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ORIGINAL RESEARCH

Prevalence of *Chlamydia trachomatis*, *Neisseria gonorrhoeae*, and Bacterial Vaginosis and Their Association with Maternal and Neonatal Outcomes in Women Presenting with Threatened Preterm Labor, Preterm Labor, and Preterm Prelabor Rupture of Membranes

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Background: *Chlamydia trachomatis* (CT) and *Neisseria gonorrhoeae* (NG) are sexually transmitted infections implicated in preterm birth and neonatal morbidity. Thailand does not routinely screen for CT and NG antenatally. Their prevalence among women with threatened preterm labor (TPL), preterm labor (PTL), and preterm prelabor rupture of membranes (PPROM) remains unclear.

Methods: We conducted a prospective observational cohort study of 330 pregnant women with TPL, PTL, or PPROM at 28 weeks 0 days to 36 weeks 6 days of gestation who delivered at Siriraj Hospital, Bangkok, Thailand, from 2023 to 2025. Cervical and vaginal swabs underwent nucleic acid amplification testing for CT and NG and were assessed for bacterial vaginosis; maternal and neonatal outcomes were examined using logistic regression.

Results: CT prevalence was 5.8% and bacterial vaginosis 8.3%; no NG infection was detected. CT was associated with younger maternal age ($P < 0.001$) and multiple sexual partners ($P = 0.028$). CT prevalence was highest in PPROM (12.5%), followed by TPL (5.1%) and PTL (4.5%). CT infection showed a nonsignificant trend toward higher intrapartum fever (12.5% vs 3.5%; $P = 0.130$). Although overall low birth weight rates were similar, CT-positive cases had more very low birth weight infants (< 2000 g: 25.0% vs 10.6%; $P = 0.108$). Apgar scores and neonatal intensive care unit admission were similar between groups. Bacterial vaginosis was not associated with preterm subtype or maternal or neonatal outcomes.

Conclusion: Although *Chlamydia trachomatis* infection was relatively uncommon, it showed a trend toward higher rates of intrapartum fever and very low birth weight (<2000 g) among women with preterm conditions. CT infection was more frequently detected at earlier gestational ages and was most common in women presenting with PPROM. Risk-based CT screening in women presenting with TPL, PTL, or PPROM may facilitate early detection and prevention of infection-related preterm morbidity.

Trial Registration: Thai Clinical Trials Registry TCTR20221118005; date of registration: November 16, 2022; date of initial participant enrollment: June 2023.

Plain Language Summary: This study looked at how common certain infections are in pregnant women who experience early labor or early rupture of the membranes before birth. These infections can increase the risk of complications for both mothers and babies, but they are often not tested for during routine pregnancy care in Thailand. Researchers studied 330 pregnant women between 28 and

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36 weeks of pregnancy at Siriraj Hospital in Bangkok. They tested for *Chlamydia trachomatis* (CT), *Neisseria gonorrhoeae* (NG), and bacterial vaginosis (BV). They also followed mothers and babies to understand how these infections may affect health outcomes around the time of birth.

The results showed that CT was found in about 6% of women and BV in about 8%, while NG was not detected. CT infection occurred more often in younger women and in those who had early rupture of the membranes. Although serious complications were uncommon, women with CT infection showed trends toward higher rates of fever during labor and very low birth weight babies. Overall, this study shows that these infections are not common, but they may still play a role in some early birth complications. Testing women who show signs of early labor or membrane rupture may help doctors find and treat infections earlier and support safer outcomes for mothers and babies.

Keywords: *chlamydia trachomatis*, nucleic acid amplification test, PPROM, pregnancy, preterm labor, sexually transmitted infection, threatened preterm labor

Introduction

Preterm birth is a leading cause of neonatal morbidity and mortality worldwide, accounting for approximately 10% of all births and more than 14 million preterm infants annually.[1] Its etiology is multifactorial; intrauterine infection and inflammation are major contributors.[2] Among infectious causes, sexually transmitted infections (STIs), notably *Chlamydia trachomatis* (CT) and *Neisseria gonorrhoeae* (NG), are consistently linked to adverse pregnancy outcomes, including preterm labor, preterm premature rupture of membranes (PPROM), and low birth weight.[3,4]

CT is the most prevalent bacterial STI globally; asymptomatic infection is common, leading to undiagnosed and untreated disease.[5,6] During pregnancy, CT has been associated with premature rupture of membranes, preterm delivery, and neonatal conjunctivitis and pneumonia. NG is associated with chorioamnionitis, preterm birth, PPROM, neonatal conjunctivitis, and higher perinatal mortality.

Diagnosis of CT and NG relies primarily on nucleic acid amplification testing (NAAT), the gold standard due to its superior sensitivity and specificity compared with culture or antigen detection. This diagnostic advantage improves prevalence estimates and underscores the importance of incorporating NAAT in studies of pregnancy-related infections.

In addition to sexually transmitted infections, bacterial vaginosis (BV) has been associated with preterm birth and preterm prelabor rupture of membranes through altered vaginal microbiota and inflammatory pathways.[7,8] Previous studies have reported inconsistent associations between BV and adverse pregnancy outcomes, particularly among women with preterm presentations.[9,10] Given this potential but variable contribution, BV was included in the present study as a secondary infection of interest.

Despite increasing evidence of their impact on pregnancy, epidemiological estimates vary across regions. Prevalence data for high-risk groups such as women with preterm labor, threatened preterm labor, and PPROM remain limited, particularly in low- and middle-income settings.[11,12] Screening and treatment of *Chlamydia trachomatis* during pregnancy have been associated with reductions in adverse pregnancy and neonatal outcomes, including preterm birth. Although the magnitude of benefit varies across studies, several investigations report meaningful reductions in preterm birth following early detection and treatment, supporting the role of targeted screening in high-risk populations.[5]

Given limited data in Thailand, particularly among pregnant women presenting with preterm labor and PPROM,[13,14] this study aims to determine the prevalence of CT and NG infections in this high-risk population. Establishing local prevalence data will provide evidence to strengthen screening strategies, guide antibiotic use, and improve maternal and neonatal outcomes.

