

Initial COVID-19-related restrictions (lockdown) in 2020 and birth outcomes in Switzerland: an observational study based on statistics of outpatient midwifery services

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Summary

AIMS: Heterogeneous results regarding changes in the risk of preterm births and other perinatal outcomes during COVID-19-related restrictions (lockdowns) have been reported. We aimed to investigate the association between adverse birth outcomes and the initial COVID-19-related lockdown in Switzerland in 2020.

METHODS: We included singleton births recorded in the nationwide statistics of outpatient midwifery services in Switzerland (2018–2020). Using logistic regression, we estimated odds ratios (ORs) with 95% confidence intervals (CIs) for the risk of three birth outcomes between 16 March 2020 and 10 May 2020 (lockdown period) compared to any time between January 2018 and the start of the lockdown period. The outcomes of interest were preterm birth (<37 weeks), caesarean section and an Apgar score <7 at 5 minutes of age. Analyses were adjusted for calendar day and month and for geographical region. We conducted sensitivity analyses by geographic region.

RESULTS: Of 218,273 singleton births between January 2018 and December 2020, 5.3% were preterm births, 30.2% were caesarean sections and 2.2% resulted in a newborn with an Apgar score <7 at 5 minutes. The risk of preterm birth was slightly but not statistically significantly higher during the lockdown period in Switzerland (OR: 1.09, 95% CI: 0.97–1.22). This was driven by an OR for preterm birth of 2.05 (95% CI: 1.10–3.85) for the canton of Ticino, which accounted for most COVID-19 infections during this time, but with no meaningful change in risk of preterm birth in other regions of Switzerland. We did not observe any change in the proportion of caesarean sections during the lockdown period. The Switzerland-wide risk of a recorded Apgar score <7 at 5 minutes had an OR of 1.41 (95% CI: 1.19–1.69), again driven by the highest OR of 4.60 (95% CI: 1.70–12.34) in the canton of Ti-

cino as well as increased ORs in Geneva (2.40, 95% CI: 1.20–4.70) and Bern (2.84, 95% CI: 1.79–4.48).

CONCLUSIONS: The risk of birth outcomes remained unchanged during the first COVID-19 lockdown in 2020 in most parts of Switzerland. The cause of the observed increased risk of preterm birth in Ticino needs to be followed up, as sample size was small and a chance finding cannot be ruled out.

Introduction

Proportions of preterm birth and other perinatal outcomes during coronavirus disease of 2019 (COVID-19)-related restrictions (referred to as lockdowns) varied widely across countries. A nationwide Danish study reported 90% fewer extremely preterm births (gestational week [GW] ≤28) during the local lockdown between 12 March and 14 April 2020, when compared to the average proportion of extremely preterm births during the same time period in the previous five years [1]. Consequently, an abundance of methodologically heterogeneous studies from different countries reported anything from a strongly reduced [2–7] to an unchanged [8–10] up to an increased risk of preterm births [11]. In January 2023, the large International Perinatal Outcomes in the Pandemic (iPOP) study, which collected harmonised data from 26 countries (52 million births) between 2015 and 2020, was published [12]. Primary analyses included standardised population-based data from 18 countries and yielded a statistically significant 3–4% decrease in preterm births during the first three months of lockdown in high- and middle-income countries. However, this result was not confirmed in a subset of 486,357 included births from Switzerland (BEVNAT) [12] nor in an observational study using data from the birth registry of the Swiss Federal Statistical Office (FSO) as well as from the Swiss Neonatal Network and Follow-Up Group (Swiss-NeoNet) [13]. Potential mechanisms behind observed

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changes in the proportion of preterm births during COVID-19-related lockdowns are a reduction in infections, air pollution, or physical stress. However, a reduction in preterm births might signal a reduction in the quality of obstetric care of high-risk women [12].

Other perinatal endpoints, such as caesarean sections or neonatal Apgar scores, have not been investigated in Switzerland. A single-centre observational study at the maternity ward of a large hospital in Zurich, Switzerland, reported a decrease in the proportion of caesarean sections from 38% to 30% (similarly for planned and unplanned caesarean sections) during the first wave of the COVID-19 pandemic (1 March to 31 May 2020) when compared to the same time period in the two previous years [14]. However, studies based on single centres are prone to channelling bias. Studies evaluating the association between lockdowns in Switzerland and neonatal Apgar scores have not been conducted to date. Moreover, potential regional differences in birth outcomes during lockdowns have not been investigated, although different regions in Switzerland were differently affected during the first wave of COVID-19. We aimed to investigate the association between the first COVID-19-related lockdown in Switzerland (16 March to 10 May 2020, appendix table S1 [15–17]) and the proportion of different maternal and neonatal birth outcomes (preterm births, caesarean sections and Apgar scores <7 at 5 minutes) overall and within different regions of Switzerland using the nationwide statistics of outpatient midwifery services in Switzerland.

Materials and methods

Study design and data source

We conducted an observational study using anonymised data from the statistics of outpatient midwifery services in Switzerland. This data source was established in 2005 and has since been continuously developed. The statistics of outpatient midwifery services in Switzerland include information on all outpatient visits by a midwife in association with pregnancy, birth, and postpartum care of women in Switzerland [18]. The quality and completeness of the records has improved markedly since 2018, when it became mandatory for midwives to bill their provided services electronically. Data entered in the billing system are directly fed into the database, and there are several quality control measures in place during data entry (standardised variable format, feedback questions if values are outside the reference range) and processing (quality control checks and correction or deletion of implausible values). In 2020, 85,914 live births were registered in Switzerland and 83,715 women (>93%) were cared for by midwives during outpatient postpartum care. Mandatory health insurance covers between 10 and 16 outpatient postpartum visits by a midwife [18–21].

The statistics of outpatient midwifery services in Switzerland encompass anonymised information on demographics of the women, pregnancy- and birth-related records (gravidity, parity, multiple birth status, birth mode, birth place [hospital, birth centre, home]), child-related records (birth date, gestational week at birth, birthweight, Apgar scores), as well as number of visits, date of visit, type of visit (related to pregnancy, birth, or postpartum), frequently oc-

curing healthcare problems during the postpartum period (e.g. breastfeeding problems, depression, exhaustion of the mother, hyperbilirubinaemia of the newborn), and indications for (possible) hospital (re)admission of mother or child.

Study population

We included all births between 2018 and 2020 to women with at least one postpartum-related outpatient visit by a midwife. We excluded births of women whose birth year was inconsistently recorded or if ≥ 3 key variables (i.e. birth mode, birth year of the mother, gravidity, parity, multiple birth status, gestational age at birth, birthweight of the child, birth place, or all three Apgar scores i.e. at 1, 5 and 10 minutes) were lacking. We also excluded multiple births and miscarriages (births at gestational week <22 or birthweight <500 g). Midwives in Switzerland can choose between six different electronic billing systems; one of these does not reliably capture Apgar scores so we excluded all births billed via this system for analyses of Apgar scores ($n = 15,631$).

Outcomes

We evaluated three outcomes of interest: (1) *Preterm birth*: defined as a birth occurring <37 weeks of gestation and further subdivided into extremely preterm birth (<28 weeks of gestation), very preterm birth (28–31 weeks of gestation) or moderate/late preterm birth (32–36 weeks of gestation). The terms birth and post-term birth were defined, respectively, as births at 37–41 and ≥ 42 weeks of gestation [22]. We also stratified preterm births into births via caesarean section and vaginal births. (2) *Caesarean section birth*: overall and stratified into planned vs unplanned caesarean section, or unknown. (3) *Moderately reduced or low Apgar score at 5 minutes*: defined as an Apgar score <7. In an additional analysis, we further evaluated Apgar scores <7 at 10 minutes as well as low Apgar scores (<5) at 5 and 10 minutes separately. Apgar scores were introduced in the 1950s as a standardised way to evaluate infants shortly after birth. The score ranges from 0 to 10 and evaluates the newborn on five criteria each scored from 0 to 2: appearance (skin colour), pulse, grimace (reflexes / response to stimulus), activity (muscle tone) and respiration. In Switzerland, tests are given to the newborn at 1, 5, and 10 minutes after birth. Generally, Apgar scores 7–10 are considered normal, with scores <5 indicating that a newborn requires resuscitation. However, the ability of Apgar scores to predict clinical outcomes is limited and in clinical practice decisions about resuscitation are made before any Apgar test is given [23].

