COVID-19 communique

A report on maternal and newborn outcomes during the COVID-19 pandemic

VICTORIA
State
Government

Contents

About this report

This publication is a follow-up report on the rapid communique released in 2021. It presents data on 19 key maternity, perinatal and neonatal indicators, with a statistical comparison of the pre-pandemic and pandemic periods. This analysis aims to inform policy directions as we transition to a post-lockdown society.

Please note: While the datasets for 2018 to 2021 have undergone the routine data cleaning steps, the first 2 quarters of 2022 data are yet to be cleaned.

Abbreviations

BBA	Born Before Arrival
BMI	Body Mass Index
CCOPMM	Consultative Council on Obstetrics and Paediatrics Mortality and Morbidity
FGR	Foetal Growth Restriction
GDM	Gestational Diabetes Mellitus
LGA	Large For Gestational Age
LHN	Learning Health Network
LOS	Length Of Stay
NICU	Neonatal Intensive Care Unit
PTB	Preterm Births
SCN	Special Care Nursery
VAED	Victorian Admitted Episodes Database
VPDC	Victorian Perinatal Data Collection

Introduction

Victoria in early 2023 is a very different place to the state that experienced the pandemic lockdowns of 2020 and 2021. During 2020 to 2021, Melbourne spent almost a continuous year under "lockdown" conditions, with the most austere periods restricting residents to only leave the house for essential food and services and medical care, essential work, and care for dependents (figure 1) (1, 2). Residents were allowed an hour outside their homes to exercise daily within a 5 km perimeter radius with face coverings or masks. Curfews were also imposed from 8 PM to 5 AM and gatherings of >2 people were forbidden (3).

However, families continued to grow, and Victorian hospitals continued providing outpatient and inpatient care to over 6000 mothers and babies per month. We transformed maternity care almost overnight in response to the COVID-19 mitigation measures, including a rapid shift to telehealth appointments and visitor restrictions during antenatal visits, labour, and birth (4). Around the world, there were numerous reports of increases in a range of adverse maternal outcomes during the pandemic including stillbirths, maternal mortality, and ruptured ectopic pregnancy (2, 5), but also potential improvements such as reductions in preterm birth.

This CCOPMM COVID-19 report builds on the COVID-19 Rapid Report of 2021, which examined trends in 10 perinatal indicators during the first 10 months of the pandemic (6). In this document, we report on 19 maternal and newborn indicators and perform additional statistical significance testing to help inform future care and emergency preparedness.

Approach to the report

This analysis uses the Victorian Perinatal Data Collection (VPDC), a statutory data collection system that includes all births in Victoria, and the Victorian Admitted Episodes Database (VAED). All births in public hospitals, private hospitals and home births are included. VPDC data for the first 2 quarters of 2022 are provisional.

The findings are reported by month with the following definitions of the pre-pandemic and pandemic periods.

- **Pre-pandemic period:** January 2018 – March 2020 inclusive
- **Pandemic period:** April 2020 – June 2022 inclusive. Some indicators were only available until Dec 2021.
- **Summary statistics**: mean, median, and interquartile range (IQR)
- **Significance testing** of pre-pandemic vs pandemic medians: Rank-sum test

The monthly outcomes are displayed as run charts against the median value for the pre-pandemic period. Statistically significant patterns include "**shifts**" (6 or more consecutive months all above or all below the median) and **'trends'** (5 or more consecutive months all increasing or all decreasing). The graphs were not adjusted for seasonality, trends, or auto-correlations.

Newborn and maternal indicators

1. Unexpected stillbirths from 28 weeks' gestation (excludes terminations of pregnancy)
2. Preterm births
3. Low Apgar score
4. Severe fetal growth restriction (birthweight < 3rd centile)
5. Congenital anomalies
6. Large for gestational age (birthweight > 90th centile)
7. Newborn admission to special care nursery or neonatal intensive care at term
8. Newborn length of stay

9. Unplanned newborn readmissions

10. Homebirths (planned and unplanned)

11. In transit births

12. Maternal BMI > 25

13. Gestational diabetes mellitus (Field) – updated dedicated data field available only from Jan 2020

14. Gestational diabetes mellitus (Derived) – previous GDM indicator available from Jan 2018

15. Eclampsia/Pre-eclampsia (Derived)

16. Pertussis vaccination coverage

17. Influenza vaccination coverage

18. Maternal length of stay

19. Unplanned maternal readmissions

- The definitions and statistical methods are presented in Appendix 1.

- Detailed results tables including significant testing are in Appendix 2.

Figure 1: Number of new COVID-19 cases in Victoria (7) (in blue) and Government Stringency Index[1](8) in Australia (in yellow)

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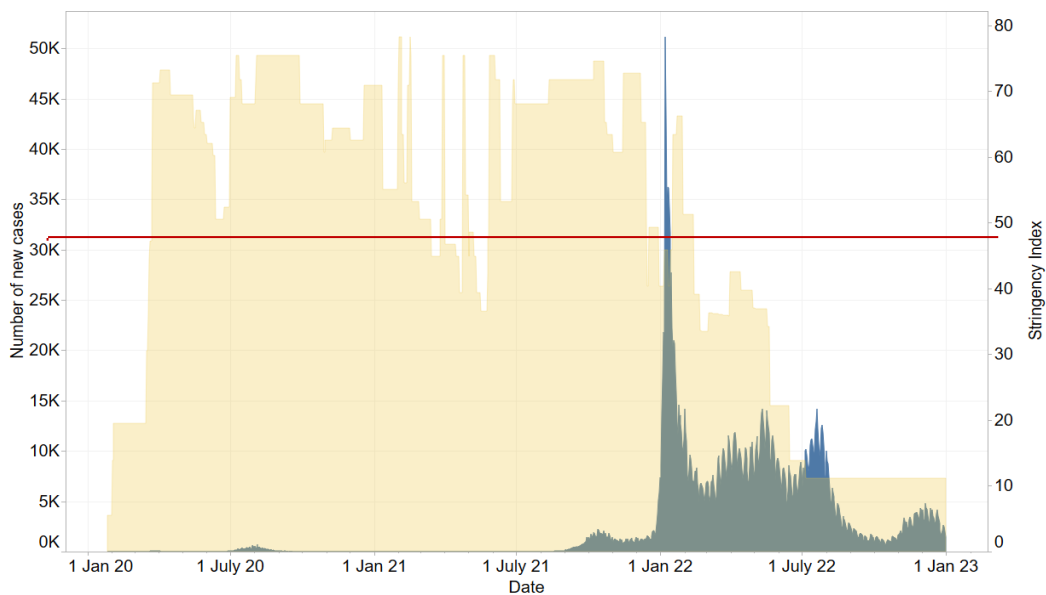
[1] Stringency index of ≥50 is considered a lockdown8. Mathieu E, Ritchie H, Rodés-Guirao L, Appel C, Giattino C, Hasell J, et al. COVID-19: Stringency Index [Webpage]. The United Kingdom: University of Oxford; 2023 [updated "Coronavirus Pandemic (COVID-19)"2023]. Coronavirus Pandemic (COVID-19)"].

Summary of findings

The period of the COVID-19 pandemic was associated with significant changes in key quality indicators in maternal and newborn health.

Compared to the pre-pandemic period (Jan 2018 to March 2020), the pandemic period (April 2020 to June 2022) was associated with the following statistically significant changes.

REDUCED rates of:

- Preterm birth (including total preterm births <37 weeks, 32-36 weeks, 20-23 weeks, and iatrogenic and spontaneous preterm births)

- Newborn admissions to Special Care Nursery (SCN), or Neonatal Intensive Care Unit (NICU)

- Severe fetal growth restriction (birthweight $\leq$ 3rd centile)

- Low Apgar score in term infants

- Lengths of hospital stay $\geq$ 3 days for mothers and babies

- Maternal readmission due to post-partum infections

INCREASED rates of:

- Large for gestational age infants (LGA)

- Births outside hospital (including in-transit, planned and unplanned home births)

- Gestational diabetes mellitus (GDM)

- Maternal overweight or obesity at first antenatal visit (Body mass index > 25 kg/m^2)

- Unplanned newborn readmissions due to feeding problems and infectious diseases

- Maternal readmissions due to hypertensive disorders

Indicator Run Charts

1. Total births per month, Victoria, January 2018 – June 2022
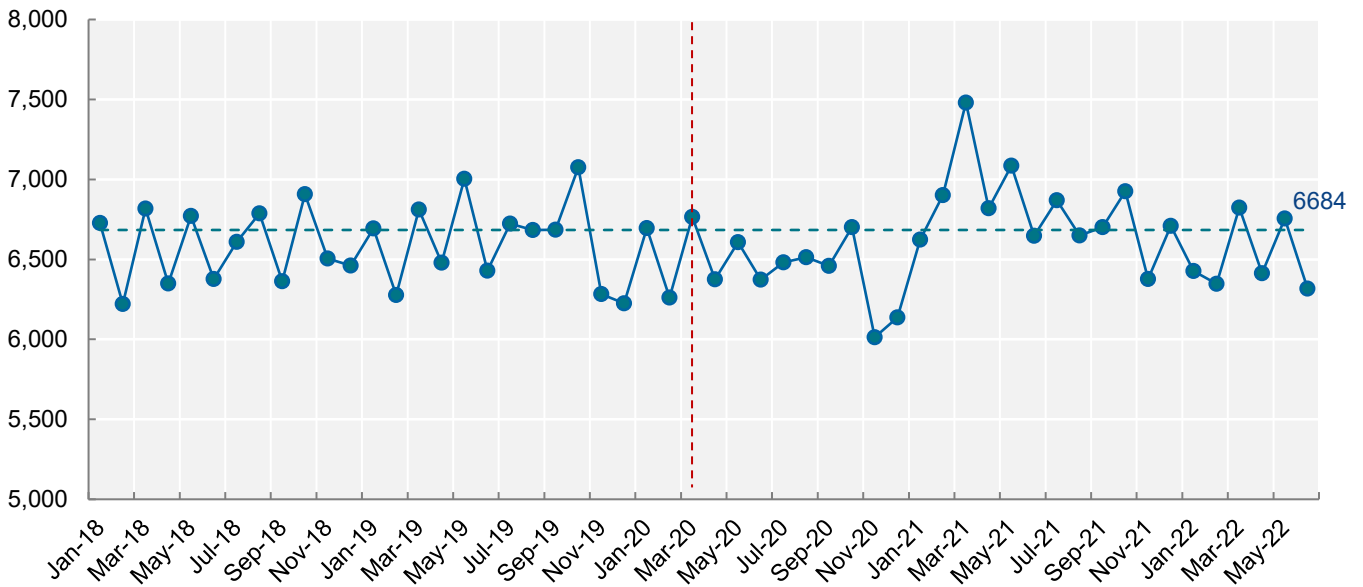
2. COVID-19 vaccination status among women giving birth
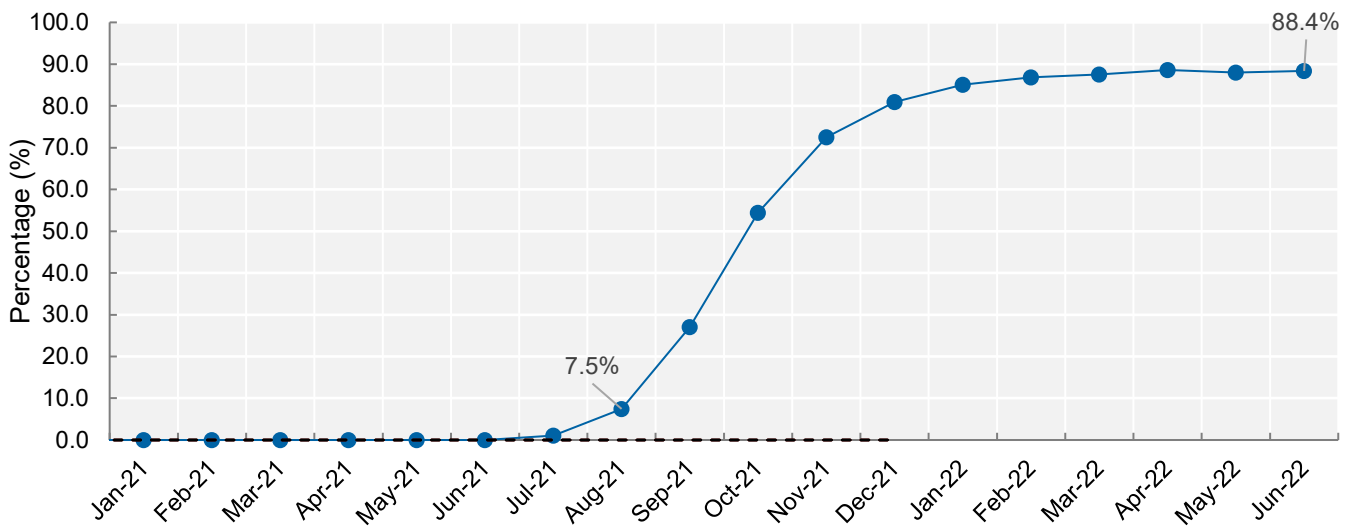
COVID-19 vaccination before or during pregnancy

Figure 3 shows monthly rate of women giving birth after receiving at least > 1 dose of COVID-19 vaccine before or during their pregnancy. The Australian government recommended COVID-19 vaccination during pregnancy in June 2021(10, 11).

3. Unexpected stillbirths > 28 weeks

Proportion of eligible births that resulted in a stillbirth

Denominator: Number of births that met criteria of (a) gestational age ≥ 28 weeks (b) ≥ 400 grams (c) no major congenital anomalies.

Exclusions: Birth status not stated/ inadequately described

Numerator: Number of babies who met the denominator criteria and who were stillborn
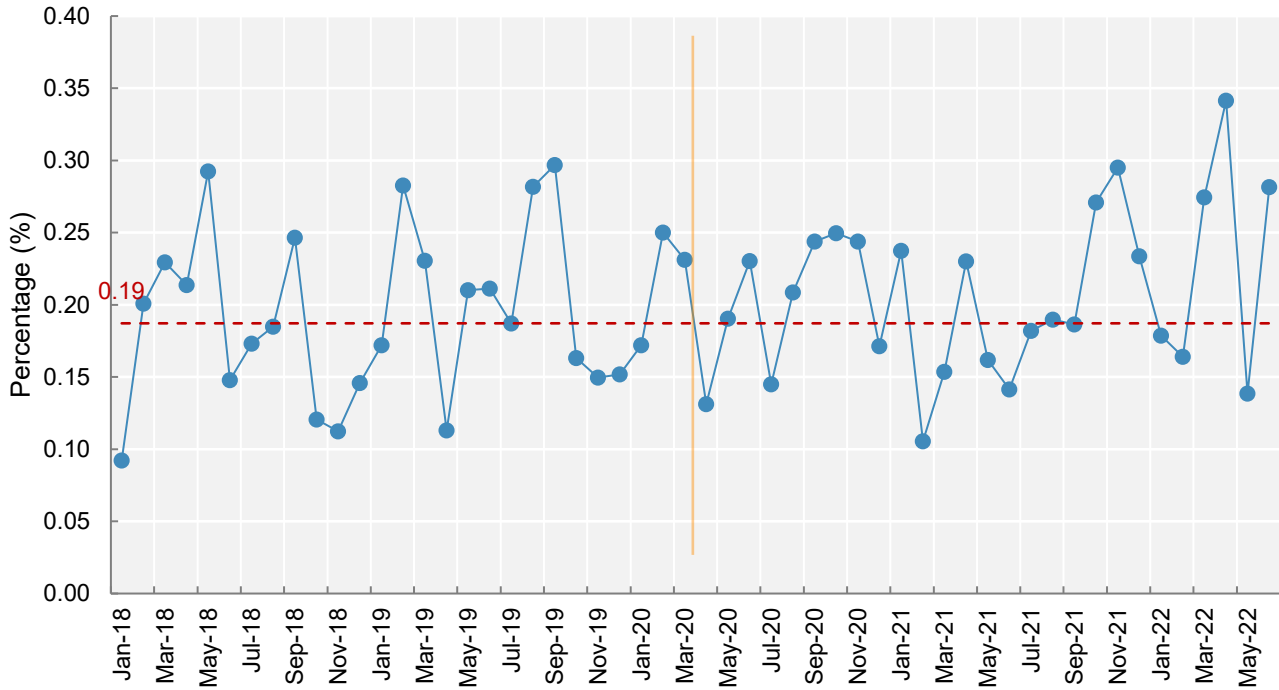
4. Preterm births

Proportion of babies who were born preterm (including terminations of pregnancies).

Denominator: Number of babies who were born > 20 weeks' gestation.

