Outcomes of Multiple Gestation Births Compared to Singleton: Analysis of Multicenter KID Database

Renjithkumar Kalikkot Thekkeveedu (rkalikkot@gmail.com)
University of Mississippi University Hospital: The University of Mississippi Medical Center
https://orcid.org/0000-0003-3864-0911

Nilesh Dankhara
University of Mississippi University Hospital: The University of Mississippi Medical Center

Jagdish Desai
University of Mississippi University Hospital: The University of Mississippi Medical Center

Angelle L Klar
University of Mississippi University Hospital: The University of Mississippi Medical Center

Jaimin M Patel
University of Mississippi University Hospital: The University of Mississippi Medical Center

Research Article

Keywords: Neonates, Outcomes, Twins, Triplets, Higher-order multiples

DOI: https://doi.org/10.21203/rs.3.rs-700774/v1

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Abstract

Background

The available data regarding morbidity and mortality associated with multiple gestation births is also conflicting and contradicting.

Objective

To compare morbidity, mortality, and length of stay (LOS) outcomes between multiple gestation (twin, triplet and higher-order) and singleton births.

Methods

Data from national multicenter Kids' Inpatient Database of the Healthcare Cost and Utilization Project from the years 2000, 2003, 2006, 2009, 2012, and 2016 were analyzed using complex survey design using SAS. Neonates with ICD9 and ICD10 codes indicating singletons, twins or triplets, and higher-order multiples were included. Mortality was compared between these groups after excluding transfer outs to avoid duplicate inclusion. To analyze LOS, we included inborn neonates, and excluded transfers and who died inpatient and any neonates who appear to have been discharged less than 33 weeks PMA. The LOS was compared by gestational age groups.

Results

A total of 22,853,125 neonates were analyzed for mortality after inclusion-exclusion; 2.96% were twins, and 0.13% were triplets or more. A total of 22,690,082 neonates were analyzed for LOS. Mean GA, expressed as mean (SD), for singleton, twins and triplets were 38.30(2.21), 36.39 (4.21), and 32.72(4.14), respectively. The adjusted odds for mortality were similar for twin births compared to singleton (aOR: 1.004, 95% CI:0.960-1.051, p=0.8521). The adjusted odds of mortality for triplet or higher-order gestation births were higher (aOR: 1.33, 95% CI: 1.128-1.575, p =0.0008) as compared to singleton. Median LOS (in days) was significantly longer in multiple gestation compared to singleton overall (Singletons: 1.59 [1.13, 2.19] vs twins 3.29 [2.17, 9.59] vs triplets or higher order multiples 19.15 [8.80, 36.38], p <.0001), and this difference remained significant within each GA category.

Conclusion

Multiple gestation births have higher mortality and longer LOS when compared to singleton births. This population data from multiple centers across the country could be useful in counseling parents when caring for multiple gestation pregnancies.

Introduction
The United States and other developed countries have witnessed an increased prevalence of multiple gestation births in the late 20th century and the first decade of 21st Century (1-5), which is primarily attributed to the evolution of assisted reproductive techniques (6-8). Data from many developed countries have shown that while there is a significant drop in the number of triplets or higher order births, the number of twin births has remained stable or continued to rise (9-12).

Multiple gestation births account for 3-4.5% of all births (11, 13), are more likely to be associated with premature births (14, 15), and more commonly result in babies who are small for gestational age (SGA) and also low birth weight (LBW) (16-19). Such factors may play a role in the outcomes of multiple gestation births, but little information is available in published literature. The available data regarding morbidity and mortality associated with multiple gestation births is also conflicting and contradicting. (6, 17, 20-23).

Most of the previous studies include a select few centers that are primarily academic and are also limited by relatively small sample sizes (22, 24), thus results may not be generalizable. There are two multicountry collaboration studies, neither of which include outcomes of neonates born in the United States (24, 25). Hence, there is a need for data from a representative population-based sample in the United States to address the impact of multiple gestation births on outcomes while controlling for various baseline characteristics.

The objective of this study is to compare morbidity, mortality, and LOS outcomes between multiple gestation and singleton births among neonatal discharges in a nationally representative large dataset.