Statistical methods

We applied standard descriptive methods to document demographics and characteristics of the study population, stratified by year of birth, and compared these to the corresponding statistics of the Swiss Federal Office of Statistics. We also plotted proportions of all outcomes of interest per calendar week over time, separately for the years 2018, 2019, and 2020.

We conducted a logistic regression analysis to quantify changes in the proportion of outcomes (complete case

analyses) in association with the lockdown in Switzerland [24]. For this, we included data between the start of January 2018 and the end of the lockdown period in 2020. The lockdown period was defined as the 8-week period between 16 March and 10 May 2020 (table S1 displays restrictions in Switzerland).

The logistic regression models included an indicator variable for the time of the lockdown along with calendar day as a numerical trend variable, birth month and residential region of the mother (German-, French-, or Italian-speaking part of Switzerland, or unknown/international) as categorical variables.

To adjust for potential clustering due to mothers with more than one delivery in the observation period, the maternal identifier was treated as a cluster variable and robust variance estimates were used. Estimated effects of the lockdown are reported as odds ratios (ORs) with 95% confidence intervals (CIs). To address the uncertainty of a potential lag between the implementation of the lockdown and the studied outcomes, and the fact that the strict lockdown in Switzerland lasted only eight weeks (table S1 [16]), we ran two additional models extending and shortening the lockdown period to 6 and 10 weeks from 16 March 2020 for the three primary endpoints. We conducted sensitivity analyses by region of residence of the mother, i.e. Italian-speaking (Ticino), French-speaking, or German-speaking part of Switzerland. Because the German-speaking part of Switzerland is the largest part of the country, we also subdivided it into subregions (Northwest, Central, and Eastern Switzerland, as well as the cantons of Zurich and Bern). We further evaluated individual cantons with large university hospitals wherever sample size allowed; this was the case for Zurich, Bern, Geneva and Vaud (the latter two were also the cantons which, besides Ticino,

were most heavily affected by the first COVID-19 wave in spring 2020). The cantons of Basel City and Lucerne have university hospitals but the sample size was too small for individual analysis [25]. We also conducted a sensitivity analysis only including women with a recorded inpatient birth. We further conducted two sensitivity analyses for the outcome “moderate/low Apgar score at 5 minutes”, in which we excluded (1) all births <37 weeks of gestation because preterm birth and moderate/low Apgar score are likely collinear and (2) all births in 2018, as Apgar scores were recorded less reliably in these two subsamples. All analyses were conducted using SAS statistical software (version 9.4; SAS Institute, Cary, NC, USA).

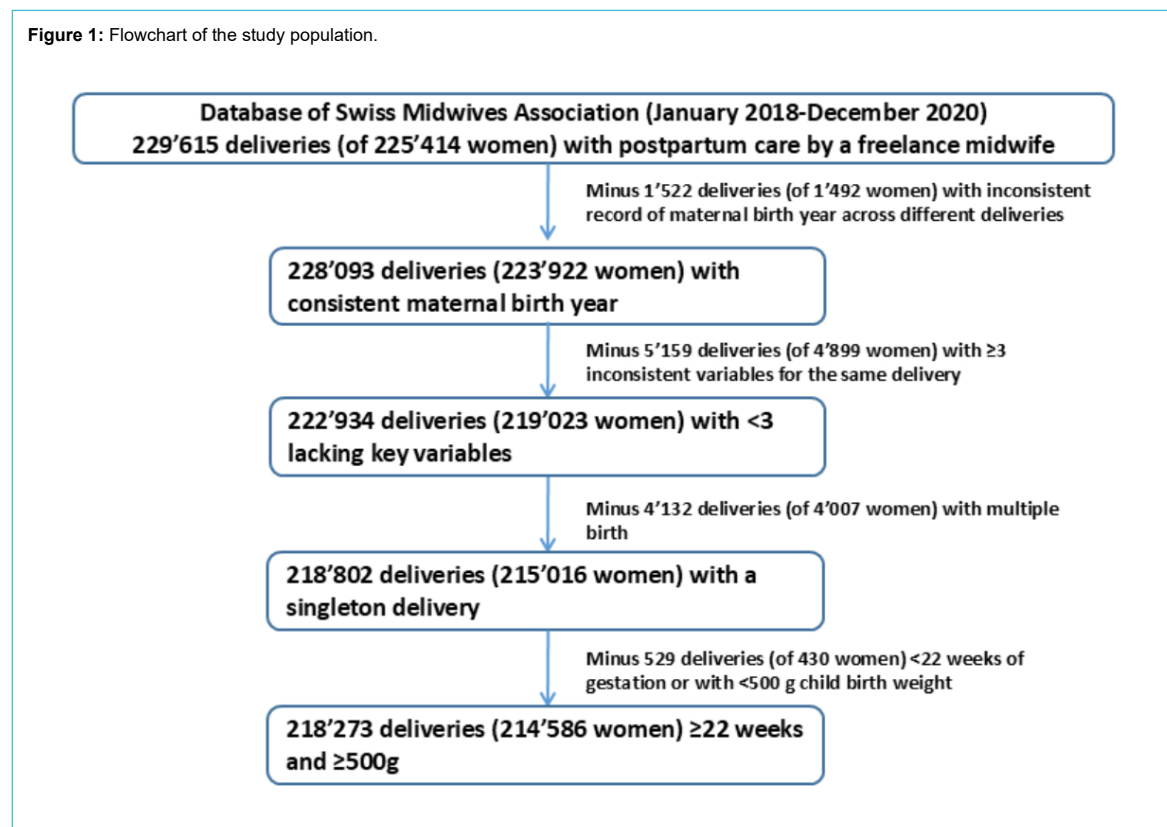
Results

Our final study population included 218,273 singleton births to 214,586 women between 2018 and 2020 (flowchart in figure 1).

The largest proportion of women were aged 31–35 years when they gave birth (39.9%), and half of all births were a first-time birth (49.6%). Of all singleton newborns with recorded information on gestational age at birth (92.8%), 5.3% were born preterm (4.5% moderate/late preterm). In total, 30.2% of infants were born via caesarean section. Between 2018 and 2020, slightly more infants were born in the summer and autumn (51.5% between June and November) than in winter and spring (48.5%, table 1).

Our study population was comparable to data of the Swiss Federal Statistical Office regarding the average age of women giving birth and the percentage of preterm births in different subgroups (appendix table S2). The percentage of neonates who were born prematurely between 2018 and 2020 was lower in the statistics of outpatient midwifery

Figure 1: Flowchart of the study population.



services in Switzerland than in the data of the Swiss Federal Statistical Office, which is likely explained by the fact that our study population excluded multiple births, whereas multiples were included in the Federal Statistical Office dataset.

Results of the logistic regression analyses are shown in figures 2A–2D and in appendix table S3. The lockdown in Switzerland was associated with a slight but not statistically significant increase in the proportion of preterm births during the 8-week lockdown period in Switzerland (OR: 1.09, 95% CI: 0.96–1.23), which became larger and statistically significant when the lockdown period was ex-

tended to 10 weeks (OR: 1.12, 95% CI: 1.01–1.25). After stratification by region, we observed a statistically significantly increased OR for preterm birth of 2.05 (95% CI: 1.10–3.85) during the lockdown period in the canton of Ticino, but not in any other region/canton of Switzerland (figure 2B, table S3). Figures 3–5 and appendix figure S1 graphically display the weekly proportion of the primary endpoints over time in 2018, 2019, and 2020.

We did not observe an association between the lockdown period and the proportion of caesarean sections overall and after stratification into planned and unplanned caesarean sections (figures 2A and 2C, figure 4, table S3). This was

Table 1:
Characteristics of women who received postpartum care by a midwife in Switzerland (2018–2020).

