The Impact of Severe Maternal Morbidity on Very Preterm Infant Outcomes

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Abstract

Objective: To estimate the prevalence of severe maternal morbidity (SMM) among very preterm births and determine its association with very preterm infant mortality and morbidity.

Study design: This study used New York City Vital Statistics birth and death records linked with maternal and newborn discharge abstract data for live births between 2010 and 2014. We included 6901 infants without congenital anomalies born between 24^{+0} and 31^{+6} weeks of gestation. SMM was identified as life-threatening conditions or life-saving procedures. Outcomes were first-year infant mortality, severe neonatal morbidity (bronchopulmonary dysplasia, severe necrotizing enterocolitis, Stage 3–5 retinopathy of prematurity and intraventricular hemorrhage Grades 3–4) and a combined outcome of death or morbidity.

Results: 12% of very preterm live-born infants had a mother with SMM. Maternal and pregnancy characteristics associated with occurrence of SMM were multiparity, being non-Hispanic black and preexisting health conditions, but gestational age and the percentage small for gestational age did not differ. Infants whose mothers experienced SMM had higher first-year

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mortality, 11.2% versus 7.7% without SMM, yielding a relative risk of 1.39 (95% confidence interval: 1.14–1.70) after adjustment for maternal characteristics, preexisting co-morbidities, pregnancy complications and hospital factors. Severe neonatal morbidity was not associated with SMM.

Conclusions: Severe maternal morbidity is an independent risk factor for mortality in the first year of life among very preterm infants after consideration of other maternal and pregnancy risk factors.

Severe maternal morbidity, defined as a life-threatening diagnosis or a lifesaving procedure during the delivery hospitalization (1, 2) occurs more frequently in very preterm than term deliveries. In high income countries, 1–2% of women experience SMM during their delivery hospitalization, with an estimated 20% of cases occurring before 31^{+6} weeks of gestation (3). There has been a significant focus on the life threatening nature of SMM for moms, but no inquiry on how it impacts vulnerable very preterm babies. Very preterm babies account for over one-half of infant deaths and face high risks of morbidity and developmental impairment (4–7).

Research on mothers and very preterm infants is often conducted in silos and therefore it is not known what percent of very preterm infants have a mother who experiences a severe morbid event. This information may be particularly relevant for very preterm infants because the context and events around birth, including the quality of obstetrical management, are determinant for their prognosis (8–12). Sub-optimal care during the delivery hospitalization has been shown to raise a mother's risks of SMM (13, 14) and this may extend to higher risks for her infant. SMM could also be a marker for the severity of some pregnancy complications which have a negative impact on the infant.

Our goal was to estimate the prevalence of SMM among births before 31^{+6} weeks of gestation, to identify risk factors for co-occurrence of SMM in the setting of very preterm birth and to investigate its association with risks of infant mortality and severe neonatal morbidity.

Methods

We used New York City Vital Statistics birth and death records linked with New York State discharge abstract data, The Statewide Planning and Research Cooperative System (SPARCS), for all live births in New York City hospitals in the years 2010 to 2014. The New York State Department of Health and Human Services linked the data using a probabilistic linking methodology and more than 98% of all infant records were linked to vital statistics data and a further 98% of maternal discharge abstracts were linked with infant records. The linked dataset included birth data, death data, and the infant's and mother's hospital discharge records for all infants born from 2010 to 2014 who were discharged by December 31, 2014, and all infant deaths from 2010 to 2015. Institutional Review Board approvals were obtained from the New York City Department of Health and Mental Hygiene, the New York State Department of Health, and the Icahn School of Medicine at Mount Sinai.

The study population included births without congenital anomalies between 24^{+0} and 31^{+6} weeks of gestation (6901 infants who were born to 6138 mothers). We focused on very preterm births, defined as births under 31^{+6} weeks (15) as these infants face highest risks of mortality and morbidity, and care quality in the perinatal period has been associated with their risks of mortality and morbidity (8–12). We excluded births less than 24^{+0} weeks of gestational age and those with congenital anomalies because of their high risks of mortality and the possibility that death may have reflected a decision to abstain from active treatment. Cases with congenital anomalies were excluded based on diagnosis codes from the infant's SPARCS record, following previous studies (16, 17).

