Modest reduction in adverse birth outcomes following the COVID-19 lockdown

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Condensation, Short Title, AJOG at a Glance, and Keywords

Condensation

Using a birth outcomes surveillance study in Botswana including over 119,000 births, we found a modest reduction in adverse birth outcomes following the COVID-19 lockdown.

Short Title

COVID-19 lockdown and adverse birth outcomes in Botswana

AJOG at a Glance

A. Why was the study conducted?

Widespread lockdowns imposed during the COVID-19 crisis may have impacted birth outcomes worldwide.

B. What are the key findings?

The post-lockdown period in 2020 was associated with a 1.72 percentage point reduction (95% CI, -3.42%, -0.02%) in the risk of any adverse outcome (stillbirth, preterm birth, small-for-gestational-age [SGA], and neonatal death) and a 1.62 percentage point reduction (95% CI, -2.69%, -0.55%) in the risk of any severe adverse outcome (stillbirth, very preterm birth, very SGA, and neonatal death). Reductions in adverse outcomes were largest among women with HIV and among women delivering at urban sites, driven primarily by reductions in preterm birth and SGA.

C. What does the study add to what is already known?

Our data provide the first evaluation from Sub-Saharan Africa of the impact of a COVID-19 lockdown on birth outcomes, and suggest a modest reduction in preterm birth and SGA following the lockdown period.
Abstract

Background: Widespread lockdowns imposed during the COVID-19 crisis may impact birth outcomes.

Objective: To evaluate the association between the COVID-19 lockdown and the risk of adverse birth outcomes in Botswana.

Study Design: In response to COVID-19, Botswana enforced a lockdown that restricted movement within the country. We used data from an ongoing nationwide birth outcomes surveillance study to evaluate adverse outcomes (stillbirth, preterm birth, small-for-gestational-age [SGA], and neonatal death) and severe adverse outcomes (stillbirth, very preterm birth, very SGA, and neonatal death) recorded pre-lockdown (January 1 – April 2), during lockdown (April 3 – May 7), and post-lockdown (May 8 – July 20). Using difference-in-differences analyses, we compared the net change in each outcome from the pre-lockdown to lockdown periods in 2020 relative to the same two periods in 2017-2019, and the net change in each outcome from the pre-lockdown to post-lockdown periods in 2020 relative to the same two periods in 2017-2019.

Results: 68,448 women delivered a singleton infant in 2017-2020 between January 1 and July 20 and were included in our analysis (mean [interquartile range] age of mothers, 26 [22,32] years). Across the included calendar years and periods, the risk of any adverse outcome ranged from 27.92% to 31.70% and the risk of any severe adverse outcome ranged from 8.40% to 11.38%. The lockdown period was associated with a 0.81 percentage point reduction (95% CI, -2.95%, 1.30%) in the risk of any adverse outcome (3% relative reduction) and a 0.02 percentage point reduction (95% CI, -0.79%, 0.75%) in the risk of any severe adverse outcome (0% relative reduction). The post-lockdown period was associated with a 1.72 percentage point reduction (95% CI, -3.42%, -0.02%) in the risk of any adverse outcome (5% relative reduction) and a 1.62 percentage point reduction (95% CI, -2.69%, -0.55%) in the risk of any severe adverse outcome (14% relative reduction). Reductions in adverse outcomes were largest among women with HIV and among women delivering at urban delivery sites, driven primarily by reductions in preterm birth and SGA.

Conclusions: Adverse birth outcomes decreased from the pre-lockdown to post-lockdown periods in 2020, relative to the change during the same periods in 2017-2019. Our findings may
provide insights into associations between mobility and birth outcomes in Botswana and other low- and middle-income countries.

**Keywords:** HIV, mobility, neonatal death, pregnancy outcomes, preterm birth, SGA, stillbirth
Introduction

Widespread lockdowns imposed during the COVID-19 crisis may have impacted birth outcomes worldwide, but the magnitude and direction of these effects remain uncertain. A hospital in Ireland reported a 73% decrease in the incidence of very low birthweight infants from January to April 2020 compared with the same period in the previous two decades,¹ a study in Denmark found a 90% decrease in the incidence of preterm birth during the lockdown period from March 12 to April 14 compared with the same period during the previous five years,² and a study in The Netherlands found reductions in the incidence of preterm birth across various time windows surrounding the implementation of COVID-19 mitigation measures (e.g., an odds ratio of 0.77 comparing 2 months after and 2 months before March 9th).³ In the United States, one hospital in Nashville estimated there were 20 percent fewer infants in the neonatal intensive care unit in March than during that month in previous years.⁴ Still, many hospitals around the world reported no differences in preterm births during the lockdown⁴ and there is concern that lockdown restrictions could also lead to increases in more severe outcomes such as stillbirth and neonatal death. A study using data from a London hospital found a higher incidence of stillbirth during the COVID-19 pandemic period compared with the period immediately prior to the pandemic, but no difference in preterm birth.⁵ A study in nine hospitals across Nepal found a higher incidence of stillbirth, neonatal mortality, and preterm birth during the 9.5-week lockdown compared with the 12.5 weeks prior to the lockdown.⁶ Finally, a study using data from four hospitals in western India found a higher incidence of stillbirth during the 10 weeks following the lockdown compared with the 10 weeks prior to the lockdown.⁷ The mechanisms underlying all of these reported findings are speculative, and in most cases need to be considered in the
context of the additional unknown effect of severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) infection itself.8