		2018	2019	2020	Total
Number of births		75,909	70,770	71,594	218,273
Number of women		75,738	70,583	71,422	214,586*
Maternal age at birth, n (%)	≤20 years	562 (0.7)	449 (0.6)	411 (0.6)	1422 (0.7)
	21–25 years	5355 (7.1)	4890 (6.9)	4676 (6.5)	14,921 (6.8)
	26–30 years	19,573 (25.8)	18,069 (25.5)	18,629 (26.0)	56,271 (25.8)
	31–35 years	29,711 (39.1)	28,335 (40.0)	28,884 (40.3)	86,930 (39.8)
	36–40 years	16,774 (22.1)	15,739 (22.2)	15,882 (22.2)	48,395 (22.2)
	41–45 years	3220 (4.2)	2948 (4.2)	2872 (4.0)	9040 (4.1)
	≥46 years	249 (0.3)	251 (0.4)	228 (0.3)	728 (0.3)
	Unknown	465 (0.6)	89 (0.1)	12 (0.0)	566 (0.3)
Gestational age at birth, n (%)	Extremely preterm (<28 weeks)	198 (0.3)	212 (0.4)	217 (0.3)	627 (0.3)
	Very preterm (28–31 weeks)	303 (0.4)	251 (0.4)	265 (0.4)	819 (0.4)
	Moderate/late preterm (32–36 weeks)	3611 (4.8)	2807 (4.0)	2788 (3.9)	9206 (4.2)
	Term (37–41 weeks)	70,445 (92.8)	58,840 (83.1)	61,245 (85.5)	190,530 (87.3)
	Post-term (≥42 weeks)	477 (0.6)	424 (0.6)	440 (0.6)	1341 (0.6)
	Unknown**	875 (1.1)	8236 (11.6)	6639 (9.3)	15,750 (7.2)
Apgar score at 5 minutes***, median (IQR)		9 (9–10)	9 (9–10)	9 (9–10)	9 (9–10)
Apgar score at 5 minutes***, n (%)	Apgar <7	1319 (1.8)	1142 (1.8)	1426 (2.2)	3887 (1.9)
	Apgar ≥7	60,251 (80.3)	57,326 (91.6)	58,926 (90.7)	176,503 (87.1)
	Missing	13,513 (18.0)	4095 (6.6)	4644 (7.2)	22,252 (11.0)
Birth mode, n (%)	Vaginal	52,367 (69.0)	48,826 (69.0)	48,964 (68.4)	150,157 (68.8)
	Caesarean section planned	11,729 (15.5)	11,021 (15.6)	11,325 (15.8)	34,075 (15.6)
	Caesarean section unplanned	10,928 (14.4)	9889 (14.0)	10,098 (14.1)	30,915 (14.2)
	Unknown	885 (1.2)	1034 (1.5)	1207 (1.7)	3126 (1.4)
Parity, n (%)	1	38,005 (50.1)	34,986 (49.4)	35,238 (49.2)	108,229 (49.6)
	≥2	37,683 (49.6)	35,701 (50.5)	36,280 (50.7)	109,664 (50.2)
	Unknown	221 (0.3)	83 (0.1)	76 (0.1)	380 (0.2)
Place of birth#, n (%)	Hospital	–	58,544 (82.7)	61,743 (86.2)	120,287 (84.5) (84.5)
	Home	–	792 (1.1)	947 (1.3)	1739 (1.2)
	Birth house	–	1861 (2.6)	1788 (2.5)	3649 (2.6)
	Other	–	367 (0.5)	408 (0.6)	775 (0.5)
	Missing	–	9206 (13.0)	6708 (9.4)	15,914 (11.2)
Place of birth during lockdown##, n (%)	Hospital	–	6704 (84.3)	6877 (85.5)	13,581 (84.9)
	Home	–	89 (1.1)	140 (1.7)	229 (1.4)
	Birth house	–	208 (2.6)	222 (2.8)	430 (2.7)
	Other	–	36 (0.5)	48 (0.6)	84 (0.5)
	Missing	–	915 (11.5)	756 (9.4)	1671 (10.5)
Season at birth, n (%)	Winter (Dec/Jan/Feb)	19,253 (25.4)	16,881 (23.9)	16,451 (23.0)	52,585 (24.1)
	Spring (Mar/Apr/May)	17,052 (22.5)	17,879 (25.3)	18,299 (25.6)	53,230 (24.4)
	Summer (Jun/Jul/Aug)	19,212 (25.3)	18,742 (26.5)	19,047 (26.6)	57,001 (26.1)
	Autumn (Sept/Oct/Nov)	20,392 (26.9)	17,268 (24.4)	17,797 (24.9)	55,457 (25.4)

* Some women gave birth multiple times during the 3-year study period, which is why the total number of individual women does not equal the sum of individual women of the three individual calendar years.

** Changes in the proportion of missing values between calendar years are due to changes in the billing software. The main provider made gestational age a non-compulsory variable after 2018.

*** 15,631 births excluded because they were billed via a billing system that does not reliably record Apgar scores.

Place of birth was not well captured in 2018.

Between 17 March 2019/2020 and 26 April 2019/2020.

true for Switzerland overall and after stratification by region.

Figure 5 shows a slightly higher proportion of newborns with a moderately reduced or low Apgar score (<7) at 5 minutes of age during the lockdown (calendar weeks 12–17) compared to the same period in 2018/2019. Logistic regression analysis (figure 2A and table S3) revealed a statistically significantly increased risk of an Apgar score <7 at 5 minutes during the lockdown period (OR: 1.41, 95% CI: 1.19–1.69). These results were robust to a shortening and lengthening of the lockdown period to 6 and 10 weeks, as well as in two sensitivity analyses (table S3), in which we excluded (1) preterm infants born <37 weeks of gestation and (2) all births in 2018. The corresponding association was stronger for Apgar scores at 10 minutes of age (OR: 1.94, 95% CI: 1.46–2.59, table S3 and appendix figure S2). Furthermore, proportions of newborns with a low Apgar score (<5) at 5 minutes and 10 minutes of age during the lockdown period were also increased, resulting in ORs of 1.58 (95% CI: 1.17–2.15) and 1.89 (95% CI: 1.24–2.86, table S3).

During the lockdown period, the risk of a 5-minute Apgar score <7 was strongly increased in the canton of Ticino with an OR of 4.60 (95% CI: 1.70–12.34), but the sample size was small (figure 2D, table S3). In the German-speak-