Our primary outcome variable was first year mortality, including deaths in-hospital and after discharge. We also investigated severe neonatal morbidity, defined by the presence on the infant birth hospital record of the ICD-9 codes of any of the following diagnoses: bronchopulmonary dysplasia, necrotizing enterocolitis (Unspecified, Stage 2–3, Laparotomy), retinopathy of prematurity (Stage 3–5), intraventricular hemorrhage (Grade 3–4), as in previous studies (18, 19); detailed codes are provided in Table 1 (available at www.jpeds.com). We created a composite variable of either first-year death or any neonatal morbidity during the delivery hospitalization. We assumed that children discharged home without these diagnoses were at very low risk of developing them after discharge.

We used a published algorithm to identify severe maternal morbidity, using diagnoses for life-threatening conditions and procedure codes for life-saving procedures defined by investigators from the Centers for Disease Control and Prevention (20, 21). The algorithm excludes severe maternal diagnoses for hospitalizations with a short length of stay in order to reduce misclassification associated with coding errors. A short length of stay is defined as less than the 90th percentile corresponding to   2 days for vaginal,   4 days for primary cesarean, and   3 days for repeat cesarean deliveries) However, length of stay reclassification is not applied to in-hospital maternal deaths, transfers or delivery hospitalizations with severe complications identified by procedure codes (20). We calculated in-hospital stay based on postpartum stay, as done by other researchers developing SMM indicators (22). Because pregnant women with high risk pregnancies can have long antenatal hospitalizations unrelated to severe maternal morbidity, postpartum stay is more relevant for our population. As this deviates from the published algorithm, we also computed SMM using total hospital stay and found an almost identical proportion of SMM cases.

Co-variables included socioeconomic and clinical characteristics known to influence both maternal and infant outcomes that were available on the birth certificate, including self-identified race and ethnicity, maternal age, country of birth, multiple pregnancy, history of previous cesarean delivery, body mass index and prenatal care. Maternal co-morbidities were ascertained from the mother's SPARCS record as well as the birth certificate in order to maximize sensitivity of our measures (23). We included medical risk factors that could lead to maternal morbidity, but were likely present on admission to the hospital (e.g., diabetes, hypertension, disorders of placentation) (24, 25). We also took into consideration newborn characteristics in our models, including gestational age, sex and small for gestational age based on US birthweight charts (26). We also described mode of delivery, but did not include it in our models as we did not have information on its timing with respect to

SMM. Finally, we included hospital characteristics, including public/private ownership and nursery level.

Missing data were infrequent in this dataset; variables with the most missing data were the number of prenatal visits (3.9%), maternal prepregnancy body mass index (1.6%) and maternal educational level (0.8%).

Statistical Analyses

We first estimated the prevalence of SMM in our very preterm cohort, defined as the percent of newborns who had a mother with SMM. To assess risk factors for co-occurrence of SMM, we described the distribution of co-variables among newborns with and without mothers with SMM and modeled adjusted risk ratios, considering demographic and social variables and pregnancy complications. To evaluate the impact of SMM on infant outcomes, we compared our outcomes based on SMM co-occurrence using Chi squared tests. We then estimated risk ratios, adjusting for maternal, infant and hospital factors and taking into consideration clustering within hospitals and within multiple pairs (27, 28). Adjusted relative risks were derived using a modified Poisson regression model with robust standard errors (27, 28). To describe risks of mortality over time, we constructed Kaplan-Meier survival curves and survival estimates over the first six months of life were derived from the life table. Log rank tests were used to compare survival. We also looked at the proportion of deaths occurring before and after discharge from hospital. We used SAS 9.4 for all analyses.

