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Epidemiologic Factors and Urogenital Infections Associated With Preterm Birth in a Midwestern U.S. Population

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Abstract

Objective—To correlate epidemiologic factors with urogenital infections associated with preterm birth.

Methods—Pregnant women were sequentially included from four Wisconsin cohorts: large urban, midsize urban, small city, and rural city. Demographic, clinical, and current pregnancy data were collected. Cervical and urine specimens were analyzed by microscopy, culture, and polymerase chain reaction for potential pathogens.

Results—Six hundred seventy-six women were evaluated. Fifty-four (8.0%) had preterm birth: 12.1% (19/157) large urban, 8.8% (15/170) midsize urban, 9.4% (16/171) small city, and 2.3% (4/178) rural city. Associated host factors and infections varied significantly among sites. Urogenital infection rates, especially *Mycoplasma hominis* and *Ureaplasma parvum*, were highest at the large urban site. Large urban site, minority ethnicity, multiple infections, and certain historical factors were associated with preterm birth by univariable analysis. By multivariable analysis, preterm birth was associated with prior preterm birth (adjusted odds ratio [aOR] 2.76, 95% confidence interval [CI] 1.27–6.02) and urinary tract infection (aOR 2.62, 95% CI 1.32–519), and negatively associated with provider-assessed good health (aOR 0.42, 95% CI 0.23–0.76) and group B streptococcal infection treatment (surrogate for healthcare utilization) (aOR 0.38, 95% CI

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0.15–.99). Risk and protective factors were similar for women with birth at < 35 weeks, and additionally associated with *M hominis* (aOR 3.6, 95% CI 1.4–9.7).

Conclusion—These measured differences between sites are consistent with observations that link epidemiologic factors, both environmental and genetic, with minimally pathogenic vaginal bacteria, inducing preterm birth, especially at less than 35 weeks of gestation.

INTRODUCTION

Preterm birth, defined as delivery at a gestation of less than 37 weeks or 259 days, occurs in 11% to 12% of all U.S. births and is a significant health problem (1). Accepted risk factors for preterm birth include low socioeconomic status, Black race, low body mass index, prior preterm birth, multiple gestation, short interpregnancy interval, and the use of tobacco or illicit drugs, among others (2). Preterm birth is also associated with infections. Histologic evidence of chorioamnionitis has been found in placentas of 40% of all preterm births (3,4) and is particularly prevalent in births before 30 weeks of gestation.

Infections of the lower genitourinary system have been associated with preterm birth and small for gestational age neonates. These include sexually transmitted pathogens, and bacterial vaginosis (BV), and urinary tract infection (UTI) (4,5). Vaginitis and UTI are manifested by disrupted vaginal flora, with a shift from acidophilic and facultative H₂O₂-producing lactobacilli toward anaerobes or *Enterobacteriaceae*, respectively (5,6).

Some urogenital mollicutes (*Mycoplasma* and *Ureaplasma* species, which are bacteria without cell walls) have been associated by culture with preterm birth in many (7,8,9,10), but not all (5,11,12), studies. Causality for preterm birth or labor is plausible because mollicutes possess adhesion molecules that interact with toll-like receptors and stimulate secretion of pro-inflammatory cytokines IL2, IL4, and IL6 (2,4,5,6,12,13,14).

In this epidemiologic cohort investigation, we sought to identify host factors associated with preterm birth across a Midwestern U.S. population and to correlate these factors with urogenital infections.

MATERIALS AND METHODS

This study was approved by an institutional review board (IRB) from each of four Wisconsin study sites: Aurora Health Care IRB – Biomedical; Meriter Hospital, Inc. IRB; Gunderson Clinic, Ltd. Human Subjects Committee IRB; and Marshfield Clinical Research Foundation IRB. Preterm birth was defined as occurring before 37 weeks of gestation. A subset of preterm birth occurring at less than 35 weeks of gestation was separately evaluated against all others.

