
OBSTETRICS

Neonatal Sepsis and Outcomes of Maternal Group B Streptococcus Colonization in Preterm Birth

Chanikarn Rungvachira, M.D.*,
Siriporn Trainak, M.D.*

** Department of Obstetrics and Gynecology, Chonburi Hospital, Chonburi, Thailand*

ABSTRACT

Objectives: To evaluate the association between maternal group B Streptococcus (GBS) colonization in preterm birth and neonatal outcomes.

Materials and Methods: A single-center retrospective paired cohort study was conducted at Chonburi Hospital, Thailand, from January 2014 to December 2024. Pregnant women admitted with preterm labor and delivery who underwent recto-vaginal swab culture were included. Pregnant women were categorized into two group based on GBS cultured status. Maternal and neonatal outcomes were compared between group. For adjusted analyses, GBS-positive mothers were matched 1:1 with GBS-negative mothers by year of recto-vaginal swab collection and gestational age at delivery. Logistic regression was performed to identify independent risk factors for neonatal sepsis in paired cohort.

Results: Among 3,895 women with preterm delivery, 114 mothers (2.9%) were colonized with GBS, accounting for 123 neonates. In the unpaired analysis, neonatal sepsis did not differ significantly between neonates born to GBS-positive and GBS-negative mothers (33.9% vs 36.5%, $p = 0.556$). The rate of stillbirth occurred more among GBS-positive mothers. In the paired cohort of 114 matched maternal pairs and their neonates, maternal GBS colonization was not independently associated with neonatal sepsis or other neonatal morbidities. Multivariable analysis identified lower gestational age and birth weight between 1.5–2.5 kg as an independent risk factors for neonatal sepsis.

Conclusion: Maternal GBS colonization in preterm birth was not an independent risk factor for neonatal sepsis. Neonatal sepsis was primarily related to prematurity-associated factors, while stillbirth was more frequent among GBS-positive mothers.

Keywords: preterm birth, preterm labor, group B Streptococcus, neonatal sepsis, neonatal outcome

Correspondence to: Chanikarn Rungvachira, M.D., Department of Obstetrics and Gynecology, Chonburi Hospital, Chonburi, Thailand. E-mail: oomii.z_@hotmail.com

Received: 29 September 2025, **Revised:** 23 February 2026, **Accepted:** 30 March 2026

ภาวะติดเชื้อทารกแรกเกิดและผลต่อทารกเกิดก่อนกำหนดในมารดาที่มีเชื้อสเตรปโตคอคคัสกรู๊ปบี

ชนิกานต์ รุ่งวชิรา, สิริพร ไตรนาถ

บทคัดย่อ

วัตถุประสงค์: เพื่อประเมินความสัมพันธ์ระหว่างการตรวจพบเชื้อสเตรปโตคอคคัสกรู๊ปบีในมารดาที่มีภาวะคลอดก่อนกำหนดกับผลลัพธ์ของทารกแรกเกิด

วัสดุและวิธีการ: เป็นการศึกษาเชิงพรรณนาแบบจับคู่ย้อนหลัง โดยรวบรวมมารดาที่มีประวัติการเจ็บท้องและคลอดก่อนกำหนดที่ได้รับการตรวจเพาะเชื้อทางช่องคลอด จากประวัติการคลอดและเวชระเบียนของโรงพยาบาลชลบุรี ตั้งแต่ มกราคม ปี พ.ศ. 2557 จนถึง ธันวาคม ปี พ.ศ. 2567 ทารกแรกเกิดจากมารดาที่ตรวจพบเชื้อสเตรปโตคอคคัสกรู๊ปบีจะถูกจับคู่กับทารกจากมารดาที่ไม่พบเชื้อ โดยทำการจับคู่ตามปีที่ตรวจเพาะเชื้อและอายุครรภ์ขณะคลอดในอัตราส่วน 1:1 ข้อมูลของมารดาและทารก ผลกระทบต่อทารกที่เกิดก่อนกำหนด รวมถึงการติดเชื้อของทารกแรกเกิดจะถูกนำมาวิเคราะห์หาความสัมพันธ์กับเชื้อสเตรปโตคอคคัสกรู๊ปบี นอกจากนี้มีการใช้การวิเคราะห์ถดถอยโลจิสติก (logistic regression) เพื่อหาปัจจัยเสี่ยงที่สัมพันธ์กับการเกิดภาวะติดเชื้อในทารกแรกเกิด

ผลการศึกษา: จากสตรีตั้งครรภ์ที่มีภาวะคลอดก่อนกำหนดทั้งหมด 3,895 ราย พบมารดาที่ตรวจพบเชื้อสเตรปโตคอคคัสกรู๊ปบีจำนวน 114 ราย (ร้อยละ 2.9) ซึ่งให้กำเนิดทารกแรกเกิด 123 ราย ในการวิเคราะห์แบบไม่จับคู่ อุบัติการณ์ของภาวะติดเชื้อในทารกแรกเกิดไม่แตกต่างกันอย่างมีนัยสำคัญระหว่างทารกที่เกิดจากมารดาที่ตรวจพบเชื้อสเตรปโตคอคคัสกรู๊ปบีและไม่พบเชื้อ (ร้อยละ 33.9 เปรียบเทียบกับ 36.5, $p = 0.556$) อย่างไรก็ตาม อัตราการตายคลอดพบสูงกว่าในกลุ่มมารดาที่ตรวจพบเชื้อสเตรปโตคอคคัสกรู๊ปบี หลังการจับคู่มารดา 114 คู่ ไม่พบว่าการตรวจพบเชื้อ สเตรปโตคอคคัสกรู๊ปบีในมารดามีความสัมพันธ์อย่างอิสระกับภาวะติดเชื้อหรือความเจ็บป่วยอื่นๆ ของทารกแรกเกิด การวิเคราะห์ถดถอยโลจิสติก (logistic regression) พบว่า อายุครรภ์ที่น้อย และน้ำหนักแรกเกิด 1.5–2.5 กิโลกรัม เป็นปัจจัยเสี่ยงอิสระต่อการเกิดภาวะติดเชื้อในทารกแรกเกิด