Numerator: Number of babies who met the denominator criterion and were born at < 37 weeks gestation, disaggregated into the subgroups to align with CCOPMM reporting.

a. Preterm birth rate < 37 weeks
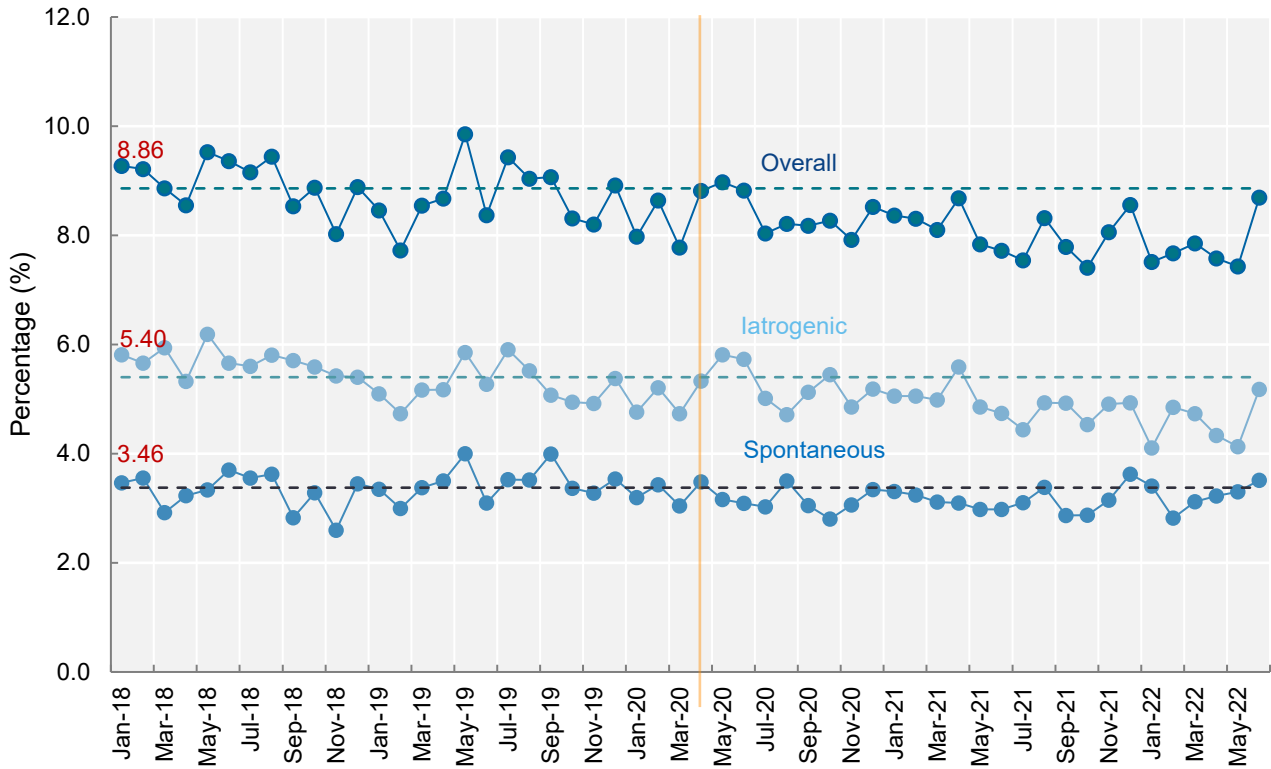
Iatrogenic preterm birth: any preterm birth by Cesarean section prior to the onset of labour, or any preterm birth preceded by an induction of labour

Spontaneous preterm birth: any preterm birth after the spontaneous onset of labour

b. Preterm birth rate 32-36 weeks
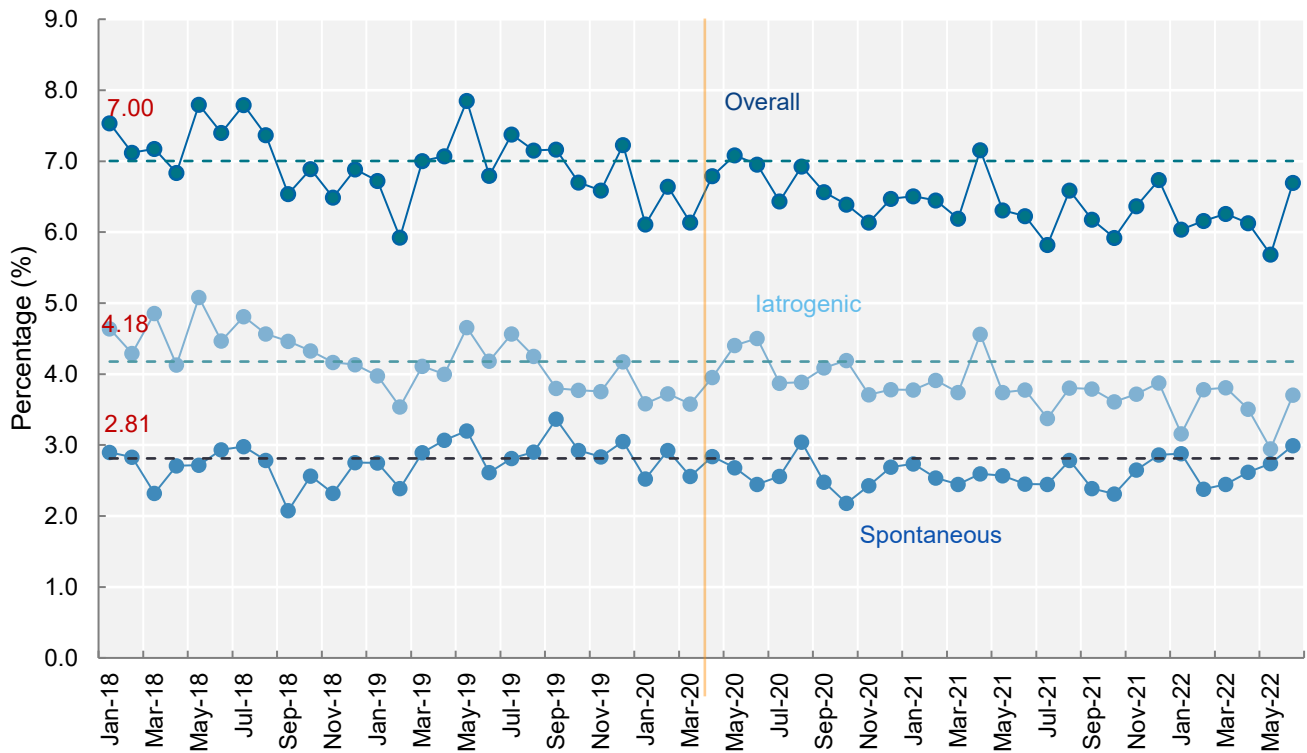
c. Preterm birth rate 28-31 weeks
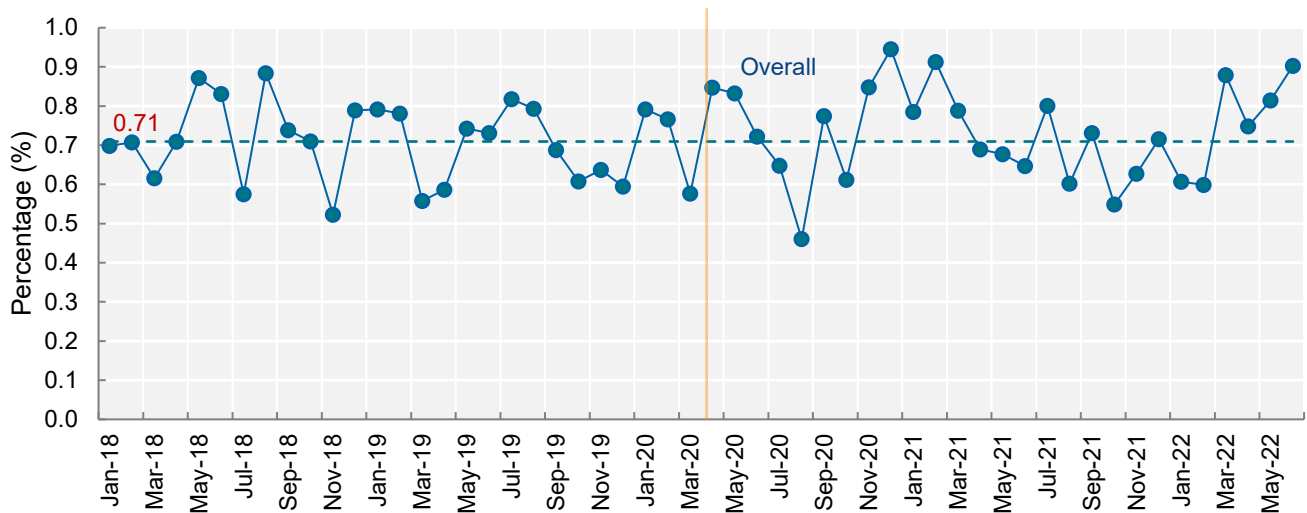
d. Preterm birth rate 24-27 weeks
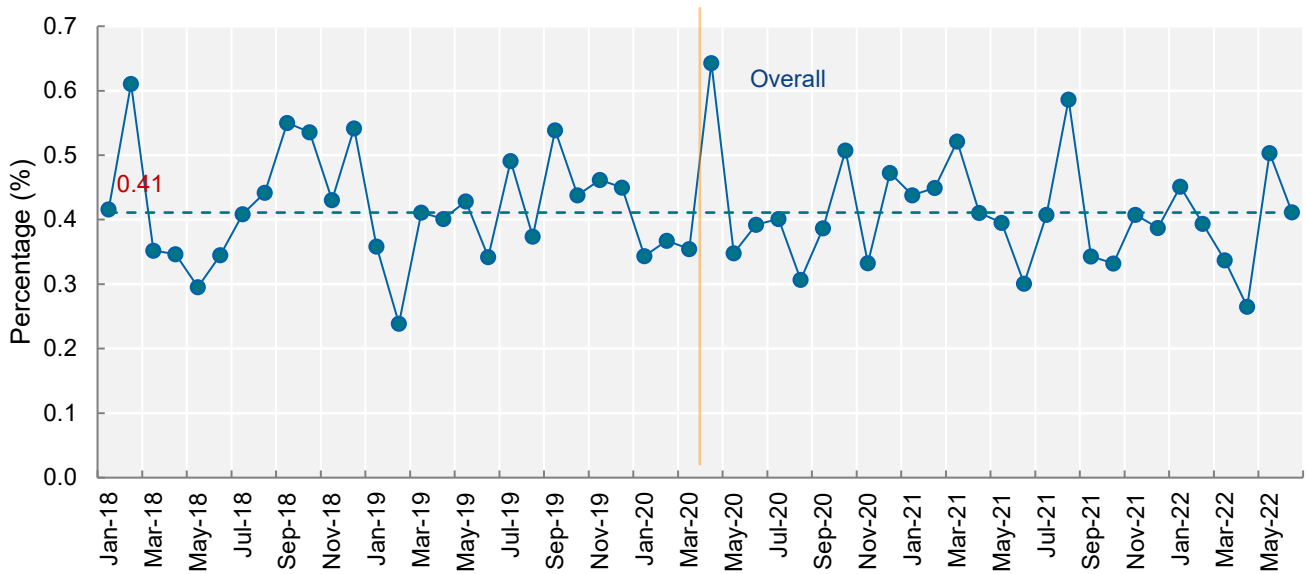
e. Preterm birth rate 20-23 weeks
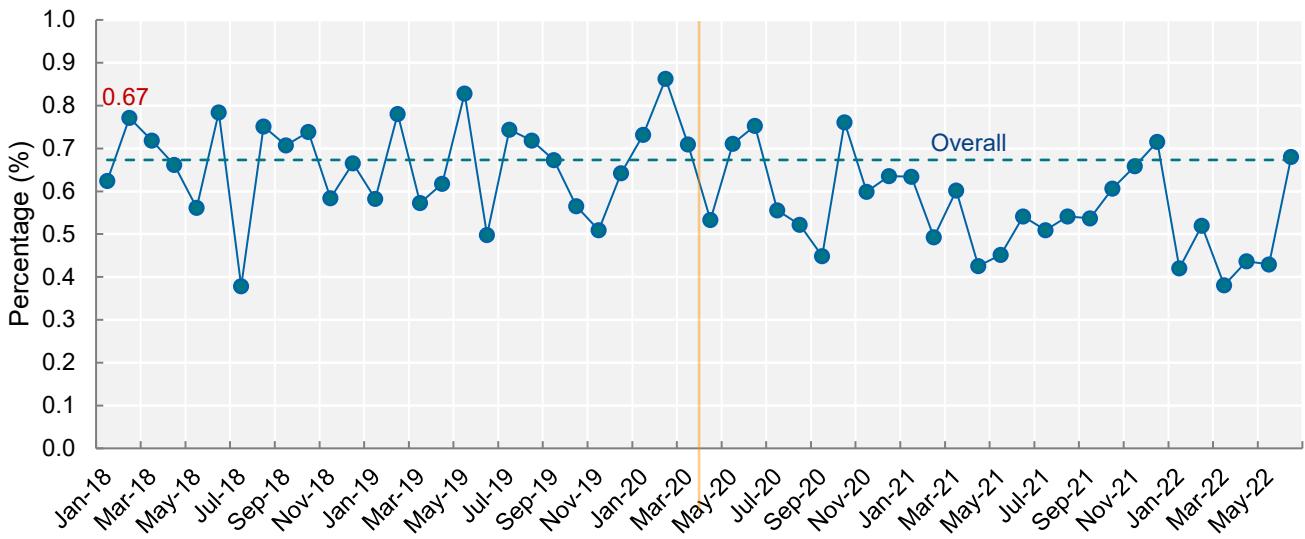
5. Low Apgar score (live term infants)

Measures the wellbeing of babies at 37 or more weeks gestation and without congenital anomalies at birth.

Denominator: Number of singletons, liveborn babies at > 37 weeks gestation with no congenital anomalies.

Numerator: Number of babies who met the denominator criteria and had Apgar score<7 at 5 mins.
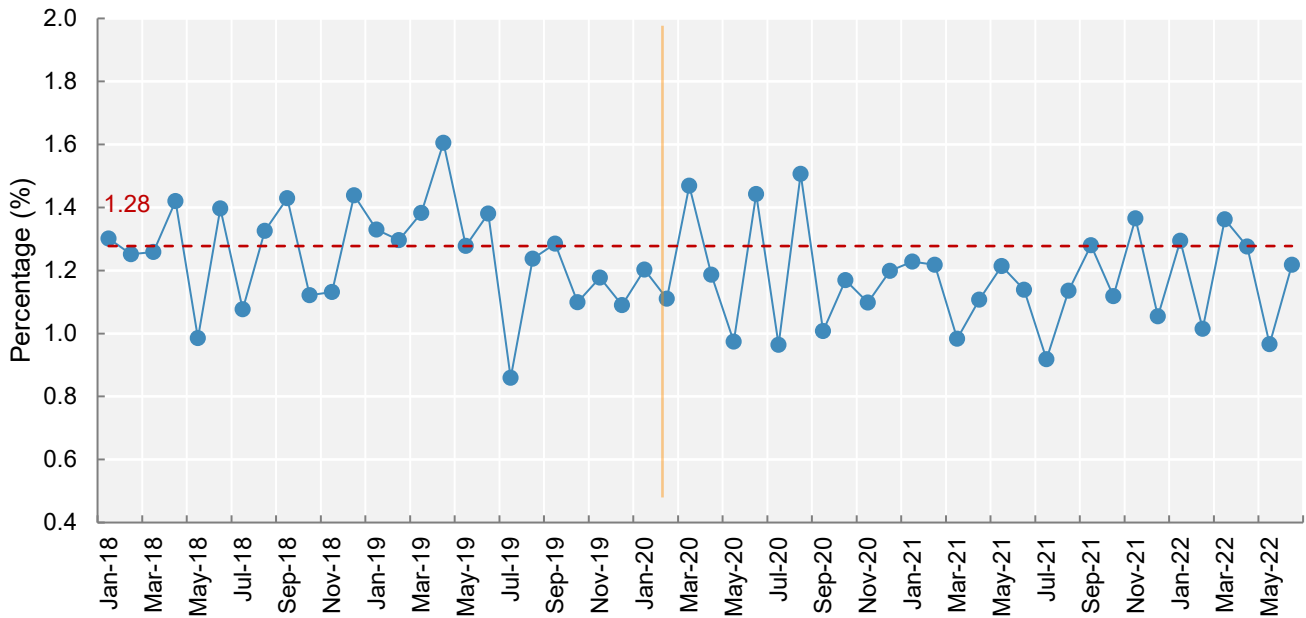
6. Severe fetal growth restriction

Proportion of severely growth restricted singleton babies (defined as birthweight below the third centile, corrected for gestational age, plurality and sex)(7) who were born at or after 40 weeks gestation

Denominator: Number of singleton babies (live and stillborn) with severe FGR who were born at 32 or more weeks gestation

Numerator: Number of babies who met the denominator criteria and were born at 40 or more weeks gestation
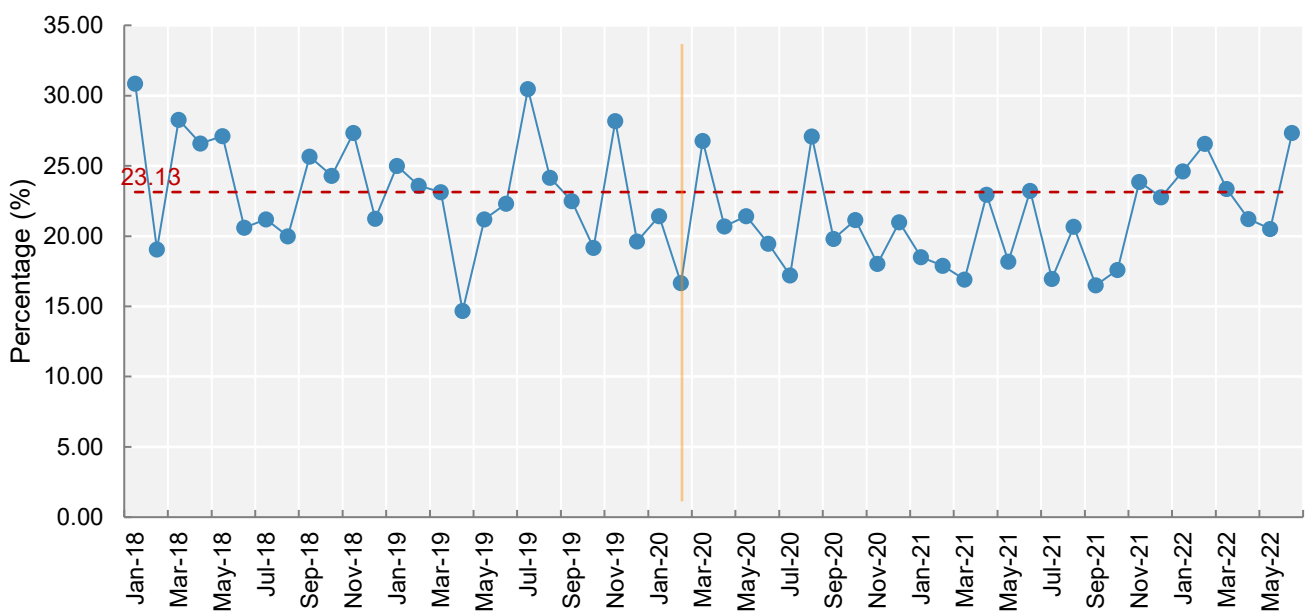
7. Congenital anomalies

Proportion of babies born > 20 weeks gestation with congenital abnormalities diagnosed before or during the birth episode

