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## Changes in testing and incidence of *Chlamydia trachomatis* and *Neisseria gonorrhoeae* – the possible impact of the COVID-19 pandemic in the three Scandinavian countries

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### ABSTRACT

**Background:** This study aimed to investigate what impact the COVID-19 pandemic and its associated restrictions had on *Chlamydia trachomatis* and *Neisseria gonorrhoeae* infections in Sweden, Denmark and Norway, countries with very different governmental strategies for handling this pandemic.

**Methods:** Retrospective analysis of data collected via requests to Swedish regions and to health authorities in Denmark and Norway. The data were collected for the years 2018–2020 and the data from Sweden were more detailed.

**Results:** When the pandemic restrictions were installed in 2020, the number of reported chlamydia cases decreased. The decline was most pronounced in Norway 10.8% (2019:  $n = 28,446$ ; 2020:  $n = 25,444$ ) while it was only 3.1% in Denmark (2019:  $n = 35,688$ ; 2020:  $n = 34,689$ ) and 4.3% in Sweden (2019:  $n = 34,726$ ; 2020:  $n = 33,339$ ). Nucleic acid amplifications tests for chlamydia decreased in Sweden (10%) and Norway (18%) in 2020 compared to 2019, while in Denmark a 21% decrease was noted in April 2020 but thereafter increased to a higher level than 2019. The number of reported gonorrhoea cases decreased in Sweden (17%) and in Norway (39%) in 2020 compared to 2019, while a 21% increase was noted in Denmark.

**Conclusions:** Pandemic restrictions had an impact on the number of reported chlamydia infections in all three countries, but only temporarily and did not seem to be correlated to the restriction levels. The number of reported gonorrhoea infections in Sweden and Norway significantly decreased but not in Denmark. Pandemic restrictions appear to have had a limited effect on the spread of chlamydia and gonorrhoea.

### KEYWORDS

COVID-19  
sexually transmitted infections (STI)  
chlamydia  
gonorrhoea  
*Chlamydia trachomatis*  
pandemic

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## Introduction

The World Health Organization (WHO) declared the COVID-19 outbreak a global emergency on 30 January 2020 [1]. The aetiological agent of COVID-19 is a novel coronavirus, severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) which can cause respiratory illness, pneumonia, lung failure and death [2].

The pandemic has placed a high pressure on healthcare systems worldwide and reports from China early in the pandemic illustrate the stress put on the hospital staff [3]. Governments all over the world have enforced various policies to reduce COVID-19 transmission and implemented restrictions that changed everyday lives of billions of people [4]. Decisions made in the beginning of the COVID-19 pandemic were based on limited evidence and substantial variation was seen even between countries with similar population demographics, healthcare infrastructures and economic systems such as the Scandinavian countries Denmark, Norway and Sweden [5].

Community spread of SARS-CoV-2 was recognized in the Scandinavian countries by early March 2020 [6]. However, the implemented social and physical restrictions differed among the countries with Sweden being more lenient in their government response, mostly focussing on protecting the persons at highest risk, mainly elderly 70+ years and there was no general lockdown [5,7–9]. All three countries imposed recommendations to avoid unnecessary travels. Denmark and Norway also introduced guidelines and restrictions to protect elderly people, but in addition they introduced strict social and physical distancing measures about the same time and initiated the closing of schools, workplaces and other non-essential services between March 10 and March 16 [5]. In Denmark and Norway, the healthcare authorities recommended people to avoid unnecessary visits to the healthcare system. In Sweden, schools for children aged 16+ years were closed by March 17, and people were recommended to work as much as possible from home. Schools for children up to 16 years old remained open [8]. Sweden experienced substantially higher COVID-19 case rates and death rates than its Scandinavian neighbours [5].

A survey investigating the impact of the early pandemic on everyday life of individuals from Norway and Sweden showed that >80% in both countries said they did not live their lives as usual [10]. Hence, whether living in a country with rigorous restrictions or in a country with more voluntary-based measures, it seems that the COVID-19 pandemic had a clear effect on everyday life.

