

# Sexually Transmitted Infections, the Epidemic That Persists After the COVID-19 Pandemic: a Time-series Analysis of the Primary Care Electronic Health Records Covering About 5 Million People in Catalonia

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## Research Article

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## Abstract

**Background:** The COVID-19 pandemic and related control measures have affected the diagnosis of other diseases, including sexually transmitted infections (STI). Our aim is to analyse the impact of the COVID-19 pandemic on the incidence of STI diagnosed in primary care.

**Methods:** Time-series study of STI, using data from primary care electronic health records in Catalonia (Spain) from January 2016 to March 2021. We obtained the monthly expected incidence of STI using a temporary regression, where the response variable was the incidence of STI from 2016 to 2019 and the adjustment variables were the trend and seasonality of the time series. Excess or reduction of STI were defined as the number of observed minus the expected cases, globally and stratified by age, sexe, type of STI and socioeconomic status.

**Results:** Between March 2020 and March 2021 we observed a reduction of 20.2% (95% CI: 13.0% to 25.8%) on STI diagnoses compared to the expected. This reduction was greater during the lockdown period (-39%), in women (-26.5%), in people aged under 60 years (up to -22.4% in people aged 30-59 years), less deprived areas (-24%) and some types of STI, specially chlamydia (-32%), gonorrhoea (-30.7%) and HIV (-21.5%). Conversely, syphilis and non-specific STI were those with lesser reductions with -3.6% and -7.2%, respectively,

**Conclusions:** The COVID-19 pandemic has impacted on STI incidence, reducing the number of diagnoses performed in primary care and raising concerns about future evolution of STI trends. Those STI that are less symptomatic or diagnosed through screening will deserve special attention regarding potential diagnostic delays.

## Background

The coronavirus diseases 2019 (COVID-19) pandemic has become one of the greatest public health challenges in recent times. By 31 August 2021, SARS-CoV-2 has caused more than 216 million confirmed cases and 4.5 million deaths worldwide [1]. The first cases in Europe were identified in France on 24 January 2020 [2] and the first official case in Catalonia (Spain) was reported a month later on 25 February. Many countries established a national lockdown in March 2020 to face the pandemic leading to a disruption of usual health care delivery systems [3, 4]. In Spain, the lockdown began on 14 March and ended on 21 June 2020 [5], encompassing a de-escalation strategy from 28 April, allowing limited social contact. Face-to-face visits were dramatically reduced during the lockdown period with variability in its subsequent recovery. Therefore preventive care, such as screening, diagnosis and testing were also affected [6–8]. These activities involve common health problems like chronic diseases, malignant neoplasms or other infections such as sexually transmitted ones [9, 10]. In October, in order to control the second wave of the COVID-19 pandemic, additional social restrictions were implemented in Spain, as in many European countries, including a time limit in bars and restaurants schedules, restrictions in cultural and mass events, different levels of perimeter lockdowns and at night curfew. All these measures may have reduced casual sexual encounters. National and international circulation and tourism have also been restricted. Tourism has been related to more sexual contacts and sexually transmitted infections (STI) [11].

In the last few years, the incidence of STI has increased in Europe with more than half a million STI notifications in the European Union and the UK annually. Chlamydia is the most frequently reported STI in Europe, followed by gonorrhoeae, with an increasing trend [12]. In Spain and Catalonia, the incidences of these STI are one of the greatest incidences in Europe, as well as for syphilis [12]. In 2015, an Integrated System of Epidemiological Surveillance of AIDS/HIV and Sexually Transmitted Infections of Catalonia was created. It integrates strategic sources of information such as the system of notifiable diseases and the Microbiological Notification System of Catalonia. Syphilis, HIV, trichomoniasis, gonorrhoeae, chlamydia genital infection and lymphogranuloma venereum are of mandatory and individualised notifications [13]. This notification system is integrated in the electronic health records (EHR) software implemented in primary health care in Catalonia. The main non-complicated STI are managed in primary care practices (PCP), where laboratory tests for etiological diagnoses are available. General practitioners are supported by sexually transmitted diseases consultants.

The COVID-19 pandemic has led to a reduction in new diagnoses of common diseases including notified infectious diseases like other respiratory transmitted and sexually transmitted infections (14, 15). However, controversy exists in published data about the duration, the magnitude of this reduction -or even an increase in some of them- and their underlying causes. This study aims to analyse the impact of the COVID-19 pandemic on the incidence of sexually transmitted infections recorded in primary care EHR in Catalonia.

