Confused SARS-CoV-2 infection in Scottish neonates 2020–2022: a national, population-based cohort study


ABSTRACT

Objectives To examine neonates in Scotland aged 0–27 days with SARS-CoV-2 infection confirmed by viral testing; the risk of confirmed neonatal infection by maternal and infant characteristics; and hospital admissions associated with confirmed neonatal infections.

Design Population-based cohort study.

Setting and population All live births in Scotland, 1 March 2020–31 January 2022.

Results There were 141 neonates with confirmed SARS-CoV-2 infection over the study period, giving an overall infection rate of 153 per 100 000 live births (141/92 009, 0.15%). Among infants born to women with confirmed infection around the time of birth, the confirmed neonatal infection rate was 1812 per 100 000 live births (15/828, 1.8%). Two-thirds (92/141, 65.2%) of neonates with confirmed infection had an associated admission to neonatal or (more commonly) paediatric care. Six of these babies (6/92, 6.5%) were admitted to neonatal and/or paediatric intensive care; however, none of these six had COVID-19 recorded as their main diagnosis. There were no neonatal deaths among babies with confirmed infection.

Implications and relevance Confirmed neonatal SARS-CoV-2 infection was uncommon over the first 23 months of the pandemic in Scotland. Secular trends in the neonatal confirmed infection rate broadly followed those seen in the general population, although at a lower level. Maternal confirmed infection at birth was associated with an increased risk of neonatal confirmed infection. Two-thirds of neonates with confirmed infection had an associated admission to hospital, with resulting implications for the baby, family and services, although their outcomes were generally good. Ascertainment of confirmed infection depends on the extent of testing, and this is likely to have varied over time and between groups: the extent of unconfirmed infection is inevitably unknown.

INTRODUCTION

Confirmed neonatal infection with SARS-CoV-2, defined as a positive viral test in the first 27 days after birth, is uncommon. A UK study identified 66 neonates with confirmed infection admitted to the hospital between 1 March and 30 April 2020, giving an estimated infection/admission rate of 5.6/10 000 live births. Less than 2% of babies born to women with confirmed infection around the time of birth developed confirmed infection themselves. However, babies born to women with confirmed infection are more likely to be born prematurely or be admitted to the neonatal unit, regardless of infant SARS-CoV-2 status. Neonates with confirmed
infection can develop severe disease; however, reports on the proportion of SARS-CoV-2 positive neonates requiring admission to intensive care vary, depending on the definition of intensive care.\textsuperscript{1,2,9,10} To date, most neonatal SARS-CoV-2 studies have focused on the risk and consequences of transmission to the neonate from an infected mother.\textsuperscript{3,11} However, in the neonatal period, babies are exposed to multiple other potential sources of infection, for example, other caregivers and healthcare professionals. Previous studies have included neonates admitted to the hospital with a positive SARS-CoV-2 test;\textsuperscript{7} however, population-level data including those testing positive in the community are lacking.\textsuperscript{3} The aim of this study was to examine all confirmed cases of SARS-CoV-2 infection in infants aged 0–27 days in Scotland from 1 March 2020 to 31 January 2022.

METHODS

Study population

Detailed methods are provided as online supplemental material. In brief, data were obtained from the ‘COVID-19 in Pregnancy in Scotland’ (COPS) study dataset.\textsuperscript{12,13} COPS contains data on all ongoing and completed pregnancies to women in Scotland, and liveborn babies resulting from those pregnancies, from 1 January 2015 onwards linked to information on SARS-CoV-2 viral testing, admissions to neonatal and paediatric care, and deaths.\textsuperscript{12} For this study, we included all live births in Scotland between 1 March 2020 and 31 January 2022 with a valid Community Health Index (CHI) number available within the COPS dataset.

Identifying confirmed SARS-CoV-2 infections

COPS includes information on all positive SARS-CoV-2 viral tests undertaken on women and babies within the cohort.\textsuperscript{12,14} Up to and including 5 January 2022, confirmed SARS-CoV-2 infection was defined as a positive viral reverse transcription-polymerase chain reaction (RT-PCR) test result. From 6 January 2022 onwards, confirmed infection was defined as a positive viral RT-PCR or a positive lateral flow device (LFD) test (unless the positive LFD result was followed by a negative RT-PCR result within 48 hours). For any individual, the date that their first positive test sample was taken was used as the date of onset of their first episode of infection. Confirmed neonatal infection was defined as a positive test with date of onset from birth to 27 days old inclusive. Maternal infection at the time of birth was defined as a confirmed infection with date of onset in the 14 days leading to birth, on the day of birth or the day after giving birth.