Using literature data, statistical predictions on urogenital mollicute infection rate, and a preliminary prevalence study, 200 pregnancies per site were estimated to be adequate (15). Data and specimen collection occurred from 23 January 2008 through 11 March 2011. This prospective, observational study was undertaken at four sites, from urban centers with mixed genetic-cultural diversity through rural centers serving primarily Americans of northern

European descent. Study sites were 1) a large urban site in Milwaukee (population 597,867) serving a low-income, underserved obstetric population (up to 300% of federal poverty level) with 45 providers delivering 2600 pregnancies annually; 2) a midsize urban site in Madison (population 240,323) with 89 providers delivering 3795 pregnancies annually; 3) a small city site in La Crosse (population 69,500) with 28 providers delivering 1380 pregnancies annually; and 4) a rural city site in Marshfield (population 19,118) with 34 providers delivering 3377 pregnancies annually. All sites follow the obstetric quality guidelines of the Wisconsin Hospital Association and the Joint Commission Accredited Hospitals and had similar quality scores.

Women aged 18 to 44 years who were from 10 to 14 weeks of gestation at their initial prenatal visit for a currently uncomplicated pregnancy were eligible for the study. Previous preterm birth or labor was not an exclusion factor. Patients were enrolled sequentially upon receipt of their written informed consent.

Prospectively collected questionnaire data included age, race or ethnicity, relationship status, education, employment status, and prior or current substance use (alcohol, tobacco, and illicit drugs). Medical history collected included medication use prior to pregnancy, prior live births, menstruation history, contraception prior to pregnancy, health problems prior to 6 weeks of a birth, history of infection complications during a pregnancy, prior preterm birth or labor, and pregnancy complications.

Information collected regarding the study pregnancy included body mass index, prenatal care status, assessment of health, history of sexual intercourse 6 weeks before birth, number of sexual partners during pregnancy, and laboratory data of sexually transmitted infections (STIs) 6 months before or during the pregnancy. The latter included diagnosis of any STIs, including *Trichomonas vaginalis*, *Chlamydia trachomatis*, *Neisseria gonorrhea*, *Treponema pallidum*, Herpes simplex, and human immunodeficiency virus infection, and Hepatitis B and C. Additional infection information was collected from the medical record, including diagnosis of vaginitis, UTI, group B streptococcal infection, and non-genitourinary infections (enteritis, skin infection, or respiratory infections).

Postenrollment complications, including gestational diabetes and prescription of antibiotics, were reviewed. Recorded pregnancy outcomes, whether spontaneous or induced, included gestational age at delivery, delivery method, and infant birth weight, and abortion.

Cervical specimens for polymerase chain reaction (PCR) and routine *Streptococcus agalactiae* (group B streptococcus) cultures were obtained during initial pelvic examinations performed at approximately 11.5 (± 3.7) weeks gestation. A diagnosis of vaginitis was based on symptoms, signs, and a vaginal wet mount microscopy for yeast, *T vaginalis*, and clue cells. A UTI diagnosis was based on results of a routine culture of a first-void, clean-catch urine specimen obtained during gestation weeks 18 to 28 for asymptomatic bacteruria, or at the time of symptoms or signs of UTI. Specimen storage, DNA extraction, and PCR hybridization probes were as reported elsewhere (15,16,17,18), with details available on request.

Data were entered by study coordinators from each site (large urban: S.S. and M.M.; midsize urban: B.B., D.D.D., T.M., and C.R.; small city: S.C. and J.S.; rural city: C.B.) into a password-protected central database maintained by the University of Wisconsin Institute for Clinical and Translational Research (ICTR), of which WiNHR is a component. Study coordinators at each site had access to only their own site's data. Only the primary study coordinator (M.J.W.) had access to the full database. Coordinators were alerted to records with missing or conflicting data and made corrections or confirmed the accuracy of the records using source documents. Potential predictive factors for preterm birth were preliminarily compared between study sites and racial or ethnic groups using either Pearson χ^2 or Fisher exact tests for categorical data, and t tests or 1-way analysis of variance with a post-hoc Tukey test for continuous data. The relationship between infant weight, gestation duration, and other risk factors was established using simple and multivariable linear regression. The association between potential predictive factors and preterm birth was assessed by univariable logistic regression, and factors that displayed a modest association ($P < .15$, Wald χ^2 test) or stronger were included in the final multivariable model. Multivariable modeling of risk factors used 2-step logistic regression with a dichotomous outcome variable (preterm vs not preterm). The first step included all factors identified through univariable analysis; factors with an effect significance of $P < .15$ were included in the second step. Fit quality was assessed using the Hosmer-Lemeshow test and receiver operating characteristic (ROC) analysis. All analysis was conducted using SAS/STAT (version 9.3, Cary, NC).

