




Burden of Disease of Gonorrhoea in Latin America: Systematic Review and Meta-analysis

Ariel Bardach · Tomás Alconada · Carolina Palermo · Carlos Rojas-Roque ·
María Macarena Sandoval · Jorge Gomez · Thatiana Pinto ·
Agustin Ciapponi 

Received: December 12, 2022 / Accepted: April 19, 2023
© GSK 2023

ABSTRACT

Introduction: *Neisseria gonorrhoeae* causes gonorrhoea, a globally neglected but increasing disease. This systematic review and meta-analysis reviewed the epidemiology and economic burden of gonorrhoea in Latin America and the Caribbean (LAC).

Methods: We searched PubMed, EMBase, Cochrane Library, EconLIT, CINAHL, CRD, LILACS, Global Health, Global Dissertations and Theses, SciELO, Web of Science databases, countries' ministries of health, and the IHME's Global Burden of Disease databases. Studies

published in the last 10 years (20 years for economic studies) were included if conducted in any LAC country, without language restrictions. The main outcome measures were incidence/prevalence, proportion of co-infections, case fatality rates, specific mortality/hospitalisation rates, direct/indirect costs, and impact of gonorrhoea on quality of life. To assess evidence quality, we used a checklist developed by the US National Heart, Lung, and Blood Institute for observational studies and trial control arms, the Cochrane Effective Practice Organization of Care Group tool for randomised controlled trials, and the CICERO checklist for economic studies.

Results: We identified 1290 articles; 115 included epidemiological studies and one included an economic study. Ministry of health data

Supplementary Information The online version contains supplementary material available at <https://doi.org/10.1007/s40121-023-00814-0>.

A. Bardach · T. Alconada · C. Palermo ·
C. Rojas-Roque · M. M. Sandoval · A. Ciapponi (✉)
Institute for Clinical Effectiveness and Health
Policy, Dr Emilio Ravignani 2024, C1014CPV
Buenos Aires, Argentina
e-mail: aciapponi@iecs.org.ar

A. Bardach
e-mail: abardach@iecs.org.ar

T. Alconada
e-mail:alconadatomas@gmail.com

C. Palermo
e-mail: mariacarolinapalermo@yahoo.com.ar

C. Rojas-Roque
e-mail: crojas@iecs.org.ar

M. M. Sandoval
e-mail: macarena_sandoval@yahoo.com.ar

J. Gomez
GSK, Buenos Aires, Argentina
e-mail: Jorge.a.gomez@gsk.com

T. Pinto
GSK, Panama City, Panama
e-mail: thatiana.x.pinto@gsk.com

from Argentina, Brazil, Chile, Colombia, Mexico, and Uruguay were identified. Gonorrhoea prevalence was 1.46% (95% confidence interval [CI] 1.00–2.00%) from 48 studies and 5.68% (95% CI 4.23–7.32%) from 58 studies for non-high-risk and high-risk populations, respectively. Cumulative incidence for the high-risk population was 2.05 cases per 100 persons/year. Few published studies were rated as “good” in the risk of bias assessments. Variations in the methodology of the sources and limited information found in the countries’ surveillance systems hinder the comparison of data.

Conclusion: The burden of gonorrhoea in LAC is not negligible. Our results provide public health and clinical decision support to assess potential interventions to prevent gonorrhoea.

Trial Registration: The protocol is registered on PROSPERO (CRD42021253342). The study was funded by GlaxoSmithKline Biologicals SA (GSK study identifier VEO-000025).

Keywords: Caribbean; Economics; Epidemiology; Gonorrhoea; Latin America; Systematic review

Key Summary Points

Why carry out the study?

Gonorrhoea is a sexually transmitted disease that can cause serious complications.

Rates of gonorrhoea are increasing in many countries, and some population groups are at a disproportionately high risk of gonorrhoea.

To our knowledge, this systematic review is the first to estimate the disease burden of gonorrhoea in Latin America and the Caribbean including information from scientific literature, GBD, and ministries of health databases.

What was learned from the study?

Gonorrhoea prevalence was high (1.46%) in Latin America and the Caribbean and higher (5.68%) in high-risk populations, including men who have sex with men, sex workers, transgender people, and vulnerable groups comprising ethnic minorities, low educational level, or low socioeconomic status; rates of gonorrhoea were higher in men than in women; co-infections with other pathogens were frequent.

Our results will be valuable to decision-makers considering potential health policies to control gonorrhoea.

INTRODUCTION

Gonorrhoea is a sexually transmitted disease (STD) caused by infection with the bacterium *Neisseria gonorrhoeae*, transmitted by either sexual or perinatal contact. Many gonorrhoea infections are asymptomatic, and therefore reported cases underestimate the true burden of disease [1]. Untreated gonorrhoea can cause serious complications such as pelvic inflammatory disease (which in turn may result in chronic pain, infertility, and increased risk of ectopic pregnancy) and may also increase the risk of acquiring or transmitting human immunodeficiency virus (HIV) [1].

Global incidence rates for gonorrhoea in people aged 15–49 years were estimated by the World Health Organisation (WHO) at 20 per 1000 women and 26 per 1000 men, with approximately 87 million new infections in 2016 [2]. Estimated prevalence was 0.9% in women and 0.7% in men, or 30.6 million cases worldwide [2]. Prevalence was highest in the WHO Africa region (1.9% in women, 1.6% in men) [2]. Rates of gonorrhoea are increasing in many countries, and the disease is an expanding public health concern [3].

Some population groups bear a disproportionately high burden of gonorrhoea compared with the general population. These risk groups

include gay, bisexual, and other men who have sex with men (MSM) [3], transgender women [4], sex workers [5], racial and ethnic minorities [6], indigenous populations [6] and international travellers [3, 7].

Detailed data on the epidemiology and economic burden of gonorrhoea in individual countries in Latin America and the Caribbean (LAC) will be valuable to decision-makers considering potential health policies to control the disease. The primary objective of this systematic review and meta-analysis was to estimate the disease burden (incidence, prevalence, direct and indirect cost, and impacts on health-related quality of life) of gonorrhoea in LAC. Secondary objectives included identifying information on disease burden in pregnant women and high-risk population groups, co-infections and trends in disease burden over time.

METHODS

This systematic review and meta-analysis were part of a broader systematic literature review that also considered studies on antimicrobial resistance in gonorrhoea. This article presents the epidemiological and economic studies identified.

This review included published and unpublished local, regional and international data following Cochrane methods [8]. A meta-analysis of data from observational studies conducted in LAC (including the control arms of clinical trials) was conducted, following MOOSE [9] guidelines for meta-analyses of observational studies and PRISMA guidelines for reporting systematic reviews and meta-analyses [10, 11]. The protocol followed the PRISMA-P declaration [12] and was registered in PROSPERO, an international prospective registry of systematic reviews, under the registration number CRD42021253342.

Eligibility Criteria

Eligibility criteria are summarised in Table 1. Systematic reviews and meta-analyses were considered only as a source of primary studies. When data or subsets of data were reported in

more than one publication, we selected the one with the largest sample size. We planned to use international dollars adjusted for inflation.