For all babies with confirmed neonatal infection, data were obtained from the COPS database regarding the age of the baby in days at date of onset of infection; maternal age, socioeconomic level, ethnicity, and infection status at the time of birth: and the baby’s sex and gestation at birth. Maternal socioeconomic level was based on the Scottish Index of Multiple Deprivation quintile.\textsuperscript{15}

Identifying hospital admissions associated with confirmed neonatal SARS-CoV-2 infection

A hospital admission associated with confirmed neonatal SARS-CoV-2 infection was defined as an admission of a baby with confirmed neonatal infection to neonatal or paediatric care (1) where the date of onset of infection was in the 7 days prior to, or during, the admission (hence date of admission at up to 27 + 7 = 34 days old inclusive), or (2) where the admission occurred at any point in the neonatal period (hence date of admission at up to 27 days old inclusive) if COVID-19 was recorded as the main diagnosis (International Classification of Diseases, 10th Revision, code U07.1 or U07.2). An ‘admission’ was defined as an entire hospital stay from admission to discharge. The main diagnosis was taken from the first episode of care during an admission.\textsuperscript{16}

Admissions to neonatal units were identified through the Scottish Birth Record\textsuperscript{17} and admissions to paediatric wards through hospital inpatient and day-case discharge records (SMR01).\textsuperscript{16} SARS-CoV-2-associated admission records were analysed to identify the highest level of care provided in the neonatal unit or whether they included an episode in a paediatric intensive care unit (PICU) (‘significant facility’ coded to 13\textsuperscript{18}), length of stay, whether COVID-19 was listed as the main diagnosis and whether the infection was likely to be nosocomial. A probable nosocomial infection was defined as when the first positive viral test was taken on day 7 or later of an ongoing admission.

Calculation of rates and CIs

All data reported here are descriptive only with no formal statistical comparisons. Rates were calculated using the number of babies with confirmed neonatal infection and the total number of live births during the study time period. The CIs were calculated using Wilson score estimates. The analysis and generation of figures were carried out using R V.3.6.1 and RStudio V.1.1.463, and codes are available online (https://github.com/Public-Health-Scotland/COPS-public.git).

RESULTS

Overall, 92 032 live births in Scotland between 1 March 2020 and 31 January 2022 were included in the COPS dataset, of whom 92 009 had a valid CHI number. One-hundred and forty-two neonates with confirmed SARS-CoV-2 were identified from the national viral testing data. Of these, 141 neonates were within the COPS cohort and were included in the analysis. The remaining baby was presumed to have been born outside of Scotland and was excluded.

Neonatal infection rates

Across the study period, the overall neonatal confirmed SARS-CoV-2 infection rate was 153 per 100 000 live births; however, this varied by month from 0 to 663 per 100 000 live births (figure 1A and online supplemental table S1). For context, figure 1B shows the neonatal confirmed infection rate alongside the rates for older children (drawing on other population-based data held by Public Health Scotland) (online supplemental table S2). The neonatal infection rate was consistently the lowest, though all paediatric age groups showed similar peaks of infection in autumn 2021 and December 2021/January 2022. The monthly rates of confirmed infection in pregnant women are presented in online supplemental table S3.

Infant and maternal characteristics and confirmed neonatal SARS-CoV-2 infection

The infant and maternal characteristics of neonates with confirmed SARS-CoV-2 infection are shown in tables 1 and 2. Rates of confirmed neonatal infection were highest among babies born to younger women and to women from more deprived areas, although CIs overlapped. Rates of confirmed neonatal infection among babies born to women from minority ethnic groups were uncertain due to low numbers. The rate of confirmed neonatal infection was substantially higher in babies born to women with (compared with without) confirmed...
infected at the time of birth; however, the absolute risk of confirmed neonatal infection was low in both groups (table 2).