Materials And Methods

Study Design and Participants:

We performed a retrospective study using the Kid's Inpatient Database (KID) (26). The KID is a population-based administrative database compiled by the Healthcare Cost and Utilization Project (HCUP) of the Agency for Healthcare Research and Quality (AHRQ), which includes the largest collection of longitudinal hospital care data in the United States. We obtained and analyzed discharge records for the years 2000, 2003, 2006, 2009, 2012, and 2016.

Our cohort extraction started with identifying neonatal age admissions through the first 28 days after birth among all discharge records. Discharge records were excluded if (i) there was no ICD code specifying singleton verses multiple gestation birth, (ii) congenital anomalies described in appendix 1 were present, or (iii) they had indicators for “transfer out” in order to avoid counting the same patient twice. This resulting cohort was analyzed for morbidity and mortality as well as the odds ratio of being born at a premature GA.

For the LOS analysis, discharge records with indicators for both “transferred in” or “transferred out” were excluded since they may result in inaccurate estimates of the LOS. The patients who appeared to have
been discharged prior to 33 weeks Post Menstrual Age (PMA) were also excluded. Since premature infants do not achieve feeding competency in terms of a coordinated suck and swallow prior to 33 weeks PMA, discharge records for such patients likely represent erroneous LOS, hence the exclusion. The number of discharge records at each stage of cohort extraction are presented in Figure 1.

Once the cohort was identified, baseline characteristics (delivery type, GA, intrauterine growth restriction (IUGR) or SGA status, sex, race, payer) and hospital characteristics (location of hospital, hospital region and hospital bedsize) were extracted for all three groups (singleton, twin, and triplet or higher-order births). Common neonatal morbidities such as respiratory distress syndrome (RDS), pulmonary hemorrhage, pneumothorax, bacterial sepsis, necrotizing enterocolitis (NEC), intraventricular hemorrhage (IVH), periventricular leukomalacia (PVL), retinopathy of prematurity (ROP), and bronchopulmonary dysplasia (BPD) were compared. A list of ICD-9-CM and ICD-10-CM codes for singleton, twin, and triplet or higher order multiples, all inclusion-exclusion criteria, baseline characteristics, morbidities, and outcome measures can be found in Appendix 1. Our study was determined to be exempt by the University of Mississippi Medical Center Institutional Review Board.

**Statistical Analysis:**

Data use agreement training was completed by each author who analyzed data. Data was analyzed using SAS 9.4 (SAS Institute, Cary, NC), while accounting for a complex survey sample design of the HCUP dataset. We utilized weighted, stratified analysis using SAS survey procedures and reported ‘n’ as weighted cases in each group. Each analysis utilized the 2-sided significance level of 0.05.

Univariate analysis was performed for descriptive statistics and to compare baseline characteristics between the three groups, and p-values for chi-square tests were obtained. The whole cohort was divided into preterm (< 37 weeks) and term (≥37 weeks). Most GA ICD-9-CM codes span for two weeks. The presumed mean GA was taken for each ICD-9-CM code to calculate the overall GA mean for the three groups. For term births, taking CDC data into consideration, a mean GA of 38.5 was applied (27). The exact values for each GA category are available in Appendix 2. Rates and odds of having preterm birth were derived in each group. The preterm morbidity outcomes were compared by logistic regression analysis while controlling for baseline characteristics and hospital characteristics. Due to known multicollinearity between GA and birth weight (BW), only GA was used in the models along with IUGR or SGA status.

Mortality was compared separately in the preterm and term cohort. For mortality, we obtained adjusted odds ratio (aOR) for multiple gestation births compared to singleton using survey logistic regression. In preterm infants, mortality odds were adjusted for baseline demographic characteristics and comorbidities. Early neonatal deaths were defined in our study as neonatal deaths occurring in the first week of life, consistent with the World health organization (WHO) definition (28). Since a large number of neonatal deaths in each GA category occur as early neonatal deaths, we compared these early deaths among the three groups separately in addition to comparing their overall in-hospital mortality. For early
mortality analysis, we excluded patients “transferred in” as death on the day of transfer is not available in the dataset.

For the LOS analysis, we compared medians (IQR) among the three groups. The LOS of each GA group was also compared, accounting for complex survey design using clusters, stratum and weights.

