

**Examining Racial and Ethnic Disparities in the Incidence and Treatment of Urinary Tract Infection
During Pregnancy**

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Abstract

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Maternal mortality and morbidity in the United States continue to rise, with disparate burden experienced by socioeconomically disadvantaged and racial minority groups.^{1,2} Infections during pregnancy are a leading cause of morbidity during pregnancy, with urinary tract infections (UTIs) and asymptomatic bacteriuria (ASB) occurring in approximately 17-18% of pregnancies.^{3,4} We conducted a cohort study including pregnant members of an integrated healthcare system in Washington State aged 15-49 years with birth outcomes between 2011-2023. Race and ethnicity were self-identified by members and documented in the electronic health record. We identified the first urinary tract infection (UTI) per pregnancy using a combination of diagnosis code, medication, and laboratory data.

We used maternal age-adjusted modified Poisson regression to estimate risk ratios comparing UTI incidence in different racial and ethnic groups to non-Hispanic (NH) White pregnant people. We analyzed 62,562 pregnancies (63.9% NH-White, 12.6% NH-Asian, 6.5% NH-Black, 1.4% NH-Native Hawaiian/Pacific Islander [NHPI], 0.8% NH-American Indian/Alaska Native [AIAN], and 7.9% Hispanic) and 4,704 UTIs. Mean maternal age was 30.4 years and 75.9% of outcomes were live births. We observed that 13.4% of NH Native Hawaiian and Pacific Islanders experienced a UTI during pregnancy, along with 10.4% of multiracial individuals, 10.1% of Hispanic individuals, 9.0% of NH Black individuals, 8.5% of NH American Indian and Alaska Native Individuals, and 7.0% of NH Asian individuals compared to 6.8% of NH White individuals. In

age-adjusted models, UTI risk was higher among NH-NHPI individuals (adjusted risk ratio [aRR] 1.80, 95% CI 1.49-2.16) compared to NH-White, and also elevated in NH-Black (aRR 1.29, 95% CI 1.16-1.44), NH-Asian (aRR 1.14, 95% CI 1.04-1.25), and Hispanic (aRR 1.41, 95% CI 1.28-1.56) individuals, compared to NH-White. Individuals treated with an antibiotic for UTI during pregnancy were most commonly treated by nitrofurantoin (37% of UTIs) and first-generation cephalosporin (26.7% of UTIs). RR of UTI among Asian individuals compared to NH White were higher in our cohort than in previous studies.^{3,4} There were no differences in treatment specific to different racial and ethnic groups. Our results show greater burden of UTI incidence during pregnancy among racial and ethnic minority groups and clearly show the need for additional research than effectively further disaggregate race data to understand the true magnitude of disparities. There is a need to highlight the risk factors with further research on prevention options to decrease the burden of UTI during pregnancy, including through timely access to prenatal care for prompt treatment of UTI to prevent progression to adverse outcomes.

I. Introduction

Background of maternal infection burden in US

Maternal mortality and morbidity in the United States continue to rise, with disparate burden of adverse health outcomes experienced by socioeconomically disadvantaged and racial minority groups.^{1,2} Infections during pregnancy are a leading cause of morbidity during pregnancy, with urinary tract infections (UTIs) and asymptomatic bacteriuria (ASB) occurring in approximately 17-18% of pregnancies, according to recent studies.^{3,4} Some studies suggest these infections may occur even more frequently.^{3,5} With 3.66 million live births occurring in the US in 2021, the frequency of UTI occurrence presents a concerning burden to pregnant people and the wellbeing of their babies.⁶

UTI in pregnancy: Definitions and Impact

The spectrum of UTIs includes ASB, the presence of bacteria in the urine without symptoms, as well as symptomatic infections of the bladder (cystitis) or more severely kidney (pyelonephritis), which are associated with pain during urination, and urgency or frequency of urination.⁷ If left untreated, 25% of ASB can progress to symptomatic UTI and untreated UTI may lead to pyelonephritis, which can cause maternal and neonatal complications such as hypertensive conditions, maternal sepsis, preterm birth, and low birth weight.^{3,7,8} Hereafter, all classifications of UTI along the spectrum are referred to as “UTI”, unless a more specific term is specified. Thus, the American College of Obstetrics and Gynecology (ACOG) recommends early screening for asymptomatic bacteria upon initiation of prenatal care and diagnostic testing if symptoms arise during pregnancy so treatment can be initiated promptly.⁸ ACOG guidelines offer a wide range of antibiotic recommendations for treating UTI during pregnancy, but evidence for which treatments lead to the best outcomes is lacking.⁷

Risk factors for UTI and Health disparities

Biological changes to the urinary tract during pregnancy increase susceptibility to UTIs, and additional health and demographic factors have also been shown to influence risk.⁷ Such factors of history of UTI, younger age, obesity, diabetes mellitus, sickle cell trait or disease, limited access to medical care, limited or lack of insurance coverage, low socioeconomic status, inability to take regular bathroom breaks, and limited

access to healthcare for screening or diagnostics all influence risk of UTI and are more often experienced by minority racial and ethnic groups in the United States compared to White individuals.^{2,9-13}

In a study by Johnson et. al, the relative risk of UTI among pregnant individuals in the US has been reported as 1.45-fold greater among American Indian and/or Alaska Native (AI/AN) individuals compared to White individuals and is 1.28-fold and 1.31-fold greater for individuals of Black or Hispanic race, respectively, compared to White individuals.³ Asian and Pacific Islander individuals, here reported as a combined group, had the lowest reported prevalence of UTI, with UTI risk 0.68-fold that seen in Whites.³ Mechanisms associated with this higher incidence of UTI in some marginalized racial and ethnic groups could be related to factors including delayed access to care, distrust in the healthcare system as a result of historical and current mistreatment through medical racism, and inadequate provision of care by health care providers. Work recognizing and addressing the upstream factors associated with differential risk of UTI could improve prenatal healthcare and reduce adverse outcomes of UTI.

