Published in final edited form as:

Am J Obstet Gynecol MFM. 2022 May ; 4(3): 100583. doi:10.1016/j.ajogmf.2022.100583.

An evaluation of seasonal maternal–neonatal morbidity related to trainee cycles

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Abstract

BACKGROUND: The existence of the "July phenomenon" (worse outcomes related to the presence of new physician trainees in teaching hospitals) has been debated in the literature and media. Previous studies of the phenomenon in obstetrics are limited by the quality and detail of data.

OBJECTIVE: To evaluate whether the months of June to August, when transitions in trainees occur, are associated with increased maternal and neonatal morbidity.

STUDY DESIGN: Secondary analysis of an observational cohort of 115,502 mother–infant pairs that delivered at 25 hospitals from March 2008 to February 2011. Inclusion criteria were an individual who had a singleton, nonanomalous live fetus at the onset of labor, and delivered at a hospital with trainees. The primary outcomes were composites of maternal and neonatal morbidity. We evaluated the outcomes by academic quarter during which the delivery occurred, beginning July 1, and by duration of the academic year as a continuous variable. To account for clustering in

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The authors report no conflict of interest.

outcomes at a given delivery location, we applied hierarchical logistic regression with adjustment for hospital as a random effect.

RESULTS: Of 115,502 deliveries, 99,929 met the inclusion criteria. Race and ethnicity, insurance, body mass index, drug use, and the availability of 24/7 maternal-fetal medicine, anesthesia, and neonatology varied by quarter. In adjusted analysis, the frequency of the composite maternal and neonatal morbidity did not differ by quarter. No differences in composite morbidity were observed when using day of the year as a continuous variable (maternal morbidity adjusted odds ratio, 1.00; 95% confidence interval, 0.99–1.00 and neonatal morbidity adjusted odds ratio, 1.00; 95% confidence interval, 1.00–1.01) and after adjustment for hospital as a random effect. Odds of major surgical complications in quarter 2 were twice those in quarter 1. Neonatal injury and intensive care unit were less frequent in later quarters.

CONCLUSION: Maternal and neonatal morbidity in teaching hospitals was not associated with the academic quarter during which delivery occurred, and there was no evidence of a "July phenomenon".

Keywords

July phenomenon; maternal morbidity; neonatal morbidity

Introduction

Each year, approximately 26,000[1] students graduate from medical school in the United States. Of these, about 65% to 80%[2] go into clinical practice in different specialties. For most, their sole experience with clinical care by this time has been approximately 2 years of medical-school rotations.

The "July phenomenon" refers to the theory that patient outcomes deteriorate within teaching hospitals with the arrival of new physician trainees in July.[3–5] This concept has been prominent in the media, with headlines such as "Don't get sick in July."[6] There is some evidence that outcomes can differ during employee transitions in non-medical settings[7] In addition, those already in residency advance to higher but new levels of responsibility around July. It is from the combination of the presence of these less experienced physicians and the anticipated decrease in efficiency that the concept of the July phenomenon or July effect was born.

There are several specialties in which a "July phenomenon" has been reported.[8–11] The field of internal medicine found the "July phenomenon" to have such a strong association with patient care that they instituted various changes such as "trainee guidance" to mitigate "harm" in the month of July.[12] A systematic review performed by Young et al, which evaluated 39 studies of the "July phenomenon" in different specialties,[10] concluded that there was an increase in mortality and a decrease in care efficiency during this time period. They did however remark that the effect on morbidity was unknown. Moreover, the field of obstetrics has limited evidence relating outcomes to this July transition.[13] Mortality during this period has been studied in a small number of studies[14–16] and was found to not be associated with proximity to July.[13,17] In addition, previous studies of the phenomenon in obstetrics are limited by the quality of the data sources and details of the data. The existence of this phenomenon in the field of obstetrics as it relates to morbidity remains uncertain.

Therefore, we sought to determine whether time period – as it relates to trainee cycles – is associated with maternal and neonatal morbidity in a well-characterized large cohort of pregnant people. We hypothesized that the months from June to September, when major transitions in obstetrics trainee responsibilities and function occur, are associated with increased maternal and neonatal morbidity.