Denominator: Number of births (including stillbirths and terminations) with an estimated gestational age of > 20 weeks.
Numerator: Number of babies who meet the denominator criteria and were born with a congenital abnormality.
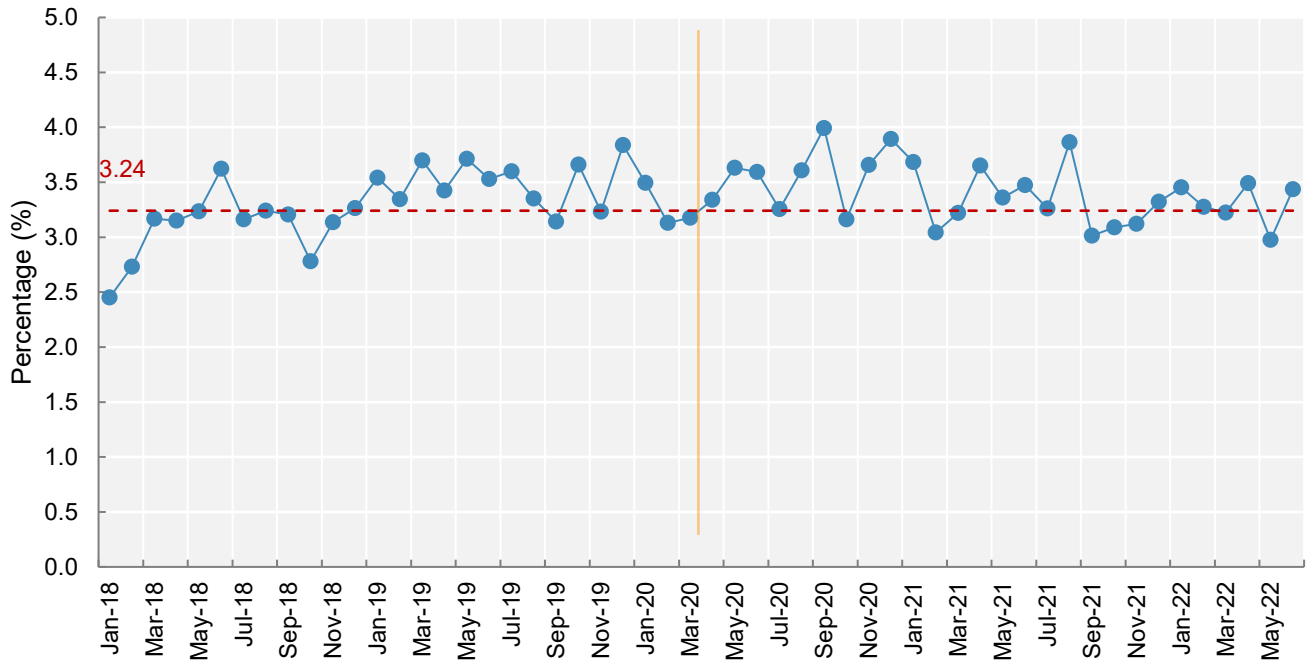
8. Newborn admission to Special Care Nurses (SCN) / Neonatal Intensive Care Unit (NICU) at term[2]

Proportion of babies born at > 37 weeks gestation without congenital anomalies who were admitted to the SCN or NICU.

Denominator: Number of babies who were born alive at > 37 weeks gestation and had no congenital anomalies detected antenatally

Numerator: Number of babies who met the denominator criteria and who were admitted to SCN/NICU or were transferred to higher level care during the birthing episode.

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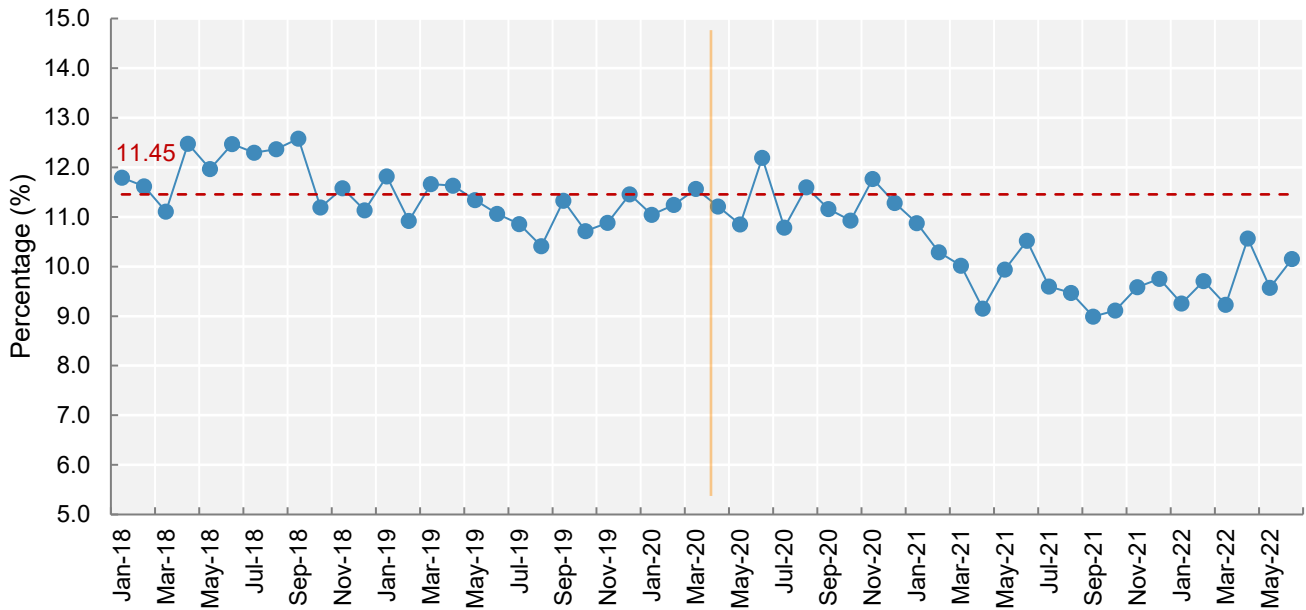
[2] Excluding infants with congenital anomalies

9. Large for gestational age (Birth weight > 90th centile)

Proportion of all singleton babies who weighed > 90th centile(7) of the same gestational age and sex.
Denominator: Number of singleton babies whose gestational age was > 28 weeks.
Numerator: Number of babies who met the denominator criteria and weighed > 90th centile for babies of the same gestational age and sex.
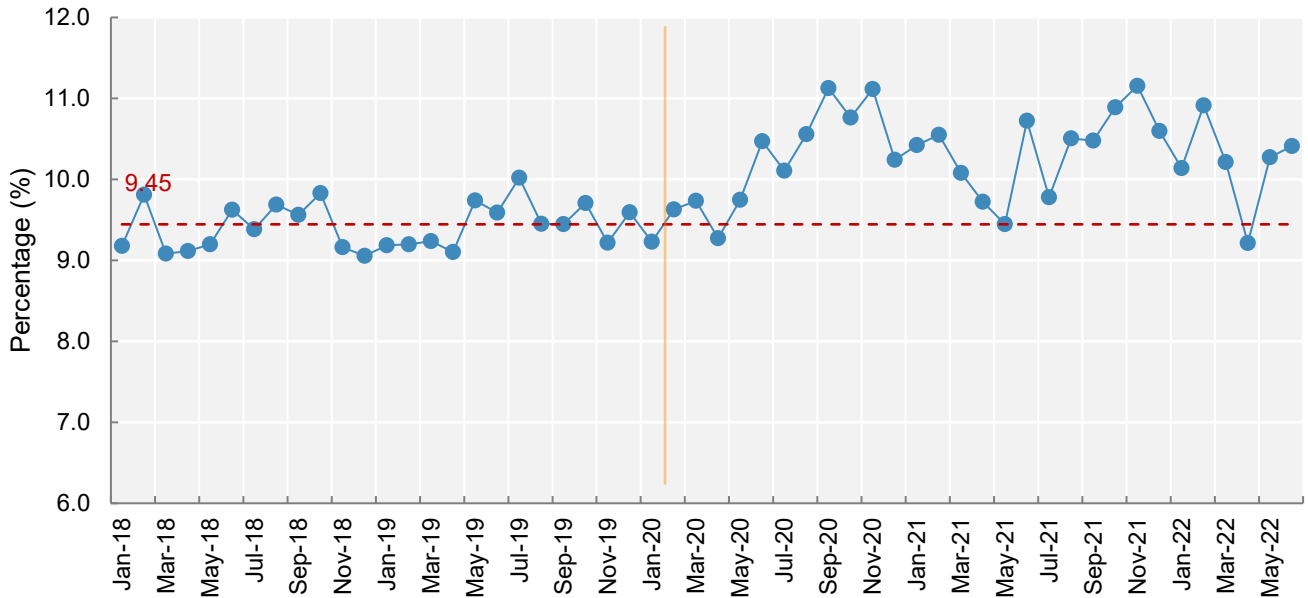
10. Newborn Length of Stay

Number of days a baby stayed in the hospital
Denominator: Number of live infants born > 20 weeks of gestation without congenital anomalies, excluding those admitted to NICU/SCN or transferred to other health services
Numerator: Number of infants who met the denominator criteria who were discharged at 0-1 day, 2 days, 3 days, 4 or more days

a. Newborn length of stay 0-1 day
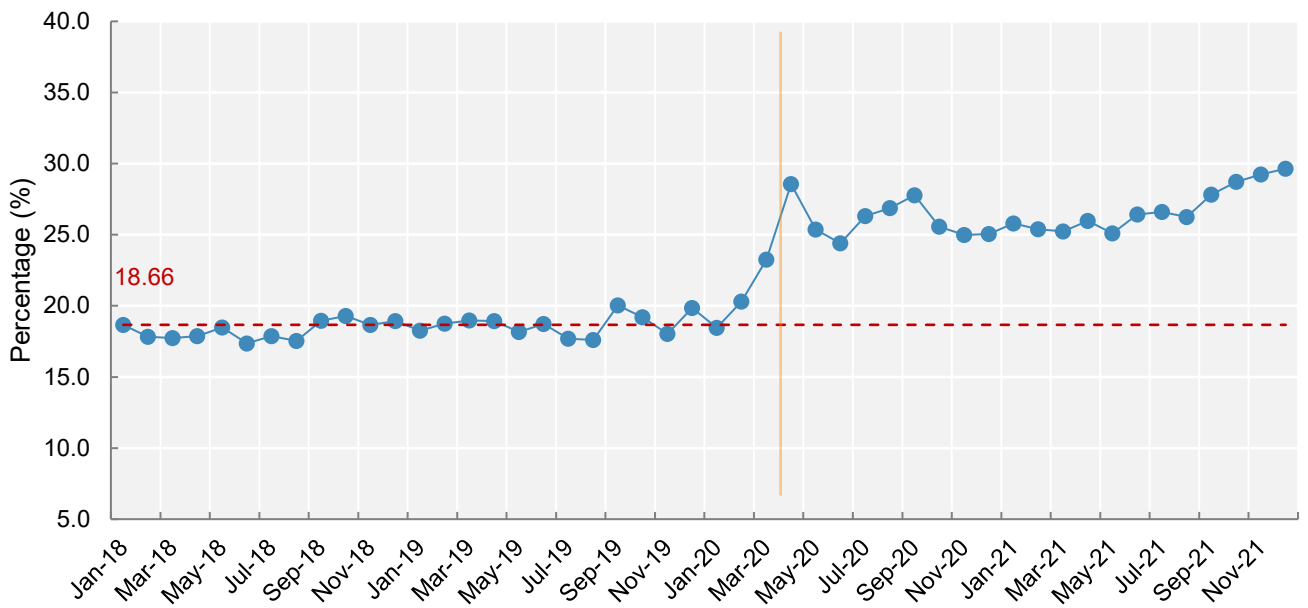
b. Newborn length of stay 2 days
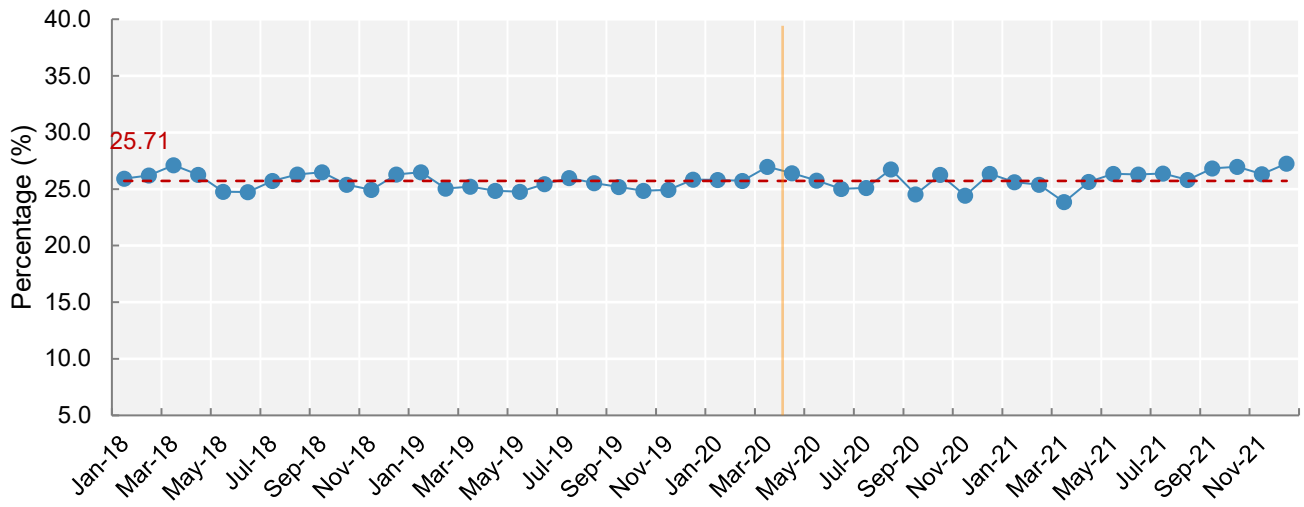
c. Newborn length of stay 3 days
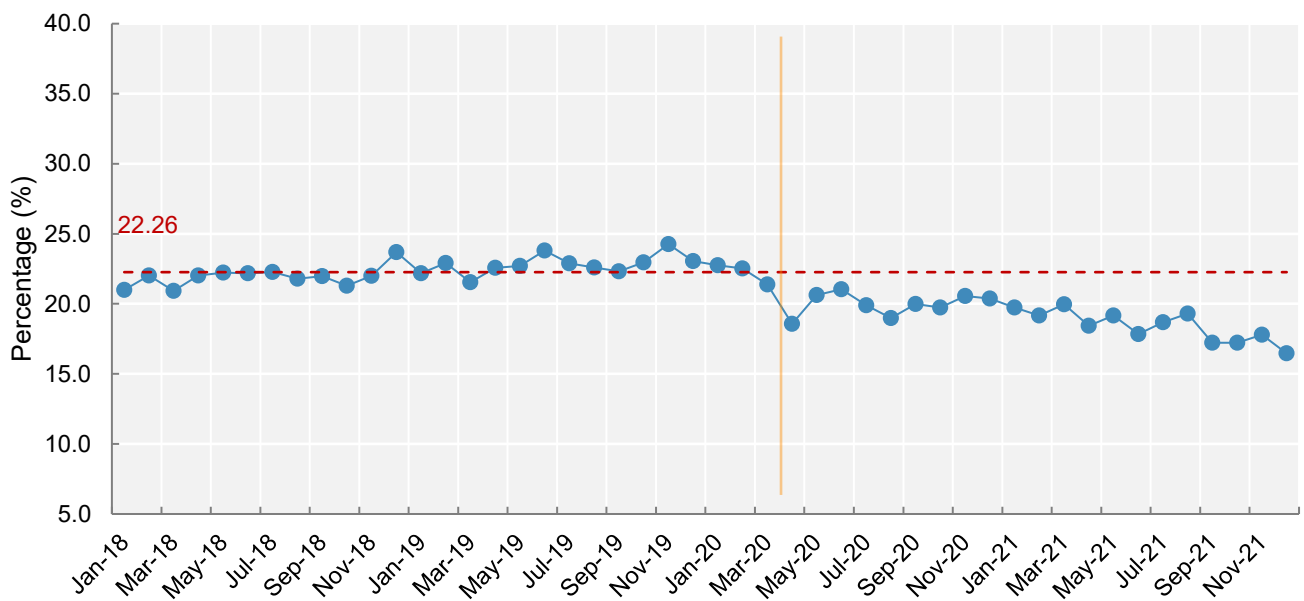
d. Newborn length of stay 4 or more days
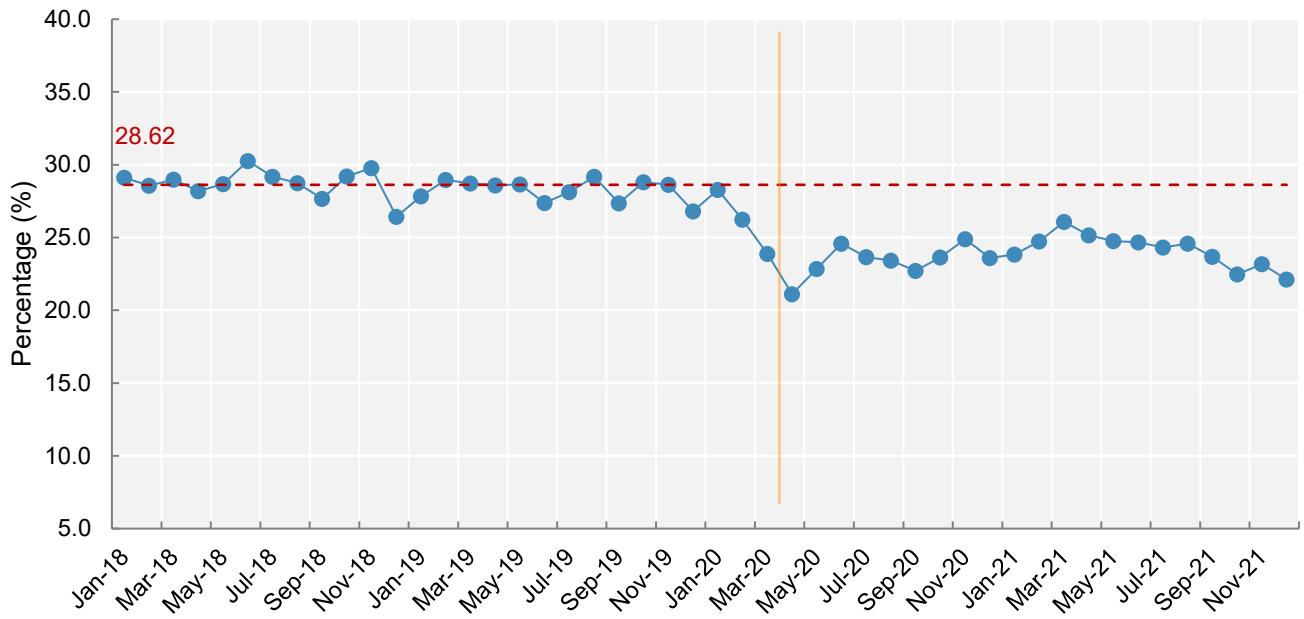
11. Unplanned newborn readmissions

Rate of unplanned and potentially preventable readmissions of babies within 28 days of discharge from hospital following a birthing admission

Denominator: Number of babies discharged from a health service, excluding stillbirths and neonatal deaths prior to discharge.