Data Sources and Search Strategy

The following electronic databases were searched for eligible articles up to 13 February 2021: PubMed, EMBase, Cochrane Library (CENTRAL), EconLIT, Cumulative Index of Nursing and Allied Health Literature (CINAHL), Centre for Reviews and Dissemination (CRD) York, Latin American and Caribbean Literature in Health Sciences (LILACS), Global Health (OVID), Global Dissertations and Theses (ProQuest), SciELO and Web of Science. Detailed search terms are presented in Supplementary Material Table S1. The reference lists of identified studies and systematic reviews/meta-analyses were hand-searched for additional information. In addition, we searched databases of proceedings of regional and international congresses and doctoral theses (e.g. ICID Abstracts, British Association of Sexual Health and HIV, XI Encuentro Nacional de Enfermedades Infecciosas 2018, Congreso Latinoamericano de Infectología Pediátrica). Websites of major regional medical societies, experts and associations such as the Pan-American Infectious Diseases Association, the Argentine Society of Infectious Diseases and the Latin American Society of Pediatric Infectious Diseases were consulted.

We also analysed the databases of regional ministries of health in which relevant information was available and searched for grey literature in Pan-American Health Organization (PAHO) and hospital reports by using generic internet search engines (Google) and through the Global Burden of Disease (GBD) model [13].

Article Selection

Publications were screened by two reviewers using title and abstract according to the eligibility criteria. Discrepancies were solved by agreement of the entire team. Potentially eligible articles were retrieved in full text for further analysis. All screening phases of the study used

Table 1 Eligibility criteria

	Criteria
Geographic scope	All LAC countries
Participants	All LAC patients, regardless of age, sex or population type
Epidemiological trial types	Randomised controlled trials (RCTs) or quasi-RCTs Controlled and uncontrolled before–after studies Interrupted time series (ITS) and controlled ITS (STIC) Cohort studies Case–control studies Cross-sectional studies Epidemiological surveillance reports Case series
Economic trial types	Cost-effectiveness studies or economic evaluations Budget impact analyses Cost of illness studies
Outcomes (at least one of)	Incidence Prevalence Proportion of co-infections Case fatality rates Specific mortality and hospitalisation rates Direct and indirect costs of gonorrhoea Impact of gonorrhoea on health-related quality of life
Date range for epidemiological studies	Published since January 1, 2011 (past 10 years)
Date range for economic studies	Published since January 1, 2001 (past 20 years)
Study size	Case series: at least 20 cases Remaining study types: at least 100 participants For studies in newborns there was no study sample size limit
Language	No language restrictions

LAC Latin America and the Caribbean

COVIDENCE [14, 15], a web-based platform designed to process systematic reviews.

Data Extraction

From eligible articles, the research team extracted data using previously piloted pre-designed data extraction forms. Data extracted were:

publication and study characteristics (type of publication, year published, authors, geographic location, study design including domains for risk of bias assessment); study population characteristics (age, sex, sample size, risk evaluation for *N. gonorrhoeae*, inclusion/exclusion criteria); and outcomes (incidence rate, prevalence, co-infections, specific *N. gonorrhoeae* mortality, case fatality rate, hospitalisation rate, length and recurrence of an acute episode, indirect and direct costs, and resource use). The original authors were contacted if necessary to obtain any missing information or clarification.

Risk of Bias Assessment

Published epidemiological studies were assessed for risk of bias by two independent reviewers, with discrepancies resolved by consensus with the whole team. For observational studies and the control arm of trials we used a checklist developed by the US National Heart, Lung, and Blood Institute [16] that classifies studies as high (poor), moderate (fair) and low risk of bias (good). For evaluation of cohort studies and cross-sectional studies the tool comprises 14 items, and for case series there are 9 items. For randomised controlled trials (RCTs) and quasi-RCTs the Cochrane Effective Practice Organization of Care (EPOC) Group [17] tool was used, and for before-after studies, ITS and STIC we used the relevant items from the Cochrane EPOC criteria [17]. Each criterion was scored as low, high or uncertain risk. For those rated as uncertain we attempted to obtain more information from the study authors.

For economic studies quality assessment was conducted using the Criteria for Cost-Effectiveness Review Outcomes (CiCERO) checklist [18].

Statistical Analysis of Epidemiological Studies

The primary meta-analyses were conducted using meta-proportion analysis, applying arc-sine transformation to stabilise the variance of proportions (Freeman-Tukey variant of the square root arc-sine method of transformed proportions), where $y = \arcsine[\sqrt{(r/$

$(n + 1)) + \arcsine[\sqrt{(r/(n + 1))/(n + 1)}]$, with a variance of $1/(n + 1)$, and where n is the size of the population [19]. The pooled ratio was calculated as the subsequent transformation of the weighted mean of the transformed proportions, using weights of variance of arc-sine inverse for the fixed and random effects model. Statistic I^2 was calculated as a measure of the proportion of the overall variation attributable to heterogeneity between studies [20]. A value of $I^2 > 60\text{--}70\%$ was considered as substantial heterogeneity and below 30% as low heterogeneity. We applied DerSimonian-Laird weights for the random effects model [21] where heterogeneity was found between studies [22]. Stats Direct and STATA 14.0 were used for all analyses.

There was considerable variation in follow-up period, so incidence rates were calculated in person-years by dividing the number of new cases in the follow-up period by the total person-years in the group at risk, expressed as number of cases per 100,000 person-years. This incidence density rate is an appropriate measure of incidence when follow-up times are uneven [23].

Publication bias between studies was explored using funnel graphs where there were at least ten studies. Selective reporting within studies was evaluated by comparing available protocols with the published studies.

Subgroup analyses were conducted for three groups, defined according to their risk of having gonorrhoea (high-risk, non-high-risk or unreported risk). The high-risk population included MSM, sex workers, transgender people and vulnerable groups comprising ethnic minorities, low educational level or low socioeconomic status. Non-high risk was defined as those not at high risk. Further subgroup analyses were conducted on the different categories defining high risk. Further subgroup analyses were performed according to: the type of study sampling (representative sampling, health system convenience sampling and community convenience sampling); the symptoms compatible with gonorrhoea (yes, no, not reported); the population HIV status (positive, negative); pregnancy (yes, no); biological sex (male, female); the type of sample for females (urine,

endocervical/vaginal); and age group (15–29 years, 30–50 years, 18–50 years).

Sensitivity analyses were performed by restricting the analyses to studies with a low risk of bias.

Compliance with Ethics Guidelines

Ethics approval was not required as this study was based on published data and therefore did not involve human participants.

RESULTS

Literature Search

After removing duplicates, the literature searches identified 1290 articles to be screened using title and abstract, of which 279 were retrieved for full-text assessment. Of these, 115 epidemiological studies [24–138] (three of which also reported data on antimicrobial resistance) [47, 122, 138] and one economic study [139] were eligible for inclusion in the review (Fig. 1). There were 91 full papers, 22 abstracts and 3 epidemiological bulletins. Studies excluded at full-text review are listed in Supplementary Material Table S2.