The aspects of life that include intimate and sexual contacts, especially with new partners may be reduced by the social and physical restrictions during the pandemic and consequently, decreasing the transmission of sexually transmitted infections (STIs). However, the willingness to seek healthcare and diagnostic testing for various conditions, including STIs as well as a potential reduction in access to healthcare due to service interruptions may also increase transmission of STIs due to undetected infections [11].

Chlamydia and gonorrhoea are the two most reported bacterial STIs in the Scandinavian countries, both notifiable infections according to the Communicable Diseases Act in all three countries. The ages with highest burden of chlamydia are 15–29 years with minor differences for the Scandinavian countries [12–14]. For gonorrhoea, the population is different from that of chlamydia in several aspects. It is affecting men and men who have sex with men to a greater extent and a substantial number of cases are reported to be acquired abroad [12–14].

Nucleic acid amplification tests (NAATs) for diagnosis of chlamydia and gonorrhoea in Sweden are available for free either by visiting any healthcare facility or by ordering a self-sampling test on the internet and subsequently submitting the sample to a laboratory for diagnostic testing. Such internet-based self-sampling for chlamydia and gonorrhoea is presently available in all of Sweden's 21 healthcare regions. Since its implementation, the number of tests taken by self-sampling has steadily increased over time and is now a part of the routine diagnostics in Sweden [15]. In Denmark and Norway, self-sampling is not available as a public health service and it is only of limited use as commercial tests.

This study aimed to investigate associations between different government restrictions of the Scandinavian countries and the diagnostic testing and incidence of chlamydia and gonorrhoea.

## Methods

The study was a cross-national, retrospective, descriptive analysis of available data on reported number of detected chlamydia and gonorrhoea cases and, if possible, the number of diagnostic NAATs performed for these STIs in Sweden, Denmark and Norway during the years 2018–2020. For Denmark and Norway, numbers of NAATs performed for gonorrhoea were not available. All national data on cases refer to reported cases, i.e. not the number of positive samples for chlamydia or

gonorrhoea. The data collected from Sweden were more detailed than for the other Scandinavian countries.

### **Evaluation of governmental restrictions in the Scandinavian countries**

The strictness of the governmental restrictions during the pandemic was evaluated by 'The Oxford COVID-19 Government Response Tracker' [16]. This data source assesses the stringency of measures implemented by governments in response to COVID-19 (such as school closing, workplace closing, cancelling of public events, closing of public transport, restrictions on internal movement, etc.) and provides a single indexed value, i.e. The Governmental Stringency Index. This index (ranging from 0 to 100, with 100 = strictest) reflects the general severity of restrictions made in a nation on any given date and was used in our study.

### **Data from five healthcare regions in Sweden**

A request form for data on chlamydia and gonorrhoea for the years 2018–2020 was sent to the diagnostic microbiological laboratory of five healthcare regions in Sweden (Dalarna, Gävleborg, Jönköping, Uppsala and Västerbotten). These regions comprise about 13% of the Swedish population and have previously been shown as representative for chlamydia rates in Sweden [15].

For chlamydia, the request form included data on the number of NAATs performed per month, age group (15–19, 20–24, 25–29, 30–39 and 40+ years) and sex (male and female), and the number of positive cases per month, age group and sex. Data were additionally collected on number of NAAT samples taken *via* a visit to a clinic or by internet-based self-sampling. The data on self-sampling were specified per month and sex but not age group.

For gonorrhoea the total amount of diagnostic analyses per month was investigated, no differentiation was made by age group or sex. The data included both NAATs and diagnostic culture.

Demographic data were partly collected *via* the request form with details on sex and age groups and additionally obtained from Statistics Sweden [17].

### **Data from all 21 healthcare regions in Sweden**

Data were collected from all the 21 Swedish healthcare regions through a request form. The form included all NAATs performed for diagnosis of chlamydia and

gonorrhoea in 2019–2020, per month and sex (male, female, not reported) [18].

### **Data from the Public Health Agency of Sweden**

Cases of chlamydia and gonorrhoea reported to the Public Health Agency of Sweden according to the Communicable Diseases Act of Sweden during the years 2018, 2019 and 2020 were examined. A chlamydia case was defined as a person with *C. trachomatis* detected at one or more body sites during a year. Reports of repeated infections during one year were possible. Furthermore, the number of cases per month per 100,000 inhabitants of chlamydia and gonorrhoea was investigated [14,19].