**Results**

Cohort extraction: Baseline characteristics of the cohort are presented in Table 1.

i) Prematurity:

The preterm birth rate for singleton, twins, and triplets was 6.7%, 54.9% and 94.5%, respectively. Odds of being born preterm were OR: 17.79 (95% CI: 17.513-18.085, p<0.001) for twins as compared to singletons. Mean GA, expressed as mean (SD), for singleton, twins and triplets were 38.30(2.21), 36.39(4.21), and 32.72(4.14), respectively (Table 1).

ii) Morbidities:

Neonatal morbidities were compared among the three groups (Table 2) only for preterm infants. Interestingly, odds of having RDS were significantly lower in twins and triplets as compared to singleton preterm infants, while odds of pulmonary hemorrhage were higher in twins and triplets as compared to singletons. Odds of BPD, any IVH and bacterial sepsis were lower in twins as compared to singletons, while odds of severe IVH were higher in twins as compared to singletons. Triplets or more had higher odds of pulmonary hemorrhage, BPD, and any ROP as compared to singletons. There was no difference in severe ROP and NEC between the three groups.

iii) Mortality:

Mortality rates among preterm infants were 3.01%, 2.65%, and 5.07% in singleton, twins, and triplets or higher-order multiple gestation births respectively. The adjusted odds for mortality were similar for twin births compared to singleton (aOR: 1.004, 95% CI:0.960-1.051, p=0.8521). The adjusted odds of mortality for triplet or higher-order gestation births were higher (aOR: 1.33, 95% CI: 1.128-1.575, p =0.0008) as compared to singleton. Early mortality rates were 2.48%, 2.18%, and 4.15% in singleton, twin, and triplet or higher-order multiple gestation births respectively. The adjusted odds for early mortality were similar for twin births (aOR: 1.02, 95% CI:0.967-1.074, p=0.4798) and higher for triplet or higher-order multiple gestation births s (aOR: 1.424, 95% CI: 1.169-1.735, p =0.0005) as compared to singleton.

The mortality rates among term infant births were 0.03%, 0.24%, and 5.24% respectively for singleton, twin, and triplet or higher-order multiple gestation births. The adjusted odds for mortality in term twin neonates were higher (aOR: 5.263, 95% CI: 4.524-6.122, p <0.0001) as compared to singletons. Since most triplets are born premature, we did not compare the mortality in triplet against singletons.
iv) Length of Stay:

Median LOS was significantly longer in all multiple gestation births when compared to singleton overall (Median Days [IQR]: Singletons: 1.59 [1.13, 2.19] vs. Twins 3.29 [2.17, 9.59] vs. Triplets or higher 19.15 [8.80, 36.38], p <.0001), and this difference remained significant within each GA category. (Table 3).

Discussion

In this study, we compared birth GA, morbidities, mortality, and LOS between singleton and multiple gestation births among neonatal discharges from 2000 through 2016 utilizing the Kid’s Inpatient Database (KID), which is a large population-based administrative database compiled by the HCUP of AHRQ. This report is the largest one of its kind representing >4000 hospitals and >22 million discharge records over the last two decades. Our analysis controlled for baseline characteristics and previously identified variables that could affect the outcome, such as IUGR or SGA status. We believe these results are widely generalizable and could be of benefit with perinatal counseling in the case of multiple gestation pregnancies.

In our study, the percentages of premature babies in each GA category from 24 to 34 weeks were significantly higher among triplets and higher-order births compared to twins, which, in turn, were significantly higher than the singleton. The mean birth GA was lower in multiple gestation births compared to singleton. The mean GA for singletons was significantly higher -expressed as mean (SD) -at 38.30 (2.21) weeks of GA compared to twin (36.39(4.21)) and triplets or higher-order multiples (32.72(4.14)). The mean GA in our study was similar to another large study from the United States, which reported mean GA as 39 weeks in singletons, 35.8 weeks in twins, and 32.5 weeks in triplets (29). Similarly, in each BW category below 2500 grams, the representation of twins, triplets, or higher-order births was significantly higher than the singleton (Table 1). IUGR or SGA babies were significantly higher among all multiple gestation births compared to singleton. This data underlines the previous reports suggesting that the incidence of preterm and LBW deliveries increases with multiple births (17, 29, 30).