Materials and Methods

This was a secondary analysis of a multihospital (25 hospitals) observational cohort performed between March 2008 and February 2011 within the *Eunice Kennedy Shriver* National Institute of Child Health and Human Development Maternal Fetal Medicine Units Network. The parent study was approved by the institutional review board at all sites included in the study. The primary study was designed to evaluate outcomes and their variation across hospitals in obstetrics as safety metrics.[18,19] The current analysis included individuals who had a nonanomalous singleton delivery and delivered a live fetus at a hospital with residents/trainees. We excluded mother–infant pairs in which the fetus was known to have a major anomaly. Those who were eligible for analysis were categorized according to the academic quarter of the month in which their deliveries occurred: mid-June through mid-September (Q1), mid-September through mid-December (Q2), mid-December through mid-March (Q3), and mid-March through mid-June (Q4). We chose July 1 as day 1 because this is the approximate date at which residency programs typically begin their transitions. We performed analyses on the basis of both quarters of delivery and duration of the academic year represented as a continuous variable (in days). These defined our exposures of interest. Our primary outcomes were composites of maternal and neonatal morbidity. The maternal composite included any major surgical complications, uterine rupture, blood transfusion, sepsis, suspected chorioamnionitis, post-partum endometritis, wound cellulitis, need for wound exploration, maternal death, and intensive care unit (ICU) admission. The neonatal composite comprised the presence of 5-minute Apgar score ≤3, need for infant intubation or continuous positive airway pressure support, encephalopathy, seizures, sepsis, intracranial hemorrhage, birth trauma, and death. Secondary outcomes included maternal (major surgical complications, blood transfusion, and ICU admission) and neonatal complications (encephalopathy, death, neonatal trauma, and neonatal ICU admission).

Statistical analysis

We compared baseline demographics and study outcomes between exposure groups using the chi-square test and the Wilcoxon test. The chi-square test was used to compare morbidity by quarter in which the deliver took place. We then adjusted for significant baseline characteristics using hierarchical logistic regression with adjustment for hospital as a random effect.

We computed adjusted odds ratios (aOR) with 95% confidence intervals (CIs) for each study outcome according to quarter of delivery. Baseline characteristics considered for adjustment included maternal age, body mass index (BMI), type of insurance, parity, and comorbidities, as shown in Table 1. We also assessed the composite outcomes adjusting for availability of in-house maternal-fetal medicine, anesthesia dedicated to obstetrics, and neonatology physicians who were available 24/7. Criteria to determine statistical significance included a *P* value <.05 or 95% CI that did not cross 1. No adjustments were made for multiple comparisons. All analyses were performed with SAS 9.4 (SAS Institute, Cary, NC).

Results

Of 115,502 deliveries during the time period from March 2008 to February 2011, 99,929 met the inclusion criteria and were included in the analysis; 3372 of those were excluded because of a diagnosis of fetal anomalies, as shown in Figure 1. Baseline characteristics are shown according to quarter of delivery in Table 1. Race and ethnicity, insurance, BMI, drug use, and availability of 24/7 maternal-fetal medicine, anesthesia, and neonatology varied by quarter. The frequency of the primary outcomes (composites of maternal and neonatal morbidity) was 11.8% (Table 2). No significant differences were observed in these outcomes when compared by quarter (Table 2). In addition, there were no differences observed in adjusted analyses for the combined primary outcomes (Table 2). Furthermore, the analysis using duration of the academic year as a continuous variable was not associated with the primary outcome, even after adjustment for hospital as a random effect (Figure 2). When evaluating this relationship as a continuous variable in adjusted analyses, there was also no statistical significance noted (Table 3). Major surgical complications were significantly increased in the period from September to December compared with June to September (Table 2). No other differences were observed. Neonatal injury and ICU care were also less frequent in later quarters but not significantly different (Table 2).

Comment

Principal findings

We found that composite maternal and neonatal morbidity outcomes in teaching hospitals were not associated with the academic quarter during which the delivery occurred or with the length of time that passed since July 1. In other words, we found no evidence of a “July phenomenon.”

