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Major Article

Gonorrhea prevalence in adults in Brazil: Spectrum-STI trend estimation, 2000–2020

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ABSTRACT

Background: Gonorrhea is not a notifiable disease in Brazil, and the national health information system does not collect data on reported cases or infection prevalence.

Methods: We compiled published data on gonorrhea prevalence in Brazil from cross-sectional surveys and clinical trials between 2000 and 2020. The study entry criteria included a sample size of 50 or more, and *Neisseria gonorrhoeae* infection detected in urine, urethral, anal, or cervicovaginal specimens using either Nucleic Acid Amplification Test or culture. Gonorrhea prevalence trends between 2000 and 2020 were generated using Spectrum-STI, a statistical trend-fitting model.

Results: Forty-five studies with 59 gonorrhea prevalence data points were identified. Fifty data points were for women and represented 21,815 individuals, eight for men encompassing a total of 4,587 individuals, and one for transgender people comprising 345 individuals. The Spectrum-STI estimate for the prevalence of urogenital infection with gonorrhea in women 15–49 in 2020 was 0.63% (95% confidence interval (CI): 0.13–2.23) and was lower than the 1.05% estimated value for 2000 (95% CI: 0.36–2.79). The corresponding figures for men were 0.70% (95% CI: 0.16–2.44) and 1.14% (95% CI: 0.34–3.15). Anal prevalence estimates could not be generated because of insufficient data (three data points).

Conclusions: These results suggest that the overall prevalence of genitourinary gonococcal infections in Brazil is less than 1%. Data on gonorrhea prevalence in men and in populations at increased STI vulnerability are limited.

Keywords: Gonorrhea. Prevalence. Surveillance. Brazil.

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INTRODUCTION

Gonorrhea is a sexually transmitted infection (STI) spread through vaginal, anal, and oral sex. In men, gonorrhea is usually symptomatic and presents as urethritis. Approximately half of women with gonorrhea experience vaginal discharge, pain on urination, or lower abdominal pain. If left untreated, gonorrhea can cause severe and irreversible health problems, including pelvic inflammatory disease, ectopic pregnancy, infertility, chronic pelvic pain, and arthritis[1-3].

Neisseria gonorrhoeae (*N. gonorrhoeae*), the bacterium that causes gonorrhea, is a pathogen of global public health concern because of increasing antibiotic resistance and dwindling treatment options[2,4-7]. Antimicrobial resistance in *N. gonorrhoeae* has emerged in all empirical first-line treatment drugs. Ceftriaxone-resistant gonococcal strains have been spreading, and in 2018, the first strain with ceftriaxone resistance and high-level resistance to azithromycin was isolated in the UK and Australia[8-11].

Data on the antimicrobial resistance of *N. gonorrhoeae* in Brazil are collected by the SenGono project. SenGono is a national antimicrobial susceptibility surveillance program linked to the World Health Organization (WHO) Global Gonococcal Antimicrobial Surveillance Programme. Data from the SenGono project[12,13] have highlighted the development of antimicrobial resistance in gonorrhea in Brazil. This contributed to Brazil's decision to update the national STI treatment guidelines in 2017 and replace ciprofloxacin with ceftriaxone in dual therapy with azithromycin for syndromic treatment and etiologically diagnosed gonorrhea[3,14].

Gonorrhea is not a notifiable disease in Brazil, and the national and state health information systems do not collect data on reported cases or infection prevalence. However, data on gonorrhea prevalence are available from different studies conducted in Brazil. To inform ongoing gonorrhea surveillance and planning activities, the Brazilian Ministry of Health, with support from Avenir Health and the Global Antibiotic R&D Partnership, collated the available data on gonorrhea prevalence and generated trend estimates between 2000 and 2020 using Spectrum-STI. Spectrum-STI is a statistical trend-fitting model developed by Avenir Health with support from the WHO. Spectrum-STI has been used to estimate gonorrhea prevalence and incidence in several countries, including South Africa[15], Fiji[16], Federated States of Micronesia[16], Papua New Guinea[16], Samoa[16], Zimbabwe[17], Morocco[17], and Colombia[18].