Numerator: The number of babies readmitted to any health service (with a potentially preventable readmission principal diagnosis code) within 28 days of discharge. Babies who are readmitted on the same day of discharge are excluded.
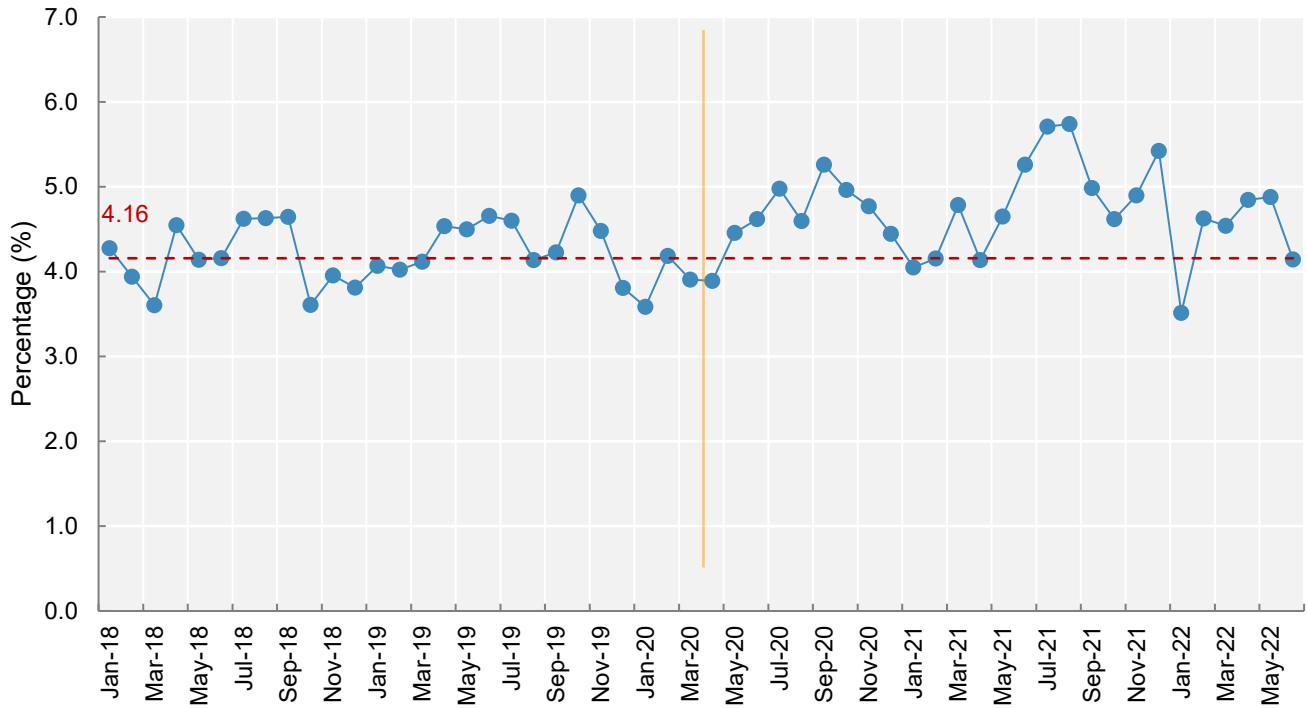
e. Newborn readmission for jaundice[3]
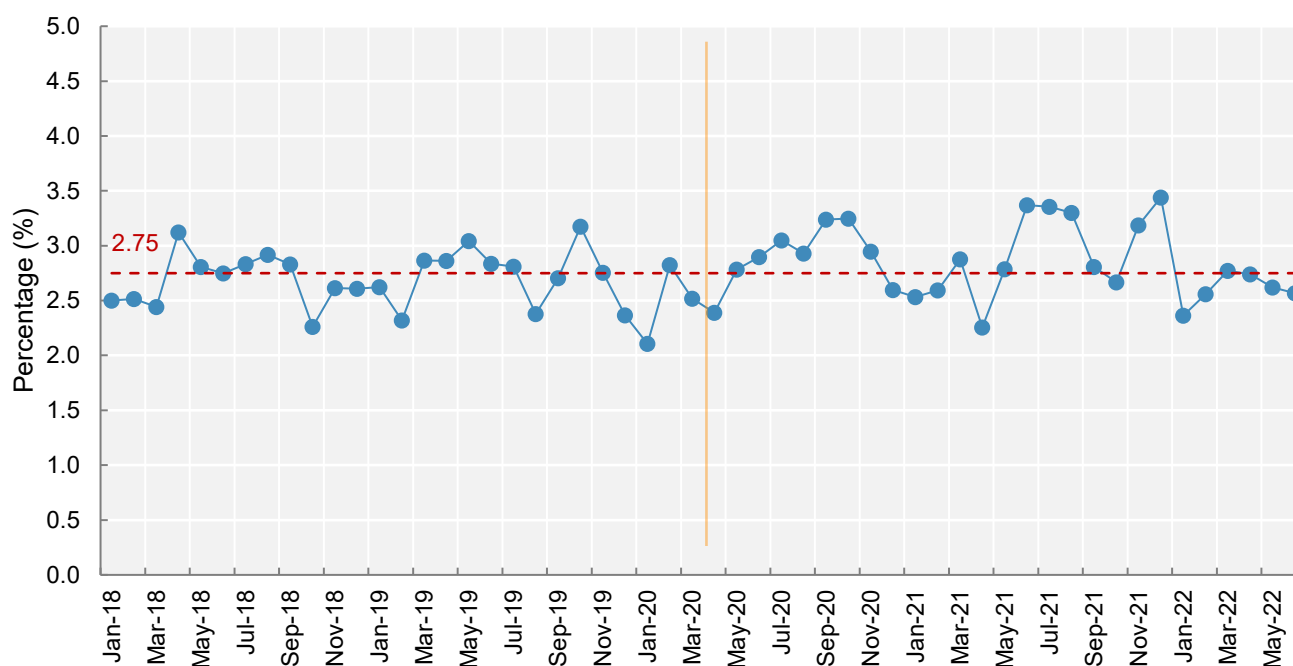
f. Newborn readmission for feeding problems[4]

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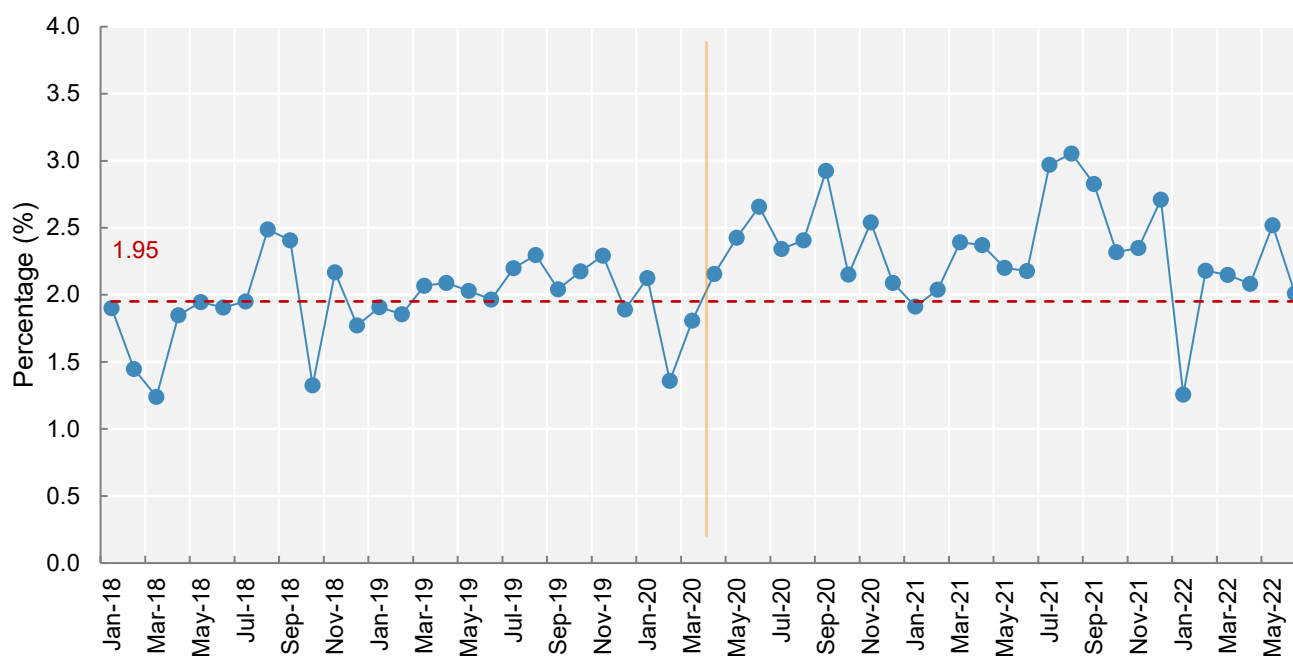
[3] Jaundice – P590 (Neonatal jaundice with preterm delivery, P598 (Neonatal jaundice from other specified causes), P599 (Neonatal jaundice unspecified), P551 (ABO isoimmunisation of fetus and newborn)

[4] Feeding problems – P929 (Feeding problem of newborn unspecified), P928 (Other feeding problems of newborn), P741 (Dehydration of newborn), R634 (Abnormal weight loss of the newborn)

g. Newborn readmissions for infection-related conditions[5]
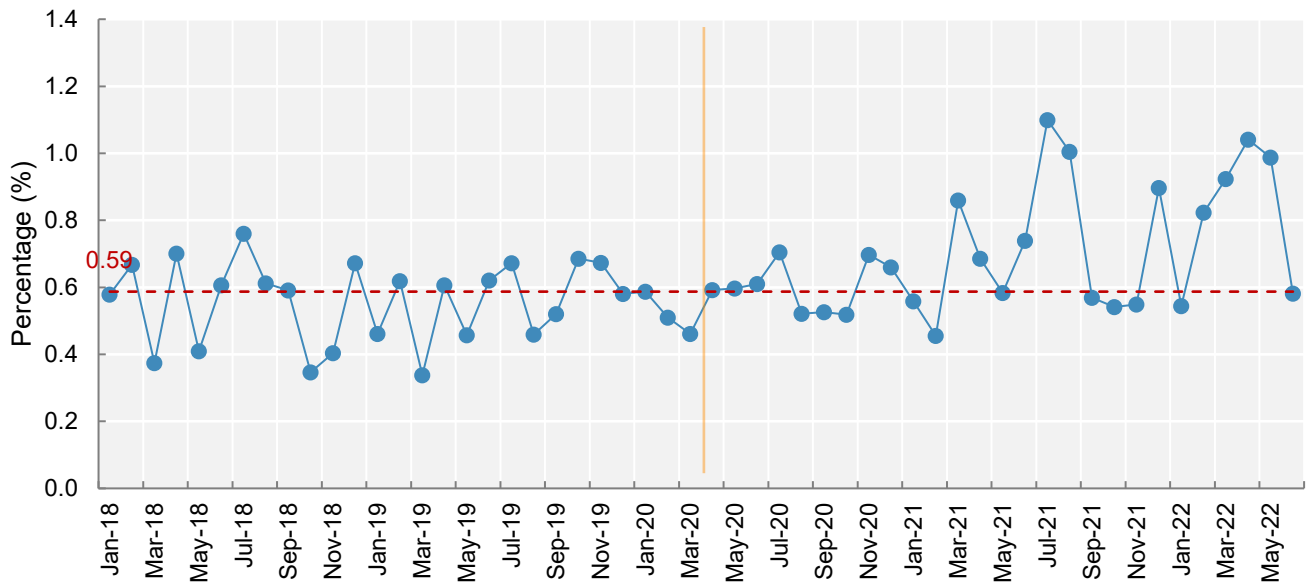
h. Other indications for newborn readmission[6]

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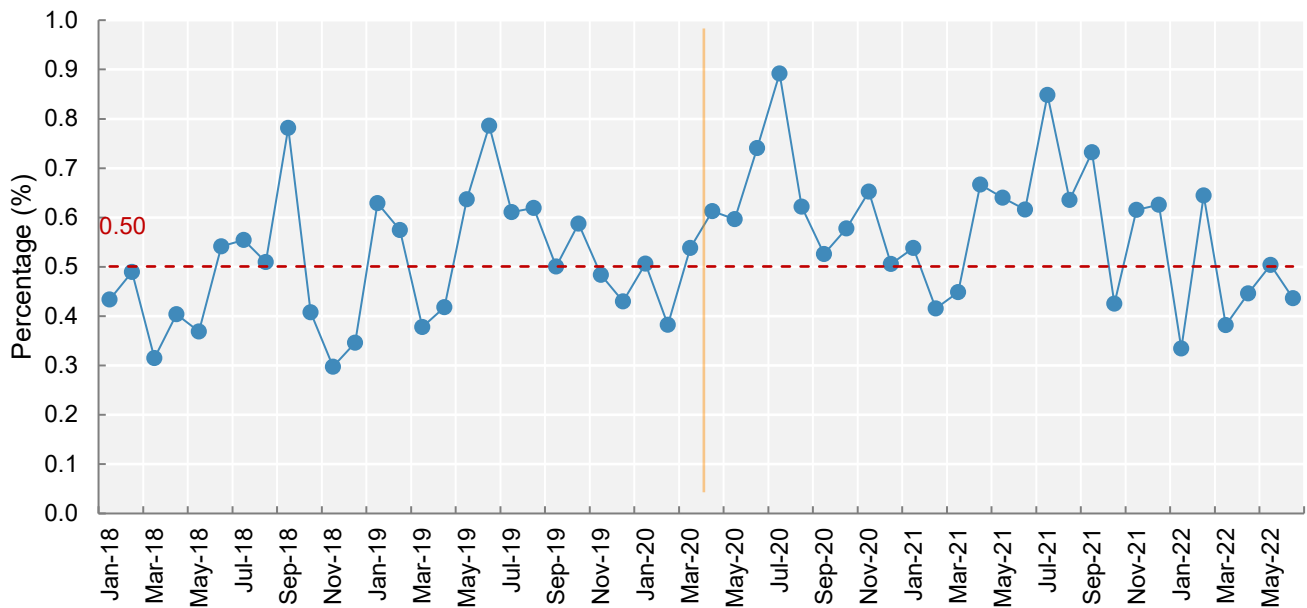
[5] Infections – Z0371 (Observation of newborn for suspected infectious condition), A870 (Enteroviral meningitis), P369 (Bacterial sepsis of newborn unspecified), P38 (Omphalitis of newborn with or without mild haemorrhage)

[6] Other – P90 (Convulsions of newborn), P0732 (Preterm infant, 32 or more completed weeks but less that 37 completed weeks), P282 (Cyanotic attacks of newborn), P2840 (Apnoea of newborn, unspecified), P809 (Hypothermia of newborn unspecified), R628 (Other lack of expected normal physiological development)

12. Planned and unplanned homebirths

Proportion of women who gave birth at home
Denominator: Number of women who gave birth at 20 or more weeks gestation
Numerator: Number of women who met denominator criteria with actual birth setting is home
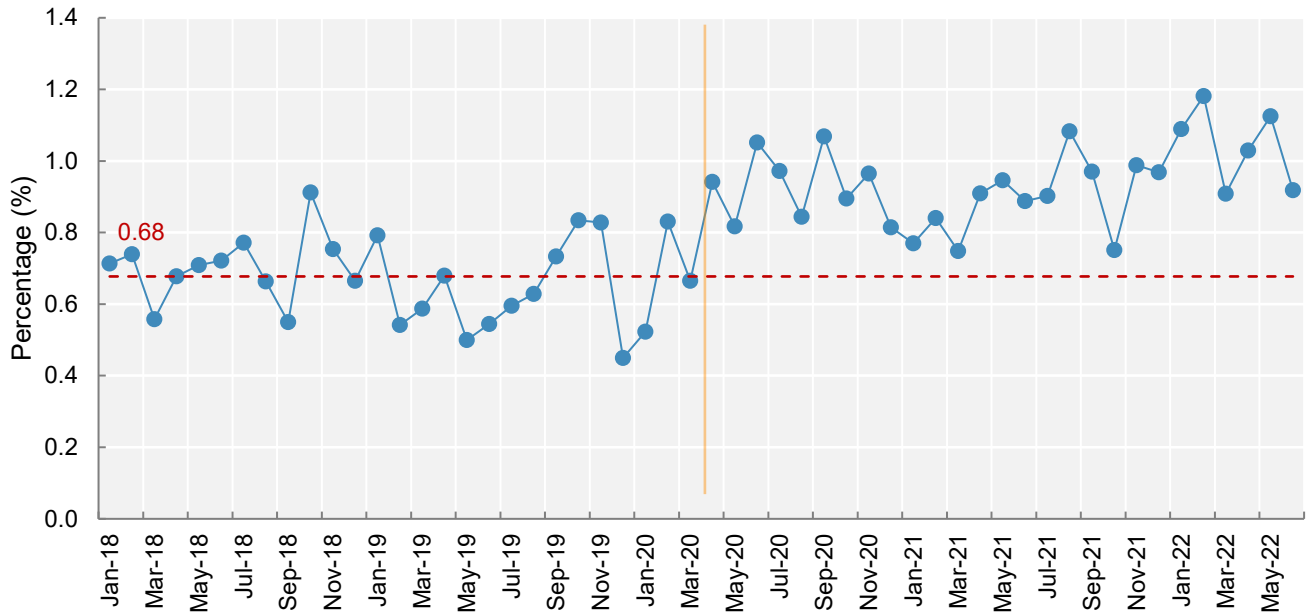
13. Births in transit to hospital

