ARTICLE

Risk of unexpected newborn complications by day of the week and time of birth in US term singleton births

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OBJECTIVE: To evaluate how the risk of unexpected newborn complications among term births varied by time of birth for 12.4 million full-term singleton births in the United States.
STUDY DESIGN: A population-based nationwide study. Exposures included time of birth, divided into four shifts and 42 distributed 4-h intervals. Logistic regression estimated the variations in the risk of unexpected newborn complications.
RESULT: The risk of unexpected newborn complications was higher during night shifts (OR 1.13, 95% CI: 1.12–1.14) and on weekends than on day shifts and weekdays. The risk of seizures and a 5-min Apgar score ≤3 increased steadily at the start of day shifts (07:00), while the risks of transfer, assisted ventilation ≥6 h, and neonatal death remained stable during day shifts. All outcomes increased during night shifts, peaking between 23:00 and 06:59.
CONCLUSION: Unexpected newborn complications were more frequent during night shifts and weekends, particularly between 23:00 and 06:59.

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INTRODUCTION

Ensuring equitable and high-quality care at all times is a critical goal across clinical scenarios, particularly in obstetrics, where the health of both mothers and infants is at stake. Historically, measures of obstetrical care quality have primarily focused on maternal outcomes, such as cesarean delivery rates, or neonatal outcomes in high-risk births, such as low birth weight or preterm deliveries [1]. However, there has been limited focus on outcomes among low-risk term births.

The quality of care for term births is particularly significant, as these deliveries constitute over 90% of all births in the United States (US), yet more than 7000 full-term infants die annually [2], translating to a mortality rate exceeding 2 deaths per 1000 live births [3]. In response to this concern, the California Maternal Quality Care Collaborative introduced the metric of unexpected newborn complications in term births in 2011, which the Joint Commission officially adopted in 2019 as a quality indicator for adverse outcomes in otherwise healthy term infants without pre-existing conditions [4–6].

It is reasonable to hypothesize that the risk of unexpected newborn complications in term births may vary by the day of the week and time of birth, given that factors such as fatigue, circadian misalignment, or staffing differences may impact the performance of healthcare professionals and pregnant women [7–9]. Previous studies have identified elevated risks of adverse neonatal outcomes during off-hours or weekends [1, 9–14]. However, there is limited evidence specifically addressing unexpected newborn complications in term births.

Accordingly, we conducted a nationwide study to estimate the associations of the day of the week and time of birth with the risk of unexpected newborn complications among full-term low-risk infants in the US.

SUBJECTS AND METHODS

Data sources

This cross-sectional study utilized period-linked birth/infant death data between 2018 and 2021 from the Centers for Disease Control and Prevention's National Center for Health Statistics [15]. This dataset includes birth and infant death certificates from all 50 states and the District of Columbia, linking births to deaths within the first year of life by certificate numbers [15]. Our analysis focused exclusively on singleton full-term births (≥37 weeks of gestation) with birth weights of at least 2500 grams, a 5-min Apgar score >0, and without congenital malformations. We excluded births to mothers who were non-US residents, infants born outside of hospitals or with unknown birth dates, and those with missing data on any indicators of unexpected newborn complications, including neonatal death within 28 days of birth, transfer to another facility, assisted ventilation for at least 6 h, seizures, and a 5-min Apgar score of 3 or less. Births with missing data

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on maternal pre-existing conditions (which were included in the adjusted models) were also excluded. After applying these exclusion criteria, the final analytic sample comprised 12,430,161 term births. As the data were de-identified and publicly available, institutional review of the study plan was waived.

Defining the exposures

The primary exposures in this study were the day of the week (Monday–Sunday) and time of birth (nursing day versus night shifts). Time of birth was classified based on typical 12-h nursing shifts in US hospital settings [16]. Day shift was defined as births occurring between 7:00 am and 6:59 pm, while night shift was defined as those occurring between 7:00 pm and 6:59 am.

To examine temporal variation in the risk of unexpected newborn complications in term newborns, we first analyzed the variations by the day of the week and time of birth separately. For a more granular view of temporal variation, we further examined combinations of day of the week and time of birth using two complementary approaches: four-time frames and 42-time frames within a week.

