-CoV-2 tests performed in Sweden and Denmark, number of cases diagnosed with SARS-CoV-2, number of COVID-19-associated admissions to ICU (Sweden), and COVID-19-associated mortality were downloaded from the ECDC webpage [2–5]. Data on Danish COVID-19-associated ICU admissions were obtained from Statens Serum Institut (SSI) [6].

Data on restrictive interventions in the society enforced by law by the Danish government were obtained through the webpage www.coronasmitte.dk [7] and from the Folkhälsomyndigheternes webpage (Folkhälsomyndigheten—Myndigheten för folkhälsofrågor (folkhalsomyndigheten.se))[8]

Estimates of excess mortality were obtained through the euroMOMO webpage [9].

Study design

Setting

The study design is a retrospective register study comparing the restrictive efforts to control the COVID-19 epidemic in Denmark and Sweden to the measures of the recorded disease burden in 2020 measured by the number of recorded new cases of SARS-CoV-2, number of COVID-19-associated admissions to intensive care, and number of COVID-19-associated mortality and estimates of excess mortality, in 2020. The data were obtained from official webpages in early January 2021. Inclusion of data was limited to 2020.

Participants

All cases recorded to be COVID-19 related (number of new cases, admissions to intensive care and mortality) by the ECDC webpage were included in the study.

Variables

The number of new cases of SARS-CoV-2 was recorded as actual numbers of positive SARS-CoV-2 tests (PCR throat swaps) reported by local governments to the ECDC per day. The data were not filtered for the same person having multiple positive test results. The number of COVID-19-associated admissions to intensive care was obtained from ECDC and SSI, based on daily records from the intensive care units. According to the ECDC, a COVID-19 death is defined for surveillance purposes as a death resulting from a clinically compatible illness in a probable or confirmed COVID-19 case, unless there is a clear alternative cause of death that cannot be related to COVID disease (e.g., trauma). There should be no period of complete recovery between the illness and death. A death due to COVID-19 may not be attributed to another disease (e.g., cancer) and should be counted independently of pre-existing conditions that are suspected of triggering a severe course of COVID-19.

Quantitative variables

All cases were reported in actual numbers per day (tests, number of new cases of SARS-CoV-2, number of COVID-19 admissions to ICU, and COVID-19-associated deaths).

Bias

Testing activity was significantly higher in Denmark compared to Sweden (by 5 times), thus significantly biasing the recorded number of new SARS-CoV-2 cases. For this reason, the number of new SARS-CoV-2 cases was not compared between countries. Estimates of disease burden were instead based on mortality and ICU admissions.

Demographics of Sweden and Denmark

Sweden is the largest country in Northern Europe with 450 295 square kilometers (173 860 square miles). Sweden is connected to Denmark through a bridge–tunnel across the Oresund strait. The capital city is Stockholm. Sweden has a total population of 10.3 million inhabitants [10], of which 20% are children under the age of 18. The average population density is just over 25 people per km^2 (65 per square mile). Eighty-seven percent of population live in urban areas, which cover 1.5% of the entire land areas. One in five Swedish residents are born outside of Sweden [10]. Stockholm is home to 22% of swedes.

In contrast, Denmark is one of the smallest countries in Northern Europe. Denmark consists of the peninsula Jutland and 443 designated islands, with the largest being Zealand. Denmark has a total area of 42 924 Km^2 (16 573 square miles) and a population of 5.82 million [10]. The population density of Denmark is 137 per km^2 (355 per square mile). 88% of Danes live in urban areas. Children under the age of 18 make up 20% of the total population. People of foreign heritage make up 13.3 % of Denmark's population [10].

The national pandemic response in Denmark: "the hammer and the dance"

The Danish response to the COVID-19 pandemic was nicknamed "the hammer and the dance" because of its "strike hard first with lockdowns" strategy. The strategy has also been applied by many other European countries.

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To enable a national lockdown strategy, the Danish government had provisionally to change the Danish Epidemic Act ("Epidemiloven"). The change in act was urgently processed and adopted by March 11, 2020. Because of this change, the Minister of Health was periodically able to close schools, business/shops, transportation, churches, concerts, and other events, for example, festivals. Under normal conditions and in accordance with the constitutional rights in Denmark, this would not by legal.

The earliest epidemic response (quarantine of cases, from the occurrence of the first COVID-19 case in Denmark February 27 to March 11): The national strategy was based on testing persons with symptoms only and to place infected persons in home quarantine or isolation at a hospital ward. The authorities advised that events with more than 1000 people should be canceled or postponed.