1) Morbidities:

A) Respiratory morbidities:

Our data shows that the rate of short term respiratory morbidity like RDS was significantly lower in all multiple gestation births, whereas pulmonary hemorrhage was significantly higher in all multiple gestation births compared to singleton. We also found a significantly higher incidence of BPD among triplets or higher order multiples compared to singletons and a similar trend in twins when compared to singletons, but it was not statistically significant. Wadhawan et al. (31) looked at the short-term and long-term outcomes of more than 13 000 extremely LBW babies (birthweight 401-1000 g) born out of multiple births in participating centers of the Neonatal Research Network between 1996 and 2005. They reported a significantly higher need for surfactant therapy in twin and triplets compared to singletons, and also a
higher need for mechanical ventilation in triplets compared to singletons. They also had reported a higher incidence of BPD among twins, compared to triplets. These authors did not adjust for BW, GA or other confounding characteristics while reporting their short term clinical outcomes which could account for the difference in their outcomes compared to our results. Garg et al. (32) also have published the perinatal characteristics and neonatal outcome data of preterm singletons, twins, and triplets born at 22-31 weeks’ gestation from Australia in the years 1994-2005 after adjusting for birthweight percentile, GA and other population based characteristics. In this study, twins were more likely to have hyaline membrane disease compared to singletons. Surprisingly they have reported a lower rate of BPD in twins compared to the other groups. Neonatal practices and outcomes vary across the world. The neonatal practices in Australia in 1990’s and early 2000’s may be different from United states in the years 2000-2016, which could attribute to the difference in outcomes.

B) Intraventricular hemorrhage and Periventricular Leukomalacia:

In our study, the incidence of any IVH was significantly lower in twins compared to singletons, whereas the incidence of severe IVH, (grade 3 and 4) was significantly higher in twins compared to singletons. The difference in the incidence of any IVH or severe IVH was not statistically significant in triplets or higher order multiples compared to singletons. Kaufman and colleagues (33) had reported an increased incidence of mild IVH in triplets compared to singletons. Garg et al. (32) have reported similar severe IVH rates between singletons, twins, and triplets, whereas Yee and group (34) have reported a lower risk of IVH in triplet infants with BW < or = 1250 g, compared to singletons, and twins with similar BW and GA. The difference in outcomes between these studies could be related to the variation in the populations studied or the changes in the management practices in different neonatal units across the world over time. The incidence of PVL was significantly lower in triplets or higher order multiples compared to singletons, whereas there was no difference in PVL incidence when comparing twin gestation births to singleton. This was in contrast to Resch et al. (35), who reported a significantly higher incidence of PVL in twins and triplets, which may be explained due to this study reporting rates of PVL per pregnancy as opposed to per discharge record in our study. In addition, their sample size was relatively small. The protective effects of antenatal steroids in preventing IVH is well documented. Higher antenatal steroid coverage may be one of the reasons for lower IVH and PVL in triplets or higher order births.

C) Sepsis and Necrotizing enterocolitis:

In our study, the incidence of bacterial sepsis was significantly lower in twin gestation births compared to singleton. While other studies have reported similar rates of sepsis in multiple gestation births compared to singleton (36-38), the large sample size and adjustment for baseline characteristics may have allowed for this study to detect differences not previously noted.

The incidence of NEC was not significantly different between any of the three groups, although the severe NEC was marginally higher in the triplet or higher-order multiple group. Similar to our study, many of the previous studies have reported comparable rates of NEC among twins and triplets (19, 37-39).
D) Retinopathy of prematurity:

In our study, we found an increased rate of all stages of ROP in triplet or higher-order gestation births compared to singleton, although we did not find any significant difference in the incidence of severe ROP between the groups. Like our findings, Kaufman and colleagues (33) also have reported increased incidence of ROP in triplets, but they also found an increased incidence of severe ROP in triplets compared to singletons. Some other authors (38, 40) have also reported a significantly higher rate of advanced ROP (stages II-III) in singletons compared to multiple gestation births. Consistent with our findings, Garg et al. (32) have also reported a similar incidence of severe ROP among singletons, twins, and triplets. There has been an overall decline in incidence of severe ROP in recent years (41, 42), which may have contributed to the inability to detect differences in severe ROP in our study. The incidence of stage 3, 4, or 5 ROP was very low in our study (<0.40% in all groups). Improvements in neonatal practices, including better oxygen saturation targeting, which minimize repeat episodes of alternating hypoxia and hyperoxia may have led to a reduction in the incidence of severe ROP requiring intervention(41).