สรุป: การตรวจพบเชื้อสเตรปโตคอคคัสกรู๊ปบี ในมารดาที่มีภาวะคลอดก่อนกำหนดไม่พบว่าเป็นปัจจัยเสี่ยงอิสระต่อการเกิดภาวะติดเชื้อในทารกแรกเกิด โดยภาวะติดเชื้อสัมพันธ์กับปัจจัยที่เกี่ยวข้องกับการคลอดที่อายุครรภ์น้อย และน้ำหนักแรกเกิดน้อย อย่างไรก็ตาม พบว่ามีอัตราการตายคลอดที่สูงกว่าในกลุ่มมารดาที่ตรวจพบเชื้อสเตรปโตคอคคัสกรู๊ปบี

คำสำคัญ: การคลอดก่อนกำหนด, การเจ็บครรภ์คลอดก่อนกำหนด, เชื้อสเตรปโตคอคคัสกรู๊ปบี, ภาวะติดเชื้อในทารกแรกเกิด, ผลกระทบต่อทารกแรกเกิด

Introduction

Preterm birth, defined as delivery before 37 completed weeks of gestation, is a leading cause of neonatal morbidity and mortality globally. Approximately 13.4 million newborns were born preterm in 2020, accounting for 9.9% of all births⁽¹⁾. In Thailand, the proportion of preterm births accounted up to 18% for some provinces in 2023⁽²⁾. Preterm birth is also a major cause of children under-five mortality, along with intrapartum-related complications and infectious diseases⁽³⁾. Preterm neonates who survive remain have burdens from immediate complications such as respiratory distress syndrome, intraventricular hemorrhage, necrotizing enterocolitis and sepsis to long-term disabilities.

Many risk factors have been associated with preterm birth, including spontaneous preterm labor, preterm prelabor rupture of membranes, delivery for maternal or fetal indications, and higher-order multifetal pregnancies. Almost half of preterm births are from spontaneous preterm labor⁽⁴⁾. A study from tertiary hospital in Northeast Thailand found that spontaneous preterm birth accounted for up to 67% of all preterm births⁽⁵⁾. Infection is one of the major causes of spontaneous preterm labor and is also an important risk factor for neonatal infection, particularly group B *Streptococcus* (GBS).

GBS, a Gram-positive bacterium that colonizes in the maternal genital and gastrointestinal tracts, is known to contribute to adverse outcomes including preterm labor, premature rupture of membranes (PROM), and urinary tract infection. Vertical transmission during pregnancy or delivery can result in severe neonatal infections, including both early-onset and late-onset sepsis⁽⁶⁾. These complications carry high risks of morbidity and mortality in preterm infants whose immature organ systems render them more vulnerable.

The clinical significance of maternal GBS colonization has been supported by multiple studies worldwide. A systematic review and meta-analysis demonstrated that maternal GBS colonization increased the risk of preterm birth by nearly two-fold⁽⁷⁾. Further cohort studies in tertiary hospital in India and China

showed significant associations with neonatal systemic illness, pneumonia, and sepsis^(8,9). Research in Europe, nearly half of neonates diagnosed with invasive GBS disease were found to have been born to colonized mothers⁽¹⁰⁾. These findings suggest that maternal GBS colonization is not only linked to preterm delivery but also contributes to adverse neonatal outcomes.

Despite these global findings, data on the impact of maternal GBS colonization specifically in preterm births remains scarce in Thailand, and no published study has emerged from Chonburi Hospital. Therefore, this study aimed to evaluate the association between maternal GBS colonization and neonatal outcomes, including neonatal sepsis, among preterm infants in Thailand, to provide crucial local evidence for prevention and management strategies.

Materials and Methods

This study was a single-center retrospective paired cohort study conducted at Chonburi Hospital. The projected was approved by the Chonburi Hospital Institutional Ethics Committee (reference number 32/67/R/h2). Pregnant women admitted to Chonburi Hospital with a diagnosis of preterm labor and preterm delivery (record as ICD-10 O60.1) between January 1, 2014, and December 31, 2024 were included, provided that medical records and follow-up data were available in the electronic medical record system.

At our institution, universal antenatal screening for GBS at 36^{0/7}–37^{6/7} weeks of gestation is not routinely performed. Recto-vaginal swab cultures for GBS were obtained in women presenting with preterm labor who had unknown GBS status or whose previous GBS screening had been performed more than five weeks prior to admission. The recto-vaginal swab was collected at admission concurrently with investigations to identify other potential causes of preterm labor, including complete blood count and urinalysis. Intrapartum antibiotic prophylaxis was administered to women with preterm labor who progressed to the active phase of labor, defined as cervical dilatation greater than 4-6 cm. Ampicillin was used as the first-line antibiotic for GBS prophylaxis. In women with a documented penicillin

allergy, clindamycin was administered. When GBS was isolated, antimicrobial susceptibility testing was performed to confirm clindamycin sensitivity. The recto-vaginal swab collection rate among women presenting with preterm labor was nearly 100%.

We excluded patient who limited to obtain recto-vaginal swab examination due to imminent delivery, patient who threaten preterm labor but deliver term neonate and patient who induction preterm delivery due to maternal or fetal conditions.

Maternal data were extracted from medical records and included age, nation, body weight, height, gestational age at delivery, history of preterm, history of abortion, multiple gestation, duration of membrane ruptured to delivery, intrapartum antibiotic used, mode of delivery, antenatal corticosteroid used, maternal body temperature at admit, number of white blood cell in complete blood count, and GBS status from recto-vaginal swab culture.

Neonatal data were also extracted from medical records and included gender, Apgar score at 1 and 5 minutes, birth body weight, length of stays, admission, antibiotic used, and neonatal outcomes which were neonatal sepsis (record as ICD-10 P00.82, P02.7, P36.0, P36.1, P36.8, P36.9), suspected sepsis which diagnosed from neonates who had clinical sepsis and received antibiotic more than 48 hours, and congenital pneumonia (record as ICD-10 P23.3, P23.9).

Preterm delivery was defined as delivery occurring from gestational age of 24^{0/7} weeks or a birth weight $\geq$ 500 grams, up to 36^{6/7} weeks of gestation⁽¹¹⁾. Gestational age was determined based on the last menstrual period (LMP) or ultrasound, according to American College of Obstetricians and Gynecologists (Methods for Estimating the Due Date, ACOG committee opinion, Number700, May 2017⁽¹²⁾).