The first lockdown response (March 13–April 13): With the increase in number of daily cases and evidence of local transmission in Denmark, the strategy for handling of the pandemic switched to a national lockdown, aiming at avoiding overburdening of the healthcare system. People working in non-essential functions in the public sector were ordered to stay at home for two weeks. In the private sector, employers were urged to allow their employees to stay at home in the same period. All secondary education institutions like high schools, universities, libraries, indoor cultural institutions, and similar were closed, initially for two weeks. Hospitals closed non-acute functions such as outpatient visits and planned operations. By March 16, also all primary schools, daycare, and similar institutions were closed for two weeks. The municipalities established limited daycare for children whose parents had essential functions in society. On March 23, the lockdown was extended to April 13.

Gradual reopening (April 14–October 2020): By May 12, the reopening of the society was followed by an offensive testing strategy of both symptomatic and asymptomatic individuals aiming at strengthening contact tracing.

Increase of restrictions in fall In early fall, a rise in incidence of COVID-19 cases led to a gradual closing of activities in society. From September to October 2020, the maximum size of public gatherings was reduced from 100 to 50 persons, and closing hours for restaurants, cafés, and bars were restricted to 10 PM. Further, use of facemasks in such settings besides in public facilities such as hospitals, offices of private practitioners, and other healthcare centers became mandatory. In early October 2020, the government issued an order of killing of all mink in Denmark because of identification of SARS-CoV-2 variants associated with farmed mink that showed moderately decreased sensitivity to neutralizing antibodies, and because of the large reservoir for transmission that mink farms represented. In addition, municipalities where the mink variants had been identified were locked down.

The second lockdown As infection rates continued to increase, a national lockdown was imposed by December 2020. Mass testing among young adults aged 15–25 years was initiated because of increased transmission in this group. At December 9, public gatherings were restricted to a maximum of 10 persons in addition to recommendations of a maximum of 10 persons in private homes and of social contacts. Also, the following were closed—schools from 5th grade and up, after-school activities, universities, restaurants, café and bars, cultural institutions, and liberal businesses such as hairdressers. Hospitals were closed for non-acute activities. Indoor sports activities were banned, and work from home in all public and private sectors was encouraged. By December 17, all schools and all shops except groceries and pharmacies were closed.

For specific initiatives, see Table 1.

The National pandemic response in Sweden: "mitigation"

The Swedish national response to the COVID-19 pandemic was implemented by the Swedish Government on advice from the Swedish Public Health Agency (short PHA, in Swedish: "Folkhälsomyndigheten"). Unlike other European countries, Sweden did not impose a lockdown but had a national strategy of mitigation while keeping large parts of the society open. The national pandemic response has been described in detail by Professor Jonas Ludvigsson [11]. The reasons for avoiding a general lockdown in Sweden are partly explained by the legal framework for the pandemic in Sweden [12]. The Swedish Constitution has stipulated that "Swedish citizens have the right to move freely within Sweden and leave the country." Although the Swedish Infectious Diseases Act can restrict individuals, it does not allow for a general lockdown, which is why so many COVID-19 measures in Sweden have been voluntary, rather than compulsory. The constitution also stipulates that the government cannot influence how individual government agencies carry out their work, especially regarding individual citizens. The Swedish Constitution also stipulates that municipalities enjoy local self-government. These are responsible for infrastructure, housing, business development, schools, and care of the elderly. However, during spring and winter 2020, Sweden did switch to distance learning for children over 16 years of age, recommended facemasks in public transport during rush hours, and restricted the number of people per table in restaurants by December 2020.

For specific initiatives, see Table 1.

Denmark had a more offensive test strategy compared to Sweden

With over 11.5 million unique tests being performed in over 4 million people by January 2021 [6], Denmark has performed more SARS-CoV-2 tests than Sweden and many other countries. Testing is performed by throat swaps analyzed by real-time polymerase chain reaction (RT-PCR) specific for SARS-CoV-2 RNA. Unfortunately, an official number of the total number of tests performed in Sweden in 2020 is not available. Figure 1 illustrates the weekly numbers of tests performed in both countries [2]. In Denmark, the weekly number of SARS-CoV-2 tests gradually increased from 0 to 25 000 in March 2020 to 450 000–500 000 in most of December 2020. In week 51, over 800 000 tests were performed in a single week. The greater test activity in week 51 was partly due to mass testing of young adults between 15 and 25 years of age and the upcoming Christmas holiday. In March 2020, the weekly number of tests in Sweden was like that of Denmark, around 10–25 000, but in December 2020, only a little over 250 000 tests per week. Consequently, the larger