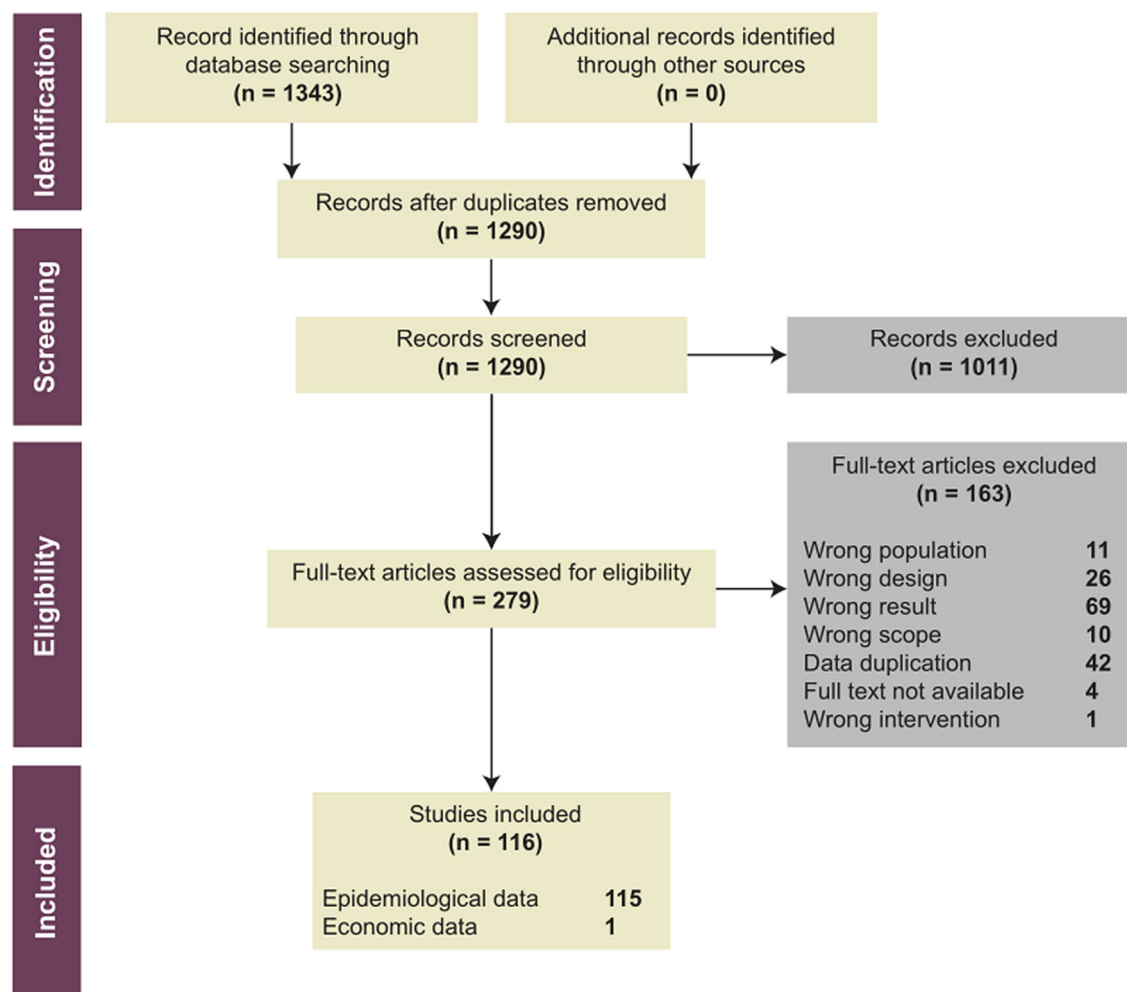


Fig. 1 Flow chart

Table 2 Results of the meta-analysis of proportions of gonorrhoea

	General population			Non-high-risk population			High-risk population		
	Central estimate	95% CI, lower limit	95% CI, upper limit	Central estimate	95% CI, lower limit	95% CI, upper limit	Central estimate	95% CI, lower limit	95% CI, upper limit
Risk level									
Non-high	1.46%	1.00%	2.00%						
High	5.68%	4.23%	7.32%						
Not reported	5.97%	2.47%	10.86%						
Sampling									
Random representative sampling				0.40%	0.11%	0.88%	1.66%	1.32%	2.04%
Convenience (health system)				1.82%	1.24%	2.51%	6.16%	3.94%	8.85%
Convenience (community)				0.19%	0.01%	0.90%	4.46%	3.24%	5.88%
Symptoms									
Yes				7.26%	0.96%	18.73%	12.82%	3.07%	27.89%
No				1.10%	0.07%	1.54%	5.37%	3.81%	7.17%
HIV-positive	2.02%	1.14%	3.15%						
Pregnant women				1.16%	0.37%	2.39%	2.98%	1.67%	4.65%
Biological sex									
Male				2.68%	0.02%	9.59%	6.57%	4.56%	8.93%
Female				1.61%	0.98%	2.39%	3.73%	2.26%	5.54%
Risk category									
Sex worker	3.77%	1.99%	6.09%						
MSM	6.01%	4.14%	8.20%						
Transgender	7.90%	6.08%	9.93%						
Vulnerable group	5.86%	0.89%	14.8%						
Type of sample in females									
Urine				1.26%	0.69%	2.00%	3.69%	1.76%	6.28%
Endocervical/vaginal				1.95%	0.12%	2.84%	3.84%	2.00%	6.24%
Age									
15–29 years	1.39%	0.44%	2.86%						

Table 2 continued

	General population			Non-high-risk population			High-risk population		
	Central estimate	95% CI, lower limit	95% CI, upper limit	Central estimate	95% CI, lower limit	95% CI, upper limit	Central estimate	95% CI, lower limit	95% CI, upper limit
30–50 years	0.98%	0.15%	2.53%						
18–50 years	2.13%	1.08%	3.52%						
Incidence rate (cases per 100 people/year)	2.05	0.42	3.69						
Proportion of positive sites ^a									
Cervicitis	10.96%	3.46%	21.96%						
Cervical swab positive	6.80%	3.90%	10.42%						
Urethritis	42.03%	17.22%	69.22%						
Urethral swab/ urine positive	13.14%	0.15%	41.83%						
Rectitis	45.98%	21.19%	71.89%						
Rectal swab positive	18.92%	5.99%	36.89%						
Pharyngitis	32.62%	11.02%	59.15%						
Pharyngeal swab positive	33.23%	8.29%	64.90%						
Conjunctivitis	1.58%	0.06%	5.13%						
Asymptomatic carrier	72.86%	39.73%	95.77%						
5-year period									
2010–2014				2.73%	0.98%	5.32%	6.18%	3.00%	10.40%
2015–2019				1.50%	0.94%	2.20%	7.42%	4.20%	11.46%
Studies with low risk of bias				0.47%	0.11%	1.06%	1.66%	1.32%	2.04%

CI confidence interval; HIV human immunodeficiency virus; MSM men who have sex with men; + positive

^aIn studies reporting more than one site of infection

Table 3 Range of gonorrhoea prevalence reported

Population	Range of gonorrhoea prevalence reported
High-risk populations	0% [29, 54, 59, 91] to 42.8% [57]
Non-high-risk populations	0% [25, 51, 70, 72, 79, 99–101, 111, 134] to 11.8% [47]
Studies in which the population risk could not be determined	0.2% [138] to 31.5% [138]
Symptomatic patients	1% [37] to 42.8% [57] (in the latter study the symptom was purulent urethral discharge)
Asymptomatic population	0–32.5% [138]
Hospitalised patients and pregnant women	0% [25] to 3.4% [25]
Males	0% to 42.8% [57]
Females	0% [25, 29, 79, 91, 99–101] to 21.5% [43]
Sex workers	0% [29] to 15.6% [36]
Men who have sex with men	0.7% [132] to 16.2% [83]
Transgender women	3.8–12.3% [77]
Vulnerable populations	0–42.8% [57]

Characteristics of Included Studies and Participants

Supplementary Material Table S3 summarises the characteristics of the included studies. The studies included 103,965 participants, of whom 36,304 were males and 55,674 females (4898 pregnant). Age ranged from 0 years (< 3 month) [50] to 93 years [59], with mean age between 8.5 years [115] and 54 years [59] and median age between 7.9 years [113] and 45 years [95]. The reported female-to-male ratio was 1.5.