Materials and Methods

Study Design and Setting

This prospective observational cohort study was conducted at the Department of Obstetrics and Gynaecology, Faculty of Medicine Siriraj Hospital, Mahidol University, Bangkok, Thailand. The study took place in the labor and delivery units of Siriraj Hospital, a tertiary referral center for high-risk pregnancies, during June 2023–June 2025.

Ethical Approval

The protocol was approved by the Siriraj Institutional Review Board (Si-215/2023). Written informed consent was obtained from all eligible participants before specimen collection.

Definition

Threatened preterm labour (TPL) is defined as regular, painful uterine contractions occurring between approximately 20 and 37 weeks' gestation in the presence of intact fetal membranes and no or minimal cervical change; progression to cervical dilatation and/or membrane rupture reclassifies the condition as true preterm labour.[15]

Preterm labour (PTL) is defined as regular uterine contractions accompanied by progressive cervical dilatation and/or effacement before 37 completed weeks of gestation.[16]

Preterm prelabor rupture of membranes (PPROM) is defined clinically as spontaneous rupture of the fetal membranes before the onset of labor in a pregnancy that is still preterm (<37 weeks' gestation).[17]

Participant Flow and Cohort Characteristics

A total of 334 pregnant women were screened during June 2023–June 2025. Four were excluded: 1 had received recent CT treatment within the prior 6 weeks and 3 had incomplete clinical data, leaving 330 for the final analysis (Figure 1). All participants underwent endocervical NAAT for CT and NG and a vaginal smear for bacterial vaginosis (BV).

Eligible participants were pregnant women aged ≥ 18 years with singleton gestations at 28 weeks 0 days to 36 weeks 6 days who presented with TPL, PTL or PPROM. Exclusion criteria were CT or NG diagnosis or treatment within the prior 6 weeks, or maternal age < 18 years.

Sample Size Calculation

Based on reports of CT prevalence of 6.4% in women with preterm labor, we calculated the sample size using a 95% confidence level (Z = 1.96), margin of error 0.05, and expected prevalence 0.064. The minimum required sample was 92 participants, increased by 15% for anticipated attrition to 110 per subgroup. Because 3 gestational-age strata were analyzed (very, moderate, and late preterm), 330 women were enrolled.

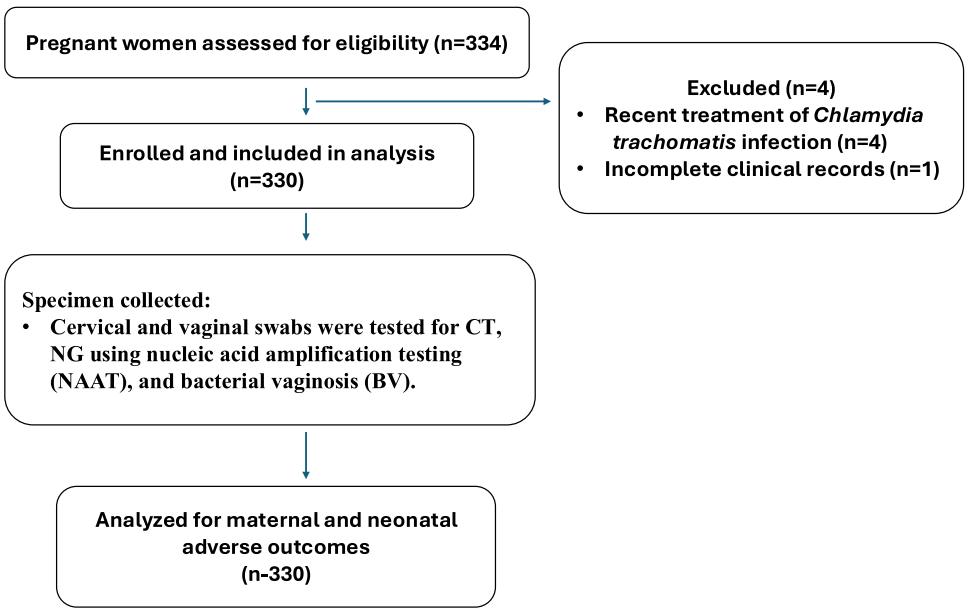

Figure 1 CONSORT-style participant flow diagram of screening, exclusions, and enrollment.
Abbreviations: CONSORT, Consolidated Standards of Reporting Trials.

Specimen Collection and Laboratory Analysis

Endocervical or vaginal swabs were collected for CT and NG detection by NAAT, which offers high sensitivity and specificity. Specimens were obtained by second-year obstetrics and gynecology residents or experienced faculty from the Sexually Transmitted Infection Clinic. After informed consent, swabs were collected with sterile technique before any digital examination. An endocervical swab was obtained using a sterile speculum when cervical effacement was < 100%; a vaginal swab was collected when effacement was 100%. One swab was used for wet smear microscopy to assess BV (≥ 20% clue cells). The second swab was placed in transport medium, stored at 4–8 °C, and sent weekly to the Bang Rak Medical Center for Sexually Transmitted Diseases (Bangkok, Thailand) for testing.

CT and NG were detected by NAAT using the GeneXpert CT/NG assay (Cepheid, Sunnyvale, CA, USA) according to the package insert. Specimens were added to single-use Xpert CT/NG cartridges and run on the GeneXpert instrument. The system performs automated specimen preparation and real-time polymerase chain reaction for DNA detection within approximately 90 minutes. Internal controls verified the presence of human DNA and proper sample processing in each test. An interlaboratory comparison program was conducted twice yearly as an external control. BV was diagnosed by wet smear microscopy using Amsel criteria.[7] Laboratory procedures followed standard protocols and were performed by trained microbiologists.

Data Collection

Demographic and lifestyle data were obtained via structured case-record forms and included maternal age, body mass index, occupation, monthly income, marital status, number of sexual partners, and prior STI history. Obstetric variables included gravidity, parity, and previous preterm birth. Clinical data included gestational age at specimen collection, gestational age at delivery, mode of delivery, and maternal complications. Gestational age at specimen collection was categorized as 28 weeks 0 days to 31 weeks 6 days, 32 weeks 0 days to 33 weeks 6 days, and 34 weeks 0 days to 36 weeks 6 days; maternal complications included fever > 38 °C, chorioamnionitis, and puerperal infection. Neonatal outcomes included birthweight, Apgar scores, need for positive-pressure ventilation, and neonatal intensive care unit (NICU) admission within 72 hours. Additional outcomes were respiratory distress syndrome, transient tachypnea of the newborn, intraventricular hemorrhage, necrotizing enterocolitis, early-onset sepsis, and length of hospital stay. Daily postpartum follow-up continued until both mother and newborn were discharged.

