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Association of Social Determinants of Health and Incident Gonorrhea and Chlamydia Infection Among the Obstetric Population at a Large, Urban Safety-Net Hospital

By

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Committee Chair

Association of Social Determinants of Health and Incident Gonorrhea and Chlamydia Infection Among the Obstetric Population at a Large, Urban Safety-Net Hospital

By

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B.A., Brown University, 2015

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An abstract of
A thesis submitted to the Faculty of the
Rollins School of Public Health of Emory University
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Abstract

Association of Social Determinants of Health and Incident Gonorrhea and Chlamydia Infection Among the Obstetric Population at a Large, Urban Safety-Net Hospital
By Hannah Wichmann

Objective: To determine if social determinant of health (SDH) screening in pregnancy predicts increased risk of gonorrhea (GC) and chlamydia (CT) infection.

Methods: Retrospective cohort study of pregnant women who received antenatal care at a large, urban safety-net hospital in Atlanta, GA between October 15, 2019 and March 12, 2020. We included all women who completed SDH screening at least once during their prenatal visits. Demographic and clinical data were collected from the initiation of prenatal care through 42 days postpartum. We used logistic regression to examine the crude associations between self-reported SDH exposures, other covariates of interest and incident CT/GC infection. Variable multicollinearity was assessed. Remaining covariates were then selected for inclusion into two adjusted models (with and without backward selection) if they were associated with the outcome using a Bonferroni-adjusted p-value to account for multiple comparisons.

Results: Our total study population consisted of 1421 women who had CT/GC test results. In this population, 12.25% were positive for CT/GC. Median age was 27 years, with 81.66% non-Hispanic black, 35.83% nulliparous, and 87.90% publicly-insured. After adjusting for confounders, in our backward selection model age <27 years (aOR 3.83, p-value <0.0001) and asthma (1.914, p-value 0.0004) were statistically associated with increased risk of CT/GC infection. Without backward selection, only age <27 years remained significant (aOR 3.675, p-value <0.0001).

Conclusion: These results highlight the connections between SDH needs and STIs in pregnancy. Though only a few of our covariates were significant, many of the others still hold clinical significance, have implications for future screening recommendations, and emphasize areas for public health interventions aimed at decreasing STIs and subsequent adverse outcomes in pregnancy. Future directions include conducting this analysis on the completed dataset, examining the connection between asthma and STIs more thoroughly, developing a risk prediction score using SDH to determine those at increased risk of CT/GC during pregnancy, and expanding this analysis to evaluate temporality of SDH needs and STIs during pregnancy.

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Introduction

Social determinants of health (SDH), are "the circumstances in which people are born, grow, live, work, and age, and the systems put in place to deal with illness… these circumstances are in turn shaped by a wider set of forces: economics, social policies, and politics."[1] It is well-established that social factors play a large role in shaping the health and well-being of patients,[2,3] and that disparities in socioeconomic status (SES), race, and ethnicity dictate health outcomes.[4,5] This is also true within obstetric populations[6-9]. Maternal and neonatal health outcomes are also shaped by SDH. In this study, we investigated the association of SDH with sexually transmitted infections (STIs) among the obstetric population at Grady Memorial Hospital (GMH). We focused specifically on incident gonorrhea (GC) and chlamydia (CT) infections, and their association with self-reported SDH measures in women receiving their obstetric care at GMH, evaluating trends in these associations.

Maternal mortality is a well-described public health crisis in the United States (US): maternal mortality in 2018 in the US was 17.4 maternal deaths per 100,000 live births.[10] In Georgia, these numbers are even higher: 35 maternal deaths per 100,000, either while pregnant or within 42 days of termination of pregnancy, with an additional 26 maternal deaths per 100,000 after 42 days, but within one year of termination of pregnancy.[10] Large racial and ethnic disparities exist in rates of maternal mortality among non-Hispanic black (41.7 deaths/100,000), non-Hispanic white (13.4), and Hispanic (11.6) women.[11] SDH such as lower levels of education, living in rural locations, and low SES contribute to adverse outcomes in adolescent pregnancies.[12] These enormous health disparities also lead to measurable differences in rates of obstetric outcomes such as preterm birth, fetal growth restriction, maternal mortality rates, and fetal demise rates.[13] Black mothers are at especially high risk due to conditions such as pre-eclampsia, eclampsia, placental abnormalities (abruptio placentae, placenta previa), and postpartum hemorrhage.[14] More broadly, Black women are at higher risk of adverse maternal outcomes, are more likely to present to prenatal care later, and to have overall inadequate prenatal care.[15]

CT and GC are the most common bacterial infections in the US, with 1.8 million cases of CT and over 616,000 cases of GC reported in 2019.[16] There are higher rates of GC/CT among non-Hispanic Blacks in general,[17] with trends in screening, infection and treatment for CT/GC at GMH specifically having been previously described.[18] GMH provides a unique setting in which to perform this type of study examining the connections between SDH measures and CT/GC infection in the obstetric setting. This study is also significant because there is little existing research on SDH and STIs in this setting. The connections between STIs in general, psychosocial stressors and pregnancy have been previously described in other settings, including in Brazil, Haiti, Mexico, Bolivia, Bangladesh, Sudan and Ghana.[19-25] The links between SDH screening, prenatal care, pregnancy and pregnancy outcomes are not well-studied or established, and it is unclear if there are empirical links between SDH and pregnancy outcomes, if there are ways to integrate SDH and health care in an evidence-based way, and if SDH interventions are effective during antenatal care. We hypothesized that women with more SDH needs have a higher risk of incident CT/GC infections during the course of their prenatal care.