Preterm labor was defined as regular uterine

contractions leading to cervical change before a gestational age of 37^{0/7} weeks⁽¹¹⁾.

Recto-vaginal swab examination was performed using a sterile swab and a Stuart transport medium. The swab was first inserted approximately 2 cm into the vagina and withdrawn, then subsequently inserted approximately 1 cm into the anal canal. The swab was then placed into the transport medium and sent to the Chonburi Hospital laboratory for analysis (laboratory code 50023-141).

Early-onset sepsis was defined as the presence of clinical signs and symptoms of sepsis, including fetal tachycardia, tachypnea, poor feeding, and temperature instability, occurring within the first 7 days of life⁽¹³⁾.

Late-onset sepsis was defined as clinical signs and symptoms of sepsis occurring from 7 to 90 days of age⁽¹³⁾.

Suspected sepsis, according to the American Academy of Pediatrics (AAP) guidelines, refers to the management of neonates with suspected or proven early-onset bacterial sepsis. If blood cultures are negative, the infant is clinically well, laboratory values are normal, the antibiotics may be discontinued after 48 hours⁽¹⁴⁾.

Included patient and their neonates were categorized into two groups based on GBS cultured status: recto-vaginal swab culture positive for GBS, and recto-vaginal swab culture negative for GBS. Then, the two groups were matched (paired cohort study) by variables including year of recto-vaginal swab culture collection and gestational age at delivery, in a 1:1 ratio using computer-generated matching. The sample size calculation was shown below. Based on study by Lakshmi⁽⁸⁾ which report neonatal systemic illness 7 neonates in maternal GBS positive and 15 neonates in maternal GBS negative group, a total of 220 neonates was needed for 90% power with an alpha of 0.05.

$$n_1 = \left[\frac{z_{1-\frac{\alpha}{2}} \sqrt{p\bar{q}\left(1+\frac{1}{r}\right)} + z_{1-\beta} \sqrt{p_1q_1 + \frac{p_2q_2}{r}}}{\Delta} \right]^2$$

$$r = \frac{n_2}{n_1}, q_1 = 1 - p_1, q_2 = 1 - p_2$$

$$\bar{p} = \frac{p_1 + p_2r}{1+r}, \bar{q} = 1 - \bar{p}$$

n = sample size = 110 in each group, total 220

z = statistic corresponding to level of confidence = 1.96

p1 = proportion of group 1 = 0.055, p2 = proportion of group 2 = 0.175

r = ratio = 1, alpha = 0.05, beta = 0.1

(calculated by STATA version 16.0)

Incidence of neonatal sepsis among preterm births with maternal GBS colonization, along with neonatal intensive care unit admission rate, neonatal Apgar scores, length of hospital stays were calculated as the primary outcomes in the unpaired cohort. The incidence of neonatal sepsis, suspected sepsis, and congenital pneumonia were assessed exclusively in live-born infants. Stillborn infants were not eligible for neonatal sepsis outcomes and were therefore excluded from neonatal morbidity analyses.

Subgroup analysis for maternal recto-vaginal swab culture was performed to assess associations with neonatal sepsis. After adjustment for potential confounding variables through matching by the year of recto-vaginal swab collection and gestational age at delivery, neonatal outcomes were compared between groups according to maternal GBS status in the paired cohort as secondary outcomes. For analyses of neonatal sepsis, only live-born infants were included. Stillbirths were also excluded from the multivariable logistic regression model for neonatal sepsis.

Statistical analyses were performed using STATA version 18.0 (StataCorp, College Station, TX, USA). Continuous variables were presented as mean

± standard deviation (SD) or median with interquartile range (IQR), and categorical variables as number (percentage). Between-group comparisons were performed using the independent t-test or Mann–Whitney U test for continuous variables, and the chi-square test for categorical variables. Odds ratios (ORs) with 95% confidence intervals (CIs) were calculated to assess associations between maternal GBS colonization and potential risk factors. Multivariable logistic regression analysis was conducted to evaluate independent risk factors for neonatal sepsis in the paired cohort, with results expressed as adjusted odds ratios (aORs) and 95% CIs. Covariates included gestational age, neonatal birth weight, intrapartum antibiotic administration, corticosteroid use, duration of membranes rupture before delivery, and maternal GBS status. A two-sided p value < 0.05 was considered statistically significant.

Results

A total of 3,895 pregnant women with preterm delivery and their 4,157 neonates were included in this study. Among them, 114 mothers (2.9%) were colonized with GBS and 3,781 mothers (97%) were recto-vaginal swab culture negative for GBS. (Fig. 1)

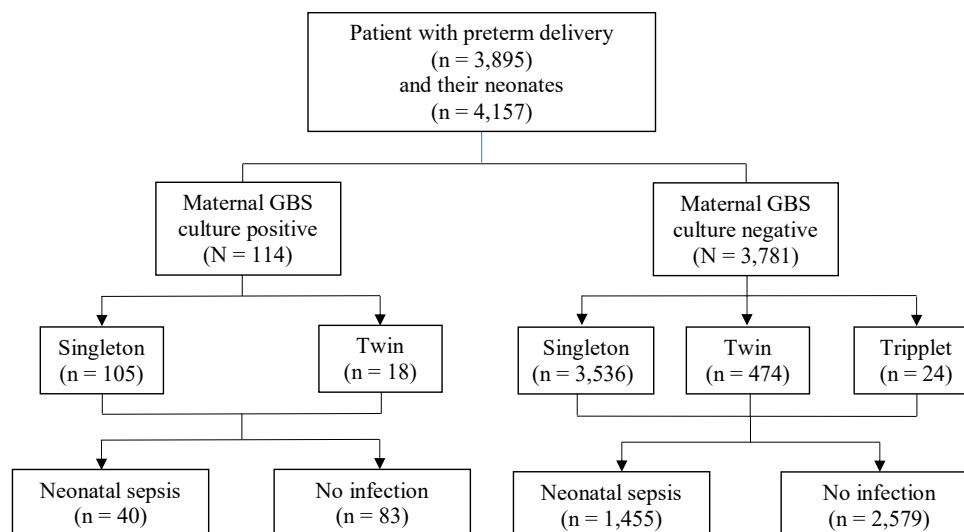


Fig. 1. Enrolment chart.