RESULTS

The percentage of women approached who consented to the study was approximately 85%. Seven hundred eighty-three women were enrolled. After exclusion, 676 were available for evaluation; 54 (8.0%) had preterm birth. In addition, 65 (9.6%) had preterm birth or labor, and 120 (17.8%) had early term birth or labor, for a total of 185 women (27.3%) with labor or birth at less than 38 weeks of gestation. Enrollment and percentage preterm by study site were: large urban, 157 (12.1%); midsize urban, 170 (8.8%), small city, 171 (9.4%), and rural city, 178 (2.3%). Most (63.0%) preterm occurred at 35 to 37 weeks of gestation, and shorter gestation times were associated with lower birth weights using simple linear regression ($\beta=0.44$ lbs/week, $t = 8.06$, $P < .001$).

One hundred seven women were excluded from the final analysis for the following reasons: missing or insufficient specimens for PCR analysis ($n=49$ cases), lost to follow-up or missing birth data ($n=39$), spontaneous abortion before 21 weeks of gestation or elective termination ($n=13$), multiple births ($n=5$), and missing essential demographic or history data ($n=1$). Excluded women were demographically similar to those included in the study. Those excluded for missing or insufficient PCR specimens who met all other inclusion criteria ($n=42$) had preterm birth or labor (9.52%) at a rate similar to that of included subjects. Analysis shown pertained to preterm birth, but the inclusion of early term would not have significantly changed the results, with the exception that the association with urogenital mycoplasma infection would no longer be significant. In addition, inclusion of only births with ruptured membranes (not shown) had similar results, but at lower power due to the reduced number of events, especially in the < 35 -week subset ($n=17$ births).

Significant differences among the patient factors between the four study sites are noted in Table 1. Combining all sites, most known host factors were significantly associated with preterm birth using univariable logistic regressions (Table 2).

The association between preterm birth and infection significantly differed both between sites and across the combined sites (Tables 3 and 4, respectively). Analysis by racial or ethnic group revealed significant differences across multiple demographic and clinical factors (Table 5).

Using predictors identified by univariable analysis, a preliminary multivariable model of preterm birth was constructed using multivariable logistic regression. Prior to calculation of test statistics, significant collinearity was noted between site and race, and between smoking prior to pregnancy and substance use during pregnancy. As a result, study site was removed from the multivariable model. Separate models, one including smoking and the other prenatal substance use, along with all other candidate predictors, were tested. The preliminary models were then further condensed into a single, final multivariable model using factors assembled from the preliminary models with $P < .15$. The final model showed an acceptable goodness of fit and predictive power (Hosmer-Lemeshow test: $\chi^2 = 2.67$, $df = 7$, $P = .91$ ROC area under the curve: 0.74).

By multivariable analysis (Table 6), preterm birth was associated with prior preterm birth (adjusted odds ratio [aOR] 2.76, 95% confidence interval [CI] 1.27–6.02) and urinary tract infection (aOR 2.62, 95% CI 1.32–5.19). Preterm birth was negatively associated with provider-assessed good health (aOR 0.42, 95% CI 0.23–0.76) and group B streptococcal infection treatment (surrogate for healthcare utilization) (aOR 0.38, 95% CI 0.15–.99).