Results

In our cohort of births between 24^{+0} and 31^{+6} weeks of gestation, 843 of 6901 (12.2%) of infants had a mother with a severe morbid event. Co-occurrence of SMM occurred more often among infants with older, multiparous and non-Hispanic black mothers, as shown in Table 2. Other sociodemographic characteristics and prenatal care visits were not significantly different. Pregestational diabetes, hypertensive disorders and preeclampsia and higher order multiple pregnancies were associated with SMM, and chorioamnionitis and gestational diabetes were similar in the 2 groups, and preterm premature rupture of membranes and precipitous labor were more common in preterm births without SMM. There were more cesarean deliveries among cases with SMM. The gestational age and percentage of small for gestational age infants did not differ by occurrence of SMM. There was also no difference in the distribution of SMM and non-SMM cases in public vs. private hospitals, but SMM cases occurred more often in hospitals with higher level nurseries.

In adjusted models (Table 3), older maternal age, multiparity, non-Hispanic black race/ ethnicity and pregestational diabetes and hypertension were related to a higher likelihood of co-occurrence of SMM. Prepregnancy obesity was negatively related to the probability of co-occurrence of SMM.

First-year mortality was higher for infants with a mother who experienced SMM: 11.2% versus 7.7% when SMM did not occur ($P< .001$). A majority of deaths in both groups took place in the first week, but relative risks remained elevated after delivery: mortality in the first day of life was 2.5% versus 1.9% (p=0.004) for children born to mothers with and

without SMM and 6.8% versus 4.6% (p=0.004) over the next six days respectively, as reported in the Figure, which shows mortality risks over the first six months. Almost all first year deaths occurred within this time frame. The proportion of deaths that occurred during the neonatal hospitalization versus after discharge was similar: 92.9% of babies in the SMM group and 92.2 % in the group without SMM.

Adjusting for sociodemographic, clinical and hospital factors reduced the relative risk of first year mortality associated with SMM from 1.47 (95% CI 1.15–1.84) to 1.39 (95% CI 1.14–1.70). Severe neonatal morbidity was not associated with the occurrence of SMM in unadjusted or adjusted models and SMM was not significant in the composite mortality and morbidity model (Table 4).

Discussion

Severe maternal morbidity occurred in 12% of very preterm live births and was associated with a 39% increased risk of infant death after adjustment for sociodemographic and clinical factors. These higher mortality risks were constant across the first 6 months of life. SMM was unrelated to gestational age or growth restriction, the main prognostic factors for very preterm mortality. By identifying SMM as a risk factor for these infants, our study raises the possibility that quality initiatives targeting SMM could achieve reductions in their mortality.

Our results are consistent with a Canadian study that found higher mortality among infants admitted to a neonatal unit when mothers were also admitted to an intensive care unit (29), but few studies have investigated the association between maternal morbidity and very preterm outcomes. The relatively high occurrence of SMM in our study is concordant with research showing that many cases of SMM are associated with very preterm delivery (30). In addition, mortality rates are in line with those reported in other cohorts of non-anomalous live births between 24+0 and 31+6 weeks of gestation (31, 32).

Our results corroborate studies showing that older maternal age, being non-Hispanic black and hypertensive disorders are risk factors for SMM (14, 24). In contrast, maternal education, number of prenatal visits, gestational age and growth restriction were not associated with SMM among very preterm births. Obesity was negatively associated with SMM risk, after adjustment for pregnancy complications such as hypertension and diabetes, which may reflect the high risk of spontaneous extremely preterm delivery among obese women (33–35). Cesarean delivery was more common in SMM cases, as seen in other studies (36, 37).

SMM did not affect risks of severe neonatal morbidity. If mortality risks are raised among the most vulnerable infants, survivors may be less likely to experience morbidity, giving the erroneous impression that morbidity risk is not impacted by SMM. Alternatively, SMM could truly have a lesser impact on morbidity risk; some studies have found that composite morbidity measures containing similar pathologies were less sensitive to perinatal management than mortality (9, 38). Additionally, there may be an impact on other morbidities, such as sepsis, which affect risks of death (39, 40), but cannot be measured reliably with hospital discharge data (41).