Follow-Up and Outcome Measures

Participants were enrolled at presentation with threatened preterm labor (TPL), preterm labor (PTL), or preterm prelabor rupture of membranes (PPROM) and were followed prospectively from enrollment until delivery and early neonatal discharge. Maternal outcomes assessed during follow-up included intrapartum fever, chorioamnionitis, postpartum hemorrhage, and puerperal infection. Neonatal outcomes assessed included birth weight, Apgar scores, need for resuscitation, neonatal intensive care unit admission, and early neonatal complications occurring prior to discharge.

The primary outcome was the prevalence of CT, NG and BV among women with TPL, PTL, or PPROM. Secondary outcomes were the associations of these infections with maternal complications and neonatal adverse outcomes across gestational-age strata (very, moderate, and late preterm).

Statistical Analysis

All analyses were performed using IBM SPSS Statistics version 28 (IBM Corp, Armonk, NY, USA). Continuous variables were expressed as mean (± SD) or median (IQR), and categorical variables as counts and percentages. Comparisons between groups employed chi-square or Fisher's exact tests for categorical data, and Student's *t*-test or the Mann–Whitney *U*-test for continuous variables, as appropriate. Variables with $P < 0.15$ in univariate analysis were entered into multivariate logistic regression using a backward-stepwise (likelihood-ratio) approach. Adjusted odds ratios (ORs) and 95% confidence intervals were reported, and $P < 0.05$ was considered statistically significant.

Results

Prevalence of CT and BV

The overall CT prevalence was 5.8% (19/330), and BV prevalence was 8.3% (26/315); no NG cases were detected. By gestational age at specimen collection, CT prevalence was 7.8% at 28 weeks 0 days to 31 weeks 6 days, 7.5% at 32 weeks 0 days to 33 weeks 6 days, and 4.0% at 34 weeks 0 days to 36 weeks 6 days ($P = 0.416$). BV prevalence across these strata was 8.2%, 9.9%, and 7.4%, respectively ($P = 0.797$).

When analyzed by gestational age at delivery, CT positivity was highest in moderate preterm births (15.8%) and lowest in late preterm (3.8%) and term (4.8%) deliveries ($P = 0.167$). BV prevalence ranged from 0% in moderate preterm to 11.4% in term deliveries ($P = 0.232$).

Across preterm phenotypes, CT was most common in preterm PPROM (12.5%) compared with preterm labor (4.5%) and threatened preterm labor (5.1%; $P = 0.162$). BV was most frequent in preterm labor (11.2%) compared with PPROM (0%; $P = 0.069$; Table 1).

Maternal Baseline Characteristics

As shown in Table 2, CT-positive women were significantly younger than uninfected women (26.0 ± 6.1 vs 30.8 ± 5.7 years; $P < 0.001$). Adolescents (< 20 years) comprised a larger proportion of infected cases (15.8% vs 2.6%; $P = 0.004$). No differences were observed in body mass index, occupation, income, marital status, or STI history (syphilis, hepatitis B virus [HBV], HIV). Most participants were married (97.8%) and nonsmokers.

Table 1 Prevalence of CT and BV by Gestational Age at Specimen Collection, Gestational Age at Delivery, and Preterm Phenotype

Total	**CT**			**BV**		
	n	**Prevalence (%)**	**(95% CI)**	***n***	**Prevalence (%)**	**(95% CI)**
	330	**19 (5.8%)**	**(3.7%–8.8%)**	**315**	**26 (8.3%)**	**(5.7%–11.8%)**
Gestational age at specimen collection						
28–31^6 weeks	64	5 (7.8%)	(3.4%–17.0%)	61	5 (8.2%)	(3.6%–17.8%)
32–33^6 weeks	93	7 (7.5%)	(3.7%–14.7%)	91	9 (9.9%)	(5.3%–17.7%)
34–36^6 weeks	173	7 (4.0%)	(2.0%–8.1%)	163	12 (7.4%)	(4.3%–12.4%)
P value	0.416			0.797		
Gestational age at delivery						
28–31^6 weeks (very preterm)	10	1 (10.0%)	(1.8%–40.4%)	8	1 (12.5%)	(2.2%–47.1%)
32–33^6 weeks (moderate preterm)	19	3 (15.8%)	(5.5%–37.6%)	17	0 (0%)	–
34–36^6 weeks (late preterm)	105	4 (3.8%)	(1.5%–9.4%)	101	6 (5.9%)	(2.8%–12.4%)
≥ 37 weeks	165	8 (4.8%)	(2.5%–9.3%)	158	18 (11.4%)	(7.3%–17.3%)
P value	0.167			0.232		
Type of preterm						
Preterm	154	7 (4.5%)	(2.2%–9.1%)	143	16 (11.2%)	(7.0%–17.4%)
Preterm pre-labor rupture of membranes (PPROM)	40	5 (12.5%)	(5.5%–26.1%)	39	0 (0%)	–
Threatened preterm labor	136	7 (5.1%)	(2.5%–10.2%)	133	10 (7.5%)	(4.1%–13.3%)
P value	0.162			0.069		

Note: Data are *n* with prevalence (% [95% CI]) unless noted. Group comparisons used chi-square tests.
Abbreviations: BV, bacterial vaginosis; CI, confidence interval; CT, *Chlamydia trachomatis*; PPROM, preterm prelabor rupture of membranes.