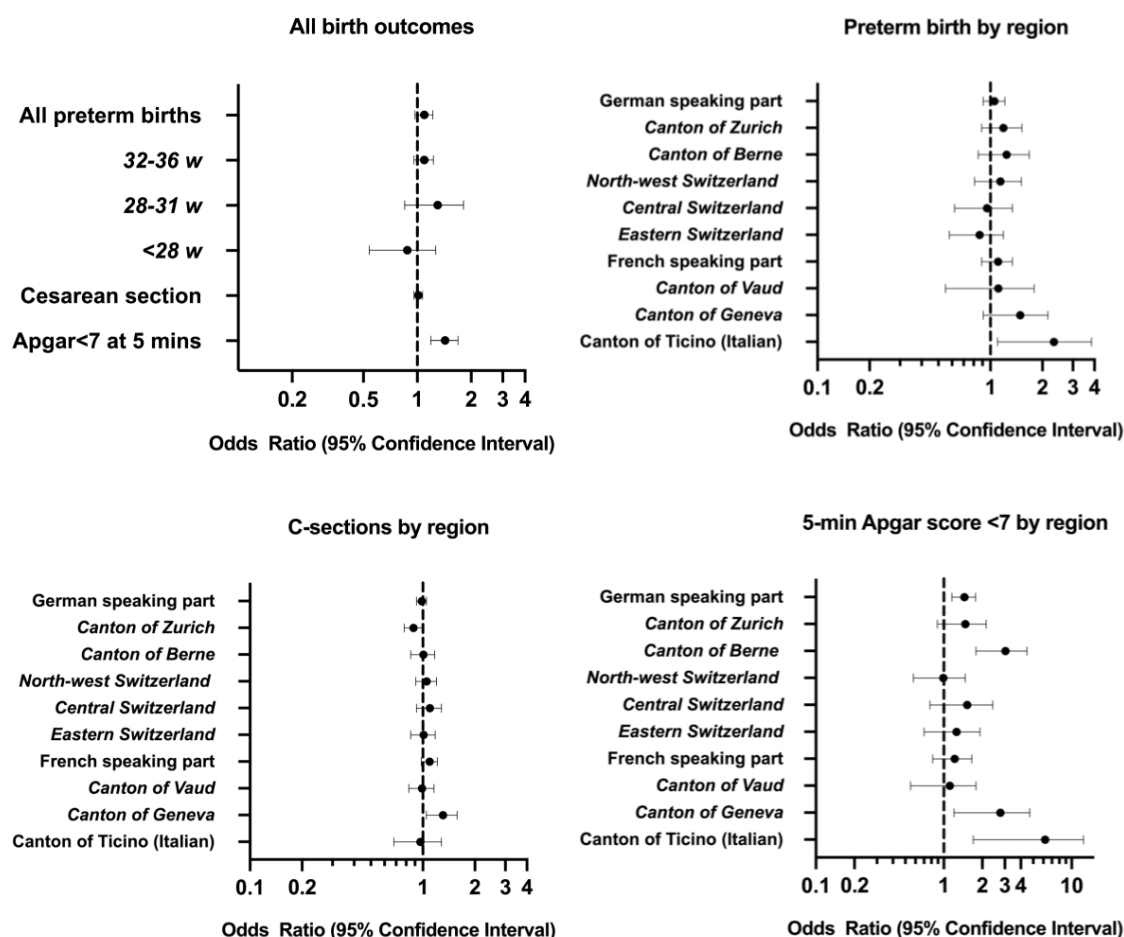
ing part of Switzerland, we observed an OR of 1.43 (95% CI: 1.16–1.77), which was driven by increased ORs in the canton of Bern (OR: 2.84, 95% CI: 1.79–4.48) whereas ORs were not meaningfully changed in other German-speaking parts of Switzerland. In the French-speaking part of Switzerland, an increased risk for a 5-minute Apgar score <7 was observed for the canton of Geneva (OR: 2.40, 95% CI: 1.20–4.70, table S3).

The proportion of missing Apgar scores did not differ between the lockdown period from 16 March 2020 to 10 May 2020 (15.8%) and the entire calendar year of 2020 (15.6%). Also, the monthly proportion of all women who received postpartum outpatient midwife care of all women who gave birth did not differ during the lockdown period compared to the baseline period in all of Switzerland or in Ticino specifically (data not shown).

Discussion

This nationwide observational study included over 85% of all singleton births in Switzerland between 2018 and 2020. We did not observe a sizeable country-wide change in the incidence of adverse birth outcomes during the COVID-19-related lockdown between 16 March and 10 May 2020. However, in the canton of Ticino, we observed a 2-fold increase in the risk of preterm birth (<37 weeks)

Figure 2: (A) Odds ratios for the risk of adverse birth outcomes during the first COVID-19-related lockdown in 2020 in Switzerland. (B) Odds ratios for the risk of preterm birth during the first COVID-19-related lockdown in 2020 stratified by region. (C) Odds ratios for the risk of a caesarean section during the first COVID-19-related lockdown in 2020 stratified by region. (D) Odds ratios for the risk of an Apgar score <7 at 5 minutes of age during the first COVID-19-related lockdown in 2020 stratified by region.



and a 4.6-fold increase in the proportion of newborns with an Apgar score <7 at 5 minutes during the lockdown period in 2020. The canton of Ticino borders northern Italy and had the highest number of COVID-19 infections during this time, but the increased risks are based on a small sample size [25]. Preterm births were not increased in other regions of Switzerland, whereas Apgar scores <7 were also more frequent in Bern (2.8-fold) and Geneva (2.4-fold). Caesarean sections were not increased during the lockdown.

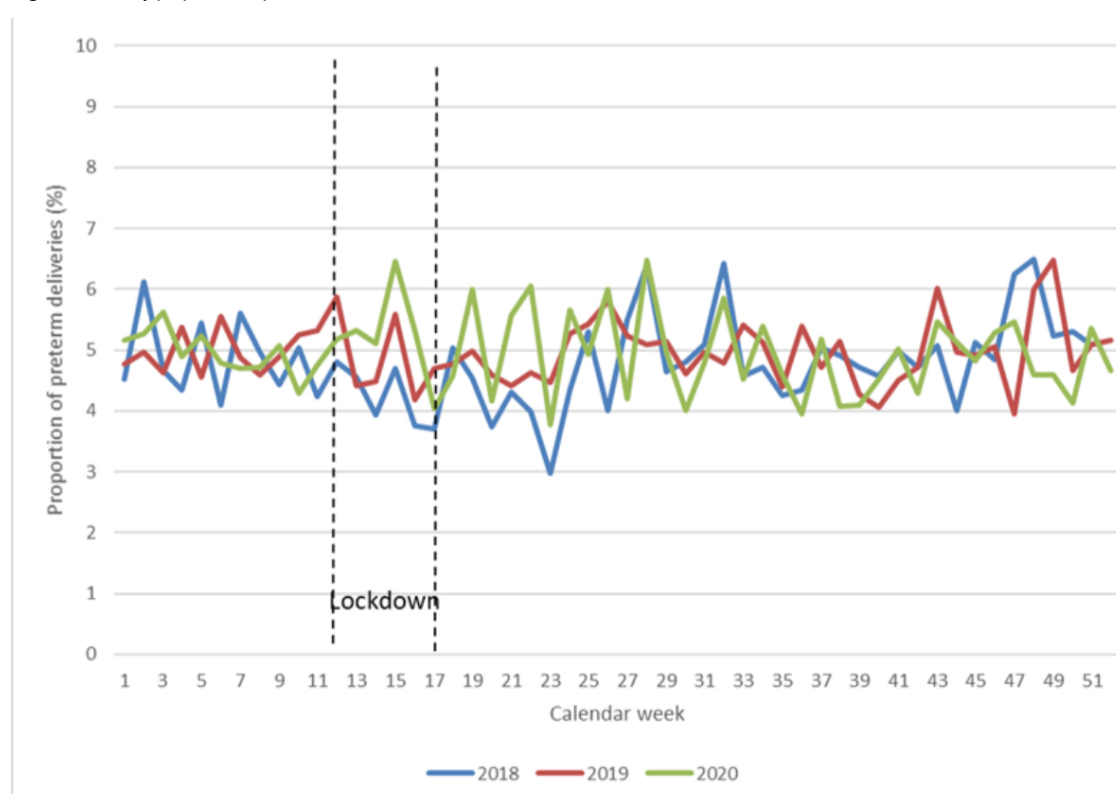
Preterm birth has been the most studied birth outcome in association with lockdowns in different countries, with varying results. Many studies reported a decreased risk of preterm birth during lockdowns, but they were based on non-representative data from selected hospitals and thus likely skewed, as high-risk births may have been unequally distributed across clinics [2–6, 9].

The international iPOP study evaluated harmonised data from 26 countries (52 million births) between 2015 and 2020. In total, 98.6% of all births originated from 18 population-based datasets from different countries/regions [12]. Results differed between population-based studies vs studies from single treatment centres or other non-population-based data sources. The iPOP study quantified a statistically significant 3–4% decrease in preterm births during the first three months of lockdown among representative data of high-income countries, including 486,357 births from Switzerland (BEVNAT). This reduced overall proportion of preterm births was driven by a large number of births (>20 million) from the US, whereas no association between preterm birth and the lockdown was observed in Switzerland and in most other high-income countries included [12]. Another large Scandinavian study also yield-

ed no change in the proportion of preterm births during the initial COVID-19 lockdown in Denmark, Sweden, and Norway [26].