METHODS

Prevalence data collection

We conducted a systematic search for studies on gonorrhea prevalence in Brazil using the Embase, PubMed, LILACS, and SciELO databases. Broad search terms were used (e.g., Brazil AND (gonorrhea OR gonorrhoeae)). The last search was performed in November 2020, and no language restrictions were applied. We also searched the Brazilian STI conference abstracts published from 2010 (the first year in which the abstracts were indexed) to 2020. Studies that met the following criteria were included: cross-sectional or clinical trials with samples collected in 2000 or later, a sample size of 50 or more, and *Neisseria gonorrhoeae* infection detected in urine, urethral, anal, or cervicovaginal specimens using either Nucleic Acid Amplification Test (NAAT) or culture. Information extracted from each study included location, sex, population, age, specimen, diagnostic test, sample size, and number of individuals who tested positive.

Trend estimates

Spectrum-STI[19] (Avenir Health, Glastonbury, CT, USA) is a statistical model that estimates national STI prevalence and incidence trends among adults over time. For gonorrhea, the spectrum-STI model was structured to generate estimates for four adult populations: female sex workers (FSW), women who were not FSW, men who have sex with men (MSM), and men who were not MSM. Before generating a trend estimate, each prevalence data point was standardized to reflect the anatomic site sampled and the sensitivity and specificity of the diagnostic test used. The data points were then divided by the sample size so that the sample size did not influence the estimated prevalence level or trend but did influence the confidence bounds. Additionally, a weighted was assigned to each data point to reflect its representativeness. For each of the four populations, Spectrum-STI fitted a weighted moving average through the standardized and user-weighted prevalence data points and calculated confidence intervals (CIs), considering variability in the observed prevalence and modelling error. For populations with insufficient data to generate a separate trend estimate (two or fewer data points), Spectrum-STI used the population prevalence ratio. **Table 1** presents the default population prevalence ratios based on values used in the 2016 and 2020 WHO global and regional prevalence and incidence estimates[20,21].

National estimates for Brazil

Brazil's estimates were run in Spectrum-STI version 5.89 Beta 1 (https://avenirhealth.org/software-spectrum.php), using default Spectrum-STI diagnostic test adjustors and population prevalence ratios[22]. Trend estimates were flat-lined at the values of the earliest and latest years with prevalence data. The annual dilution factor, the relative contribution of each data point to the estimate for a particular year, was set at 20%.

All prevalence data points were assigned a weight of 1, except for studies conducted on people living with human immunodeficiency virus (HIV), symptomatic individuals attending STI and HIV clinics,

TABLE 1: Default global prevalence ratios for gonorrhoea in Spectrum-STI.

Population	Value	Lower-bound*	Upper-bound*
Female Sex Workers (FSW) to women at low risk	10	7.5	15
Men who have Sex with Men (MSM) to men at low risk	10	7.5	15
Male to female	0.86	0.53	1.07

*The lower and upper bounds are used to estimate Confidence intervals when ratios are used.

women presenting at clinics with gynecological symptoms suggestive of STIs, and women with abnormal Papanicolaou test results. These studies did not represent the populations being modeled but represented a subset at a much higher risk of infection and were assigned a weight of 0. Studies conducted over multiple years were assigned to the midpoint study year.

Population size estimates were based on the 2013 Brazilian National Survey of Knowledge, Attitudes, and Practices of HIV and other STIs[23]. This study estimated that 9.1% of women 15–64 years of age had never had sex, and 0.97% were FSW. Among men in the same age group, 5.5% had never had sex, and 3.66% were MSM[23]. These values were used in the estimates and assumed to be constant from 2000 to 2020.

Ethics statement

No ethics review or approval was applicable. No individual patient records were used in this study. We used secondary materials, and all the data had already been published in scientific publications.