Existing studies of the association between race and ethnicity and risk of UTIs are limited by small sample sizes and issues with their outcome classifications, as they relied on self-report of UTI during pregnancy as opposed to validated outcomes, such as those obtained from electronic health records (EHR). Additionally, specific associations between race and ethnicity and choice of antibiotic for UTI have not been assessed. Additional evidence to conclude which recommended antibiotic treatments are the safest for birthing people and their children is also needed.¹⁵

Importance of the proposed work

First, we aimed to assess differences in UTI incidence during pregnancy by race and ethnicity. Secondly, among pregnant people treated for UTI, we aimed to examine whether there were racial and ethnic differences in the antibiotic agent prescribed for treatment. For this study, we conceptualized race and ethnicity as a social construct and proxy for structural racism that contributes to worse health outcomes for less privileged groups. Better understanding of incidence and treatment of UTIs in pregnancy among different racial and ethnic groups can improve awareness of structural inequalities experienced by different groups, encourage future research on reducing barriers to care, and promote interventions to improve clinical outcomes of UTI among groups who have higher risk for pregnancy complications. We hope this work may encourage consideration of

improvements to pregnancy care that aim to address the root of health disparities and systemic racism influencing differences in quality of care for Black, Indigenous, People of color (BIPOC) compared to White individuals.

II. Methods

Study Design

We used a retrospective cohort study design to assess racial and ethnic disparities in UTI incidence and antibiotic selection during pregnancy. Data came from a U.S. integrated healthcare system, Kaiser Permanente Washington (KPWA). We used self-reported race and ethnicity information in the electronic health record (EHR) for our primary variable of interest and ascertained UTIs from EHR data using diagnosis codes, laboratory test results, and medication data. Study activities were approved by the Kaiser Permanente Interregional Institutional Review Board, with a waiver of consent.

Setting

KPWA provides both healthcare and insurance coverage to about 660,000 members in the Pacific Northwest. There are approximately 7,500 pregnancies annually to KPWA members, and rich EHR data are available for classifying race and ethnicity and UTI diagnoses. Additional data for care provided outside of KPWA are available through insurance claims that are required for reimbursement, improving capture of data on outcomes and covariates from healthcare encounters and medication fills outside of KPWA facilities.

Study Subjects

For our first aim, to assess incidence of UTI by race and Hispanic ethnicity, our population included pregnant people aged 15-49 years who were enrolled in KPWA at or before 20 weeks' gestation, with evidence of a pregnancy outcome between 2010-2023. Pregnancy outcomes for this study included live birth, stillbirth, spontaneous abortion, and elective termination. Our inclusion of pregnancy outcomes beyond live birth is important as it offers a more representative sample of pregnancies and presence of UTI during pregnancy can influence whether a pregnancy results in a live or still birth.⁸ Individuals were excluded if they were missing data for both race and ethnicity. Individuals with information on either race or ethnicity were included.

For our second aim of analyses examining antibiotic agents prescribed for UTI by race and ethnicity, we restricted our sample to individuals who had a UTI diagnosed and were provided an antibiotic in the outpatient setting. We limited the sample to people treated for UTI in the outpatient setting because inpatient antibiotic choices may be quite different.^{16,17}

Data Sources

Overview

A KPWA programmer extracted data for this study from a variety of sources in the KPWA research data warehouse, which brings in information from the member electronic health records and insurance billing information. These included prescription information (medication orders), diagnostic codes and clinical outcomes, laboratory results, pharmacy data on medication dispensing, health system enrollment information, healthcare utilization such as inpatient stays, emergency department visits, and outpatient visits, and demographic or socioeconomic data such as self-reported race and ethnicity.

Identifying pregnancies

We used an algorithm developed by the Kaiser Permanente Center for Effectiveness and Safety Research (CESR) based on EHR and claims data to identify pregnancies with outcomes (i.e. live birth, stillbirth, spontaneous abortion, elective termination) and to estimate gestational age.¹⁸ We required enrollment in KPWA at or before 20 weeks' gestation through pregnancy outcome, and age between 15-49 years at the start of pregnancy.

Variable of interest

The KPWA EHR includes self-reported race and ethnicity, which is routinely asked of members at their first contact with medical care. Patients are able to select more than one option when completing the self-reported race question. Through 2020, separate questions asked about Hispanic/Latino ethnicity and racial identity. After 2020, Hispanic/Latino ethnicity was included as a category in the racial identity question. We

considered Hispanic/Latinx ethnicity with race in analyses based on how the racial and ethnic identity is currently asked of KPWA members, and because identity, rather than ancestry, is of interest here.¹⁹ Further, our use of Latinx in place of Latino for ethnicity in our study is intended to be a gender-inclusive expression as opposed to gender-neutral, to be mindful of including any genders who may become pregnant but not erase or discount different experiences.²⁰

For statistical modeling, we grouped individuals into mutually exclusive categories for race and ethnicity. Individuals who endorsed a single race and identified as not being Hispanic/Latinx (NH) or had Hispanic/Latinx ethnicity missing were represented in their selected non-Hispanic/Latinx categories, as applicable: White, Asian, Black, Native Hawaiian/Pacific Islander, or American Indian/Alaska Native. Individuals with self-identities of another race not offered in the survey options selected 'Other' and are hereafter represented as "another race". We ensure inclusion of this population as research using imputation recognizes that individuals who do not endorse race and ethnicity information are disproportionately individuals of color and ignoring this may bias results regarding health disparities by race and ethnicity.^{21,22}

Individuals who endorsed being Hispanic/Latinx and endorsed only one race (or had missing race) are represented as Hispanic.¹⁹ Individuals who endorsed two or more races, regardless of Hispanic/Latinx endorsement, are represented as multiracial. Although we opt to combine multiracial individuals with diverse backgrounds into a single group for model stability, we recognize that many of these individuals may not overlap in their identities or experiences with prenatal care and pregnancy outcomes. All biracial combinations observed in our KPWA data, as well as a table presenting how individuals are represented by each of their endorsed identities, is in the Appendix (Table I, Table II, Table III).