Table 2 Maternal Baseline Characteristics by CT Status (*N* = 330)

Variable	Overall (*N*=330)	CT Positive (*n*=19)	CT Negative (*n*=311)	*P* value
Maternal age (years), mean ± SD	30.6 ± 5.8	26.0 ± 6.1	30.8 ± 5.7	<0.001
Age group (years), *n* (%)				0.004
< 20	11 (3.3%)	3 (15.8%)	8 (2.6%)	
20–29	116 (35.2%)	11 (57.9%)	105 (33.8%)	
30–39	182 (55.2%)	5 (26.3%)	177 (56.8%)	
≥ 40	21 (6.3%)	0 (0%)	21 (6.8%)	
BMI (kg/m^2), mean ± SD	26.9 ± 5.4	25.2 ± 5.7	27.0 ± 5.4	0.158
BMI group (kg/m^2), *n* (%)				0.085
< 18.5	6 (1.8%)	1 (5.3%)	5 (1.6%)	
18.5–24.9	131 (39.7%)	12 (63.1%)	119 (38.3%)	
25.0–29.9	119 (36.1%)	3 (15.8%)	116 (37.3%)	
≥ 30	74 (22.4%)	3 (15.8%)	71 (22.8%)	
Occupation, *n* (%)				0.318
Housewife	53 (16.1%)	3 (15.8%)	50 (16.1%)	
Employee/Laborer	120 (36.4%)	11 (57.9%)	109 (35.0%)	
Self-employed	44 (13.3%)	2 (10.5%)	42 (13.5%)	
Government officer	72 (21.8%)	2 (10.5%)	70 (22.5%)	
Other	41 (12.4%)	1 (5.3%)	40 (12.9%)	
Monthly income, *n* (%)				0.050
≤ 10,000	23 (7.0%)	4 (21.1%)	19 (6.1%)	
10,000–19,999	110 (33.3%)	7 (36.7%)	103 (33.1%)	
20,000–49,999	132 (40.0%)	4 (21.1%)	128 (41.2%)	
≥ 50,000	65 (19.7%)	4 (21.1%)	61 (19.6%)	
Marital status: married, *n* (%)	323 (97.9%)	17 (89.5%)	306 (98.4%)	0.056
Multiple sexual partners (>1) in past year, *n* (%)	5 (1.5%)	2 (10.5%)	3 (1.0%)	0.028
History of STI (any), *n* (%)				
Gonorrhea	1 (0.3%)	1 (5.3%)	0 (0%)	1.000
Genital herpes	3 (0.9%)	0 (0%)	3 (1.0%)	1.000
HBsAg	2 (0.6%)	0 (0%)	2 (0.6%)	1.000
Hepatitis B	1 (0.3%)	0 (0%)	1 (0.3%)	1.000
Syphilis	2 (0.6%)	0 (0%)	2 (0.6%)	1.000
Alcohol, *n* (%)	173 (52.4%)	12 (63.2%)	161 (51.8%)	0.356
Smoking, *n* (%)	42 (12.7%)	2 (10.5%)	40 (12.9%)	1.000
Substance use, *n* (%)	7 (2.1%)	0 (0%)	7 (2.3%)	1.000

Note: Data are mean ± SD or *n* (%). Group comparisons used independent *t* tests for continuous variables and chi-square or Fisher's exact tests for categorical variables.

Abbreviations: BMI, body mass index; HBsAg, hepatitis B surface antigen; SD, standard deviation; STI, sexually transmitted infection.

Obstetric and Preterm Risk Factors

Parity, previous preterm birth, cervical surgery, and short cervix (< 25 mm) did not differ between CT-positive and CT-negative groups. Preterm subtype distribution and gestational age at specimen collection were also comparable ($P > 0.05$). For BV, parity, previous preterm birth, and short cervix likewise showed no differences (Table 3).

Table 3 Maternal Baseline Characteristics by BV Status (*N* = 315)

Variable	Overall (*N*=315)	BV Positive (*n*=26)	BV Negative (*n*=289)	*P* value
Maternal age (years), mean ± SD	30.7 ± 5.8	30.2 ± 6.7	30.8 ± 5.7	0.603
Age group (years), *n* (%)				0.651
< 20	10 (3.2%)	1 (3.8%)	9 (3.1%)	
20–29	105 (33.3%)	10 (38.5%)	95 (32.9%)	
30–39	179 (56.8%)	12 (46.2%)	167 (57.8%)	
≥ 40	21 (6.7%)	3 (11.5%)	18 (6.2%)	
BMI (kg/m^2), mean ± SD	26.9 ± 5.4	28.8 ± 9.0	26.7 ± 5.0	0.251
BMI group (kg/m^2), *n* (%)				0.597
< 18.5	6 (1.9%)	0 (0%)	6 (2.1%)	
18.5–24.9	123 (39.1%)	10 (38.4%)	113 (39.0%)	
25.0–29.9	116 (36.8%)	8 (30.8%)	108 (37.4%)	
≥ 30	70 (22.2%)	8 (30.8%)	62 (21.5%)	
Occupation, *n* (%)				0.349
Housewife	50 (15.8%)	5 (19.2%)	45 (15.6%)	
Employee/laborer	112 (35.6%)	13 (50.1%)	99 (34.3%)	
Self-employed	43 (13.7%)	1 (3.8%)	42 (14.5%)	
Government officer	71 (22.5%)	5 (19.2%)	66 (22.8%)	
Other	39 (12.4%)	2 (7.7%)	37 (12.8%)	
Monthly income, *n* (%)				0.463
≤ 10,000	22 (7.0%)	2 (7.7%)	20 (6.9%)	
10,000–19,999	101 (32.0%)	5 (19.2%)	96 (33.3%)	
20,000–49,999	130 (41.3%)	14 (53.9%)	116 (40.1%)	
≥ 50,000	62 (19.7%)	5 (19.2%)	57 (19.7%)	
Marital status: married, *n* (%)	308 (97.8%)	25 (96.2%)	283 (97.9%)	0.456
Multiple sexual partners in past year, *n* (%)	5 (1.6%)	1 (3.8%)	4 (1.4%)	0.352
History of STI (any), *n* (%)				
Gonorrhea	1 (0.3%)	0 (0%)	1 (0.3%)	1.000
Genital herpes	3 (1.0%)	2 (0.7%)	1 (3.8%)	0.228
HBsAg	–	–	–	–
Hepatitis B	1 (0.3%)	0 (0%)	1 (0.3%)	1.000
Syphilis	1 (0.3%)	0 (0%)	1 (0.3%)	1.000
Alcohol, *n* (%)	162 (51.4%)	12 (46.2%)	150 (51.9%)	0.683
Smoking, *n* (%)	40 (12.7%)	6 (23.1%)	34 (11.8%)	0.119
Substance use, *n* (%)	6 (1.9%)	1 (3.8%)	5 (1.7%)	0.406

Note: Data are mean ± SD or *n* (%). Group comparisons used independent *t* tests for continuous variables and chi-square or Fisher's exact tests for categorical variables.