To date there have been no studies on the impact of the COVID-19 lockdowns on adverse pregnancy outcomes in Sub-Saharan Africa, a region with one of the greatest burdens of adverse pregnancy outcomes, and risk factors that are often distinct from those in high-income countries. Despite having only three reported SARS-CoV-2 cases at the time,9 Botswana announced a state of emergency due to COVID-19 on March 31, 202010 and a nationwide lockdown commenced at midnight on April 2, 2020.11-13 After the initial 28 day period, the lockdown was extended until May 7, 2020.14 Movement restrictions were gradually lifted between May 8 and May 22, 2020.15-19 While SARS-CoV-2 swept through South Africa, infecting 364,328 people as of July 20th, 202020, COVID-19 largely spared Botswana during this early phase of the pandemic; through July 20th there were 522 cases of SARS-CoV-2 and no confirmed cases in pregnancy.20 This provides a unique opportunity to isolate the impact of the lockdown from any direct impact of SARS-CoV-2.

The Tsepamo Study has been conducting birth outcomes surveillance at delivery hospitals throughout Botswana since August 2014 and includes data from more than 119,000 births. In this analysis, we used Tsepamo data to estimate the risk of adverse birth outcomes prior to (January 1 – April 2), during (April 3 – May 7), and after (May 8 – July 20) the COVID-19 national lockdown in 2020, and compared these risks with the same three time-periods in 2017-2019. We also examined whether the impact of the lockdown varied by HIV status, by urban or rural delivery hospital, and by other demographic factors.

Materials and Methods
The Tsepamo Study

Tsepamo is a birth outcomes surveillance study in Botswana. Data are abstracted from the maternity obstetric record (a record of antenatal care) at the time of delivery from all women delivering at selected hospitals throughout the country. Tsepamo included 8 sites (~45% of all births in Botswana) from August 2014-July 2018 and 18 sites (~72% of all births nationwide) from July 2018-July 2020. The Tsepamo study captures data on >99% of all births that take place at the included sites as almost all women bring their antenatal medical records ('maternity card') to delivery. In Botswana, approximately 95% of women deliver at a hospital.

Eligibility criteria and exposure groups

Women who delivered a singleton baby after at least 24 weeks gestation in 2017-2020 between January 1 and July 20 were included in our analysis (in Botswana, pregnancies that end before 24 weeks are considered miscarriage and admitted to the general medical wards). We defined January 1 – April 2 as the period prior to the lockdown (“pre-lockdown”), April 3 – May 7 as the period during the lockdown (“lockdown”), and May 8 – July 20 as the period following the lockdown (“post-lockdown”). We compared the lockdown year, 2020, with the previous three years, 2017-2019.

Outcomes

Shelter-in-place adherence: We defined the proportion of people remaining in one location over a 24-hour period as an indicator of shelter-in-place adherence. We calculated the average number of Facebook users with location services turned on that were present in the same 600 x 600 meter grid location over a 24-hour period. Presence in the same location was defined as GPS pings in at
least three different time blocks of the day. We created heat maps to depict the 24-hour staying-put percentage by region of Botswana from 28 February until 24 July, 2020.

Birth outcomes: The primary outcomes of interest were the combined endpoints of any adverse outcome and any severe adverse outcome. Any adverse outcome comprised stillbirth, preterm birth, small for gestational age (SGA), or neonatal death. Any severe adverse outcome comprised stillbirth, very preterm birth, very SGA, or neonatal death. Secondary endpoints were the individual outcomes. Stillbirth was defined as fetal death $\geq$ 24 weeks (summed Apgar score of 0). Preterm birth was defined as a birth at less than 37 weeks’ completed gestation and very preterm was a birth at less than 32 weeks’ completed gestation. Tertiary outcomes were birth at less than 34 weeks’ completed gestation and continuous gestational age at delivery. Gestational age was calculated at the time of delivery by the midwife using the estimated date of delivery determined during antenatal care, typically using reported LMP. SGA was defined as less than the 10th percentile and very SGA as less than the 3rd percentile of birthweight by gestational age according to the Intergrowth-21 norms. Neonatal deaths included deaths within 28 days of birth among infants who had never left the hospital.