Two distinct groups of gestation times were noted (Figure 1)—the first distributed about a mean gestation time of 39 weeks and extending from 35 to 42 weeks, and the second representing a constant rate of moderately early preterm births at < 35 weeks ($n=20$). The 20 women with birth at < 35 weeks had demographic and clinical risk factors similar to those associated with preterm births between 35 and 37 weeks, with the notable exception of moderately elevated rates of mollicute species (90% vs 64.7%, $P = .04$), specifically moderately elevated rates of *M hominis* carriage (40.0% vs 17.7%, $P = .07$), and previous preterm birth (40.0% vs 14.7%, $P = .09$), with added support using a multivariable logistic regression model based on the final model of all preterm births and the addition of *M hominis*.

DISCUSSION

Preterm birth is known to be unevenly distributed in the American population. This cohort study with a range from 12.1% in the large urban site to only 2.3% in the rural city, further supports this observation.

Significant epidemiologic differences were found between the four sites, and when the sites were combined, univariable analysis of demographic risk factors supported recent literature (19). Fifty percent of births at < 35 weeks occurred in the large urban site, and 55% of all

preterm births occurred in the Black and other minority groups, primarily at the large urban site.

Differences between sites were also found for infectious factors, including STIs, UTI, *S agalactiae* colonization, BV, nonurogenital infections, and treatment with antibiotic not active for mollicute infection. Combining sites for infectious factors, only UTI, any urogenital mollicute colonization, and *M hominis* colonization reached significance for preterm birth, while therapy for group B streptococcal or nonurogenital bacterial infection (markers of healthcare utilization) was associated with decreased risk of preterm birth.

By combined site multivariable analysis, poor health, UTI, and prior preterm birth were associated with increased risk of preterm birth, but diagnosis of a group B streptococcal or nonurogenital infection was associated with a decreased risk. Births at < 35 weeks were associated with *M hominis* colonization.

In our large urban cohort, rates of urogenital mollicute carriage, especially *M hominis* and *U parvum*, were very high (91%) in the Black racial subset of that population. These mollicute rates have been associated with sexual behaviors (20,21). Additionally, the carriage rate of *M hominis* or either *Ureaplasma* species was widespread in women who gave birth at < 35 weeks (Figure 1).

Conflicting associations between mollicutes and preterm birth have had a long history, not only related to population tested, but also to testing itself (culture vs PCR) (5,7,8,9,10,11,12,16,20,21,22,23,24,25,26). We used PCR probes that can separate *M hominis*, *M genitalium*, and *U parvum* from *U urealyticum* (18). The approximate prevalence of the four combined urogenital mollicutes is similar to that reported by others (14).

Vaginitis also complicates the association of mollicutes with preterm birth. In an earlier study, *U urealyticum* (by culture) was found to be associated with bacterial vaginosis and colonization with *M hominis*, but it was not found to be a factor in preterm birth (11). In another study, bacterial vaginosis (by lack of *Lactobacillus*) and *M hominis* (by genital culture) were associated with preterm birth, but *U urealyticum* by genital culture was not (27). In contrast, a recent Brussels study (28) of nearly 2000 pregnancies found *Ureaplasma* species to be a significant risk for preterm birth, and a commensurate risk of preterm birth was associated with abnormal flora, but only if *Ureaplasma* species was culture positive. These variable results may be related to differences in vaginal ecologies as recently described in studies of high-risk pregnancies (29,30).

Another association that stands out in our study is the use and availability of health care for pregnant women. The proportion of women receiving regular prenatal care was statistically higher in lower risk, non-large urban cohorts. Furthermore, using antibiotic prescriptions as a surrogate for health care utilization, antibiotics were more frequently prescribed in the non-large urban cohorts for nongenitourinary infections. Confirming negative effects seen by others (5,28,29,31), our study did not show a reduced risk for preterm birth with the non-randomized prescription of antibiotics considered active against urogenital mollicutes,

possibly due to reinfection, antibacterial resistance, inadequate drug levels at site of infection, or lack of eradication secondary to non-bacteriocidal therapy (5,31,32,33,34).

Recently, the association of preterm birth and genitourinary infections in black women has been emphasized (35). We also believe further study and methods to decrease infection risks to preterm birth are needed, particularly in high-risk groups (36).