N: maternal number, n: neonatal number, GBS: group B Streptococcus

Baseline maternal demographics are summarized in Table 1. Maternal age ≥ 35 years was more common in the GBS-positive group compared with the GBS-negative group (49.1% vs 39.6%, $p = 0.041$). The prevalence of leukocytosis ($WBC \geq 15,000$ cells/ μ L) was

significantly lower in the GBS-positive group (21.9% vs 33.2%, $p=0.009$). No significant differences were found regarding nationality, body mass index, gravida, multiple gestation, history of preterm birth, abortion, mode of delivery, or duration of membranes rupture.

Table 1. Maternal demographics.

Maternal demographics	GBS positive, n (%) (n = 114)	GBS negative, n (%) (n = 3,781)	p value
Nation			0.398
Thai	99 (86.8%)	3172 (83.9%)	
Others	15 (13.2%)	609 (16.1%)	
Age (years)			0.041
≥ 35	56 (49.1%)	1498 (39.6%)	
< 35	56 (49.1%)	1498 (39.6%)	
BMI (kg/m ²)			0.451
≥ 30	26 (22.8%)	754 (19.9%)	
< 30	88 (77.2%)	3027 (80.1%)	
Gravida			0.489
Primigravida	88 (77.2%)	3027 (80.1%)	
Multigravida	46 (40.4%)	1649 (43.6%)	
Multiple gestation	9 (7.9%)	245 (6.5%)	0.547
History of preterm birth	6 (5.3%)	346 (9.2%)	0.154
History of abortion	22 (19.3%)	752 (19.9%)	0.876
Gestational age (weeks)			0.492
22 ^{0/7} – 33 ^{6/7}	46 (40.4%)	1648 (43.6%)	
34 ^{0/7} – 36 ^{6/7}	68 (59.6%)	2133 (56.4%)	
Mean $\pm$ SD.	33.38 $\pm$ 2.7	33.12 $\pm$ 3	0.372
Mode of delivery			0.812
Vaginal	76 (66.7%)	2480 (65.6%)	
Cesarean	38 (33.3%)	1301 (34.4%)	
Complete blood count (cells/ μ L)			0.009
WBC $\geq 15,000$	25 (21.9%)	1255 (33.2%)	
WBC $< 15,000$	87 (76.3%)	2424 (64.1%)	

GBS: group B Streptococcus, BMI: body mass index, WBC: white blood cell

Of the 4,157 neonates, 123 neonates were from GBS colonization mothers, 5 neonates were stillbirth, and incidence of neonatal sepsis were 33.9% ($p = 0.556$). Neonatal demographics are shown in Table 2. The distribution of birth weight, gestational age, sex, and Apgar scores did not

differ significantly between the two groups. The rate of stillbirth was significantly higher among infants of GBS-positive mothers (4.1% vs 1.3%, $p = 0.010$).

Table 3 shows the subgroup analysis within the GBS-negative mothers. 27.3% of GBS-negative

mothers were culture-positive for organisms other than GBS. The incidence of neonatal sepsis in these subgroups was similar: 580 of 1,147 neonates (50.6%) born to mothers with culture-positive for other organisms versus 1,532 of 2,887 (53.0%)

born to culture-negative mothers. These differences were not statistically significant ($p = 0.117$). In other words, detection of non-GBS organisms in the mother's culture did not significantly alter the risk of neonatal sepsis in this cohort.

Table 2. Neonatal demographics.

Neonatal demographics	GBS positive, n (%) (n = 123)	GBS negative, n (%) (n = 4,034)	p value
Gender			0.868
Male	67 (54.5%)	2246 (55.7%)	
Female	55 (44.7%)	1788 (44.3%)	
Birth weight (kg)			0.074
> 2.5	41 (33.3%)	1221 (30.3%)	
1.5 - 2.5	70 (56.9%)	2088 (51.8%)	
1 - 1.5	6 (4.9%)	487 (12.1%)	
< 1	5 (4.1%)	238 (5.9%)	
Apgar score at 5minute			0.855
≤ 7	12 (9.8%)	414 (10.3%)	
> 7	111 (90.2%)	3620 (89.7%)	
Admission			0.159
PP	55 (44.7%)	1710 (42.4%)	
SNB	36 (29.3%)	1037 (25.7%)	
NICU	27 (22%)	1234 (30.6%)	
Stillbirth	5 (4.1%)	53 (1.3%)	0.010
Neonatal sepsis	40/118 (33.9%)	1455/3981 (36.5%)	0.556
Clinical suspected sepsis	16/118 (13.6%)	657/3981 (16.5%)	0.395
Pneumonia	7/118 (5.9%)	172/3981 (4.3%)	0.399

GBS Group B streptococcus, PP Postpartum ward, SNB Sick newborn ward, NICU Neonatal intensive care unit

Table 3. Maternal recto-vaginal cultured profile and neonatal sepsis.

Rectovaginal swab culture	Neonatal sepsis n (%) (n = 2,168)	No sepsis n (%) (n = 1,989)	OR (95% CI)	p value
				0.117
Positive for GBS	56 (2.58%)	67 (3.3%)	0.76 (0.53-1.09)	
Positive for other organisms	580 (26.7%)	567 (28.5%)	0.92 (0.80-1.05)	
Negative	1532 (70.6%)	1355 (68.1%)	1.13 (0.99-1.29)	

GBS: group B Streptococcus, OR: odds ratio, CI: confidence interval

In the paired cohort (114 GBS-positive vs 114 GBS-negative), maternal baseline characteristics remained balanced. No statistically significant differences were observed in maternal age, BMI,

gestational age, history of preterm history of abortion, multiple gestation, mode of delivery, duration of membranes ruptured to delivery, corticosteroid used, maternal temperature and leukocytosis. (Table 4)

Table 4. Maternal, neonatal characteristics and GBS colonization in paired cohort.