Background

Gonorrhea (GC) and chlamydia (CT) are the most common bacterial STIs in the US, with disproportionate burden in the Southeast, urban settings, and in Black women[26] GC and CT are often asymptomatic in pregnant women and can cause serious maternal and neonatal

complications if untreated such as preterm and stillbirths, and neonatal conjunctivitis and pneumonia.[27] Antibiotic treatment is effective in decreasing these complications, and the CDC recommends screening all women under 25 years of age, as well as older women who have risk factors, during pregnancy.[28] These risk factors include multiple sexual partners, inconsistent condom use, young age, non-Hispanic black race/ethnicity, and previous STI diagnoses.[28] The recommended test of choice for both GC and CT is the nucleic acid amplification test (NAAT) because it is both highly specific and sensitive. After a positive test, the recommendation is treatment with antibiotics, followed by a repeat test of cure three to four weeks later.[29,30]

As previously mentioned, medical care alone is not sufficient to ensure better health outcomes. SDH—including factors such as education, job or employment status, family and social supports, income, community, safety, and physical environment—all contribute to the health outcomes of patients. Health behaviors—such as tobacco use, diet, exercise, alcohol use, and sexual activity—access to healthcare, and health care quality account for the rest of patient health outcomes. The American College of Obstetricians and Gynecologists (ACOG) recommend that awareness and inquiry about SDH in caring for patients can lead to better health outcomes via better understanding, more effective communication and the provision of more patient-centered care.[31] SDH influence health conditions like cardiovascular disease, and are critical to address if we are to comprehensively address cardiovascular outcomes.[32] Studies have shown that neighborhood-level factors that indicate racial and income disparities help explain some of the black/white racial disparities also seen in STI acquisition during pregnancy.[33] Specifically, a study of pregnant women in five states in the United States showed a higher rate of STI prevalence among women who were younger, non-Hispanic black, unmarried, had less than college education, had lower income, and who lacked pre-pregnancy health insurance.[34]

Maternal gonorrhea and chlamydia are strongly associated with increased rates of preterm birth.[35-44] Preterm birth is defined as birth before 37 weeks of gestation; almost 10% of infants are born pre-term in the US.[45] It remains the most important cause of neonatal death and is a leading cause of children under five years of age.[46,47] These statistics highlight the public health significance of the connections between SDH and CT/GC infections. Pregnancy is often one of the few times that women interact with the healthcare system. Patients are able to self-assess and prioritize social services that impact health in a way that will improve overall health, so understanding women's assessment of their own SDH needs is critical to designing effective interventions.[48] State Medicaid programs understand the importance of social determinants of health in improving overall health outcomes, but it is challenging to translate these into programs that effectively address these needs.[49] It has been shown that using an integrated approach, whereby patients' social determinants of health needs are addressed simultaneously with their health concerns, results in more effective management of health conditions such as hypertension and depression.[50]

Methods

Ethics. Institutional Review Boards at Emory University, Morehouse University, and Grady approved this study.

Study design and objective. We conducted a retrospective cohort study of pregnant women who received antenatal care at Grady Memorial Hospital (GMH), supervised by Emory and Morehouse University clinicians. The data were collected from October 15, 2019 through

October 14, 2020. A partial dataset was used for this analysis (from October 15, 2019 through March 12, 2020). The objective of the study was to determine if SDH screening in pregnancy predicts increased risk of gonorrhea and chlamydia infection.

Setting. GHM is a safety net and urban teaching hospital serving Atlanta, GA and the surrounding catchment area. GMH serves a diverse patient population, including many underinsured and underserved patients. The study is part of a larger initiative of social determinant of health (SDH) screening at GMH that was piloted in certain clinics, including the obstetric clinic, which is run by both Emory and Morehouse services.

Participants. Our study population was all women seen in the Obstetric Clinic at GMH who presented for routine prenatal care. Those included were all women who presented for an antenatal care visit at GMH, delivered at GMH, Emory Decatur, or Emory Midtown, and completed SDH screening at least once during their prenatal visits. Those excluded were patients presenting for post-partum (PP) blood pressure checks, walk-in visits, registered nurse visits, lab only visits, and all patients presenting for gynecologic issues because these women represented patients presenting for unknown issues, were seen by non-physician providers, or fell outside of the study because they were not presenting for obstetric care. The women included in this study underwent SDH screening and referral, including screening from medical assistants, nurse midwives and physicians.

Outcome of interest. Our primary outcome was incident gonorrhea (GC) and/or chlamydia (CT) infection during pregnancy, defined as at least one positive GC and/or CT infection during the pregnancy. GC and CT tests for incident infection during pregnancy are performed as routine part of prenatal care. These infections are detected via nuclei acid amplification tests (NAAT), which involve a polymerase chain reaction (PCR) test performed on a urine sample or cervical swab.

SDH exposures of interest. The primary exposures of interest were specific SDH needs captured on an SDH screener (see Appendix 1): literacy need, maternal security, transportation issues, financial strain, social supports, and safety/intimate partner violence. These were self-reported by women presenting to the Obstetric Clinic at GMH (see Appendix for SDH screener). Medical assistants identified eligible patients and helped them to complete the SDH screener with the patient. In subsequent visits, SDH screener responses were reviewed again with the patient. Nurses were alerted to any high risk SDH answers, and they referred patients to appropriate resources. Certified nurse midwives and doctors reviewed completed screeners and referrals and added this information to the patients EMR and after visit summary. Completed SDH screeners were placed in a folder in clinic and collected by study staff; these screeners were then stored in a locked file cabinet in the Grady Perinatal Center where they were organized by patient estimated due date.

Resources for women reporting SDH needs. Resources were provided for women who needed help with childcare, housing, domestic violence, financial strain, transportation, and food insecurity. Social workers were consulted if the patient answered “yes” to any of the high-risk questions. High-risk questions included immediate intimate partner violence (IPV) concerns, immediate shelter concerns, if the patient was >32 weeks gestation, if the patient had >3 needs, if

the patient is unable to resolve after three visits, or if there was a planned patient admission to the hospital.

Other covariates of interest. Additional covariates of interest included demographic information (race/ethnicity, age at delivery, insurance status, language preference, education, employment, substance use, gravidity and parity), comorbidities (obesity, asthma, cardiovascular disease, HIV, pre-existing hypertension, kidney disease and autoimmune disease), and antenatal care behavior (timing of initial prenatal visit, total number of visits, total weight gain, and fetal assessments). We created a composite variable to represent whether women had no/any chronic medical conditions.