A gonorrhoea case was defined as a person with reported *N. gonorrhoeae* detected at one or more body sites during a year. Reports of repeated infections during one year were possible.

### **Data from Denmark**

Data from Denmark were collected by request from Statens Serum Institut (SSI) and by using the publicly accessible data from the website at SSI [20]. Data on NAATs performed for chlamydia in Denmark were extracted from [21] and by request. For chlamydia, the data included the number of detected cases per month for the years 2018–2020. For Denmark, the chlamydia case definition was: A patient with one or more positive specimens from one or more anatomical locations within a 42-day period.

For Denmark, laboratory data for gonorrhoea were not available for the years 2018–2020. The present report therefore shows the number of cases reported by the treating clinicians. Episodes within a time span of 21 days was considered to represent one case. For gonorrhoea, the data included the number of clinically reported cases and the number of cases per 100,000 inhabitants per month for the years 2018–2020 [22].

### **Data from Norway**

From Norway, the data on chlamydia and gonorrhoea cases and NAAT rate were collected *via* request from the Norwegian Surveillance System for Communicable Diseases (MSIS) [23]. The data were collected for the years 2018–2020. Population data were collected from Statistics Norway [24].

## Statistics

Statistical analysis was made with R version 4.0.5 using Poisson regression. Data were obtained on differences in percentage, 95% confidence intervals for chlamydia and gonorrhoea cases in the respective countries, comparing 2019 and 2020 and the period of March–April in 2019 and 2020. Also, data on internet-based self-testing in Sweden were analysed in the same way comparing the years 2019 and 2020.

## Ethics

The collected information was merged statistical data without any patient identification data and hence, no ethical permission was needed.

## Results

### Pandemic restrictions in the Scandinavian countries

By the end of March 2020 the Stringency Index for Sweden was 59.26, for Denmark 72.22 and for Norway 79.63. Later on the difference disappeared and from November Sweden had even higher index than Norway and Denmark (Supplementary figure 1).