**Age in days at date of first positive test**

The incidence of confirmed infection over the neonatal period followed a linear trend (figure 2 and online supplemental table S4). Of the 15 babies with confirmed neonatal infection who were born to a woman with confirmed infection at birth, none tested positive at <2 days of age, 9 first tested positive between days 2 and 7, and 6 on day 8 or later. Thus, none of these babies met the WHO criteria for confirmed or possible in utero or intrapartum transmission, and would be classified as ‘indeterminate’ status for early postnatal SARS-CoV-2 maternal to child transmission.11

**Hospital admission and outcomes of babies with confirmed neonatal SARS-CoV-2 infection**

Of the 141 babies with confirmed neonatal infection, 92 (92/141, 65.2%) had a total of 101 admissions to neonatal and/or paediatric care that were temporally associated with their positive SARS-CoV-2 test (first positive test taken in the 7 days prior to, or during, the admission). There were no additional associated admissions in the neonatal period with COVID-19 coded as the main diagnosis that did not meet the temporal association criteria.

None of the six SARS-CoV-2-associated admissions to a neonatal unit had COVID-19 coded as the main diagnosis, and three involved probable nosocomial infection. By contrast, 66% (64/97) of the SARS-CoV-2-associated admissions to paediatric care had COVID-19 coded as the main diagnosis, and only one involved probable nosocomial infection. Six of the babies with an associated admission (6/92, 6.5%) had a total of six admissions involving an episode of care in neonatal and/or paediatric intensive care (with two involving a transfer between neonatal and paediatric intensive care). None of these admissions had COVID-19 coded as the main diagnosis (table 3). Over the 23-month study period, the proportion of babies with confirmed neonatal infection that were admitted to hospital remained broadly consistent (online supplemental table S5 and online supplemental figure S1).

There were no neonatal deaths among the 141 babies with confirmed neonatal infection. The background neonatal mortality rate in March 2020–January 2022 was 2.2/1000 live births (206/91 864, 95% CI 2.0 to 2.6) among uninfected babies.

**DISCUSSION**

These results show that confirmed neonatal SARS-CoV-2 infection was uncommon in Scotland over the first 23 months of the pandemic, with only 141 neonates having confirmed infection between 1 March 2020 and 31 January 2022. The secular trend in the confirmed neonatal infection rate followed that seen in older age groups, although at much lower levels. Factors associated with higher infection rates among pregnant women, such as young maternal age and living in a more deprived area, were associated with higher infection rates among pregnant women, such as young maternal age and living in a more deprived area, were associated with higher neonatal infection rates. The rate of confirmed neonatal infection was significantly higher in babies born to women with confirmed infection. Only 6.5% of admitted babies required intensive care, and none of these babies had COVID-19 coded as the main diagnosis. There were no neonatal deaths among babies with confirmed infection.

### Table 1 Infant characteristics and confirmed neonatal SARS-CoV-2 infection

<table>
<thead>
<tr>
<th>Infant sex</th>
<th>Total live births (n)</th>
<th>Neonates SARS-CoV-2 positive (n)</th>
<th>Rate per 100 000 live births</th>
<th>Lower CI</th>
<th>Upper CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>47 232</td>
<td>79</td>
<td>167</td>
<td>133</td>
<td>210</td>
</tr>
<tr>
<td>Female</td>
<td>44 777</td>
<td>62</td>
<td>138</td>
<td>107</td>
<td>179</td>
</tr>
<tr>
<td>Gestation at birth</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Preterm (22–36 weeks)</td>
<td>7231</td>
<td>17</td>
<td>235</td>
<td>142</td>
<td>385</td>
</tr>
<tr>
<td>Earlier preterm (22–33 weeks)</td>
<td>1946</td>
<td>3</td>
<td>154</td>
<td>40</td>
<td>490</td>
</tr>
<tr>
<td>Later preterm (34–36 weeks)</td>
<td>5285</td>
<td>14</td>
<td>265</td>
<td>151</td>
<td>456</td>
</tr>
<tr>
<td>Term+ (37–44 weeks)</td>
<td>84 735</td>
<td>124</td>
<td>146</td>
<td>122</td>
<td>175</td>
</tr>
<tr>
<td>Unknown</td>
<td>43</td>
<td>0</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Total</td>
<td>92 009</td>
<td>141</td>
<td>153</td>
<td>129</td>
<td>181</td>
</tr>
</tbody>
</table>
These data align with previous studies on admission rates for neonatal SARS-CoV-2 infection and give an insight into the total burden of confirmed neonatal infection in the UK. A strength of this study is that it takes a population-level view of neonatal SARS-CoV-2 infection, rather than confining results to only those born to infected women, or only those admitted to hospital. Our data also encompass almost 2 years of the pandemic, including the emergence of new viral variants and the introduction of COVID-19 vaccines. In keeping with published rates, we found just under 2% of babies born to women with confirmed infection at the time of birth had confirmed neonatal infection. Not all babies of infected women were tested (see further), and rates may have been higher if all were screened.