RESULTS

LITERATURE REVIEW-PREVALENCE DATA

A total of 133 studies were identified through a literature review. Forty-five studies met the inclusion criteria and provided 59 prevalence data points (**Table 2**). The reasons for exclusion included review articles with no original data (11), duplicates (three), and no prevalence data (74) (**Supplementary Material 1**).

Women

Forty studies provided 50 gonorrhea prevalence data points (21,815 women). Twenty-five data points were collected between 2000 and 2009 (14,569 women) and 25 (7,246 women) between 2010 and 2020 (**Table 2** and **Supplementary Material 2**). All studies were conducted on women who reported being sexually active. The prevalence data were obtained from all five regions of Brazil. Fifteen studies provided data on women from the Southeast (4,745 women), eight studies from the Northeast (2,943 women), six studies from the South (3,828 women), four studies from the North (1,025 women), and three studies from the Central-West (1,341 women). Four studies (7,933 women) collected data from different cities nationwide.

Thirty-three of the 50 prevalence data points were clinic-based: antenatal care clinics (five data points), primary health care, cancer screening, or family planning clinics (15 data points); and STI clinics or clinics where STIs were likely to be a problem (13 data points). Five data points were obtained from studies conducted on youths or students, four from community-based studies, seven from studies on women living with HIV, and one from a study on FSW.

Forty-six of the 50 prevalence data points were from studies that used an NAAT, and genital fluid was the most commonly collected specimen (39 data points), followed by urine (11 data points).

Men

Eight studies provided data on gonorrhea prevalence (4,587 men) (**Table 2 and Supplementary Material 2**). All the studies were conducted in men who reported being sexually active. Four data points were collected between 2000 and 2009 (3,477 men) and four between 2010 and 2020 (1,110 men). Two studies were conducted in the Northeast (289 men), one in the North (285 men), and three in the Southeast (917 men). No studies have been conducted in the Southern or Central-Western regions. Two studies collected data from two or more regions (3,096 men). The sampled populations included men attending STI clinics (two data points), MSM (two data points), men living with HIV (one data point), occupation-based studies (two data points), and youths or students (one data point).

All eight prevalence data points were from studies that used NAAT, and urine was the most commonly collected specimen (3,756 of 4,587 samples) (six data points), followed by urethral (one data point) and rectal (one data point).

Transgender people

Only one study was identified involving transgender individuals (**Table 2 and Supplementary Material 2**). This study was conducted in Rio de Janeiro from August 2015 to January 2016. Rectal specimens were collected from transgender women. Of the 345 rectal specimens collected, 25 (7 %) were positive for gonorrhea.

SPECTRUM-STI TREND ESTIMATES

Women

The Spectrum-STI estimates for women who were sexually active but not FSW were based on the 49 data points identified. Twenty-nine data points were assigned a weight of 1, and 20 were assigned a weight of 0. The data points assigned a weight of 0 were from studies conducted in STI clinics (three data points), clinics attended by women where problems were likely to be STI-related (10 data points), and women living with HIV (seven data points). **Figure 1** shows the data points (diagnostic test-adjusted) for the 29 data points assigned a weight of 1 and the Spectrum-STI trend estimate for this population. The trend estimates for women who were sexually active but not FSW suggests a decline in prevalence from 1.09% (95% CI: 0.38–2.92) in 2000 to 0.66% (95% CI: 0.13–2.37) in 2020, although the CIs were wide and overlapped. For FSW, only one data point was identified (test-adjusted prevalence of 0.0% from a study conducted in 2008). Therefore, the default population prevalence ratio was used to generate estimates for this population, and the estimated prevalence in 2020 was 7.1% (95% CI: 1.6–25.2) (**Table 3**).