A limitation of this cohort study was the small number of non-European-Americans in all but the large urban site, which precluded a robust analysis of the risk factors of smaller ethnic populations in the other cities. Because 88% of the Wisconsin population outside of Milwaukee is of European descent, a Wisconsin study with sufficient enrollment of non-European-Americans to allow such an analysis would be prohibitively large.

In conclusion, a reasonable hypothesis remains that genetic and environmental factors coupled with infections, perhaps with a change in vaginal flora, trigger cytokines to cause amniotic inflammation, inducing preterm birth, especially before 35 weeks of gestation (2,27,28,29,31). By this study and multiple others, the infecting organisms appear, by epidemiologic associations, to be easily overlooked or difficult to detect and are usually considered commensal bacteria.

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Figure 1.

A. Distribution of all births by week gestation and urogenital mollicute carriage. **B.** Distribution of births at less than 35 weeks of gestation by week gestation and urogenital mollicute carriage.

Table 1

Comparison of Demographic Factors Between Study Sites

Characteristic	Large Urban n = 157	Midsize Urban n = 170	Small City n = 171	Rural City n = 178	P
Preterm birth	19 (12.1)	15 (8.8)	16 (9.4)	4 (2.3)	.007
Age, y	23.5 ± 4.9	27.7 ± 5.5	28.6 ± 4.5	28.3 ± 4.6	<.001
BMI, kg/m ²	28.3 ± 7.4	28.4 ± 8.3	26.6 ± 6.6	27.0 ± 5.5	.069
Non-White or Asian race [*]	132 (84.1)	37 (21.8)	3 (1.8)	3 (1.7)	<.001
Married or Cohabiting	20 (12.7)	114 (67.1)	146 (85.4)	154 (86.5)	<.001
Post-high school degree	19 (12.1)	102 (60.0)	114 (66.7)	112 (62.9)	<.001
Employment part- or full-time	99 (63.1)	134 (78.8)	145 (84.8)	144 (80.9)	<.001
Prior tobacco use	39 (24.8)	34 (20.0)	23 (13.5)	21 (11.8)	.005
Prior alcohol use	19 (12.1)	54 (31.8)	73 (42.7)	54 (30.3)	<.001
Prior recreational drug use	12 (7.6)	7 (4.1)	1 (0.6)	1 (0.6)	<.001
Prenatal substance use	26 (16.6)	16 (9.4)	21 (12.3)	17 (9.6)	.16
Parity					<.001
First pregnancy	71 (45.2)	83 (48.8)	70 (40.9)	48 (27.0)	
Prior preterm	13 (8.3)	17 (10.0)	18 (10.5)	12 (6.7)	
Prior full-term birth(s)	73 (46.5)	70 (41.2)	83 (48.5)	118 (66.3)	
Caesarean delivery [†]	42 (26.8)	49 (28.8)	35 (20.5)	34 (19.1)	.055
Regular prenatal care	98 (62.4)	156 (91.8)	145 (84.8)	170 (95.5)	<.001
Patient in good health	79 (50.3)	142 (83.5)	132 (77.2)	173 (97.2)	<.001

BMI, body mass index.

Data are mean ± standard deviation or number of patients (%) unless otherwise specified.

^{*} Includes Indigenous American, 7; Pacific Islander, 2; Black, 139; Hispanic or Latino, 20; multiple races, 7. Nine Asians were included with the Whites.[†] Delivery method missing for 5 Large Urban site patients, 6 Midsize Urban patients, and 1 Small City patient.

