Received: 9 July 2023 | Revised: 20 January 2024 | Accepted: 9 February 2024 | Published online: 29 February 2024

DOI: 10.1002/ijgo.15447

CLINICAL ARTICLE

Obstetrics

Prevalence of *Chlamydia trachomatis*, *Neisseria gonorrhoeae*, *Trichomonas vaginalis*, and *Mycoplasma genitalium* and risk factors among pregnant women in Brazil: Results from the national molecular diagnosis implementation project

Angélica Espinosa Miranda[1,2] | Pâmela Cristina Gaspar[1,3] | Marcos André Schörner[4] | Fernando Hartmann Barazzetti[4] | Guilherme Borges Dias[1] | Alisson Bigolin[1] | Ana Roberta Pati Pascom[1] | Dráurio Barreira[1] | Maria Luiza Bazzo[4] | Brazilian Surveillance for STIs in Pregnant Women Group

[1]Departamento de HIV/AIDS, Tuberculose, Hepatites Virais e Infecções Sexualmente Transmissíveis do Ministério da Saúde, Brasília, Distrito Federal, Brazil

[2]Programa de Pós-Graduação em Doenças Infecciosas da Universidade Federal do Espírito Santo, Vitória, Espírito Santo, Brazil

[3]Programa de Pós-Graduação em Saúde Coletiva da Universidade de Brasília, Brasília, Distrito Federal, Brazil

[4]Laboratório de Biologia Molecular, Microbiologia e Sorologia do Programa de Pós-Graduação em Farmácia da Universidade Federal de Santa Catarina, Florianópolis, Santa Catarina, Brazil

Correspondence
Angélica Espinosa Miranda, SRTVN Quadra 701, lote D, Edifício PO700—5° andar, CEP: 70719-040 Brasília, Distrito Federal, Brazil.
Email: amiranda.ufes@gmail.com

Funding information
Pan-American Health Organization and the Department of HIV/AIDS, tuberculosis, viral hepatitis and sexually transmitted infections - Brazilian Ministry of Health, Grant/Award Number: 111/2017-TC66-OPAS

Abstract

Background: Sexually transmitted infections (STIs) are a public health problem. The aim of the present study was to assess the prevalence and risk factors associated with at least one STI (*Chlamydia trachomatis* [CT], *Neisseria gonorrhoeae* [NG], *Trichomonas vaginalis* [TV], and *Mycoplasma genitalium* [MG]) in Brazil.

Methods: A cross-sectional study was conducted using secondary data from the pilot implementation of the National Service for molecular diagnosis of CT, NG, TV, and MG in pregnancy. We obtained Ministry of Health surveillance data from the implementation project. Data encompassing pregnant women aged 15–49 years from public antenatal clinics in Brazil in 2022 were included.

Results: A total of 2728 data of pregnant women were analyzed. The prevalence of at least one infection was 21.0% (573), with the highest prevalence in the Southeast region (23.3%) and the lowest in the Center-West region (15.4%). The prevalence of CT was 9.9% (270), NG 0.6% (16), TV 6.7% (184), and MG 7.8% (212). Factors associated with any infection were from 15 to 24 years (AOR = 1.93; 95% CI: 1.58–2.35); reported family income up to US$400 (AOR = 1.79; 95% CI: 1.03–3.34); declared not living maritally with their partners (AOR = 1.90, 95% CI: 1.52–2.37) and had more than one sexual partner in their lifetime (AOR = 2.09, 95% CI: 1.55–2.86).

Conclusion: This study showed a high prevalence of at least one STI among pregnant women in Brazil, particularly among younger women. It also provides up-to-date national data on CT, NG, TV, and MG infections in this population. These findings underscore the importance of enhancing access to STI screening for young pregnant women within the Brazilian public health system.

Angélica Espinosa Miranda and Pâmela Cristina Gaspar share co-first authorship.

KEYWORDS
Brazil, *Chlamydia trachomatis*, *Mycoplasma genitalium*, *Neisseria gonorrhoeae*, pregnancy, sexually transmitted infections, surveillance, *Trichomonas vaginalis*

1 | INTRODUCTION

Sexually transmitted infections (STIs) remain a significant public health concern despite decades of scientific advances in prevention, diagnosis, and treatment.[1–3] Many bacterial STIs, such as *Neisseria gonorrhoeae* (NG), *Chlamydia trachomatis* (CT), and *Mycoplasma genitalium* (MG) infections during pregnancy, have been associated with adverse outcomes, such as premature rupture of membranes, preterm birth, and low birth weight.[4–6] Furthermore, CT and NG are well-known causes of neonatal conjunctivitis, while MG is associated with pulmonary issues in neonates, especially premature ones. CT is also recognized as one of the causes of pneumonia in newborns.[4,7] Untreated *Trichomonas vaginalis* (TV) infections in pregnant women, another STI that predominantly affects the female genital tract, are associated with an increased risk of low birth weight, preterm delivery, pelvic inflammatory disease, and premature rupture of membranes.[8–10]