There are several explanations for the association between SMM and infant mortality. Quality of care is a determinant of adverse maternal as well as very preterm outcomes (9, 13), including in our prior research in New York City (14, 17). Higher risks for infants could be observed if poorly performing hospitals for mothers also performed poorly for babies, as suggested in a previous study which found a correlation between hospital performance for SMM and term newborn morbidity (25). Future research on SMM and infant outcomes should include an expanded population of moderate preterm and term infants to evaluate whether these adverse effects are observed after the very preterm period.

Another explanation could be a negative impact of some maternal complications, such as preeclampsia or placental abruption, which increase risks for an SMM event and are also at the origin of the preterm birth. However, although these complications are risk factors for poor outcome in general population studies (42, 43), research on very preterm infants has not shown that they increase mortality risks (44), although abruption may be related to neonatal morbidity (45). It is possible, nonetheless, that SMM may be a marker of the severity of some complications which are poorly captured by available data on co-morbidities.

Our study calls attention to the relevance of a research framework based on the mother-child dyad. This paradigm could have broader application. For instance, SMM may have longer-term effects on very preterm children's health and development. It is negatively associated with breastfeeding (46), which requires initiation and frequent milk expression soon after delivery, and leads to longer maternal hospitalization, often in a different facility (29), which could affect the process of bonding with the newborn. More broadly, mothers who experience severe maternal morbidity may be at increased risk for postpartum depression or suffer from other health sequelae which could impact the mother-baby relationship (47, 48). There is some evidence that maternal depression and anxiety are related to adverse developmental outcomes for children born very preterm (49). Furthermore, child outcomes may be associated with maternal risks of SMM or with maternal recovery and resilience after SMM, as suggested in the previously cited Canadian study, where the mother's risks of death in the ICU was higher when her infant was admitted to a neonatal intensive care unit (29).

This study's strengths are its population-based design, use of variables from hospital discharge and vital statistics, linkage of maternal and newborn data, the large sample enabling investigation of two uncommon outcomes and consideration of clustering within hospitals and multiple pairs. Because we had data on timing of death, we were able to compare changes in mortality risks over time; however, information on timing was not available for neonatal or maternal morbidities. Other limitations include the exclusion of stillbirths. Given that SMM may affect risks of intrapartum death, adding stillbirths could lead to a strengthening of the association between SMM and mortality. Further, coding errors for diagnoses and procedures are of concern when using hospital discharge and birth certificate data (50), although using both sources improves the sensitivity of data on maternal co-morbidites (23). Finally, it was not possible to differentiate between maternal and fetal indications for delivery.

Severe maternal morbidity occurred in over one in ten very preterm deliveries and was a risk factor for infant death, but not severe neonatal morbidity, after adjusting for other known prognostic factors. Further investigation is needed to understand the causes of this excess mortality risk in order to develop strategies to improve perinatal management. These results should encourage researchers to include data on maternal outcomes related to childbirth in research network databases and cohort studies of very preterm infants.

Acknowledgments

List of abbreviations

SPARCS   Statewide Planning and Research Cooperative System

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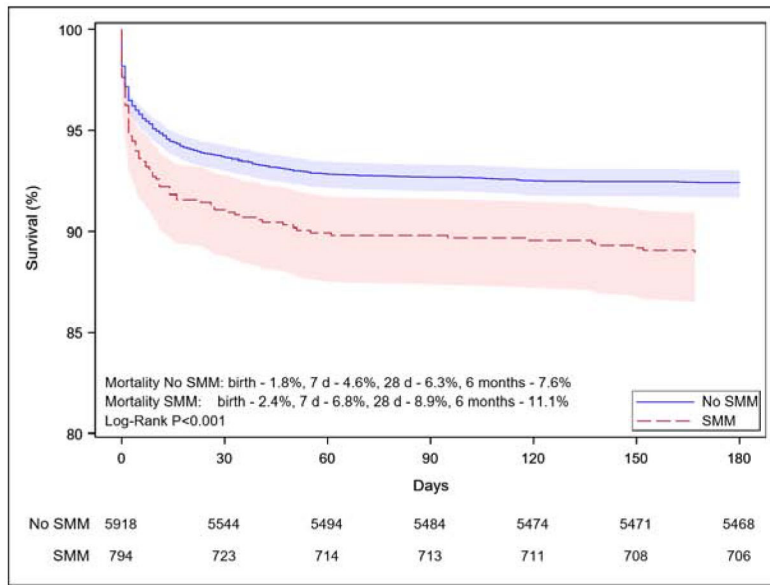
Figure.
Infant survival over the first six months of life by occurrence of severe maternal morbidity