The four-time frames categorized births into four groups: weekday day shifts (Monday–Friday, 7:00 am–6:59 pm), weekday night shifts (Monday–Friday, 7:00 pm–6:59 am), weekend day shifts (Saturday–Sunday, 7:00 am–6:59 pm), and weekend night shifts (Saturday–Sunday, 7:00 pm–6:59 am) [7]. The 42-time frames divided births into groups that combined each day of the week with six evenly distributed 4-h time segments within a day: 07:00–10:59, 11:00–14:59, 15:00–18:59, 19:00–22:59, 23:00–02:59, and 03:00–06:59 [7].

Defining the outcome

Unexpected newborn complications in term births, a perinatal quality metric, was initially introduced by the California Maternal Quality Care Collaborative in 2011 and later incorporated as a core part of the Perinatal Core Measures by the Joint Commission in 2019 [4–6]. This metric was originally defined using administrative and electronic health record data. However, due to the lack of access to these data in our dataset, we approximated unexpected newborn complications in term births using information from birth certificates. The denominator was similar to the Joint Commission measure and was defined as live-born infants (5-min Apgar score >0) who were term (≥37 weeks of gestation), singleton, nonanomalous, in-hospital births with a birth weight of at least 2500 g. The numerator was defined as infants who experienced any of the following: neonatal death within 28 days of birth, transfer to another facility, assisted ventilation for at least 6 h, seizures, or a 5-min Apgar score of 3 or less. This approach to approximating unexpected newborn complications has been validated and used in previous studies [4].

Covariates

Demographic, lifestyle, and clinical information was collected from the US standard certificate of live birth. Maternal age was categorized into six groups: <18 years, 18–24 years, 25–29 years, 30–34 years, 35–39 years, and ≥40 years. Maternal pre-pregnancy body mass index (BMI) was classified as underweight (<18.5 kg/m^2), normal weight (18.5–24.9 kg/m^2), overweight (25.0–29.9 kg/m^2), and obesity (≥30 kg/m^2) [17]. Race and ethnicity were defined based on the 1997 Office of Management and Budget standards [17], and categorized as non-Hispanic White, non-Hispanic Black, non-Hispanic Asian, Hispanic, and Other Race. The "Other Race" category included non-Hispanic American Indian or Alaska Native, non-Hispanic Native Hawaiian or Other Pacific Islander, and non-Hispanic individuals identifying as more than one race [18].

Statistical analysis

We used logistic regression to assess whether the risk of unexpected newborn complications differed by the day of the week and time of births. In the models, we adjusted for maternal age, race and ethnicity, education, marital status, parity, pre-pregnancy BMI, smoking during pregnancy, diabetes, chronic hypertension, gestational diabetes, gestational hypertension, eclampsia, previous preterm birth, previous cesareans, mode of delivery, insurance coverage, prenatal care use, maternal transfer, gestational age of the infant, infant sex, and birth weight.

We first separately analyzed the variations by day of the week and time of birth. For a more granular view of temporal variation, we further examined combinations of day of the week and time of birth using two complementary approaches: four-time frames within the week (weekday day shift as the reference category) and 42-time frames within the week (Monday, 07:00–10:59 as the reference category).

We reported both adjusted odds ratios (aOR) and absolute risk difference (ARD) to evaluate the risk of unexpected newborn complications, by day of the week and time of birth. The ARD was calculated as $(1 - 1/\text{aOR}) \times \alpha$, where α represents the rate of neonates with unexpected newborn complications in the reference category [19–21]. To quantify the statistical uncertainty of the point estimates, 95% confidence intervals (95% CI) were calculated using the delta method [20].

To evaluate whether the changes in risk of unexpected newborn complications varied by race and ethnicity, we conducted stratified analyses for Non-Hispanic White, Non-Hispanic Black, Non-Hispanic Asian, and Hispanic.