Proportion of women who gave birth at home
Denominator: Number of women who gave birth at 20 or more weeks gestation
Numerator: Number of women who met denominator criteria with actual birth setting is "in transit"
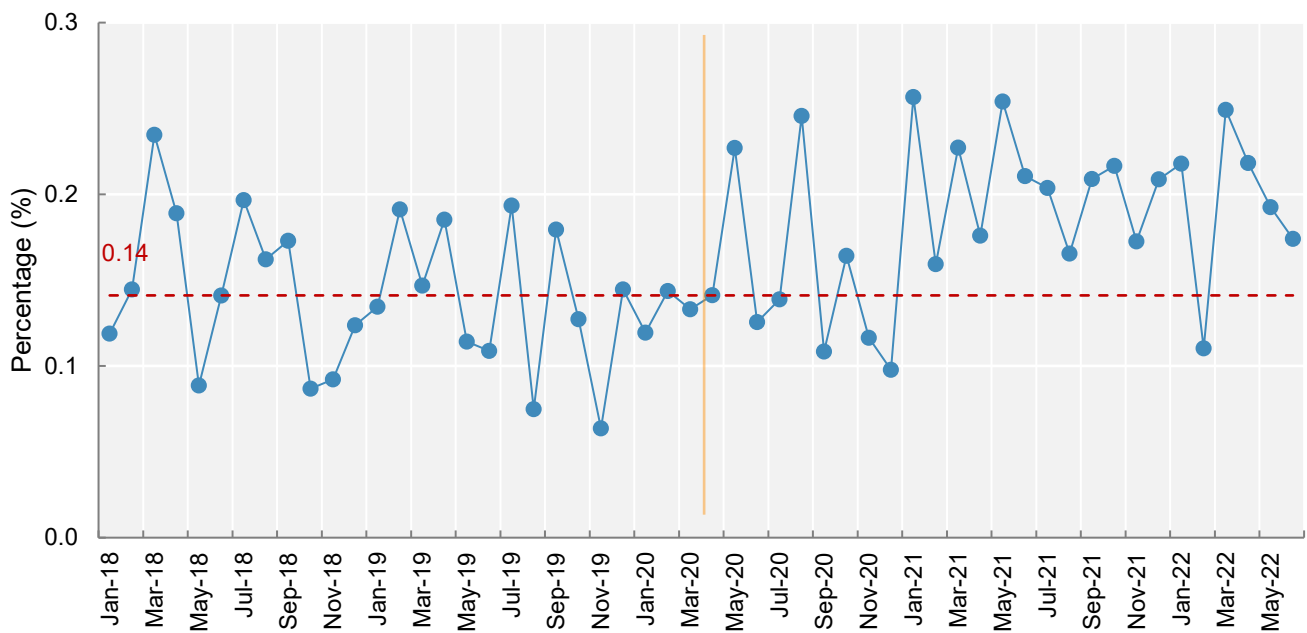
14. Maternal body mass index > 25

Proportion of women who have a BMI >25

Denominator: Number of women who gave birth at 20 or more weeks gestation
Numerator: Number of women who met denominator criteria and who had an enrolment BMI of >25
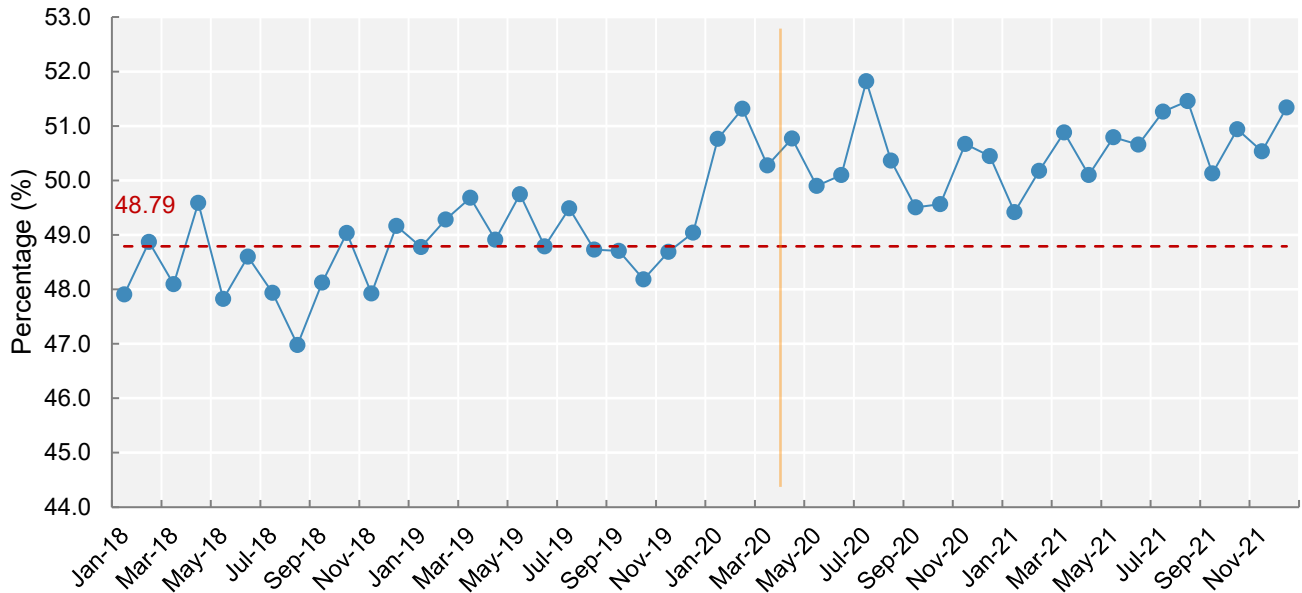
15. Gestational diabetes mellitus (field)

Proportion of women who were diagnosed with gestational diabetes during pregnancy.

Denominator: Number of women who gave birth at 20 or more weeks gestation
Numerator: Number of women who met denominator criteria and diagnosed with gestational diabetes – new indicator from January 2020.
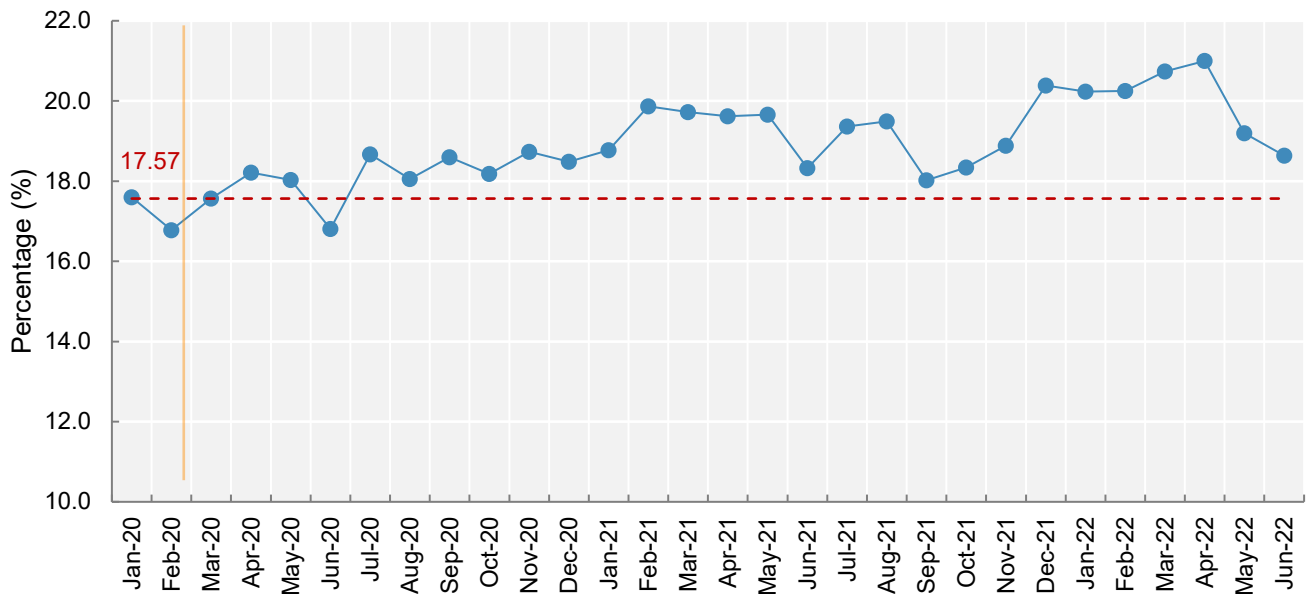
16. Gestational diabetes mellitus (derived)

Proportion of women who were diagnosed with gestational diabetes during pregnancy.

Denominator: Number of women who gave birth at 20 or more weeks gestation

Numerator: Number of women who met denominator criteria and who had any of the following diagnoses listed in obstetric complications: O2442, 02443, 02444, O2449, O2493, O2494, O2499[7]

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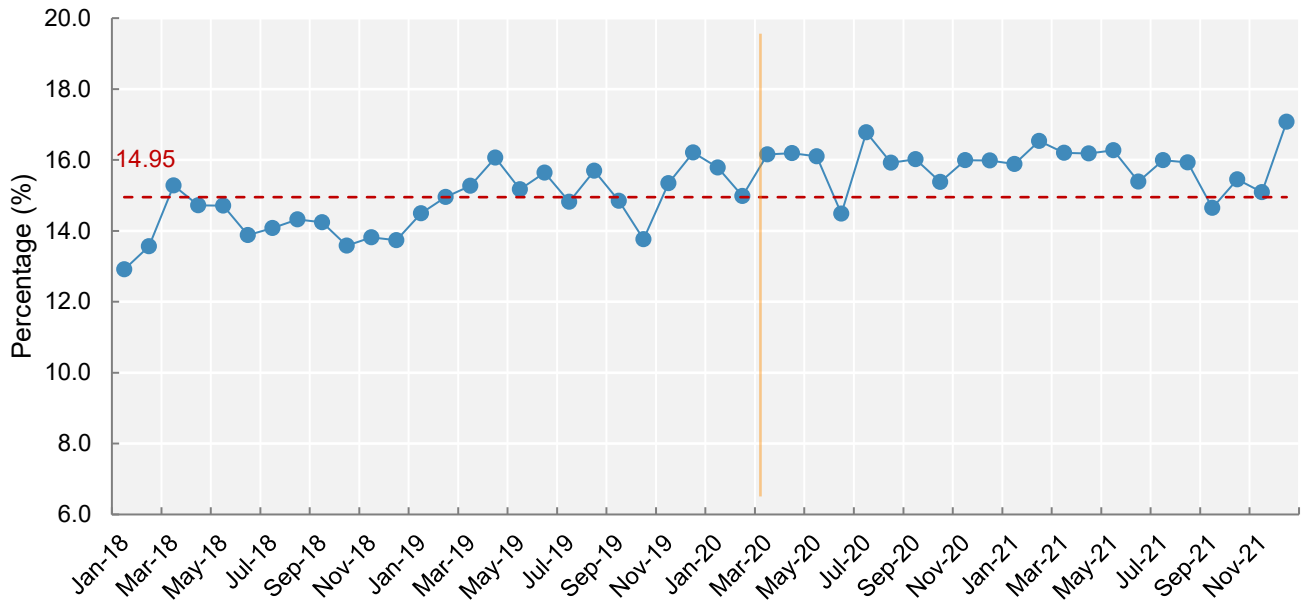
[7] O2442 – (Diabetes mellitus arising during pregnancy, insulin treated) , 02443 – (Diabetes mellitus arising during pregnancy, oral hypoglycaemic therapy), 02444 –(Diabetes mellitus arising during pregnancy, other) , O2449 – (Diabetes mellitus arising during pregnancy, unspecified), O2493 – (Diabetes mellitus in pregnancy, childbirth and the puerperium, unspecified onset, oral hypoglycaemic therapy) , O2494 – (Diabetes mellitus in pregnancy, childbirth and the puerperium, unspecified onset, other), O2499 – (Diabetes mellitus in pregnancy, childbirth and the puerperium, unspecified onset, unspecified)

17. Eclampsia/Pre-eclampsia

Proportion of women who were diagnosed with hypertensive disorders of pregnancy or severe pre-eclampsia or eclampsia during pregnancy.

Denominator: Number of women who gave birth at 20 or more weeks gestation

Numerator: Number of women who met denominator criteria and who had any of the following diagnoses:

• O141, 0142, O149, O150, O151, O152[8]

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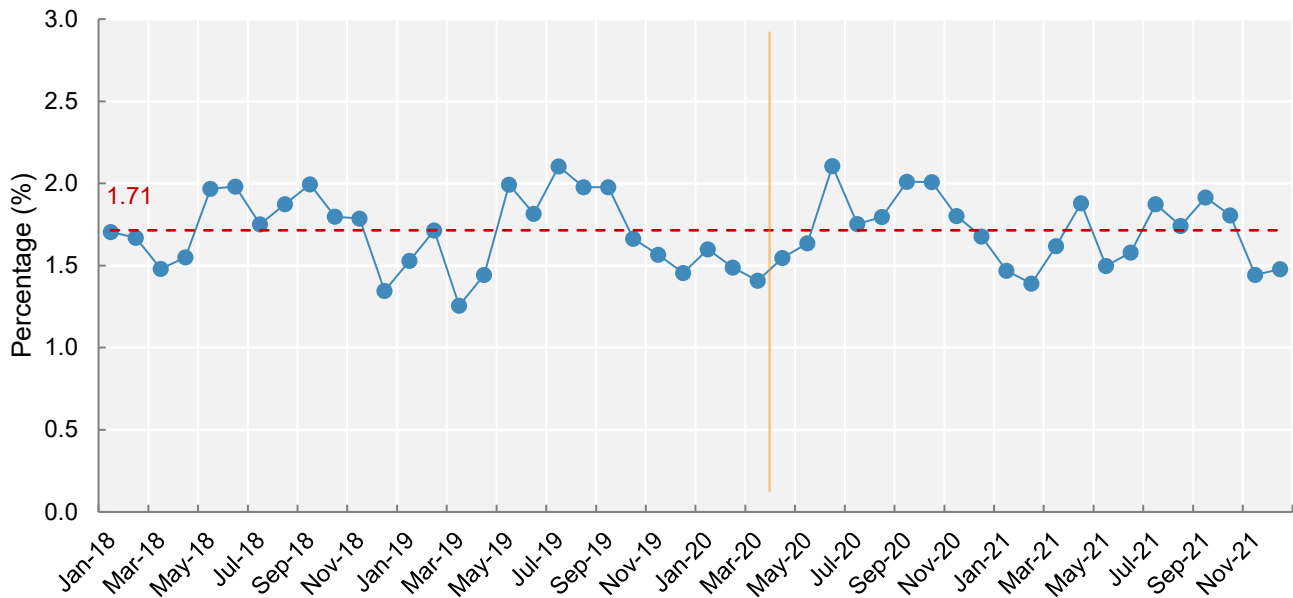
[8] O141 - (Severe pre-eclampsia), 0142 - (HELLP syndrome), O149 - (Pre-eclampsia, unspecified), O150 - (Eclampsia in pregnancy), O151 - (Eclampsia in labour), O152 - (Eclampsia in the puerperium)

18. Antenatal pertussis vaccination

Proportion of women who received pertussis vaccine during pregnancy

Denominator: Number of women who gave birth at 20 or more weeks gestation
Numerator: Number of women who met the denominator criteria who had pertussis vaccination during pregnancy
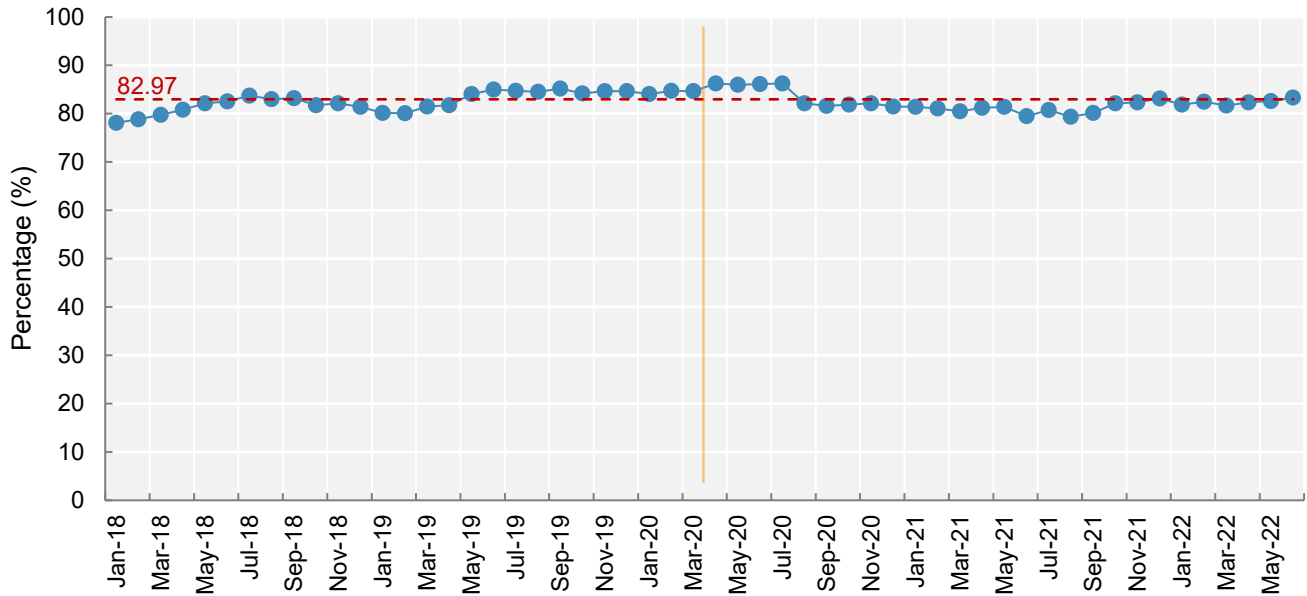
19. Antenatal influenza vaccination