According to Global Health Sector Strategies 2022–2030, enhancing STI surveillance is considered a priority by the WHO.[11,12] In this respect, molecular diagnosis also plays a crucial role in providing epidemiological data and improving clinical management. Nucleic acid amplification tests (NAATs) effectively detect these pathogens and are commercially available in various versions worldwide, including those which simultaneously investigate more than one pathogen. Utilizing tests that can investigate multiple STIs in a single biological sample offers the advantages of expanded testing access and expedited care.[13] Despite the availability of CT/NG molecular tests in Brazil, a test that can detect CT/NG/TV/MG simultaneously in a single sample is not yet available in the Brazilian public health system.[14]

Insufficient and fragmented data on STIs, particularly stratified by gender, are one of the main challenges to implementing effective prevention and assistance policies. The lack of consistent and comprehensive data at national and subnational levels difficult the progress in controlling STIs and identify priority areas for intervention measurement.[12] This problem is evident in Brazil, where certain STIs, such as NG, CT, MG, and TV, are not included in the list of nationally notifiable diseases, unlike syphilis. As a result, no official statistics are available for these pathogens in the country.[15] Current data on these infections in pregnant women primarily come from infrequent national surveys, which further exacerbates the scarcity of information. The published data in Brazil reveals a prevalence of CT ranging from 9.4% to 9.8%, GC from 1.0% to 1.5%,[16,17] and TV of 7.7%[18] among pregnant women. Unfortunately, there are no national data on MG available for this population.

This study aimed to assess the prevalence and risk factors associated with CT, NG, TV, and/or MG infections among pregnant women in Brazil, with a particular focus on generating surveillance data for implementing a screening program during prenatal care.

2 | MATERIALS AND METHODS

A cross-sectional study was conducted using secondary data from the pilot implementation of the National Service for Molecular Diagnosis of CT/NG/MG/TV in Pregnancy. We obtained Ministry of Health surveillance data from the implementation project. Data encompassing pregnant women aged 15–49 years from public antenatal clinics in the five geographic macro-regions of Brazil, attended from January to December 2022, were included in the study and analyzed.

2.1 | Data collection

For the implementation project, the Brazilian Ministry of Health had selected, through a list of random numbers, 21 municipalities with representation from the five geographical regions (North, Northeast, Center-West, Southeast, and South) with probability proportional to the number of childbirths in the year. After this first step, low-risk and public antenatal care units were chosen according to the proportion of attended pregnant women in each municipality.

In those services, during antenatal consultation, healthcare professionals asked the pregnant women if they wished to participate in the pilot network for CT/NG/TV/MG testing with a vaginal swab collection. Due to the potential interference with testing results, leading to false negatives, pregnant women who had used antibiotics 3 months before the consultation for any causes could not participate in the pilot testing network. Pregnant women diagnosed as being infected with any pathogen received treatment according to the Brazilian Guidelines for Sexually Transmitted Diseases Control.[19]

A unique code was assigned to all pregnant women enrolled by the antenatal care units professionals, aiming to ensure the confidentiality and anonymity of the participants. Sociodemographic, behavioral, and clinical variables were collected through in-person questionnaire and included in this analysis. Sociodemographic variables were age, race/color, schooling, marital status, and family income (less than four minimum Brazilian wages ≤ US$400). Behavioral variables included were age at first sexual intercourse, age at first pregnancy, number of partners in the lifetime, and number of partners during the last year. Clinical variables were prior STI – excluding syphilis, STI symptoms, abortion history, stillbirth history, syphilis previous year, and HIV infection.

Using a single vaginal sample per patient collected by a healthcare professional, the samples were tested on the Hologic Panther

platform (San Diego, USA) using three tests: Aptima Combo 2 assay for CT/NG, Aptima *Mycoplasma genitalium* assay and Aptima *Trichomonas vaginalis* assay. The platform is based on transcription-mediated amplification. In this study the assays were carried out and scored in strict accordance with the manufacturer's protocol.

All data were anonymized and included in the database for analysis. The number of positive results was used as the numerator and the denominator were all women in the database, who were all women attended in the clinic, who met the inclusion criteria, accepted to participate in the pilot network implementation and were tested. We received the database without identification for analysis.

2.2 | Statistical analysis

Statistical analysis was performed using the R software (version 4.2.1). We estimated the prevalence of CT, NG, TV and/or MG among pregnant women as the proportion of participants at the pilot implementation with a positive test result. We used descriptive statistics to assess sociodemographic, behavioral, and clinical characteristics of pregnant women diagnosed with any infection (CT, NG, TV and/or MG), including frequency distribution for qualitative variables and calculation of mean and standard deviation for quantitative variables.

We used the chi-square test or the Fisher exact test to verify the presence of association between the infections and demographic, behavioral, and clinical variables, and performed using the epitools R package (version 0.5-10.1). Associations for the likelihood of being diagnosed with any pathogen were assessed by crude and adjusted odds ratios based on univariate and bivariate logistic regression, using the glm function from the stats R package (version 4.2.1). Variables with *P* value ≤0.15 in the bivariate analysis were included in the multivariate logistic regression model. Variables were considered as statistically significant when the *P* value was less than 0.05.