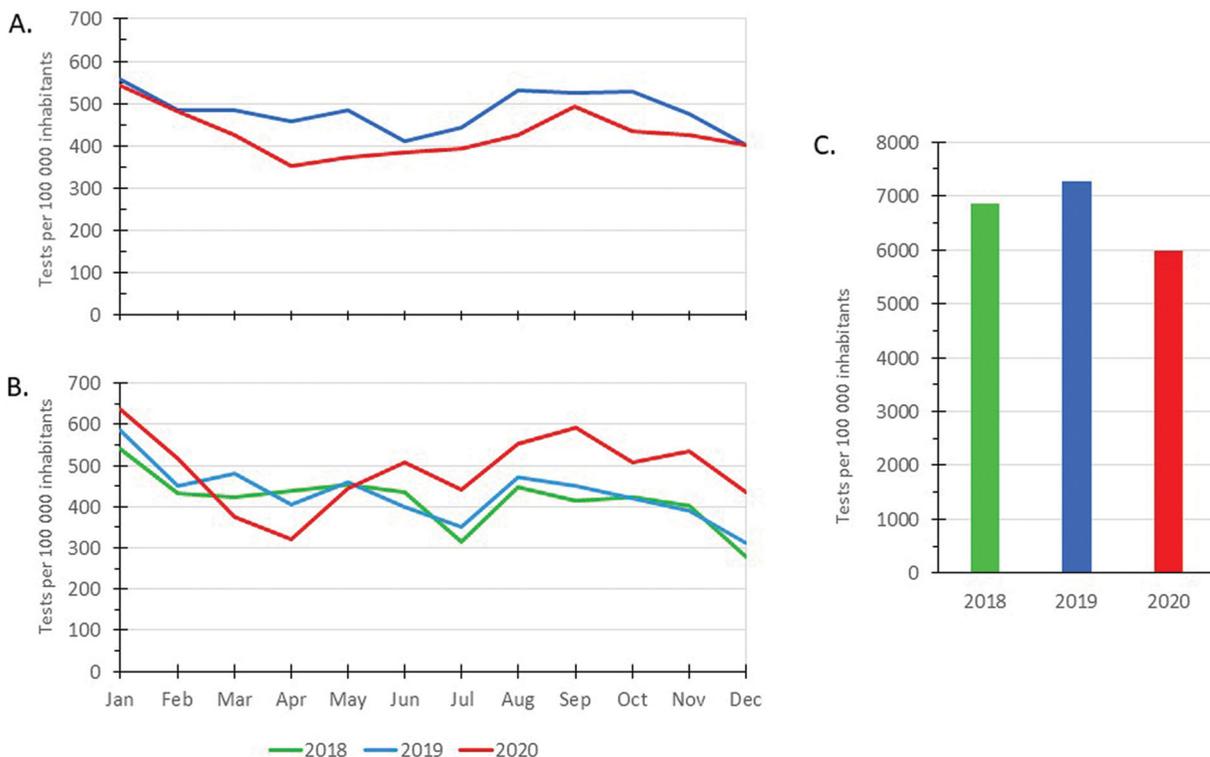
## Chlamydia

*Chlamydia tests:* The number of tests per 100,000 inhabitants is shown in Figure 1. In Sweden, 19 out of 21 (91%) healthcare regions reported on diagnostic NAATs performed for chlamydia. However, one region did not report on NAAT volumes per month. The number of NAATs performed for chlamydia decreased from 2019 to 2020 by about 10% (607,062 tests in 2019 and 543,540 in 2020) (Figure 1(A)).

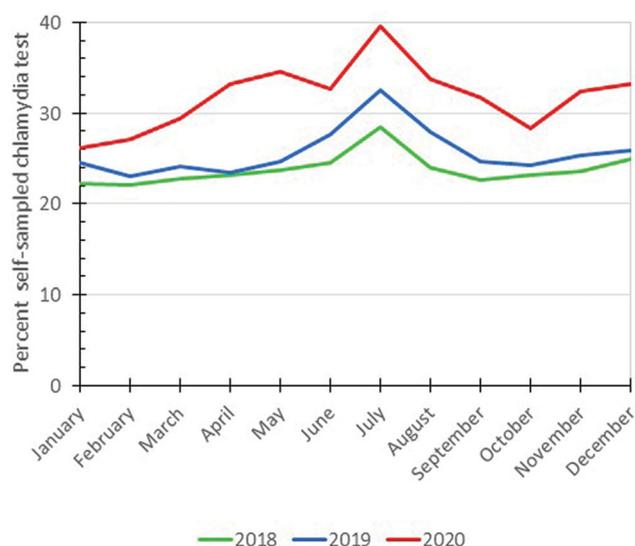
For Denmark NAATs performed for chlamydia were reported for the years 2018–2020, see Figure 1(B). The number of NAATs performed was reduced by 21% in April 2020 compared to data for April in 2019. From May to December in 2020, the number of NAATs performed increased to levels even higher than 2019.

From Norway, volumes of diagnostic NAATs were only available per year. The NAATs performed for chlamydia was 5985 per 100,000 inhabitants in 2020 compared to 7263 in 2019 and 6847 in 2018. Thus, compared to 2019, the NAATs performed decreased by 18% in 2020 (Figure 1(C)).

In summary, the NAAT rates decreased in Sweden and Norway in 2020 compared to 2019. In Denmark, the NAAT rates decreased during the first lockdown period in March–April 2020 but were subsequently similar to the rates in 2019. Data on internet-based self-sampling



**Figure 1.** The number of chlamydia nucleic acid amplification tests (NAATs) per 100,000 inhabitants per month (Sweden and Denmark) and per year (Norway). (A) Sweden, (B) Denmark and (C) Norway.