Data collection and management. Demographic and clinical data was abstracted from the patient electronic health records (EMR) from the initiation of prenatal care at Grady, through 42 days postpartum. This abstraction was initially performed manually by trained medical and public health graduate students, as well as a Maternal-Fetal Medicine (MFM) fellow and was captured and managed using the Research Electronic Data Capture (REDCap) [cite]. The first few charts that each student abstracted was re-checked for quality; as questions arose during the data abstraction process, they were logged and addressed by the MFM research lead. Subsequently, we developed a way to abstract EMR data automatically. SDH screener data was input into REDCap by study staff.

Data analyses. Analyses were conducted using SAS software version 9.4 (SAS Institute Inc., Cary, NC, USA). For age, we used the median to create a binary variable. Age at delivery was divided into a binary variable at 27 years of age, because this was the median of our population. Most of our population is non-Hispanic Black, with significantly smaller numbers in all of the other race and ethnicity variables we captured, so this variable was dichotomized into non-Hispanic Black versus Other. For chronic medical conditions, we created a composite variable that identified women with any of the specific chronic medical conditions we evaluated. These were all determined using ICD codes. Chronic hypertension in this obstetric population was defined as hypertension with an onset before 20 weeks of pregnancy. We also used SDH screener data to create variables indicating the continuous number of total SDH needs reported, and composite variables indicating any/no food, housing, transportation or intimate partner violence (IPV) needs.

Categorical variables were described overall and stratified by the outcome of interest using counts and percentages, with statistical differences across outcomes quantified using Chi-square or Fischer's exact p-values. We then used logistic regression evaluate the crude associations between self-reported SDH exposures and other covariates of interest and incident gonorrhea and chlamydia infection. Crude prevalence odds ratios and 95% confidence intervals are reported. Variables associated with the outcome at $p<0.05$ in unadjusted analyses were assessed for multicollinearity. Variable multicollinearity was assessed using proc corr at greater than or equal to 80% correlation; if any two variables were found to be collinear, the variable with the weakest association with the outcome was removed. Remaining covariates were then selected for inclusion into an adjusted model if they were associated with the outcome using a Bonferroni-adjusted p-value to account for multiple comparisons. A second adjusted model was also created using backwards selection.

Results

The initial cohort size was 1468 deliveries during the study time period from October 15, 2019 through March 12, 2020. Of these, 47 were missing gonorrhea and chlamydia test results and were excluded from the analysis. Therefore, the final sample size was 1421 patients. Figure 1 shows how we achieved our final sample size from the initial cohort of 1468 patients.

The median age at delivery was 27 years old, with an interquartile range (IQR) of 23-32 years. The median age at delivery for the CT/GC negative group was 28 (IQR 23-33); the median age at delivery for the CT/GC positive group was 23 (IQR 19-27). Of the total study group of 1421, 9 were missing race/ethnicity information. Of these, 81.66% were non-Hispanic Black. In the CT/GC positive group, 90.17% were non-Hispanic Black versus 80.47% in the CT/GC negative group. Over a third of women (35.83%) were nulliparous with a higher frequency of women with no children in the CT/GC group (50.87%) versus the non-CT/GC group (33.73%). We had substance use data on all 1421 of the women in the final cohort. Of those, 107 (7.53%) had a substance use diagnosis, and the distribution of substance use did not differ by CT/GC status. Among the total study sample of 1421, 144 (10.13%) had private insurance, 1249 (87.90%) had public insurance, and 28 (1.97%) were completely uninsured. Among those who were CT/GC positive, 6.9% were privately insured, 91.38% were publicly insured, and 1.72% were uninsured.

Of the 1421 total women, 60.80% had no chronic medical conditions, and 39.20% had at least one condition. Among those who were CT/GC positive, about half had no chronic medical conditions (52.30%), and half had at least one (47.70%). We also examined individual chronic medical conditions, including asthma, cardiovascular disease, diabetes, HIV, and hypertension. There were 21.46%) women with asthma, which was more common among those having CT/GC (36.78%) versus CT/GC negative women (19.33%). Among those with cardiovascular disease, diabetes, HIV or hypertension, the rates of CT/GC positivity were substantially lower (12.64% for hypertension, and <3% for the remaining comorbidities). The following characteristics were statistically significantly ($p<0.05$) different between the CT/GC negative and CT/GC positive groups: age at delivery, age less than 27 years old, non-Hispanic Black race/ethnicity, parity, the presence of at least one chronic medical condition, and having asthma.

Of the 1421 total study population, 55.52% reported no SDH needs, and 44.48% reported at least one SDH need over the course of the study. Among those with a positive CT/GC result, the percentage reporting at least one SDH need was higher, at 60.92% versus 42.18% in the CT/GC negative group. Of the total study population, 24.21% of women reported a literacy need; this rose to 30.46% among those who were CT/GC positive (vs 23.34% in the CT/GC negative group). There were 15.34% of women who reported that they were concerned about running out of food; this number rose to 20.69% among those who were CT/GC positive ((vs 14.60% in the CT/GC negative group). There was a similar percentage (15.41%) of women who reported that they had actually run out of food in the last 12 months, which rose to 25.29% among those who had tested positive for CT/GC (vs 14.03% in the CT/GC negative group). Almost one in five women (19.35%) indicated any kind of food insecurity, which rose to 28.74% among those who were CT/GC positive (vs 18.04% in the CT/GC negative group).

Of the 1421 women in our total study population, 10.56% of women reported that they had been homeless at some point in the last 12 months; this number rose to 17.24% among those who were CT/GC positive (vs 9.62% in the CT/GC negative group). There was a similar doubling of percentages seen in the women who expressed concern about losing their housing when

compared to those who were concerned about losing housing and were CT/GC positive (7.46% in total population, 12.07% in CT/GC positive vs 6.82% in CT/GC negative group). These numbers followed the same trend in our composite housing variable (14.14% in total population, 22.41% in CT/GC positive vs 12.99% in CT/GC negative group). In our assessment of those with difficulty obtaining utilities, only 7.53% indicated a utilities need, but this jumped to 10.92% in those who were CT/GC positive (vs 7.06% in the CT/GC negative group).