Sensitivity analysis

To assess the robustness of our findings, we performed five main sensitivity analyses. First, to rule out the influence of planned births, we restricted our analyses to spontaneous births. Second, given that maternal smoking may increase the risk of unexpected newborn complications [4], we restricted the analysis to mothers who did not smoke during pregnancy. Third, in the main analysis, we defined low-risk pregnancies as live, singleton, gestational age at least 37 weeks, in-hospital births weighing at least 2500 g, and without congenital malformations. To apply a stricter definition of low-risk pregnancies [22], we further excluded mothers with maternal ages less than 18 or more than 40 years, pre-pregnancy BMI over 30 kg/m^2, prenatal care initiated after the sixth month of pregnancy, or any pre-existing risk factors. These exclusions included women with diabetes, gestational diabetes, chronic hypertension, gestational hypertension, eclampsia, previous preterm births, and previous cesarean deliveries. Fourth, we accounted for potential changes in prenatal care practices and risks associated with the COVID-19 pandemic by performing a stratified analysis. Temporal variations in the risk of complications were compared between births occurring in 2018–2019 and those in 2020–2021. Fifth, to address potential bias from neonatal transfer, which is less common in hospitals with higher levels of neonatal care, we repeated the main analysis for the metric without neonatal transfer. Finally, to reflect the actual clinical workflow, birth times were categorized according to the hospital shift schedule. The shift periods were defined as first shift (7:00–15:59), second shift (16:00–23:59), and third shift (0:00–06:59). This classification aimed to facilitate the analysis of variations in perinatal care quality across different working shifts.

All analyses were conducted in R statistical software (version 4.3.2). The "survival" package version 3.2-7 was used for the logistic regression. A two-tailed p-value < 0.05 was considered statistically significant.

RESULTS

Between 2018 and 2021, a total of 12,430,161 neonates were included in the final study cohort (Fig. S1), of whom 159,755 (1.3%) experienced unexpected newborn complications (Table S1). Births were most frequent occurring during nursing day shifts (61.1%) and on Tuesday (16.3%). Births were also most frequent occurring during weekdays from 07:00 to 18:59 (50.1%), and decreased during weekdays from 19:00 to 06:59 (29.6%). Fewer births occurred on weekends, particularly on Sunday (9.4%) and 19:00–06:59 (9.3%) (Table S1).

The rate of unexpected newborn complications was lower among newborns born during 07:00–18:59 on weekdays (1.28%) and weekends (1.27%), and slightly higher during 19:00–6:59 on both weekdays (1.29%) and weekends (1.29%) (Table S2). Among infants with unexpected newborn complications, most were born to mothers aged 25–34 years, with an educational attainment beyond high school, who were married, non-smoking, and had few maternal risk factors. The median gestational age for these births was 39 weeks, and 87.5% of the infants had a normal birth weight. In terms of race and ethnicity, the most prevalent group was non-Hispanic White (58.2%), followed by Hispanic (18.0%), non-Hispanic Black (14.6%), and non-Hispanic Asian (4.2%) (Table S1).

The risk of unexpected newborn complications was higher during nursing night shifts and weekends (Tables 1 and 2). For

Table 1. Associations between unexpected newborn complications and day of the week and time of birth among term births from 2018 to 2021 in the US.

Day of the week and time of birth	Total	Transfer to another facility	Assisted ventilation for at least 6 h	Seizures	Neonatal death within 28 days of birth	5-min Apgar score of 3 or less
Nursing shift of birth						
Day (07:00−18:59)	Reference	Reference	Reference	Reference	Reference	Reference
Night (19:00–06:59)	1.13 (1.12–1.14)	1.07 (1.05–1.09)	1.12 (1.10–1.14)	1.45 (1.35–1.56)	1.11 (1.05–1.17)	1.36 (1.33–1.39)
Day of the week of birth						
Monday	Reference	Reference	Reference	Reference	Reference	Reference
Tuesday	1.00 (0.99–1.02)	1.02 (1.00–1.05)	0.99 (0.96–1.01)	0.97 (0.85–1.11)	0.93 (0.85–1.03)	1.02 (0.97–1.06)
Wednesday	1.01 (0.99–1.03)	1.02 (1.00–1.05)	0.98 (0.96–1.01)	1.04 (0.92–1.18)	0.95 (0.87–1.05)	1.06 (1.02–1.11)
Thursday	1.01 (0.99–1.03)	1.00 (0.98–1.03)	0.99 (0.96–1.01)	1.02 (0.89–1.16)	0.98 (0.89–1.08)	1.10 (1.05–1.14)
Friday	1.02 (1.00–1.03)	1.01 (0.99–1.04)	1.00 (0.97–1.02)	1.02 (0.90–1.16)	0.95 (0.86–1.05)	1.09 (1.04–1.14)
Saturday	1.09 (1.07–1.11)	1.07 (1.03–1.10)	1.09 (1.06–1.12)	1.18 (1.03–1.36)	0.96 (0.86–1.07)	1.20 (1.15–1.26)
Sunday	1.10 (1.08–1.13)	1.08 (1.05–1.11)	1.12 (1.09–1.16)	1.38 (1.20–1.58)	1.00 (0.89–1.12)	1.21 (1.15–1.27)