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Table 1. Restrictive initiative in 2020 various areas of society [7, 8]

Designation	Denmark	Sweden
Workplaces	March 13–April 13, December 16-present: non-essential functions in the public sector ordered to stay at home. Private sector urged to allow employees to stay at home	March 17—present, advise on work from home when possible
Quarantine	Infected households were advised to quarantine themselves during the epidemic.	Infected households were not advised to self-quarantine
Facemasks	August 22 public transportation October 2020 in hospitals, supermarkets, restaurants, bars and cafés, and in all situations where social distancing was not possible	Recommended in public transportations during rush hours from December 18
Public gatherings and physical distance	Restriction on public gatherings: February: 1000 people. March 11–16: 100 March 17 :10 June 15:50 October 26:10 Gatherings were not prohibited in private homes. Social distancing of 2 meters was mandatory. By April 25, a ban for gathering in certain areas of Copenhagen city was introduced.	Public gatherings of more than 500 people were banned on March 11. and reduced to less than 50 two weeks later. On April 1, the Folkhälsomyndigheten (PHA) emphasized the importance of physical distancing to reduce transmission, which was the key component of the mitigation strategy since the beginning of the pandemic. Distances of 1.0, 1.5, or 2.0 meters were recommended depending on the situation.
	Kindergartens/daycare	Closed from March 13 to April 6. Emergency care for children with parents with essential functions in society was available
Open		
Elderly/Nursing homes/ inpatients	From March 13 to June 2020, visits to nursing homes for the elderly were prohibited by law with few exceptions.	On March 10th, the public was advised to avoid unnecessary visits to hospital wards or elderly care facilities. Private elderly care providers and nursing facility providers banned visits shortly hereafter, while municipal nursing facilities banned visits from March 30. The PHA urged people over 70 years or above to avoid close contact with others from March 16. On March 10, the PHA urged people with COVID-19 symptoms to avoid working with elderly or other people at risk.
Schools	March 13 – April 6 and December 4-present all schools including schools for teenagers older than 16 years of age and universities were closed and replaced by online or parent-based learning.	On March 19—August, December—present children over the age of 16 switch to online learning
Restaurants/ nightlife	Closed from March 13 to May 20. Restaurants and bars still close at 10 pm. Alcohol sale banned after 10 pm (October 2020-December 2020)	Open, however, advice to keep distance. December 18 maximum 4 people at a table and ban alcohol sale after 8pm
Testing strategy	February to June: Testing focused on people with symptoms relating to COVID-19. June 2020 test capacities increased to include patients with mild or no symptoms and people exposed to the disease. Routine screening of hospitalized individuals was introduced as well as screening of certain high-risk hospital staff. During summer 2020 scaling up testing so all individuals can be tested also non-symptomatic	The Government requested increased virus testing on March 4 and April 17. Testing initially focused on patients with symptoms for severe COVID-19. During the early months of the pandemic, there was a lack of test capacity in Sweden. In June, test capacities had increased so individuals with milder symptoms could be tested. Self-testing using nostril and mouth swaps was also introduced
National border	Closed March 13 to April 13	Open.

test activity in Denmark (5 times higher per million inhabitants) most likely has a large impact on the recorded cases in the two countries and numbers of recorded cases are thus not comparable. We have chosen to describe the number of recorded cases because it reflects the dynamics in the epidemic. Differences in admissions to ICU and