Table 1

(on-line) Severe neonatal morbidity ICD-9 diagnosis and procedure codes

Outcome	Subgroup	ICD-9 code
BPD		770.7
NEC		
	NEC_unspec	777.5
	NEC_stage2	777.52
	NEC_stage3	777.53
	Laparotomy	456, 4561, 4562, 4563, 457, 4571, 4572, 4573, 4574, 4575, 4576, 4579, 458, 459, 4590, 4591, 4592,4593, 4594, 4595, 460, 4601, 4602, 4603, 4604, 4605, 461, 4610, 4611, 4613, 4614, 462, 4620, 4621 4622, 4623, 4624, 463, 4631, 4632, 4639, 464, 4640, 4641, 4642, 4643, 468, 4680, 4681, 4682, 4685, 4686, 4687, 541, 541,5411, 5412, 5419
ROP		
	ROP_stage3	362.25
	ROP_stage4	362.26
	ROP_stage5	362.27
	ROP_surg	142, 1421, 1422, 1423, 1424, 1425, 1426, 1427, 1429, 1434, 144, 1441, 1449, 145, 1451, 1452, 1453, 1454, 1455, 1459
IVH		
	IVH_grade3	772.13
	IVH_grade4	772.14

TABLE 2.

Characteristics of live born very preterm newborns overall and by whether their mother had severe maternal morbidity (SMM)

	All newborns	Mother without SMM	Mother with SMM	P value
	n (%)	n (%)	n (%)	
Total	6901 (100)	6057 (87.8)	843 (12.2)	
Mother's age				<0.001
<20	369 (5.4)	339 (5.6)	30 (3.6)	
20–34	4620 (67.0)	41056 (67.8)	515 (61.1)	
35–39	1400 (20.3)	1187 (19.6)	213 (25.3)	
40 or older	512 (7.4)	427 (7.0)	85 (9.1)	
Parity				<0.001
Nulliparous	3060 (44.3)	2757 (45.5)	303 (35.9)	
Multiparous	3819 (55.3)	3288 (54.3)	531 (63.0)	
Mother's race				0.008
Non-Hispanic black	2639 (38.2)	2274 (37.5)	365 (43.3)	
Hispanic	2089 (30.3)	1842 (30.4)	247 (29.3)	
Non-Hispanic white	1385 (20.1)	1241 (20.5)	144 (17.1)	
Asian	749 (10.9)	669 (11.0)	80 (9.5)	
Mother's education				0.9à
Less than high school	1557 (22.6)	1365 (22.5)	192 (22.8)	
High school	1608 (23.3)	1416 (23.4)	192 (22.8)	
Greater than high school	3682 (53.4)	3241 (53.5)	443 (52.6)	
Mother's insurance				0.07
Governmental	4209(61.0)	3665(60.5)	544(64.5)	
Commercial	2493(36.1)	2214(36.5)	279(33.1)	
Uninsured	199(2.9)	179(3.0)	20(2.4)	
Mother's prenatal visits				0.9
0–5	1923 (27.9)	1682 (27.8)	241 (28.6)	
6–8	2006 (29.1)	1760 (29.1)	246 (29.3)	
9 plus	2717 (39.4)	2394 (39.5)	323 (38.3)	
missing	255 (3.7)	222 (3.7)	33 (3.9)	
Smoked during pregnancy	270 (3.9)	238 (3.9)	32 (3.8)	0.90
Pre-pregnancy body mass index				0.55
Underweight (<18.5)	315(4.6)	278(4.6)	37(4.5)	
Normal weight (18.5–24.9)	3078(45.3)	2695(45.1)	383(46.8)	
Overweight (25.0–29.9)	1751(25.8)	1536(25.7)	215(26.3)	
Obese (30)	1655(24.3)	1472(24.6)	183(22.4)	
Plurality				
Singleton	5124 (74.3)	4506 (74.4)	618 (73.3)	0.02
Twins	1580 (22.9)	1393 (23.0)	187 (22.2)	
Triplets or quadruplets	197 (2.9)	159 (2.6)	38 (4.5)	