Our study confirmed the absence of a sizeable overall change in the risk of preterm birth in Switzerland during the first COVID-19 lockdown. However, we observed a doubling of the risk of preterm birth (<37 weeks) in the canton of Ticino, which borders northern Italy, where the number of COVID-19 infections was highest during the first wave of COVID-19 in 2020 [25]. It is possible that COVID-19 infections in pregnant women may account for some preterm births [27]. However, the number of pregnant women infected with COVID-19 during the early pandemic remains unknown, and COVID-19 infections are not captured in this dataset [28]. Moreover, a study from northern Italy reported a decreased risk of preterm birth during the first year of the COVID-19 pandemic [7]. Another possibility is that pregnant women may have been reluctant to seek medical care, and impending preterm births might have been attended to later than usual. It is also possible that other changes in the provision of healthcare during this time led to this increase. Third, a change in the proportion of preterm births may be related to an inverse change in the number of stillbirths, as medical interventions to induce birth early are often implemented when a woman is at risk of stillbirth. Stillbirths are not reliably captured in the Swiss statistics of independent midwives. The number of stillbirths in Switzerland was low, between 3.7 and 4.3 per 1000 births in 2018–2020 [29], and the iPOP study showed no statistically significant change in monthly stillbirths during the lockdown period in Switzerland [12]. However, we are unable to analyse any association between the lockdown and the proportion of still-

Figure 3: Weekly proportion of preterm births between 2018 and 2020 in Switzerland.



births in Switzerland or in Ticino specifically. Finally, the increased proportion of preterm births in Ticino is based on a small number of women who gave birth during the lockdown in this canton ($n = 217$), and a chance finding cannot

Figure 4: Weekly proportion of caesarean sections between 2018 and 2020 in Switzerland.

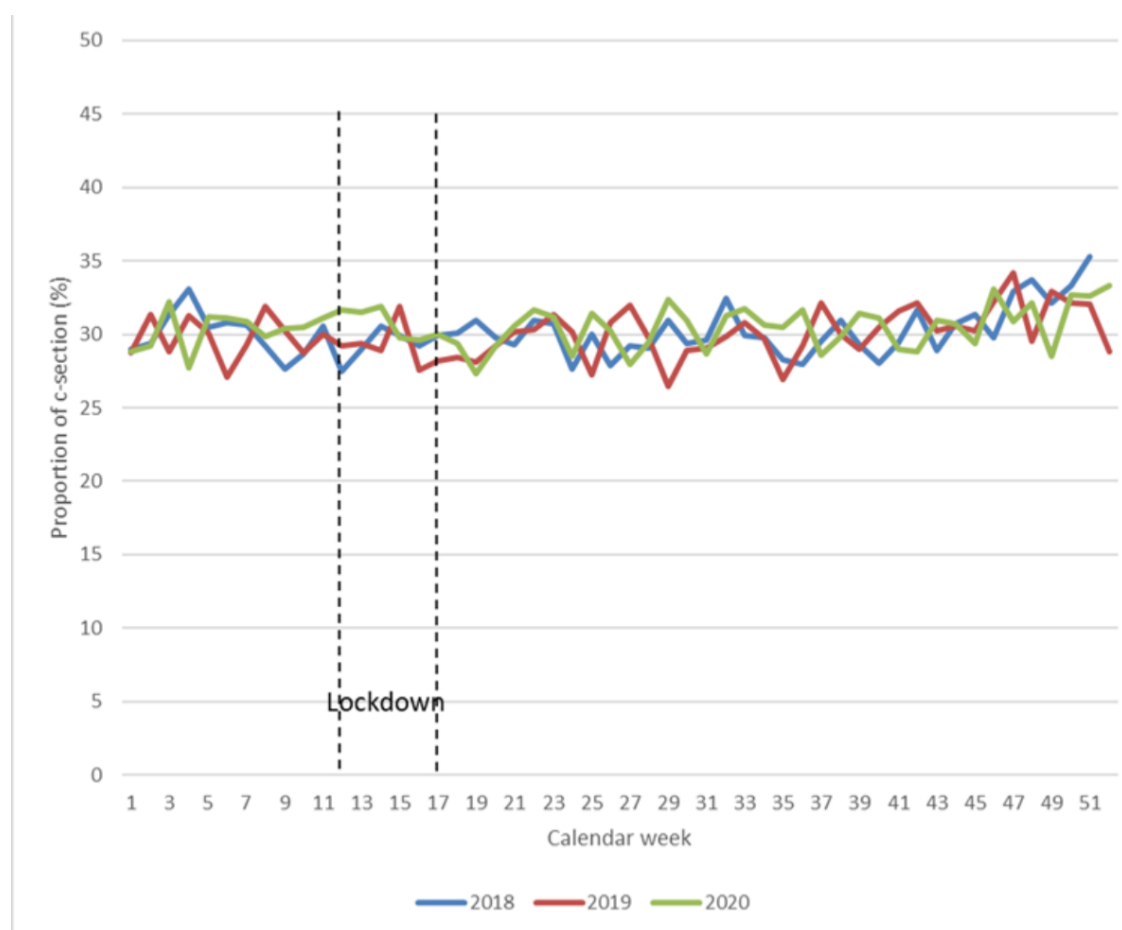
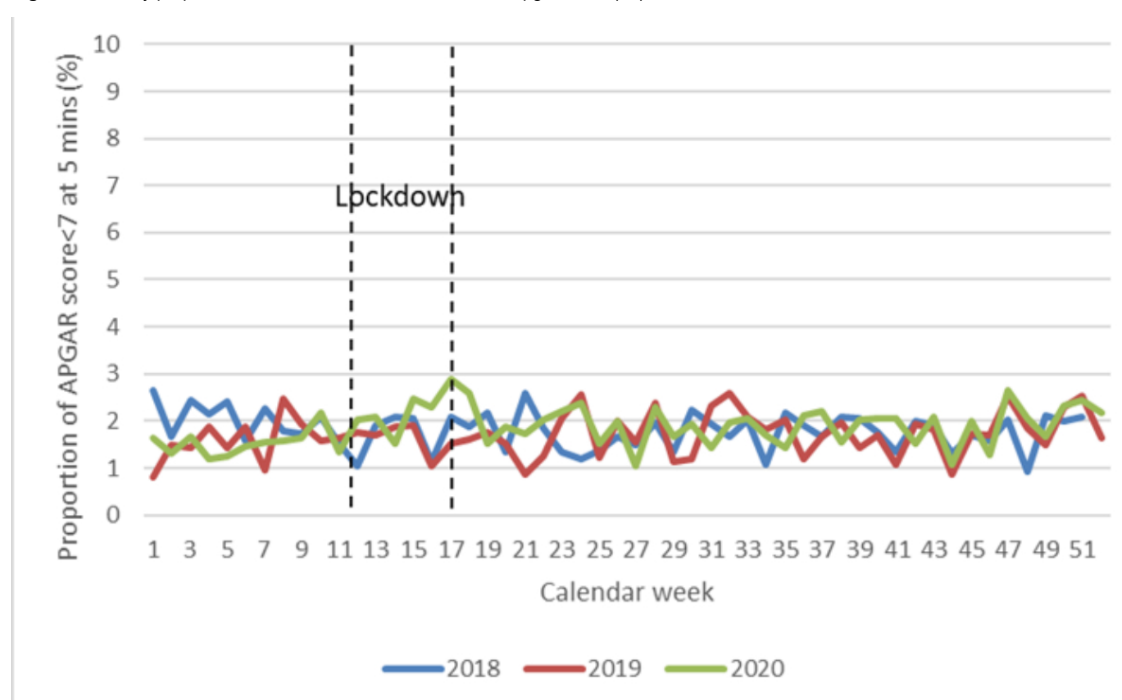


Figure 5: Weekly proportion of newborns with a moderate/low Apgar score (<7) at 5 minutes between 2018 and 2020 in Switzerland.



be ruled out. Further studies are needed to verify this result and to get to the bottom of the cause for this association.