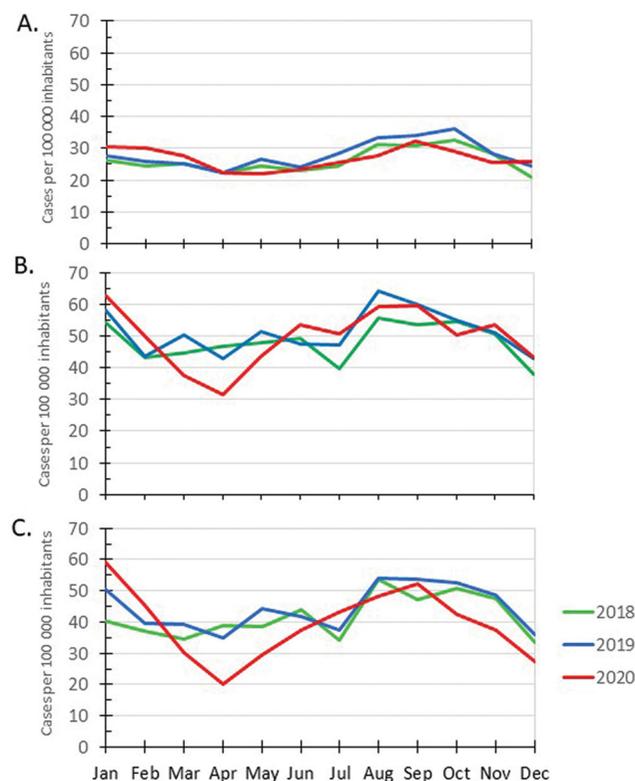
**Figure 2.** The proportion of internet-based self-sampled chlamydia tests in five Swedish regions.

compared to clinic-based testing were examined for the five healthcare regions. The trend was the same as for the total of Sweden. Hence, overall, there was a decrease in the amount of NAATs performed as well as for the number of detected cases from 2019 to 2020. However, the proportion of chlamydia NAATs performed by internet-based self-sampling increased in 2020 compared to 2018 and 2019. The number of NAATs performed by self-sampling was 23,644 in 2019 and 26,149 in 2020, this corresponds to an increase in self-sampled NAATs by 10.6% in 2020 compared to 2019 (95% CI 8.4 to 12.2). The percentage of NAATs taken by self-sampling in 2020 was about 26% in January and then increased to about 33% in April, while the proportion taken by self-sampling in April 2019 was about 23% (see Figure 2).

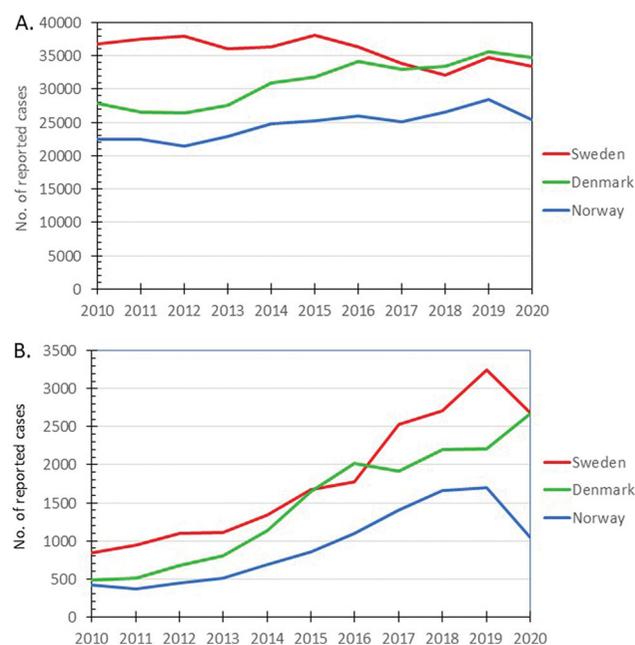
Internet-based self-sampling in Denmark and Norway is not available as a public health service but is now gradually established. A comparison with Sweden was therefore not possible.

### Chlamydia cases

In Sweden the number of reported chlamydia cases increased by 5.7% (95% CI 1.7 to 9.9) in March–April 2020 compared to March–April 2019, see Figure 3(A). The reported number of chlamydia cases in Sweden (cases per 100,000 inhabitants) has slightly been decreasing from 2011 to 2020 with exceptions of small increases in the years 2015 and 2019 (Figure 4(A)). The national chlamydia case rate per 100,000 inhabitants was 336 in 2019 and 321 in 2020. The total number of reported chlamydia cases decreased by 4.3% (95% CI 5.7



**Figure 3.** The total number of reported chlamydia cases per 100,000 inhabitants per month. (A) Sweden, (B) Denmark and (C) Norway.