Maternal characteristics		GBS positive n (%) (n = 114)	GBS negative n (%) (n = 114)	OR (95% CI)	p value
Age (years)	mean ± SD	28.21 ± 6.33	26.79 ± 6.75	1.03 (0.99 - 1.08)	0.103
Nation	Thai	99 (86.8%)	97 (85.1%)	Reference	
	Others	15 (13.2%)	17 (14.9%)	0.86 (0.41 - 1.83)	0.703
BMI (kg/m ²)	mean ± SD	26.46 ± 4.96	26.22 ± 4.99	1.01 (0.96 - 1.06)	0.714
Gestational age (weeks)	mean ± SD	33.38 ± 2.7	33.77 ± 2.38	1 (0.9 - 1.11)	0.985
History of preterm	Yes	6 (5.3%)	6 (5.3%)	NA	1
	No	108 (94.7%)	108 (94.7%)	Reference	
History of abortion	Yes	22 (19.29%)	29 (25.4%)	0.7 (0.37-1.31)	0.126
	No	92 (80.7%)	85 (74.6%)	Reference	
Multiple gestation	Yes	9 (7.89%)	8 (7%)	1.14 (0.37 - 3.52)	0.801
	No	105 (92.1%)	106 (93%)	Reference	
Mode of delivery	Cesarean	38 (33.3%)	27 (23.7%)	1.61 (0.90 - 2.88)	0.107
	Vagina	76 (66.6%)	87 (76.3%)	Reference	
Duration of membrane ruptured to delivery (hours)	median (IQR)	3.03 (0.08, 11.9)	1.21 (0.13, 11.25)	1 (1 - 1.01)	0.55
Intrapartum antibiotic	No	20 (17.5%)	13 (11.4%)	1.48 (0.67-3.26)	0.262
	< 4 hrs	37 (32.5%)	46 (40.4%)	0.78 (0.44-1.38)	0.354
	≥ 4 hrs	57 (50%)	55 (48.2%)	Reference	
Corticosteroid*	Incomplete	85 (74.6%)	92 (80.7%)	0.70 (0.37 - 1.31)	0.267
	Complete	29 (25.4%)	22 (19.3%)	Reference	
Maternal	≥ 38	4 (3.5%)	2 (1.8%)	2.04 (0.37 - 11.35)	0.417
Body temperature (oC)	< 38	110 (96.5%)	112 (98.2%)	Reference	
Complete blood count (cells/μL)	WBC ≥ 15,000	25 (21.9%)	38 (33.3%)	0.57 (0.32 - 1.03)	0.057
	WBC < 15,000	87 (76.3%)	75 (65.8%)	Reference	
Neonatal characteristics		GBS positive n (%) (n = 123)	GBS negative n (%) (n = 122)	OR (95% CI)	p value
Gender	Male	67 (54.4%)	73 (59.8%)	Reference	
	Female	55 (44.7%)	49 (40.2%)	1.22 (0.73 - 2.02)	0.442
Apgar at 1 min	≤ 7	25 (20.3%)	26 (21.3%)	0.94 (0.50 - 1.74)	0.849
	> 7	98 (79.7%)	96 (78.7%)	Reference	
Apgar at 5 min	≤ 7	12 (9.8%)	7 (5.7%)	1.77 (0.67 - 4.67)	0.24
	> 7	111 (90.2%)	115 (94.3%)	Reference	
Birth body weight (g)	mean ± SD	2188.5 ± 546.01	2169.18 ± 584.73	1.01 (0.99 - 1.01)	0.789
Birth body weight (g)	NICU	27 (21.9%)	34 (27.9%)	0.87 (0.62 - 1.22)	0.405
	SNB	36 (29.2%)	34 (27.9%)	1.01 (0.75 - 1.35)	0.948
	PP	55 (44.7%)	53 (43.4%)	Reference	
Stillbirth		5 (4.1%)	1 (0.8%)	1.68 (1.15-2.46)	0.213
Length of stay (days)	median (IQR)	6 (2, 19)	8 (2, 20)	1 (0.98 - 1.01)	0.474
Antibiotic required	Yes	60 (49.2%)	70 (57.4%)	0.71 (0.42 - 1.21)	0.178
	No	63 (47.1%)	52 (42.6%)	Reference	
Neonatal sepsis	Early onset	53/118 (44.9%)	66/121 (54.5%)	0.82 (0.63-1.06)	0.137
	Late onset	7/118 (5.9%)	3/121 (2.5%)	1.45 (0.95-2.22)	0.178
Pneumonia	Yes	7/118 (5.9%)	7/121 (5.8%)	1.01 (0.59-1.74)	0.961
	No	111/118 (94.1%)	114/121 (94.2%)	Reference	

GBS: group B Streptococcus, BMI: body mass index, WBC: white blood cell, NICU: neonatal intensive care unit, SNB: sick newborn ward, PP: postpartum ward, SD: standard deviation, IQR: interquartile range, OR: odds ratio, CI: confidence interval

*Complete course of corticosteroid was defined as administration of dexamethasone for promote lung maturity, consisting dexamethasone 6 mg IM every 12 hours for 4 doses, incomplete course was defined as no dexamethasone administration or fewer than 4 doses

Intrapartum antibiotic profile used are shown in Table 5 which were similar between both groups. In primary outcomes, neonatal baseline characteristic included Apgar scores at 1 and 5 minutes, NICU admission rate, length of stays, neonatal sepsis or pneumonia were no statistically differences. However, late onset sepsis cases were more frequent in maternal GBS positive group (OR 1.45, 95%CI 0.95, 2.22, $p = 0.178$).

In multivariate logistic regression (Table 6), lower

gestational age and low neonatal birth weight were independent risk factors for neonatal sepsis. Specifically, gestational age < 34 weeks was associated with higher sepsis risk (adjusted OR 0.56, 95%CI 0.43, 0.73, $p < 0.001$). Infants weight 1.5–2.5 kg had increased risk of sepsis (adjusted OR 3.13, 95%CI 1.40, 7.02, $p = 0.006$). Maternal GBS colonization was not an independent risk factor for neonatal sepsis in the multivariate model (adjusted OR 0.59, 95%CI 0.29, 1.22, $p = 0.155$). These findings are summarized in Table 6.

Table 5. Intrapartum antibiotic prophylaxis used in paired cohort.

GBS status	GBS positive n (%) (n = 114)	GBS negative n (%) (n = 114)	p value
Appropriate IPA	57 (50%)	55 (48.2%)	0.791
Inappropriate/none	57 (50%)	59 (51.7%)	

GBS: group B Streptococcus, IPA: intrapartum antibiotic

*Appropriate intrapartum antibiotic prophylaxis used in this cohort including ampicillin, clindamycin, cefazolin and ceftriaxone using duration ≥ 4 hours before delivery.