Of the included studies, 51 ($n = 50,926$ participants; 49%) assessed a population at increased risk of gonorrhoea (sex workers, MSM, transgender people, vulnerable groups), and 49 studies ($n = 47,086$ participants; 45%) assessed a population at non-high risk for gonorrhoea. In two studies ($n = 1997$ participants; 2%) the included participants belonged to high-risk and non-high-risk groups in similar proportions, and the population risk was not reported in 14 studies ($n = 3956$ participants; 4%). The most frequently reported risk categories were sex

workers ($n = 34,931$, 34% of total) and MSM ($n = 14,988$, 14% of total).

Risk of Bias Assessment

Most of the cross-sectional/cohort studies ($n = 71$) (Supplementary Material Table S4) and the only case series (Supplementary Material Table S5) were categorised as ‘fair’. Six studies were categorised as ‘good’ (Supplementary Material Table S4).

Epidemiological Results

Prevalence

Table 2 summarises the results of meta-analyses of proportions of patients with gonorrhoea conducted (for details of each analysis, see Supplementary Material Figures S1 to S48). In the general population the prevalence for individuals at non-high risk was 1.46% (95% confidence interval [CI] 1.00%, 2.00%) from 48 studies, and for people at high risk the prevalence was 5.68% (95% CI 4.23%, 7.32%) from 58 studies. Prevalence in the HIV + population

Table 4 Number of hospitalisations due to gonococcal infections by gender in Brazil, 2009–2020 [143]

Year	Age < 1	Age 1–4	Age 5–9	Age 10–14	Age 15–19	Age 20–29	Age 30–39	Age 40–49	Age 50–59	Age 60–69	Age 70–79	Age 80 +	Total
2009	0	0	0	0	0	0	0	0	0	1	0	0	1
2010	9	3	0	2	4	4	4	1	1	1	0	2	31
2011	15	2	0	1	2	12	8	5	1	0	0	1	47
2012	25	3	1	1	12	15	4	2	4	1	0	1	69
2013	17	2	1	1	7	14	13	6	5	2	1	1	70
2014	24	4	0	1	6	19	13	8	7	2	4	0	88
2015	26	0	1	1	12	16	14	8	5	4	0	2	89
2016	26	1	1	2	11	19	12	9	7	3	4	1	96
2017	35	6	2	5	10	20	21	13	11	7	8	5	143
2018	26	4	4	3	6	26	18	7	7	2	6	3	112
2019	24	2	2	4	15	19	22	10	7	4	6	3	118
2020	17	2	1	3	5	16	17	8	6	1	2	2	80

Table 5 Total cost and mean cost of hospital days due to gonococcal infection in Brazil between 2008 and 2020 [143]

Year	Total cost (Brazilian real R\$)	Average cost (Brazilian real R\$)
2008	18,173	454
2009	59,818	1129
2010	15,277	477
2011	25,917	632
2012	49,523	718
2013	33,442	492
2014	57,799	688
2015	48,342	483
2016	41,464	451
2017	67,395	492
2018	71,237	614
2019	62,037	526
2020	42,903	442

Brazilian real prices were adjusted for inflation based on the Brazilian consumer price index and are reported as Brazilian real in 2021 [143]

was 2.02% (95% CI 1.14%, 3.15%) from 17 studies, and in pregnant women it was 1.16% (95% CI 0.37%, 2.39%) for those at non-high risk and 2.98% (95% CI 1.67%, 4.65%) for those at high risk (Table 2). The range of gonorrhoea prevalence reported in various populations is shown in Table 3.

One study reported 802,162 for gonococcal infection in Brazil between 2009 and 2019 [31], and another reported two hospitalisations for gonococcal meningitis in children aged < 3 months [50] in Mexico (2012–2017). In the city of Medellin, 700 outpatient consultations for gonorrhoea were reported between 2002 and 2006 (76.4% men), equivalent to 2.8% of the consultations for STDs registered in the city in that period [46].

Incidence

Six studies reported incidence data for high-risk populations [27, 32, 49, 58, 68, 93]. Two [32, 68] provided CI information, which enabled a meta-analysis, resulting in an estimate of 2.05 cases per 100 people/year (95% CI 0.42 to 3.69; I^2 66.7%) (Table 2). In the other four [27, 49, 58, 93], although no variability was

reported, a median value corresponding to 24 cases per 100 people/year with an interquartile range of 10.1 to 36.4 per 100 people/year was estimated. In the non-high-risk population, no studies reported incidence density. In the studies in which population risk could not be determined, the reported incidence was 8.3/100 000 inhabitants [40, 41] and 31.6/100 000 inhabitants [119], and in another study the incidence range in males and females was 14–57 and 3–12 cases per 100 000 inhabitants, respectively [75].

Deaths and Complications

No deaths from gonorrhoea were reported. One study [63] reported two cases of infertility as the only complication of gonococcal disease. No cases of disseminated disease or obstetric complications were reported. Two cases of meningitis as a manifestation of neonatal disease were reported [50] and 13 cases of neonatal gonococcal ophthalmia (0.1% of gonorrhoea cases reported in the study; 13/9613 cases) [41].

Co-infections

Co-infections were common: 42.9% with herpes simplex virus (HSV) [48], 0.8% [103] to 100% [63, 82, 103] with *Chlamydia trachomatis*, 5.6% [140] to 100% [117] with human papillomavirus (HPV), 7.1% [48] to 20% [73, 117] with syphilis, 15.7% [115] to 50% [38] with *Trichomonas vaginalis*, 10.5% with concomitant bacterial

vaginosis [115], 11.1% [118] to 21.4% [48] with *Mycoplasma genitalium*, 100% with *Mycoplasma hominis* [98], 75.3% with *Ureaplasma urealyticum/parvum* and 2.8% with hepatitis C virus [140]. One study reported 81.5% of co-infections with more than one microorganism (*M. genitalium*, *M. hominis*, *Gardnerella vaginalis* and *T. vaginalis*) [43]. In the 14 studies that included 100% of people living with HIV, between 0% [54, 72] and 13.3% [93] were associated with *N. gonorrhoeae*.

Sensitivity Analysis

In the sensitivity analysis restricted to studies with a low risk of bias, the combined prevalence was 0.47% (95% CI 0.11%, 1.06%) in the general population at non-high risk and 1.66% (95% CI 1.32%, 2.04%) in the general population at high risk (Table 2).

Health-Related Quality of Life

No studies were found reporting information on health-related quality of life.