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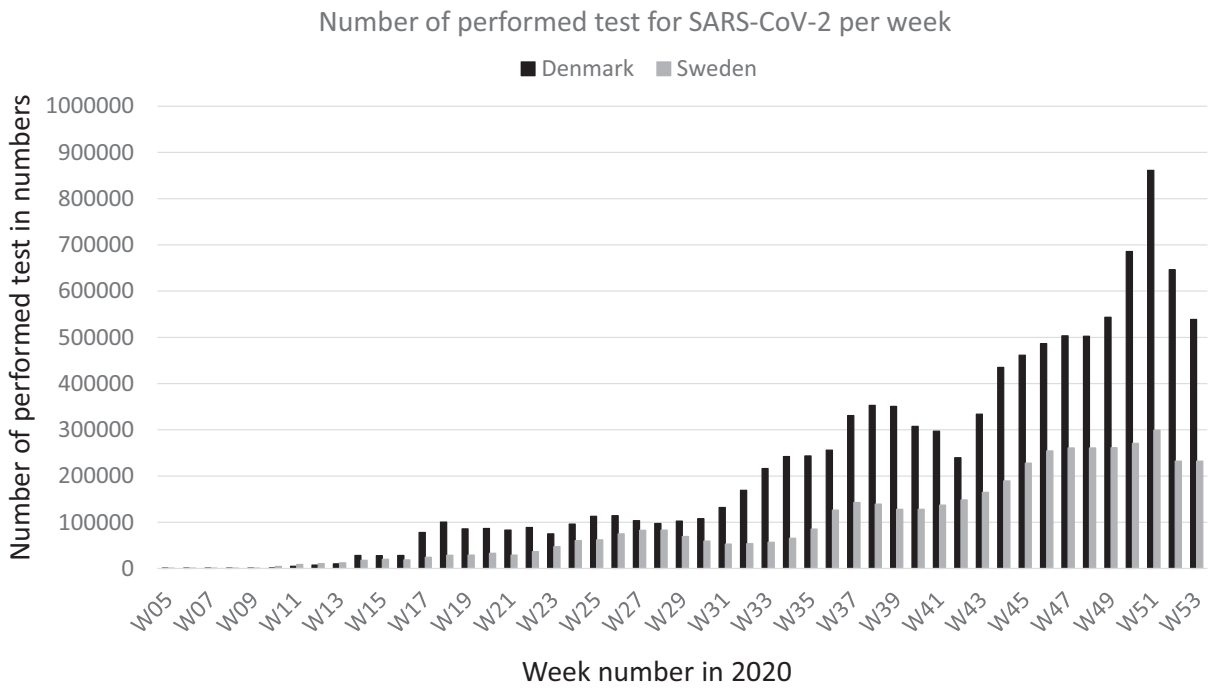

Fig. 1. The number of test for SARS-CoV-2 performed per week in Denmark and Sweden, data from ECDC [2].

mortality are probably more accurate reflections on disease burdens in the two countries.

The epidemic in crude numbers

In Sweden, the first case of COVID-19 appeared January 31. The person had visited the Wuhan region in China and fell ill with respiratory symptoms shortly after arriving to Sweden [3]. Local transmission was not detected until end of February 2020. As of January 1, 2021, a total of 482 482 people have been diagnosed with COVID-19 in Sweden (46 842 cases per million), and there has been 9262 COVID-19-related deaths [4]. Large regional differences in the spread of COVID-19 characterize the epidemic in Sweden. The vast majority of COVID-19 cases occurred in the capital city of Stockholm with a total of 125 150 cases [4], while other parts of Sweden have seen considerably fewer cases.

In comparison, the first case of COVID-19 in Denmark was reported on February 24, three weeks after the first case in Sweden. As of today, a total of 176 837 cases (30 384 cases per million) have been diagnosed with COVID-19, and 1487 deaths have been noted [4]. Most cases have been reported in the capital region of Copenhagen (61 583 cases) relative to other Danish regions.

Serology may better reflect the true burden of disease in a given country or region because serology-based screens are independent of testing and reporting strategies. Large population-based serology surveys from Denmark and Sweden are in preparation, but unfortunately not yet available. However, a survey of 3272 adults employed by *Falck* in Sweden and Denmark from June 22 to August 10, 2020, found a lower seroprevalence among Danish Falck employees than among those from Sweden (2.8% vs 8.3%) supporting a greater disease burden in Sweden compared to Denmark [13]. Additionally, a survey of seroprevalence among Swedish healthcare workers between April 14 and 8 May 2020 found 19.1% of the 2149 healthcare workers to be IgG positive [14]. A similar study of Danish healthcare workers between April 15 and April 23 showed a seroprevalence of 4.04% (1163 of 28 792), with frontline personnel having a higher seropositivity compared to healthcare workers in other settings (4.55% vs 3.29%) [15]. Although these studies may not be representative of the general populations, they do suggest a greater disease burden in Sweden compared to Denmark.