Statistical analysis

We used a difference-in-differences analysis to assess the relationship between the lockdown and each outcome. That is, we compared the change in each outcome from the pre-lockdown to lockdown periods in 2020 (the first difference) with the change in each outcome during the same two periods in 2017-2019 (the second difference). We also compared the change in each outcome from the pre-lockdown to post-lockdown periods in 2020 with the change in each outcome during the same two periods in 2017-2019. We obtained 95% confidence intervals
using a linear probability model$^{30}$ with robust standard errors to account for clustering within delivery sites.$^{31,32}$ Relative risk reductions were calculated using the average baseline risk in the pre-lockdown period from 2017 to 2020.

We conducted separate analyses for the primary outcomes by maternal HIV status, delivery location (urban: delivery sites in Gaborone or Francistown; rural: all other delivery sites), parity (first child versus one or more children), and occupation (salaried versus non-salaried). In post-hoc analyses, we examined subgroups defined by multiple factors (e.g., HIV status and delivery location).

In sensitivity analyses we adjusted our estimates for individual-level demographic variables (HIV status, calendar year of delivery, age, occupation, education, parity, gravity, marital status, delivery location, smoking status, and use of alcohol), and extended the lockdown period through May 21 to include the two-week period where restrictions were gradually lifted.

Finally, we plotted the weekly risk of the primary outcomes over a 28-week period (January 3 – July 16) in 2020 compared with the same period (January 2 – July 16) in 2017-2019.

Institutional approval for this study was granted by the Health Research and Development Committee in Botswana and by the institutional review board of Harvard T. H. Chan School of Public Health in Boston, Massachusetts. Maternal consent was waived as data were collected anonymously and via chart abstraction.

**Results**

A total of 68,448 women delivered a singleton infant in 2017-2020 between January 1 and July 20 and were included in our analysis. Table 1 shows the number of births during the pre-
lockdown, lockdown, and post-lockdown periods in 2020 and during the same calendar periods in 2017-2019. Comparing 2020 with the previous year, the number of births was similar during the lockdown period (3,589 versus 3,432) but slightly lower during the post-lockdown period (7,162 versus 7,413). Demographic characteristics were similar across years and across periods, except the median number of antenatal visits decreased from ten across all periods in 2017-2019 to nine across all periods in 2020 (Table 1). Median maternal age was 26 years, 23% were living with HIV, 38% delivered at an urban delivery site, 62% had other children, and 33% had a salaried occupation. Of the 15,767 women with HIV, the proportion who self-reported discontinuing antiretrovirals during pregnancy was less than 0.6% across all years and did not differ in 2020, including during the lockdown period (data not shown). To our knowledge no modifications to antenatal care were put in place during the lockdown period, and telemedicine was not routinely available. A food insecurity mitigation strategy was implemented in Botswana during the lockdown, with food baskets provided free of charge at locations throughout the country.

Shelter-in-place adherence: Figure 1 shows the 24-hour staying-put percentage from February 28 to July 24 2020, by region in Botswana. Staying-put percentage increased from 10% to 40-50% when the nationwide lockdown was instituted on April 3, gradually decreased following the phased relaxation of extreme social-distancing measures beginning on May 8, and was consistent with pre-lockdown levels by June 5. Changes in staying-put percentage over time were consistent across the country.

Birth outcomes: Table 2 shows the net change in the risk of each outcome from the pre-lockdown to lockdown periods in 2020 relative to the same two periods in 2017-2019, and the net change in the risk of each outcome from the pre-lockdown to post-lockdown periods in 2020.
relative to the same two periods in 2017-2019. The lockdown period was associated with a 0.81 percentage point reduction (95% CI, -2.95%, 1.30%) in the risk of any adverse outcome (3% relative reduction) and a 0.02 percentage point reduction (95% CI, -0.79%, 0.75%) in the risk of any severe adverse outcome (0% relative reduction). The post-lockdown period was associated with a 1.72 percentage point reduction (95% CI, -3.42%, -0.02%) in the risk of any adverse outcome (5% relative reduction) and a 1.62 percentage point reduction (95% CI, -2.69%, -0.55%) in the risk of any severe adverse outcome (14% relative reduction). The largest reduction associated with the lockdown period for an individual outcome was for preterm birth (-1.52 percentage points, [95% CI, -3.14%, 0.10%] or 9% relative reduction), whereas the largest reduction associated with the post-lockdown period for an individual outcome was for SGA (-1.07 percentage points [95% CI, -2.26%, 0.12%] or 7% relative reduction). There was no difference in neonatal death or stillbirth during the lockdown or post-lockdown periods. Findings were similar when evaluating birth at less than 34 weeks’ completed gestation and continuous gestational age at delivery (Appendix Table 1).