3 | RESULTS

Between January–December (2022), 2728 pregnant women were included in the pilot network analysis. The prevalence of CT infection was 9.9% (95% CI: 8.8–11.1; *N* = 270), NG was 0.6% (95% CI: 0.3–1.0; *N* = 16), TV was 6.7% (95% CI: 5.8–7.8; *N* = 184), and MG was 7.8% (95% CI: 6.8–8.8; *N* = 212). For the presence of any infection, the prevalence was 21.0% (95% CI: 19.5–22.6; *N* = 573), with the highest and lowest prevalence in the Southeast (23.3%; 95% CI: 20.9–25.8; *N* = 272) and Center-West (15.4%; 95% CI: 10.0–22.3; *N* = 15.4%) regions, respectively (Table 1).

Table 2 shows the sociodemographic, behavioral, and clinical characteristics of the pregnant women included in this study. The mean age was 27 years old (standard deviation [SD] = 6.7), the majority were black/brown (57.0%), 39.5% had 8 years or more of formal education, and 72.7% reported family income <US$400. Of the participants, 21.6% reported having first sexual intercourse before 15 years old, and 61.4% had more than one sexual partner in lifetime. Most pregnant

TABLE 1 Prevalence of *C. trachomatis, N. gonorrhoeae, T. vaginalis and M. genitalium* infections in Brazilian pregnant women attending public antenatal care units, by geographical region. Brazil, 2022 (*N* = 2616).

		CT+	NG+	TV+	MG+	Any infection
	Sample size	*N* (% ± 95% CI)	*N* (% ± 95% CI)	*N* (% ± 95% CI)	*N* (% ± 95% CI)	*N* (% ± 95% CI)
North	284	23 (8.1 ± 5.2–11.9)	1 (0.4 ± 0–1.9)	11 (3.9 ± 1.9–6.8)	20 (7 ± 4.4–10.7)	50 (17.6 ± 13.4–22.5)
Northeast	572	59 (10.3 ± 7.9–13.1)	6 (1 ± 0.4–2.3)	29 (5.1 ± 3.4–7.2)	54 (9.4 ± 7.2–12.1)	119 (20.8 ± 17.5–24.4)
Center-West	149	14 (9.4 ± 5.2–15.3)	1 (0.7 ± 0–3.7)	4 (2.7 ± 0.7–6.7)	9 (6 ± 2.8–11.2)	23 (15.4 ± 10–22.3)
Southeast	1167	123 (10.5 ± 8.8–12.4)	5 (0.4 ± 0.1-1)	110 (9.4 ± 7.8–11.2)	85 (7.3 ± 5.9–8.9)	272 (23.3 ± 20.9–25.8)
South	556	51 (9.2 ± 6.9–11.9)	3 (0.5 ± 0.1-1.6)	30 (5.4 ± 3.7–7.6)	44 (7.9 ± 5.8–10.5)	109 (19.6 ± 16.4–23.2)
Brazil	2728	270 (9.9 ± 8.8–11.1)	16 (0.6 ± 0.3–1)	184 (6.7 ± 5.8–7.8)	212 (7.8 ± 6.8–8.8)	573 (21.0 ± 19.5–22.6)

Abbreviation: CI, confidence interval.

TABLE 2 Sociodemographic, behavioral and clinical characteristics of pregnant women attending public antenatal care units according to the presence of any infection (*C. trachomatis*, *N. gonorrhoeae*, *T. vaginalis* and/or *M. genitalium*) Brazil, 2022 ($N = 2616$).

	Sample size *n* (%)	With any infection (+) *n* (%)	Without any infection (−) *n* (%)	OR (95% CI)	*P* value
Demographical variables					
Age (year)					
15–24	1081 (39.6)	312 (11.4)	769 (28.2)	2.15 (1.79–2.6)	***
25–47	1647 (60.4)	261 (9.6)	1386 (50.8)	1	
Race/color					
White/yellow	787 (28.8)	151 (5.5)	636 (23.3)	1	
Black/brown	1556 (57.0)	321 (11.8)	1235 (45.3)	1.09 (0.88–1.36)	
Indigenous	7 (0.3)	2 (0.1)	5 (0.2)	1.76 (0.22–8.62)	
Missing	378 (13.9)	99 (3.6)	279 (10.2)	1.49 (1.12–2)	
Schooling (year)					
Up to 7	339 (12.4)	71 (2.6)	268 (9.8)	1.06 (0.78–1.42)	
Eight or more	1077 (39.5)	216 (7.9)	861 (31.6)	1	
Missing	1312 (48.1)	286 (10.5)	1026 (37.6)	1.11 (0.91–1.36)	
Marital status					
Does not live with partner	657 (24.1)	204 (7.5)	453 (16.6)	2.41 (1.95–2.97)	***
Married or living together	1669 (61.2)	263 (9.6)	1406 (51.5)	1	
Missing	402 (14.7)	106 (3.9)	296 (10.9)	1.91 (1.48–2.47)	***
Family income (01 Brazilian minimum wage = ~US$200)					
Up to 1.9	1247 (45.7)	285 (10.4)	962 (35.3)	2.39 (1.39–4.42)	**
Two to 3.9	736 (27.0)	125 (4.6)	611 (22.4)	1.65 (0.94–3.1)	*
Four to 10	128 (4.7)	14 (0.5)	114 (4.2)	1	-
>10	6 (0.2)	1 (0)	5 (0.2)	1.79 (0.06–12.81)	
Missing	611 (22.4)	148 (5.4)	463 (17)	2.58 (1.48–4.83)	***
Geographical region					
North	284 (10.4)	50 (1.8)	234 (8.6)	0.88 (0.6–1.27)	
Northeast	572 (21)	119 (4.4)	453 (16.6)	1.08 (0.81–1.44)	
Center-West	149 (5.5)	23 (0.8)	126 (4.6)	0.75 (0.45–1.21)	
Southeast	1167 (42.8)	272 (10)	895 (32.8)	1.25 (0.97–1.6)	
South	556 (20.4)	109 (4)	447 (16.4)	1	
Behavioral variables					
Age at first sexual intercourse					
Under 15 years	588 (21.6)	152 (5.6)	436 (16)	1.56 (1.25–1.95)	***
15 years or over	1666 (61.1)	304 (11.1)	1362 (49.9)	1	-
Missing	474 (17.4)	117 (4.3)	357 (13.1)	1.47 (1.15–1.87)	**
Age at first pregnancy					
Under 15 years	90 (3.3)	22 (0.8)	68 (2.5)	1.31 (0.78–2.11)	
15 years or over	2124 (77.9)	423 (15.5)	1701 (62.4)	1	
Missing	514 (18.8)	128 (4.7)	386 (14.1)	1.33 (1.06–1.67)	
No. partners/life					
1	494 (18.1)	59 (2.2)	435 (15.9)	1	
>1	1676 (61.4)	378 (13.9)	1298 (47.6)	2.14 (1.61–2.9)	
Missing	558 (20.5)	136 (5)	422 (15.5)	2.37 (1.71–3.33)	