The course of the epidemic in the two countries

A biphasic curve of the epidemic with peaks in spring and fall/winter of 2020 was observed in both countries. Figure 2 illustrates the daily number of cases diagnosed with SARS-CoV-2 [4]. Due to differences in testing strategies, the numbers are not entirely comparable but still give an impression of the development of the epidemic in the two countries. In Sweden, the reported number of new daily cases rose from the introduction of the virus in February 2020 to around 600–800 in April–May, further increasing to 1000–1500 during June. The number of daily cases decreased during July and August to around 100–300. However, in the fall of 2020, the daily number of new cases quickly rose from around 4000 per day by mid-October, to 7000–8000 cases by day by December.

In contrast, the spring epidemic in Denmark peaked in early April 2020 with around 500 new cases on a single day, followed by a gradual decease. Already by early

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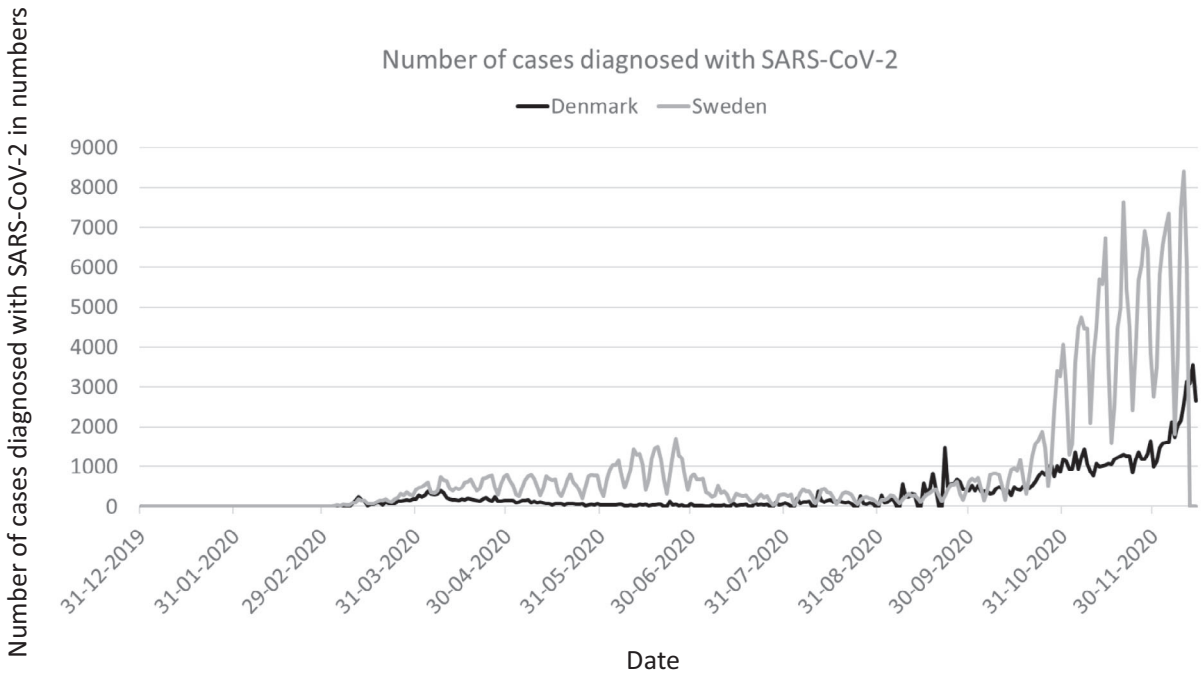

Fig. 2. The number of cases diagnosed with SARS-CoV-2 in Denmark and Sweden in 2020, data from ECDC [4].

May, the epidemic curve declined with a daily number of cases decreasing to 20–50 per day remaining at this low level through June, July, and August. As in Sweden, a subsequent increase in the daily numbers during the fall of 2020 was observed in Denmark. The increased number of cases occurred about a month earlier in Denmark (September compared to October). Already by September 2020, the number of new daily cases had increased to around 500, peaking in December with up to 3000 daily cases.

Taken together, in both countries, high numbers of cases in spring and fall/winter with in-between low numbers during the summer were observed. The decrease in the number of cases in late spring, 2020, occurred two months earlier in Denmark compared to Sweden, leading to low numbers for four months (May, June, July, and August) compared with three months in Sweden (July, August, and September). The fall/winter acceleration of the epidemic was less steep in Denmark compared to Sweden, possibly because of the re-initiation of restrictive efforts.