**Figure 4.** The number of reported cases of chlamydia and gonorrhoea for the years 2010–2020 in Sweden, Denmark and Norway. (A) Chlamydia and (B) Gonorrhoea.

to 2.8) in 2020 compared to 2019 (34,726 in 2019 and 33,339 in 2020). However, no notable decrease was seen in 2020 when compared with the reported rates in 2018, see Figure 3(A).

More detailed data on sex and age groups were reported from five representative healthcare regions in Sweden (described above). In these regions, the number of reported chlamydia cases decreased more for men (29%) than women (15%) aged 15–29 years between March–April 2019 and March–April 2020 (Supplementary figure 2). During the second half of 2020, the number of reported cases increased to levels in previous years, especially for women. The decrease in number of chlamydia NAATs performed and reported cases was less noticeable in the ages above 30 years, but for these ages the number of cases was low and statistically less reliable. The chlamydia NAAT positivity rate decreased for women in March to May 2020 compared to 2019 but not for men (Supplementary figure 3). This difference vanished later during 2020.

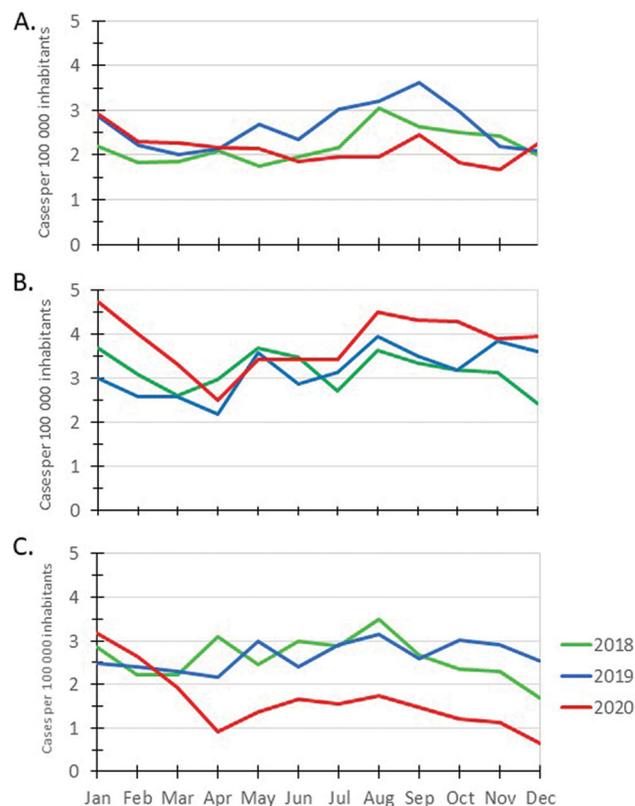
In Denmark, the number of chlamydia cases decreased in March–April 2020 with 25.9% (95% CI 28.8 to 22.8) compared to March–April 2019 (Figure 3(B)). The annual number of reported chlamydia cases was 34,689 in 2020 and 35,688 in 2019, which corresponds to a 3.1% decrease in 2020 (95% CI 4.5 to 1.6).

In Norway, the reported number of chlamydia cases decreased by 31.6% in March–April 2020 compared to March–April 2019 (95% CI 34.9 to 28.2). The decrease in detected cases from 2019 (28,446 cases) to 2020 (25,444 cases) was 10.8% (95% CI 12.3 to 9.3). Figure 3(C) shows the monthly chlamydia case rates per 100,000 inhabitants in Norway. The number of reported chlamydia cases in Norway has mainly been increasing since 2015 with a minor decrease in 2017, and in the beginning of 2020, the number of cases was higher than in the previous five years.

The long-term trend for chlamydia was increasing for Denmark and Norway, comparing 2011–2012 with 2018–2019 (Figure 4(A)).