Abbreviations: BMI, body mass index; BV, bacterial vaginosis; GA, gestational age; HBsAg, hepatitis B surface antigen; SD, standard deviation; STI, sexually transmitted infection.

Maternal and Neonatal Outcomes by CT Status

Among 330 cases, CT was not associated with intrapartum fever, postpartum hemorrhage, or other maternal complications. Mean birth weight was 2626.9 ± 700.7 g in CT-positive versus vs 2778.1 ± 611.5 g in CT-negative women (P = 0.340). Apgar score < 7 at 1 minute was 6.7% versus 4.6% (P = 0.523). NICU admission occurred in 12.5% versus 17.7% (P = 1.000; Table 4). The 1-minute Apgar score was evaluated to reflect immediate neonatal adaptation and need for early resuscitation, while most infants had normal 5-minute Apgar scores.

Table 4 Obstetric and Preterm Risk Factors by Infection Status: CT and BV

Variable	Overall (*N*=330)	CT Positive (*n*=19)	CT Negative (*n*=311)	*P* value	Odds Ratio (95% CI)	*P* value
Parity (P≥1), *n* (%)	160 (48.5%)	10 (52.6%)	150 (48.2%)	0.815	1.193 (0.472, 3.015)	0.710
Preterm type, *n* (%)				0.162		
Preterm labor	154 (46.7%)	7 (36.8%)	147 (47.2%)		1	
Preterm premature rupture of membranes (PPROM)	40 (12.1%)	5 (26.4%)	35 (11.3%)		3.000 (0.899, 10.014)	0.074
Threatened preterm labor	136 (41.2%)	7 (36.8%)	129 (41.5%)		1.140 (0.389, 3.335)	0.812
Previous preterm birth, *n* (%)	13 (3.9%)	1 (5.3%)	12 (3.9%)	0.544	1.384 (0.170, 11.245)	0.761
Previous cervical surgery, *n* (%)	6 (1.8%)	0 (0%)	6 (1.9%)	1.000	N/A	N/A
Short cervix <25 mm, *n* (%)	14 (4.2%)	1 (5.3%)	13 (4.2%)	0.572	1.274 (0.158, 10.284)	0.821
Gestational age at specimen collection (weeks), mean ± SD	33.7 ± 2.1	33.7 ± 2.1	33.2 ± 2.3	0.279	0.893 (0.727, 1.097)	0.280
Gestational age at specimen collection (weeks), *n* (%)				0.416		
$28–31^6$ weeks	64 (19.4%)	5 (26.4%)	59 (19.0%)		1	
$32–33^6$ weeks	93 (28.2%)	7 (36.8%)	86 (27.7%)		0.969 (0.291, 3.171)	0.947
$34–36^6$ weeks	173 (52.4%)	7 (36.8%)	166 (53.3%)		0.498 (0.152, 1.628)	0.249
Variable	**Overall (*N*=315)**	**BV positive (*n*=26)**	**BV negative (*n*=289)**	***P* value**	**Odds ratio (95% CI)**	***P* value**
Parity (P≥1), *n* (%)	153 (48.6%)	13 (50.0%)	140 (48.4%)	1.000	1.064 (0.477, 2.375)	0.879
Preterm type, *n* (%)				0.069		
Preterm labor	143 (45.4%)	16 (61.5%)	127 (43.9%)		1	
Preterm premature rupture of membranes (PPROM)	39 (12.4%)	0 (0%)	39 (13.5%)		N/A	N/A
Threatened preterm labor	133 (42.2%)	10 (38.5%)	123 (42.6%)		0.645 (0.282, 1.477)	0.300
Previous preterm birth, *n* (%)	13 (4.1%)	2 (7.7%)	11 (3.8%)	0.292	2.106 (0.441, 10.055)	0.350
Previous cervical surgery, *n* (%)	6 (1.9%)	0 (0%)	6 (2.1%)	1.000	N/A	N/A
Short cervix <25 mm, *n* (%)	14 (4.4%)	0 (0%)	14 (4.8%)	0.616	N/A	N/A
GA at specimen collection (weeks), mean ± SD	33.7 ± 2.1	33.7 ± 2.1	33.8 ± 1.8	0.665	1.044 (0.858, 1.271)	0.664
GA at specimen collection (weeks), *n* (%)				0.797		
$28–31^6$ weeks	61 (19.4%)	5 (19.2%)	56 (19.4%)		1	
$32–33^6$ weeks	91 (28.9%)	9 (34.6%)	82 (28.4%)		1.229 (0.391, 3.862)	0.724
$34–36^6$ weeks	163 (51.7%)	12 (46.2%)	151 (52.2%)		0.890 (0.300, 2.640)	0.834

Note: Data are mean ± SD or *n* (%). Group comparisons used independent *t* tests for continuous variables and chi-square or Fisher's exact tests for categorical variables.
Abbreviations: BV, bacterial vaginosis; CT, *Chlamydia trachomatis*; GA, gestational age; PPROM, preterm prelabor rupture of membranes; SD, standard deviation; TPL, threatened preterm labor.

Maternal and Neonatal Outcomes by BV Status

BV-positive women had a nonsignificant trend toward higher fever rates compared with BV-negative women (12.0% vs 3.1%; $P = 0.062$). Postpartum hemorrhage rates were similar (4.0% vs 3.1%; $P = 0.569$). Neonatal parameters, including birth weight, Apgar scores, and NICU admission, did not differ (Table 5). No maternal infections or neonatal complications (respiratory distress, intraventricular hemorrhage, necrotizing enterocolitis, or sepsis) were observed in either group.