This was an observational study, with cases of confirmed infection identified through the results of ‘real-world’ testing carried out in the community and hospitals across Scotland. Not all babies will have been tested, and some infections may therefore have been missed. The extent of unconfirmed infection is inevitably unknown. The proportion of all infections that are confirmed will be influenced by the extent of testing, and this is likely to have varied over time and between groups.

During the study period, infants may have been tested due to having clinical signs of infection, having contact with a case, or as part of routine hospital admission testing. Around half of neonates with SARS-CoV-2 infection appear well or show mild clinical signs which may not prompt testing. Scottish policy recommended testing of all emergency hospital admissions (including to paediatric and maternity care) from early December 2020. Guidance on testing of neonates varies between countries. In the UK, professional guidance on testing in neonatal care in place throughout our study period recommended testing babies born to mothers with confirmed infection who required admission, those readmitted from the community, those with clinically suspected COVID-19 and weekly testing for those receiving respiratory support. Testing neonates less than 72 hours old was not recommended due to difficulties interpreting results. Routine testing of newborns, including those born to mothers with confirmed infection, who were well and remained in postnatal settings was not recommended. Access to community-based RT-PCR testing became widely available (including for children) from August 2020 and free home LFD testing was available from April 2021.

It is likely that over the study period, babies showing more severe clinical signs, those born to mothers with confirmed infection and those admitted to neonatal or paediatric care (for whatever reason) are more likely to have undergone testing, and hence ascertainment of confirmed infection is likely to have been biased towards higher rates.
been more complete in these groups. However, this is unlikely to account for the greater than 10-fold increased risk of confirmed neonatal infection seen in babies born to mothers with confirmed infection at the time of birth.

Reassuringly, we demonstrate that the clinical outcomes of neonates with confirmed SARS-CoV-2 infection are good, with no deaths and no intensive care admissions for which COVID-19 was the main diagnosis. Other studies have recorded higher rates of critical care admissions; Swann reported that up to 33% of UK neonates with confirmed infection early in the pandemic required critical care,9 and a subsequent study over a longer period found that 20% of neonates required critical care.25 However, these studies only included admitted babies, and the definition of critical care included admission to a PICU or any level of care in a neonatal unit.25 Our data suggest that a much lower proportion of neonates with SARS-CoV-2 infection truly require intensive care.

Despite these positive outcomes, around two-thirds (92/141, 65.2%) of neonates with confirmed SARS-CoV-2 infection had a temporally associated hospital admission. This is perhaps not surprising, as fever is a common sign of SARS-CoV-2 infection in neonates,1 2 10 20 23 24 28 and according to UK guidelines,29 a temperature above 38°C should prompt blood and urine tests, lumbar puncture and intravenous antibiotics. This demonstrates the indirect effects of SARS-CoV-2 on infants who may receive invasive investigations and treatments aimed at potential bacterial infections. This study was limited in that detailed information on signs and treatments received in hospital was lacking. However, detailed information on the care of babies admitted with SARS-CoV-2 early in the pandemic in the UK is available.30

In summary, confirmed SARS-CoV-2 infection in neonates was uncommon over the first 23 months of the pandemic in Scotland. Two-thirds of neonates with confirmed infection had an associated hospital admission. There were no neonatal deaths among babies with confirmed infection. Continued vigilance will be important to assess the ongoing impact of SARS-CoV-2 in the neonatal population as testing, isolation requirements and vaccination programmes continue to evolve, and new viral variants emerge.

### Table 3 Hospital admissions temporally associated with a positive SARS-CoV-2 test among babies with confirmed neonatal infection

<table>
<thead>
<tr>
<th>Maximum level of care</th>
<th>COVID-19 coded as main diagnosis</th>
<th>Yes</th>
<th>No</th>
<th>All</th>
</tr>
</thead>
<tbody>
<tr>
<td>PICU</td>
<td></td>
<td>0</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>No PICU</td>
<td></td>
<td>64</td>
<td>27</td>
<td>91</td>
</tr>
<tr>
<td>Probable nosocomial infection</td>
<td></td>
<td>0</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>No</td>
<td></td>
<td>64</td>
<td>32</td>
<td>96</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>64</td>
<td>33</td>
<td>97</td>
</tr>
</tbody>
</table>