The association between local lockdowns and the risks of maternal and neonatal birth outcomes might differ by country and even by region, depending on the stringency of the lockdown, the infectious burden of COVID-19, or other aspects pertinent to local healthcare systems. Compared to other countries, the nationwide lockdown, which started on 16 March in Switzerland, was rather “mild” (table S1) [17], and the number of infections remained relatively low during the first wave of COVID-19 [28]. Hospitals in most regions of the country never surpassed their capacity limits, and overall recorded fewer hospitalisations compared to previous years due to cancelled interventions [30]. However, the number of COVID-19 infections varied between different regions in Switzerland, with Ticino accounting for the proportionally highest number of COVID-19 infections and declaring a state of emergency with additional restrictions on 11 March 2020, before the rest of Switzerland [25, 31]. It is therefore important to evaluate potential public health impacts of lockdowns at a national or even regional level. Thus, our results are specific to Switzerland and may not be generalisable to other countries.

We did not observe a change in the proportion of planned or unplanned caesarean sections in Switzerland (approx. 1/3 births) overall or within the German-, French-, or Italian-speaking parts separately during the initial COVID-19 lockdown. We hypothesised that fear of high numbers of COVID-19 cases may have affected planning of elective caesarean sections, whereas an increase in birth complications could have increased secondary caesarean sections, but our results suggest that this was not the case. Our finding is in line with a nationwide study from England [32]. On the other hand, a study from Iceland reported a 32% decrease in planned caesarean sections during COVID-19 lockdowns [33], highlighting how differently healthcare systems reacted to lockdowns, and that in some countries elective caesarean sections were performed less frequently whereas in others this was not the case. A nationwide study from Iran even reported a 2% increase in the proportion of caesarean sections during the first wave of the COVID-19 pandemic compared to previous years [34]. A previous observational study at a large city hospital in Zurich reported an 8% reduction in planned and unplanned caesarean sections, which may have been due to channelling of pregnant women or by changes in the management of births at this hospital. The authors did report some relatively small changes in the demographic characteristics of pregnant women and a slight increase in the proportion of birth inductions (29.3% vs 26.9%) during the lockdown vs 2018/2019 [14]. Of note, great regional differences exist in the proportion of caesarean sections across Switzerland, with proportions between 13% and 53% at the municipality level [35].

Finally, we observed an increased proportion of moderately reduced/low Apgar scores (<7) at 5 minutes of age during the lockdown for the cantons of Ticino (4.6-fold), Geneva (2.4-fold) and Bern (2.8-fold), but no meaningful change for the rest of Switzerland. Interestingly, after Ticino, Geneva was the canton with the second highest infection numbers during the first wave of COVID-19 [28]. This regional distribution of changes in Apgar scores suggests

that our results are not pure chance findings. Several mechanisms may explain these findings; it is possible that there might have been changes in the quality of neonatal healthcare right after birth in regions/healthcare facilities highly affected by COVID-19. Furthermore, it is possible that COVID-19 infections in pregnant women may have led to reduced Apgar scores. However, changes in staff or routines during the lockdown may have led to inconsistencies in the recording of lower Apgar scores in some cases. It is a known problem that Apgar scores are not an exact measure and are subject to large inter-rater variability and subjectivity. Moreover, despite their common use, their ability to predict clinical outcomes is limited [23]. Thus, these results have to be interpreted cautiously [36]. Moreover, the absolute excess number of newborns with moderately reduced or low Apgar scores during the lockdown vs 2018/2019 was small.

This study is based on a nationwide database. A prior validation study has shown that all outcomes of interest in this study are reliably captured in the database (table S2). Nevertheless, certain limitations need to be considered. First, we did not have information on COVID-19 infections, which are an individual risk factor for birth complications [12]. Second, we did not have information available on the actual birth facility or the attending midwife/physician, and we therefore cannot infer upon differences in risk by specific birth facilities. Third, we only had data between 2018 and 2020 available. Having more pre-pandemic years available would have made analyses more robust. Fourth, it is possible that women left the hospital earlier and that more women who would otherwise have remained hospitalised may have received postpartum outpatient midwife care instead. On the other hand, it is possible that women may have decided not to see a midwife in their home due to fear of infection. However, the monthly proportion of women with postpartum midwife care remained stable when comparing before vs during the lockdown in Switzerland overall and in Ticino specifically. Thus, our results are unlikely altered due to increased or decreased midwife care of women with preterm births or other complications during the lockdown period. However, the statistics of outpatient midwifery services may not cover some women with severe birth complications who remain hospitalised for an extended period of time, and thus our results may not be generalisable to these women. Fifth, other maternal outcomes, which would have been of interest, such as psychological or lactation problems during the postpartum period, are not reliably captured in the database. Finally, we did not evaluate the course of birth outcomes after the first lockdown. It is possible that the risk of certain birth outcomes changed during the second lockdown in late 2020, and future studies should evaluate these associations.

Conclusion

This observational study included over 85% of all births in Switzerland between 2018 and 2020. Our results suggest no change in the risk of preterm birth, caesarean section, or reduced Apgar scores at 5 minutes during the first COVID-19 lockdown in Switzerland in 2020. Increased risks of preterm birth during the lockdown were recorded in the canton of Ticino, which borders northern Italy, and

was the region with the highest COVID-19 burden in Switzerland during that time. However, the absolute number of infants born in Ticino during this time was small and a chance finding cannot be ruled out.

Data sharing statement

The study data belong to the Swiss Federation of Midwives. Access and/or use is only possible under contractually agreed conditions.

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Potential competing interests

All authors have completed and submitted the International Committee of Medical Journal Editors form for disclosure of potential conflicts of interest. No potential conflict of interest related to the content of this manuscript was disclosed.

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Appendix

Table S1: Summary of initial Covid-19 mitigation measures in Switzerland in 2020 [1]

Date	Mitigation measures
28. February	Ban of events >1000 persons
4. March	Recommendations on hygiene and social distancing
13. March	- Ban of events >100 persons (>50 in restaurants, bars and clubs) - School closure - Restrictions on border crossings
16. March	- Closure of shops, markets, restaurants, bars, entertainment and leisure establishments (except grocery shops, healthcare facilities, postal service) - Restrictions in public transport - Restriction of hospitals and medical practices to only conduct urgent interventions - Further restrictions on border crossings
20. March	Ban of events >5 persons
Date	Ease of mitigation measures
27. April	- Abolishment of restrictions for hospitals and medical practices - Re-opening of some non-essential shops and leisure establishments
11. Mai	- Re-opening of all shops, restaurants and further leisure establishments - Re-opening of primary and secondary schools - First ease of restrictions in border crossings - Public transport normalized
6. June	- Events with up to 300 persons allowed - Re-opening of vocational schools, universities and entertainment and leisure establishments

Table S2: Comparison of our dataset for analyses of the statistics of outpatient midwifery services in Switzerland with data of the Swiss Federal Statistical Office (FSO)

	2018		2019		2020	
	SSFM	FSO	SSFM	FSO	SSFM	FSO
(Live) Births, N^a	75'909	87'851 [2]	70'770	86'172 [2]	71'594	85'914 [2]
Women cared for after birth by freelance midwives, N	75'738	NA	70'583	NA	71'422	NA
Average age of mother at birth in years	32.5 [3] ^b	32.0 [4]	32.6 [3] ^b	32.1 [4]	32.6 [3] ^b	32.2 [4]
Gestational age in weeks, %						
22-27	0.3	0.4 [5]	0.4	0.3 [5]	0.3	0.4
28-31	0.4	0.6 [5]	0.4	0.6 [5]	0.4	0.6
32-36	4.8	6.0 [5]	4.0	5.8 [5]	3.9	5.4
37-41	92.8	92.4 [5]	83.1	92.7 [5]	85.5	93.1
>41	0.6	0.6 [5]	0.6	0.6 [5]	0.6	0.6 [5]
missing	1.1	NA	11.6 ^c	NA	9.3 ^c	NA
Birth by Caesarian section, %	30.3	NA	29.6	32.0 [6]	29.9	32.6 [6]

Abbreviations: SSFM, Swiss Statistics of Freelance Midwives; FSO, Federal Statistical Office; SD, standard deviation; NA, not available.