Table 2. Absolute risk of unexpected newborn complications by day of the week and time of birth among term births from 2018 to 2021 in the US.

Day of the week and time of birth	Total	Transfer to another facility	Assisted ventilation for at least 6 hours	Seizures	Neonatal death within 28 days of birth	5-min Apgar score of 3 or less
Nursing shift of birth						
Day (07:00–18:59)	Reference	Reference	Reference	Reference	Reference	Reference
Night (19:00–06:59)	14.46 (13.27–25.65)	3.79 (2.95–4.62)	6.57 (5.73–7.41)	0.67 (0.56–0.78)	0.39 (0.18–0.59)	5.25 (4.90–5.60)
Day of the week of birth						
Monday	Reference	Reference	Reference	Reference	Reference	Reference
Tuesday	0.62 (−1.62 to 2.86)	1.33 (−0.11 to 2.78)	0.72 (−2.29 to 0.86)	−0.07 (−0.38 to 0.24)	−0.29 (−0.73 to 0.15)	0.33 (−0.53 to 1.20)
Wednesday	0.99 (−1.25 to 3.22)	1.25 (−0.20 to 2.71)	−1.07 (−2.66 to 0.52)	0.09 (−0.19 to 0.38)	−0.20 (−0.62 to 0.23)	1.22 (0.40–2.04)
Thursday	0.94 (−1.30 to 3.18)	0.08 (−1.41 to 1.58)	−0.75 (−2.33 to 0.83)	0.04 (−0.26 to 0.33)	−0.09 (−0.51 to 0.32)	1.77 (0.97–2.56)
Friday	1.92 (−0.31 to 4.15)	0.71 (−0.77 to 2.19)	−0.19 (−1.76 to 1.37)	0.04 (−0.25 to 0.34)	−0.20 (−0.63 to 0.23)	1.66 (0.86–2.46)
Saturday	10.15 (7.84–12.47)	3.46 (1.90–5.02)	5.11 (3.50–6.71)	0.36 (0.09–0.63)	−0.18 (−0.66 to 0.30)	3.42 (2.64–4.20)
Sunday	11.98 (9.60–14.37)	4.17 (2.55–5.78)	6.73 (5.10–8.36)	0.63 (0.40–0.87)	−0.01 (−0.49 to 0.47)	3.50 (2.69–4.32)