The SDH screener assessed transportation insecurity also using two questions. There were 13.44% of women who reported that a lack of transportation had kept them from medical appointments, which increased to 21.84% among those who were CT/GC positive (vs 12.27% in the CT/GC negative group). Similar percentages were seen in women reporting barriers to accessing activities of daily living, with the exception that almost one fourth (24.14%) of those who were CT/GC positive reported this SDH need (vs 12.11% in the CT/GC negative group). Overall, 16.68% of women reported some kind of transportation need, with over a quarter (27.01%) of those with CT/GC indicating difficulty obtaining adequate transportation (vs 15.24% in the CT/GC negative group).

We assessed three different facets of IPV. There were 4.29% of women who reported feeling physically or emotionally unsafe in their current living situations, which was similar to the number of CT/GC positive women who reported feeling unsafe (5.17%, vs. 4.17% in the CT/GC negative group). Only 2.89% of women reported being hit, slapped, kicked or otherwise physically hurt within the last 12 months, but this increased to 8.05% of those who were CT/GC positive (vs 2.17% in the CT/GC negative group). Finally, 3.87% of women reported being humiliated or emotionally abused, which also increased to 8.05% of those who were CT/GC positive (vs 3.29% in the CT/GC negative group). About 7% of women reported some kind of IPV, which nearly doubled to 12.64% among those who were CT/GC positive (vs 6.26% in the CT/GC negative group).

In evaluating number of SDH needs reported by our study sample, there were 44.48% of women who reported at least one need, 27.02% who reported at least two needs, and 18.65% who reported three or more needs. Among those who were positive for CT/GC, these numbers rose to 60.92%, 39.08%, and 28.74%, respectively (vs 42.18%, 25.34% and 17.24%, respectively in the CT/GC negative groups). These results can be seen in Table 1.

In our univariate model, SDH factors statistically significantly associated with incident CT/GC infection included reporting a literacy need (crude odds ratio (cOR) 1.439, p-value 0.0405), any food need (cOR 1.832, p-value 0.0009), concern about running out of food (cOR 1.527, p-value 0.00378), actually running out of food (cOR 2.073, p-value 0.0002), any housing need (cOR 1.935, p-value 0.0002), concern about losing housing (cOR 1.876, p-value 0.0149), lack of housing (cOR 1.957, p-value 0.0026), any transportation need (cOR 2.059, p-value 0.0001), lack of transportation preventing access to medical care (cOR 1.998, p-value 0.0006), lack of transportation preventing access to activities of daily living (cOR 2.31, p-value <0.0001), IPV (cOR 2.169, p-value 0.0025), physical (cOR 3.954, p-value <0.0001) and emotional (cOR 2.574, p-value 0.0032) abuse. These results can be seen in Table 2.

The multi-collinearity assessment showed that our variables for any reported SDH need and for more than one reported SDH need were collinear as expected, so the variable for any reported SDH need was dropped. The variable for concern about running out of food and the composite variable for any reported food need were collinear, so the variable for concern about running out of food was dropped. Similarly, the variable for actually running out of food was collinear with the composite food need variable, so the composite food need variable was also dropped. Finally,

the variable indicating homelessness and the composite variable indicating any housing insecurity were collinear, so the composite variable was dropped.

In our multivariate analysis with a backward selection model, using a Bonferroni correction p-value of 0.0029, we determined that only age <27 years (aOR 3.83, p-value <0.0001) and asthma (aOR 1.914, p-value 0.0004) remained significant. Though not statistically significant, reporting running out of food in the last 12 months (aOR1.754, p-value 0.0072), and reporting physical abuse (aOR 2.79, p-value 0.0058) were also associated with CT/GC positivity. Without a backward selection model, only age <27 years was statistically significant (aOR 3.675, p-value <0.0001). Though not statistically significant, asthma (aOR 1.975, p-value 0.0205), reporting a literacy need (aOR 1.11, p-value 0.5904), lack of transportation for medical appointments (aOR 1.203, p-value 0.6809), lack of transportation for activities of daily living (aOR 2.117, p-value 0.1751), or physical abuse (aOR 3.311, p-value 0.0461) were all associated with CT/GC positivity. These results can be seen in Table 3.

Discussion

The only variables statistically significantly associated with CT/GC infection in adjusted models were age <27 years and asthma. Compared to those who were CT/GC negative, women who tested positive for CT/GC were more likely to be non-Hispanic Black, and have parity greater than zero, although none of these reached significance. Compared to those who were CT/GC negative, women who tested positive for CT/GC were more likely to have any SDH need, and to report a literacy need, a food need, housing need, transportation need, or IPV need, although none of these were statistically significant either. The association between age less than 27 years and CT/GC infection is consistent with other data that younger women are at higher risk of sexually transmitted infections.[34] We hypothesized that race and ethnicity would be associated with CT/GC infection, but did not have the sample size to examine more categories than non-Hispanic Black and Other, which limited our ability to detect a difference. Though not statistically significant, the adjusted odds of being non-Hispanic Black compared to being Other in the CT/GC group was 1.574 (p-value 0.1033), which trends in the expected direction. Our results with respect to parity made sense: higher rates of CT/GC infection in women were seen in those who were nulliparous (50.87%) compared to parity >0, although these were not significant in either the univariate or multivariate analyses. It is likely that this is a reflection of the age of the women in each parity subgroup. Our substance use results were surprisingly not significant at any stage of the analysis, but we only had 107 women who had any kind of substance use diagnosis in our dataset, so we were likely not powered to evaluate CT/GC infection by substance use diagnosis. In the unadjusted model, those in the CT/GC positive group had 1.393 greater odds of also having a substance use diagnosis. These diagnoses designations were also based on ICD codes, which may have underestimated the true rates of substance use in this population.