Men

Six data points were from studies that were not specifically done in MSM. Three of these studies were conducted on men living with HIV or individuals attending STI clinics, and the remaining three data points were from before 2010. For MSM, there were only two data points. As a result, the Spectrum-STI default population prevalence ratios were used to generate the estimates, leading to an estimated prevalence in 2020 of 0.6 (95% CI: 0.1–2.0) for sexually active men who did not identify as MSM and 6.2% in MSM (95% CI: 1.3–22.6) (**Table 3**).

National estimates

Table 3 summarizes the Spectrum-STI national and population-specific estimates for individuals 15–49 years of age in Brazil for 2000, 2010, and 2020. The median prevalence declined in women and men over time, although the CIs remained high. The median prevalence estimates in women were lower than those in men, reflecting the prevalence and relative sizes of the four population groups.

TABLE 2: Prevalence of gonorrhea in women and men: Number of data points over time.

Population	2000-2009 Data points [Number of people tested]	2010-2020 Data points [Number of people tested]	TOTAL Data points [Number of people tested]	Most recent data point
Women				
Women attending antenatal care (ANC)	3 [6,093]	2 [523]	5 [6,616]	2018/2019: Porto Alegre-RS. Pregnant women attending 10 public antenatal care clinics.
Women attending Primary Health Care (PHC), cancer screening, or family planning clinics (ie. non STI related)	8 [2,441]	7 [2,315]	*15* [4,756]	2015/2016: Tapajós region, Amazon, Brazil.
Community-based studies (Women from population/ occupation studies)	2 [729]	2 [307]	4 [1,036]	2015: Botucatu-SP and surrounding regions. Women who have sex with women.
Youth/ Students	3 [876]	2 [385]	5 [1,261]	2011: São Paulo-SP. Athletes.
Female Sex Workers (FSW)	1 [102]	0 [0]	1 [102]	2008/2009: Botucatu-SP.
STI clinics	2 [2,296]	1 [185]	3 [2,481]	2013: Salvador-BA.
Women attending clinics where problems likely to be STI related (eg. HIV testing centres, women with cervical cancer)	5 [1,094]	5 [1,247]	10 [2,341]	2016/2017. São Paulo-SP. Women undergoing initial infertility investigation.
Women living with HIV	1 [938]	6 [2,284]	7 [3,222]	2015: Nine Brazilian states. Women attending referral centers.
TOTAL – data points	**25 [14,569]**	**25 [7,246]**	**50 [21,815]**	
Men				
Population/ occupation-based studies	2 [2,614]	0 [0]	3 [2,614]	2009. Brazilian Amazon region. Adults recruited from "Hot Spots".
Youth / students	1 [96]	0 [0]	1 [96]	2000. Salvador-BA. Students attending supplementary courses.
Men who have sex with men (MSM)	0 [0]	2 [819]	2 [819]	2014/2016: São Paulo-SP & Rio de Janeiro-RJ. PrEP clientes.
STI Clinics	1 [767]	1 [98]	2 [865]	2014/2015: São Paulo-SP.
Men living with HIV	0 [0]	1 [193]	1 [193]	2013/2015: Salvador-BA. Men attending state reference centre for STI & HIV.
TOTAL – data points	**4 [3,477]**	**4 [1,110]**	**8 [4,587]**	
Transgender				
Transwomen	0 [0]	1 [345]	1 [345]	2015/2016: Rio de Janeiro-RJ. Respondent-driven sampling.
TOTAL – data points	**0 [0]**	**1 [345]**	**1 [345]**	