Economic Studies

Only one economic study meeting our criteria was identified [139], a cost-effectiveness study using a Markov model to compare usual care with a strategy for reducing the incidence of sexually transmitted infections (including gonorrhoea) in female sex workers located on the northern border of Mexico. The CiCERO checklist categorised the study as having a low risk of bias. The study provided information on some unit costs for gonorrhoea management in Mexico: diagnostic test for gonorrhoea, US\$22; azithromycin 100 mg, US\$14; ceftriaxone 125 mg, US\$7.70; benzathine penicillin, US\$5 [139]. No other health resources or costs for gonorrhoea were identified.

Ministry of Health Databases

In Argentina, 30,348 cases of genital gonococcal infection were registered between 2011 and

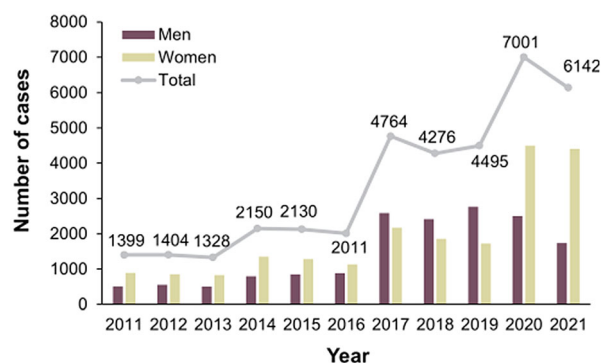


Fig. 2 Number of cases of gonococcal infection in the genitourinary tract in Mexico, 2011–2021 [146]

2018, and in 2018, 53% of the total registered cases were verified ($n = 16\,150$). A new version of the National Health Surveillance System (SNVS), SNVS 2.0, was implemented in 2018, which may have led to the increase seen in the number of cases registered. In all years with data available by biological sex, gonorrhoea cases predominated in males, triple the number in females (Supplementary Material Table S6). Between 2011 and 2018 just one death attributable to gonococcal infection was registered in Argentina (in 2018), in a male aged 70–74 years [141, 142].

In Brazil, 43 deaths associated with gonococcal infection were recorded between 2009 and 2020. The peak was reported in 2017, when ten deaths occurred (70% male). Hospitalisations due to gonococcal infections increased from 1 in 2009 to 80 in 2020, with the highest number in people aged < 1 year and 20–39 years (Table 4) [143]. The cost of hospital days due to gonococcal infection reached 42,903 Brazilian reais in 2020 (Table 5).

In Chile, hospital days due to gonococcal infection totalled 306 in 2018, with females having more total days than males (229 compared with 77) but with no statistically significant difference between the averages ($p > 0.798$) (Supplementary Material Table S7) [144]. The number of new cases was 2768 in 2017 (Supplementary Material Table S8).

In Colombia, six deaths due to gonorrhoea as defined by International Classification of Diseases (ICD)-10 codes were registered between 2011 and 2020, all male and most (4/6) aged > 65 years (Supplementary Material Table S9) [145].

In Mexico, the number of gonococcal infections registered has shown an increasing trend in recent years, peaking at 7001 cases in 2020. In 2017–2019, cases in males exceeded those in females, while in 2011–2016, 2020 and 2021 there were more cases in females than in males (Fig. 2, Supplementary Material Table S10) [146].

In Uruguay, there were 53 hospital discharges for gonorrhoea between 2015 and 2019, according to a Department of Health Surveillance (DEVISA) report (Supplementary Material Table S11).

We could not find any detailed information about the burden of disease due to gonorrhoea for the Central American countries.

Global Burden of Disease (GBD)

From GBD, we obtained modelled information on incidence rates, prevalence, mortality and disability-adjusted life-years (DALYs) for different age groups (0–14, 15–19, 20–24, 25–49, 50–69 and ≥ 70 years) between 2011 and 2019 from most LAC countries. Incidence and prevalence rates, expressed as new and prevalent cases per 100 000 person-years, respectively, remained stable over this period in most of the countries included. In all countries, in both sexes, the highest incidence and prevalence rates both occurred between 20 and 24 years of age and decreased towards the extreme ages of life. The mortality rate, expressed as deaths per 100,000 person-years, also remained stable in the period evaluated in most of the countries.

DISCUSSION

This systematic review and meta-analysis summarised available evidence from the scientific literature on the epidemiological burden of gonorrhoeal disease in LAC over the past 10 years. Almost half the population in the identified epidemiological studies was from groups at increased risk for gonorrhoea, such as sex workers, MSM, transgender people and vulnerable groups. Prevalence in the non-high-risk population was 1.46%, lower than that in the high-risk population, which was 5.68%. The estimated incidence was 2.05 cases per 100 people/year in the high-risk population. Our review indicates a higher rate of gonorrhoea in men than in women, mainly in the high-risk population.

To our knowledge, this is the first comprehensive review of the burden of gonorrhoea across the countries of the LAC region that includes information from ministries of health databases and GBD as well as the scientific literature. However, this review has some limitations arising from variations in the

methodology of the sources, particularly regarding the ministries of health surveillance systems. Furthermore, most of the published studies identified were rated as “fair” in the risk of bias assessments and few ($n = 6$) were rated as “good”. Five of the six studies with randomised sampling were conducted in specific population subgroups and may not be generalisable to wider populations. The limited information found in the countries’ surveillance systems hinders the comparability with data obtained from GBD [147].

Our results are consistent with previous publications. In a systematic review covering the global general adult (aged 15–49 years) population excluding risk groups, the prevalence of gonorrhoea in 2016 was found to be 0.9% (95% uncertainty interval [UI] 0.7–1.1%) in females and 0.7% (95% UI: 0.5–1.1%) in males [2]. In South Africa, the prevalence of gonorrhoea in the general adult population in 2017 was 6.6% in females and 3.5% in males [148]. Two reviews involving populations of female sex workers, one in China (2000–2011) and one in Africa (1999–2019), reported a gonorrhoea prevalence of 6% and 5.46% respectively [149, 150], similar to our results in the high-risk population. A systematic review of the prevalence of four STDs in young people aged 10–25 years in LAC was published in 2022, after the cut-off date for our search [151]. This review identified 15 population-based studies, of which eight reported data on the prevalence of *N. gonorrhoeae*. Prevalence in women ranged from 0 to 2.9% (8 studies, 4845 participants), prevalence in pregnant women was 1% (1 study, 2071 participants), and prevalence in men aged < 20 years was 0% (2 studies, 666 participants) [151]. The results from this review are specific to populations aged 10–25 years [151] and therefore cannot be compared directly with the results from our study which included subjects of all ages.

Our study also included relevant epidemiological information obtained through the ministries of health. The scarcity or absence of data on mortality or hospitalisations is striking, possibly reflecting the low lethality of gonorrhoea and/or probable under-reporting of data. For example, in Argentina, registered rates were

6.68–8.09 cases per 100,000 inhabitants, while in Canada in 2011–2014 a rate of 34.8–45.7 cases per 100,000 inhabitants was reported [152], with the disease predominating among males in both countries.

The higher prevalence of gonorrhoea in high-risk populations reported in this study underscores the need for targeted interventions and prevention strategies for these populations, such as improved access to testing, treatment and prevention methods such as condoms and pre-exposure prophylaxis. The study’s finding that gonorrhoea is more prevalent in men than women can serve as a basis for screening and treatment guidelines, particularly in symptomatic patients. The fact that no serious complications or deaths from gonorrhoea were reported in the included studies suggests that the disease has a low lethality, but the limited information found in country surveillance systems limits comparison with data from other regions.