### Gonorrhoea

In Sweden, the number of NAATs performed for gonorrhoea decreased from 2019 to 2020 by about 9% (2019: 544,795; 2020: 493,787) in 18 reported regions. The number of reported cases increased between 2011 (951 cases) and 2019 (3245 cases) (Figure 4(B)) but decreased in 2020 (2692 cases). The reported number of cases decreased by 17% from 2019 to 2020 (95% CI 21.4 to 12.9) (Figure 5(A)). The proportion of gonorrhoea cases contracted abroad was 13% in 2020 (347 cases) compared to 24% in 2019 (774 cases). In the previous four years, the proportion of cases contracted abroad was between 24% and 30%.



**Figure 5.** The total number of reported gonorrhoea cases per 100,000 inhabitants per month. (A) Sweden, (B) Denmark and (C) Norway.

In Denmark, the number of reported gonorrhoea cases decreased during the first four months but was higher in 2020 compared to 2019 (Figure 5(B)). Subsequently, the number of reported cases increased and continued to be higher than in 2018 and 2019 during the rest of the year. Thus, overall the number of reported cases was 21% (95% CI 16.5 to 25.5) higher in 2020 (2670) compared to 2019 (2210).

In Norway, the number of cases of gonorrhoea decreased by 36% in March–April 2020 compared to March–April 2019 (95% CI 47.8 to 21.7) (Figure 5(C)). There were 1045 cases of gonorrhoea in 2020 and 1704 cases in 2019, this represented a 39% decrease from 2019 to 2020 (95% CI 43.4 to 34).

The 10-year trend for gonorrhoea showed a constant and striking rise in number of reported cases for all three countries (Figure 4(B)).

### Discussion

This was a unique cross-national study comparing the three Scandinavian countries with different governmental strategies to cope with the COVID-19 pandemic. It

aimed to examine how this has affected the diagnostic testing and the number of reported cases of chlamydia and gonorrhoea in 2020.

In summary, the number of detected cases of chlamydia and gonorrhoea decreased in the three Scandinavian countries when the COVID-19 pandemic spread in Europe and restrictions were installed in March 2020. During the second half of the year, the number of detected chlamydia cases recovered to similar levels as seen in the previous two years in all three countries, but for gonorrhoea the retrieval trend differed between the countries.

Sweden, Denmark and Norway have many cultural and sociological resemblances and similar public health-care systems for STIs. It is presumed that the social, physical and travelling restrictions combined with following advice concerning use of hand disinfectants and wearing face masks (mostly used in Denmark and Norway) could have contributed to the reported reduced spread of infectious diseases in general [25,26]. Here, we wanted to find out if this was valid for STIs and if so, whether the effects were the same in countries with different strategies for the COVID-19 pandemic.

For chlamydia, the decrease was most pronounced in Norway and Denmark, having more strict and mandatory restrictions compared to Sweden, that only had voluntary recommendations of social distancing. The Public Health Agency of Sweden declared to focus on elderly people and their recommendation to keep social distance may not have been followed by the most sexually active age groups. During the second half of the year, the number of reported cases recovered to similar levels as seen in the previous two years in all three countries. Interestingly even in Finland, the reported chlamydia incidence did not decrease during the pandemic despite extraordinary restrictions and by far the lowest COVID-19 detection rate in Europe [27].

The number of detected chlamydia cases may have been affected by less testing, especially among asymptomatic persons. In Sweden, however, the decrease in performed NAATs was only about 10% in 2020 compared to 2019, and therefore the number of reported chlamydia cases was likely not substantially affected. The well-established internet-based self-sampling service in Sweden increased its proportion of chlamydia and gonorrhoea tests and comprised about a third of all chlamydia tests in 2020. This probably compensated for less willingness or opportunities to physically visit a clinic for examination and testing, and the diminished

access to clinic-based service. Chlamydia NAAT volumes in Denmark decreased for a limited time likely contributing to the simultaneous drop in chlamydia cases. However, Danish test rates rapidly recovered and were not affected later in 2020. In contrast, the 18% decrease in NAAT testing in Norway between 2019 and 2020 is likely to be an effect of the COVID-19 pandemic and may also contribute to the decrease in reported cases. Overall, the testing activity in Scandinavia was much less affected compared to reports from other countries where test volumes fell with up to 50% [28].