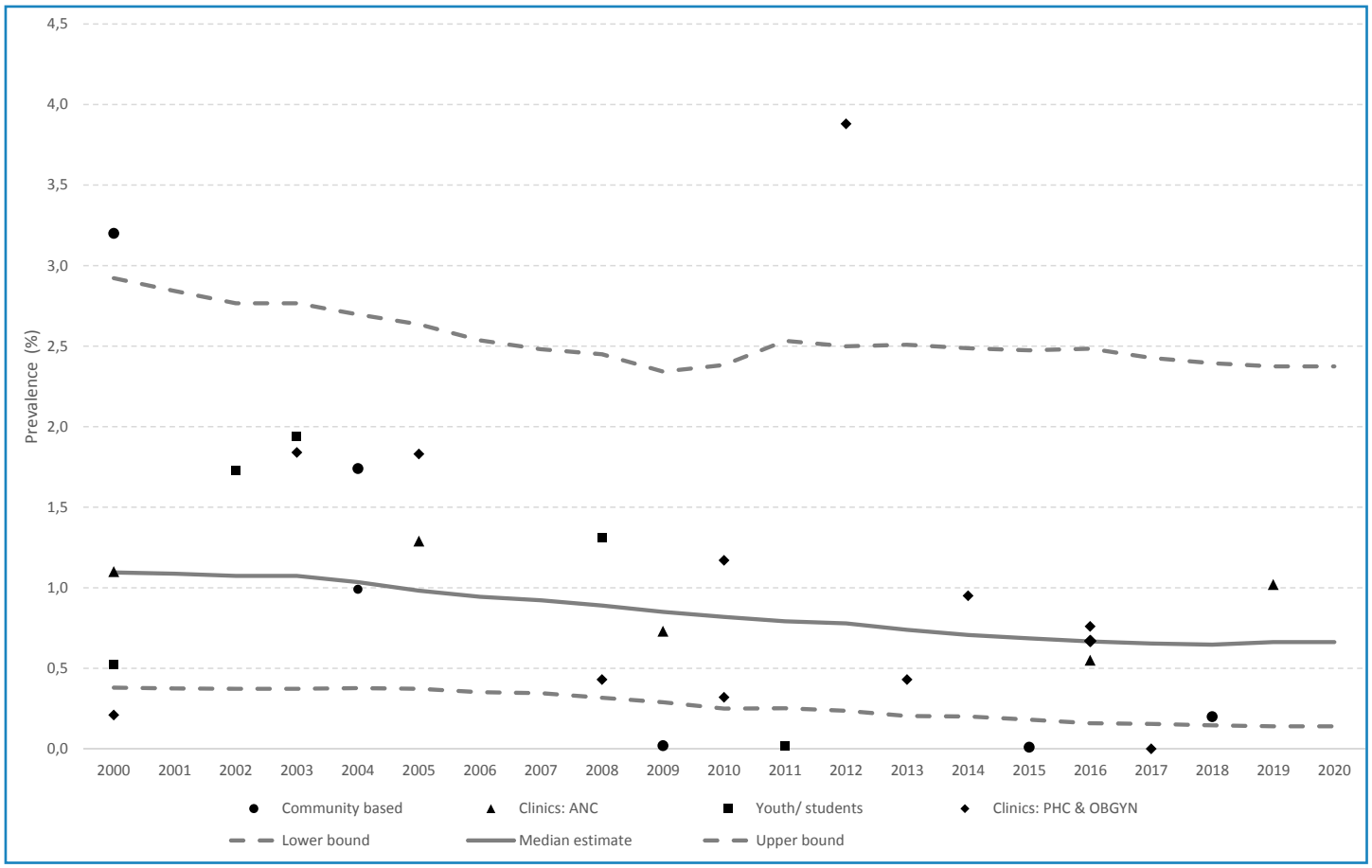

FIGURE 1: Urogenital gonorrhea prevalence in Brazil in women aged 15–49 who are sexually active but not FSW between 2000 and 2020. Spectrum-STI trend estimates, and the data points included in the estimates are shown. For studies that covered multiple years, the midpoint year is presented on the graph. **ANC:** antenatal care; **PHC:** Primary Health Care; **OBGYN:** Obstetrics/gynecology clinics. Prevalence estimates were adjusted for the diagnostic test and specimen used.

TABLE 3: Spectrum-STI estimates of the prevalence of urogenital gonorrhea (%) in 2000, 2010 and 2020, Brazil base case scenario.