TABLE 2 (Continued)

	Sample size *n* (%)	With any infection (+) *n* (%)	Without any infection (−) *n* (%)	OR (95% CI)	*P* value
No. partners last year					
1	2120 (77.7)	405 (14.8)	1715 (62.9)	1	-
>1	183 (6.7)	61 (2.2)	122 (4.5)	2.12 (1.52–2.92)	***
Missing	425 (15.6)	107 (3.9)	318 (11.7)	1.43 (1.11–1.82)	**
Clinical variables					
Prior STI (excluding syphilis)					
Yes	30 (1.1)	7 (0.3)	23 (0.8)	1.18 (0.46–2.65)	
No	2274 (83.4)	471 (17.3)	1803 (66.1)	1	
Missing	424 (15.5)	95 (3.5)	329 (12.1)	1.11 (0.86–1.42)	
STI symptom					
Yes	810 (29.7)	165 (6)	645 (23.6)	0.95 (0.77–1.16)	
No	1918 (70.3)	408 (15)	1510 (55.4)	1	
Abortion history					
Yes	528 (19.4)	115 (4.2)	413 (15.1)	1.08 (0.85–1.37)	
No	1725 (63.2)	354 (13)	1371 (50.3)	1	
Missing	475 (17.4)	104 (3.8)	371 (13.6)	1.09 (0.85–1.39)	
Stillbirth history					
Yes	58 (2.1)	9 (0.3)	49 (1.8)	0.72 (0.33–1.42)	
No	2081 (76.3)	426 (15.6)	1655 (60.7)	1	
Missing	589 (21.6)	138 (5.1)	451 (16.5)	1.19 (0.95–1.48)	
Syphilis previous year					
Yes	59 (2.2)	21 (0.8)	38 (1.4)	2.2 (1.26–3.76)	**
No	2358 (86.4)	474 (17.4)	1884 (69.1)	1	
Missing	311 (11.4)	78 (2.9)	233 (8.5)	1.33 (1.01–1.75)	*
HIV					
Yes	13 (0.5)	2 (0.1)	11 (0.4)	0.72 (0.1–2.75)	
No	2572 (94.3)	542 (19.9)	2030 (74.4)	1	
Missing	143 (5.2)	29 (1.1)	114 (4.2)	0.96 (0.62–1.43)	

Abbreviation: CI, confidence interval; OR, odds ratio; STI, sexually transmitted infection.

*P value ≤ 0.15. **P value ≤ 0.05. ***P value ≤ 0.001.

women were asymptomatic for any STIs (70.3%), 0.5% of them were HIV positive, 2.2% reported having had syphilis and 1.1% had other STIs in the previous year. Around 19.4% had an abortion history.

Factors associated with any infection are described in Table 3. Women with detection test for any pathogen were younger (15–24 years vs 25–47 years) (aOR = 1.93; 95% CI: 1.58–2.35); declared not living maritally with their partners (aOR = 1.90, 95% CI:1.52–2.37); reported family income up to US$400 (aOR = 1.79; 95% CI: 1.03–3.34) and had more than one sexual partner in lifetime (aOR = 2.09, 95% CI: 1.55–2.86).