	All newborns	Mother without SMM	Mother with SMM	P value
	n (%)	n (%)	n (%)	
Vaginal delivery	2118 (30.7)	2040 (33.7)	78 (9.2)	<0.001
Cesarean section	4783 (69.3)	4018 (66.3)	765 (90.8)	<0.001
Trial of labor	672 (9.7)	574 (9.5)	98 (11.6)	0.001
Maternal complications				
Pregestational diabetes	185 (2.7)	140 (2.3)	45 (5.3)	<0.001
Gestational diabetes	676 (9.8)	591 (9.8)	85 (10.1)	0.76
Pregestational hypertension	592 (8.6)	472 (7.8)	120 (14.2)	<0.001
Gestational hypertension	1749 (25.3)	1449 (23.9)	300 (35.6)	<0.001
Preeclampsia	1243 (18.0)	1031 (17.0)	212 (25.2)	<0.001
Chorioamnionitis	1197 (17.4)	1059 (17.5)	138 (16.4)	0.42
Premature rupture of the membranes	2537 (36.8)	2331 (38.5)	206 (24.4)	<0.001
Precipitous labor	316 (4.6)	300 (5.0)	16 (1.9)	<0.001
Gestational age (wks)				
24–25	1014 (14.7)	899 (14.8)	115 (13.6)	
26–27	1283 (18.6)	1113 (18.4)	170 (20.2)	
28–29	1707 (24.7)	1487 (24.6)	220 (26.1)	
30–31	2897 (42.0)	2559 (42.2)	338 (40.1)	0.32
Infant small for gestational age [1]	911 (13.2)	785 (13.0)	126 (15.0)	0.11
Sex				
Female	3301 (47.8)	2871 (47.4)	430 (51.0)	
Male	3600 (52.2)	3187 (52.6)	413 (50.0)	0.05
Hospital characteristics				
Public	1364 (19.8)	1181 (19.5)	183 (21.7)	0.13
Private	5537 (80.2)	4877 (80.5)	660 (78.3)	
Nursery level				0.002
2	235 (3.4)	218 (3.6)	17 (2.0)	
3	3585 (52.0)	3177 (52.4)	408 (48.4)	
4	3081 (44.7)	2663 (44.0)	418 (50.0)	

Note:

[1]. Birthweight <10th percentile of US birthweight charts (26).

Table 3:

Characteristics associated with having a mother with SMM for very preterm newborns