Proportion of women who received influenza vaccine during pregnancy

Denominator: Number of women who gave birth at 20 or more weeks gestation
Numerator: Number of women who met the denominator criteria who had influenza vaccination during pregnancy
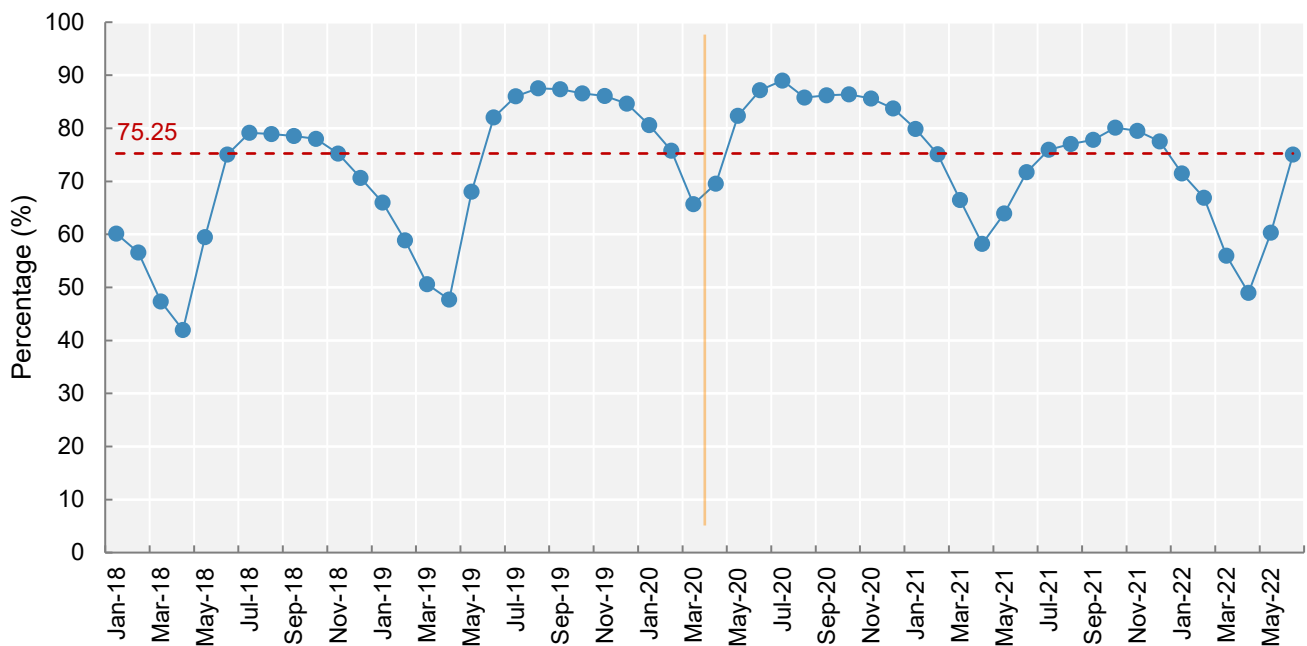
20. Maternal length of stay

Number of days a mother stayed in the hospital

Denominator: Number of pregnant women who gave birth > 20 weeks gestation

Numerator: Number of pregnant women who met the denominator criteria who were discharged at 0-1 day, 2 days, 3 days, 4 or more days

i.   Maternal length of stay 0-1 day
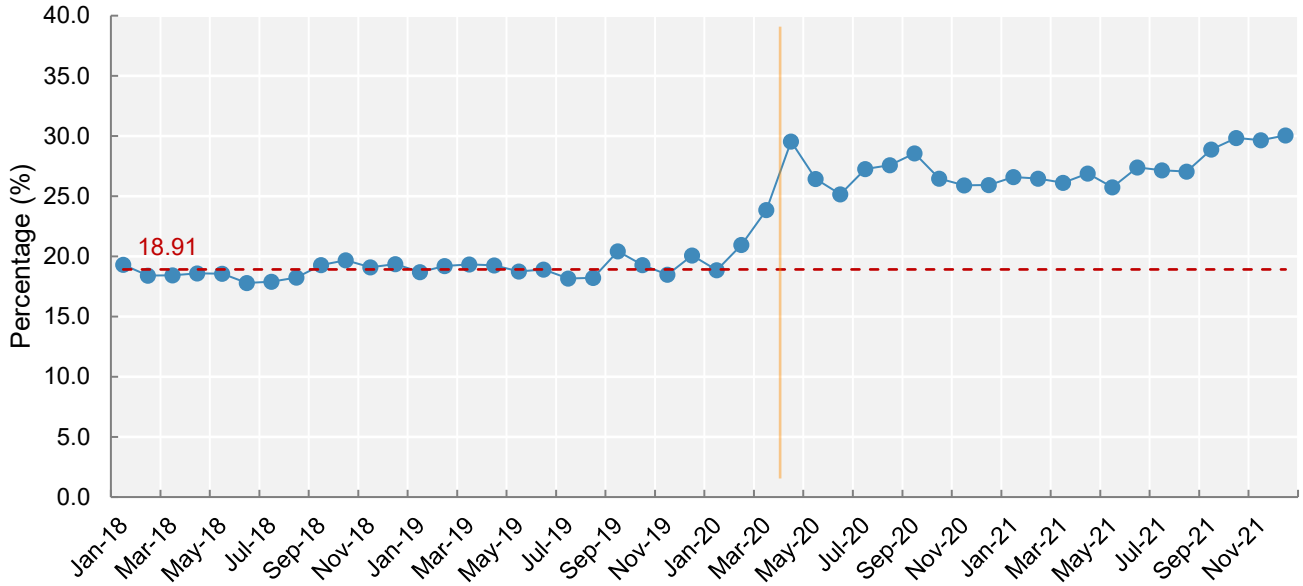
j.   Maternal length of stay 2 days
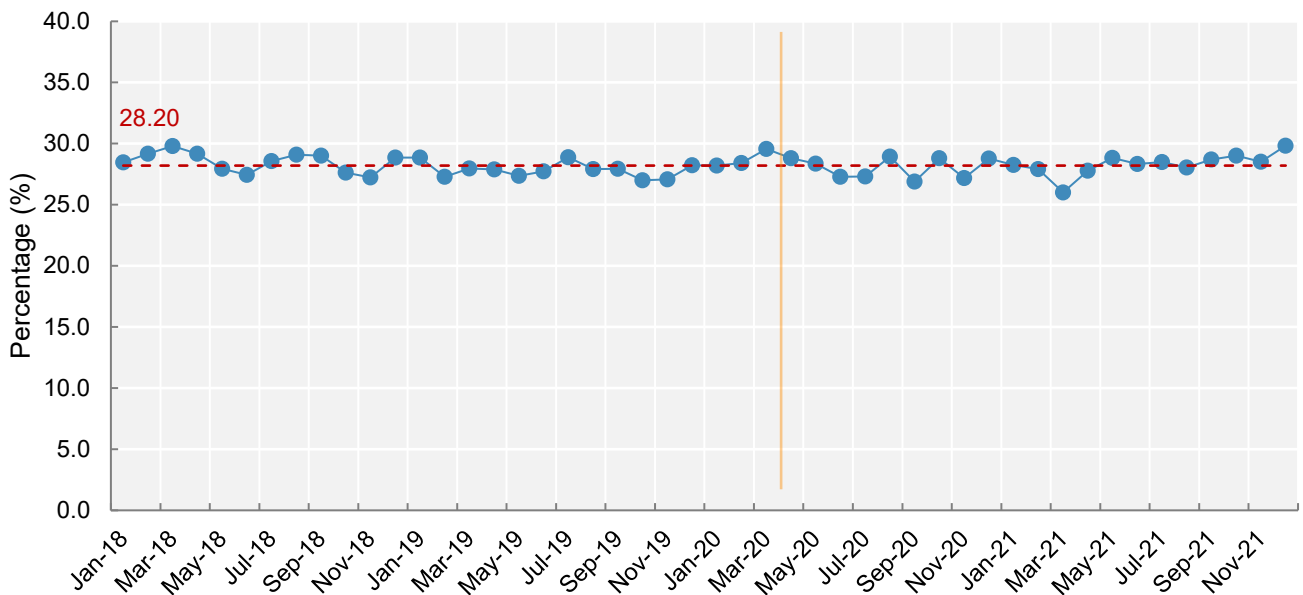
k. Maternal length of stay 3 days
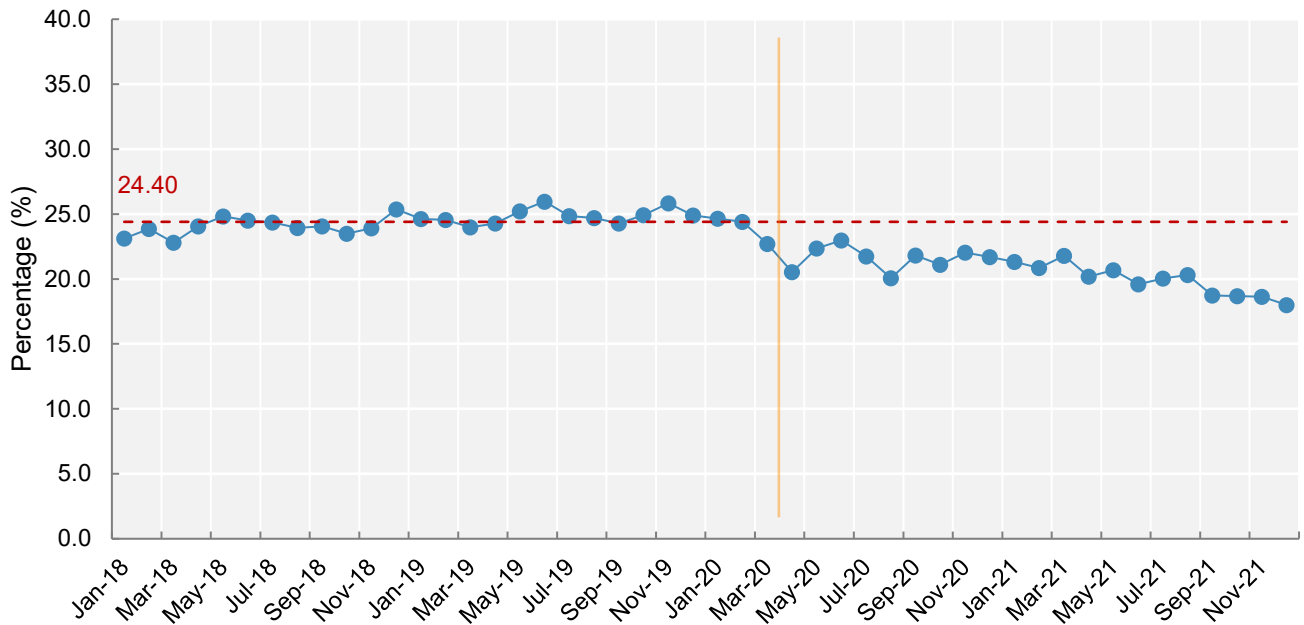
l. Maternal length of stay 4 or more days
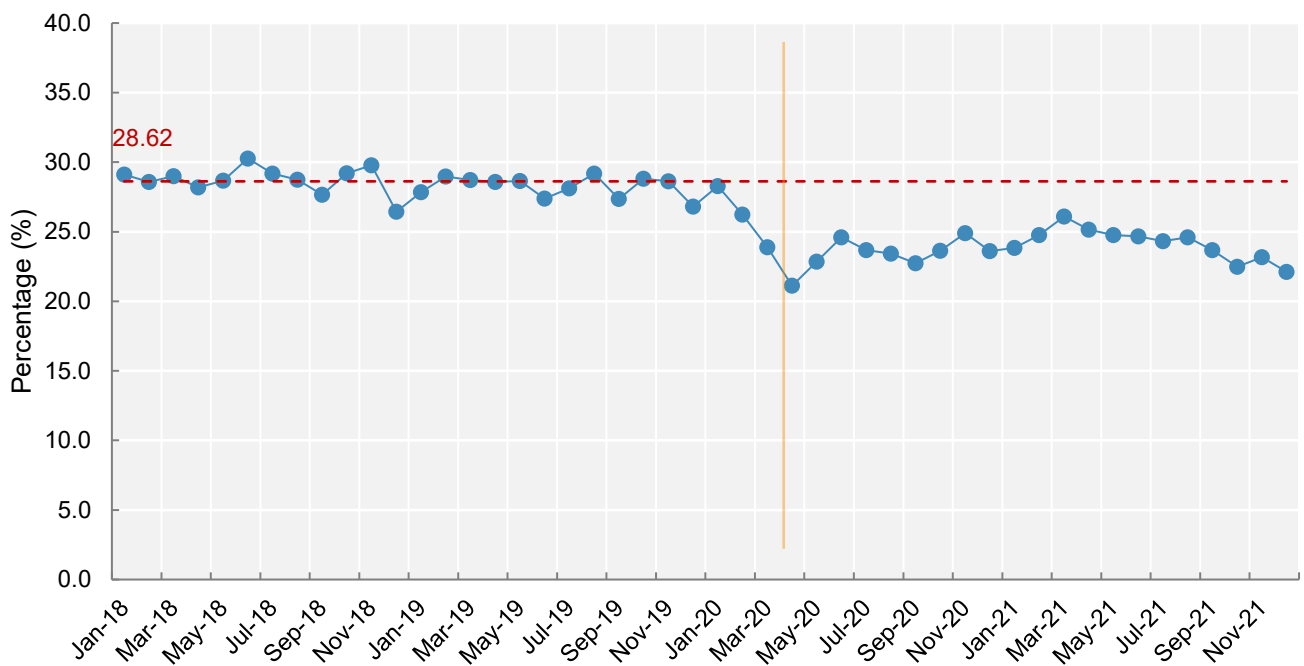
21. Unplanned maternity readmissions (all indications)

Rate of unplanned and potentially preventable readmissions of women and babies within 28 days of discharge from hospital following a birthing admission.

Denominator: Number of women provided admitted postnatal care prior to discharge

Numerator: The number of women readmitted to any health service with a potentially preventable readmission principal diagnosis code within 28 days of a birthing admission

Unplanned maternity readmissions (all indications)
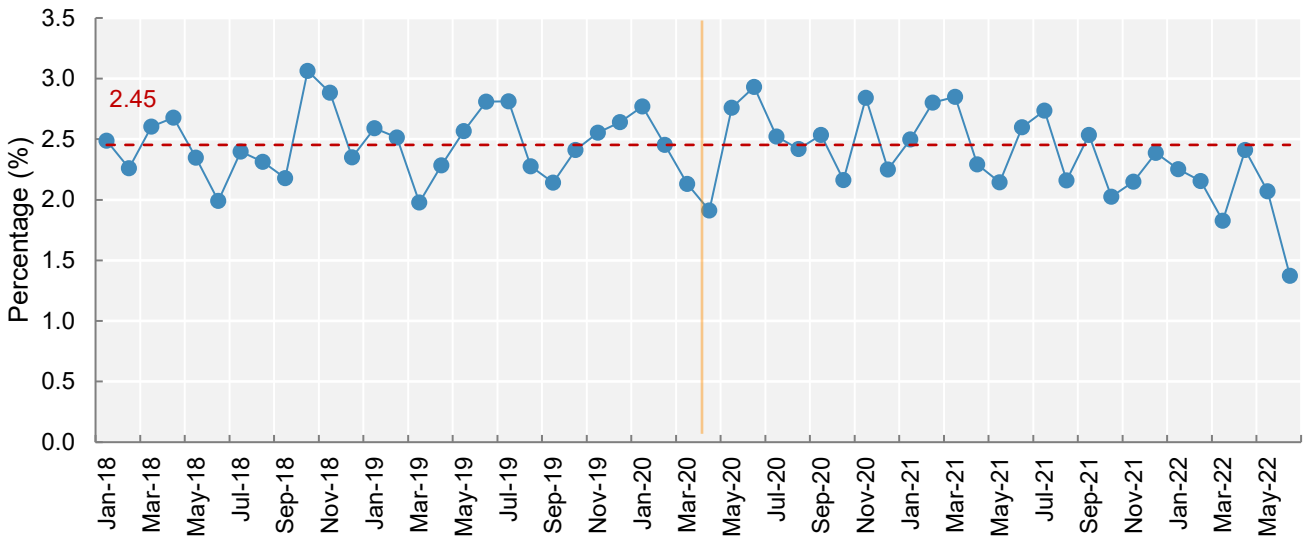
a. Maternal readmission for obstetric wound complications[9]
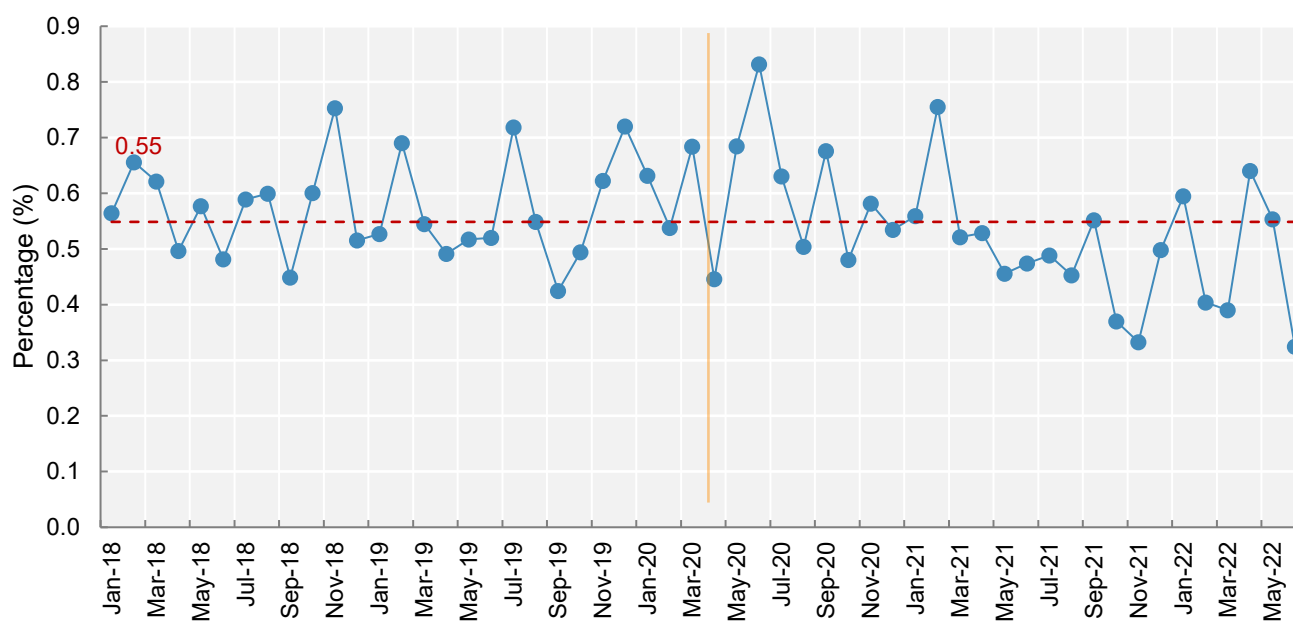
b. Maternal readmission for secondary post-partum haemorrhage and its complications[10]