Prevalence of CT and BV by Gestational Age and Preterm Phenotype

The prevalence of CT and BV varied by both gestational age at specimen collection and type of preterm presentation (Figure 2).

Table 5 Maternal and Neonatal Outcomes by Infection Status: CT and BV

Variable	Overall (*N*=299)	CT Positive (*n*=19)	CT Negative (*n*=280)	*P* value	Odds Ratio (95% CI)	*P* value
Maternal outcomes						
Fever >38 °C, *n* (%)	12 (4.0%)	2 (12.5%)	10 (3.5%)	0.130	3.900 (0.779, 19.518)	0.098
PPH, *n* (%)	9 (3.0%)	0 (0%)	9 (3.2%)	1.000	N/A	N/A
Neonatal outcomes						
Birth weight (g), mean ± SD	2770.0 ± 616.3	2626.9 ± 700.7	2778.1 ± 611.5	0.340	N/A	N/A
Birth weight (g), *n* (%)				0.108		
< 2000	34 (11.4%)	4 (25.0%)	30 (10.6%)		2.811 (0.852, 9.270)	0.090
2000–2499	59 (19.7%)	1 (6.3%)	58 (20.5%)		0.306 (0.039, 2.417)	0.261
≥ 2500	206 (68.9%)	11 (68.7%)	195 (68.9%)		0.993 (0.335, 2.943)	0.990
APGAR score <7 at 1 min, *n* (%)	14 (4.7%)	1 (6.7%)	13 (4.6%)	0.523	1.484 (0.181, 12.160)	0.713
APGAR score <7 at 5 min, *n* (%)	3 (1.0%)	0 (0%)	3 (1.1%)	1.000	N/A	N/A
Ventilator support, *n* (%)	60 (20.1%)	2 (12.5%)	58 (20.5%)	0.748	0.554 (0.122, 2.507)	0.443
NICU admission, *n* (%)	52 (17.4%)	2 (12.5%)	50 (17.7%)	1.000	0.666 (0.147, 3.022)	0.598
Neonatal status, *n* (%)				0.107		
Healthy	295 (98.7%)	15 (93.7%)	280 (98.9%)		0.161 (0.016, 1.639)	0.123
Stillbirth	1 (0.3%)	1 (6.3%)	0 (0%)		N/A	N/A
Early neonatal death	2 (0.7%)	0 (0%)	2 (0.7%)		N/A	N/A
Late neonatal death	1 (0.3%)	0 (0%)	1 (0.4%)		N/A	N/A
Variable	**Overall (*N*=284)**	**BV positive (*n*=25)**	**BV negative (*n*=259)**	***P* value**	**Odds ratio (95% CI)**	***P* value**
Maternal outcomes						
Fever >38 °C, *n* (%)	11 (3.9%)	3 (12.0%)	8 (3.1%)	0.062	4.278 (1.059, 17.291)	0.041
PPH, *n* (%)	9 (3.2%)	1 (4.0%)	8 (3.1%)	0.569	1.307 (0.157, 10.898)	0.804
Neonatal outcomes						
Birth weight (g), mean ± SD	2770.0 ± 616.3	2994.0 ± 469.0	2763.3 ± 615.8	0.070	N/A	N/A
Birth weight (g), *n* (%)				0.245		
< 2000	31 (10.9%)	1 (4.0%)	30 (11.5%)		0.318 (0.042, 2.437)	0.270
2000–2499	56 (19.7%)	3 (12.0%)	53 (20.5%)		0.474 (0.136, 1.653)	0.242
≥ 2500	197 (69.4%)	21 (84.0%)	176 (68.0%)		2.476 (0.824, 7.443)	0.106
APGAR score <7 at 1 min, *n* (%)	13 (4.6%)	1 (4.0%)	12 (4.6%)	1.000	0.858 (0.107, 6.883)	0.885
APGAR score <7 at 5 min, *n* (%)	3 (1.1%)	1 (4.0%)	2 (0.8%)	0.242	5.354 (0.468, 61.22)	0.177
Ventilator support, *n* (%)	55 (19.4%)	4 (16.0%)	51 (19.7%)	0.795	0.777 (0.255, 2.363)	0.656
NICU admission, *n* (%)	47 (16.5%)	3 (12.0%)	44 (17.0%)	0.778	0.666 (0.191, 2.324)	0.524

(*Continued*)

Table 5 (Continued).

Variable	Overall (*N*=284)	BV positive (*n*=25)	BV negative (*n*=259)	*P* value	Odds ratio (95% CI)	*P* value
Neonatal status, *n* (%)				0.242		
Healthy	281 (98.9%)	24 (96.0%)	257 (99.2%)		0.187 (0.016, 2.136)	0.177
Stillbirth	–	–	–		–	–
Early neonatal death	2 (0.7%)	1 (4.0%)	1 (0.4%)		10.708 (0.649, 176.7)	0.097
Late neonatal death	1 (0.4%)	0 (0%)	1 (0.4%)		N/A	N/A

Notes: Data are mean ± SD or *n* (%). Group comparisons used independent *t* tests for continuous variables and chi-square or Fisher's exact tests for categorical variables. No maternal infections or neonatal respiratory complications, IVH, NEC, sepsis, or hypoglycemia were observed in either group.
Abbreviations: BV, bacterial vaginosis; CT, *Chlamydia trachomatis*; IVH, intraventricular hemorrhage; min, minute(s); NEC, necrotizing enterocolitis; NICU, neonatal intensive care unit; PPH, postpartum hemorrhage; RDS, respiratory distress syndrome; SD, standard deviation; TTNB, transient tachypnea of the newborn.

- By gestational age: CT infection was more frequently detected in women whose specimens were collected at earlier gestational ages (<32 weeks) compared with later gestations, suggesting an inverse relationship between gestational age and infection prevalence.
- By clinical presentation: The highest CT prevalence was observed in PPROM (12.5%), followed by threatened preterm labour (5.1%) and preterm labour (4.5%).
- Bacterial vaginosis: BV was relatively consistent across gestational age groups and preterm subtypes, with no significant trend or association with gestational age or preterm phenotype.