Results

The results of this study are similar to the findings from studies within general surgery which showed that no “July phenomenon” existed with regard to morbidity.[3,5,20] We did find that there was a significant difference in the incidence of major surgical complications by academic quarter of delivery with the highest incidence occurring in the September to December quarter. This is not consistent with the “July phenomenon” theory. There was no observed increase in neonatal morbidity, regardless of the quarter in which the delivery occurred, which may be related both to obstetrical and neonatal care.

Clinical implications

Compared with other studies in which a "July phenomenon" was evaluated, our study outcomes were evaluated on the basis of academic quarter of delivery rather than the month of delivery. We believed this would make it more likely to observe a difference in morbidity, and therefore the potential presence of a "July (or trainee-transition) phenomenon." Our findings support the conclusion of Thomas et al[13] that there is no effect on maternal morbidity regardless of the quarter in which delivery occurs, even though morbidity in their study was measured by different components.

Research implications

Future research could examine the overall effect of time period on morbidity in all specialties as a longitudinal study.

Strengths and limitations

The strengths of our study include the large size of the cohort in a multiinstitutional dataset. Secondly, given the differences in baseline characteristics, we controlled for potential confounders in our analysis. Thirdly, the study outcomes were also collected by means of abstraction by trained research personnel, making the data as accurately ascertained as possible. Finally, several of the studies in the literature evaluated single-institution data, whereas ours used a cohort from multiple hospitals.

Despite these strengths, our study is not without limitations. First, we cannot exclude the interhospital variation that exists, which may affect outcomes. Along the same lines, we do not have any information about the level of involvement from the senior resident and faculty and oversight (which may differ between institutions). Finally, despite controlling for confounding, there could be unmeasured confounding present in our study. We do not have ample data on mortality to speak meaningfully to that outcome for pregnant people and newborns.

Conclusions

On the basis of these results, we conclude that although there were differences among the outcomes in each quarter, maternal and neonatal morbidity in teaching hospitals was not associated with the time of the year (academic quarter) during which delivery occurred, and there was no evidence of a "July phenomenon."

ACKNOWLEDGMENTS

The authors thank Elizabeth Thom, PhD, Madeline M. Rice, PhD, Brian M. Mercer, MD, and Catherine Y. Spong, MD, for protocol development and oversight.

The project described was supported by grants from the *Eunice Kennedy Shriver* National Institute of Child Health and Human Development (HD21410, HD27869, HD27915, HD27917, HD34116, HD34208, U10HD36801, HD40500, HD40512, HD40544, HD40545, HD40560, HD40485, HD53097, HD53118) and the National Center for Research Resources (UL1 RR024989; 5UL1 RR025764). Comments and views of the authors do not necessarily represent views of the National Institutes of Health

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AJOG MFM at a Glance

Why was this study conducted?

The study was conducted to evaluate whether there is a relationship between the quarter in which delivery occurs and maternal and neonatal morbidity.

Key findings

There is no association between maternal and neonatal morbidity and the quarter in which deliveries occur.

What does this add to what is known?

There is no evidence of a “July phenomenon” affecting maternal and neontal morbidity.