Table 2

Univariable Analysis of Demographic Factors by Preterm Birth, Combined Sites

Characteristic	Preterm Birth	Odds Ratio (95% CI)	P
Age, y	--	0.97 (0.92–1.03)	.30
BMI, kg/m ²	--	1.02 (0.98–1.06)	.47
Non-White or Asian race*	22 (12.6)	2.11 (1.19–3.74)	.011
Married or Cohabiting	30 (6.9)	0.67 (0.39–1.18)	.17
Post-high school degree	17 (4.9)	0.41 (0.22–0.74)	.003
Employed part or full-time	39 (7.5)	0.75 (0.40–1.40)	.36
Prior tobacco use	15 (12.8)	1.96 (1.01–3.69)	.037
Prior alcohol use	14 (7.0)	0.82 (0.44–1.54)	.54
Prior recreational drug use	3 (14.3)	1.97 (0.56–6.93)	.29
Prenatal substance use [†]	12 (15.0)	2.33 (1.17–4.64)	.017
Parity			
First pregnancy	24 (8.8)	Reference	--
Prior preterm	13 (21.7)	2.86 (1.36–6.01)	.006
Prior full-term birth(s)	17 (4.9)	0.54 (0.28–1.02)	.058
Caesarean delivery [‡]	18 (11.3)	1.81 (0.99–3.31)	.054
Regular prenatal care	41 (7.2)	0.56 (0.29–1.09)	.087
Patient in good health	31 (5.9)	0.35 (0.20–0.61)	<.001

CI, confidence interval; BMI, body mass index.

Data are number of patients (%) unless otherwise specified.

* Includes Indigenous American, Pacific Islander, Black, Hispanic or Latino, and multiple races.

[†] Includes tobacco, alcohol, or recreational drug use, or any combination thereof.[‡] Delivery method missing for 12 patients.

Table 3

Comparison of Infectious Factors Between Study Sites

Characteristic	Large Urban n = 157	Midsized Urban n = 170	Small City n = 171	Rural City n = 178	P
Preterm births	19 (12.1)	15 (8.8)	16 (9.4)	4 (2.3)	
Sexually transmitted infection	61 (38.9)	13 (7.7)	13 (7.6)	9 (5.1)	<.001
Chlamydia	30 (19.1)	2 (1.2)	0	1 (0.6)	<.001
Gonorrhea	6 (3.8)	1 (0.6)	0	0	.001
Herpes	20 (12.7)	6 (3.5)	7 (4.1)	1 (0.6)	<.001
Human Papillomavirus	15 (9.6)	4 (2.4)	6 (3.5)	7 (3.9)	.012
Vaginitis during pregnancy	83 (52.9)	12 (7.1)	6 (3.5)	6 (3.4)	<.001
Urinary tract infection during pregnancy	47 (29.9)	11 (6.5)	12 (7.0)	13 (7.3)	<.001
Carriage of group B streptococci	43 (27.4)	41 (24.1)	32 (18.7)	31 (17.4)	.09
Other nonurogenital infections	32 (20.4)	22 (12.9)	16 (9.4)	27 (15.2)	.04
Antibiotic active against urogenital mollicutes	28 (30.1)	19 (25.3)	1 (2.7)	12 (22.2)	<.001
Any urogenital mollicute	144 (91.1)	105 (58.7)	79 (45.7)	82 (46.1)	<.001
<i>Ureaplasma parvum</i>	112 (71.3)	80 (47.1)	64 (37.4)	75 (42.1)	<.001
<i>Ureaplasma urealyticum</i>	16 (10.2)	14 (8.2)	7 (4.1)	13 (7.3)	0.2
<i>Mycoplasma hominis</i>	53 (33.8)	27 (15.9)	33 (19.3)	6 (3.4)	<.001
<i>Mycoplasma genitalium</i>	5 (3.2)	1 (0.6)	2 (1.2)	1 (0.6)	.19

Data are number of patients (%) unless otherwise specified.

Table 4

Univariable Unadjusted Analysis of Infectious Factors by Preterm Birth, Combined Sites