Summary of Results

CT prevalence was 5.8% and BV prevalence was 8.3%; no NG was detected. Younger maternal age was associated with CT infection ($P < 0.001$). No significant associations were found between infection status and obstetric or neonatal outcomes, although BV showed a trend toward higher prevalence in preterm labor ($P = 0.069$). CT infection was more frequent in younger pregnancies and in pregnancies with PROM.

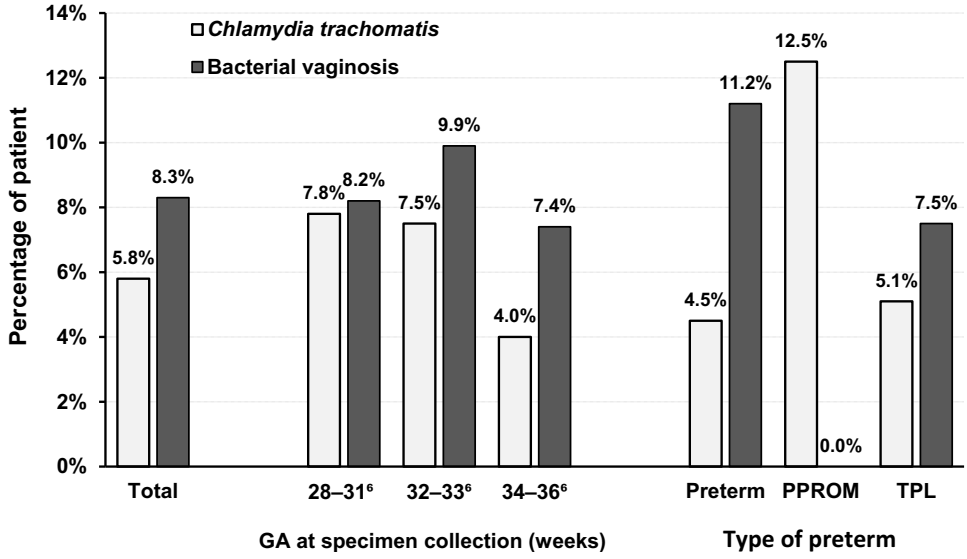

Figure 2 Prevalence of CT and BV by gestational age at specimen collection and preterm phenotype.
Abbreviations: BV, bacterial vaginosis; CT, *Chlamydia trachomatis*; GA, gestational; age; PPROM, preterm prelabor rupture of membranes; TPL, threatened preterm labor.

Discussion

This study examined the prevalence of CT, NG, and BV among pregnant women presenting with preterm labor, threatened preterm labor, and PPROM. Using NAAT, we found CT in 5.8% and BV in 8.3% of participants, whereas NG was not detected. Although between-group differences across gestational-age subgroups were not statistically significant, CT was more frequent in PPROM and earlier gestations. CT infection was also associated with higher rates of intrapartum fever and showed a trend toward increased NICU admission, though the latter did not reach statistical significance.

The CT prevalence in our cohort (5.8%) aligns with reports among pregnant women in Asia of 3%–10%,[12] and with Thai population-based antenatal screening data showing 4%–6% positivity.[13,14] Among women presenting with TPL, PTL, or PPROM, reported chlamydia prevalences typically range from approximately 5% to 15%, and infection has been consistently associated with an increased risk of preterm birth and PPROM in these high-risk populations.[3–5] Studies from other middle-income countries, including the Philippines and Indonesia, report 5%–7% prevalence, reflecting regional similarity in disease burden.[12] The absence of NG-positive cases likely reflects Thailand's sustained national STI screening and treatment programs, which have reduced gonorrhea rates in reproductive-age women.

The observed BV prevalence (8.3%) was lower than several reports in preterm cohorts describing 10%–25%.[9] This difference may reflect our urban, hospital-based setting, where routine antenatal care and prior antibiotic exposure could decrease detection. Both CT and BV tended to be more common at earlier gestational ages and among women with PPROM, supporting an infection–inflammation pathway leading to PPROM.[8]

Although not statistically significant, CT prevalence declined stepwise from 10.0% in very preterm (< 32 weeks) to 4.8% at term, suggesting a contribution of infection to earlier delivery.[3,18] This pattern is consistent with studies indicating that untreated CT doubles the risk of preterm birth and PPROM.[5,19,20] CT infection was more frequent among younger mothers and those reporting multiple sexual partners, paralleling global epidemiology of chlamydial infection.[21,22] In contrast, BV showed no strong demographic or obstetric predictors, consistent with its polymicrobial etiology and multifactorial triggers.[10,23,24]

In adjusted analyses, CT infection independently predicted maternal intrapartum fever (OR 3.78) and neonatal NICU admission (OR 7.50). These findings align with reports linking chlamydial infection to subclinical chorioamnionitis, fetal inflammatory responses, and neonatal respiratory or infectious complications.[3–5] In the present study, most neonatal outcomes, including Apgar scores and mortality, did not differ significantly on statistical testing. However, the direction of effect toward higher rates of low birth weight and NICU admission suggests clinically meaningful risk even at modest prevalence. BV was not associated with adverse outcomes in this cohort, possibly because of low prevalence and the small number of positive cases.

Comparison with Previous Studies

Our findings reinforce evidence from high- and low-income settings that CT contributes to adverse pregnancy outcomes. A meta-analysis of 24 studies found higher odds of preterm delivery among CT-positive women (OR 2.28; 95% CI 1.64–3.16).[25] Another meta-analysis of 50 studies reported associations with preterm birth (OR 1.73; 95% CI 1.30–2.32) and PPROM (OR 2.82; 95% CI 1.33–5.97) in high-quality studies.[4] Odds were even higher when using culture-based detection (OR 4.34).[4] Thai data specifically examining women with preterm complications remain limited; therefore, our results fill a local evidence gap and support targeted screening in high-risk pregnancies. Our findings indicate that CT infection tends to occur earlier in gestation and more often among women presenting with PPROM, supporting the hypothesis that ascending cervical infection may contribute to membrane rupture and preterm complications. In contrast, BV prevalence appeared independent of gestational timing or preterm subtype.