The reduction in both primary outcomes during the lockdown period was larger among women with HIV and among women with salaried employment (Table 3). The reduction in both primary outcomes during the post-lockdown period was larger among women with HIV, women delivering at urban delivery sites, and women who already had children. The largest reductions were observed during the post-lockdown period among women with HIV (-3.86 percentage points [95% CI, -6.32%, -1.39%] or 10% relative reduction for any adverse outcome and -2.26 percentage points [95% CI, -4.14%, -0.38%] or 16% relative reduction for any severe adverse outcome) and among women delivering at urban delivery sites (-3.37 percentage points [95% CI, -6.30%, -0.44%] or 10% relative reduction for any adverse outcome and -2.93 percentage points...
In a post-hoc analysis, we calculated that for a woman with HIV delivering at an urban delivery site (9.3% of study population), there was a 6.31 percentage point reduction (95% CI, -14.21%, 1.59%) in the risk of having any adverse outcome (16% relative reduction) and a 2.17 percentage point reduction (95% CI, -7.88%, 3.55%) in the risk of having any severe adverse outcome (13% relative reduction) during the lockdown period. In this same subgroup, there was a 3.43 percentage point reduction (95% CI, -9.64%, 2.77%) in the risk of having any adverse outcome (9% relative reduction) and a 3.52 percentage point reduction (95% CI, -8.01%, 0.96%) in the risk of having any severe adverse outcome (22% relative reduction) during the post-lockdown period.

Adjusting for individual-level demographic variables and extending the lockdown period by two weeks had no material impact on our estimates (data not shown).

Figure 2 shows the risks of any (panel A) and any severe (panel B) adverse outcomes from January to June in 2017-2019 and in 2020. Although some seasonal or calendar time variation may have been present in all years, when comparing 2020 with 2017-2019, the weekly risks were similar during the 13 weeks prior to the lockdown period and the 5 weeks during the lockdown period, but lower during the 10 weeks following the lockdown period.

**Comment**

1. **Principal Findings**

We utilized a large birth outcomes surveillance study in Botswana to estimate changes in the risk of adverse birth outcomes following the COVID-19 national lockdown in 2020, comparing to
similar time-periods in 2017-2019 to present a novel difference-in-differences analysis. During the lockdown period, the number of deliveries remained constant, there was noticeable adherence to the shelter-in-place order (40-50%), and no meaningful differences in adverse birth outcomes were observed. However, we found modest reductions in the risk of any adverse outcome and any severe adverse outcome from the pre-lockdown to post-lockdown periods, relative to changes during the same two periods in 2017-2019. These reductions were mostly driven by reductions in preterm birth, very preterm birth, SGA, and very SGA, whereas there was little evidence for a change in neonatal death or stillbirth. We found evidence for effect modification by HIV status and urban versus rural delivery site; the post-lockdown period was associated with a more than 3 percentage point reduction (~10% relative reduction) in the risk of any adverse outcome and a more than 2 percentage point reduction (16-21% relative reduction) in the risk of any severe adverse outcome among women with HIV and among women delivering at urban sites.

2. Results

Our findings are consistent with some previous studies that found decreases in the risk of low birth weight\textsuperscript{1} and preterm birth\textsuperscript{2,3} following COVID-19 lockdowns, although the magnitude of our findings was smaller. Our results differ from studies in London, Nepal, and India that found an increased risk of stillbirth during the lockdown period.\textsuperscript{5-7} The differences between our findings and studies conducted in Western Europe and the United States could be explained by differences in risk factors for adverse birth outcomes between high-income and low- and middle-income countries. In addition, the previous studies compared the lockdown period to the period immediately prior to the lockdown or to the same period in previous years, even though adverse
birth outcomes vary by season and by calendar year. For example, several studies conducted in Sub-Saharan Africa have found more favorable birth outcomes in the dry season compared with the rainy season, and previous work in Botswana found modest reductions in adverse birth outcomes over calendar time. By using a difference-in-differences approach, our analysis was able to adjust for both seasonal and calendar variation in adverse birth outcomes. An additional strength of our study was the inclusion of more than half of all births in Botswana across multiple delivery sites, ensuring a representative sample of births in the country.