The methodological limitations in data sources and the lack of economic studies of the burden of gonorrhoea in the LAC region noted in the study highlight the need for further research to improve understanding of the disease’s epidemiology and economic burden in this region. This could help to inform resource allocation and policy decisions regarding gonorrhoea prevention, screening and treatment. Overall, the study findings underscore the importance of monitoring and addressing the global burden of gonorrhoea, particularly in high-risk populations, and improving the availability of quality data for informed decision-making.

CONCLUSION

Although we identified many published studies in this review, population-based epidemiological studies were scarce, and only one economic study was identified from the LAC region. This indicates a need for more evidence on costs and resource utilisation associated with gonorrhoea, together with epidemiological studies representative of the general population, to form a more comprehensive view of the

epidemiological and economic burden of gonorrhoea in LAC countries. Our findings will be useful to decision-makers considering potential health interventions to control gonorrhoea.

ACKNOWLEDGEMENTS

Funding. GlaxoSmithKline Biologicals SA funded this study and was involved in all stages of the study conduct, including analysis of the data. GlaxoSmithKline Biologicals SA also took in charge all costs associated with the development and publication of this manuscript, including the journal's Rapid Service Fee.

Medical Writing and Editorial Assistance. The authors would like to thank Business & Decision Life Sciences platform for editorial assistance and manuscript coordination, on behalf of GSK. Carole Nadin (Fleetwith Ltd, on behalf of GSK) provided writing support.

Author Contributions. Ariel Bardach, Tomás Alconada, Carolina Palermo, Carlos Rojas-Roque, Maria Sandoval, Jorge Gomez, Thatiana Pinto, Agustin Ciapponi contributed to conception and design, acquisition of data, analysis, interpretation of data, drafting the article, revising it critically for important intellectual content. Ariel Bardach, Tomás Alconada, Carolina Palermo, Carlos Rojas-Roque, Maria Macarena Sandoval, Jorge Gomez, Thatiana Pinto, Agustin Ciapponi had full access to the data and gave final approval before submission.

Disclosures. All authors have completed the ICMJE uniform disclosure form at <http://www.icmje.org/disclosure-of-interest/> and declare: Jorge Gomez and Thatiana Pinto are employed by GSK. Jorge Gomez hold shares in GSK. Ariel Bardach, Tomás Alconada, Carolina Palermo, Carlos Rojas-Roque, Maria Macarena Sandoval, Agustin Ciapponi received funding from GSK to complete the work disclosed in this manuscript. Authors declare no other financial and non-financial relationships and activities and no conflicts of interest. This study was supported by GlaxoSmithKline Biologicals SA in the form

of grants awarded and all costs associated with the development and publication of this manuscript.

Compliance with Ethics Guidelines. Ethics approval was not required as this study was based on published data and therefore did not involve human participants.

Data Availability. All data generated or analysed during this study are included in this published article/as Supplementary Material files.

Open Access. This article is licensed under a Creative Commons Attribution-Non-Commercial 4.0 International License, which permits any non-commercial use, sharing, adaptation, distribution and reproduction in any medium or format, as long as you give appropriate credit to the original author(s) and the source, provide a link to the Creative Commons licence, and indicate if changes were made. The images or other third party material in this article are included in the article's Creative Commons licence, unless indicated otherwise in a credit line to the material. If material is not included in the article's Creative Commons licence and your intended use is not permitted by statutory regulation or exceeds the permitted use, you will need to obtain permission directly from the copyright holder. To view a copy of this licence, visit <http://creativecommons.org/licenses/by-nc/4.0/>.

REFERENCES

1. Centers for Disease Control and Prevention. Gonorrhoea–CDC Fact Sheet (Detailed Version). 2022. <https://www.cdc.gov/std/gonorrhea/stdfact-gonorrhea-detailed.htm>. Accessed 14 Apr 2022.
2. 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):548–62. <https://doi.org/10.2471/BLT.18.228486>.
3. Kirkcaldy RD, Weston E, Segurado AC, Hughes G. Epidemiology of gonorrhoea: a global perspective.

- Sex Health. 2019;16(5):401–11. <https://doi.org/10.1071/SH19061>.
4. Callander D, Cook T, Read P, et al. Sexually transmissible infections among transgender men and women attending Australian sexual health clinics. *Med J Aust*. 2019;211(9):406–11. <https://doi.org/10.5694/mja2.50322>.
 5. Mc Grath-Lone L, Marsh K, Hughes G, et al. The sexual health of female sex workers compared with other women in England: analysis of cross-sectional data from genitourinary medicine clinics. *Sex Transm Infect*. 2014;90:344–50.
 6. Centers for Disease Control and Prevention. Sexually Transmitted Disease Surveillance. 2017. <https://stacks.cdc.gov/view/cdc/59237>.
 7. Svensson P, Sundbeck M, Persson KI, et al. A meta-analysis and systematic literature review of factors associated with sexual risk-taking during international travel. *Travel Med Infect Dis*. 2018;24:65–88.
 8. Higgins J, Thomas J, Chandler J, et al. *Cochrane Handbook for Systematic Reviews of Interventions* version 6.0 (updated August 2019). 2019. www.training.cochrane.org/handbook. Accessed 5 Mar 2023.
 9. Stroup DF, Berlin JA, Morton SC, et al. Meta-analysis of observational studies in epidemiology: a proposal for reporting. Meta-analysis of Observational Studies in Epidemiology (MOOSE) group. *JAMA*. 2000;283(15):2008–12.
 10. Liberati A, Altman DG, Tetzlaff J, et al. The PRISMA statement for reporting systematic reviews and meta-analyses of studies that evaluate health care interventions: explanation and elaboration. *PLoS Med*. 2009;6(7):e1000100. <https://doi.org/10.1371/journal.pmed.1000100>.
 11. Moher D, Liberati A, Tetzlaff J, Altman DG. Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. *PLoS Med*. 2009;6(7):e1000097. <https://doi.org/10.1371/journal.pmed.1000097>.
 12. Moher D, Shamseer L, Clarke M, et al. Preferred reporting items for systematic review and meta-analysis protocols (PRISMA-P) 2015 statement. *Syst Rev*. 2015;4:1. <https://doi.org/10.1186/2046-4053-4-1>.
 13. Institute for Health Metrics and Evaluation (IHME). GBD compare. Seattle: IHME University of Washington; 2020. <http://vizhub.healthdata.org/gbd-compare>. Accessed 8 Mar 2020.
 14. Babineau J. Product review: covidence (systematic review software). *J Can Health Libr Assoc*. 2014;35:68–71.
 15. Covidence systematic review software. [computer program] M, Australia: Veritas Health Innovation. 2023.
 16. National Institutes of Health (NIH). Study Quality Assessment Tools. 2020. <https://www.nhlbi.nih.gov/health-topics/study-quality-assessment-tools>. Accessed 19 Mar 2020.
 17. EPOC. Cochrane Effective Practice Organisation of Care Group. Suggested risk of bias criteria for EPOC reviews. 2014. https://epoc.cochrane.org/sites/epoc.cochrane.org/files/public/uploads/Resources-for-authors2017/suggested_risk_of_bias_criteria_for_epoc_reviews.pdf. Accessed 7 Apr 2014.
 18. Mandrik OL, Severens JLH, Bardach A, et al. Critical appraisal of systematic reviews with costs and cost-effectiveness outcomes: an ISPOR good practices task force report. *Value Health*. 2021;24(4):463–72. <https://doi.org/10.1016/j.jval.2021.01.002>.
 19. Freeman MF, Tukey JW. Transformations related to the angular and the square root. *Ann Math Stat*. 1950;21:607–11.
 20. Higgins JP, Thompson SG, Deeks JJ, Altman DG. Measuring inconsistency in meta-analyses. *BMJ*. 2003;327(7414):557–60.
 21. DeSimonian R, Laird N. Meta-analysis in clinical trials. *Control Clin Trials*. 1986;7(3):177–88. [https://doi.org/10.1016/0197-2456\(86\)90046-2](https://doi.org/10.1016/0197-2456(86)90046-2).
 22. Higgins J, Green S. *Cochrane Handbook for Systematic Reviews of Interventions* Version 5.0.2 [updated September 2009]. The Cochrane Collaboration. 2008.
 23. Rothman K, Greenland S, editors. *Modern epidemiology*. Philadelphia: Lippincott-Raven; 1998.
 24. Cunha CB, Friedman RK, de Boni RB, et al. Chlamydia trachomatis, *Neisseria gonorrhoeae* and syphilis among men who have sex with men in Brazil. *BMC Public Health*. 2015;15:686.
 25. Adachi K, Klausner JD, Bristow CC, et al. Chlamydia and Gonorrhea in HIV-infected pregnant women and infant HIV transmission. *Sex Transm Dis*. 2015;42(10):554–65.
 26. Alcântara MG. Perfil clínico e laboratorial de Pacientes soropositivos atendidos no CTA/SAE de Barcarena-PA, no período de 2010 a 2018. In: XXI Congresso Brasileiro de Infectologia. 2019.
 27. Allan-Blitz LT, Konda KA, Calvo GM, et al. High incidence of extra-genital gonorrheal and chlamydial infections among high-risk men who have sex with men and transgender women in Peru. *Int J STD AIDS*. 2018;29:568–76.