## Methods

We performed a time-series study of sexually transmitted infections. Data were extracted from the primary care EHR of the *Institut Català de la Salut* (Catalan Institute of Health, ICS, for its Catalan initials). ICS is the main primary care provider in Catalonia. It manages 3 out of 4 PCPs in the Catalan public health system and covers about 5.8 million people.

We included all patients older than 14 years old with a STI diagnosis recorded in the EHR (see ICD-10 codes in supplementary material 1). The study period included all months between January 2016 and March 2021. We divided this period into two for the time-series analysis: training (2016–2019) and analysis (2020–2021). In addition, we separated the 2020–2021 available months into three periods for the calculation of the reductions of STI: “lockdown period” from March to June 2020 coinciding with the state of alarm in Spain (including the lockdown and different phases of de-escalation), the “summer period” from July to September 2020 with few restrictions in place; and the “autumn-winter period” from October 2020 to March 2021 which includes a second state of alarm in Spain with some mobility restrictions and at night curfew.

Time-series analysis were performed globally, by sex, age groups (15–29 years old, 30–59 years old and older than 59 years old), type of infection, socioeconomic status and rurality. We assessed the socioeconomic status using the validated MEDEA deprivation index [16]. We categorised the MEDEA

deprivation index into quartiles where 1st and 4th quartiles are the least and most deprived areas, respectively. Rural areas were categorised separately and were defined as areas with less than 10,000 inhabitants and a population density lower than 150 inhabitants/km<sup>2</sup>.

## Statistical analysis

We calculated monthly STI incidence rates per 10<sup>5</sup> population as the number of new diagnoses divided by the number of alive population assigned to ICS PCPs and multiplied by 100,000.

We obtained the expected incidence for the study period using a time series regression, where the response variable was the incidence rate per 10<sup>5</sup> inhabitants from 2016 to 2019, and the adjustment variables were the trend and seasonality of the time series. Dataset was divided into two sets: training set (from 2016 to 2019) and analysis set (from 2020 to March 2021). We used the training set to adjust the model and we projected the estimated time series to our analysis set.

The number of expected STI for each period was obtained by multiplying the projected incidence by the population and dividing by 100,000. Excess or reduction of diagnosis were defined as the number of observed minus expected, estimated monthly and only for the periods where the observed incidence was outside the 95% confidence interval (95% CI) of the time-series. We also calculated the percentage of excess or reduction as follows: (number of observed diagnoses - number of expected diagnoses) / number of expected diagnoses.

We calculated 95% CI for each estimate.

All analyses have been conducted using R, version 3.5.1 [17].

## Results

The population structure assigned to ICS' PCPs is depicted in Table 1.

Table 1  
Baseline characteristics of the study population by set: training set (2016–2019) and analysis set (2020–2021).

Variable	2016–2019	2020–2021
Population older than 14 years	4,846,503	4,938,445
% of women	51.19	51.11
% of population between 15 and 29 years old	18.01	18.46
% of population between 30 and 59 years old	52.94	52.17
% of population older than 59 years	29.05	29.37
Socioeconomic status: % of people in the first quartile (least deprived)	21.71	21.62
Socioeconomic status: % of people in 2nd quartile	14.23	15.26
Socioeconomic status: % of people in 3rd quartile	20.91	20.68
Socioeconomic status: % of people in the 4th quartile (most deprived)	18.24	18.4
% of people in rural areas	23.91	24.03

From January 2016 to March 2021, 68,192 new STI were registered in the Catalan primary care EHR. This represents a monthly average incidence per 10<sup>5</sup> population of 22.6 during the 2016–2019 period and 21.8 during the 2020–2021 period. From January 2020 to March 2021, 16,143 new STI were recorded, of which 76.1% were men, 51.8% were between 30 and 59 years old, 43% younger than 30 years old and only 5.2% were older than 59 years, with similar distribution to previous years.

Figure 1 shows the observed and estimated rates of monthly new STI diagnoses (with 95% CI) since January 2020. Since March 2020 we observed that incidence was lesser than expected for all age groups.

We estimated that the difference between expected and observed diagnoses accounted for 3,499 less STI (95% CI: 1,956 to 5,043) from March 2020 to March 2021. This represents a reduction of 20.2% of the diagnosis of STI compared to the expected. This reduction was greater during the lockdown period with 39% reduction (95% CI: 30.1–45.9%) compared to the expected versus 14% reduction (95% CI 6.2–20%) during the summer period and 10.7% reduction (95% CI 4.8–15.2%) during the autumn-winter period (Table 2).