We had predicted that primary insurance type would be associated with CT/GC infection, but this was not statistically significant at any point in the analysis. This was likely due to our sample size (there were 144 with private insurance, and 28 who were uninsured, with only 12/144 with private insurance who were CT/GC positive, and 3/28 who were uninsured who were CT/GC positive). This may also represent a bias, in that women who were uninsured may not have been able to present for their prenatal appointments at all, may have presented later or less frequently for care, or may have faced higher barriers to obtaining their STI screening. Though not statistically significant, these results may still be clinically significant, as the results

of our unadjusted model indicate that in the CT/GC positive group, women are more likely to have public insurance or be uninsured. Finally, we had predicted that women with chronic medical conditions would be at increased risk of CT/GC infection, but only found that asthma and our composite variable of all chronic medical conditions were associated with increased risk in our unadjusted model; only asthma was significant in the final backwards selection model. In the unadjusted model, those with asthma had a 2.429 (CI 1.731, 3.408, p-value <0.0001) times odds of CT/GC positivity, likely accounting for the statistical significance of our any chronic medical condition variable as well. This strong association between asthma and incident CT/CG infection was a surprising finding. We hypothesize that clinicians in the obstetric clinic likely documented asthma more regularly than other chronic medical conditions because of its importance in dictating the medications that can later be used in the case of postpartum hemorrhage. Women with asthma may have also been more likely to present to their prenatal appointments regularly, and receive their routine CT/GC tests, because they were used to interacting with the healthcare system in the context of their asthma care.

The only variables statistically significantly associated with CT/GC infection in adjusted models were age <27 years and asthma. Though none of the other SDH variables were statistically significant in the adjusted model, a number of these variables had odds ratios that trended in the expected direction and may have clinical significance. Though not statistically significant, reporting running out of food in the last 12 months and reporting physical abuse were also associated with CT/GC positivity. Food insecurity has been linked to poor sexual health outcomes in a number of populations, including men[51], adolescents[52], and those aged 15-44 years[53] so it is not surprising that we also saw an association between food insecurity and CT/GC positivity in our population. Research has suggested that food insecurity drives high-risk sexual behaviors in exchange for food or resources to acquire food[53], and studies of other diverse urban obstetric populations have shown levels of food insecurity less than what we found in our population (11%[54], compared to over 15% in our population). It is well-established that women, and pregnant women, are disproportionately affected by IPV.[55] IPV is also associated with increased risk of STIs[56,57] because of higher-risk sexual behaviors, including condomless sex, earlier sexual debut, multiple partners, and consumption of other substances during sexual encounters.[58] Our findings that reporting physical abuse was associated with CT/GC positivity are consistent with this prior research. Women who also reported that a lack of transportation had kept them from medical appointments or from activities of daily living had 1.203 and 2.117 higher adjusted odds, respectively, of testing positive for CT/GC. This may represent difficulty accessing healthcare in general, leading to delays in treatment or may reflect lack of access to protection like condoms, but this is difficult to parse out from our data. In pregnancy specifically, these challenges may become exacerbated because of the well-established increased psychosocial vulnerability seen in pregnancy.[59] Clinically, though only the age and asthma variables were significant, these results are informative. The overall trend of increased SDH need being associated with increased CT/GC infection incidence is consistent with other literature and indicates an area of potential intervention.

There are a number of important limitations to this study. First, regarding our study population, we performed this at a safety-net teaching hospital in the Atlanta area, with a population that is known to be high-risk, underserved and underinsured. [cite]. Though advantageous in many ways, this unique study population also means that our results may not be able to be generalized to all pregnant women, or to the broader public. Second, in terms of our study methods, many limitations stem from the fact that this was a self-reported SDH study.

Women were asked to evaluate their own SDH needs, based on the questions asked on our SDH screener. Literacy needs were reported in almost a quarter of our population (24.21%), indicating that reading, understanding or interpreting the screener may have been a challenge for a large subset of the population we were trying to evaluate. In addition, women may have over- or underestimated their true SDH need, and there is no way for us to correct for this statistically. Research has shown that for women affected by social determinants of health needs, initial and repeat screening offers important opportunities to address these needs.[60] Our study was designed to ask women about their SDH need repeatedly, at each prenatal visit, with an option to indicate "no change from prior" in SDH needs from the previous visit, but women may not have completed the screener consistently, the screeners may not have been collected and entered perfectly, and women may not have accurately indicated "no change from prior". Research has established that while clinicians recognize the importance of inquiring about SDH needs, they struggle to find the time and resources to address these needs.[61] Regarding our set of IPV questions, the answers to these questions may not have been reported accurately due to safety concerns, especially if women presented to their prenatal appointments with the individual who was perpetrating the IPV. Finally, women were allowed to decline the survey for any reason, which introduces a bias. We have no way of knowing whether these women were differentially affected by SDH needs.

Third, the chronic medical conditions we evaluated were those for which there was a diagnosis ICD code. This included many of the relevant chronic medical conditions (asthma, cardiovascular disease, diabetes, HIV, and hypertension), but we were unable to assess other conditions such as anemia, COPD, sickle cell disease, clotting disorders, liver cirrhosis, chronic kidney disease, hypothyroidism, hyperthyroidism, seizure history, lupus, and other autoimmune conditions. Fourth, CT/GC testing is done routinely, but there are also instances when this testing is not completed according to the prescribed algorithm – women don't go to the lab for testing, provider error in ordering tests, women decline testing, women may not be able to come back for follow up prenatal appointments, women present too late for prenatal appointments, potential lab error. We know that women with adequate prenatal care have better obstetric outcomes,[62] so inadequate prenatal care may have impacted both the CT/GC infection rates observed as well as our ability to measure it.

Fifth, in designing the statistical analysis, we had to make several assumptions. We assumed that women were sexually active because they were presenting to the obstetric clinic for pregnancy, but we did not assess whether they were currently sexually active, or whether they had been sexually active throughout their pregnancy thus far. We did not differentiate between women who had once instance of CT/GC infection and those who had repeated or untreated infections. We created a composite variable of women who were positive for either CT or GC, but did not separate the analysis into each specific STI, look at coinfection rates, or examine coinfection with any other STIs. Finally, we would be remiss not to mention the impact that COVID-19 may have had on these study results. This study was started before the COVID-19 pandemic started, and completed after the pandemic had already begun. Dramatic changes in patient behavior, ability to attend prenatal care appointments, and the SDH needs faced by our population as a result of the pandemic may have introduced bias into these study results.

In addition to these limitations, we also have a number of strengths of this study. We have a large sample size, collected data over a long period of time, and will have an even larger, more robust dataset once all data collection is completed. Our study population was uniquely suited to this study because of their overall high rates of SDH needs. We were able to capture a

group of women who have routine interaction with the healthcare system for prenatal care, and who are routinely tested for STIs, including gonorrhea and chlamydia. Finally, we only had to exclude 47 women because they did not have CT/GC results.