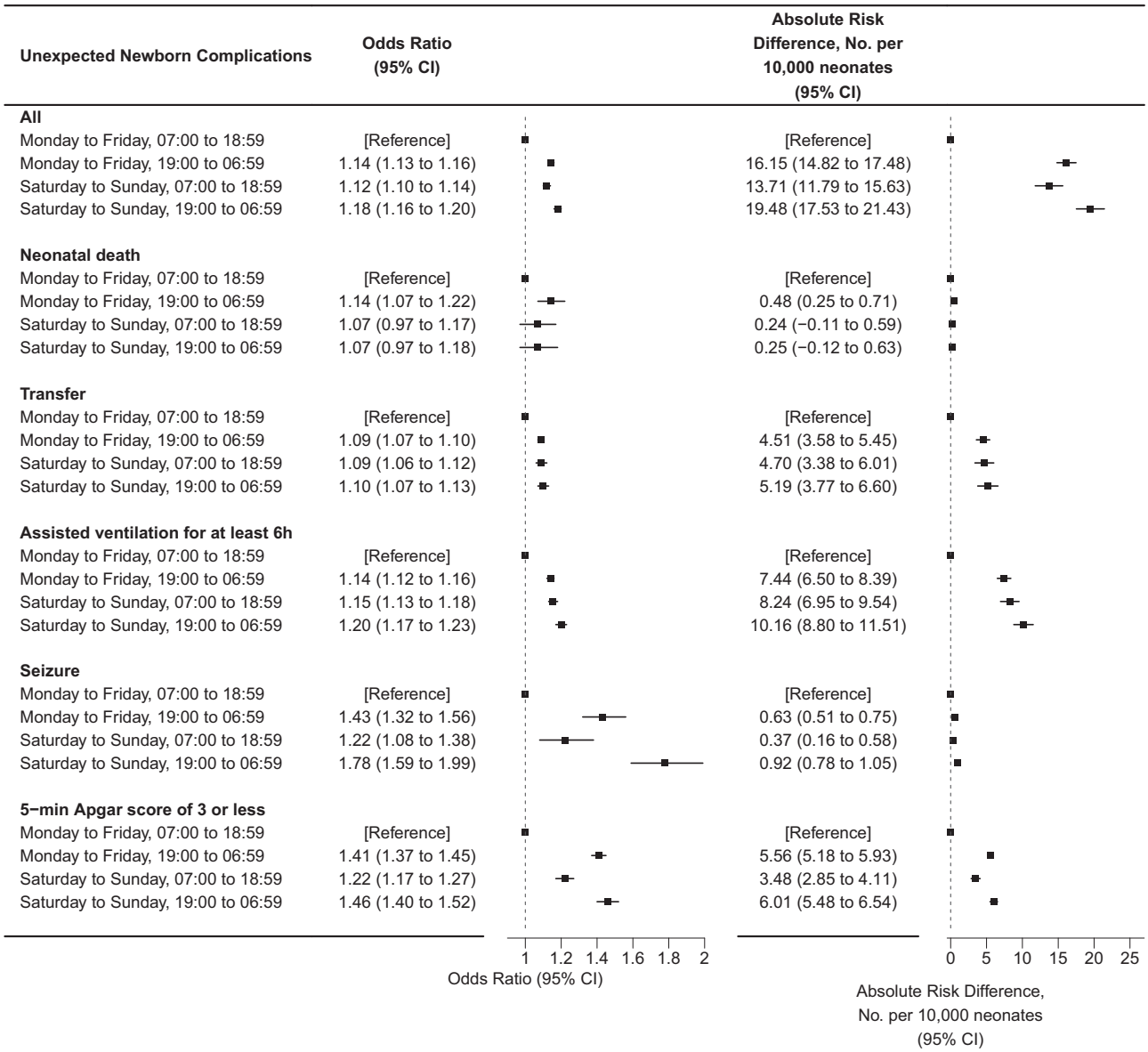

Fig. 1 Associations between unexpected newborn complications and the combination of day of the week and time of birth among term births in the US.

example, compared to nursing day shifts, births during nursing night shifts were associated with an increased risk of unexpected newborn complications, with an adjusted odds ratio of 1.13 (95% CI: 1.12, 1.14) (Table 1), corresponding to 14.46 (95% CI: 13.27, 25.65) excess cases of unexpected complications per 10,000 term neonates (Table 2). The increased risk during nursing night shifts and weekends was also observed for specific adverse outcomes, including neonatal death within 28 days of birth, transfer to another facility, assisted ventilation for at least 6 h, seizures, or a 5-min Apgar score of 3 or less. Among these, seizures demonstrated the most pronounced increase in risk, while neonatal death did not show an increase during weekends (Tables 1 and 2).