2) Mortality:

We found a higher incidence of mortality for twins and triplets compared to singletons among term babies, even after adjusting for baseline and hospital characteristics. In the preterm group, our analysis showed that adjusted odds of mortality were higher for triplets and higher-order births compared to singleton. However, adjusted odds of mortality were similar for twins and singletons. Heino et al analyzed the neonatal death from the Euro-Peristat project which included 5 million births from 29 countries and reported a pooled relative risk of 7.0 (95% CI 6.1-8.0) for neonatal mortality among multiple gestation births compared to singleton (14). Martin et al reported that mortality was higher for multiple gestation births compared with singletons when analyzing the birth data in the US for 1980-97 (17). Shinwell et al. also have reported an increased risk of death among triplets on his analysis on Israel's national very low birthweight (VLBW) infant database (43).

Several other reports suggested no significant increased risk of mortality among multiple births. In a retrospective, cohort study, which was matched for GA, sex and country of birth, Shah et al. analyzed the outcomes of a total of 6 079 triplets and 18 232 singletons of 24 to 32 weeks’ gestation or 500 to 1499 g (25). This study reported no significant difference in the primary outcome between triplets and singletons. Similarly, Garite et al. (19) reported no difference in mortality between the preterm singleton, twin or triplet infants born at 23 to 35 weeks of gestation.

In contrast to these reports, Russell et al., using National Center for Health Statistics data of the United States from 1980 to 1999, showed that VLBW and moderately LBW multiple gestation infants had a lower mortality rate than for singletons in similar BW categories (44). Jacquemyn et al. also have reported lower perinatal mortality in twins compared to singletons (36). The statistical methods used in these studies were considerably different which could account for the variations in the results.
3) **Length of stay:**

We found that the median LOS was significantly longer in multiple gestation births compared to the singleton overall, and also within each GA category. Only a very few studies with a relatively smaller sample size have compared the LOS between singletons and multiple gestation births, including twins, triplets and higher-order multiples. Vachharajani et al. (45), reported that twins and triplets had a longer LOS compared to singletons born at 34 weeks, but the LOS for twins and triplets was comparable to that of singletons at 35 weeks and 36 weeks. A few studies did not find any difference between singletons and multiple gestation births with regards to the LOS. Yee and colleagues have reported no difference in the mean LOS for twin and triplet infants compared with singletons (34). They had >1700 babies in their analysis and included babies ≤ 1250 grams. Qiu et al. (38) and Maayan-Metzger et al. (37) also found no difference in the duration of NICU stay between the singletons and multiple gestation births.

When we analyze the data from a large population-based data set, such as KID, demographic variables like the distribution of sex, race, primary insurance or payer, and the type of hospital may be significantly different among the groups. In addition, there are wide variations in neonatal practices, including prenatal care, resuscitation guidelines, ventilation strategies, and nutritional management among the newborn nurseries across the country. These differences in socio-demographic parameters and patient care variations may have played a significant role in determining the variable outcomes of these babies.

**Limitations:**

This study has limitations due to the retrospective administrative database-related limitations. The findings heavily rely on the accurate reporting of the ICD codes and other variables. There are additional limitations in the case of transfers since discharge records are not linked in KID. We accounted for this limitation by excluding discharge records with indicators for “transfer in” or “transfer out”. In doing so, it is possible that the LOS reported was inadvertently shorter since the sicker patients would be more likely to undergo transfer and the LOS from the multiple hospitalizations were not combined in the database. In addition, KID does not include neurodevelopmental outcomes, thus they were not analyzed. Furthermore, evidence exists to reflect the evolution of neonatal care over the years, including the years analyzed in this study between 2000 and 2016. This study could not account for advancements in clinical practice which could change the outcome of these babies over the time.

**Conclusion**

This study is the largest in the United States which compared morbidity, mortality, and LOS outcomes between singleton, twin, triplet and higher-order multiple births. Twin and triplet gestation patients are born at a younger GA compared to singleton. Multiple gestation births remain at higher risk for various morbidities and mortality compared to singletons, even after adjusting for baseline characteristics. The LOS for multiple gestation births is higher compared to singleton of the similar GA.
Abbreviations

KID : Kid's inpatient database
IUGR : Intra Uterine Growth Restriction
SGA : Small for Gestational Age
LBW: Low Birth weight
LOS: Length of Stay
PMA: Post Menstrual Age
RDS: Respiratory Distress Syndrome
NEC: Necrotizing Entero Colitis
IVH: Intra Ventricular Hemorrhage
PVL : Periventricular leukomalacia
ROP: Retinopathy of prematurity
BPD: Bronchopulmonary dysplasia
GA: Gestational Age
BW: Birth Weight

Declarations

Conflict of Interest:
Authors hereby declare that we do not have any competing financial interests in relation to the work described above.