Conclusion

These results may help us identify women at higher risk of STIs, specifically chlamydia and gonorrhea, so that they can be screened appropriately. Pregnancy offers a unique time for intervention on SDH needs and STIs due to the increased interaction with the healthcare system. In addition, we hope that this examination of SDH needs highlights the connections between SDH needs and STIs in pregnancy. These connections could have implications for future screening recommendations and emphasize areas for public health interventions aimed at decreasing STIs and subsequent adverse outcomes in pregnancy. Improved identification of those at highest risk for CT/GC infections during pregnancy could allow for targeted screening to increase identification and treatment of STIs in pregnant women, therefore leading to decreased length of infection, decreased infection incidence during pregnancy, and decreased rates of preterm birth. Future directions include conducting this analysis on the completed data set. We would also like to develop a risk prediction score using SDH to determine those at increased risk of CT/GC during pregnancy, and use this score to identify and screen women at increased risk of CT/GC during pregnancy. It would be interesting to investigate the connection between CT/GC positivity and asthma more thoroughly, and we could also potentially expand this analysis to include other STIs and to evaluate temporality of SDH needs and STI during the course of pregnancy.

Figure 1. Creation of analytic dataset

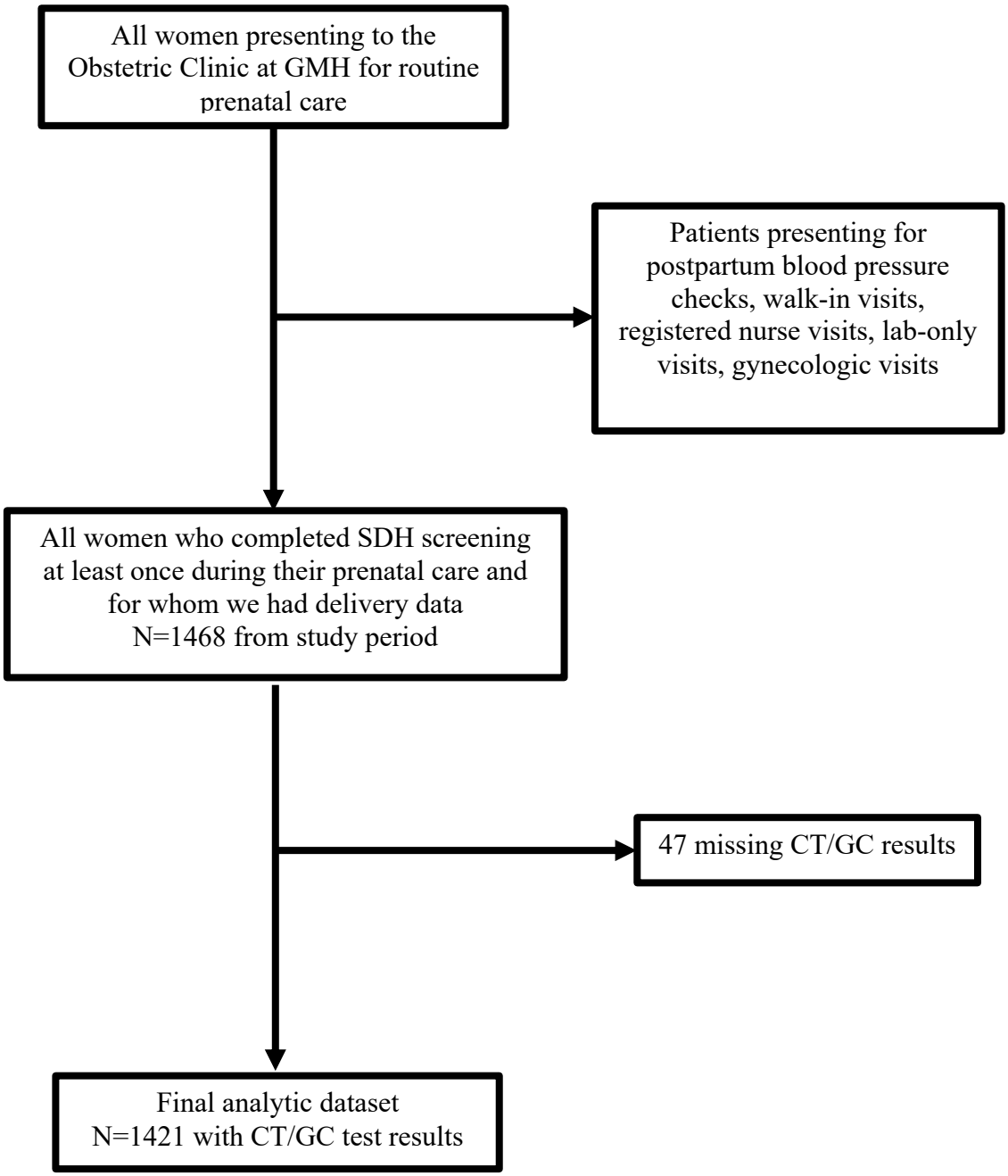

Table 1. Demographic and Clinical Characteristics by Incident Maternal *Chlamydia trachomatis* and *Neisseria gonorrhea* infection