The estimated number of underdiagnosed STI and the percentage of underdiagnoses compared to the expected is presented stratified by age, sex, type of STI, socio-economic status and rurality in Table 2. Women accounted for a larger percentage of reduction (26.5% vs 18.3% in men), especially during the summer period: 30.4% reduction in women versus 11.4% in men (Table 2 and Fig. 2). Regarding age, reductions were similar between 15 and 59 years and lesser in older than 59 years.

Table 2  
Estimated number (N) of underdiagnosed STI and percentage (%) of reduction compared to the expected, overall and by periods

	Total		Lockdown period (March 2020 - June 2020)		Summer period (July 2020- September 2020)		Autumn-winter period (October 2020 - March 2021)	
	N (95% CI)	% (95% CI)	N (95% CI)	% (95% CI)	N (95% CI)	% (95% CI)	N (95% CI)	% (95% CI)
<b>Total</b>	<b>3499</b> (1956–5043)	<b>20.2</b> (13–25.8)	<b>2086</b> (1406–2766)	<b>39</b> (30.1–45.9)	<b>554</b> (214–894)	<b>14</b> (6.2–20)	<b>859</b> (336–1382)	<b>10.7</b> (4.8–15.2)
Between 15 and 29	1456 (848–2064)	19.6 (13.2–24.6)	942 (640–1245)	41.1 (32.2–48)	232 (81–383)	13.9 (5.6–20.2)	282 (127–436)	8.2 (4.2–11.1)
Between 30 and 59	2035 (963–3106)	22.4 (12.5–29.6)	1078 (651–1504)	38.5 (27.4–46.6)	453 (134–771)	21.6 (7.5–31.9)	505 (178–831)	12 (5–17.1)
Older than 59	73 (18–128)	8.5 (2.9–11.6)	54 (17–91)	20.1 (8.7–26.6)	0	0	19 (1–37)	4.7 (0.3–7.2)
Women	1211 (618–1804)	26.5 (16.7–33.2)	649 (386–911)	45.5 (33.2–54)	308 (112–505)	30.4 (13.7–41.7)	254 (120–388)	11.9 (6.9–15.3)
Men	2331 (1221–3441)	18.3 (10.9–23.9)	1440 (951–1929)	36.7 (27.7–43.7)	334 (90–579)	11.4 (3.5–17.5)	556 (180–933)	9.4 (3.5–14)
1st Q (least deprived)	1076 (502–1651)	24 (13.7–31)	594 (340–849)	42.7 (29.9–51.6)	269 (79–460)	26.2 (9.4–37.8)	213 (83–342)	10.3 (4.9–13.9)
2nd Q	575 (290–861)	23.5 (13.9–30.5)	260 (147–373)	34.7 (23.1–43.2)	87 (30–143)	16.3 (6.7–23.1)	228 (112–344)	19.6 (11.3–25.7)
3rd Q	693 (289–1097)	19.9 (10.6–25.9)	481 (251–710)	43.5 (28.6–53.1)	60 (3–118)	7.5 (0.5–12.2)	152 (35–269)	9.6 (2.9–13.9)
4th Q (most deprived)	592 (302–882)	15 (8.9–19.7)	427 (262–592)	35.7 (25.4–43.5)	102 (19–184)	11.3 (2.4–18)	64 (21–107)	3.5 (1.3–5.1)
Rural	283 (136–430)	9.6 (5.9–11.9)	283 (136–430)	31.3 (19.2–39.2)	0	0	0	0
Genital warts	865 (417–1314)	19.1 (11.8–23.9)	683 (385–982)	46 (32.4–55)	98 (24–173)	9.7 (3–14)	84 (9–158)	4.2 (0.6–6.4)
Syphilis	31 (5–56)	3.6 (0.9–4.7)	31 (5–56)	11.6 (3–15.1)	0	0	0	0
Gonorrhoea	487 (206–768)	30.7 (17.4–38.6)	205 (112–297)	45.9 (34.6–52)	94 (33–156)	25 (11.7–33.3)	187 (61–314)	24.5 (10.6–33)
Chlamydia	696 (361–1030)	32 (20.8–39.5)	357 (224–490)	55.4 (43.8–63.1)	159 (59–258)	33.4 (15.7–44.9)	180 (77–282)	17.1 (9.1–22.5)