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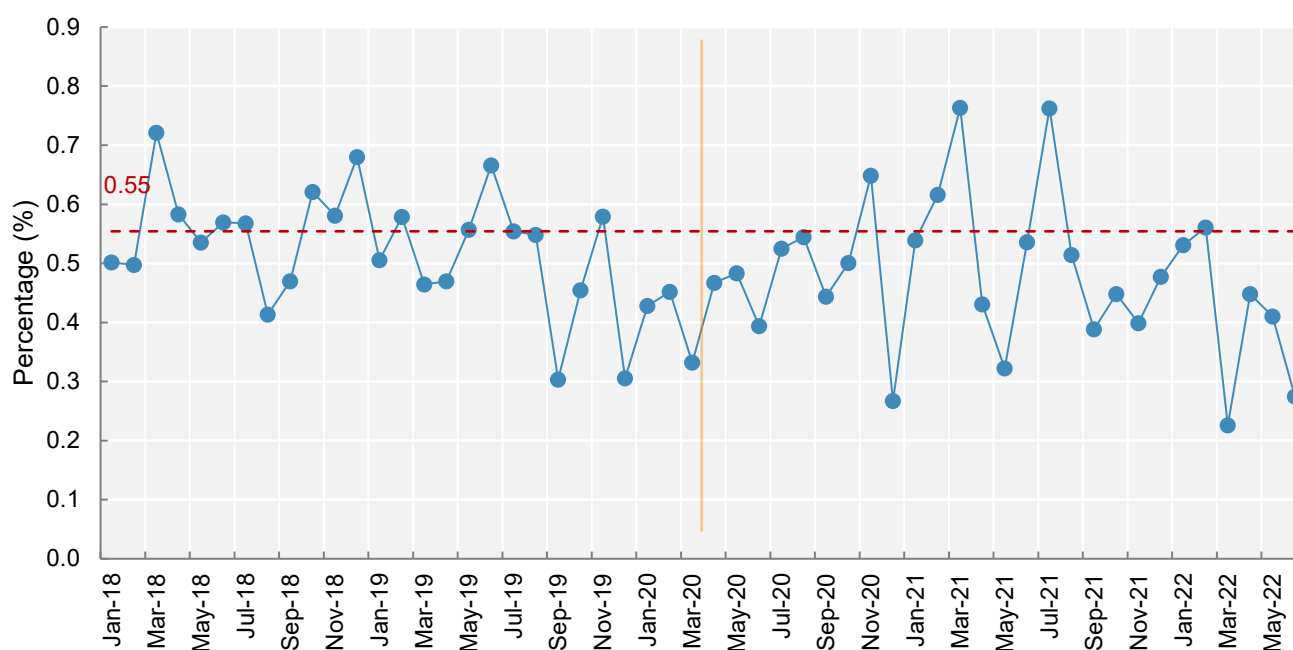
[9] Complications of obstetric wounds – O860 (Infection of obstetric surgical wound), O901 (Disruption of perineal obstetric wound), O900 (Disruption of caesarean section wound), O902 (Haematoma of obstetric wound)

[10] Secondary post-partum haemorrhage and its complications – O731 (Retained portions of placenta and membrane), O720 (Third-stage haemorrhage), O721 (Other immediate post-partum haemorrhage), O722 (Delayed and secondary post-partum haemorrhage, O9903 (Anaemia in childbirth and the puerperium)

c. Maternal readmission for post-partum infections[11]

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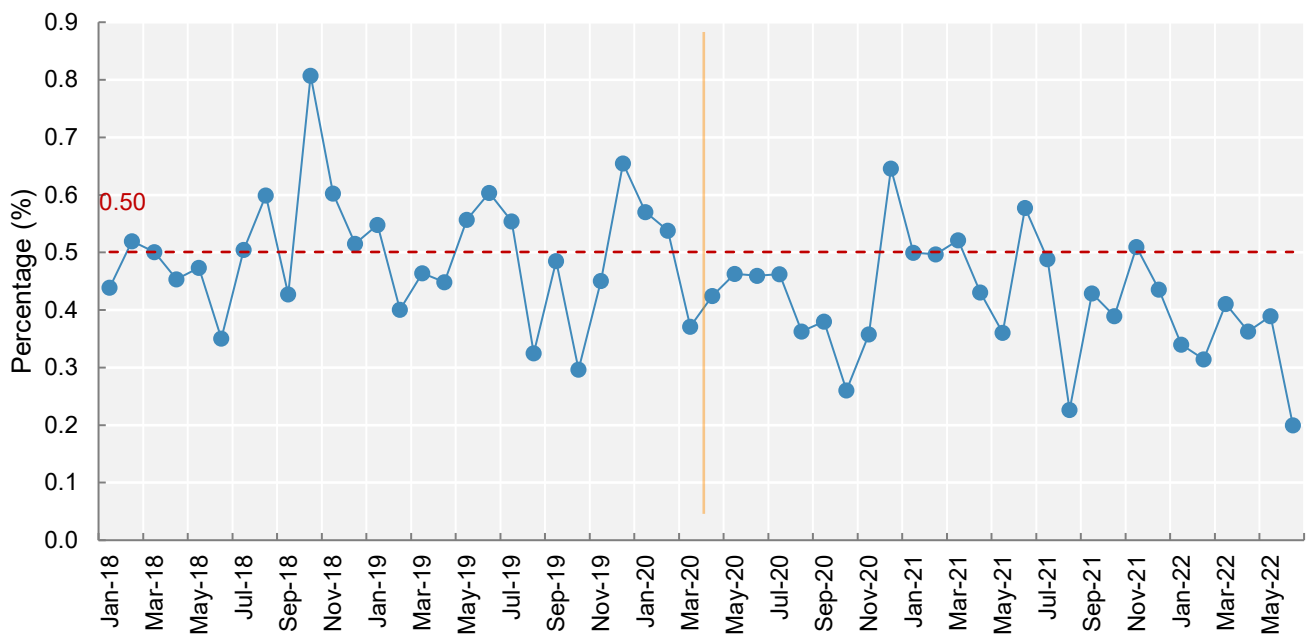
[11] Post-partum infections – O85 (Puerperal sepsis), O862 (Urinary tract infection following delivery), N390 (Urinary tract infection site not specified), R509 (Fever unspecified)

d. Maternal readmission for lactation complications[12]
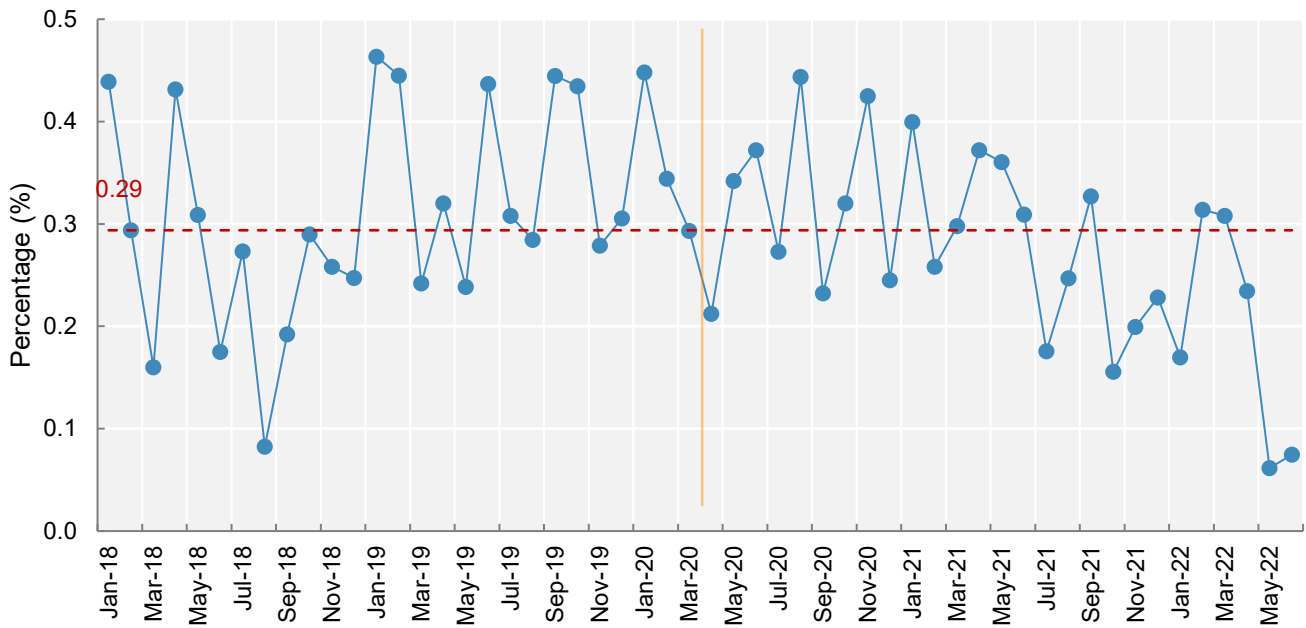
e. Maternal readmission due to hypertensive disorders of pregnancy and the puerperium[13]

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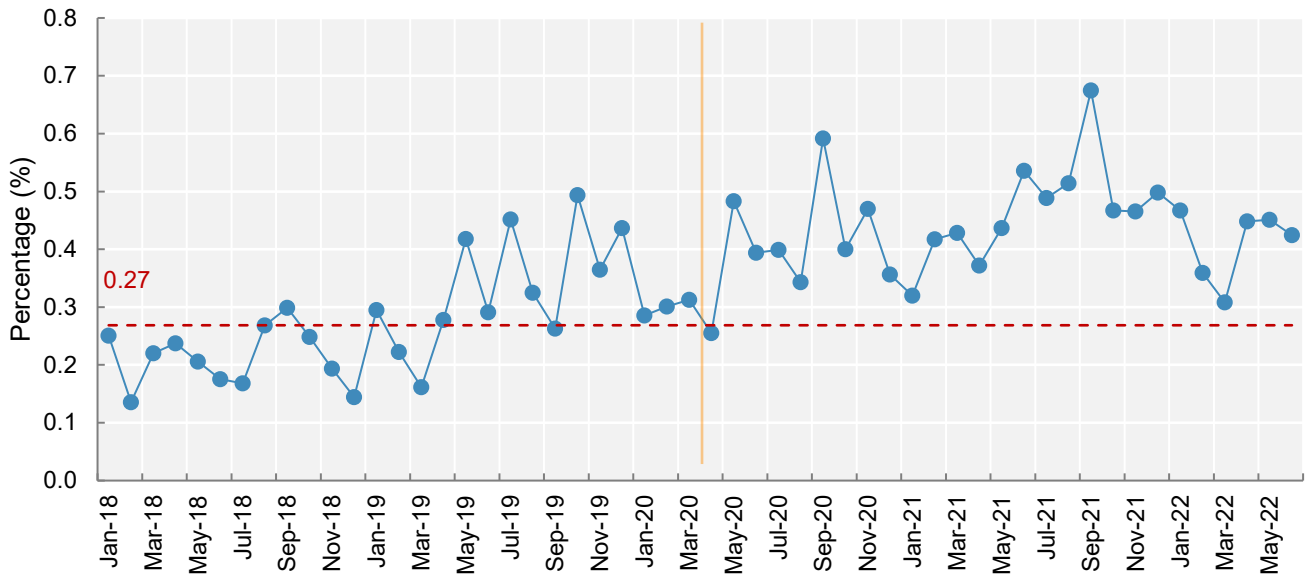
[12] Lactation complications – O9120 (Non purulent mastitis associated with childbirth, without mention of attachment difficulty), O9121 (Non purulent mastitis associated with childbirth, with mention of attachment difficulty)

[13] Hypertensive disorders of pregnancy and the puerperium – O16 (Unspecified maternal hypertension), O13 (Gestational Hypertension), O149 (Pre-eclampsia unspecified), O152 (Eclampsia in the puerperium)

f. Maternal readmission due to other reasons not classified[14]

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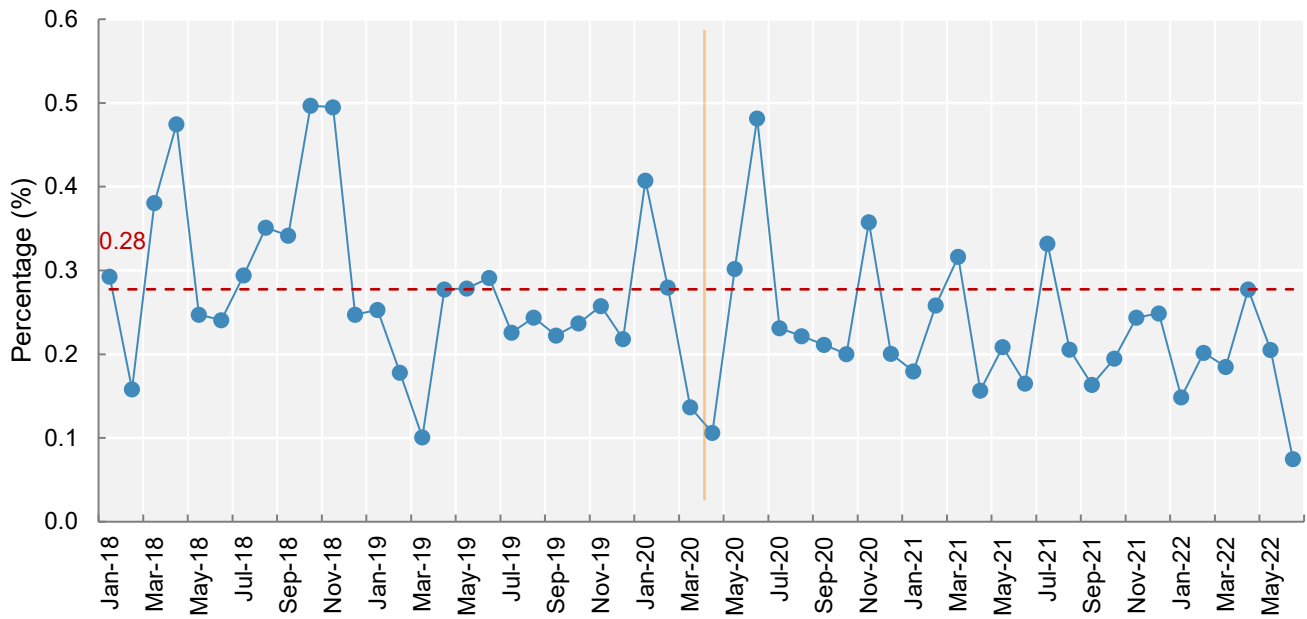
[14] Other – T8852 (Headache due to anaesthesia), G9719 (Reaction to spinal and lumbar puncture, not elsewhere classified), R33 (Retention of urine), Z466 (Fitting and adjustment of urinary device), Z391 (Care and examination of lactating mother), F530 (Mild mental and behavioural disorders associated with the puerperium, not elsewhere classified), F531(Severe mental and behavioural disorders associated with the puerperium not elsewhere classified)

Commentary

The COVID-19 pandemic has led to several unexpected changes in maternal and perinatal health outcomes in Victoria. One notable change is the decrease in both spontaneous and iatrogenic preterm births, a trend that has been observed in some other high-income countries (1, 2). These reductions in preterm birth – in particular the decrease in iatrogenic preterm births at 32-36 weeks gestation - should be interpreted in the context of Victoria's participation in the national program to reduce preterm birth (The Australian Preterm Prevention Alliance)(8). It has been speculated that the decline in spontaneous preterm births may be associated with reduced physical activity or reduction in other environmental exposures (9). Further research is needed to explore the contributing factors to the reduction in preterm birth and their relationship to lockdown restriction.

Another change observed during the pandemic was the sustained reduction in hospital length of stay for mothers and babies, which has persisted after lifting of lockdown restrictions. While this is a potentially beneficial change for both families and health services, it was also associated with a rise in unplanned readmissions for newborns. This increase in unplanned newborn readmissions may reflect a lack of support for new parents in the first days of life and may affect successful breastfeeding and long-term infant outcomes. The impact of this reduction in hospital stay requires further investigation, as domiciliary midwifery, maternal child health nurse, emergency department, and GP visits were not measured in the studies conducted.

The pandemic was also associated with an increase in the proportion of larger for gestational age babies, overweight mothers, and gestational diabetes mellitus, all of which may be related to reductions in maternal physical activity and changes in diet. However, these indicators were rising prior to the onset of the pandemic and further analysis is required to determine the specific contribution of the pandemic to these changes. Maternal overweight, GDM and LGA all have important short and long-term consequences for maternal and child health and require ongoing monitoring (10, 11).

Not surprisingly, there was a significant increase in the rate of births out of hospital, including home births and birth during transit to hospital. This change is likely due to several factors, including differences in health-seeking behaviours of pregnant women during lockdowns or delayed transport to hospital after the onset of labour (12, 13). Further research is needed to ascertain if the growing number of home births were accompanied by skilled birth attendants. Understanding women's experiences of hospital-based care may help to avoid births in unintended places and improve outcomes for mothers and babies.

The COVID-19 pandemic represented an opportunity to examine the responsiveness of the maternity during a national emergency. Reassuringly, there was no significant increase in third trimester stillbirths observed in this analysis. However, this state-wide analysis contrasts with a previous report on the metropolitan Melbourne population, which experienced a significant increase in stillbirths from 24 weeks in the first year of lockdown (5). An individual patient level analysis of the causes of stillbirths and contributing factors is currently in progress.

Further research is needed to explore the long-term outcomes of being born during a pandemic, as well as the immediate health and economic impacts of the changes reported here.