28. Andrade J, Oliveira MA, Freneda de Parada AP, et al. Vulnerabilidade de mulheres que fazem sexo com mulheres às infecções sexualmente transmissíveis. *Cien Saude Colet*. 2020;25(10):3809–19. <https://doi.org/10.1590/1413-812320202510.03522019>.
29. Baldin-Dal-Pogetto MR, Silva MG, Parada CMGDL. Prevalence of sexually transmitted diseases in female sex workers in a city in the interior of São Paulo, Brazil. *Rev Lat Am Enferm*. 2011;19(3):493–9. <https://doi.org/10.1590/s0104-11692011000300007>.
30. Barbosa M, Pinto VM, Moherdau F, et al. Prevalence of *Neisseria gonorrhoeae* and *Chlamydia trachomatis* infection in men attending STD clinics in Brazil. *Sex Transm Infect*. 2011;87(Suppl 1):A102–3. <https://doi.org/10.1136/sextrans-2011-050108.8>.
31. Bastos TdR. Infecção gonocócica: uma análise da prevalência no Brasil no período de 2009 a 2019. In: XXI Congresso Brasileiro de Infectologia. 2019.
32. Bazzi AR, Rangel G, Martinez G, et al. Incidence and predictors of HIV and sexually transmitted infections among female sex workers and their intimate male partners in northern Mexico: a longitudinal, multilevel study. *Am J Epidemiol*. 2015;181:723–31.
33. Benzaken A, Sabidó M, Galban E, Rodrigues Dutra DL, Leturiondo AL, Mayaud P. HIV and sexually transmitted infections at the borderlands: Situational analysis of sexual health in the Brazilian Amazon. *Sex Transm Infect*. 2012;88:294–300.
34. Boldrini N, Miranda AE, Cossate JS, et al. Sexually transmitted infections among women living with HIV attending a clinic in Brazil. *Int J Gynecol Obstet*. 2018;143:854.
35. Bristow CC, Espinosa da Silva C, Vera AH, Gonzalez-Fagoaga JE, Rangel G, Pines HA. Prevalence of bacterial sexually transmitted infections and coinfection with HIV among men who have sex with men and transgender women in Tijuana Mexico. *Int J STD AIDS*. 2021;32(8):751–7.
36. Bristow CC, Klausner JD, Morris SR, et al. Healthcare access and antibiotic use for genitourinary symptoms among female sex workers in Tijuana Mexico. *Sex Transm Infect*. 2017;93:A201–2.
37. Bristow CC, Desgrottes T, Cutler L, et al. The aetiology of vaginal symptoms in rural Haiti. *Int J STD AIDS*. 2014;25:669–75.
38. Bristow CC, Mathelier P, Ocheretina O, et al. *Chlamydia trachomatis*, *Neisseria gonorrhoeae*, and *Trichomonas vaginalis* screening and treatment of pregnant women in Port-au-Prince. Haiti *Int J STD AIDS*. 2017;28:1130–4.
39. Cabeza J, Segura ER, Montano SM, et al. Extra-genital and urethral *Chlamydia trachomatis* and *Neisseria gonorrhoeae* prevalence and associated risk factors in men who have sex with men and transgender women in Lima, Peru. *Sex Transm Infect*. 2015;91:A177.
40. Cáceres-Burton. Situación Epidemiológica, 2012 (DATOS PROVISORIOS, SEMANAS 1 A 52). Santiago de Chile, Chile. 2012.
41. Cáceres-Burton K. Informe: Situación epidemiológica de las infecciones de transmisión sexual en Chile, 2017. *Rev Chil Infectol*. 2019;36(2):221–33. <https://doi.org/10.4067/s0716-10182019000200221>.
42. Cáceres-Burton K. Programa de Prevención y Control del VIH y las ITS, Departamento de Salud y Pueblos Indígenas e Interculturalidad Unidad de migración y salud. Informe Anual 2016 Situación epidemiológica de gonorrea (CIE 10: A54). *Rev Chil Infectol*. 2018;35(4):403–12. <https://doi.org/10.4067/s0716-10182018000400403>.
43. Campos GB, Lobão TN, Selis NN, et al. Prevalence of *Mycoplasma genitalium* and *Mycoplasma hominis* in urogenital tract of Brazilian women. *BMC Infect Dis*. 2015;15:60.
44. Campos PE, Buffardi AL, Cárcamo CP, et al. Reaching the unreachable: providing STI control services to female sex workers via mobile team outreach. *PLoS ONE*. 2013;8: e81041.
45. Cárcamo CP, Campos PE, García PJ, et al. Prevalences of sexually transmitted infections in young adults and female sex workers in Peru: a national population-based survey. *Lancet Infect Dis*. 2012;12:765–73.
46. Cardona Arango D, Berbesí Fernández DY, Segura Cardona AM. Comportamiento de las consultas por infecciones de transmisión sexual Medellín, Colombia 2002–2006. *Investig Andin*. 2012;14:560–75.
47. Casco RH, García SD, Perazzi BE, et al. *Neisseria gonorrhoeae* Resistencia a los antibióticos. *Dermatol Argent*. 2011;17:396–401.
48. Casillas-Vega N, Morfín-Otero R, García S, et al. Sexually transmitted pathogens, coinfections and risk factors in patients attending obstetrics and gynecology clinics in Jalisco Mexico. *Salud Publica Mex*. 2012;58:437–45.
49. Castillo R, Konda KA, Leon SR, et al. HIV and sexually transmitted infection incidence and associated risk factors among high-risk MSM and male-to-female transgender women in Lima, Peru. *J Acquir Immune Defic Syndr*. 2015;69:567–75.