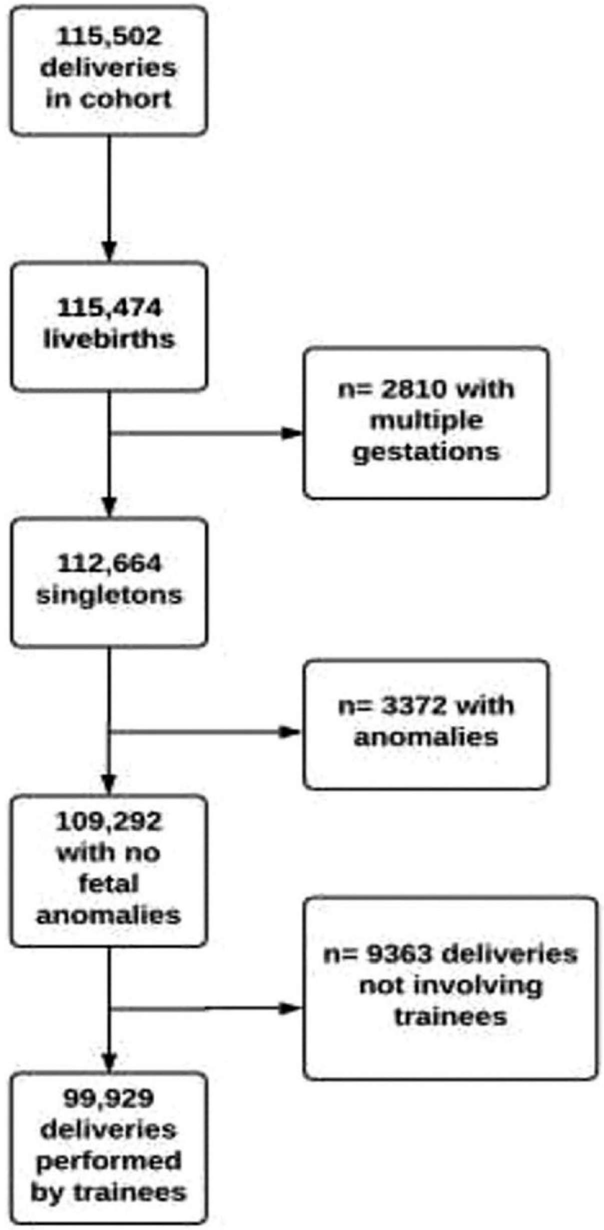

FIGURE 1.
Flowchart of patients included and excluded in secondary analysis

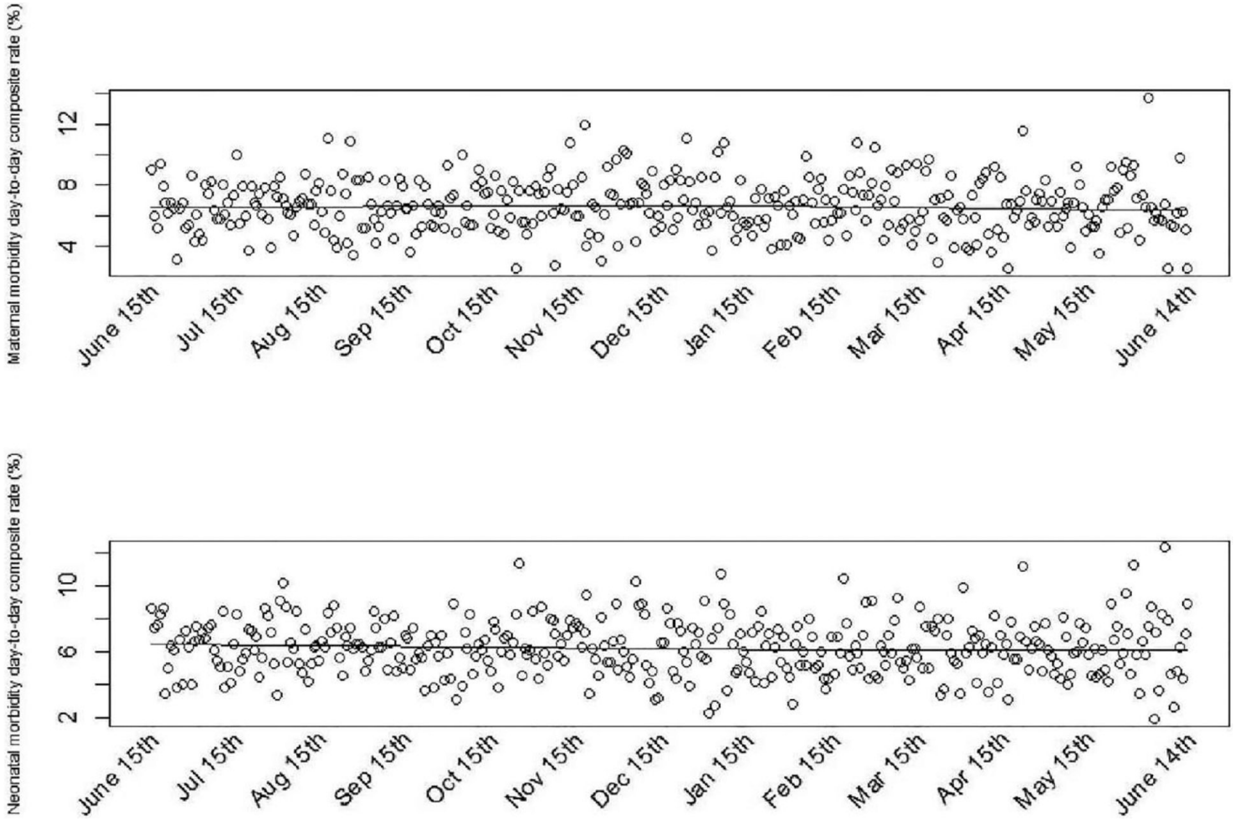

FIGURE 2. Scatter plot

Reflecting composite outcomes using day of the year as a continuous variable.

TABLE 1

Baseline demographics of patients in the analysis

	Delivery quarter				
Characteristics	**July 1–Sept. 30**	**Oct 1–Dec. 31**	**Jan. 1–March 30**	**April 1–June 30**	***P* value**
	26,684 (26.7)	24,544 (24.6)	24,065 (24.1)	24,636 (24.7)	
Maternal age (y)					.62
<20	2456 (9.2)	2350 (9.6)	2257 (9.4)	2288 (9.3)	
20–34.9	19,870 (74.5)	18,169 (74.0)	17,962 (74.6)	18,370 (74.6)	
>35	4358 (16.3)	4025 (16.4)	3846 (16.0)	3978 (16.2)	
BMI (mean+SD; kg/m^2)	31.3±6.4	31.3±6.5	31.2±6.3	31.3±6.4	.68
BMI (kg/m^2)					.13
<25	3287 (12.6)	3009 (12.5)	3061 (13.0)	3066 (12.7)	
25–29.9	9587 (36.7)	8743 (36.4)	8461 (35.9)	8754 (36.3)	