Table 6. Logistic regression analysis of the risk factors for neonatal sepsis.

Factors	Multivariate	
	Adjusted OR (95%CI)	p value
Age (years)	1.00 (0.95-1.06)	0.901
Gestational ages (weeks)	0.56 (0.43-0.73)	< 0.001
Gestation		
Single gestation	Reference	1
Multifetal gestation	3.50 (0.59-20.87)	0.169
Birth body weight (kg)		
> 2.5	Reference	1
1.5 – 2.5	3.13 (1.40-7.02)	0.006
< 1.5	4.81 (0.43-53.23)	0.200
Duration of membrane ruptured to delivery (hours)		
< 18	Reference	1
≥ 18	2.90 (0.92-9.14)	0.069
IPA used		
≥ 4 hrs	Reference	
< 4 hrs	1.49 (0.65-3.45)	0.348
No	0.91 (0.29-2.84)	0.874
Corticosteroid		
Complete*	Reference	1
Incomplete	0.90 (0.35-2.36)	0.835
GBS colonization		
Negative	Reference	1
Positive	0.59 (0.29-1.22)	0.155
Leukocytosis		
WBC < 15,000 cells/ μ L	Reference	1
WBC $\geq 15,000$ cells/ μ L	0.87 (0.37-2.02)	0.740

IPA: intrapartum antibiotic, GBS: group B Streptococcus, WBC: white blood cell, OR: , CI:

*Complete course of corticosteroid was defined as administration of dexamethasone to promote lung maturity, consisting dexamethasone 6 mg IM every 12 hours for 4 doses, incomplete course was defined as no dexamethasone administration or fewer than 4 doses

Discussion

In this retrospective cohort study of preterm deliveries, we found that maternal GBS colonization was not an independently associated with neonatal sepsis. The prevalence of maternal GBS colonization in our population was 2.9%, which was lower than the 10–30% reported in Western countries⁽⁶⁾, 11.1% reported in southeast Asia⁽¹⁵⁾ and 19% of previous research in Thailand⁽¹⁶⁾. Although the prevalence of maternal GBS colonization in this study was lower than that reported in population-based screening studies, GBS status was based on microbiologically confirmed recto-vaginal cultures. All results were retrieved from the hospital laboratory database using a standardized culture protocol and coding system, ensuring reliable ascertainment of exposure status. Therefore, while the prevalence may be underestimated due to selective testing in preterm labor. In our hospital setting, universal GBS screening according to ACOG recommendations is not routinely practiced. GBS cultures are mainly obtained from women presenting with preterm labor, which may partly explain the lower prevalence of maternal GBS colonization compared with studies employing universal screening.

When comparing maternal baseline characteristics, women with GBS colonization were more likely to be of advanced maternal age (49.1% vs 39.6%, $p = 0.041$). Which was correlate with previous study that older maternal age was risk factor of maternal GBS colonization⁽¹⁶⁻¹⁸⁾. Interestingly, maternal leukocytosis was significantly more frequent in the GBS-negative group than in the GBS-positive group (33.2% vs 21.9%, $p = 0.009$). This paradox may be explained by the fact that GBS colonization typically represents asymptomatic carriage rather than active infection, and therefore does not usually trigger systemic inflammatory response. Systematic review and meta-analysis showed that incidence of maternal GBS disease was 0.38 per 1000 pregnancies⁽¹⁹⁾. Edwards et al⁽²⁰⁾ reported that only

0.1% of maternal GBS colonization developed sepsis. In contrast, many GBS-negative mothers in our cohort likely received intrapartum antibiotics for obstetric indications such as prolonged rupture of membranes, suspected chorioamnionitis, or maternal fever. These conditions, may not unrelated to GBS, are more likely to be associated with maternal inflammatory changes and elevated white blood cell counts. However, when reanalyzed in the paired cohort, the difference in leukocytosis between GBS-positive and GBS-negative mothers was no longer statistically significant.

The incidence of neonatal sepsis was paradoxically higher in the GBS-negative group compared with the GBS-positive group (36.5% vs 33.9%, $p = 0.556$). This finding contrasts with the study by Warriar et al⁽⁸⁾, which was used for sample size calculation and reported a higher proportion of neonatal systemic illness among infants born to GBS-positive mothers. One key explanation is the role of intrapartum antibiotic prophylaxis (IAP). It is well-established that administering IAP to GBS-colonized mothers dramatically reduces early-onset GBS infection⁽²¹⁾. In fact, widespread use of IAP has led to a steep decline in GBS disease incidence worldwide. In our study all indicated mothers in both groups received antibiotics per protocol (Table 5), so the total rate of IAP did not differ post-matching. Nonetheless, prophylaxis in the GBS-positive group would have been specifically targeted to the colonizing strain. In other words, infants born to known GBS carriers benefited from targeted IAP (usually penicillin or ampicillin) that likely prevented many GBS transmissions. By contrast, GBS-negative mothers by definition received no GBS-directed prophylaxis (unless other indications arose), leaving their infants susceptible to sepsis from any pathogens present.

In contrast, neonatal sepsis in the GBS-negative group may have been driven by non-GBS pathogens. In the era of widespread GBS prophylaxis, organisms such as *Escherichia coli* and other Gram-

negative bacteria have emerged as leading causes of early-onset neonatal sepsis, particularly in preterm infants⁽²²⁾. These pathogens are often associated with ascending intrauterine infection, chorioamnionitis, or prolonged rupture of membranes, conditions that may not be fully prevented by GBS-directed prophylaxis. The higher sepsis rate observed in the GBS-negative group may therefore reflect the contribution of non-GBS organisms rather than a protective effect of GBS negativity itself.

However, this difference did not reach statistical significance, and multivariate analysis revealed that maternal GBS colonization was not an independent predictor of neonatal sepsis (aOR 0.59, 95% CI 0.29, 1.22, $p = 0.155$). Rather, traditional perinatal risk factors—including lower gestational age and low birth weight—emerged as the strongest determinants of neonatal sepsis, consistent with established evidence in preterm populations^(23, 24).