To examine the combined effects of the day of the week and time of birth, we classified births as occurring during 4-time frames in the week: weekday day shifts, weekday night shifts, weekend day shifts, and weekend night shifts. Compared to births during weekday day shifts, the adjusted odds ratio of unexpected newborn complications was 1.14 (95% CI 1.13, 1.16) for births during weekday night shifts, 1.12 (95% CI: 1.10, 1.14) for births during weekend day shifts, and 1.18 (95% CI: 1.16, 1.20) for births during weekend night shifts, corresponding to 16.15 (95% CI: 14.82, 17.48), 13.71 (95% CI: 11.79, 15.63), and 19.48 (95% CI: 17.53, 21.43) excess cases of unexpected complications per 10,000 term neonates, respectively (Fig. 1). This pattern was also observed for five specific adverse outcomes. For example, in the case of seizures, compared to births during weekday day shifts, the adjusted odds ratio of unexpected newborn complications was 1.43 (95% CI 1.32, 1.56) for births during weekday night shifts, 1.22 (95% CI: 1.08, 1.38) for births during weekend day shifts, and 1.78 (95% CI: 1.59, 1.99) for births during weekend night shifts, corresponding to 0.63 (95% CI: 0.51, 0.75), 0.37 (95% CI: 0.16, 0.58), and 0.92 (95% CI: 0.78, 1.05) excess cases of unexpected complications per 10,000 term neonates, respectively (Fig. 1).

The increased risk of unexpected newborn complications during nursing night shifts and weekends was consistent across racial and ethnic groups (Tables S3 and S4, Fig. S2). For example, compared to weekday day shifts, the risk of unexpected newborn complications during weekend night shifts increased by 19% (95% CI: 16%, 22%) for newborns of non-Hispanic White mothers, 18% (95% CI: 13%, 24%) for those of non-Hispanic Black mothers, 14%