	Total		Lockdown period (March 2020 - June 2020)		Summer period (July 2020- September 2020)		Autumn-winter period (October 2020 - March 2021)	
HIV	143 (26–260)	21.5 (7.2–26.8)	82 (13–152)	38.1 (10.7–49.5)	0	0	61 (14–108)	20.3 (8.9–24.4)
Genital herpes	407 (136–678)	17.3 (7.4–23.7)	246 (92–400)	33.5 (15.8–45)	51 (13–89)	9.5 (3.1–13.6)	110 (32–188)	10.2 (3.8–14.3)
Non-specific STI	68 (23–113)	7.2 (3.5–9.1)	68 (23–113)	24.5 (12.2–30.8)	0	0	0	0
Non-specific urethritis	280 (136–425)	7.7 (4.5–10)	193 (98–289)	17.6 (10.8–22.5)	0	0	87 (38–136)	5.2 (2.7–6.9)
Others	88 (14–161)	15.1 (4.1–19.6)	24 (5–42)	13.7 (4.9–16.9)	20 (1–38)	16.1 (1.4–21.3)	45 (8–82)	15.8 (4.6–20.8)

Reductions were observed in all types of STI although were greater in gonorrhoea and chlamydia (Table 2 and Fig. 3) with 30.7% overall reduction (95% CI 17.4–38.6%) and 32% (95% CI 20.8–39.5%) respectively. In addition, we observed only a small excess at the end of 2020 in non-specific urethritis.

Regarding socio-economic status and rurality, rural areas had less reduction than urban areas (9.6% overall reduction in rural versus 24% in less deprived areas) and this reduction only accounted for the lockdown period. In general, less deprived areas had greater reductions than most deprived areas, especially during the summer and autumn-winter periods (Table 2 and Fig. 4).

## Discussion

### Summary

This time-series study encompassing EHR's reported cases of STI in primary care in Catalonia found a global decrease of 20.2% of the expected monthly incidence of STI in the 2020–2021 analysis period compared to the expected. This reduction was greater during the lockdown period (up to 39%). The most affected groups were women, people under the age of 60 years, less deprived urban areas and some types of STI (chlamydia, gonorrhoea and HIV).

### Comparison with existing literature

Several studies reported a decline in new STI diagnosis during the lockdown period probably related to the impact of social distancing measures [9, 10, 14, 15, 18–20]. In addition, some studies described a reduction in the number of casual sex encounters [21, 22], although others showed a stable number or even an increase in some high-risk sexually active populations [23]. On the other hand, many countries in the WHO European Region reported severe disruptions in test provision (up to more than 50% decline in testing volume) due in part to testing site closure, reduced attendance, laboratories overburdened, etc [24].

Overall, Chlamydia genital infection was the STI with the greatest reduction in our study. This finding was higher than the under 20% reported in literature [9, 15, 20]. In Spain, a multitest including gonococcal, chlamydia, mycoplasma genitalium and trichomonas infection is available in primary care centres. This may explain the concordance of reduction in chlamydia and gonococcal infections, with a higher decline in the first one due to a higher number of asymptomatic cases detected by screening measures that were halted during the lockdown period. However, some European countries did not find relevant changes in incidence [15] or attendance [6] for chlamydia or gonococcal infections, maybe due to lesser restricted social and travel measures [25]. Gonococcal genital infection showed disparities in previous studies with a wide range from increased incidence [9, 14, 20, 26] (up to 56% in Taiwan [14]) to reduced new diagnoses [9, 15, 18] (up to 36,9% reduction in Greece [18]).

In Melbourne, despite keeping usual care in sexual centres, a reduction of 40% in attendees, 65% in screening or 40% in non-gonococcal urethritis was found during the lockdown period (23 March to 10 May 2020) compared with the previous months of the year. However, non-significant differences were observed in such STI with marked symptoms, like syphilis or pelvic inflammatory disease. In our study, the STI with lesser reduction was syphilis. This result is consistent with other data reported elsewhere, showing little increased figures and reductions of less than 10% in syphilis trends [9, 14, 18, 20]. This may suggest that people presenting more severe clinical conditions seek medical attendance, leading to a specific STI diagnosis [10]. Another reason could be that extragenital or skin transmissible lesions of syphilis escape from the use of barrier methods to prevent STI, compared with urethral discharge characteristic of gonorrhoea, which had shown greater reductions than syphilis in the context of the COVID-19 pandemic [19, 20]. In addition, non-specific STI and urethritis were the only STI that rose above the expected during the post lockdown period; except in January 2021 for urethritis, coinciding with a third wave of coronavirus disease in Catalonia. Probably, restrictions affecting both laboratory and PCP's accessibility could lead to an increase of non-specific diagnoses at the expense of an underreporting of etiologic STIs.