Our subgroup analysis (Table 3) further demonstrated that within the GBS-negative group, mothers colonized with other organisms and those with negative cultures exhibited incidence of neonatal sepsis 50.56% and 53.06%, respectively. This pattern likely reflects the multifactorial pathways of sepsis in preterm infants. First, intrauterine inflammation can cause neonatal sepsis even when maternal genital tract cultures are negative. Villamor-Martinez et al⁽²⁵⁾ reported that only 27.7% of histologic chorioamnionitis had positive cultures. In other words, the majority of placentas with inflammation yielded no bacteria on cultures. Second, organisms such as *Ureaplasma* and *Mycoplasma* are difficult to detect with standard cultures but are strongly linked to neonatal sepsis^(26, 27). Third, the widespread use of intrapartum antibiotics before GBS status is confirmed in women presenting with preterm labor. This practice reduces vertical transmission of GBS and early-onset sepsis, narrowing between-group differences in neonatal sepsis rates. A meta-analysis (14 studies, including 13 RCTs > 2,000 women) reported that neonatal

GBS colonization was about 90% lower when mothers received intrapartum antibiotics (relative risk ~0.10, 95% CI 0.06, 0.16)⁽²⁸⁾. Finally, because of intrapartum antibiotic prophylaxis in preventing GBS transmission, *Escherichia coli* (*E.coli*) has surpassed GBS as the predominant cause of early-onset sepsis in preterm neonates⁽²²⁾. Together, these factors provide plausible explanations for higher neonatal sepsis rate in maternal culture-negative group in our study.

Despite the absence of a significant association between GBS colonization and overall neonatal sepsis, secondary outcomes revealed important clinical concerns. The rate of stillbirth was significantly higher among infants of GBS-positive mothers (4.1% vs 1.3%, $p = 0.01$). This suggests that while GBS may not markedly increase sepsis frequency in this study, infection due to GBS carries a higher risk of severe outcomes. Previous studies have shown GBS to be a contributor to stillbirths⁽²⁹⁾, and ACOG notes that mortality from GBS early-onset disease is markedly higher in preterm infants, reaching 19.2%⁽⁶⁾.

Neonatal characteristics, including gestational age, birth weight, sex, and Apgar score, were not significantly different between GBS-positive and GBS-negative groups.

Our multivariate regression analysis identified lower gestational age and birth weight between 1.5-2.5 kg as independent risk factors of neonatal sepsis. These findings aligned with previous studies^(23, 24, 30-32). In a meta-analysis of observational studies, lower gestational age was significantly associated with early-onset sepsis (OR 1.31, 95% CI 1.18, 1.44)⁽³⁰⁾. A recent study in Thailand reported that maternal clinical factors such as gestational age < 34 weeks was also significantly associated with early-onset neonatal sepsis in preterm neonates⁽³³⁾. A systematic review in Ethiopia found preterm infants had roughly 3.4-fold higher odds of neonatal sepsis than term infants and low birth weight had 1.4-fold higher odds than normal weight ($\geq 2,500$ g) infants⁽³¹⁾. Similarly,

in a cohort of pregnancies with pre-ruptured of membrane, neonates born before 37 weeks had dramatically higher sepsis risk (OR 18.59) compared to term infants⁽³²⁾. While Guo L et al⁽³⁰⁾ found very low birth weight conferred higher risk of neonatal sepsis (OR 3.79, 95%CI 2.14, 6.73), our study also found association risk but not reach statistical significance (aOR 4.81, 95%CI 0.43, 53.23, $p = 0.2$).

Taken together, our study suggests that while maternal GBS colonization is not an independent predictor of neonatal sepsis, it remains clinically important due to its association with increased of stillbirth. Intrapartum antibiotics prophylaxis could plausible substantially reduce early-onset GBS disease but do not eliminate the overall burden of neonatal sepsis, particularly in preterm populations where multiple infectious and non-infectious risk factors are present. This highlights the importance of focusing not only on GBS screening and prophylaxis but also on identifying and managing other perinatal risk factors for sepsis, such as prematurity and low birth weight.

Strengths of our study included the paired cohort design and comprehensive maternal-neonatal data collection. These features reduced confounding and allowed comparison between groups. Nonetheless, several limitations related to its retrospective design should be acknowledged. Data collection depended on the completeness and accuracy of medical records, making some discrepancy in data numbers, and the timing of recto-vaginal swab culture could not be standardized. Pathogen-specific data for neonatal sepsis were limited, preventing confirmation of whether cases were due to GBS or other organisms. Additionally, details regarding the exact timing and dosage of intrapartum antibiotics could not be fully standardized, which may have influenced neonatal outcomes.

Conclusion

In this retrospective cohort of preterm deliveries, maternal GBS colonization was not

independently associated with neonatal sepsis. Although the overall incidence of sepsis was comparable between groups, the rate of stillbirth occurred more among infants born to GBS-positive mothers, underscoring the need for careful surveillance in this population. By contrast, the major determinants of neonatal sepsis were classical obstetric risk factors—prematurity and low birth weight—rather than maternal GBS status. These findings emphasize the multifactorial nature of neonatal sepsis and suggest that preventive strategies should extend beyond GBS prophylaxis to address broader perinatal risk factors.

Potential conflicts of interest

The authors declare no conflicts of interest.

References

1. Bradley E, Blencowe H, Moller AB, Okwaraji YB, Sadler F, Gruending A, et al. Born too soon: global epidemiology of preterm birth and drivers for change. *Reprod Health* 2025;22:105.
2. World Health Organization. “Healthy Beginnings, Hopeful Futures”: Thailand Marks World Health Day 2025 with Commitment to Strengthen Care for Preterm Infants. In; 2025.
3. Fund UNCs. Under-five mortality. In: UNICEF Data: Monitoring the situation of children and women; 2025.
4. Cunningham FG LK, Bloom SL, Dashe JS, Hoffman BL, Casey BM, Spong CY. *Williams Obstetrics*. 26th ed. New York: McGraw-Hill Education; 2022.
5. Kornwalai Kinpoon SC. The incidence and risk factors for preterm delivery in Northeast Thailand. *Thai J Obstet Gynaecol* 2021;29:100-11.
6. Prevention of group B Streptococcal early-onset disease in newborns: ACOG Committee Opinion, Number 797. *Obstet Gynecol* 2020;135:e51-e72.
7. Bianchi-Jassir F, Seale AC, Kohli-Lynch M, Lawn JE, Baker CJ, Bartlett L, et al. Preterm birth associated with group B Streptococcus maternal colonization worldwide: Systematic review and meta-analyses. *Clin Infect Dis* 2017;65:S133-s42.
8. Warriar LM, Joy S, C RR, Bashir RA. Group B Streptococcal colonization among pregnant women and neonates in a tertiary care hospital in South India. *Indian J Pediatr* 2022;89:1187-94.