Outcomes

UTIs were defined using ICD-9 and ICD-10 diagnosis codes, urine culture results, and antibiotic orders and dispensing (Appendix Table IV). We defined UTI broadly, using the full spectrum of UTI severity; our UTI definition includes ASB, acute cystitis, and pyelonephritis. We identified UTIs in the outpatient setting (including telehealth and emergency department visits) as the presence of an antibiotic medication listed in Table 3 prescribed or dispensed within either 1) 5 days of one or more ICD-9 or 10 diagnosis codes for UTI or 2) 8

days of the sample date of a urine sample that yielded a positive urine culture. Positive culture was defined as the presence of selected bacterial organisms commonly accepted to cause UTI, as confirmed via consultation with an infectious disease specialist, at a concentration of >10,000 CFU/mL. When calculating rates of antibiotic prescribing and UTI outcomes, we used a patients' first UTI during pregnancy identified from outpatient, inpatient, and emergency department settings.

For our primary aim of calculating incidence of UTI during pregnancy, we considered UTI to be present in the inpatient setting if there was at least one ICD-9 or 10 diagnosis code. Because KPWA does not operate its own hospitals, we lacked access to lab and medication data from inpatient admissions, so we were unable to require that additional information for confirmation. In order to assess the burden of pyelonephritis, we identified new diagnoses of pyelonephritis during pregnancy, defined as a pyelonephritis diagnosis code without a pyelonephritis code in the prior 90 days.

For our Aim 2 analyses examining antibiotic treatment of UTI by race and ethnicity in the outpatient setting, we defined treatment as having an order or dispensing of a study oral antibiotic (Table 3) within 5 days of the diagnosis or 8 days of the positive urine sample. We grouped antibiotic agents prescribed in our population based on their medication classes and examined the proportion of UTIs treated with each class by race and ethnicity, to see if any classes were more or less likely to be prescribed for certain racial or ethnic groups than others (Table 3).

Covariates

Baseline characteristics associated with increased risk of UTI in pregnancy or potential difference in choice of antibiotic were extracted from the EHR, including chronic illnesses like diabetes and sickle cell trait or disease, body mass index (BMI), maternal age at delivery, history of UTI, need for interpreter services, and estimated gestational age at prenatal care initiation. Information on immunosuppressive illnesses (human immunodeficiency virus [HIV], acquired immunodeficiency syndrome [AIDS], cancer, systemic autoimmune conditions, spinal cord injuries) and medications were also extracted. The Neighborhood Deprivation Index (NDI) was used as a proxy for individual-level socioeconomic status (SES) data, which is not collected at KPWA, with higher values indicating greater neighborhood deprivation. NDI is based on census tract of residence and includes information on income, education level, and family poverty levels at the neighborhood

level gathered from the 2020 American Community Survey and applied to addresses recorded in the EHR at pregnancy onset.^{23,24,25}

Analysis

Race and Ethnicity and UTI

We calculated cumulative incidence of UTI for each racial and ethnic group during pregnancy and estimated risk ratios (RR) of experiencing a UTI with 95% confidence intervals (CIs) for each racial and ethnic subgroup (variable of interest) compared to our referent group (Table 2). We calculated unadjusted RRs and also RRs adjusted for age at start of pregnancy. Non-Hispanic White individuals, the racial and ethnic group with the most privilege in the U.S., served as our reference group. All pregnancies served as the denominator for RR calculation, meaning some people contributed more than one pregnancy to the analysis. Additionally, we did sensitivity analyses using all pregnancies that resulted in a live birth as the denominator because pregnancy duration impacts risk of developing the outcome of interest. Using the same denominators, we estimated the unadjusted and age-adjusted relative risks via a modified Poisson regression model using the robust sandwich estimator, with an independence working correlation matrix, to accurately calculate relative risk and account for multiple pregnancies to the same person during the study time period.^{26,27,28} We used the Wald test with robust standard error to compare unadjusted and age-adjusted estimates for each racial and ethnic subgroup compared to NH Whites.²⁹ Distributions of covariates other than age are presented descriptively rather than included as adjustment covariates in regression models, as many of these covariates were expected to lie on the causal pathway between race or ethnicity and risk of UTI.^{10,30} Thus, adjusting for these characteristics could attenuate the results for our relationship of interest.

Antibiotic Agents by Race and Ethnicity

We examined which antibiotic agents were prescribed to treat UTI during pregnancy by race and ethnicity by calculating unadjusted proportions, and 95% CIs, of individuals treated with specific classes of antibiotics (Table 3) among all pregnancies that had a UTI that was treated. We compared proportions of different antibiotic agents across racial and ethnic groups.

All analyses were conducted using R version 4.3.2.

III. Results

Study Sample

Our analyses included 62,562 pregnancies. The mean maternal age for all pregnancies was 30.4 years (SD 5.6) and 75.9% of pregnancies resulted in live births (Table 1). NDI scores from within our cohort range from -2.23 to 3.86, with higher values indicating greater neighborhood deprivation. The population included 0.8% NH American Indian or Alaska Native, 1.4% NH Native Hawaiian or Pacific Islander, 8.0% Hispanic, 6.5% NH Black, 12.6% NH Asian, 63.9% NH White, 1.8% NH Another race, and 5.0% multiracial. Our population reflects the distribution of race and ethnicity in Washington state, which is approximately 0.9% NH American Indian or Alaska Native, 0.6% NH Native Hawaiian or Pacific Islander, 10% Hispanic, 3.7% NH Black, 8.9% NH Asian, 66.5% NH White, 0.4% NH another race, and 8.0% Multiracial.³¹ In our cohort, a disproportionate share of individuals in the fourth NDI quartile (greatest neighborhood deprivation) were NH Black individuals (42.3%), NH Native Hawaiian and Pacific Islander individuals (40.3%), NH American Indian and Alaska Native individuals (36.9%), Hispanic individuals (30.8%), and Multiracial individuals (29.8%).