Admission to intensive care and mortality

Throughout the epidemic in 2020, the number of COVID-19 cases in intensive care units (ICU) has been disproportionally higher in Sweden compared with Denmark, Fig. 3 [5], (www.ssi.dk). During the peak of the epidemic in the spring, number of ICU admissions in Sweden was twice as high as those in Denmark (35–40 new daily admissions in Sweden vs 15–20 in Denmark). In Denmark, the number of ICU admissions decreased steeply from mid-March, while Sweden experienced a high number of ICU admissions throughout the spring and early summer (3–4 times the numbers of Denmark), with a rise again in autumn/winter. During November, the number in ICU admissions increased in both countries, 4 times greater in Sweden than in Denmark.

The cumulative number of COVID-19-related deaths in Sweden as of January 2020 was 9262 (899 per million inhabitants) compared to 1487 in Denmark (255 per million inhabitants) [4]. Figure 4 illustrates the number of daily COVID-19-related deaths [4]. The biphasic shape of the mortality curves in the two countries resemble those of the epidemic curves. In both countries, COVID-19-associated mortality peaked in spring in mid-April with 80–100 daily registered COVID-19-associated deaths in Sweden compared to 15–20 in Denmark. Similar to the numbers of daily infections and ICU admissions, the COVID-19-associated mortality in Denmark decreased to low numbers already by the end of May, whereas in Sweden the decrease in mortality first occurred by the end of July. Mortality rose during autumn/winter in both countries, again with a relatively steeper increase in Sweden than in Denmark. In Sweden, mortality increased from 10 to 60 daily COVID-19-related deaths from end of October to mid-November, whereas COVID-19-related deaths in Denmark only rose from about 5–15 per day in the same period.

Additionally, 2020 estimations from the EuroMOMO [9], a European mortality monitoring activity, suggest an excess mortality in Sweden between weeks 13 and 23, especially among individuals older than 65 [14]. For Denmark 2020, excess mortality was within the normal ranges for all age groups, throughout 2020. Excess death in Sweden, but not in Denmark from mid-February through May 2020 was also found by Kontis et al. [16]. Although Z-scores are not directly comparable between countries,

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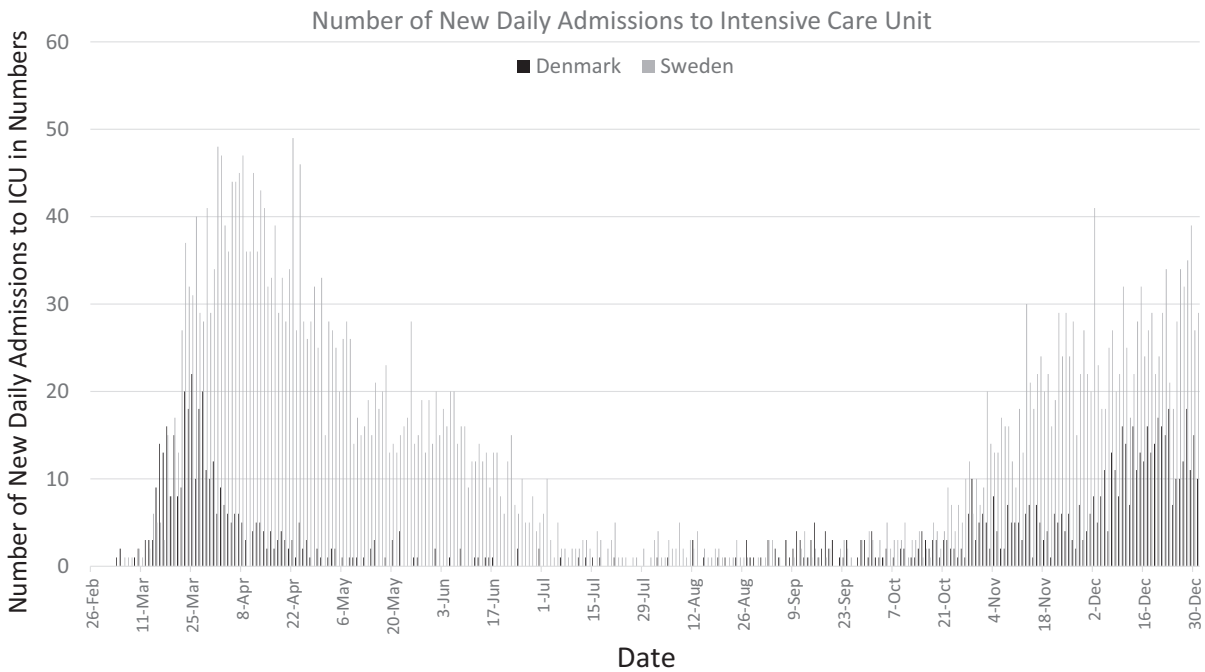

Fig. 3. The number of new daily admission to intensive care unit in Denmark and Sweden in 2020, data from ECDC [5] and Statens Serum Institut in Denmark.