3. Clinical Implications

Several possible explanations have been proposed for the favorable impact of COVID-19 lockdown on preterm birth and low birth weight, including reducing inflammation, decreasing the risk of influenza and other infections, decreasing physical labor, decreasing stress, and decreasing exposure to air pollution. In Botswana, we found that the shelter-in-place order successfully led to more people staying-put, which could have reduced physical labor, exposure to infections and air pollution, and some sources of stress. The food insecurity mitigation strategy implemented in Botswana could have increased nutritional support during the lockdown, but its impact remains unknown. It is also possible that the lockdown led to a reduction in preterm iatrogenic delivery. In addition, we did not find any evidence that the shelter-in-place order negatively impacted access to medications for the 23% of women living with HIV. We saw greater reductions in adverse outcomes among women delivering at urban delivery sites, women with HIV, and women with salaried employment, suggesting that the lockdown could have impacted the daily lives of these women to a larger extent. While the greater reduction in adverse outcomes among women with HIV could be due to these women being more likely to deliver at
urban deliver sites, it is also possible that sheltering in place directly impacted adverse outcomes in this population, for example through reducing inflammation. It is possible that stay-at-home orders had less of an impact on women in rural areas and women without salaried employment because these women may have continued physical labor such as farming during the lockdown period. It is also possible that the stay-at-home order increased stress, anxiety, and undernutrition (despite mitigation strategies), especially among those who were food insecure and economically disadvantaged. The reduction in adverse outcomes was greater (albeit modest) in the post-lockdown period and negligible in the lockdown period. A plausible explanation for this finding is that the lockdown had a delayed effect on pregnancy outcomes, related to factors in the second trimester or early in the third trimester.

4. **Research Implications**

Further studies are needed to identify both the mechanism and the gestational window for potential benefits related to decreasing movement during pregnancy, and factors associated with pregnancy outcomes during pandemics. While our findings may not be generalizable to other settings with different distributions of risk factors for adverse birth outcomes (such as maternal nutrition, age, and HIV prevalence), they may also provide insight into potential interventions to reduce unknown causes of adverse outcomes.

5. **Strengths and Limitations**

Difference-in-differences analyses rely on the assumption that the trend in adverse outcomes in 2017-2019 would be parallel to the trend in adverse outcomes in 2020 in the absence of the lockdown. Our finding that the weekly trend in adverse outcomes during the pre-lockdown
period was similar in 2017-2019 compared with the same period in 2020 provides support that this “parallel trends” assumption may approximately hold. In addition, we found little variation in the demographic characteristics of women delivering throughout the study period. However, the parallel trends assumption would not be met if other changes occurred in Botswana at the same time as the lockdown that also impacted adverse outcomes. Difference-in-differences analyses also require an assumption of “strict exogeneity” that the choice to impose a lockdown was not determined by the pre-lockdown risk of adverse outcomes. Since the lockdown was imposed exclusively to stop the spread of COVID-19, this assumption is likely to hold.

Our study has important limitations. First, our analysis only captures women delivering at a hospital included in the surveillance study. If women were more likely to deliver at home or at a local hospital not included in the surveillance study following the lockdown, our results could be biased. We found that the proportion of births during the post-lockdown period in 2020 was slightly lower than the proportion of births during the same period in 2017-2019; however, it is unlikely that this ~1% decrease would explain our findings. Second, our analysis only captures births after at least 24 weeks gestation. If the risk of miscarriage changed during the lockdown period, we would not be able to capture this. Third, we were not able to assess individual-level mobility. While staying-put percentage increased during the lockdown period, we were not able to evaluate the relationship between individual-level mobility and adverse outcomes.

6. Conclusions

In conclusion, we found a 1.72 percentage point reduction (5% relative reduction) in any adverse outcome and a 1.62 percentage point reduction (14% relative reduction) in any severe adverse
outcome from the pre-lockdown to post-lockdown periods in 2020, relative to changes during the
same two periods in 2017-2019. We found no meaningful differences in adverse birth outcomes
from the pre-lockdown to lockdown periods. The greatest impact was on preterm birth and SGA,
and among women with HIV and those delivering in urban areas. While these reductions were
modest, they may provide insights into identifying potential interventions to reduce adverse birth
outcomes in Botswana and in other low- and middle-income countries throughout the world.

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**References**

   2. 2020.06.03.20121442.
   2. 2020.05.22.20109793.


Table 1. Characteristics of women giving birth in Botswana during the pre-lockdown (January 1-April 2), lockdown (April 3-May 7), and post-lockdown (May 8-July 20) periods in 2020 and in the same calendar periods in 2017-2019.