4 | DISCUSSION

This study represents the first nationwide screening in Brazil to detect four STI pathogens (CT/NG/MG/TV) among pregnant women, revealing a significant prevalence of at least one infection (21.0%). Our study comprises a representative sample of the low-risk pregnant women who attend antenatal care in Brazil, and therefore we provided estimates of national prevalence of these infections. Among the identified pathogens, CT exhibited the highest prevalence (9.9%), while NG (0.6%) was the less frequent, TV (6.7%), and MG (7.8%) were detected at rates closer to the CT ones. The prevalence rates of CT, NG, and TV align with previous national studies conducted in Brazil.[16–18,20] Our findings are also similar to a systematic review and meta-analysis in sub-Saharan Africa, which estimated the prevalence of curable STIs in pregnant women to be 10.8%, 3.3%, 13.8%, and 13.5% for CT, NG, TV, and MG, respectively.[21] However, our results indicate considerably higher prevalence rates compared to a study conducted in the Netherlands, where STIs were detected in 2.4% of pregnant women (CT 1.8%, NG 0.4%, TV 0.4%).[22] Another study conducted

TABLE 3 Multivariate analysis of factors associated with any infection (*C. trachomatis*, *N. gonorrhoeae*, *T. vaginalis* and/or *M. genitalium*) in pregnant women attending Brazilian public antenatal care units, 2022.

Age (years)	Sample size *n* (%)	Any infection (+) *n* (%)	Any infection (–) *n* (%)	aOR (95% CI)
15–24	1081 (39.6)	312 (11.4)	769 (28.2)	1.93 (1.58–2.35)
25–47	1647 (60.4)	261 (9.6)	1386 (50.8)	1
Marital status				
Does not live with partner	657 (24.1)	204 (7.5)	453 (16.6)	1.9 (1.52–2.37)
Married or living together	1669 (61.2)	263 (9.6)	1406 (51.5)	1
Missing	402 (14.7)	106 (3.9)	296 (10.9)	1.81 (1.16–2.79)
Income (01 Brazilian minimum wage = ~US$200)				
Up to 1.9	1247 (45.7)	285 (10.4)	962 (35.3)	1.79 (1.03–3.34)
2 to 3.9	736 (27)	125 (4.6)	611 (22.4)	1.48 (0.84–2.81)
4 to 10	128 (4.7)	14 (0.5)	114 (4.2)	1
>10	6 (0.2)	1 (0)	5 (0.2)	1.81 (0.09–13.67)
Missing	611 (22.4)	148 (5.4)	463 (17)	1.98 (1.05–3.93)
No. partners/life				
1	494 (18.1)	59 (2.2)	435 (15.9)	1
>1	1676 (61.4)	378 (13.9)	1298 (47.6)	2.09 (1.55–2.86)
Missing	558 (20.5)	136 (5)	422 (15.5)	1.89 (1.16–3.06)

in Nepal reported a lower overall prevalence of STIs (8.6%), with a CT prevalence of 1.5% and TV of 7.1%, while NG was not detected among those pregnant women.[23] Global estimates of STI prevalence among women, as reported by Rowley et al., indicate lower rates for CT (3.8%) but similar rates for NG (0.9%) and TV (5.3%) compared to our findings.[24]

In our study, we observed that women who tested positive for any STI pathogens were generally younger, reported not living with their partners, had a family income of up to US$ 400, and had multiple sexual partners throughout their lifetime. It is important to note that adolescents are increasingly affected by STIs worldwide, and they are often considered a neglected population in terms of STI care.[25] In Brazil, for instance, reported cases of acquired syphilis have more than doubled between 2015 and 2021, with a significant proportion occurring among young individuals.[26] Furthermore, poverty has been associated with an increased risk of STI infection in pregnant women, as evidenced by studies conducted in Haiti.[27] Consistent with other authors' findings, our study also demonstrated an association between having multiple sexual partners throughout lifetime and STI infection, with a higher frequency observed among women with more than one partner.[6,17,18]

In general, STIs present a higher impact among vulnerable women as shown in our study, and the situation is even more complicated when it occurs during pregnancy. It highlights the importance of an adequate antenatal care, for offering a high-quality assistance, and primary care units must ensure easy and effective access to healthcare services for these women. This is an important initiative since the number of prenatal consultations does not necessarily reflect the quality of care. Many pregnant women lack access to timely diagnosis and treatment for some infections, leading to cases of vertical transmission and neonatal complications. For example, the high rates of congenital syphilis in Brazil.[28] It is equally important to equip managers and healthcare professionals with the necessary skills to meet the diverse needs of clients, as a flexible and personalized approach can greatly enhance service delivery. This action relies on an ongoing education process for these professionals who require updates on recommendations for the clinical management of cases.[3,19,28] The current structure of the healthcare system and certain policy factors may pose barriers to effective engagement in STIs care activities within our healthcare system. However, with strong governmental commitment and leadership at the local level, opportunities can be identified to prioritize and enhance efforts in this field.[29] The success of such initiatives relies on overcoming obstacles and fostering collaboration among stakeholders, while integrating surveillance and care services that span the entire spectrum of engagement.

There were several limitations in our study. (1) The use of secondary data without independent validation, susceptible to information bias. (2) Missing data in some independent variables that could have reduced the statistical power of the analysis. (3) The lack of pregnant and perinatal outcomes since pregnant women were not followed. However, these limitations did not invalidate our results or diminish their significance because this study provided novel data on the prevalence of these STIs in pregnant women in Brazil. According to the Ministry of Health, 75% of the approached pregnant women accepted to be tested. These data will be essential for the development of strategies for prevention and control of these pathogens during prenatal care.