We observed 4,704 (7.5%) UTIs among pregnancies between 2011-2023, and for pregnancies with a UTI, the mean maternal age was 28.8 (SD 6.1). UTIs were most common among pregnant individuals in the youngest age group of 15-19 years (17.4% compared to 5.6% in people age 40-49), those in ≥ 30 kg/m² BMI category (9.5% compared to the 7.4% among those with BMI 18.5-24.9 kg/m²), and among individuals with greater neighborhood deprivation (9.2% for people in the fourth quartile of NDI, representing greater deprivation, compared to 5.7% in the first quartile). 63 total cases of pyelonephritis were observed in our cohort and were not disaggregated by racial and ethnic groups to avoid presentation of very small counts.

Combining all racial and ethnic groups, the antibiotic most commonly prescribed for UTI during pregnancy was nitrofurantoin (37% of prescriptions), and the second most common was the class of first-generation cephalosporins (27.5%). Fluoroquinolones and second or third generation cephalosporins were the least commonly prescribed agents in our population (less than 2% of prescriptions).

Race and Ethnicity and UTI

We calculated cumulative incidence of UTI during pregnancy for all eight racial/ethnic groups. We observed that 13.4% of NH Native Hawaiian and Pacific Islanders experienced a UTI during pregnancy, along with 10.4% of multiracial individuals, 10.1% of Hispanic individuals, 9.0% of NH Black individuals, 8.5% of NH American Indian and Alaska Native Individuals, and 7.0% of NH Asian individuals compared to 6.8% of NH White individuals (Table 2). After adjusting for maternal age, we observed that every non-White group remained at higher risk of UTI during pregnancy compared to NH Whites (Table 2). NH Native Hawaiians and Pacific Islanders had the highest risk of all the groups, being 1.80 times as likely (95% CI: 1.49, 2.16) to experience a UTI during pregnancy compared to NH White individuals. Multiracial individuals had a 1.42 times higher risk (95% CI: 1.27, 1.60) compared to NH White individuals. Risk of experiencing a UTI for Hispanic individuals was 1.41 times higher (95% CI: 1.28, 1.56), for NH Black individuals was 1.29 times higher (95% CI: 1.16, 1.44), for NH another race individuals was 1.26 times higher (95% CI: 1.03, 1.54), and for Asian individuals was 1.14 times higher (95% CI: 1.04, 1.25) compared to NH White individuals. Lastly, NH American Indian and Alaska Native individuals had a 1.15-times higher risk of UTI compared to NH White individuals (95% CI: 0.85, 1.55), but this result was not statistically significant.

Antibiotic Agents by Race and Ethnicity

UTIs in this cohort were most often treated with nitrofurantoin (37%) and first-generation cephalosporins (26.7%). The distribution of antibiotics selected to treat UTIs during pregnancy did not vary significantly among different racial and ethnic groups (Table 3). Trimethoprim alone (without sulfamethoxazole) was prescribed only three times over our study period so was excluded from these analyses. Prescribers of antibiotics in this cohort (N=3,946) were majority female (74.1%), physicians with an MD or DO (54.5%), and practicing in specialties of Family Medicine (42.5%) or Obstetrics (41.5%) (Appendix Table V).

IV. Discussion

Summary of findings

Our study found substantial disparities in the incidence of UTI during pregnancy by race and ethnicity. Individuals who identified as NH Native Hawaiian and Pacific Islanders were at greatest risk of experiencing a

UTI during pregnancy with a risk ratio of 1.80 compared to NH White individuals. All other racial and ethnic groups had higher rates of UTI than the NH White group, with the largest disparities seen for Native Hawaiian and Pacific Islander, Multiracial, and Hispanic groups (Table 2). Among those who had a UTI, nitrofurantoin was the most common antibiotic prescribed, followed by first-generation cephalosporins, with no evidence of disparities in treatment among different racial and ethnic groups.

Past Study Review

Our study differed from prior work on disparities of maternal health complications in our characterization of some race and ethnicity categories and our calculation of risk ratios based on incident cases of UTI rather than prevalence.^{3,4} Data for our study came from Washington state, which has one of the largest Asian populations in the U.S. Therefore, we had sufficient data to assess NH Native Hawaiian and Pacific Islanders separately from NH Asian individuals, and we classified individuals who selected more than one racial identity as multiracial for analyses. In contrast to results from Whitehead et al and Johnson et al, our study found a higher risk of UTI among NH Asian individuals and NH Native Hawaiian and Pacific Islander individuals compared to our NH White population.^{3,4} Additionally, our study identified a higher risk of UTI in Hispanic individuals, which was consistent with findings of Johnson et al. but inconsistent with Whitehead et al. who reported a lower adjusted prevalence ratio of UTI compared to NH White individuals. Our study was consistent with Johnson et al. in observing a higher risk ratio of UTI among NH Black individuals around 1.29 compared to NH White.³ The antibiotic agents most prevalent in treatment of UTIs in our population were consistent with regimens recommended by ACOG.⁸

Strengths and Limitations

Main strengths of this study include its large sample size and inclusion of a diverse population from the Pacific Northwest United States. We estimated risk for 8 racial and ethnic groups in our population, which is an increase from 5 and 6 groups analyzed in prior work in this area.^{3,4} We were able to analyze certain groups separately, such as NH Asian and NH Native Hawaiian/Pacific Islander, that previous studies had analyzed in aggregate, letting us observe important differences in risk missed by previous studies. Additionally, our study outcome, UTI, was defined with clinical data, including laboratory culture data in the EHR, as opposed to

historical self-report of infection after the pregnancy which improves accuracy of our outcome measurement. Self-report may have been subject to recall bias or inaccurate inclusion of events that were not UTI. Our study results are also strengthened by our decision to only adjust for at the start of pregnancy, such that we did not attenuate our results by adjustment for other factors that are believed to be on the causal pathway between race and ethnicity and diagnosis of UTI during pregnancy.