Population	% of population	Median Prevalence % (Lower Bound - Upper Bound)		
		2000	2010	2020
Women				
Never had sex	9.1	0 (0.0-0.0)	0 (0.0-0.0)	0 (0.0-0.0)
Had sex - not FSW	89.93	1.09 (0.38-2.92)	0.82 (0.25-2.38)	0.66 (0.13-2.37)
Had sex - FSW	0.97	11.59 (3.94-33.08)	8.72 (2.83-26.41)	7.14 (1.56-25.25)
National estimate -women	**100**	**1.05 (0.36-2.79)**	**0.78 (0.24-2.26)**	**0.63 (0.13-2.23)**
Men				
Never had sex	5.5	0 (0.0-0.0)	0 (0.0-0.0)	0 (0.0-0.0)
Had sex – not MSM	90.84	0.93 (0.29-2.59)	0.70 (0.22-2.22)	0.58 (0.13-2.00)
Had sex –MSM	3.66	10.10 (2.92-28.39)	7.65 (2.32-23.71)	6.16 (1.32-22.58)
National estimate -men	**100**	**1.14 (0.34-3.15)**	**0.87 (0.26-2.66)**	**0.70 (0.16-2.44)**

DISCUSSION

Based on the data available and using Spectrum-STI, we estimated that in Brazil in 2020, the prevalence of urogenital infection with gonorrhea in women aged 15–49 was 0.63% (95% CI: 0.13–2.23) and 0.70% (95% CI: 0.16–2.44) in men. These estimates are comparable to the WHO 2020 gonorrhea estimates for the Americas: 0.6% (95% CI: 0.3–0.9) in women and 0.5% (95% CI: 0.2–0.9) in men[21] and the 2017 estimates for Colombia: 0.70% (95% CI: 0.15–1.90) in women and 0.60% (95% CI: 0.1–1.9) in men[18].

A literature review identified 45 studies that provided 59 data points on gonorrhea prevalence in Brazil between 2000 and 2020. Most data points (85%, 50 of 59) were from studies conducted on women, highlighting the need for additional studies on men. Just two studies provided data on MSM, one study on FSW, and one on transgender people, and only three studies provided data on rectal infections.

Spectrum-STI is a statistical trend-fitting model that generates national prevalence trends based on the identified prevalence data after adjusting for specimen, diagnostic test, and study representativeness. We used Spectrum-STI to estimate gonorrhoea prevalence over time in one of four populations in Brazil based on the available data. Estimates for the other three populations were generated using default population prevalence ratios. The trend estimates for women aged 15–19 who were sexually active but not FSW showed a decline in the urogenital gonococcal infection prevalence (excluding studies specifically done in FSW) between 2000 and 2020 from 1.09% (95% CI: 0.38–2.92) to 0.66% (95% CI: 0.13–2.37). However, the CIs were wide and overlapped. The trend estimates may partially reflect the studies included in the analysis. Comparing the studies before and after 2010, the studies conducted after 2010 were primarily from the South and Southeast regions and sampled older women, which may have biased the results.

Quality national STI surveillance disaggregated by geography, population, sex, and age is important for planning and evaluating STI public policies and practices[21,24]. However, few countries have high-quality national statistics or estimates of gonorrhea prevalence and incidence. This reflects a lack of investment in STI surveillance systems, the high cost of quality diagnostic tests, and the fact that many infected individuals are asymptomatic[2,20,24,25].

The literature review and modeling presented in this study highlight the need for a more systematic collection of gonorrhea prevalence data in the general population and populations at increased STI vulnerability, such as MSM, transgender women, and sex workers. The Brazilian Ministry of Health has used the results from this study to inform the design and prioritization of population-based studies on the prevalence and patterns of gonorrhea and other STIs. Improved data on the prevalence and burden of gonorrhea in different populations will help inform the allocation of STI resources, prioritize regions for resistance monitoring, support implementation policies, and promote research investments in new drugs, diagnostics, and vaccines.

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