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Year</th>
<th>Pre-lockdown period (Jan 1-April 2)</th>
<th>Lockdown period (April 3-May 7)</th>
<th>Post-lockdown period (May 8-July 20)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of births (%)</td>
<td>2017-2019*</td>
<td>22,356 (46.5%)</td>
<td>8,316 (17.3%)</td>
<td>17,396 (36.2%)</td>
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<td></td>
<td>2017</td>
<td>6,584 (46.6%)</td>
<td>2,537 (17.9%)</td>
<td>5,020 (35.5%)</td>
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<tr>
<td></td>
<td>2018</td>
<td>6,341 (46.5%)</td>
<td>2,347 (17.2%)</td>
<td>4,963 (36.4%)</td>
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<tr>
<td></td>
<td>2019</td>
<td>9,431 (46.5%)</td>
<td>3,432 (16.9%)</td>
<td>7,413 (36.6%)</td>
</tr>
<tr>
<td></td>
<td>2020</td>
<td>9,629 (47.3%)</td>
<td>3,589 (17.6%)</td>
<td>7,162 (35.1%)</td>
</tr>
<tr>
<td>Age, median (IQR) years</td>
<td>2017-2019</td>
<td>26 (22, 32)</td>
<td>26 (22, 32)</td>
<td>26 (22, 32)</td>
</tr>
<tr>
<td></td>
<td>2020</td>
<td>26 (22, 32)</td>
<td>27 (22, 33)</td>
<td>26 (22, 32)</td>
</tr>
<tr>
<td>Nulliparity, No. (%)</td>
<td>2017-2019</td>
<td>8,524 (38.3%)</td>
<td>3,215 (38.9%)</td>
<td>6,607 (38.1%)</td>
</tr>
<tr>
<td></td>
<td>2020</td>
<td>3,478 (36.3%)</td>
<td>1,265 (35.4%)</td>
<td>2,588 (36.2%)</td>
</tr>
<tr>
<td>Women living with HIV, No. (%)</td>
<td>2017-2019</td>
<td>5,164 (23.1%)</td>
<td>1,941 (23.3%)</td>
<td>4,032 (23.2%)</td>
</tr>
<tr>
<td></td>
<td>2020</td>
<td>2,190 (22.7%)</td>
<td>785 (21.9%)</td>
<td>1,655 (23.1%)</td>
</tr>
<tr>
<td>Delivery at urban delivery location, No. (%)</td>
<td>2017-2019</td>
<td>9,119 (40.8%)</td>
<td>3,380 (40.6%)</td>
<td>7,020 (40.4%)</td>
</tr>
<tr>
<td></td>
<td>2020</td>
<td>3,146 (32.7%)</td>
<td>1,124 (31.3%)</td>
<td>2,284 (31.9%)</td>
</tr>
<tr>
<td>Salaried occupation, No. (%)</td>
<td>2017-2019</td>
<td>7,371 (33.0%)</td>
<td>2,795 (33.6%)</td>
<td>5,701 (32.8%)</td>
</tr>
<tr>
<td></td>
<td>2020</td>
<td>3,188 (33.1%)</td>
<td>1,197 (33.4%)</td>
<td>2,289 (32.0%)</td>
</tr>
<tr>
<td>Antenatal visits, median (IQR)</td>
<td>2017-2019</td>
<td>10 (7,12)</td>
<td>10 (7,12)</td>
<td>10 (7,12)</td>
</tr>
<tr>
<td></td>
<td>2020</td>
<td>9 (6,12)</td>
<td>9 (6,12)</td>
<td>9 (6,12)</td>
</tr>
</tbody>
</table>

*The number of births increased in 2019 due to the expansion of the birth outcomes surveillance study in July 2018

**Gaborone and Francistown
Table 2. Risk difference and difference-in-differences (95% CI) of each adverse birth outcome during the pre-lockdown (January 1-April 2), lockdown (April 3-May 7), and post-lockdown (May 8-July 20) periods in 2020 and in the same calendar periods in 2017-2019.