Admissions/transfers to paediatric care (n=97)

<table>
<thead>
<tr>
<th>Maximum level of care</th>
<th>COVID-19 coded as main diagnosis</th>
<th>Yes</th>
<th>No</th>
<th>All</th>
</tr>
</thead>
<tbody>
<tr>
<td>PICU</td>
<td></td>
<td>0</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>No PICU</td>
<td></td>
<td>64</td>
<td>27</td>
<td>91</td>
</tr>
<tr>
<td>Probable nosocomial infection</td>
<td></td>
<td>0</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>No</td>
<td></td>
<td>64</td>
<td>32</td>
<td>96</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>64</td>
<td>33</td>
<td>97</td>
</tr>
</tbody>
</table>

There were 101 separate admissions to neonatal or paediatric care of 92 neonates (two admissions involved a transfer from neonatal to paediatric intensive care).

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### References

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REFERENCES


Confirmed SARS-CoV-2 infection in Scottish neonates 2020-2022: a population-based cohort study

Supplementary data and figures

Supplementary methods

Study population

We derived and analysed data from the “COVID-19 in Pregnancy in Scotland” (COPS) study dataset as updated in mid-May 2022. The COPS dataset is described in detail elsewhere (1, 2). In brief, it comprises a population-based, dynamic cohort which includes data on all ongoing and completed pregnancies to women in Scotland, and live born babies resulting from those pregnancies, from 1 January 2015 onwards. The dataset is based on linkage of health service and statutory national datasets, including those relating to pregnancy-related care and births, SARS-CoV-2 viral testing and COVID-19 vaccinations, admissions to neonatal and paediatric care, and deaths (1). All individuals in Scotland who receive care from the National Health Service (NHS) (which will include essentially all pregnant women and neonates as there is no private maternity care in Scotland) are assigned a unique patient identifier, the Community Health Index (CHI) number (3) which allows for linkage of medical records relating to an individual. Within the COPS database, the CHI number for both the mother and the baby are included on NHS live birth notification records, further allowing intergenerational linkage of records relating to mothers and their babies. For this study, we included all live born babies born in Scotland between 1st March 2020 and 31st January 2022 who had a valid CHI number available within the COPS dataset.

Identifying confirmed SARS-CoV-2 infections

COPS includes information on all positive SARS-CoV-2 viral tests undertaken on women and babies within the cohort from the NHS Scotland Corporate Data Warehouse. The warehouse includes results of all Reverse Transcription Polymerase Chain Reaction (RT-PCR) SARS-CoV-2 tests processed
through NHS Scotland and UK Government Regional Testing Centre ('Lighthouse') laboratories. It also includes information on all SARS-CoV-2 Lateral Flow Device (LFD) tests where the result has been logged by the individual taking the test (or their parent/carer) on the UK Government website (1, 4). Up to and including 5 Jan 2022, confirmed SARS-CoV-2 infection was defined as a positive viral RT-PCR test result. From 6 Jan 2022 onwards, confirmed infection was defined as a positive viral RT-PCR test result or a positive LFD test result (unless the positive LFD result was followed by a negative viral RT-PCR result within 48 hours). This is consistent with the contemporaneous case definition in Scotland (5).

For any individual, the date that their first positive test sample was taken was used as the date of onset of their first episode of infection. Information on the presence of clinical signs, and date of onset of signs, was not always available on testing records. Subsequent positive samples taken within 90 days of a first positive sample were discounted. A subsequent positive sample taken more than 90 days after a first positive result was taken as indicating a subsequent confirmed infection.

Confirmed neonatal infection was defined as a confirmed infection with date of onset at any point from birth to 27 days old inclusive. By this definition, each infected baby can therefore only have one episode of confirmed infection during the neonatal period. Maternal infection at the time of childbirth was defined as a confirmed infection with date of onset in the 14 days leading to birth, on the day of childbirth, or on the day after giving birth.

For all babies with confirmed neonatal infection, data were obtained from the COPS database regarding: the age of the baby in days at date of onset of infection; maternal age, socioeconomic status, ethnicity, infection status at the time of childbirth; the baby’s sex and gestation at birth. Maternal socioeconomic status was based on the Scottish index of multiple deprivation (SIMD) quintile. SIMD is an area-based measure of material deprivation derived from the postcode of residence (6)).