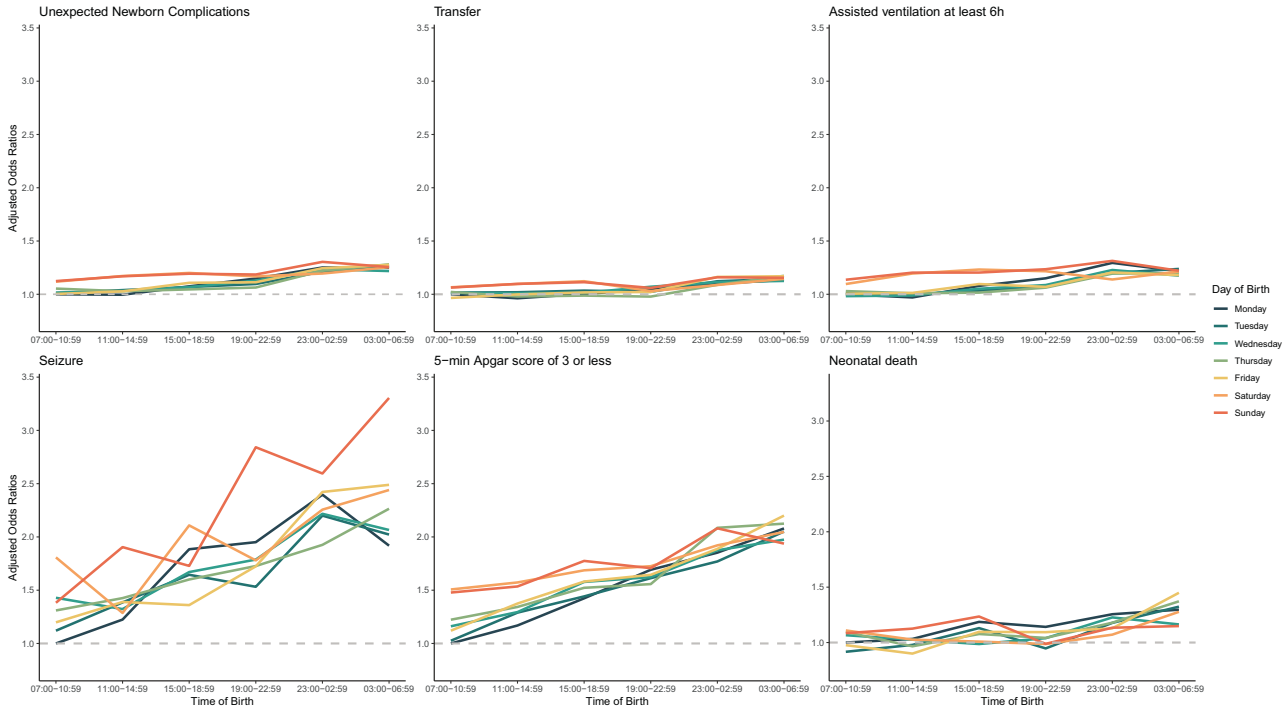

Fig. 2 Temporal pattern and time variation of unexpected newborn complications among term births in the US.

(95% CI: 5%, 24%) for those of non-Hispanic Asian mothers, and 14% (95% CI: 9%, 19%) for those of Hispanic mothers (Fig. S2).

To provide a more granular view of temporal variation, we used a 7-day categorization for day of birth (Monday–Sunday) and divided each day into six 4-h time blocks: 07:00–10:59, 11:00–14:59, 15:00–18:59, and 19:00–22:59, 23:00–02:59, and 03:00–06:59, resulting in a total of 42-time categories. Again, the risk of unexpected newborn complications was higher during nursing night shifts and weekends (Fig. 2). For unexpected newborn complications as well as transfer to another facility, assisted ventilation for at least 6 h and neonatal deaths within 28 days of birth, the risk was generally stable during weekday day shifts but increased during night shifts, peaking at 23:00–02:59; however, this nighttime increase in risk was not observed during weekends. In contrast, for seizures and a 5-min Apgar score of 3 or less, the risk showed a continuous increase starting from the beginning of the nursing day shift (07:00) and peaked at 23:00–02:59 on both weekdays and weekends (Fig. 2).

These results remained consistent across sensitivity analyses, including those restricted to spontaneous births, births to non-smoking mothers, births meeting a stricter definition of low-risk pregnancies, births occurring before and during the COVID-19 pandemic, and analyses excluding neonatal transfer in the metric of unexpected newborn complications (Tables S5–S9, Fig. S3). Compared with delivery at first shift (7:00–15:59), all unexpected newborn complications were significantly higher if the delivery occurred at the second (16:00–23:59) and the third (00:00–06:59) shifts across weekdays and weekends (Tables S10 and S11).

DISCUSSION

In this nationwide observational study of 12,430,161 term singleton births in the US, we found that the risk of unexpected newborn complications was higher during night shifts and weekends, with this pattern consistent across racial and ethnic groups. The risks for seizures and 5-min Apgar score of 3 or less steadily increased as the day shifts began. In contrast, the risks of transfer to another facility, assisted ventilation for at least 6 h, and neonatal deaths within 28 days of birth remained largely stable throughout the day shifts. However, all five outcomes of unexpected newborn complications consistently increased during night shifts, with peaks observed between 23:00 and 06:59.

Rates of unexpected newborn complications varied widely, with higher rates observed among black and Hispanic infants, infants born to younger or less educated women, those with more medical comorbidities, or deliveries occurring in hospitals with lower levels of neonatal care [4, 23]. Previous studies have also highlighted that unexpected newborn complications in low-risk term births are not uncommon [4, 24]. In our study, using two criteria to define low-risk term births, the nationwide rates of unexpected complications in the US ranged from 1.0% to 1.3%, which was consistent with findings from prior studies based on regional data [4, 22, 24]. Despite its significance, unexpected newborn complications remain largely understudied. Previous studies mostly focused on changes in shift schedules or the weekend effect; only one prior study has examined the temporal variation in these complications [24]. Conducted in the US, California, using birth data from 2011 to 2013 [24], that study similarly reported increased risks of unexpected newborn complications during nursing night shifts and weekends, consistent with our findings.

Several factors may contribute to the higher rates of unexpected newborn complications during night shifts and weekends. Pregnancies without prenatal risk factors are often perceived as being at lower risk for severe complications [22]. This perception may inadvertently limit obstetric care providers' ability to anticipate and respond to unexpected complications, resulting in fewer medical resources being allocated to these cases [22]. Additionally, long working hours, unreasonable shift lengths, and reduced staffing levels can impair the accuracy of diagnostic and therapeutic decisions [25–29], potentially leading to unexpected newborn complications. Beyond the reduced quality of care from health providers, pregnant women delivering at night may experience sleep deprivation and fatigue, further heightening the risk of adverse birth outcomes [30].