<table>
<thead>
<tr>
<th>Any adverse outcome</th>
<th>Pre-lockdown period (Jan 1-April 2), Risk (n/total)</th>
<th>Lockdown period (April 3-May 7), Risk (n/total)</th>
<th>Post-lockdown period (May 8-July 20), Risk (n/total)</th>
<th>Difference-in-differences (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2017-2019</td>
<td>2020</td>
<td>2020</td>
<td></td>
</tr>
<tr>
<td>Any severe adverse outcome</td>
<td>11.38% (2,451/21,540)</td>
<td>9.66% (774/8,015)</td>
<td>-0.31% (-1.44%, 0.82%)</td>
<td>-1.12% (-2.94%, 0.70%)</td>
</tr>
<tr>
<td>Stillbirth</td>
<td>2.37% (530/22,354)</td>
<td>2.20% (183/8,316)</td>
<td>-0.16% (-0.55%, 0.23%)</td>
<td>-0.08% (-0.65%, 0.48%)</td>
</tr>
<tr>
<td>Preterm birth</td>
<td>16.38% (3,563/21,746)</td>
<td>16.30% (1,316/8,075)</td>
<td>15.51% (2,624/16,916)</td>
<td>15.02% (518/3,448)</td>
</tr>
<tr>
<td>Very preterm birth</td>
<td>3.83% (833/21,746)</td>
<td>3.34% (270/8,075)</td>
<td>3.41% (577/16,916)</td>
<td>3.28% (99/3,448)</td>
</tr>
<tr>
<td>SGA</td>
<td>16.55% (3,560/21,517)</td>
<td>14.66% (1,173/8,001)</td>
<td>15.34% (2,575/16,785)</td>
<td>14.41% (493/3,421)</td>
</tr>
<tr>
<td>----------------------</td>
<td>-----------</td>
<td>-----------</td>
<td>-----------</td>
<td></td>
</tr>
<tr>
<td>Very SGA</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>6.28% (1,352/21,517)</td>
<td>5.19% (415/8,001)</td>
<td>5.60% (940/16,785)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>6.31% (584/9,251)</td>
<td>5.17% (177/3,421)</td>
<td>4.67% (321/6,879)</td>
<td></td>
</tr>
<tr>
<td><strong>Difference, 2020 vs 2017-2019</strong></td>
<td>-0.03% (-0.56%, 0.62%)</td>
<td>-0.01% (-0.90%, 0.87%)</td>
<td>-0.93% (-1.54%, -0.33%)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>-0.04% (-1.03%, 0.94%)</td>
<td>-0.96% (-1.87%, -0.05%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Neonatal death</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>1.49% (324/21,771)</td>
<td>1.18% (96/8,119)</td>
<td>1.25% (212/16,991)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1.11% (104/9,400)</td>
<td>0.91% (32/3,511)</td>
<td>1.08% (76/7,005)</td>
<td></td>
</tr>
<tr>
<td><strong>Difference, 2020 vs 2017-2019</strong></td>
<td>-0.38% (-0.65%, -0.12%)</td>
<td>-0.27% (-0.66%, 0.12%)</td>
<td>-0.16% (-0.46%, 0.13%)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>-0.11% (-0.54%, 0.76%)</td>
<td>0.22% (-0.16%, 0.60%)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Calculated as the difference between the change in each outcome from the pre-lockdown to lockdown periods in 2020 and the change in each outcome during the same two calendar periods in 2017-2019.

**Calculated as the difference between the change in each outcome from the pre-lockdown to post-lockdown periods in 2020 and the change in each outcome during the same two calendar periods in 2017-2019.
Table 3. Difference-in-differences (95% CI) of the composite adverse birth outcomes during the pre-lockdown (January 1-April 2), lockdown (April 3-May 7), and post-lockdown (May 8-July 20) periods in 2020 and in the same calendar periods in 2017-2019, by key subgroups.

<table>
<thead>
<tr>
<th>Any adverse outcome</th>
<th>Overall</th>
<th>Pre-lockdown period risk</th>
<th>Lockdown vs. pre-lockdown*</th>
<th>Post-lockdown vs. pre-lockdown**</th>
</tr>
</thead>
<tbody>
<tr>
<td>Women with HIV</td>
<td>37.69%</td>
<td>31.61%</td>
<td>-3.51% (-9.40%, 2.38%)</td>
<td>-3.86% (-6.32%, -1.39%)</td>
</tr>
<tr>
<td>Women without HIV</td>
<td>29.58%</td>
<td>0.09%</td>
<td>-1.91% (2.10%)</td>
<td>-0.98% (-3.12%, 1.17%)</td>
</tr>
<tr>
<td>Urban(^a) delivery sites</td>
<td>33.79%</td>
<td>-0.60%</td>
<td>(-4.33%, 3.13%)</td>
<td>-3.37% (-6.30%, -0.44%)</td>
</tr>
<tr>
<td>Rural(^b) delivery sites</td>
<td>30.23%</td>
<td>-0.88%</td>
<td>(-3.74%, 1.98%)</td>
<td>-0.83% (-2.17%, 0.52%)</td>
</tr>
<tr>
<td>Nulliparous women</td>
<td>33.43%</td>
<td>-1.39%</td>
<td>(-4.21%, 1.43%)</td>
<td>-0.64% (-2.98%, 1.71%)</td>
</tr>
<tr>
<td>Parous women</td>
<td>30.39%</td>
<td>-0.47%</td>
<td>(-3.14%, 2.20%)</td>
<td>-2.30% (-4.48%, -0.12%)</td>
</tr>
<tr>
<td>Women with HIV delivering at urban(^a) site</td>
<td>39.67%</td>
<td>-6.31%</td>
<td>(-14.21%, 1.59%)</td>
<td>-3.43% (-9.64%, 2.77%)</td>
</tr>
<tr>
<td>Women with salaried employment</td>
<td>27.36%</td>
<td>-2.41%</td>
<td>(-5.99%, 1.17%)</td>
<td>-2.45% (-5.80%, 0.90%)</td>
</tr>
<tr>
<td>Women without salaried employment</td>
<td>33.73%</td>
<td>-0.03%</td>
<td>(-2.12%, 2.06%)</td>
<td>-1.40% (-3.61%, 0.80%)</td>
</tr>
<tr>
<td>Women with HIV delivering at urban(^a) site</td>
<td>16.22%</td>
<td>-2.17%</td>
<td>(-7.88%, 3.55%)</td>
<td>-3.52% (-8.01%, 0.96%)</td>
</tr>
</tbody>
</table>