Infectious Factor	Preterm Birth	Adjusted OR (95% CI)	P
Sexually transmitted infection	9 (9.4)	1.23 (0.51–2.67)	.55
Chlamydia	2 (6.1)	0.73 (0.17–3.15)	.68
Gonorrhea	0	--	.99
Herpes	3 (8.8)	1.12 (0.33–3.80)	.85
Human papillomavirus	4 (12.5)	1.70 (0.57–5.03)	.34
Vaginitis during pregnancy	12 (11.2)	1.59 (0.81–3.12)	.18
Urinary tract infection during pregnancy	15 (18.1)	3.13 (1.64–5.98)	<.001
Carriage of group B streptococci	5 (3.4)	0.35 (0.14–0.88)	.026
Other nonurogenital infections	3 (3.1)	0.33 (0.10–1.08)	.067
Antibiotic active against urogenital mollicutes	4 (6.7)	0.81 (0.28–1.32)	.69
Any urogenital mollicute	40 (10.0)	2.07 (1.10–3.88)	.024
<i>Ureaplasma parvum</i>	29 (8.8)	1.23 (0.70–2.15)	.47
<i>Ureaplasma urealyticum</i>	6 (12.0)	1.64 (0.67–4.05)	.28
<i>Mycoplasma hominis</i>	14 (11.8)	1.72 (0.91–3.28)	.098
<i>Mycoplasma genitalium</i>	0	--	.99

OR, odds ratio; CI, confidence interval.

Data are number of patients (%) unless otherwise specified.

Table 5

All Risk Factors Compared by Racial or Ethnic Group

Characteristic	Preterm Birth n = 54	Racial or Ethnic Group		P
		White or Asian n = 501	All Other* n = 175	
Preterm births		32 (6.4)	22 (12.6)	.009
Age, mean y $\pm$ standard deviation		28.5 $\pm$ 4.8	23.3 $\pm$ 4.7	<.001
Body mass index, mean kg/m ² $\pm$ standard deviation		26.9 $\pm$ 6.4	29.2 $\pm$ 8.3	.004
Married or Cohabiting	30 (6.9)	410 (81.8)	27 (13.7)	<.001
Post-high school degree	17 (4.9)	324 (64.7)	23 (13.1)	<.001
Employed part- or full-time	39 (7.5)	411 (82.0)	111 (63.4)	<.001
Parity				.046
First pregnancy	24 (8.8)	188 (37.5)	84 (48.0)	
Prior preterm	13 (21.7)	45 (9.0)	15 (8.6)	
Prior full-term birth(s)	17 (4.9)	268 (53.5)	76 (43.4)	
Sexually transmitted infection	9 (9.4)	36 (7.2)	60 (34.3)	<.001
Vaginitis during pregnancy	12 (11.2)	25 (5.0)	82 (46.9)	<.001
Urinary tract infection during pregnancy	15 (18.1)	40 (8.0)	43 (24.6)	<.001
Carriage of group B streptococci	5 (3.4)	103 (20.6)	44 (25.1)	.21
Other nonurogenital infections	3 (3.1)	63 (12.6)	34 (19.4)	.03
Antibiotic active against urogenital mollicutes	4 (6.7)	30 (6.0)	30 (17.1)	<.001
Any urogenital mollicute	40 (10.0)	247 (49.3)	154 (88.0)	<.001

Data are number of patients (%) unless otherwise specified.

* Includes Indigenous American, Pacific Islander, Black, Hispanic or Latino, and multiple races.

Table 6

Final Multivariable Models of Risk Factors and Preterm Birth

Effect	Birth < 37 weeks		Birth < 35 weeks	
	Adjusted OR (95% CI)	P	Adjusted OR (95% CI)	P
Parity				
First pregnancy	Reference		Reference	
Prior preterm	2.76 (1.27–6.02)	.011	7.3 (2.3–22.9)	<.01
Prior full-term birth(s)	0.60 (0.31–1.15)	.12	0.8 (0.3–2.6)	.73
Carriage of group B streptococci	0.38 (0.15–0.99)	.047	0.2 (0.1–1.2)	.08
Other nonurogenital infections	0.30 (0.09–1.02)	.053	--*	
Patient in good health	0.42 (0.23–0.76)	.005	--*	
Positive for UTI, yes vs no	2.62 (1.32–5.19)	.006	4.2 (1.6–11.0)	<.01
<i>Mycoplasma hominis</i>	--†		3.6 (1.4–9.7)	<.01

OR, odds ratio; CI, confidence interval; UTI, urinary tract infection.

* Not included in the birth at < 35-week model.

† Not included in the birth at < 37-week model.