^a The SSFM included live births and still births whereas the FSO data included only live births. Between 2018 and 2020 between 3.7 and 4.3 newborns / 1000 births were born stillborn.[7] Furthermore the statistics of outpatient midwifery services in Switzerland excluded multiple births whereas these were included in the FSO. Between 2018 and 2020 between 3.1% and 3.7% of live births in Switzerland were multiples.[8]

^b Given that maternal age at delivery was provided to the researchers in 5-year categories due to confidentiality reasons, the here provided mean age was extracted from the yearly report of statistics of outpatient midwifery services in Switzerland and includes multiple births [9]

^c Given the data of gestational age in weeks of 2018 in the Swiss statistics of independent midwives, we assume that most missing values of gestational age in weeks in 2019 and 2020 correspond to term births.

Table S3: Comparison of the risk of preterm birth, Cesarean-section, and Apgar score between the lockdown period in 2020 (March 16 2020--May 10 2020) and the corresponding time periods in 2019 & 2018 (proportions and adjusted odds ratios)

Outcome	Duration of lockdown period	Events during lockdown 2020 n (%)	Events during same time period 2018/19 n (%)	Adjusted OR	95% CI	
Preterm overall (<37 weeks)						
	10 weeks	673 (5.3)	1407 (5.1)	1.12	1.01	1.25
	8 weeks	521 (5.2)	1037 (5.2)	1.09	0.97	1.22
	6 weeks	381 (5.2)	741 (5.1)	1.09	0.96	1.25
Moderate/late preterm (32-36 weeks)						
	10 weeks	557 (4.4)	1201 (4.4)	1.12	1.00	1.26
	8 weeks	433 (4.3)	895 (4.5)	1.09	0.96	1.23
	6 weeks	314 (4.3)	647 (4.5)	1.07	0.93	1.23
Very preterm (28-31 weeks)						
	10 weeks	70 (0.6)	114 (0.4)	1.29	0.91	1.83
	8 weeks	52 (0.5)	76 (0.4)	1.24	0.85	1.81
	6 weeks	36 (0.5)	54 (0.4)	1.20	0.77	1.85
Extremely preterm (<28 weeks)						
	10 weeks	46 (0.4)	92 (0.3)	0.83	0.55	1.25
	8 weeks	36 (0.4)	66 (0.3)	0.83	0.54	1.27
	6 weeks	31 (0.4)	40 (0.30.3)	1.13	0.71	1.79
C-sections (planned and unplanned)						
	10 weeks	4129 (29.6)	8516 (29.2)	1.02	0.97	1.08
	8 weeks	3258 (29.3)	6156 (29.0)	1.01	0.96	1.07
	6 weeks	2429 (30.2)	4440 (28.9)	1.05	0.99	1.11
APGAR score <7 at 5 mins						
	10 weeks	239 (2.1)	389 (1.7)	1.33	1.11	1.61
	8 weeks	245 (2.6)	342 (2.0)	1.41	1.19	1.69
	6 weeks	168 (2.5)	238 (1.9)	1.44	1.17	1.76
Sensitivity Analyses						
Planned c-section	8 weeks	1793 (16.2)	3230 (15.2)	1.06	0.99	1.13
Unplanned C-section sections	8 weeks	1465 (13.2)	2926 (13.8)	0.96	0.89	1.03
Preterm c- section	8 weeks	267 (2.7)	500 (2.5)	1.13	0.96	1.33
Preterm vaginal delivery	8 weeks	254 (2.5)	537 (2.7)	1.04	0.89	1.22
Apgar <7 at 10 min	8 weeks	109 (1.2)	89 (0.5)	1.94	1.46	2.59
Apgar <5 at 5 mins	8 weeks	93 (1.0)	85 (0.5)	1.58	1.17	2.15
Apgar < 5 at 10 mins	8 weeks	58 (0.6)	32 (0.2)	1.89	1.24	2.86
Excluding women with delivery <37 GW						
Apgar <7 at 5 mins	8 weeks	185 (2.1)	271 (2.1)	1.34	1.10	1.64
Apgar <7 at 10 mins	8 weeks	73 (0.8)	68 (0.4)	1.89	1.34	2.67
Excluding deliveries in 2018						
Apgar <7 at 5 mins	8 weeks	245 (2.6)	342 (2.0)	1.41	1.19	1.69
Canton Ticino only (Italian speaking part)						
Preterm <37 weeks	8 weeks	22 (7.4)	25 (4.3)	2.05	1.10	3.85

C-section	8 weeks	92 (29.6)	166 (27.6)	0.94	0.68	1.28
Apgar <7 at 5 mins	8 weeks	12 (4.3)	5 (0.9)	4.60	1.70	12.34
Apgar <7 at 10 mins	8 weeks	3 (1.1)	2 (0.4)	NA	NA	NA
French speaking part only						
Preterm <37 weeks	8 weeks	161 (5.4)	301 (5.0)	1.09	0.89	1.34
C-section	8 weeks	823 (26.3)	1580 (25.6)	1.09	0.98	1.21
Apgar <7 at 5 mins	8 weeks	54 (2.0)	94 (1.7)	1.17	0.82	1.66
Apgar <7 at 10 mins	8 weeks	24 (0.9)	16 (0.3)	2.18	1.18	4.03
German speaking part of Switzerland only						
Preterm <37 weeks	8 weeks	333 (5.0)	696 (5.3)	1.05	0.91	1.21
C-section	8 weeks	2310 (30.6)	4334 (30.5)	0.99	0.92	1.05
Apgar <7 at 5 mins	8 weeks	176 (2.8)	237 (2.1)	1.43	1.16	1.77
Apgar <7 at 10 mins	8 weeks	81 (1.3)	71 (0.6)	1.87	1.34	2.62
French speaking sub-regions / cantons						
Vaud Preterm <37 weeks	8 weeks	57 (4.9)	95 (4.2)	1.07	0.76	1.50
Vaud C-section	8 weeks	320 (26.7)	611 (26.7)	0.98	0.83	1.16
Vaud Apgar <7 at 5 mins	8 weeks	18 (1.7)	36 (1.8)	1.00	0.55	1.79
Geneva Preterm <37 weeks	8 weeks	41 (5.7)	72 (5.1)	1.40	0.91	2.15
Geneva C-section	8 weeks	221 (29.9)	387 (27.4)	1.29	1.05	1.58
Geneva Apgar <7 at 5 mins	8 weeks	22 (3.6)	21 (1.7)	2.40	1.20	4.70
German speaking sub-regions / cantons						
Zurich preterm <37 weeks	8 weeks	97 (5.4)	191 (5.1)	1.16	0.89	1.52
Zurich C-section	8 weeks	667 (32.8)	1369 (33.8)	0.88	0.78	0.99
Zurich Apgar <7 at 5 mins	8 weeks	37 (2.2)	66 (2.1)	1.38	0.89	2.15
Berne preterm <37 weeks	8 weeks	63 (5.8)	122 (5.5)	1.20	0.85	1.68
Berne C-section	8 weeks	378 (29.9)	718 (29.5)	1.00	0.85	1.17
Berne Apgar <7 at 5 mins	8 weeks	44 (4.5)	44 (2.3)	2.84	1.79	4.48
Northwest Switzerland ^a preterm <37 weeks	8 weeks	71 (4.7)	144 (5.1)	1.11	0.81	1.51
Northwest Switzerland ^a C-section	8 weeks	538 (31.5)	938 (30.6)	1.05	0.91	1.20
Northwest Switzerland ^a Apgar <7 at 5 mins	8 weeks	28 (2.4)	47 (2.3)	0.90	0.54	1.52
Central Switzerland ^b preterm <37 weeks	8 weeks	44 (4.3)	116 (5.7)	0.91	0.62	1.34
Central Switzerland ^b C-section	8 weeks	355 (30.5)	653 (29.5)	1.09	0.92	1.28
Central Switzerland ^b Apgar <7 at 5 mins	8 weeks	25 (2.5)	29 (1.7)	1.38	0.78	2.41
Eastern Switzerland Preterm <37 weeks	8 weeks	54 (4.7)	113 (5.2)	0.83	0.58	1.19
Eastern Switzerland C-section	8 weeks	348 (27.0)	612 (26.7)	1.00	0.85	1.18

Eastern Switzerland Apgar <7 at 5 mins	8 weeks	34 (3.1)	43 (2.3)	1.16	0.70	1.92
Hospital Birth only^d						
Preterm <37 weeks		515 (5.4)	494 (5.3)	1.14	0.99	1.31
C-section		2916 (30.6)	2748 (29.6)	1.01	0.94	1.08
APGAR<7 at 5 mins		240 (2.7)	168 (1.9)	1.48	1.19	1.84

^a Northwestern Switzerland included the cantons of Basel City, Basel Country, Aargau, and Solothurn.