Characteristic	Total study population		CT/GC negative		CT/GC positive	
	n	%	n	%	n	%
Total	1421		1247	87.76%	174	12.25%
Age at delivery, years (median (IQR))*	27	23-32	28	23-33	23	19-27
<27	648	45.60%	518	41.54%	130	74.71%
>/=27	773	54.40%	729	58.46%	44	25.29%
Race/ethnicity	1412	99.37%	1239	99.36%	173	99.43%
Non-Hispanic black	1153	81.66%	997	80.47%	156	90.17%
Other	259	18.34%	242	19.53%	17	9.83%
Parity*	1418	99.79%	1245	99.84%	173	99.43%
0	508	35.83%	420	33.73%	88	50.87%
1	342	24.12%	309	24.82%	33	19.08%
2	267	18.83%	240	19.28%	27	15.61%
3 or more	301	21.23%	276	22.17%	25	14.45%
Substance use	1421		1247		174	
Yes	107	7.53%	90	7.22%	17	9.77%
No	1314	92.47%	1157	92.78%	157	90.23%
Primary insurance type	1421		1247		174	
Private	144	10.13%	132	10.59%	12	6.90%
Public	1249	87.90%	1090	87.41%	159	91.38%
Uninsured	28	1.97%	25	2.00%	3	1.72%
Chronic medical conditions	1421		1247		174	
None	864	60.80%	773	61.99%	91	52.30%
Any*	557	39.20%	474	38.01%	83	47.70%
Asthma*	305	21.46%	241	19.33%	64	36.78%
Cardiovascular disease	55	3.87%	51	4.09%	4	2.30%
Diabetes	56	3.94%	52	4.17%	4	2.30%
HIV-positive	47	3.31%	44	3.53%	3	1.72%

Hypertension	239	16.82%	217	17.40%	22	12.64%
No SDH need reported	789	55.52%	721	57.82%	68	39.08%
Any SDH need reported*	632	44.48%	526	42.18%	106	60.92%
Literacy need*	344	24.21%	291	23.34%	53	30.46%
Food*	275	19.35%	225	18.04%	50	28.74%
A: concern about running out food*	218	15.34%	182	14.60%	36	20.69%
B: actually run out of food*	219	15.41%	175	14.03%	44	25.29%
Housing*	201	14.14%	162	12.99%	39	22.41%
A: stayed outside/in a car/tent/etc.*	150	10.56%	120	9.62%	30	17.24%
B: concern about losing housing*	106	7.46%	85	6.82%	21	12.07%
Utilities	107	7.53%	88	7.06%	19	10.92%
Transportation*	237	16.68%	190	15.24%	47	27.01%
A: lack of transport kept from medical appts*	191	13.44%	153	12.27%	38	21.84%
B: lack of transport kept from daily living*	193	13.58%	151	12.11%	42	24.14%
IPV*	100	7.04%	78	6.26%	22	12.64%
A: feel unsafe	61	4.29%	52	4.17%	9	5.17%
B: physical abuse*	41	2.89%	27	2.17%	14	8.05%
C: emotional abuse*	55	3.87%	41	3.29%	14	8.05%
Number of SDH needs reported						
0	789	55.52%	721	57.82%	68	39.08%
1 or more*	632	44.48%	526	42.18%	106	60.92%
2 or more*	384	27.02%	316	25.34%	68	39.08%
3 or more*	265	18.65%	215	17.24%	50	28.74%

*indicates variables that are statistically significant using p-value ≤0.05

Table 2. Univariate logistic regression model for positive GC/CT testing, by demographic and clinical characteristics, and maternal SDH self-reported needs

Characteristic	Crude OR	CI		p-value
		low	high	
Age at delivery, years	0.865	0.837	0.893	<0.0001*
<27	4.157	2.901	5.958	<0.0001*
>/=27	Ref			
Race/ethnicity				
Non-Hispanic black	2.227	1.324	3.746	0.0025*
Other	Ref			
Parity				
0	Ref			
1	0.51	0.333	0.781	0.0019*
2	0.537	0.339	0.85	0.008*
3 or more	0.432	0.27	0.691	0.0005*
Substance use				
Yes	1.393	0.808	2.4	0.2331
No	Ref			
Primary insurance type				
Private	Ref			
Public	1.605	0.868	2.965	0.1311
Uninsured	1.32	0.347	5.018	0.6837
Chronic medical conditions				
None	Ref			
Any	1.488	1.082	2.046	0.0146*
Asthma	2.429	1.731	3.408	<0.0001*
Cardiovascular disease	0.552	0.197	1.546	0.258
Diabetes	0.541	0.193	1.514	0.2418
HIV-positive	0.48	0.147	1.562	0.2226
Hypertension	0.687	0.429	1.1	0.1178

No SDH need reported	Ref			
Any SDH need reported	2.137	1.544	2.956	<0.0001*
Literacy need	1.439	1.016	2.039	0.0405*
Food	1.832	1.28	2.622	0.0009*
A: concern about running out food	1.527	1.024	2.275	0.0378*
B: actually run out of food	2.073	1.422	3.024	0.0002*
Housing	1.935	1.306	2.865	0.001*
A: stayed outside/in a car/tent/etc.	1.957	1.265	3.026	0.0026*
B: concern about losing housing	1.876	1.131	3.114	0.0149*
Utilities	1.614	0.957	2.725	0.0729
Transportation	2.059	1.424	2.976	0.0001*
A: lack of transport kept from medical appts	1.998	1.343	2.973	0.0006*
B: lack of transport kept from daily living	2.31	1.569	3.4	<0.0001*
IPV	2.169	1.313	3.585	0.0025*
A: feel unsafe	1.254	0.607	2.591	0.5417
B: physical abuse	3.954	2.031	7.698	<0.0001*
C: emotional abuse	2.574	1.373	4.827	0.0032*

*indicates variables that are statistically significant using p-value ≤0.05

Table 3. Multivariate logistic regression model (with and without backwards selection) for positive GC/CT testing, by demographic and clinical characteristics, and maternal SDH self-reported needs

Characteristic	*Without backwards selection*				*With backwards selection*			
	Adjusted OR	**CI**		**p-value**	**Adjusted OR**	**CI**		**p-value**
		low	**high**			**low**	**high**	
Age at delivery, years								
<27	3.675	2.4	5.626	<0.0001*	3.83	2.647	5.542	<0.0001**
>/=27	Ref				Ref			
Race/ethnicity								
Non-Hispanic black	1.574	0.912	2.717	0.1033				
Other	Ref							
Parity								
0	Ref							
1	0.644	0.412	1.007	0.0538				
2	0.924	0.559	1.53	0.7599				
3 or more	1.029	0.59	1.795	0.9188				
Chronic medical conditions								
None	Ref							
Any	0.887	0.516	1.526	0.6655				
Asthma	1.975	1.111	3.512	0.0205	1.914	1.341	2.732	0.0004**
SDH need reported								
Literacy need	1.11	0.759	1.622	0.5904				
Food								
B: actually run out of food	1.51	0.932	2.446	0.0938	1.754	1.165	2.642	0.0072
Housing								
A: stayed outside/in a car/tent/etc.	0.944	0.534	1.667	0.8421				
B: concern about losing housing	0.928	0.488	1.765	0.821				
Transportation	0.63	0.165	2.412	0.5004				
A: lack of transport kept from medical appts	1.203	0.498	2.904	0.6809				