Our study also has limitations. First, approximately a third of pregnancies from the 2011-2023 KPWA cohort were excluded from our study due to missing data for both race and ethnicity (Appendix Figure 1). Relatedly, we acknowledge that not all individuals who are eligible to share their identity or select more than one race category may do so, perhaps based on different demographic, political, or social factors associated with minority or majority identities.¹⁹ We assume that our information is complete within our population and recognize that enrollees with missing data may disproportionately represent minority groups and KPWA may serve a more diverse population than reported here.²¹ We are not able to discern different racial and ethnic groups that are represented in the Another race group nor are we able to distinguish ethnic groups among Asian individuals. Also, our decision to aggregate individuals who selected more than one race into the multiracial category may have limited our conclusions about risk among American Indian and Alaska Native individuals, as approximately half of this population identified as American Indian Alaska Native and White.

KPWA is an integrated health system with mostly privately insured members with access to family or employer-based insurance policies. Our patient population included 6.0% Medicaid-insured pregnancies but did not include uninsured pregnancies. Thus, we likely underestimate the true magnitude of disparities for racial and ethnic groups who are more likely to have uninsured or publicly insured pregnancies. Members also lived in the Pacific Northwest region of the United States. This may affect generalizability. A further limitation may be misclassification of our outcome; one way this could arise would be if people had a UTI diagnosis attached to ordering of diagnostic tests instead of assigning the diagnosis based on the result, influencing incidence in Aim 1. However, we expect this was rare due to our requirement of an antibiotic prescription in addition to diagnosis code for outpatient UTI diagnoses. Finally, we were not able to measure other covariates of interest, including individual-level income and education, which are linked to ability to access quality maternity care, including screening and treatment for UTI.

Conclusions and Implications

Our findings of racial and ethnic disparities incidence of UTI during pregnancy in Washington state call for additional work in understanding how systemic racism contributes to increased risk of infection during pregnancy. More attention should be paid to understanding the existing prenatal healthcare access or quality barriers for different racial and ethnic groups with higher incidence of infection. We encourage additional work and effort in data collection methods to further disaggregate racial and ethnic identities to explore further levels of difference in pregnancy outcomes. Our findings may support additional screening and prevention efforts, such as screening for upstream risk factors and social determinants of health, by providers of these higher risk groups in advance of pregnancy and during prenatal care. Ideally future qualitative and national mixed methods work can encourage more conscious efforts in promoting prevention of urinary tract infection through quality care for all pregnant people.

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Tables and Figures.

Table 1. Selected Baseline Characteristics of the Study Population, by race and ethnicity.

Characteristic	Overall (N=62,562) n (%)	NH White (N=39,959) n (%)	NH Asian (N=7,913) n (%)	NH Black (N=4,069) n (%)	NH Native Hawaiian/ PI (N=871) n (%)	NH AI/AN (N=531) n (%)	NH Another race (N=1,148) n (%)	Hispanic (N=4,973) n (%)	Multi-racial (N=3,098) n (%)
Maternal age at pregnancy onset (years), median (IQR)	31.0 (27.0-34.0)	31.0 (27.0-34.0)	32.0 (29.0-35.0)	30.0 (26.0-35.0)	29.0 (24.0-33.0)	28.0 (24.0-33.0)	31.0 (27.0-35.0)	29.0 (25.0-33.0)	29.0 (24.0-33.0)
Maternal age groups at pregnancy onset (years)									
15-19	1,723 (2.8)	976 (2.4)	65 (8.2)	181 (4.4)	58 (6.7)	30 (5.6)	36 (3.1)	181 (3.6)	196 (6.3)
20-24	8,148 (13.0)	5,161 (12.9)	403 (5.1)	625 (15.4)	197 (22.6)	117 (22)	134 (11.7)	915 (18.4)	596 (19.2)
Age 25-29	16,114 (25.8)	10,446 (26.1)	1,740 (22.0)	1,076 (26.5)	218 (25.0)	151 (28.4)	291 (25.3)	1,425 (28.7)	767 (24.8)
Age 30-34	21,748 (34.8)	14,266 (35.7)	3,171 (40.1)	1,167 (28.7)	230 (26.4)	134 (25.2)	355 (30.9)	1,467 (29.5)	958 (30.9)
Age 35-39	11,772 (18.8)	7,349 (18.4)	1,965 (24.8)	743 (18.3)	142 (16.3)	77 (14.5)	259 (22.6)	779 (15.7)	458 (14.8)
Age 40+	3,057 (4.9)	1,761 (4.4)	569 (7.2)	277 (6.8)	26 (3.0)	22 (4.1)	73 (6.4)	206 (4.1)	123 (4.0)
Pregnancy outcome*									
live birth	47,451 (75.9)	31,043 (77.7)	5,971 (75.5)	2,684 (66.0)	641 (73.6)	393 (74.0)	800 (69.7)	3,656 (73.5)	2,263 (73.0)
spontaneous abortion	9,706 (15.5)	5,912 (14.8)	1,345 (17.0)	736 (18.1)	132 (15.2)	80 (15.1)	207 (18.0)	815 (16.4)	479 (15.5)
elective termination	4,429 (7.1)	2,350 (5.9)	517 (6.5)	560 (13.8)	84 (9.6)	51 (9.6)	132 (11.5)	424 (8.5)	311 (10.0)
other*	976 (1.6)	654 (1.6)	<1.5% [‡]	89 (2.2)	14 (1.6)	<1.5% [‡]	<1.5% [‡]	78 (1.6)	45 (1.5)
Gestation type[†]									
singleton	47,623 (98.5)	31,143 (98.4)	5,975 (98.9)	2,716 (98.2)	647 (98.9)	394 (98.7)	798 (98.6)	3,678 (98.7)	2,272 (98.6)
multiple	723 (1.5)	502 (1.6)	67 (1.1)	51 (1.8)	7 (1.1)	5 (1.3)	11 (1.4)	48 (1.3)	32 (1.4)
Preterm births[†]	17,458 (27.9)	10,240 (25.6)	2,310 (29.2)	1,560 (38.3)	284 (32.6)	174 (32.8)	394 (34.3)	1,544 (31)	952 (30.7)
Year of Pregnancy Start									
2010-2011	8,150 (13.0)	5,405 (13.5)	953 (12.0)	480 (11.8)	120 (13.8)	109 (20.5)	133 (11.6)	552 (11.1)	398 (12.8)
2012-2013	9,599 (10.5)	6,402 (16.2)	1,108 (14.0)	616 (15.1)	141 (16.2)	110 (20.7)	168 (14.6)	597 (12)	457 (14.8)