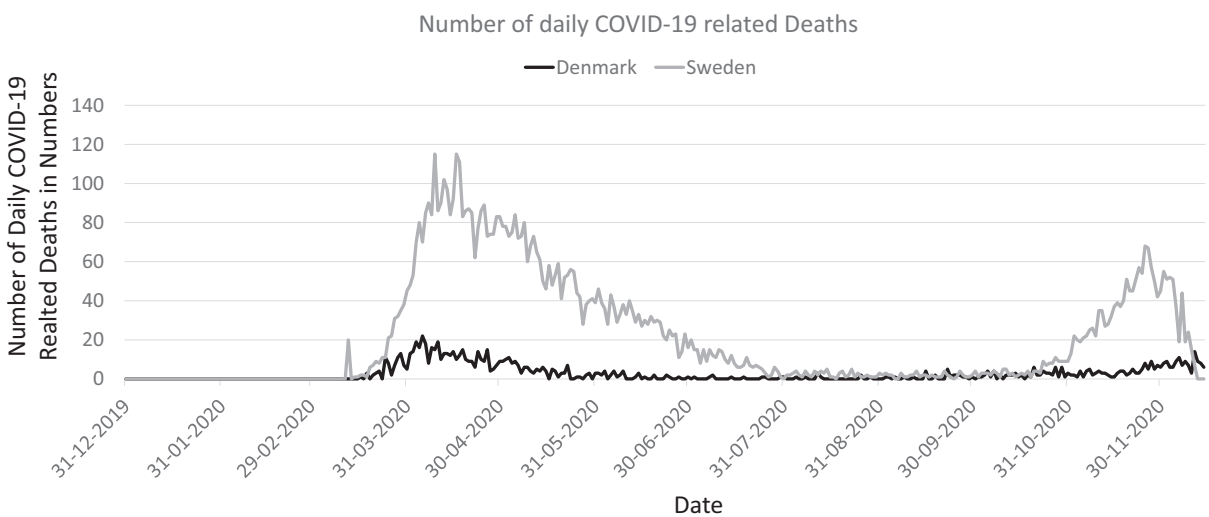

Fig. 4. The number of daily COVID-19-related deaths in Denmark and Sweden, data from ECDC [4].

the results indicate a greater COVID-19-related mortality in Sweden compared to Denmark. Figure 5 depicts 2020 excess mortality in Sweden and Denmark [14].

Discussion

Denmark and Sweden are highly alike when it comes to cultural, socioeconomic, and healthcare structures. However, differences in political organization and constitutional rights have led to very different strategies for handling of the COVID-19 pandemic. Denmark quickly adopted extensive provisionary legislative changes in order to bypass constitutional rights and to enforce national lockdown to avoid overburdening of the healthcare system. This resulted in closing of childcare, schools, borders, restaurants and nightlife, non-essential shops as hairdressers, and such. In addition, visits to nursing homes were restricted and employees in the public sector with non-essential functions were referred to work from home. Hospitals halted non-acute activities. In addition,