30–34.9	7361 (28.2)	6745 (28.1)	6780 (28.8)	6866 (28.5)	
35–39.9	3439 (13.2)	3199 (13.3)	3174 (13.5)	3253 (13.5)	
≥40	2471 (9.5)	2309 (9.6)	2099 (8.9)	2170 (9.0)	
Gestational age (wk)					.81
37+0 to 41+4	23,985 (89.9)	22,054 (89.9)	21,614 (89.8)	22,084 (89.6)	
<37	2699 (10.1)	2490 (10.2)	2451 (10.2)	2552 (10.4)	
Race					<.001
Non-Hispanic White	11,351 (42.5)	10,116 (41.2)	10,174 (42.3)	10,677 (43.3)	
Non-Hispanic Black	5553 (20.8)	5506 (22.4)	5337 (22.2)	5248 (21.3)	
Non-Hispanic Asian	1349 (5.1)	1342 (5.5)	1208 (5.0)	1258 (5.1)	
Hispanic	6827 (25.6)	6124 (25.0)	5990 (24.9)	6184 (25.1)	
Other	1197 (4.5)	1245 (5.1)	1098 (4.6)	1061 (4.3)	
Not documented	407 (1.5)	211 (0.9)	258 (1.1)	208 (0.8)	
Method of payment					<.001
Government-assisted	11,127 (42.0)	10,445 (42.9)	9869 (41.4)	9935 (40.7)	
Other	15,365 (58.0)	13,907 (57.1)	13,969 (58.6)	14,465 (59.3)	