2014-2015	9,364 (15.0)	6,242 (15.6)	1,069 (13.5)	579 (14.2)	132 (15.2)	84 (15.8)	137 (11.9)	661 (13.3)	460 (14.8)
2016-2017	9,559 (15.3)	6,215 (15.6)	1,153 (14.6)	604 (14.8)	130 (14.9)	71 (13.4)	177 (15.4)	757 (15.2)	452 (14.6)
2018-2019	10,433 (16.7)	6,471 (16.2)	1,407 (17.8)	696 (17.1)	150 (17.2)	71 (13.4)	228 (19.9)	912 (18.3)	498 (16.1)
2020-2021	10,518 (16.8)	6,345 (15.9)	1,477 (18.7)	761 (18.7)	126 (14.5)	59 (11.1)	214 (18.6)	991 (19.9)	545 (17.6)
2022-2023	4,939 (7.9)	2,879 (7.2)	746 (9.4)	333 (8.2)	72 (8.3)	27 (5.1)	91 (7.9)	503 (10.1)	288 (9.3)
Diabetes mellitus	1,618 (2.6)	849 (2.1)	235 (3.0)	147 (3.6)	51 (5.9)	27 (5.1)	37 (3.2)	176 (3.5)	97 (3.1)
Pre-pregnancy BMI available	49,717 (79.5)	30,944 (77.4)	6,705 (84.7)	3,438 (84.5)	710 (81.5)	375 (70.6)	941 (82.0)	3,998 (80.4)	2,606 (84.1)
Pre-pregnancy BMI (kg/m²), median (IQR) †	25.5 (22.4-30.5)	25.5 (22.4-30.3)	23.4 (21.0-26.6)	27.9 (24.0-33.5)	30.0 (25.0-35.9)	28.7 (24.8-35.1)	25.6 (22.4-30.2)	27.3 (23.7-32.4)	26.9 (23.2-32.8)
Pre-pregnancy BMI categories (kg/m²)									
<18.5-24.9	22,844 (45.9)	14,369 (46.4)	4,324 (64.5)	1,083 (31.5)	177 (25.0)	99 (26.4)	434 (46.1)	1,372 (34.3)	986 (37.8)
25-29.9	13,616 (27.4)	8,486 (21.2)	1,637 (20.7)	992 (24.4)	178 (20.4)	116 (21.8)	263 (22.9)	1,216 (24.4)	728 (23.5)
30+	13,256 (26.7)	8,089 (20.2)	744 (9.4)	1,363 (33.5)	355 (40.8)	160 (30.1)	244 (21.3)	1,410 (28.4)	892 (28.8)
Sickle cell trait or disease	254 (0.4)	12 (0.03)	11 (0.1)	177 (4.4)	0	<1.5%‡	13 (1.1)	17 (0.3)	21 (0.7)
Medicaid	3746 (6.0)	1881 (4.7)	302 (3.8)	666 (16.4)	107 (12.3)	42 (7.9)	101 (8.8)	369 (7.4)	278 (9.0)
Neighborhood Deprivation Index (NDI), quartiles §									
Q1 [-2.23, -0.82)	15,585	10,462 (26.2)	2,604 (32.9)	446 (11)	74 (8.5)	77 (14.5)	323 (28.1)	968 (19.5)	631 (20.4)
Q2 [-0.82, -0.39)	15,604	10,312 (25.8)	2,006 (25.4)	778 (19.1)	210 (24.1)	92 (17.3)	283 (24.7)	1,161 (23.3)	762 (24.6)
Q3 [-0.39, 0.14)	15,551	10,152 (25.4)	1,553 (19.6)	1,120 (27.5)	235 (27)	165 (31.1)	245 (21.3)	1,308 (26.3)	773 (25)
Q4 [0.14, 3.86)	15,564	8,806 (22)	1,743 (22)	1,721 (42.3)	351 (40.3)	196 (36.9)	295 (25.7)	1,530 (30.8)	922 (29.8)
‡missing	258 (0.4%)	227 (0.6%)	7 (0.1%)	4 (0.1%)	1 (0.1%)	1 (0.2%)	2 (0.2%)	6 (0.1%)	10 (0.3%)

Individuals who endorsed a single race and identified as not Hispanic/Latinx or had Hispanic/Latinx ethnicity missing were included in their selected non-Hispanic/Latinx categories, as applicable: White, Asian, Black, Native Hawaiian/Pacific Islander, American Indian/Alaska Native, or Another race.

Individuals who endorsed being Hispanic/Latinx and endorsed only one race (or had missing race) are represented as Hispanic.¹⁹ Individuals who endorsed two or more races, regardless of Hispanic/Latinx endorsement, are represented as multiracial.

NH = non-Hispanic; AI/AN = American Indian & Alaska Native; PI= Pacific Islander.

*Pregnancy outcome 'other' includes stillbirth (281 total), live birth & still birth (17 total), live birth or stillbirth (we have an outcome, but classification is unclear newborn vital status is unknown, 597 total), and unknown type of early loss (81 total).

†Gestation type and Preterm birth are each calculated only among pregnancies with a known pregnancy outcome of live birth or still birth, N = 48,346.

‡Pre-pregnancy BMI distribution was calculated among those individuals with pre-pregnancy BMI recorded.

§We do not report exact numbers or percentages here to avoid reporting cells with small numbers.