HIV was underdiagnosed in consonance with published data [14, 15, 20] or persistently allocated in the low expected confidence interval during the three periods analysed in 2020–2021. Regardless of the small number of HIV cases, it deserves special attention due to the burden of the disease. In the near future, special efforts should focus on monitoring whether there will be a rebound or greater diagnostic delay in new HIV cases, hindering the achievement of the 90-90-90 WHO goals for HIV infection [27, 28].

## Limitations and strengths

We are aware of some limitations of the study. First, we performed a time-series study with ecological data thus not allowing to ensure a causal correlation between reduction of incidence and COVID-19 pandemic. As our analysis is based on crude rate, major changes in population structure could limit the results although population age and gender distribution has remained relatively stable in the study period. In addition, sex is categorized as a binary variable in the EHR, without taking into account the gender perspective or sexual orientation.

The study also has strengths to be considered. Several studies have used the Catalan primary care EHR data to perform useful research in real-world conditions including other analysis with diagnosis during the pandemic [29, 30]. Our analysis extends the first wave of COVID-19-short-term effects and lasts for more than one year in contrast to other studies focused on the lockdown period only or a few months afterwards. We assessed the socioeconomic differences of special interest for STI and vulnerable populations. Moreover, most published studies focused on some mandatory notifiable STI; in contrast, this study provides a broad overview of the most common STIs managed in primary health care. In addition, data on non-specific STIs were included. This is of great importance given the possible under-registration of new specific diagnoses due to lack of access to laboratory tests. Finally, as ICS manages about 75% of primary care practices in Catalonia, our results are generalizable and our method could be introduced in other settings using EHR.

## Conclusions

Despite government social restrictions some populations maintained high-risk sexual behaviour, maybe due to previous sexual behaviour or because of feeling at lower risk for complications in case of acquiring SARS-CoV-2 infection during close contact. We must be aware that after this year of social restrictions there could be an increase in high-risk sexual behaviors and consequently a rebound in STI or delayed HIV diagnoses. Among the lessons learnt from COVID-19 pandemic, it highlights the importance of maintaining medical access to STI-related consultations, and promoting self-testing and home-based screening strategies [31] for the vulnerable and those at the most increased sexual behaviour risk.

## Abbreviations

95%CI: 95% Confidence interval

COVID-19: Coronavirus disease 2019

EHR: Electronic health records

ICS: Catalan Institute of Health (for its Catalan initials)

ICD-10: International Classification of Diseases 10th revision

STI: Sexually transmitted infections

## Declarations

### Ethical Approval and Consent to Participate

All analysis and methods of this study have been performed in accordance with the Declaration of Helsinki (last update, Fortaleza, Brazil 2013) and existing relevant guidelines and regulations in Spain. This work was also approved by the Clinical Research Ethics Committee of the IDIAPJGol (project code: 20/172-PCV), including a waiver for the informed consent of patients taking part in the study, and the data extracted from the EHR were fully anonymised. There was no patient or public involvement in this study.

### Consent for publication:

Not applicable

### Availability of data and materials

### Competing interests

None declared.

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### Authors' contributions:

All authors contributed to the design of the study, the interpretation of the results, and reviewed the manuscript. CG, EC and FF had access to the data and acted as guarantors. EC performed the statistical analysis. CG and EC wrote the first draft of the manuscript. All authors critically revised the manuscript. The corresponding author attests that all listed authors meet authorship criteria and that no others meeting the criteria have been omitted.