Ethics approval and consent to participate:
Our study was determined to be exempt by the University of Mississippi Medical Center Institutional Review Board.

Funding:
We received no funding for the analysis or preparation of this manuscript.

Author's Contributions:
JP did the statistical analysis with help from JD and wrote the first draft of the manuscript along with RK. The manuscript was revised based on feedback and help from JD, AK and ND

Acknowledgements: None

Consent for publication: Not applicable.

Availability of data and materials

The entire data set that was used for analysis is publicly available for purchase at https://www.hcups-us.ahrq.gov/kidoverview.jsp through Agency for Healthcare Research and Quality. The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

 Synopsis

We compare morbidity, mortality, and length of stay (LOS) outcomes between multiple gestation (twin, triplet and higher-order) and singleton births using Healthcare Cost and Utilization Project Kids’ Inpatient Database for the years 2000, 2003, 2006, 2009, 2012, and 2016. We found that multiple gestation births have higher mortality and longer LOS when compared to singleton births. This difference remained significant within each GA category.

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Tables
Table 1: Cohort extraction: Baseline characteristics of the cohort
| Characteristic          | Category   | Singletons | Twins   | Triplets or More | p-value |
|------------------------|------------|------------|---------|------------------|---------|
| Gestational age        | <24 weeks  | 20277 (0.09%) | 4816 (0.71%) | 713 (2.48%) |         |
|                        | 24 weeks   | 7458 (0.03%) | 1873 (0.28%) | 245 (0.85%) | <.0001 |
|                        | 25-26 weeks| 18338 (0.08%) | 4694 (0.69%) | 676 (2.35%) |         |
|                        | 27-28 weeks| 26293 (0.12%) | 7876 (1.17%) | 1325 (4.62%) |         |
|                        | 29-30 weeks| 40542 (0.18%) | 13722 (2.03%) | 2526 (8.80%) |         |
|                        | 31-32 weeks| 81279 (0.37%) | 31474 (4.66%) | 4741 (16.51%) |         |
|                        | 33-34 weeks| 224024 (1.01%) | 77985 (11.54%) | 6888 (23.99%) |         |
|                        | 35-36 weeks| 603530 (2.72%) | 149048 (22.05%) | 3735 (13.01%) |         |
| Preterm but GA Unknown |            | 287185 (1.30%) | 65088 (9.63%) | 6312 (21.98%) |         |
|                        | >37 weeks  | 20839514 (94.09%) | 319393 (47.25%) | 1554 (5.41%) |         |
| Total                  |            | 22148440 (100.00%) | 675969 (100.00%) | 28716 (100.00%) |         |
| IUGR or SGA            | Yes        | 367274 (1.66%) | 45653 (6.75%) | 1856 (6.46%) | <.0001 |
| Sex                    | Female     | 10843182 (49.02%) | 336883 (49.89%) | 14295 (49.83%) | <.0001 |
|                        | Male       | 11274557 (50.98%) | 338380 (50.11%) | 14393 (50.17%) |         |
| Total                  |            | 22117739 (100.00%) | 675263 (100.00%) | 28687 (100.00%) |         |
| Race/Ethnicity         | White      | 9579294 (52.79%) | 330163 (59.27%) | 16247 (70.15%) | <.0001 |
|                        | Black      | 2461724 (13.57%) | 85412 (15.33%) | 2306 (9.96%) |         |
|                        | Hispanic   | 4004551 (22.07%) | 82669 (14.84%) | 2435 (10.51%) |         |
|                        | Asian/Pacific Islander | 881691 (4.86%) | 23992 (4.31%) | 833 (3.60%) |         |
|                        | Native American | 124300 (0.59%) | 3261 (0.59%) | 105 (0.45%) |         |
| Region of hospital | Northeast | 3672279 (16.58%) | 133246 (19.71%) | 6370 (22.18%) | <.0001 |
|--------------------|-----------|------------------|-----------------|-------------|--------|
| Midwest            | 4767208   | 151710 (22.44%)  | 7074 (24.63%)   |             |        |
| South              | 8412784   | 243999 (36.10%)  | 9614 (33.48%)   |             |        |
| West               | 5296168   | 147014 (21.75%)  | 5657 (19.70%)   |             |        |
| Total              | 22148440  | 675969 (100.00%) | 28716 (100.00%) |             |        |
| Hospital type      | Rural     | 2697153 (12.28%) | 50055 (7.48%)   | 467 (1.66%) | <.0001 |
|                    | Urban nonteaching | 8756542 (39.88%) | 231462 (34.61%) | 6694 (23.80%) |       |
|                    | Urban teaching | 10502357 (47.83%) | 387322 (57.91%) | 20962 (74.54%) |     |
|                    | Total       | 21956052 (100.00%) | 668839 (100.00%) | 28123 (100.00%) |      |
| Bed size of hospital | Small    | 2524672 (11.50%) | 59158 (8.84%)   | 1227 (4.36%) | <.0001 |
|                    | Medium     | 5918612          | 165112          | 5131        |        |
| Delivery type | NSVD       | CS         | Total       |
|---------------|------------|------------|-------------|
|               | (71.01%)   | (28.99%)   | (100.00%)   |
| Large         | 13512768   | 444569     | 21765       |
|               | (61.54%)   | (66.47%)   | (77.39%)    |
| Total         | 21956052   | 668839     | 28123       |
|               | (100.00%)  | (100.00%)  | (100.00%)   |
| NSVD          | 15728662   | 192045     | 1686        |
|               | (71.01%)   | (28.41%)   | (5.87%)     | <.0001      |
| CS            | 6419778    | 483924     | 27030       |
|               | (28.99%)   | (71.59%)   | (94.13%)    |
| Total         | 22148440   | 675969     | 28716       |
|               | (100.00%)  | (100.00%)  | (100.00%)   |