With regard to the missing data, we showed that they had a non-random distribution and were associated with our outcomes. Understanding these implications is fundamental to properly develop measures to enhance data quality during the expansion of this pilot project to the entire country. The availability of national surveillance data plays a crucial role in the development of effective public health policies for addressing STIs.[11,12] Furthermore, our findings underscore the importance of implementing molecular testing for STI diagnosis and the necessity of delivering targeted prevention strategies and sexual health education, particularly focusing on young individuals.[25,27,29] Additionally, the global recognition of the emergence and spread of antimicrobial resistance in pathogens such as *Neisseria gonorrhoeae* and *Mycoplasma genitalium* highlights the urgent need for public health intervention programs supported by robust local data, etiological testing, and updated treatment guidelines to effectively control the dissemination of untreatable strains.[12,30,31]

While the exact impact of STIs on maternal-child health outcomes in low- and middle-income countries is still uncertain, there is significant potential for population-level consequences given the high prevalence of STIs among pregnant women in these countries, and the availability of effective treatments. Advancements in technology have opened up new possibilities for implementing more efficient STIs screening and treatment methods.[32] The prevalence and potential adverse outcomes associated with curable STIs during pregnancy indicate that conducting etiological STIs screening for all pregnant women, followed by targeted treatment, could be beneficial. However, the high costs associated with this intervention in low- and middle-income countries, along with insufficient evidence, currently hinder the development of global recommendations for these countries.[12,32,33]

This study revealed a high prevalence of at least one STI among pregnant women in Brazil, particularly among younger women. We provide up-to-date national epidemiological data on CT, NG, and TV infections in this population, and notably, it made a groundbreaking contribution by establishing the national prevalence of *Mycoplasma genitalium*. The findings underscore the importance of enhancing access to CT/NG screening for young pregnant women within the Brazilian Public Health System. Moreover, it highlights the need for comprehensive discussions on the integration of molecular testing for TV and MG into routine prenatal care. Future studies are warranted to evaluate the cost-effectiveness of TV and MG screening and to explore the consequences of MG infection in pregnant women.

AUTHOR CONTRIBUTIONS

Angélica Espinosa Miranda, Pâmela Cristina Gaspar, Marcos André Schörner, Fernando Hartmann Barazzetti, Maria Luiza Bazzo, and the Brazilian Surveillance for STIs in Pregnant Women Group designed the study. Marcos André Schörner, Fernando Hartmann Barazzetti, Maria Luiza Bazzo and the Brazilian Surveillance for STIs in Pregnant Women Group collected the data. Angélica Espinosa Miranda, Pâmela Cristina Gaspar, Guilherme Borges Dias, Ana Roberta Pati Pascom analyzed the data. Angélica Espinosa Miranda and Pâmela Cristina Gaspar wrote the manuscript and Angélica Espinosa Miranda, Pâmela Cristina Gaspar, Marcos André Schörner, Fernando Hartmann Barazzetti, Alisson Bigolin, Ana Roberta Pati Pascom, Dráurio Barreira and Maria Luiza Bazzo edited it. All authors approved the final draft of the manuscript.

ACKNOWLEDGMENTS

We would like to thank the Brazilian Surveillance for STIs in Pregnant Women Group for their contribution: Carolina Hespanha Almeida, Aline Sales Nunes Félix, Ana Gabriela Álvares Travassos, Ana Paula Hoffman de Andrade, Aniceto Gomes de Lima Neto, Antonio Chambô Filho, Camila Balsero Sales, Claudia Marques de Oliveira Soeiro, Consuelo Chicralla Martins, Daniela Vieira Malta, Danielle Betina de Oliveira Traesel, Darlene Silva de Souza, Edilbert Pellegrini Nahn Junior, Elizabeth Bergamo Leal, Erianna Yadja Lucina de Macedo, Iândora Krolow Timm Sclowitz, Iara Maria Sant'Ana Pijpers, Janaina Boldrini França, José Florêncio de Santana Filho, Jullie Anne Chiste, Kelly Aparecida Palma Alves, Leonardo Miranda dos Santos, Luciana Amaral Lemos, Luciana Melo de Moura, Luiza Spinassé Peruchi, Maísa Silva de Sousa, Marcelle Aparecida de Barros Junqueira, Maria Alix Leite Araujo, Maria Luiza Bezerra Menezes, Mariangela Freitas da Silveira, Marianna Fachinet Brock, Marislene Pulsena da Cunha Nunes, Marta Abatepaulo de Farias, Mauro Romero Leal Passos, Michelly Luana da Silva, MonicaBaumgardt Bay, Newton Sergio de Carvalho, Ricardo Fernandes Gambôa, Rodrigo Augusto, Rosilma dos Santos Albuquerque, Sheila Koettker Silveira, and Thiago Dias Sarti.

FUNDING INFORMATION

Cooperation Agreement no 66—Organização Pan-Americana da Saúde (OPAS/OMS) e Departamento de Doenças de Condições Crônicas e Infecções Sexualmente Transmissíveis—DCCI/SVS/MS.

CONFLICT OF INTEREST STATEMENT

The authors have no conflict of interest.

DATA AVAILABILITY STATEMENT

Research data are not shared.