Priority areas for research identified in this report:

- Understanding the causes and contributors to the reduction in iatrogenic and spontaneous preterm births
- Determining the relationship between reduced length of stay and unplanned newborn readmissions
- Examining the health outcomes and consumer experience of out-of-hospital-births
- Evaluating the adequacy of domiciliary and community care for new mothers and babies, with particular focus on breast feeding rates and prevention of unplanned readmissions
- Analysing trends in maternal and infant weight and gestational diabetes to inform future health policy and health service planning; and identifying opportunities for intervention and prevention
- Studying the immediate and long-term consequences of prolonged pandemic restrictions to maternal and child health outcomes

Suggestions for data improvement

Improvement 1: Data quality

Rapid data cleaning of VPDC and VAED datasets and routine data quality checks

The Victorian Perinatal Data Collections (VPDC) and the Victorian Admitted Episodes Datasets (VAED) are robust reporting systems. It has been an important resource for researchers and policymakers state-wide and nationally. However, there is currently inadequate technical capacity to do rapid data cleaning of VPDC datasets.

Recommendation 1 - Reproducible data cleaning codes must be retained within the department and data cleaning codes run routinely as health facilities submit their regular reports.

Any discordance and data quality issues would then be reported immediately to maternity services to ensure a quick resolution. These steps will ensure that CCOPMM, stakeholders and maternity services can swiftly intervene if important signals are identified in the report.

Aside from the business rule and guidelines for VPDC reporting, there is no clear protocol for regular data quality audits for VPDC data. Most of the previous efforts on data quality checks were done as a research exercise rather than routine activities. The data quality of the newly introduced indicators such as GDM and aneuploidy screening (not reported here) has not been validated (14, 15). The inaccuracy in some items such as smoking during pregnancy precluded any analysis for this report (14, 15).

Recommendation 2 - A comprehensive data quality audit to estimate the accuracy, completeness, and reliability of datasets reported by all maternity health services should be performed on a regular basis.

Improvement 2: Data accessibility

Electronic dashboard of key maternity, perinatal and neonatal indicators for Victoria

Current VPDC indicators are currently published through the annual reports of CCOPMM, with approximately 18 months lag time. Electronic dashboards with analytic elements are not widely available state-wide, but there is a clear demand for them. Local maternity dashboards have been implemented in each health service by SCV but are not centrally integrated. The Maternity Learning Health Network Data group is currently working towards a state-wide maternity dashboard with a comprehensive range of indicators.

https://www.safercare.vic.gov.au/improvement/projects/mbc/maternity-dashboard

Recommendation 3 – Acceleration of the state-wide maternity dashboard project in consultation with Safer Care Victoria's Maternity and Newborn Learning Health Network. The LHN's data group, which includes clinicians, consumers, researchers, health systems champions and improvement experts could support this work to improve clinical care and patient outcomes through data and evidence.

Appendix 1: Definitions and computations used in this report

Outcomes	Definition	Computation
Unexpected stillbirth	Proportion of eligible births that resulted in a stillbirth (baby born dead)	**Denominator:** Number of births that met the following criteria: a) gestational age greater than or equal to 28 weeks b) birthweight greater than or equal to 400 grams c) no congenital anomalies. Exclusions: Birth status not stated/ inadequately described **Numerator:** Number of babies who met the denominator criteria and who were stillbirth
Preterm births	Proportion of babies who are born preterm.	**Denominator:** Number of babies who are born at 20 or more weeks gestation. **Numerator:** Number of babies who met the denominator criterion and were born at <37 weeks gestation, disaggregated into the following groups to align with Victoria's Consultative Council on Obstetric and Paediatric Mortality and Morbidity (CCOPMM) reporting: • 20-23 weeks • 24-27 weeks • 28-31 weeks • 32-36 weeks
Iatrogenic preterm births	Proportion of babies who are born preterm due to a planned delivery (induction of labor or cesarean section in the absence of spontaneous labor or rupture of membranes)	
Spontaneous preterm births	Proportion of babies who are born preterm due to preterm labor or preterm rupture of membrane	
Low Apgar score	Measures the wellbeing of babies at 37 or more weeks gestation and without congenital anomalies at birth.	**Denominator:** Number of singletons, liveborn babies at 37 or more weeks gestation with no congenital anomalies. **Numerator:** Number of babies who met the denominator criteria and had Apgar score<7 at 5 mins.
Large for gestational age	Proportion of all singleton babies who weighed ≥ 90th centile for gestational age and sex(7).	**Denominator:** Number of singleton babies whose gestational age is more than 27 weeks. **Numerator:** Number of babies who met the denominator criteria and weigh more than the 90th centile for babies of the same gestational age and sex.

Outcomes	Definition	Computation
Fetal Growth Restriction (FGR)	Proportion of severely growth restricted singleton babies (defined as birthweight below the third centile(7), corrected for gestational age, plurality and sex) who were born at or after 40 weeks gestation	**Denominator:** Number of singleton babies (live and stillborn) with severe FGR who were born at 32 or more weeks gestation **Numerator:** Number of babies who met the denominator criteria and were born at 40 or more weeks gestation
Congenital anomalies	Proportion of babies born at 20 or more weeks gestation with congenital abnormalities diagnosed before or during the birth episode	**Denominator:** Number of births (including stillbirths and terminations) with an estimated gestational age of 20 or more weeks. **Numerator:** Number of babies who met the denominator criteria and were born with a congenital abnormality.
Newborn admission to SCN/NICU at term excluding congenital anomalies	Proportion of babies at 37 or more weeks gestation who are admitted to either the SCN/NICU who have no congenital abnormalities.	**Denominator:** Number of babies who were born alive at 37 or more weeks gestation and had no congenital anomalies detected antenatally. **Numerator:** Number of babies who met the denominator criteria and who were admitted to special care nursery or neonatal intensive care unit or were transferred to higher level care during the birthing episode, i.e.:

Newborn length of stay	Number of days a baby stayed in the hospital	**Denominator:** Number of live infants born $\geq$ 20 or more weeks of gestation without congenital anomalies, excluding transfers NICU/SCN and to other health services
		Numerator: Number of infants who met the denominator criteria who were discharged at
		    • 0-1 day
		    • 2 days
		    • 3 days
		    • 4 or more days

Outcomes	Definition	Computation
Unplanned newborn readmission	Rate of unplanned and potentially preventable readmissions of babies within 28 days of discharge from the hospital, respectively, following a birthing admission.	**Denominator:** Number of babies discharged from health service, excluding stillbirths and neonatal deaths before discharge. **Numerator:** The number of babies readmitted to any health service (with a potentially preventable readmission principal diagnosis code) within 28 days of discharge. Babies who are readmitted on the same day of discharge are excluded. **Disaggregated by:** a.) Jaundice – P590 (Neonatal jaundice with preterm delivery, P598 (Neonatal jaundice from other specified causes), P599 (Neonatal jaundice unspecified), P551 (ABO isoimmunisation of fetus and newborn) b.) Feeding problems – P929 (Feeding problem of newborn unspecified), P928 (Other feeding problems of newborn), P741 (Dehydration of newborn), R634 (Abnormal weight loss of the newborn) c.) Infections – Z0371 (Observation of newborn for suspected infectious condition), A870 (Enteroviral meningitis), P369 (Bacterial sepsis of newborn unspecified), P38 (Omphalitis of newborn with or without mild haemorrhage) d.) Other – P90 (Convulsions of newborn), P0732 (Preterm infant, 32 or more completed weeks but less that 37 completed weeks), P282 (Cyanotic attacks of newborn), P2840 (Apnoea of newborn, unspecified), P809 (Hypothermia of newborn unspecified), R628 (Other lack of expected normal physiological development) Note: These are existing measures in the Performance Monitoring Framework (PMF) and use definitions as described in the PMF (refer to the PMF for the list of potentially preventable readmission diagnosis codes). Also, in accordance with the PMF, the scope only includes births in public hospitals.
Homebirths	Proportion of women who gave birth at home (planned and unplanned)	**Denominator:** Number of women who gave birth at 20 or more weeks gestation **Numerator:** Number of women who met denominator criteria with actual birth setting is home
In transit births	Proportion of women who gave birth in-transit before arrival to hospital	**Denominator:** Number of women who gave birth at 20 or more weeks gestation **Numerator:** Number of women who met denominator criteria with actual birth setting is "in transit"

Outcomes	Definition	Computation
BMI > 25 kg/m^2	Proportion of women who have a BMI >25 kg/m^2	**Denominator:** Number of women who gave birth at 20 or more weeks gestation **Numerator:** Number of women who met denominator criteria and who had a BMI (enrolment BMI) of >25 kg/m^2
Gestational DM (Field)	Proportion of women who were diagnosed with gestational diabetes during pregnancy.	**Denominator:** Number of women who gave birth at 20 or more weeks gestation **Numerator:** Number of women who met denominator criteria and who was diagnosed with gestational diabetes and recorded as GDM in the Birth Outcome System's field
Gestational DM (derived)	Proportion of women who were diagnosed with gestational diabetes during pregnancy.	**Denominator:** Number of women who gave birth at 20 or more weeks gestation **Numerator:** Number of women who met denominator criteria and who had any of the following diagnoses codes: • O2442, 02443, 02444, O2449, O2493, O2494, O2499
Eclampsia/Pre-eclampsia (derived)	Proportion of women who were diagnosed with hypertensive disorders of pregnancy or severe pre-eclampsia or eclampsia during pregnancy.	**Denominator:** Number of women who gave birth at 20 or more weeks gestation **Numerator:** Number of women who met denominator criteria and who had any of the following diagnoses codes: • O141, 0142, O149, O150, O151, O152
Antenatal influenza vaccination	Proportion of women who received influenza vaccine during pregnancy	**Denominator:** Number of women who gave birth at 20 or more weeks gestation **Numerator:** Number of women who met the denominator criteria who had influenza vaccination during pregnancy
Antenatal pertussis vaccination	Proportion of women who received pertussis vaccine during pregnancy	**Denominator:** Number of women who gave birth at 20 or more weeks gestation **Numerator:** Number of women who met the denominator criteria who had pertussis vaccination during pregnancy
COVID-19 vaccination before and during pregnancy	Proportion of women who received COVID-19 vaccine before and during pregnancy	**Denominator:** Number of women who gave birth at 20 or more weeks gestation **Numerator:** Number of women who met the denominator criteria who had $\geq$1 COVID-19 vaccine dose before or during pregnancy
Maternal length of stay	Number of days a mother stayed in the hospital	**Denominator:** Number of pregnant women who gave birth $\geq$ 20 weeks gestation **Numerator:** Number of pregnant women who met the denominator criteria who were discharged at • 0-1 day • 2 days • 3 days • 4 or more days

Outcomes	Definition	Computation
Unplanned maternity readmission	Rate of unplanned and potentially preventable readmissions of women and babies within 28 days of discharge from the hospital, respectively, following a birthing admission.	**Denominator:** Number of women provided admitted postnatal care prior to discharge **Numerator:** The number of women readmitted to any health service (with a potentially preventable readmission principal diagnosis code) within 28 days of a birthing admission **Disaggregated by:** a.) Post-partum infections – O85 (Puerperal sepsis), O862 (Urinary tract infection following delivery), N390 (Urinary tract infection site not specified), R509 (Fever unspecified) b.) Lactation complications – O9120 (Non-purulent mastitis associated with childbirth, without mention of attachment difficulty, O9121 (Non-purulent mastitis associated with childbirth, with mention of attachment difficulty c.) Complications of obstetric wounds – O860 (Infection of an obstetric surgical wound), O901 (Disruption of a perineal obstetric wound), O900 (Disruption of caesarean section wound), O902 (Haematoma of obstetric wound) d.) Secondary post-partum haemorrhage and its complications – O731 (Retained portions of placenta and membrane), O720 (Third-stage haemorrhage), O721 (Other immediate post-partum haemorrhages), O722 (Delayed and secondary post-partum haemorrhage, O9903 (Anaemia in childbirth and the puerperium) e.) Hypertensive disorders of pregnancy and the puerperium – O16 (Unspecified maternal hypertension), O13 (Gestational Hypertension), O149 (Pre-eclampsia unspecified), O152 (Eclampsia in the puerperium) f.) Other – T8852 (Headache due to anaesthesia), G9719 (Reaction to spinal and lumbar puncture, not elsewhere classified), R33 (Retention of urine), Z466 (Fitting and adjustment of urinary device), Z391 (Care and examination of lactating mother), F530 (Mild mental and behavioural disorders associated with the puerperium, not elsewhere classified), F531(Severe mental and behavioural disorders associated with the puerperium not elsewhere classified Note: These are existing measures in the Performance Monitoring Framework (PMF) and use definitions as described in the PMF (refer to the PMF for the list of potentially preventable readmission diagnosis codes). Also, in accordance with the PMF, the scope only includes births in public hospitals.

Appendix 2. Results tables

Table 1. General Indicators

Indicator	Prepandemic period Jan 2018 - March 2020		Pandemic period April 2020-Dec 2021		
	Median	IQR	Median	IQR	P-value
Monthly births (n)	6684	6364-6771	6623	6377-6819	0.8559
Stillbirth (%)	0.19	0.15-0.23	0.19	0.16-0.24	0.57
In-transit births (%)	0.14	0.11-0.18	0.19	0.14-0.22	**<0.001**
Home births (%)	0.68	0.56-0.75	0.94	0.84-1.03	**<0.001**

Table 2. Total preterm birth rates

	Prepandemic		Pandemic		
Indicator	Median	IQR	Median	IQR	P-value
< 37 weeks	8.77	8.37-9.21	8.10	7.72-8.52	**<0.001**
32 – 36 weeks	7.00	6.64-7.37	6.39	6.16-6.70	**<0.001**
28 – 31 weeks	0.71	0.61-0.79	0.73	0.63-0.83	0.38
24 – 27 weeks	0.41	0.35-0.46	0.40	0.34-0.45	0.59
20 – 23 weeks	0.67	0.58-0.74	0.54	0.45-0.64	<0.001

Table 3. Iatrogenic preterm birth rates

	Prepandemic		Pandemic		
Indicator	Median	IQR	Median	IQR	P-value

	Prepandemic		Pandemic		
	Median	IQR	Median	IQR	P-value
< 37 weeks	5.40	5.09-5.70	4.94	4.73-5.18	**<0.001**
32 – 36 weeks	4.18	3.80-4.57	3.78	3.71-3.91	**<0.001**
28 – 31 weeks	0.41	0.35-0.45	0.43	0.36-0.51	0.20
24 – 27 weeks	0.27	0.18-0.31	0.26	0.20-0.32	0.86
20 – 23 weeks	0.55	0.46-0.60	0.45	0.37-0.51	**<0.001**

Table 4. Spontaneous preterm birth rates

	Prepandemic		Pandemic		
Indicator	Median	IQR	Median	IQR	P-value
< 37 weeks	3.38	3.20-3.53	3.17	3.02-3.34	**<0.001**
32 – 36 weeks	2.81	2.56-2.93	2.57	2.45-2.74	**0.01**
28 – 31 weeks	0.31	0.25-0.36	0.73	0.63-0.83	0.38
24 – 27 weeks	0.14	0.11-0.19	0.17	0.11-0.20	0.88
20 – 23 weeks	0.14	0.12-0.16	0.13	0.10-0.15	0.28

Table 5. Newborn outcomes

	Prepandemic		Pandemic		
Indicator	Median	IQR	Median	IQR	P-value
Low Apgar score	1.28	1.12-1.38	1.17	1.01-1.28	**0.03**
Large for gestational age	9.45	9.19-9.69	10.42	10.08-10.72	**<0.001**
Congenital anomalies	3.24	3.15-3.54	3.36	3.22-3.63	0.30

| Admission to SCN/NICU | 11.45 | 11.06-11.82 | 10.15 | 9.57-10.93 | **<0.001** |
| Undiagnosed severe FGR | 23.13 | 20.61-26.79 | 20.69 | 18.03-23.21 | **0.02** |

Table 6. Maternal Outcomes

	Prepandemic		Pandemic		
Indicator	Median	IQR	Median	IQR	P-value
BMI > 25 kg/m^2	48.79	48.12-49.98	50.53	50.10-50.88	**<0.001**
Gestational Diabetes Mellitus	14.82	13.88-15.34	16.00	15.45-16.19	**<0.001**
Hypertensive disorders	1.71	1.54-1.96	1.66	1.46-1.86	0.41
Antenatal influenza vaccination	75.25	59.49-82.05	77.05	66.93-83;77	0.41
Antenatal pertussis vaccination	82.97	81.4-84.64	81.90	81.18-82.59	0.30

Table 8. Infant length of stay and readmission

	Prepandemic		Pandemic		
Indicator	Median	IQR	Median	IQR	P-value
Infant hospital length of stay					
0-1 day	18.66	17.87-18.97	26.24	25.37-27.77	**<0.001**
2 days	25.71	24.94-26.25	26.27	25.39-26.36	0.21
3 days	22.26	21.97-22.89	19.18	18.45-19.98	**<0.001**
4 or more days	33.68	32.59-34.29	28.44	27.70-29.54	**<0.001**
Infant readmission	4.16	3.94-4.55	4.65	4.44-4.98	**<0.001**

Neonatal jaundice	2.75	2.50-2.83	2.79	2.59-3.19	0.11
Feeding problems	1.95	1.85-2.17	2.34	2.15-2.54	**<0.001**
Infectious diseases	0.59	0.46-0.67	0.61	0.55-0.86	**0.02**
Others	0.50	0.40-0.59	0.61	0.45-0.64	**0.02**

Table 7. Maternal length of stay and readmission

	Prepandemic		Pandemic		
Indicator	Median	IQR	Median	IQR	P-value
Maternal hospital length of stay					
0-1 day	18.91	18.43-19.32	27.06	26.43-28.58	**<0.001**
2 days	28.20	27.62-28.89	28.37	27.77-28.80	0.93
3 days	24.40	23.93-24.84	20.69	20.04-21.74	**<0.001**
4 or more days	28.62	27.65-28.99	23.69	23.17-24.67	**<0.001**
Unplanned maternity admission	2.45	2.28-2.64	2.39	2.15-2.60	0.30
Post-partum infections	0.50	0.44-0.56	0.42	0.36-0.49	**0.01**
Lactation complications	0.29	0.25-0.43	0.27	0.21-0.34	0.19
Wound infections	0.56	0.52-0.63	0.52	0.45-0.59	0.08
Haemorrhage	0.54	0.45-0.58	0.48	0.40-0.54	0.11
Hypertensive disorders	0.29	0.22-0.36	0.44	0.39-0.49	**<0.001**
Others	0.25	0.21-0.29	0.21	0.19-0.26	0.23

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