In Sweden and Norway, we found a more obvious and long-lasting decrease of the reported number of gonorrhoea cases compared to the minor reduction in reported chlamydia cases that was observed in 2020. This observation is in line with the well-established fact that gonorrhoea is acquired abroad to a greater extent than chlamydia. In Sweden, the proportion acquired abroad decreased from a level between 24% and 30% in the years 2016–2019 to 13% in 2020 [14]. The extensive travel restrictions, limiting travel abroad could hence be a reason for the more dramatic decrease in detected gonorrhoea cases. This is especially true for men having sex with men that to a high degree are travelling to international hot spots for finding new partners, according to some studies [29,30]. The absence of a reduction of gonorrhoea detection rates in Denmark may be attributed to the lower proportion of cases acquired abroad, 9% [13] compared to Sweden 13% [14] and Norway 19% in 2020 [12]. Also, MSM only contribute to a minor proportion of the gonorrhoea cases in Denmark, 25%, while the situation in Norway and Sweden is opposite, 58% in Norway [12] and around 60% in Sweden [14]. Transmission of gonorrhoea in Denmark may therefore be more likely to follow the same pattern as chlamydia transmission. The higher proportion of heterosexual domestic transmission in Denmark may be a further progression of the general and more long-lasting trend of gonorrhoea increase in Scandinavia and many European countries [31].

The Swedish governmental strategy for the COVID-19 pandemic deviated from many other countries early in the pandemic and it has been criticized for lean restrictions based on voluntariness [9], especially in the light of the high death rates among elderly people [32]. Interestingly, Sweden had a lower stringency index only during a few months early in the pandemic and from November the index for Sweden was even higher than for Denmark and Norway. The image of Sweden abroad may therefore not have reflected the actual situation in

the society over time and voluntary measures may also be stringent in a society with high compliance.

The strengths of our study included that it is based on national data and an international comparison of three countries with similar healthcare systems and well-established diagnostics and surveillance of STIs but with strikingly different strategies for handling the pandemic. Our findings based on national data support early and often small studies that has reported a limited impact of the pandemic on STI incidence [27,33–36]. Thus, irrespective of pandemic restriction levels ‘not having sex is not an option’.

Our study also has significant limitations. The data from Denmark and Norway were generally less detailed than the data obtained from Sweden, which impaired a thorough comparison. Data on test volumes for gonorrhoea were missing from Denmark and Norway and test volumes on chlamydia were only per year from Norway and 2018 data were missing for Sweden. Data on sex and age groups were not available on a national level for the three countries. The number of reported gonorrhoea cases per month is relatively low, thus cautious interpretation of time trends is needed. Data on indication for testing are missing, thus it is not known if asymptomatic chlamydia and gonorrhoea cases were less frequently investigated during the pandemic. There was also a lack of data on the availability of healthcare service during the study period. However, even though data are missing it is unlikely that it has affected the conclusions.

## Conclusions

Sweden and Norway showed more similar trends with a marked decrease in gonorrhoea incidence and a less dramatic decrease in chlamydia incidence during 2020 compared to 2019. In Denmark there was a decrease in chlamydia cases during the first lockdown, but this was related with a decrease in testing. The impact of the COVID-19 pandemic on the long-term incidence of chlamydia and gonorrhoea is too early to judge, but in the light of our study it seems to only be temporal.

Strict governmental restrictions including lockdown periods did not seem to affect the transmission of chlamydia and gonorrhoea to a greater extent than a more voluntarily based governmental approach. However, further studies are needed to investigate other factors impacting sexual behaviour during the COVID-19 pandemic.

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## Author contributions

LI and BH designed the study. MASC, KE, HY, KG, LS, HK, BA, SH, ÅG and MU contributed with data. LI wrote the first draft. All authors contributed to data interpretation, critically reviewed the first draft and approved the final manuscript and agreed to be accountable for the work.

## Disclosure statement

No potential conflict of interest was reported by the author(s).

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