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## Figures

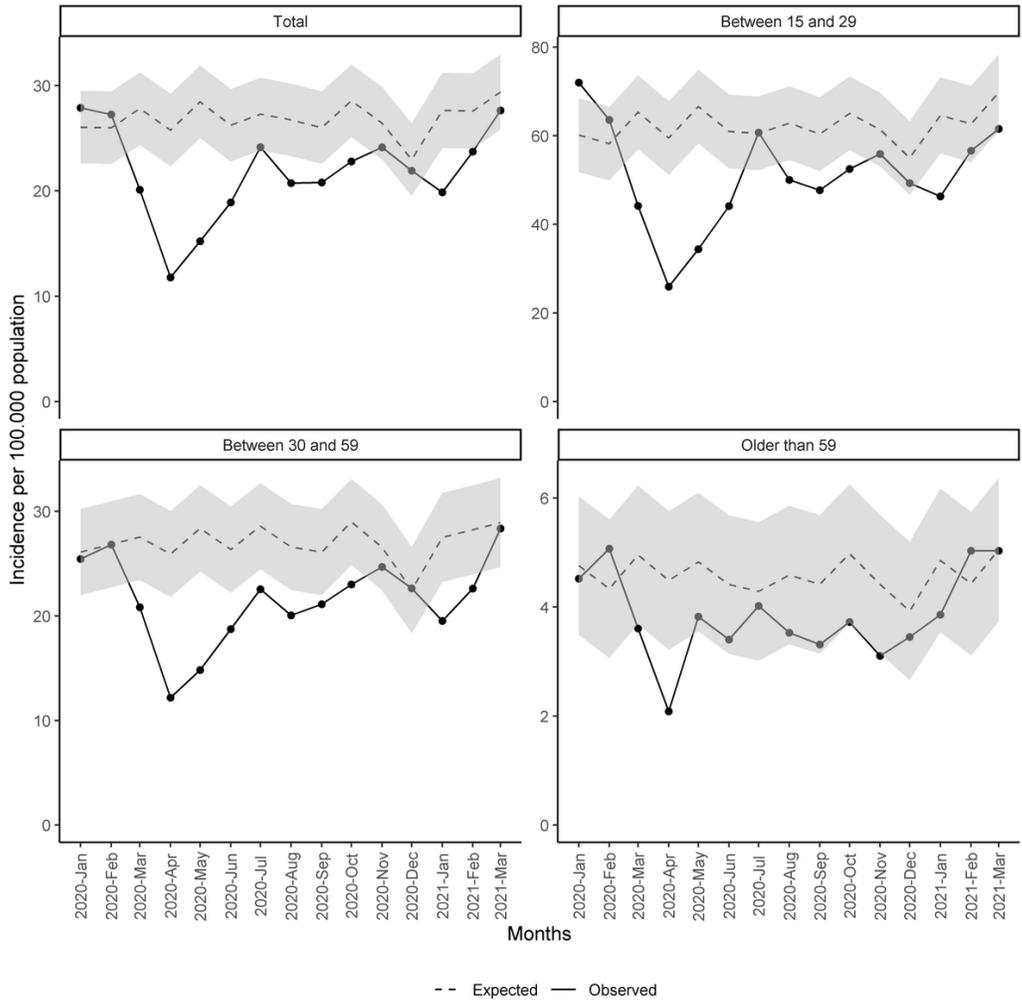
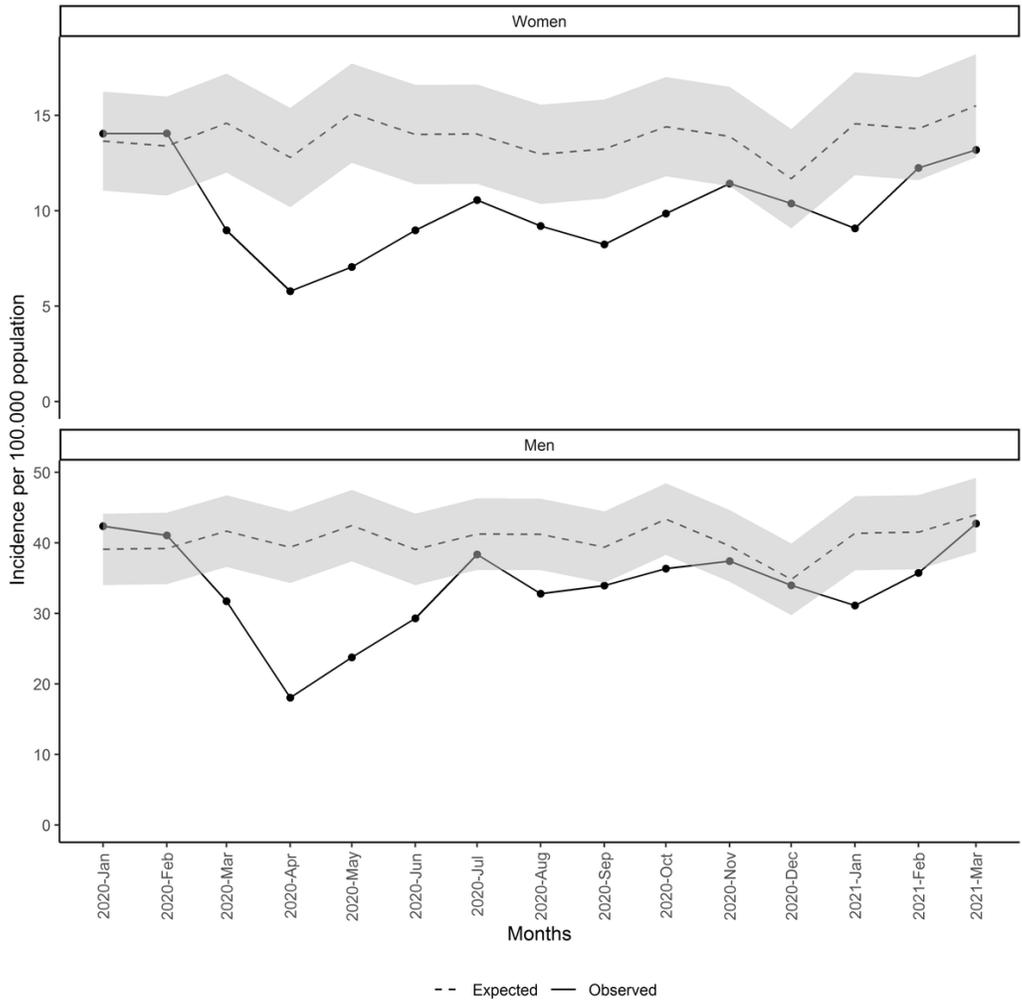