Identifying admissions of neonates with SARS-CoV-2
Neonates requiring hospital inpatient care may be cared for alongside their mother in a postnatal ward or admitted to a neonatal unit or paediatric ward (including paediatric intensive care units, PICU). Babies who have been discharged home after birth - who then require readmission to hospital - will generally be admitted to a paediatric ward (rather than a neonatal unit) to avoid importing and transmitting infections to neonatal units.

We first identified all admissions to neonatal units and paediatric wards in the neonatal period (date of admission from birth to 27 days old inclusive) for babies in our study population. Admissions to neonatal units were identified through the Scottish Birth Record (SBR, (7)), and admissions to paediatric wards through the Scottish Morbidity Record hospital inpatient and day-case discharge records (SMR01, (8)). A stay in neonatal care was defined as any SBR admission record which included at least one episode in intensive care, high dependency care, or special care. Any SMR01 record in the relevant period was included as a paediatric admission. Of note, this method does not capture neonates who were readmitted from home to a postnatal unit, rather than to a neonatal unit or paediatric care. Therefore, it is possible that some admissions may have been missed.

For babies with confirmed neonatal SARS-CoV-2 infection, we then identified SARS-CoV-2-associated admissions for further analysis. A SARS-CoV-2 associated admission was defined as an admission of a baby with confirmed neonatal infection to neonatal or paediatric care (a) where the date of onset of infection was in the 7 days prior to, or during, the admission (hence date of admission at up to 27+7=34 days old inclusive), or (b) where the admission occurred at any point in the neonatal period (hence date of admission at up to 27 days old inclusive) if COVID-19 was recorded as the main diagnosis (ICD10 code U07.1 or U07.2). An ‘admission’ was defined as an entire hospital stay from admission to discharge, which may have involved sequential episodes of care in different settings or locations. The main diagnosis recorded for an admission was taken from the diagnostic coding on the first episode of care. Usually, the main diagnosis recorded on an episode record reflects the main condition treated during that episode, however from the start of the pandemic to May 2021 inclusive, a temporary amendment to national coding guidance advised that COVID-19 (ICD10 code...
U07.1 or U07.2) should always be coded as the main diagnosis if present during an episode of care (9).

Neonatal and paediatric admission records for these SARS-CoV-2-associated admissions were analysed to identify the highest level of care provided in the neonatal unit (intensive care, high dependency, or special care) or whether the admission included an episode in a paediatric intensive care unit, length of stay for the entire admission, whether COVID-19 was recorded as the main diagnosis, and whether the infection was likely to be nosocomial. A probable nosocomial infection was defined as when the first positive test was taken on day 7 of an ongoing admission or later.

**Calculation of rates and confidence intervals**

Due to the relatively small numbers involved, all data reported here are descriptive only and no formal statistical comparisons have been made. Rates were calculated using the number of babies with confirmed neonatal infection (numerator) and the total number of live births (denominator) during the relevant time period (individual months or the full study period 1 March 2020 to 31 January 2022), with confidence intervals calculated using Wilson score estimates. This approach to calculating rates supports production of the timeliest results, however it does allow a mismatch between numerator and denominator. For example, in any one month some of the babies with confirmed infection during that month may have been born in the previous month. Given the number of live births is fairly consistent month to month, we believe that this mismatch should have minimal impact on the interpretation of our findings.
Table S1

Monthly rate of confirmed SARS-CoV-2 infection in babies aged 27 days and under per 100,000 live births, Scotland 1 March 2020 to 31 January 2022.

<table>
<thead>
<tr>
<th>Month</th>
<th>Total number of live births</th>
<th>Number of confirmed SARS-CoV-2 infections in neonates with date of onset in month</th>
<th>Overall rate of confirmed SARS-CoV-2 infection in neonates (per 100,000 live births)</th>
<th>Lower CI</th>
<th>Upper CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mar-20</td>
<td>4,001</td>
<td>0</td>
<td>0.0</td>
<td>0.0</td>
<td>119.6</td>
</tr>
<tr>
<td>Apr-20</td>
<td>3,857</td>
<td>2</td>
<td>51.9</td>
<td>9.0</td>
<td>208.9</td>
</tr>
<tr>
<td>May-20</td>
<td>3,888</td>
<td>0</td>
<td>0.0</td>
<td>0.0</td>
<td>123.1</td>
</tr>
<tr>
<td>Jun-20</td>
<td>4,083</td>
<td>0</td>
<td>0.0</td>
<td>0.0</td>
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<tr>
<td>Jul-20</td>
<td>4,282</td>
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</tr>
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<td>Aug-20</td>
<td>4,078</td>
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<td>49.0</td>
<td>8.5</td>
<td>197.6</td>
</tr>
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</table>