During day shifts, the pattern of unexpected complications varied by specific outcomes. The risks for seizures and 5-min Apgar score of 3 or less steadily increased from the start of nursing day shifts. In contrast, the risks for transfer to another facility, assisted ventilation for at least 6 h, and neonatal deaths within 28 days of birth remained stable throughout day shifts. Seizures and low Apgar scores have been linked to factors related to care during labor, such as cesarean sections, inadequate fetal risk surveillance, and the inappropriate use of oxytocin [31, 32]. These findings suggest that seizures and 5-min Apgar score of 3 or less may represent more severe complications that are particularly sensitive to the quality of obstetric care provided.

Our study has several limitations. First, we relied on birth certificate data to define unexpected newborn complications, which were originally defined by discharge diagnosis codes and clinical data. As a result, our findings may be subject to bias if the validity of this proxy measure is suboptimal. However, this approach has been validated and widely used in prior studies [4, 22–24]. Second, the lack of hospital- and county-level data (hospital level, type, location, and availability of care providers) limits our ability to assess the temporal patterns that may vary across hospitals with different volumes or across regions. However, our findings are consistent with previous studies that adjusted for these factors [7, 12, 23], supporting the reliability of our findings. Third, although our method of dividing time periods is reasonable, exploring alternative partitioning approaches provides additional insights. Identifying optimal ways to segment time periods could improve our understanding of temporal variations in care quality and help identify specific time frames for targeted interventions [33]. Despite these limitations, the use of nationwide data minimizes the potential for selection bias and improves the generalizability of our findings across diverse populations, hospitals, and regions.

Our findings highlight critical opportunities to improve perinatal care and reduce the risk of unexpected newborn complications. Obstetrical providers should prioritize educating expectant mothers about these risks, even in low-risk pregnancies, and emphasize the importance of continuous vigilance during all delivery periods, especially night shifts and weekends. Healthcare administrators should ensure adequate staffing levels and resource availability to maintain a consistent quality of care. Strategies such as optimizing shift structures, enhancing personnel training, and deploying resources effectively are essential to mitigating the risk of unexpected newborn complications. Improving labor management practices is also vital. This includes implementing advanced fetal risk surveillance protocols and the careful use of medical interventions, such as oxytocin, to minimize the risk of complications like seizures and 5-min Apgar score of 3 or less. Addressing these challenges requires a comprehensive approach that considers the temporal variations in care demands, promoting safer outcomes for both mothers and newborns.

CONCLUSIONS

In this nationwide observational study in the US, the risk of unexpected newborn complications in term infants was higher during nursing night shifts and weekends, with a pronounced peak between 23:00 and 06:59. This information could inform efforts to optimize perinatal care practices and staffing strategies, contributing to a reduction in the risk of unexpected newborn complications.

DATA AVAILABILITY

Data are available from https://www.cdc.gov/nchs/data_access/Vitalstatsonline.htm.

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AUTHOR CONTRIBUTIONS

Ruiyi Liu: Conceptualization, Writing – original draft, Formal analysis, Data curation, Investigation. Chunrong Li: Writing – original draft, review & editing. Tian Liang: Writing – review & editing. Jie Yin: Writing – review & editing. Qiang Zeng: Methodology, Writing – review & editing. Shengzhi Sun: Conceptualization, Data curation, Methodology, Writing – review & editing. Shi Zhao: Conceptualization, Data curation, Methodology, Writing – review & editing. Wangnan Cao: Conceptualization, Data curation, Methodology, Writing – review & editing.

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COMPETING INTERESTS

The authors declare no competing interests.

ETHICS APPROVAL

The data used in this study were obtained from publicly available sources. Consequently, this research was deemed exempt from ethical review by the Institutional Review Board of Capital Medical University.

ADDITIONAL INFORMATION

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