9. Dai W, Zhang Y, Xu Y, Zhu M, Rong X, Zhong Q. The effect of group B streptococcus on maternal and infants' prognosis in Guizhou, China. *Biosci Rep* 2019;39.
10. Lohrmann F, Hufnagel M, Kunze M, Afshar B, Creti R, Detcheva A, et al. Neonatal invasive disease caused by *Streptococcus agalactiae* in Europe: the DEVANI multi-center study. *Infection* 2023;51:981-91.
11. The Royal Thai College of Obstetricians and Gynaecologists. Management of Preterm Labor and Preterm Prelabor Rupture of Membranes. *RTCOG Clinical Practice Guideline* 2566;OB 66-033:9-36.
12. ACOG. Methods for estimating the due date. Washington, DC: American College of Obstetricians and Gynecologists; 2017. Committee Opinion No. 700.
13. Chess PR. Avery's neonatology board review: Certification and clinical refresher. 1st ed. Philadelphia, PA: Elsevier; 2019.
14. Gomella TLC, Douglas M, Fabien GE, Deborah JT. Neonatology: Management, procedures, on-call problems, diseases, and drugs. 7th ed. New York: McGraw-Hill Education; 2013.
15. Sosa M, Eckert LO, Kachikis A. Understanding GBS infection in pregnancy: exploring adverse maternal and pregnancy outcomes and the prospect of a GBS vaccine. *Ther Adv Infect Dis* 2025;12: 20499361251343710.
16. Khamchiangta C BA, Srisupundit K. The prevalence of group B *Streptococcus* (GBS) colonization in pregnant women. *J Med Assoc Thai* 2017;100:1162-6.
17. Chen X, Cao S, Fu X, Ni Y, Huang B, Wu J, et al. The risk factors for Group B *Streptococcus* colonization during pregnancy and influences of intrapartum antibiotic prophylaxis on maternal and neonatal outcomes. *BMC Pregnancy Childbirth* 2023; 23:207.
18. Rick AM, Aguilar A, Cortes R, Gordillo R, Melgar M, Samayoa-Reyes G, et al. Group B *Streptococci* colonization in pregnant Guatemalan women: Prevalence, risk factors, and vaginal microbiome. *Open Forum Infect Dis* 2017;4:ofx020.
19. Hall J, Adams NH, Bartlett L, Seale AC, Lamagni T, Bianchi-Jassir F, et al. Maternal disease with group B streptococcus and serotype distribution worldwide: Systematic review and meta-analyses. *Clin Infect Dis* 2017;65:S112-S24.
20. Edwards JM, Watson N, Focht C, Wynn C, Todd CA, Walter EB, et al. Group B *Streptococcus* (GBS) colonization and disease among pregnant women: A historical cohort study. *Infect Dis Obstet Gynecol* 2019;2019:5430493.
21. Lee J, Naiduvaie K, Chew KL, Charan N, Chan YH, Lin RT, et al. Preventing early-onset group B streptococcal sepsis: clinical risk factor-based screening or culture-based screening? *Singapore Med J* 2021;62:34-8.
22. Stoll BJ, Puopolo KM, Hansen NI, Sánchez PJ, Bell EF, Carlo WA, et al. Early-onset neonatal sepsis 2015 to 2017, the rise of *Escherichia coli*, and the need for novel prevention strategies. *JAMA Pediatrics* 2020;174:e200593-e.
23. Moftian N, Samad Soltani T, Mirnia K, Esfandiari A, Tabib MS, Rezaei Hachesu P. Clinical risk factors for early-onset sepsis in neonates: An international Delphi study. *Iran J Med Sci* 2023;48:57-69.
24. Briggs-Steinberg C, Roth P. Early-onset sepsis in newborns. *Pediatr Rev* 2023;44:14-22.
25. Villamor-Martinez E, Lubach GA, Rahim OM, Degraeuwe P, Zimmermann LJ, Kramer BW, et al. Association of histological and clinical chorioamnionitis with neonatal sepsis among preterm infants: A systematic review, meta-analysis, and meta-regression. *Front Immunol* 2020;11:972.
26. Poku VO. Maternal mortality: The role of *Mycoplasma hominis* and its impact on neonatal health. *Health Sci Rev* 2022;4:100036.
27. Sung TJ. *Ureaplasma* infections in pre-term infants: Recent information regarding the role of *Ureaplasma* species as neonatal pathogens. *Korean J Pediatr* 2010;53:989-93.
28. Li S, Huang J, Chen Z, Guo D, Yao Z, Ye X. Antibiotic prevention for maternal group B streptococcal colonization on neonatal GBS-related adverse outcomes: A meta-analysis. *Front Microbiol* 2017;8:2017.
29. Mahtab S, Madewell ZJ, Madhi SA, Wise A, Swart PJ, Velaphi S, et al. Stillbirths and neonatal deaths caused by group B *Streptococcus* in Africa and South Asia identified through child health and mortality prevention surveillance (CHAMPS). *Open Forum Infect Dis* 2023;10:ofad356.
30. Guo L, Han W, Su Y, Wang N, Chen X, Ma J, et al. Perinatal risk factors for neonatal early-onset sepsis: a meta-analysis of observational studies. *J Matern Fetal Neonatal Med* 2023;36:2259049.
31. Belachew A, Tewabe T. Neonatal sepsis and its association with birth weight and gestational age among admitted neonates in Ethiopia: systematic review and meta-analysis. *BMC Pediatr* 2020;20:55.
32. Ocviyanti D, Wahono WT. Risk factors for neonatal sepsis in pregnant women with premature rupture of the membrane. *J Pregnancy* 2018;2018:4823404.

33. Eiamcharoenlap J, Samutchaikij T. Maternal factors associated with early onset neonatal sepsis in preterm

newborns at Maharat Nakhon Ratchasima Hospital. Thai J Obstet Gynaecol 2025;34:42-9.