§We did not report exact numbers of 258 individuals across each racial and ethnic that had missing NDI here to avoid reporting cells with small numbers.

Table 2. Risk of UTI during pregnancy by race and ethnicity.

Race/ethnicity	Number of pregnancies	Number with UTI	UTI Cumulative Incidence (%)	Crude risk ratio (95% CI)	Age-adjusted risk ratio (95% CI)*
NH White	39,959	2,703	6.8	1.00 (Reference)	1.00 (Reference)
NH Asian	7,913	555	7.0	1.04 (0.95, 1.13)	1.14 (1.04, 1.25)
NH Black	4,069	364	9.0	1.32 (1.19, 1.47)	1.29 (1.16, 1.44)
NH Native Hawaiian & Pacific Islander	871	117	13.4	1.99 (1.67, 2.36)	1.80 (1.49, 2.16)
NH AI/AN	531	45	8.5	1.25 (0.95, 1.66)	1.15 (0.85, 1.55)
Hispanic	4,973	502	10.1	1.49 (1.36, 1.63)	1.41 (1.28, 1.56)
NH Another race	1,148	96	8.4	1.24 (1.02, 1.50)	1.26 (1.03, 1.54)
Multiracial	3,098	322	10.4	1.54 (1.38, 1.72)	1.42 (1.27, 1.60)

*Adjusted for maternal age at start of pregnancy.

Table 3. Choice of Antibiotic Agent, among those with UTI*

Agent	NH [†] White N=2620 n (%)	NH Asian N=533 n (%)	NH Black N=356 n (%)	NH Native Hawaiian/ Pacific Islander N=117 n (%)	NH American Indian/ Alaska Native N= 42 n (%)	NH Another race N=93 n (%)	Hispanic N=488 n (%)	Multi-racial N=313 n (%)	Total
Nitrofurantoin	1,032 (39.4%)	181 (34%)	138 (38.8%)	37 (31.6%)	21 (50%)	27 (29.0%)	174 (35.7%)	133 (42.5%)	1,743 (38.2%)
β-lactams									
1 st generation cephalosporins	715 (27.3%)	146 (27.4%)	101 (28.4%)	31 (26.5%)	15 (35.7%)	29 (31.2%)	140 (28.7%)	78 (24.9%)	1,255 (27.5%)
2 nd generation cephalosporins	49 (1.9%)	8 (1.5%)	< 5	6 (5.1%)	< 5	5 (5.4%)	6 (1.2%)	< 5	80 (1.8%)
3 rd generation cephalosporins	37 (1.4%)	< 5	< 5	< 5	< 5	< 5	< 5	< 5	55 (1.2%)
Amoxicillin or ampicillin	507 (19.4%)	124 (23.3%)	73 (20.5%)	28 (24%)	< 5	23 (24.7%)	90 (18.4%)	68 (21.7%)	915 (20%)
Sulfa	119 (4.5%)	22 (4.1%)	18 (5.1%)	5 (4.3%)	< 5 [‡]	6 (6.5%)	16 (3.3%)	11 (3.5%)	198 (4.3%)
Amoxicillin-clavulanate	107 (4.1%)	41 (7.7%)	15 (4.2%)	7 (6%)	< 5	< 5	42 (8.6%)	13 (4.2%)	227 (5%)
Fluoroquinolones	54 (2.1%)	8 (1.5%)	5 (1.4%)	< 5	< 5	< 5	15 (3.1%)	< 5	89 (1.9%)

*Only pregnancies with UTI in the outpatient setting and treatment data; treatment defined as having an order or dispensing of a study antibiotic listed here within 5 days of the diagnosis or 8 days of the positive urine sample

[†]NH indicates non-Hispanic

[‡]We do not report exact numbers or percentages here to avoid reporting cells with small numbers.

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Appendix

Figure 1. Application of inclusion and exclusion criteria to create the study sample