	Delivery quarter				
Characteristics	**July 1–Sept. 30**	**Oct 1–Dec. 31**	**Jan. 1–March 30**	**April 1–June 30**	***P* value**
Tobacco use	2765 (10.4)	2574 (10.5)	2450 (10.2)	2391 (9.7)	.026
Drug use	1010 (3.8)	990 (4.0)	910 (3.8)	858 (3.5)	.017
Nulliparous	10,749 (40.3)	9918 (40.4)	9649 (40.1)	9762 (39.6)	.30
Diabetes mellitus					.29
None	24,656 (92.5)	22,666 (92.4)	22,324 (92.8)	22,806 (92.7)	
Pregestational	380 (1.4)	364 (1.5)	338 (1.4)	382 (1.6)	
Gestational	1634 (6.1)	1504 (6.1)	1394 (5.8)	1424 (5.8)	
Hypertension	883 (3.3)	814 (3.3)	778 (3.2)	809 (3.3)	.952
GBS					.86
Not done or missing	5168 (19.4)	4764 (19.4)	4630 (19.2)	4760 (19.3)	
Positive or previously affected pregnancy	5674 (21.3)	5188 (21.1)	5012 (20.8)	5150 (20.9)	
Negative	15,842 (59.4)	14,592 (59.5)	14,423 (59.9)	14,726 (59.8)	
PPROM	907 (3.4)	881 (3.6)	828 (3.4)	881 (3.6)	.56
MFM, anesthesia, and neonatology available 24/7	19,221 (72.0)	17,866 (72.8)	17,218 (71.6)	17,420 (70.7)	<.001
Mode of delivery					.07
Cesarean	8006 (30.0)	7503 (30.6)	7125 (29.6)	7274 (29.6)	
Nonoperative vaginal	17,305 (64.9)	15,720 (64.1)	15,656 (65.1)	16,003 (65.0)	
Operative vaginal	1341 (5.0)	1305 (5.3)	1265 (5.3)	1329 (5.4)	
Shoulder dystocia	482 (1.8)	444 (1.8)	425 (1.8)	491 (2.0)	.24
Episiotomy	1880 (7.1)	1679 (6.8)	1683 (7.0)	1747 (7.1)	.71
Any perineal laceration	9901 (37.1)	8968 (36.6)	9064 (37.7)	9270 (37.7)	.031
Severe lacerations (third or fourth degree)	626 (2.4)	549 (2.2)	597 (2.5)	598 (2.4)	.31
Highest level of care					.32
Well baby nursery/routine	23,407 (87.7)	21,548 (87.8)	21,234 (88.2)	21,731 (88.2)	
NICU or intermediate nursery	3261 (12.2)	2979 (12.1)	2810 (11.7)	2888 (11.7)	
Baby died before NICU	16 (0.1)	16 (0.0)	21 (0.1)	17 (0.1)	

Data are represented as number (percentage) unless otherwise noted.

BMI, body mass index; *GBS*, Guillain-Barré syndrome; *MFM*, maternal-fetal medicine; *NICU*, neonatal intensive care unit; *PPROM*, preterm premature rupture of membrane; *SD*, standard deviation.