B: lack of transport kept from daily living	2.117	0.716	6.26	0.1751				
IPV	0.999	0.371	2.688	0.9979				
B: physical abuse	3.311	1.021	10.738	0.0461	2.79	1.346	5.787	0.0058
C: emotional abuse	0.746	0.22	2.525	0.6374				

*indicates variables that are statistically significant using Bonferroni-corrected p-value of ≤0.0029

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Appendix A. PubMed search terms

PubMed

Social Determinants of Health

((((((((("Social Determinants of Health"[Mesh]) OR "Socioeconomic Factors"[Mesh]) OR "Health Literacy"[Mesh]) OR "Literacy"[Mesh]) OR "Food Supply"[Mesh]) OR "Poverty"[Mesh]) OR "Homeless Persons"[Mesh]) OR "Transportation"[Mesh]) OR "Intimate Partner Violence"[Mesh]

OR

"social determinants of health"[TW] OR socioeconomic*[TW] OR transport*[TW] OR "health literacy"[TW] OR "literacy"[TW] OR litera*[TW] OR "food supply"[TW] OR "food insecurity"[TW] OR "poverty"[TW] OR impoverish*[TW] OR homeless*[TW] OR "intimate partner violence"[TW] OR violen*[TW] OR abus*[TW]

STI

((("Sexually Transmitted Diseases"[Mesh]) OR "Gonorrhea"[Mesh]) OR "Chlamydia"[Mesh]) OR "Trichomonas"[Mesh]

OR

"sexually transmitted disease"[TW] OR "sexually transmitted diseases"[TW] OR "sexually transmitted infections"[TW] OR "sexually transmitted infection"[TW] OR chlamydia[TW] OR gonorrhea[TW] or trichomonas[TW]

Pregnancy

"Pregnancy"[Mesh] NOT ("Pregnancy, Animal"[Mesh] OR "Pseudopregnancy")

OR

pregnan*[TW] OR obstet*[TW]

Search

1. ((((((((("Social Determinants of Health"[Mesh]) OR "Socioeconomic Factors"[Mesh]) OR "Health Literacy"[Mesh]) OR "Literacy"[Mesh]) OR "Food Supply"[Mesh]) OR "Poverty"[Mesh]) OR "Homeless Persons"[Mesh]) OR "Transportation"[Mesh]) OR "Intimate Partner Violence"[Mesh]
2. ((("Sexually Transmitted Diseases"[Mesh]) OR "Gonorrhea"[Mesh]) OR "Chlamydia"[Mesh]) OR "Trichomonas"[Mesh]
3. "Pregnancy"[Mesh] NOT ("Pregnancy, Animal"[Mesh] OR "Pseudopregnancy"[Mesh])
4. #1 AND #2 AND #3
5. "social determinants of health"[TW] OR socioeconomic*[TW] OR transport*[TW] OR "health literacy"[TW] OR "literacy"[TW] OR litera*[TW] OR "food supply"[TW] OR "food insecurity"[TW] OR "poverty"[TW] OR impoverish*[TW] OR homeless*[TW] OR "intimate partner violence"[TW] OR violen*[TW] OR abus*[TW]
6. "sexually transmitted disease"[TW] OR "sexually transmitted diseases"[TW] OR "sexually transmitted infections"[TW] OR "sexually transmitted infection"[TW] OR chlamydia[TW] OR gonorrhea[TW] or trichomonas[TW]pregnan*[TW]
7. pregnan*[TW] OR obstet*[TW]
8. #5 AND #6 AND #7
9. #4 OR #8

325 items found
Limit to English – 295 items
Limit to 2000 onward – 198 items

Appendix B. Social Determinants Screener used in the obstetric clinic

Social Determinants Screen

Place patient sticker here

Today's Date: _____

Pregnancy Due Date:_____

Grady

Health starts long before illness – in our homes, schools, and jobs. The more we know about you, the better health care we can provide. At Grady, we care about where you live, learn, work and understand that challenges in these areas can influence all parts of your life, including your health.

Our **Social Determinants of Health Screening** will help us understand more about you. Your care team will use your answers to help you improve your health. We may not be able to find resources for all of your needs, but we will try and help as much as we can.

These responses will be entered into your medical record, and, as with all medical information, will be kept private and confidential.

If you have any questions about why we are asking these questions, please feel free to ask your doctor, midwife, or nurse, during today's visit.

Please check (if applicable):
[ ] I have already completed this form and do not have any changes
[ ] I decline to participate

	Yes	No
Literacy		
1. Do you like having someone to help you read information from your health provider or pharmacist?		
Food		
1. Within the past 12 months, did you worry that your food would run out before you got money to buy more?		
2. Within the past 12 months, did the food you bought just not last and you didn't have money to get more?		
Housing/ Utilities		
3. Within the past 12 months, have you ever stayed: outside, in a car, in a tent, in an overnight shelter, or temporarily in someone else's home?		
4. Are you worried about losing your housing?		
5. Within the past 12 months, have you been unable to get utilities (heat, electricity) when it was really needed?		
Transportation		
6. Within the past 12 months, has a lack of transportation kept you from medical appointments?		
7. Within the past 12 months, has a lack of transportation kept you from work or doing things needed for daily living?		
Interpersonal Safety		
8. Do you feel physically or emotionally unsafe where you currently live?		
9. Within the past 12 months, have you been hit, slapped, kicked or otherwise physically hurt by anyone?		
10. Within the past 12 months, have you been humiliated or emotionally abused by anyone?		
Immediate Need		
11. Are any of your needs urgent? For example, you don't have food for tonight, you don't have a place to sleep tonight, you are afraid you will get hurt if you go home today.		
12. Would you like help with any of the needs that you have identified?		