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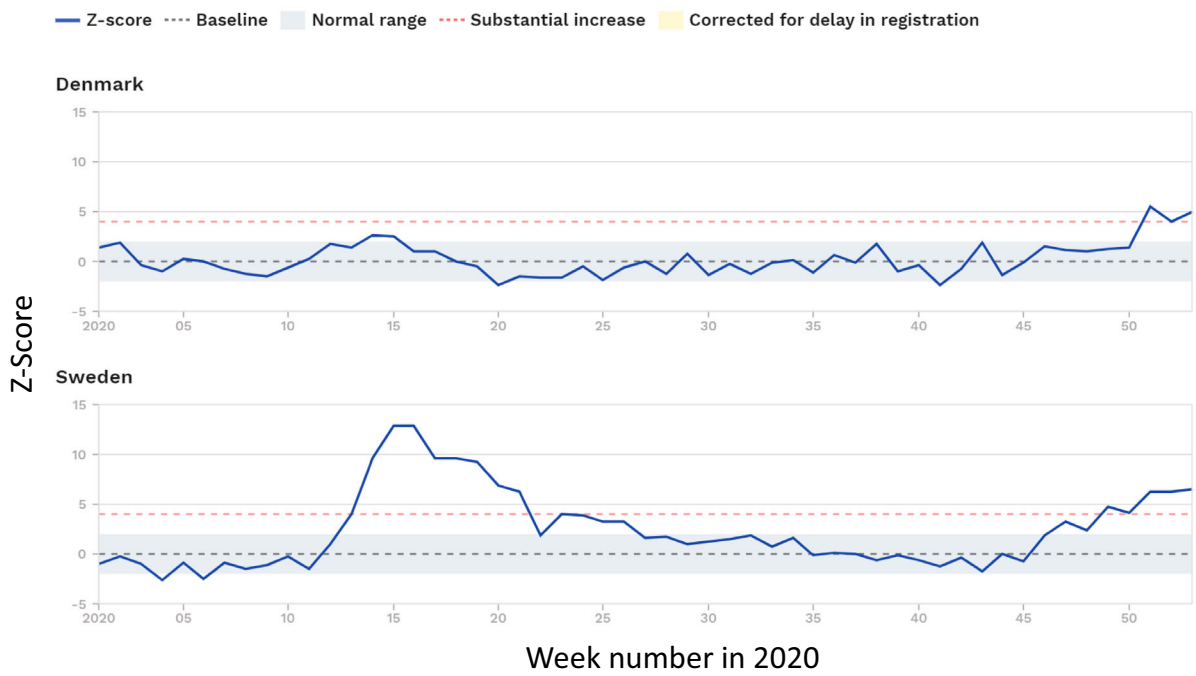

Fig. 5. Graph of the weekly Z-scores at the national level in Sweden and Denmark in 2020, form EuroMomo webpage (euromomo.eu), [14].

facemasks were required from early fall in public transportation and later in all public spaces and shops. Sweden did not bypass constitutional rights and thus kept the society running with advice on distancing and avoidance of social gatherings, although schools for children older than 16 years of age were closed during the peaks of the epidemic in spring and winter of 2020.

We suggest that the different strategies for handling of the COVID-19 pandemic may have resulted in differences in the course of the epidemic in the two countries. Before the Danish lockdown, incidence rates in the two countries were very similar but diverged immediately hereafter, resulting in a steep reduction in new COVID-19 cases in Denmark but a remaining high number of cases in Sweden during May and June. In the fall of 2020, Denmark experienced a recurrence of the epidemic earlier than Sweden. A factor playing a role in this could be that family celebrations such as weddings and confirmations banned in the spring were postponed to the fall.

While the recurrent epidemic in the fall showed a relatively steep increase in Sweden, Denmark experienced a more gradual increase in the number of cases, allowing for better preparedness in hospitals. Thus, "hammering" down the epidemic resulted in a reduction in the number of cases in the spring almost two months earlier in Denmark than in Sweden and a less steep increase in the number of cases during fall/winter.

The higher number of COVID-19 cases in Sweden compared to Denmark also resulted in a larger number of critically ill COVID-19 patients in Sweden. In the spring, Sweden had to double the number of intensive care beds. In December, lack of specialist staff to support intensive care units led the director of Region Stockholm Healthcare to request training of more specialized staff from the National Board of Health and Welfare [17].

Likewise, Sweden have experienced higher death rates than Denmark, although the healthcare system as such has not been overwhelmed. The European mortality monitoring activity (EuroMOMO) has estimated an excess mortality in Sweden in 2020 compared with previous years. Because Denmark and Sweden have similar population demographics and healthcare systems, our interpretation is that a larger incidence of COVID-19 cases in Sweden may have resulted in higher morbidity and mortality. Positively, although Sweden kept schools for children under the age of 16 open, a low incidence of severe COVID-19 among school children and children of preschool age was observed, with only 15 children being admitted to the intensive care units and no COVID-19-related deaths among this age group [18].

A potential concern of a lockdown in Denmark was the earlier re-occurrence of the epidemic in the fall that may partly be explained by the many social activities and celebrations postponed from spring. Still, this small increase in number of cases did not impede control of the epidemic at large. However, the relative contribution of the individual interventions is not clear.

In conclusion, differences in control strategies rooted in constitutional differences and health policies may, in our opinion, have led to a higher burden of COVID-19 in Sweden than in Denmark in 2020. However, public health measures against the epidemic affect many aspects of society including, for example, economic and social aspects. Therefore, the chosen initiatives are based on considerations and priorities that may vary between the countries.

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