TABLE 2

Adjusted analyses based on quarter of delivery

Outcome	Q1: July 1–Sept. 30 (N=26,684)	Q2: Oct. 1–Dec. 31 (N=24,544)	Q3: Jan. 1–March 30 (N=24,065)	Q4: April 1–June 30 (N=24,636)	aOR (95% CI)[a]
Primary outcomes					
Composite maternal morbidity[b]	1750 (6.6)	1712 (7.0)	1573 (6.5)	1629 (6.6)	Q2: 1.02 (0.94–1.09) Q3: 1.00 (0.93–1.08) Q4: 1.07 (0.99–1.15)
Neonatal composite[c]	1679 (6.3)	1537 (6.3)	1453 (6.0)	1517 (6.2)	Q2: 1.00 (0.93–1.09) Q3: 0.97 (0.90–1.05) Q4: 1.00 (0.92–1.07)
Maternal and neonatal composites combined	3163 (11.9)	2972 (12.1)	2776 (11.5)	2899 (11.8)	Q2: 1.00 (0.95–1.07) Q3: 0.98 (0.93–1.04) Q4: 1.02 (0.97–1.08)
Secondary outcomes					
Maternal					
Major surgical complication[d]	16 (0.1)	36 (0.1)	17 (0.1)	14 (0.1)	Q2: 2.53 (1.38–4.64) Q3: 1.26 (0.63–2.53) Q4: 0.95 (0.45–1.99)
Blood transfusion	396 (4.2)	345 (4.0)	359 (4.3)	319 (3.8)	Q2: 0.93 (0.80–1.09) Q3: 1.04 (0.90–1.22) Q4: 0.95 (0.81–1.11)
ICU admission	182 (1.9)	161 (1.9)	146 (1.7)	145 (1.7)	Q2: 0.88 (0.70–1.12) Q3: 0.86 (0.68–1.11) Q4: 0.92 (0.73–1.16)
Neonatal					
Encephalopathy	43 (1.3)	54 (1.8)	52 (1.9)	47 (1.6)	Q2: 1.23 (0.80–1.91) Q3: 1.30 (0.84–2.01) Q4: 1.39 (0.91–2.13)
Death[d]	42 (0.2)	51 (0.2)	47 (0.2)	53 (0.2)	Q2:1.15 (0.77–1.72) Q3:1.14 (0.76–1.70) Q4:1.33 (0.90–1.96)
Injury	332 (1.2)	266 (1.1)	250 (1.0)	277 (1.1)	Q2: 0.91 (0.77–1.07) Q3: 0.87 (0.73–1.03) Q4: 0.89 (0.75–1.06)
Highest level of care (NICU)	3261 (12.2)	2979 (12.1)	2810 (11.7)	2888 (11.7)	Q2: 0.91 (0.77–1.08) Q3: 0.87 (0.73–1.03) Q4: 0.89 (0.75–1.06)

Data are displayed as number (percentage). Observations with missing variables are excluded in the models.

aOR, adjusted odds ratio; *CI*, confidence interval; *CPAP*, continuous positive airway pressure; *ICU*, intensive care unit; *NICU*, neonatal intensive care unit.

[a] Referent is Q1: July 1–September 30. Adjusted for body mass index (continuous), insurance status, drug use, and 24/7 availability of in-house MFM, anesthesia, and neonatologist;

[b] Major surgical complication (cystotomy, bowel injury, ureteral injury), uterine rupture, blood transfusion, sepsis, suspected chorioamnionitis, postpartum endometritis, wound cellulitis, wound opening, maternal death, or ICU admission;

[c] Intrapartum stillbirth, Apgar ≤3 at 5 minutes, intubation or CPAP for respiratory support within the first 72 hours, neonatal encephalopathy, seizures, sepsis, intracranial hemorrhage, neonatal death, neonatal injury (brachial plexus, skull fracture, depressed skull fracture, facial nerve palsy, skin laceration, clavicular fracture, other skeletal fracture, or other injuries);

[d] Not adjusted for hospital as a random effect.

TABLE 3

Adjusted analyses using day of the year as a continuous variable

Outcome	aOR(95% CI)	*P* value	Percent increase/decrease in the odds of the outcome for every 30 d after July 1
Composite maternal morbidity[a]	1.00 (0.99–1.00)	.80	−0.1
Neonatal composite[b]	1.00 (0.99–1.01)	.81	0.1
Maternal and neonatal composites combined	1.00 (1.00–1.01)	.68	0.1

Models using day of the year as continuous variable starting with July 1as day 1. Adjusted for body mass index, insurance status, and availability of in-house MFM, anesthesia, and neonatologist available 24/7. Hospital is included in the model as a random effect.

aOR, adjusted odds ratio; *CI*, confidence interval; *CPAP*, continuous positive airway pressure; *ICU*, intensive care unit; *MFM*, maternal-fetal medicine.

[a] Major surgical complication (cystotomy, bowel injury, ureteral injury), uterine rupture, blood transfusion, sepsis, suspected chorioamnionitis, postpartum endometritis, wound cellulitis, wound opening, maternal death, or ICU admission;;

[b] Intrapartum stillbirth, Apgar ≤3 at 5 minutes, intubation or CPAP for respirator support within the first 72 hours, neonatal encephalopathy, seizures, sepsis, intracranial hemorrhage, neonatal death, neonatal injury (brachial plexus, skull fracture, depressed skull fracture, facial nerve palsy, skin laceration, clavicular fracture, other skeletal fracture, or other injuries).