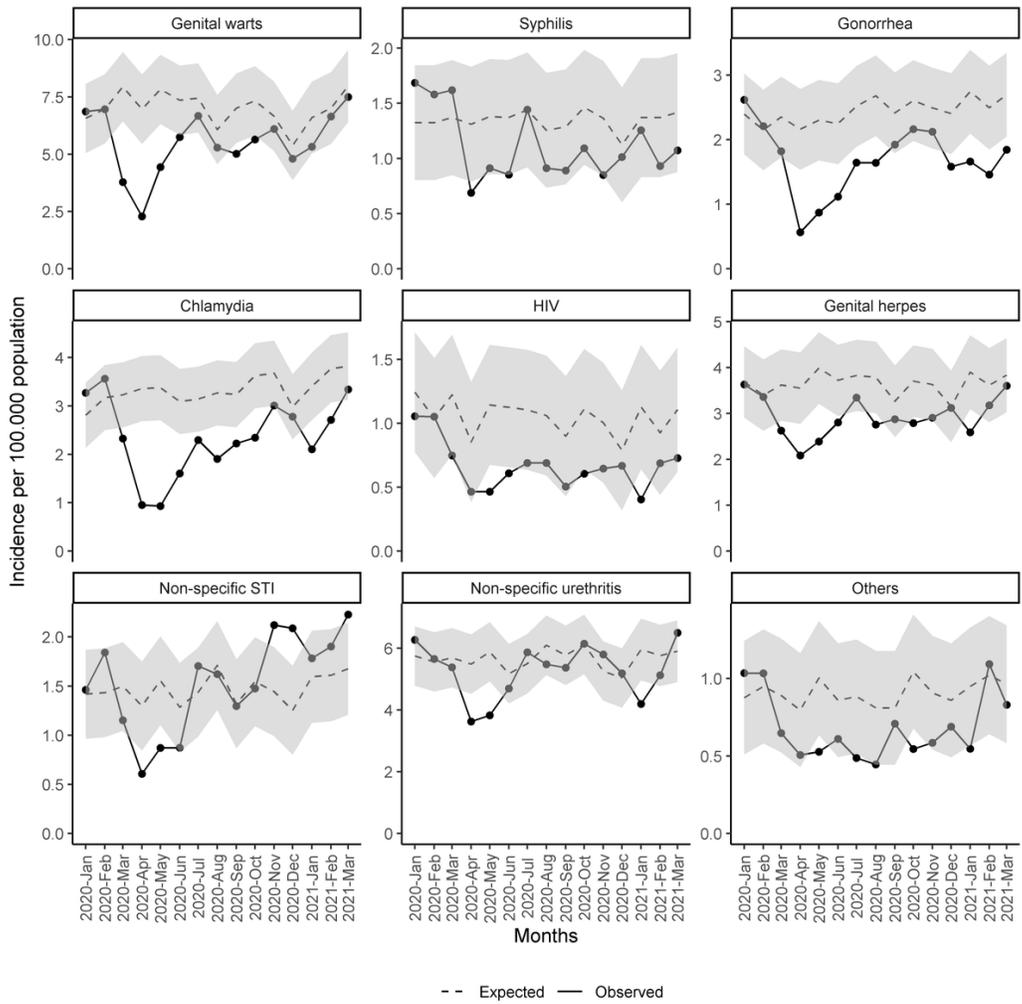
Figure 1

Monthly incidence of STI since January 2020. Total and by age group



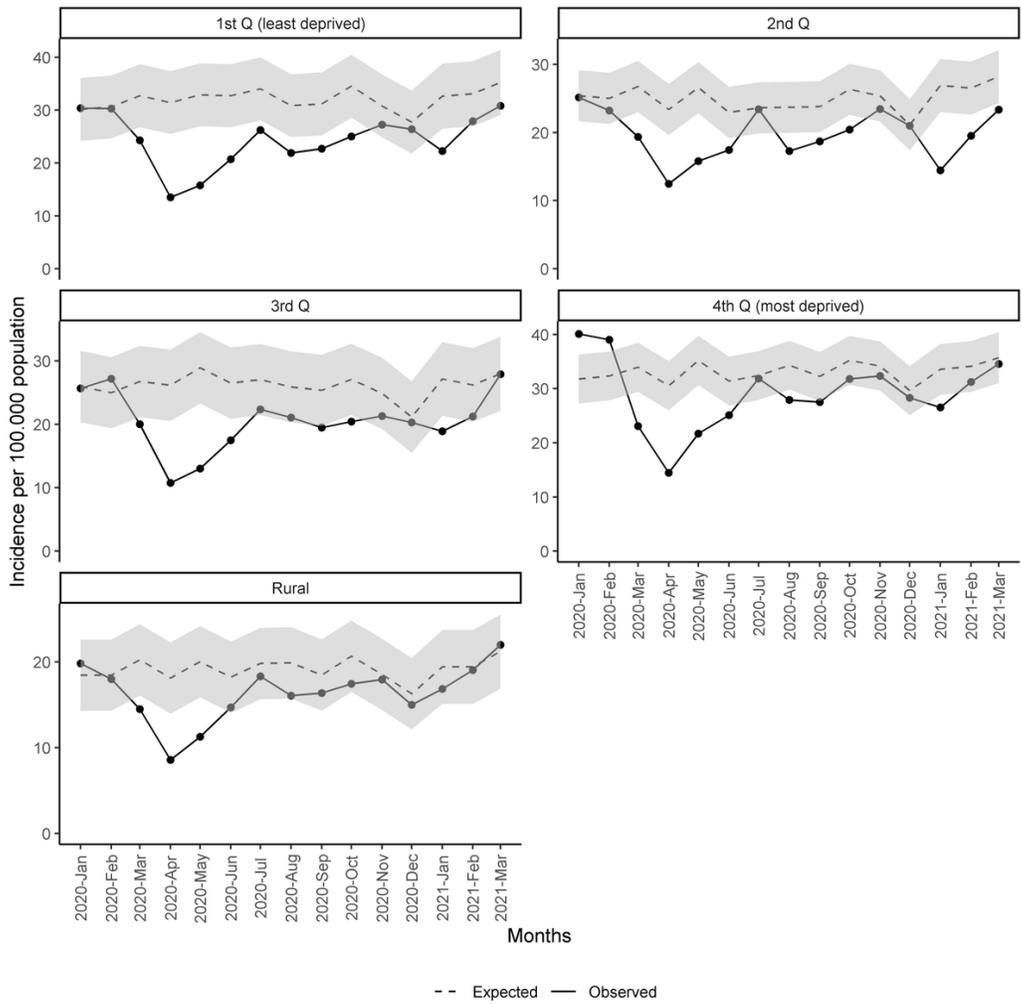
**Figure 2**

Monthly incidence of STI since January 2020 by sex



**Figure 3**

Monthly incidence of STI since January 2020 by type.



**Figure 4**  
 Monthly incidence of STI since January 2020 by socio-economic status and rurality

### Supplementary Files

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