ORCID

Angélica Espinosa Miranda https://orcid.org/0000-0002-5556-8379
Pâmela Cristina Gaspar https://orcid.org/0000-0003-4642-0783
Marcos André Schörner https://orcid.org/0000-0002-7303-6050
Fernando Hartmann Barazzetti https://orcid.org/0000-0001-6409-3021
Guilherme Borges Dias https://orcid.org/0000-0002-1459-3148
Alisson Bigolin https://orcid.org/0000-0003-4794-8045
Ana Roberta Pati Pascom https://orcid.org/0000-0002-2646-3383
Dráurio Barreira https://orcid.org/0000-0002-9626-7740
Maria Luiza Bazzo https://orcid.org/0000-0003-1292-0974

REFERENCES

1. Unemo M, Bradshaw CS, Hocking JS, et al. Sexually transmitted infections: challenges ahead. *Lancet Infect Dis*. 2017;17(8):e235-e279. doi:10.1016/S1473-3099(17)30310-9
2. Levy SB, Gunta J, Edemekong P. Screening for sexually transmitted diseases. *Prim Care*. 2019;46(1):157-173. doi:10.1016/j.pop.2018.10.013
3. WHO. World Health Organization. Guidelines for the Management of Symptomatic Sexually Transmitted Infections. 2021. Accessed May 12, 2023. http://www.who.int/Reproductive_health http://www.who.int/HIV_AIDS/
4. Mann JR, McDermott S, Gill T. Sexually transmitted infection is associated with increased risk of preterm birth in South Carolina women insured by Medicaid. *J Matern Fetal Neonatal Med*. 2010;23(6):563-568. doi:10.3109/14767050903214574
5. Moodley D, Moodley P, Sebitloane M, et al. High prevalence and incidence of asymptomatic sexually transmitted infections during pregnancy and postdelivery in KwaZulu Natal, South Africa. *Sex Transm Dis*. 2015;42(1):43-47. doi:10.1097/OLQ.0000000000000219
6. Yu J, Zhou Y, Luo H, et al. *Mycoplasma genitalium* infection in the female reproductive system: diseases and treatment. *Front Microbiol*. 2023;14:1098276. doi:10.3389/fmicb.2023.1098276
7. Vallely LM, Egli-Gany D, Pomat W, et al. Adverse pregnancy and neonatal outcomes associated with *Neisseria gonorrhoeae*, *Mycoplasma genitalium*, *M. hominis*, *Ureaplasma urealyticum* and *U. parvum*: a systematic review and meta-analysis protocol. *BMJ Open*. 2018;8(11):1-7. doi:10.1136/bmjopen-2018-024175
8. Silver BJ, Guy RJ, Kaldor JM, Jamil MS, Rumbold AR. Trichomonas vaginalis as a cause of perinatal morbidity: a systematic review and meta-analysis. *Sex Transm Dis*. 2014;41(6):369-376. doi:10.1097/OLQ.0000000000000134
9. Kissinger P. Trichomonas vaginalis: a review of epidemiologic, clinical and treatment issues. *BMC Infect Dis*. 2015;15:307. doi:10.1186/s12879-015-1055-0
10. Gamberini C, Juliana NCA, de Brouwer L, et al. The association between adverse pregnancy outcomes and non-viral genital pathogens among women living in sub-Saharan Africa: a systematic review. *Front Reprod Health*. 2023;5:1107931. doi:10.3389/frph.2023.1107931
11. World Health Organization. *Standard Protocol to Assess Prevalence of Gonorrhoea and Chlamydia among Pregnant Women in Antenatal Care Clinics ISBN 978-92-4-151467-5*. World Health Organization; 2018. https://www.who.int/publications/i/item/9789241514675
12. World Health Organization. *Global Health Sector Strategies on, Respectively, HIV, Viral Hepatitis and Sexually Transmitted Infections for the Period 2022–2030*. World Health Organization; 2022 Licence: CC BY-NC-SA 3.0 IGO.
13. World Health Organization. Laboratory diagnosis of sexually transmitted infections, including human immunodeficiency virus. 2013. Accessed June 10, 2023. https://apps.who.int/iris/bitstream/handle/10665/85343/9789241505840_eng.pdf?sequence=1
14. Brasil. Sistema de Gerenciamento da Tabela de Procedimentos, Medicamentos e OPM do SUS – SIGTAP. Procedimento: 02.02.03.099-7 - Detecção de Clamídia e Gonococo por Biologia Molecular. 2023. Accessed April 23, 2023. http://sigtap.datasus.gov.br/tabela-unificada/app/sec/procedimento/exibir/0202030997/06/2023
15. Brasil. Ministério da Saúde. Portaria de Consolidação no 5/GM/MS, de 28 de setembro de 2017. 2019. p. 1–473. Accessed April 23, 2023. http://portalsinan.saude.gov.br/images/documentos/Legislacoes/Portaria_Consolidacao_5_28_SETEMBRO_2017.pdf
16. Jalil EM, Pinto VM, Benzaken AS, et al. Prevalencia da infecção por clamídia e gonococo em gestantes de seis cidades brasileiras. *Rev Bras Ginecol Obstet*. 2008;30:614-619. doi:10.1590/S0100-72032008001200005