This study adds context-specific evidence by evaluating *Chlamydia trachomatis, Neisseria gonorrhoeae*, and bacterial vaginosis exclusively among women presenting with threatened preterm labor, preterm labor, and preterm prelabor rupture of membranes in a setting without routine antenatal screening. Using uniform nucleic acid amplification testing and phenotype-specific analyses, our findings provide contemporary data linking infection prevalence to gestational age, clinical presentation, and maternal–neonatal outcomes in a high-risk obstetric population.

Screening Strategies in Preterm Birth Risk Groups

The absence of NG detection likely reflects low prevalence among pregnant Thai women and the lack of routine antenatal screening for NG. Current national practice limits testing to symptomatic women or those with identified sexual risk factors, explaining few detected cases in this and other regional cohorts. This pattern suggests effective STI control programs but also indicates that routine dual CT/NG testing would add minimal benefit in low-prevalence settings.

In contrast, CT infection, present in 5.8% of this high-risk cohort, remains a clinically relevant and under-recognized contributor to preterm birth. Because most infections are asymptomatic,[5,11] diagnosis is often delayed until complications such as PPROM, chorioamnionitis, or spontaneous preterm labor occur.[5,8,25] In this cohort, CT was more frequent among women presenting with PPROM and threatened preterm labor, supporting the hypothesis that ascending cervical infection triggers inflammatory changes leading to preterm birth.[26] This aligns with evidence that CT approximately doubles the risk of spontaneous preterm delivery and that prompt antibiotic therapy, most often azithromycin, can mitigate adverse outcomes.[27]

Rationale for Risk-Based Screening

Thailand's antenatal screening program routinely tests for syphilis, HBV, and HIV, but not for CT because of cost and infrastructure constraints. Our findings indicate that risk-based NAAT screening is feasible and clinically meaningful, especially among women with preterm symptoms or STI coinfection. NAAT provides superior diagnostic sensitivity for asymptomatic infection and integrates readily into existing antenatal workflows. Selective testing is warranted for women with preterm labor or PPROM, a short cervix (< 25 mm), previous preterm delivery, or concurrent syphilis, HBV, or HIV infection.[5,11,28] This targeted approach could identify preventable infections while avoiding unnecessary testing in low-risk pregnancies.

Implementation and Policy Implications

Integrating CT testing into Thailand's preterm birth prevention framework is operationally feasible. Vaginal or urine-based NAAT specimens can be collected during standard antenatal visits alongside existing infectious disease screens. Pilot implementation in tertiary hospitals would allow evaluation of diagnostic yield, cost-effectiveness, and acceptability before broader rollout. Because NG was undetected, a single-target CT assay may be more cost-efficient than dual testing in low-prevalence populations. Incorporating CT screening into national maternal health programs would align with the Ministry of Public Health strategy to reduce preventable neonatal morbidity. Partner treatment, post-treatment testing, and integration into infection surveillance could further enhance control efforts and reduce reinfection.

Recommendations for National Guidelines

Emerging evidence linking CT with preterm birth supports risk-based CT screening in Thailand's national antenatal care guidelines. The Royal Thai College of Obstetricians and Gynaecologists could lead this update, leveraging infrastructure established for syphilis, HBV, and HIV testing. Screening women with preterm labor, PPROM, or a prior preterm delivery would facilitate early detection, treatment, and partner management, thereby reducing infection-related preterm morbidity. This policy would strengthen maternal–child health outcomes and align Thailand's practice with World Health Organization and US Centers for Disease Control and Prevention recommendations for targeted STI screening in high-risk pregnancies.

Strengths and Limitations

Strengths include NAAT-based diagnosis, clearly defined preterm phenotypes, and comprehensive assessment of maternal and neonatal outcomes. Limitations include the single-center design, a modest sample size limiting subgroup analyses, and the absence of longitudinal follow-up to assess treatment response or reinfection. Time-to-event analyses were not performed, as the study was not designed to evaluate latency to delivery or timing of complications. Associations between CT infection and maternal or neonatal complications were exploratory, and adjustment for potential confounders was limited by the number of outcome events. Future research should investigate microbiome interactions between CT, BV, and host immune responses that contribute to preterm birth risk.

Bacterial vaginosis was included as a secondary infection of interest in this study. BV diagnosis was based on wet smear microscopy identifying clue cells, reflecting routine clinical practice in our setting. This approach differs from full Amsel or Nugent criteria and may limit direct comparability with studies using alternative diagnostic definitions. Accordingly, findings related to BV should be interpreted conservatively as exploratory.

Conclusions

CT infection was identified in approximately 6% of pregnant women presenting with threatened preterm labor, preterm labor, or preterm prelabor rupture of membranes. Although differences did not reach statistical significance, CT-positive women showed trends toward higher rates of intrapartum fever and neonatal intensive care unit admission, indicating potential clinical relevance. NG was not detected, and bacterial vaginosis showed no clear association with adverse outcomes in this cohort. These findings suggest that CT infection may contribute to preterm complications in some cases and support further evaluation of targeted screening approaches in high-risk pregnancies.

Abbreviations

BV, bacterial vaginosis; CT, *Chlamydia trachomatis*; HBV, hepatitis B virus; NAAT, nucleic acid amplification testing; NG, *Neisseria gonorrhoeae*; NICU, neonatal intensive care unit; OR, odds ratio; PPROM, preterm prelabour rupture of membranes; STI, sexually transmitted infection.

Data Sharing Statement

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Ethics Approval and Informed Consent

This study was reviewed and approved by the Siriraj Institutional Review Board, Faculty of Medicine Siriraj Hospital, Mahidol University, Bangkok, Thailand (Si-215/2023). Ethical approval was granted on March 15, 2023. Written informed consent was obtained from all participants before enrollment and specimen collection. All procedures complied with the Declaration of Helsinki and the International Council for Harmonisation Guideline for Good Clinical Practice.

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Author Contributions

All authors made a significant contribution to the work reported, whether that is in the conception, study design, execution, acquisition of data, analysis and interpretation, or in all these areas; took part in drafting, revising or critically reviewing the article; gave final approval of the version to be published; have agreed on the journal to which the article has been submitted; and agree to be accountable for all aspects of the work.

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Disclosure

The authors declare that there are no competing interests that could influence the results or discussion reported in this paper.

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