Table 2: The results of comparison of the rate of morbidities between three groups after controlling for baseline characteristics in multivariate survey logistic models with adjusted odds ratios (referenced as a singleton) in the forest plot along with significant p-values.
1. Weighted frequency (column percent, row percent)

2. Odds ratio adjusted for baseline characteristics including gestational age, IUGR or SGA, gender, race, primary expected payer, the region of hospital, hospital type, bedsize of the hospital and delivery type.

Table 3: The results of comparison of median length of stay for singletons, twins, and higher order gestations after controlling for baseline characteristics.
| Gestational age | Singleton Median [IQR] | Twin Median [IQR] | Triplet or More Median [IQR] | \( p \)-Value |
|-----------------|------------------------|-------------------|-----------------------------|--------------|
| <24 weeks       | 118.25 [102.89, 135.90] | 121.74 [108.98, 144.31] | 119.13 [103.12, 133.52] | 0.0314       |
| 24 weeks        | 105.64 [92.39, 122.88]  | 112.53 [97.01, 130.71] | 118.84 [99.34, 139.54]   | <.0001       |
| 25-26 weeks     | 86.80 [73.97, 102.63]   | 89.66 [76.71, 106.02] | 93.50 [81.58, 112.50]    | <.0001       |
| 27-28 weeks     | 63.58 [53.24, 76.24]    | 65.44 [54.93, 77.99] | 67.18 [57.36, 81.36]     | <.0001       |
| 29-30 weeks     | 43.13 [35.17, 52.99]    | 44.68 [36.69, 54.57] | 45.90 [38.58, 55.91]     | <.0001       |
| 31-32 weeks     | 24.94 [18.46, 33.10]    | 26.93 [20.60, 34.64] | 28.91 [22.62, 36.25]     | <.0001       |
| 33-34 weeks     | 11.11 [6.62, 16.65]     | 13.32 [8.89, 18.52] | 15.45 [11.26, 20.73]     | <.0001       |
| 35-36 weeks     | 2.53 [1.59, 5.06]       | 3.39 [2.35, 6.46]  | 5.02 [3.39, 9.99]         | <.0001       |
| >37 weeks       | 1.57 [1.12, 2.05]       | 2.53 [1.80, 3.31]  | 3.51 [2.82, 5.51]         | <.0001       |
| Preterm GA Unknown | 5.81 [2.50, 13.67]       | 10.39 [3.45, 33.46] | 38.63 [18.92, 69.64]      | <.0001       |

**Figures**
Figure 1

The number of discharge records at each stage of cohort extraction are presented

**Supplementary Files**

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