17. Pinto VM, Szwarcwald CL, Baroni C, Stringari LL, Inocêncio LA, Miranda AE. Chlamydia trachomatis prevalence and risk behaviors in parturient women aged 15 to 24 in Brazil. *Sex Transm Dis*. 2011;38(10):957-961. doi:10.1097/OLQ.0b013e31822037fc
18. Miranda AE, Pinto VM, Gaydos CA. Trichomonas vaginalis infection among young pregnant women in Brazil. *Braz J Infect Dis*. 2014;18(6):669-671. doi:10.1016/j.bjid.2014.07.002
19. Brazil. Ministério da Saúde. Protocolo Clínico e Diretrizes Terapêuticas para Atenção Integral às Pessoas com Infecções Sexualmente Transmissíveis (IST). 2022. Accessed June 8, 2023. https://www.gov.br/aids/pt-br/central-de-conteudo/pcdts/2022/ist/pcdt-ist-2022_isbn-1.pdf/view
20. Adachi K, Klausner JD, Xu J, et al. Chlamydia trachomatis and Neisseria gonorrhoeae in HIV-infected pregnant women and adverse infant outcomes. *Pediatr Infect Dis J*. 2016;35(8):894-900. doi:10.1097/INF.0000000000001199
21. Nyemba DC, Haddison EC, Wang C, Johnson LF, Myer L, Davey DJ. Prevalence of curable STIs and bacterial vaginosis during pregnancy in sub-Saharan Africa: a systematic review and meta-analysis. *Sex Transm Infect*. 2022;98(7):484-491. doi:10.1136/sextrans-2021-055057
22. Op de Coul ELM, Peek D, van Weert YWM, et al. Neisseria gonorrhoea, and trichomonas vaginalis infections among pregnant women and male partners in Dutch midwifery practices: prevalence, risk factors, and perinatal outcomes. *Reprod Health*. 2021;18(1):132.
23. Dev R, Adhikari SP, Dongol A, et al. Prevalence assessment of sexually transmitted infections among pregnant women visiting an antenatal care center of Nepal: pilot of the World Health Organization's standard protocol for conducting STI prevalence surveys among pregnant women. *PLoS One*. 2021;16(4):e0250361. doi:10.1371/journal.pone.0250361
24. Rowley J, Vander Hoorn S, Korenromp E, et al. Chlamydia, gonorrhoea, trichomoniasis and syphilis: global prevalence and incidence estimates, 2016. *Bull World Health Organ*. 2019;97(8):548-562P. doi:10.2471/BLT.18.228486
25. Shannon CL, Klausner JD. The growing epidemic of sexually transmitted infections in adolescents: a neglected population. *Curr Opin Pediatr*. 2018;30(1):137-143.
26. Brasil. Ministério da Saúde. Boletim Epidemiológico de Sífilis, Número Especial, Out 2022. Ano 6, #01. ISSN: 2358-9450. Accessed May 30, 2023. https://www.gov.br/saude/pt-br/centrais-de-conteudo/publicacoes/boletins/epidemiologicos/especiais/2022/boletim-epidemiologico-de-sifilis-numero-especial-out-2022/view
27. Scheidell JD, Beau De Rochars VM, Séraphin MN, et al. Socioeconomic vulnerability and sexually transmitted infection among pregnant Haitian women. *Sex Transm Dis*. 2018;45(9):626-631. doi:10.1097/OLQ.0000000000000861
28. Miranda AE, Santos PC, Coelho RA, et al. Perspectives and challenges for mother-to-child transmission of HIV, hepatitis B, and syphilis in Brazil. *Front Public Health*. 2023;11:1182386. doi:10.3389/fpubh.2023.1182386
29. Caffe S, Perez F, Kamb ML, et al. Cuba validated as the first country to eliminate mother to child transmission of human immunodeficiency virus and congenital syphilis: lessons learned from the implementation of the global validation methodology. *Sex Transm Dis*. 2016;43(12):733-736.
30. Unemo M, Seifert HS, Hook EW 3rd, Hawkes S, Ndowa F, Dillon JAR. Gonorrhoea. *Nat Rev Dis Primers*. 2019;5(1):79. doi:10.1038/s41572-019-0128-6

31. Jensen JS, Cusini M, Gomberg M, Moi H, Wilson J, Unemo M. European guideline on the management of mycoplasma genitalium infections. *J Eur Acad Dermatol Venereol*. 2021;2022:641-650. doi:10.1111/jdv.17972
32. Grant JS, Chico RM, Lee AC, et al. Sexually transmitted infections in pregnancy: a narrative review of the global research gaps, challenges, and opportunities. *Sex Transm Dis*. 2020;47(12):779-789. doi:10.1097/OLQ.0000000000001258
33. Taylor MM, Wi T, Gerbase A, et al. Assessment of country implementation of the WHO global health sector strategy on sexually transmitted infections (2016-2021). *PLoS One*. 2022;17(5):e0263550. doi:10.1371/journal.pone.0263550

How to cite this article: Miranda AE, Gaspar PC, Schörner MA, et al. Prevalence of *Chlamydia trachomatis*, *Neisseria gonorrhoeae*, *Trichomonas vaginalis*, and *Mycoplasma genitalium* and risk factors among pregnant women in Brazil: Results from the national molecular diagnosis implementation project. *Int J Gynecol Obstet*. 2024;166:71-79. doi:10.1002/ijgo.15447