^b Central Switzerland included the cantons of Zug, Appenzell Innerrhoden, Appenzell Ausserrhoden, Glarus, Lucerne, Nidwalden, Obwalden, Schwyz, and Uri.

^c Eastern Switzerland included the cantons of Schaffhausen, Thurgau, St. Gallen, and Graubünden.

^d The variable to indicate delivery place was incompletely captured in 2018. Therefore, sample size in 2020 and 2018/2019 are similar. Births with missing information on delivery place were excluded.

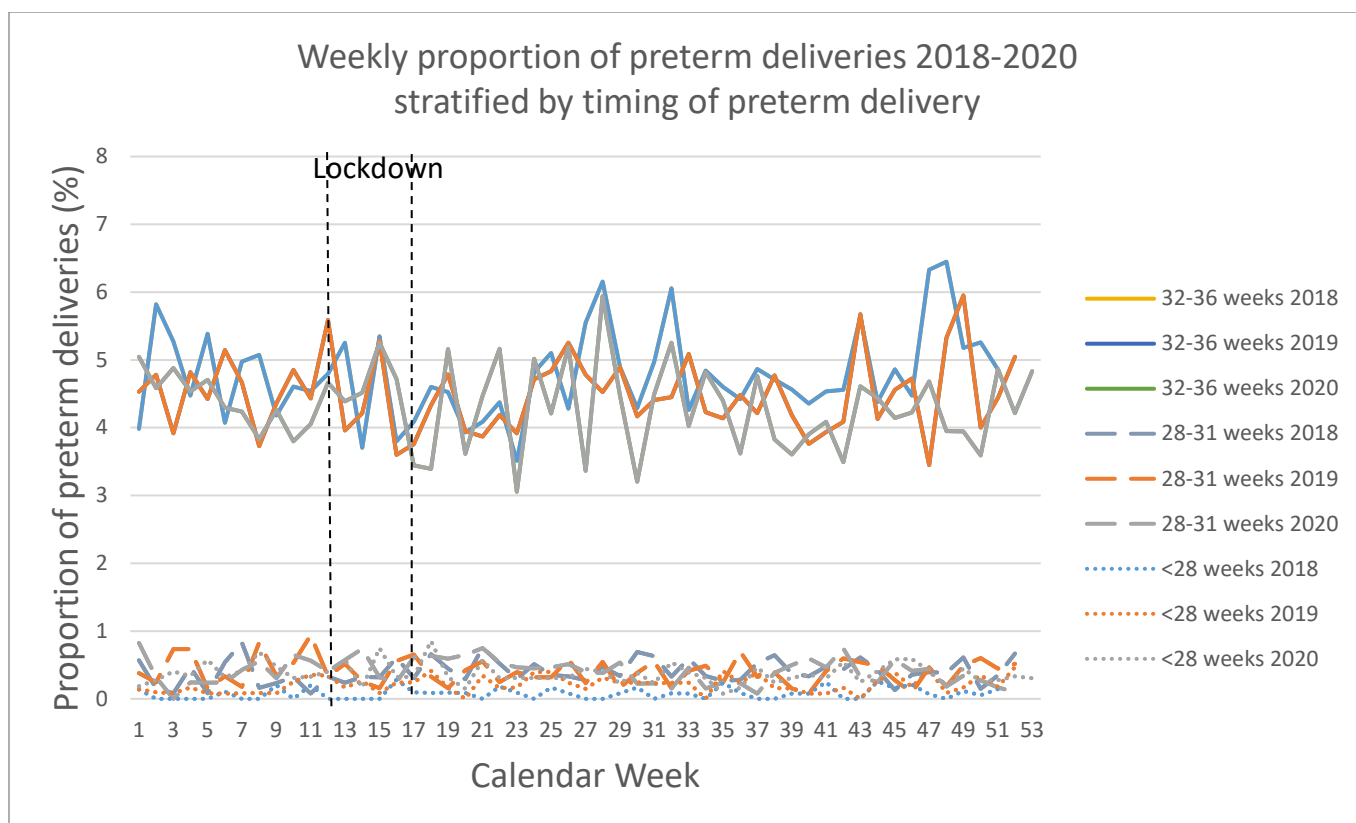


Figure S1: Weekly percentage of preterm deliveries between 2018-2020, stratified by gestational week of delivery

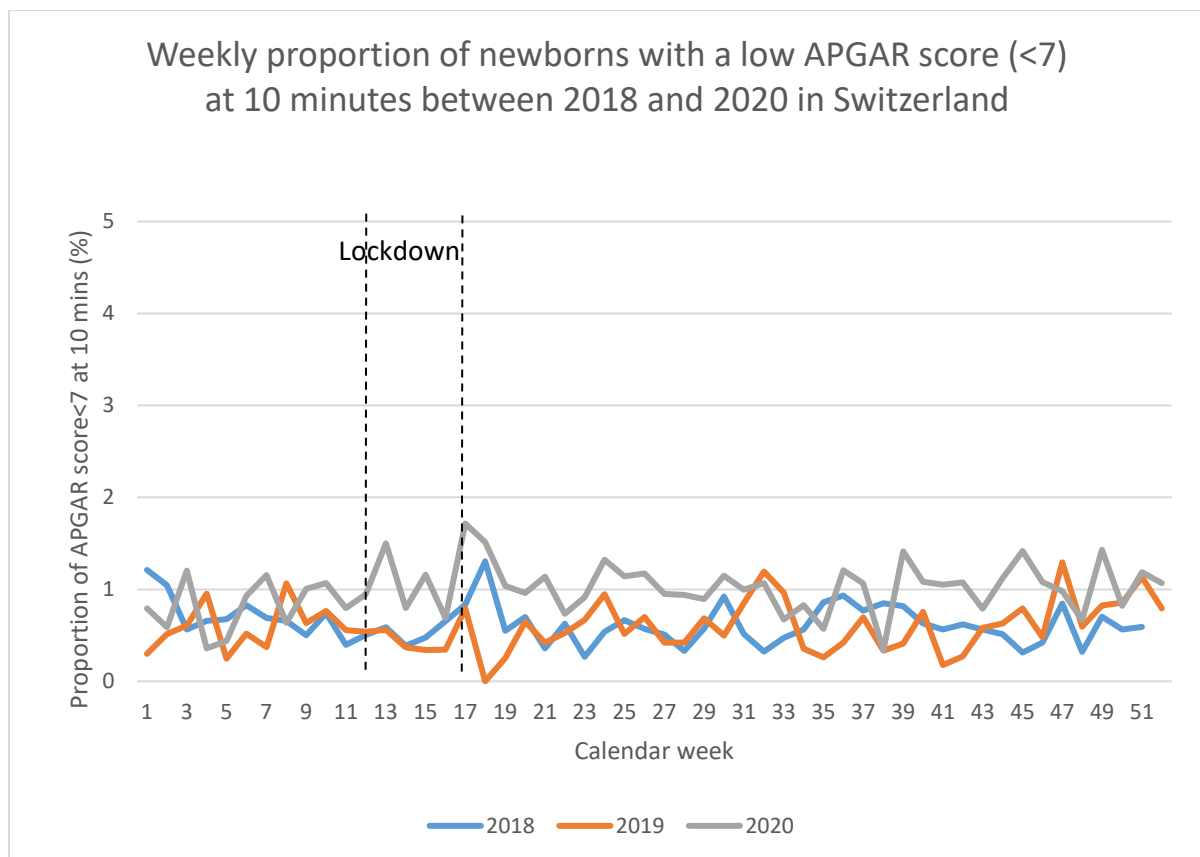


Figure S2: Weekly percentage of newborns with a low APGAR score (<7) at 10 minutes between 2018 and 2020

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