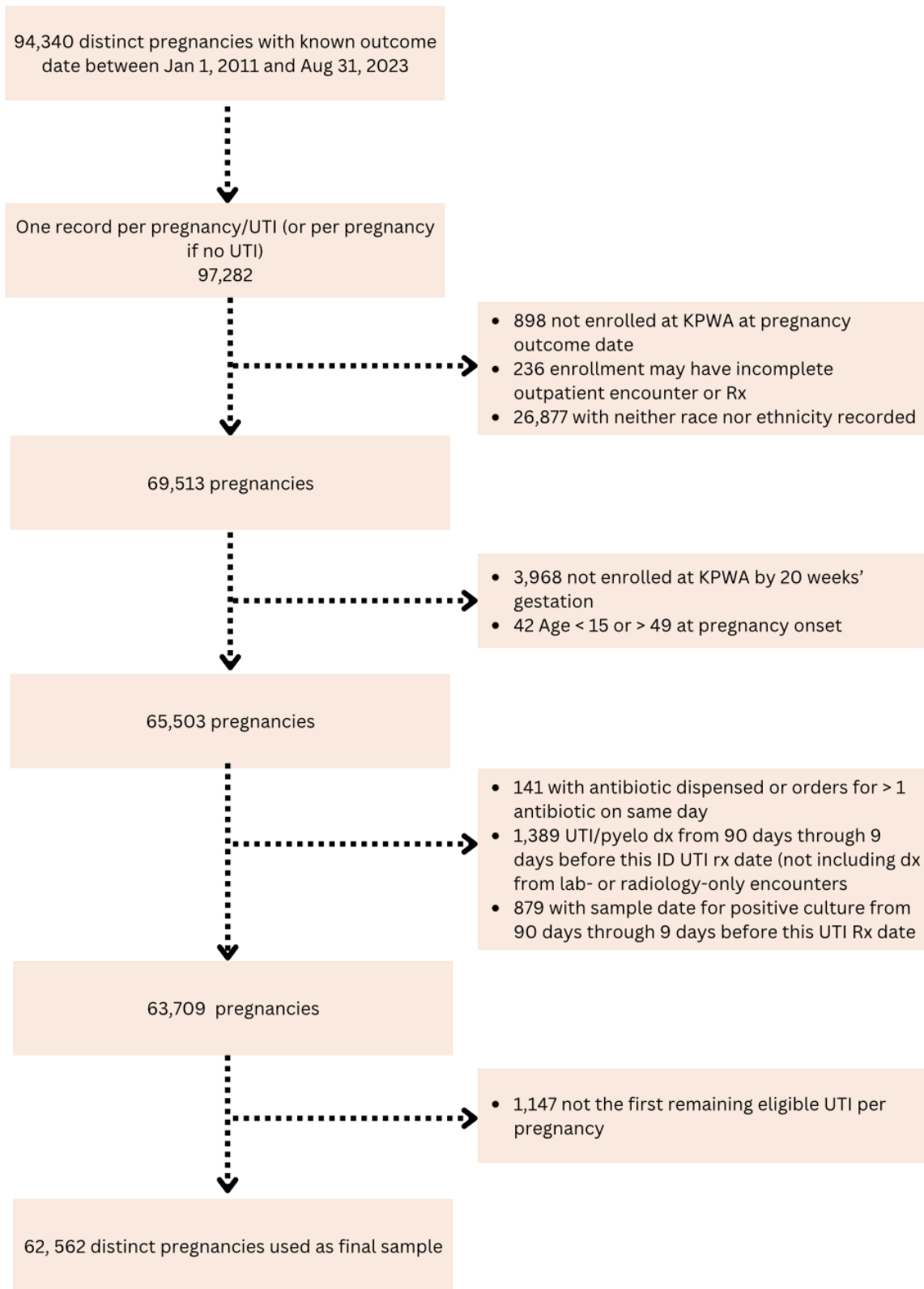


Table I. Breakdown of cohort self-identified race and ethnicity*.

Race and Ethnicity	White N (%)	Asian N (%)	Black N (%)	Native Hawaiian/ Pacific Islander N (%)	American Indian/ Alaska Native N (%)	Another race N (%)	Hispanic N (%)
Overall	44,602 (63.3%)	9,302 (13.2%)	5,268 (7.5%)	1,413 (2%)	1,297 (1.8%)	3,233 (4.6%)	5,306 (7.5%)

*All individuals in our data set represented in each of their endorsed race and ethnicity groups (if more than one), allowing for categories that are not mutually exclusive and the overall count to be larger than the main count used for analyses.

Table II. Regression results for age-adjusted risk ratio of UTI* during pregnancy by race and ethnicity restricted to live births.

Race/ethnicity	Total number of pregnancies with live birth outcome	Total number of UTIs	Reported UTI Cumulative Incidence (%)	Crude UTI risk ratio (95% CI)	Adjusted [‡] UTI risk ratio (95% CI)
NH [†] White	31,043	2,409	7.8	1.00 (Reference)	1.00 (Reference)
NH Asian	5,971	489	8.2	1.06 (0.96, 1.16)	1.15* (1.04, 1.27)
NH Black	2,684	314	11.7	1.51 (1.35, 1.68)	1.46* (1.30, 1.64)
NH Native Hawaiian & Pacific Islander	641	99	15.4	1.99 (1.65, 2.40)	1.83* (1.51, 2.22)
NH American Indian & Alaska Native	393	36	9.2	1.18 (0.86, 1.62)	1.07 (0.77, 1.49)
Hispanic	3,656	436	11.9	1.54 (1.40, 1.70)	1.46* (1.32, 1.61)
NH Another race	800	84	10.5	1.35 (1.10, 1.66)	1.38* (1.12, 1.69)
Multiracial	2,263	273	12.1	1.56 (1.38, 1.75)	1.44* (1.28, 1.63)

*Only looking at first UTI per pregnancy among those whose pregnancy outcome was live birth

[†]NH indicates non-Hispanic

[‡]Adjusted for maternal age

Supplemental Table III. Hispanic endorsement by race and ethnicity (common Hispanic and race categories).

Self-reported race identity	Self-reported Hispanic n (%)
Asian (N=8,350)	175 (2.1%)
Black (N=4,904)	233 (4.8%)

American Indian and Alaska Native (N=1,223)	199 (16.3%)
Native Hawaiian and Pacific Islander (N=1,309)	88 (6.7%)
White (N=41,514)	2,239 (5.4%)
Another race (N=3,090)	1,910 (61.8%)

Supplemental Table IV. Diagnosis Codes for Identifying UTI.

ICD-9 codes	595.0, 595.9, 599.0, 646.50, 646.53, 646.60, 646.63
ICD-10 codes	N30.00, N30.01, N30.90, N30.91, N39.0, O23.10-O23.13, O23.40-O23.43, O23.90-O23.93, R82.71

Table V. Characteristics of Providers prescribing antibiotics to patients with UTI.

Prescribers	N = 3,946*
Prescriber sex	
Female	2,923 (74.1%)
Male	1,023 (25.9%)
Prescriber age (years)	
Range	24-70
Mean	40.6
Median	40
Prescriber type	
Certified Nurse Midwife	983 (24.9%)
Physician (MD/DO)	2,151 (54.5%)
Nurse practitioner	72 (1.8%)
Physician Assistant	740 (18.8%)
Prescriber specialty	
Emergency Medicine	591 (15.0%)
Family Medicine	1,675 (42.5%)
Obstetrics	1,637 (41.5%)
Other	43 (1.1%)

*Prescriber details missing for 758 of UTIs treated.

Table VI. Cumulative Incidence of UTI by Quartile of Neighborhood Deprivation (NDI)

	NDI Quartile 1 (N=15,585)	Quartile 2 (N=15,604)	Quartile 3 (N=15,551)	Quartile 4* (N=15,564)
Number with UTI	883	1099	1283	1428

Cumulative incidence (%)	5.7%	7.0%	8.3%	9.2%
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*Quartile 4 is greatest value of NDI, representing greatest neighborhood deprivation.