CI = 95% confidence interval.
Table S2

Rates of confirmed SARS-CoV-2 infection in post neonatal infants and children up to 17 years of age, Scotland 1 March 2020 to 31 January 2022. Estimated number of children in each age group (denominator for rates) taken from National Records of Scotland, Mid-2020 Population Estimates Scotland and is kept constant throughout (10). Number of post neonatal infants (under 1 year) estimated using the Mid-2020 Population Estimate minus 4,000 (the average number of live births per month). Number of positive tests obtained from NHS Scotland Corporate Data Warehouse (4).

<table>
<thead>
<tr>
<th>Month</th>
<th>Estimated no. of post-neonates, under 1yr (d28 to d364)</th>
<th>No. confirmed SARS-CoV-2 infection post-neonates</th>
<th>Overall rate post-neonates (per 100,000)</th>
<th>Estimated no. of children aged 1-4 years</th>
<th>No. confirmed SARS-CoV-2 infection aged 1-4 years</th>
<th>Overall rate aged 1-4 years (per 100,000)</th>
<th>Estimated no. of children aged 5-11 years</th>
<th>No. confirmed SARS-CoV-2 infection aged 5-11 years</th>
<th>Overall rate children aged 5-11 years (per 100,000)</th>
<th>Estimated no. of children aged 12-17 years</th>
<th>No. confirmed SARS-CoV-2 infection children aged 12-17 years</th>
<th>Overall rate of children aged 12-17 years (per 100,000)</th>
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Table S3:

Rates of confirmed SARS-CoV-2 infection in pregnancy, Scotland 1 March 2020 to 31 January 2022. Data obtained from COPS cohort.

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<th>Month</th>
<th>Estimated No. women in Scotland with an ongoing pregnancy at start of month*</th>
<th>No. women with confirmed SARS-CoV-2 infection in pregnancy with date of onset in month**</th>
<th>Rate per 100,000 pregnant women***</th>
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<td>38.7</td>
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<td>Month</td>
<td>Pregnant Women</td>
<td>SARS-CoV-2 Infections</td>
<td>Rate (per 10,000)</td>
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<td>6,977.5</td>
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</tbody>
</table>

* The total for this column is the number of women who were pregnant at some point during the study period.
** The total for this column is the number of women with confirmed SARS-CoV-2 infection in pregnancy during the study period.
*** The total for this column is the overall rate of confirmed SARS-CoV-2 infection in pregnancy during the study period.
Table S4

Date of onset of first positive test for neonates who had a confirmed SARS-CoV-2 infection at or below 27 days of age, Scotland 1 March 2020 to 31 January 2022.

<table>
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<th>Cumulative number of confirmed SARS-CoV-2 infection in neonates</th>
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Table S5

Admission rates for neonates with confirmed SARS-CoV-2 infection, Scotland 1 March 2020 to 31 January 2022. Rounded to 1 decimal place.

<table>
<thead>
<tr>
<th>Month</th>
<th>Total number of live births</th>
<th>No. neonates with confirmed SARS-CoV-2 infection</th>
<th>No with associated hospital admission</th>
<th>No with associated admission with COVID-19 as main diagnosis</th>
<th>Overall rate of confirmed SARS-CoV-2 infection in neonates (per 100,000 live births)</th>
<th>Rate of confirmed neonatal infection with associated admission (per 100,000 live births)</th>
<th>Rate of confirmed neonatal infection with associated admission with COVID-19 as main diagnosis (per 100,000 live births)</th>
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<tbody>
<tr>
<td>Mar-20</td>
<td>4,001</td>
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<td>Returns</td>
<td>Discounts</td>
<td>Total Sales</td>
<td>Net Income</td>
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</tbody>
</table>
Figure S1

Trends in overall rate of confirmed neonatal SARS-CoV-2 infection compared to rate of neonatal infection with associated hospital admission, and with associated admission with COVID-19 coded as main diagnosis, Scotland 1 March 2020 to 31 January 2022. Per 100,000 live births.
**Additional references**