	Unadjusted Risk Ratios with 95% CI	Adjusted Risk Ratios, with 95% CI[1]
Mother's age		
<20	0.72 (0.50–1.03)	0.79 (0.54–1.14)
20–34	Ref	Ref
35–39	1.34 (1.17–1.57)	1.29 (1.11–1.51)
40 or older	1.46 (1.17–1.83)	1.41 (1.12–1.78)
Parity		
Nulliparous	Ref	Ref
Multiparous	1.40 (1.23–1.60)	1.30 (1.13–1.50)
Mother's race		
Non-Hispanic black	1.33 (1.11–1.59)	1.27 (1.04–1.54)
Hispanic	1.14 (0.94–1.38)	1.13 (0.92–1.39)
Non-Hispanic white	Ref	Ref
Asian	1.03 (0.79–1.33)	1.00 (0.77–1.31)
Mother's education		
Less than high school	1.03 (0.88–1.20)	0.97 (0.81–1.17)
High school	0.99 (0.85–1.16)	0.94 (0.79–1.11)
Greater than high school	Ref	Ref
Mother's insurance		
Governmental	1.15 (1.01–1.32)	1.16 (0.98–1.37)
Commercial	Ref	Ref
Uninsured	0.90 (0.58–1.38)	0.92 (0.58–1.45)
Mother's prenatal visits		
0–5	1.05 (0.90–1.23)	1.02 (0.87–1.21)
6–8	1.03 (0.88–1.21)	1.01 (0.87–1.18)
9 plus	Ref	Ref
Smoked during pregnancy	0.97 (0.70–1.35)	1.01 (0.72–1.40)
Body mass index		
Underweight (<18.5)	0.92 (0.67–1.26)	1.02 (0.74–1.40)
Normal weight (18.5–24.9)	Ref	Ref
Overweight (25.0–29.9)	0.96 (0.82–1.12)	0.86 (0.73–1.01)
Obese (30)	0.86 (0.73–1.02)	0.72 (0.60–0.85)
Multiple pregnancy	1.06 (0.91–1.21)	1.05 (0.90–1.23)
Maternal complications		
Pregestational diabetes	2.05 (1.57–2.66)	1.76 (1.34–2.31)
Gestational diabetes	1.03 (0.83–1.27)	1.00 (0.80–1.25)
Pregestational hypertension	1.77 (1.49–2.10)	1.29 (1.05–1.58)
Gestational hypertension	1.63 (1.42–1.85)	1.20 (0.95–1.52)
Preeclampsia	1.53 (1.32–1.76)	1.14 (0.90–1.46)
Chorioamnionitis	0.93 (0.79–1.11)	1.08 (0.90–1.29)

	Unadjusted Risk Ratios with 95% CI	Adjusted Risk Ratios, with 95% CI[1]
Premature rupture of the membranes	0.56 (0.48–0.65)	0.60 (0.51–0.71)
Precipitous labor	0.40 (0.25–0.65)	0.45 (0.28–0.73)
Newborn characteristics		
Gestational age (wks)		
24–25	0.97 (0.80–1.19)	1.15 (0.93–1.42)
26–27	1.14 (0.96–1.35)	1.20 (1.00–1.43)
28–29	1.10 (0.94–1.29)	1.14 (0.97–1.34)
30–31	Ref	Ref
Small for gestational age[2]	1.15 (0.97–1.38)	0.89 (0.74–1.07)
Sex		
Female	Ref	Ref
Male	0.88 (0.77–1.00)	0.93 (0.82–1.05)
Hospital characteristics		
Public	1.13 (0.97–1.31)	1.08 (0.91–1.29)
Private	Ref	
Nursery level		
2	Ref	
3	1.57 (0.99–2.51)	1.53 (0.94–2.49)
4	1.88 (1.18–2.99)	1.88 (1.16–3.06)

Note:

[1] Adjusted for all variables in table;

[2] <10th percentile of US birthweight charts.(26)

Table 4.

Impact of occurrence of severe maternal morbidity on very preterm outcomes

Neonatal outcomes	Mother without SMM n (%)	Mother with SMM n (%)	p-value	Unadjusted RR	95%CI	Adjusted RR[1]	95%CI
1 year mortality	462 (7.8)	91 (11.4)	<0.001	1.47	1.17–1.83	1.39	1.14–1.70
Severe neonatal morbidity	1294 (21.9)	178 (22.4)	0.75	1.02	0.87–1.20	0.97	0.85–1.11
Composite death or morbidity	1615 (27.3)	249 (31.3)	0.02	1.15	1.04–1.31	1.10	0.99–1.22

NOTE:

[1]. Adjusted for variables in Table 2 and controlling for clustering patients within the hospital of delivery and multiples.