*Calculated as the difference between the change in each outcome from the pre-lockdown to lockdown periods in 2020 and the change in each outcome during the same two calendar periods in 2017-2019.

**Calculated as the difference between the change in each outcome from the pre-lockdown to post-lockdown periods in 2020 and the change in each outcome during the same two calendar periods in 2017-2019.

\(^a\)Gaborone and Francistown; \(^b\)All other delivery sites
FIGURE LEGEND

Figure 1. Heatmap showing 24-hour staying-put percentage by region in Botswana, February 28 – July 24, 2020.

Data source: Facebook via COVID-19 Mobility Data Network. Author: Magosi, Lerato E. https://github.com/magosil86
Data are the average number of Facebook users with location services turned-on that were present in the same 600x600 m grid location over a 24-hour period. Presence in the same location considered as GPS ping in at least three different time blocks of the day. Threshold: at least 300 unique users present. Baseline: Average number of people staying put during the month of February 2020.
Figure 2. Weekly risk of any adverse outcome (A) and any severe adverse outcome (B) over a 28-week period (January 3- July 16) in 2020 compared with the same period (January 2-July 16) in 2017-2019.

(A)

(B)

The yellow vertical lines show the lockdown period.
Appendix Table 1. Mean difference, risk difference and difference-in-differences (95% CI) of gestational age at delivery and birth at <34 weeks gestation during the pre-lockdown (January 1-April 2), lockdown (April 3-May 7), and post-lockdown (May 8-July 20) periods in 2020 and in the same calendar periods in 2017-2019.

<table>
<thead>
<tr>
<th></th>
<th>Pre-lockdown period (Jan 1-April 2)</th>
<th>Lockdown period (April 3-May 7)</th>
<th>Post-lockdown period (May 8-July 20)</th>
<th>Difference-in-differences (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Gestational age at delivery</strong></td>
<td>Mean, weeks</td>
<td>Mean, weeks</td>
<td>Mean, weeks</td>
<td>Lockdown vs. pre-lockdown*</td>
</tr>
<tr>
<td>2017-2019</td>
<td>38.33</td>
<td>38.36</td>
<td>38.38</td>
<td>0.10 (-0.09, 0.05) weeks</td>
</tr>
<tr>
<td>2020</td>
<td>38.32</td>
<td>38.43</td>
<td>38.49</td>
<td>0.08 (-0.03, 0.19) weeks</td>
</tr>
<tr>
<td>Difference, 2020 vs 2017-2019</td>
<td>-0.02 (-0.09, 0.05)</td>
<td>0.08 (-0.03, 0.19)</td>
<td>0.10 (0.03, 0.18)</td>
<td>0.10 (0.01, 0.19) weeks</td>
</tr>
<tr>
<td></td>
<td><strong>Birth &lt;34 weeks</strong></td>
<td></td>
<td></td>
<td>Post-lockdown vs. pre-lockdown**</td>
</tr>
<tr>
<td>2017-2019</td>
<td>6.21% (1,350/21,746)</td>
<td>5.85% (472/8,075)</td>
<td>5.56% (941/16,916)</td>
<td>0.49% (-1.12%, 0.17%)</td>
</tr>
<tr>
<td>2020</td>
<td>5.93% (553/9,332)</td>
<td>5.08% (175/3,448)</td>
<td>4.49% (312/6,942)</td>
<td>0.79% (-1.67%, 0.10%)</td>
</tr>
<tr>
<td>Difference, 2020 vs 2017-2019</td>
<td>-0.28% (-0.86%, 0.29%)</td>
<td>-0.77% (-1.66%, 0.12%)</td>
<td>-1.07% (-1.67%, -0.47%)</td>
<td>-0.49% (-1.12%, 0.17%)</td>
</tr>
</tbody>
</table>
Data source: Facebook via COVID-19 Mobility Data Network, Author: Magoni, Lerato E. https://github.com/magoni96
Any adverse outcome by week, 2020 versus 2017-2019

Lockdown from April 3 to May 7

- 2020
- 2017-2019
Any severe adverse outcome by week, 2020 versus 2017-2019

Risk (%)

Lockdown from April 3 to May 7

2020
2017-2019