50. Chacon-Cruz E, Lopatynsky-Reyes EZ, Almada-Salazar LA, et al. *Streptococcus agalactiae*, *Streptococcus pneumoniae*, *Neisseria meningitidis*, and enterobacteriaceae as leading causes of bacterial meningitis in infants younger than 3 months old in a Mexican hospital: 6 years of active surveillance. *Open Forum Infect Dis*. 2018;5:S137–8.
51. Christofolini DM, Leuzzi L, Mafra FA, et al. Prevalence of cases of *Mycoplasma hominis*, *Mycoplasma genitalium*, *Ureaplasma urealyticum* and *Chlamydia trachomatis* in women with no gynecologic complaints. *Reprod Med Biol*. 2012;11:201–5.
52. Clark JL, Segura ER, Oldenburg CE, et al. Expedited partner therapy (EPT) increases the frequency of partner notification among MSM in Lima, Peru: a pilot randomized controlled trial. *BMC Med*. 2017;15:1–12.
53. Creswell J, Guardado ME, Lee J, et al. HIV and STI control in El Salvador: results from an integrated behavioural survey among men who have sex with men. *Sex Transm Infect*. 2012;88:633–8.
54. da Silva GAR, Motta HLSAN, de Souza EFA, et al. Chlamydia trachomatis asymptomatic urethritis recurrence among males living with HIV-1. *Rev Inst Med Trop Sao Paulo*. 2018;60:e65.
55. de Abreu AL, Malaguti N, Souza RP, et al. Association of human papillomavirus, *Neisseria gonorrhoeae* and *Chlamydia trachomatis* co-infections on the risk of high-grade squamous intraepithelial cervical lesion. *Am J Cancer Res*. 2016;6:1371–83.
56. de Lima YA, Turchi MD, Fonseca ZC, et al. Sexually transmitted bacterial infections among young women in Central Western Brazil. *Int J Infect Dis*. 2014;25:16–21.
57. de Menezes Filho JR, Sardinha JCG, Galbán E, Saceni V, Talhari C. Effectiveness of syndromic management for male patients with urethral discharge symptoms in Amazonas, Brazil. *An Bras Dermatol*. 2017;92:779–84.
58. Detels R, Green AM, Klausner JD, et al. The incidence and correlates of symptomatic and asymptomatic *Chlamydia trachomatis* and *Neisseria gonorrhoeae* infections in selected populations in five countries. *Sex Transm Dis*. 2011;38:503–9.
59. Downey RF, Hammar D, Jobe KA, et al. Epidemiology of sexually transmitted infections in rural Haitian men. *Int J STD AIDS*. 2015;26(10):710–5.
60. Duncan J, Weir S, Byfield L, et al. STI prevalence and risk behaviors among establishment-based and street-based sex workers in Jamaica. *J AIDS Clin Res*. 2014;5(7):320.
61. Edwards J, Hinds A, Lyons N, Edwards J, Quammie S, Figueroa JP. A chart review study of sexually transmitted infections among persons living with HIV attending an STI clinic in Trinidad. *J Int Assoc Provid AIDS Care*. 2019;18:1–6.
62. Edwards RJ, Hinds A, Lyons N, Figueroa JP. Prevalence and risk factors for sexually transmitted infections among people living with HIV attending a sexually transmitted infection clinic in Trinidad. *Int J STD AIDS*. 2019;30(12):1201–6.
63. Fernandes LB, Arruda JT, Approbato MS, et al. Infecção por *Chlamydia trachomatis* e *Neisseria gonorrhoeae*: fatores associados à infertilidade em mulheres atendidas em um serviço público de reprodução humana. *Rev Bras Ginecol Obstet*. 2014;36(8):353–8.
64. Figueroa JP, Weir SS, Jones-Cooper C, et al. High HIV prevalence among men who have sex with men in Jamaica is associated with social vulnerability and other sexually transmitted infections. *West Indian Med J*. 2012;61:18.
65. Gabster A, Mayaud P, Martinez A, et al. High prevalence of cervico-vaginal infections among female adolescents in four urban regions of Panama. *Sex Transm Infect*. 2019;95:A68. <https://doi.org/10.1136/sextrans-2019-sti.178>.
66. Gabster A, Pascale JM, Cislighi B, et al. High prevalence of sexually transmitted infections, and high-risk sexual behaviors among indigenous adolescents of the Comarca Ngabe-Bugle, Panama. *Sex Transm Dis*. 2019;46(12):780–7.
67. Galárraga O, Sosa-Rubí SG, González A, et al. The disproportionate burden of HIV and STIs among male sex workers in Mexico City and the rationale for economic incentives to reduce risks. *J Int AIDS Soc*. 2014;17:19218.
68. Ganley KY, Zullo AR, Sosa-Rubi SG, et al. Incidence and time-varying predictors of HIV and sexually transmitted infections among male sex workers in Mexico City. *J Int AIDS Soc*. 2016;19:20–2.
69. Garcia JI, Sabido M, Nikiforov M, et al. The UALE project: a cross-sectional approach for trends in HIV/STI prevalence among key populations attending STI clinics in Guatemala. *BMJ Open*. 2018;8(9): e022632.
70. García PJ, Fazio B, Bayer AM, et al. Sexual health knowledge and practices and STI/HIV prevalence among long-distance truck drivers in Peru. *SAGE Open Med*. 2017;5. <https://doi.org/10.1177/2050312117746308>.
71. García-González I, López-Díaz RI, Canché-Pech JR, et al. Prevalence of sexually transmitted infections

- in symptomatic and asymptomatic patients from Yucatan. *Rev del Lab Clin.* 2017;10(3):117–22.
72. Goins J, Romero LM, De María HF, et al. High prevalence of STIs and risk behaviours among persons living with HIV in Nicaragua: missed opportunities for prevention. *Sex Transm Infect.* 2011;87: A178–9.
 73. Gonzalez SM, Garcia Messina O, Angeleri P, et al. Sífilis: experiencia en un Hospital General de Agudos de la Ciudad Autónoma de Buenos Aires. XV Congreso Sociedad Argentina de Infectología 2014;22(Supl1):2014.
 74. Grinsztejn B, Jalil EM, Monteiro L, et al. Unveiling of HIV dynamics among transgender women: a respondent-driven sampling study in Rio de Janeiro, Brazil. *Lancet HIV.* 2017;4(4):e169–76.
 75. Gutiérrez-Sandí W, Chaverri-Murillo J, Navarro-Cruz JE. Enfermedades de transmisión sexual y salud sexual del costarricense: Sífilis y gonorrea. *Tecnol en Marcha.* 2016;29(4):3–15. <https://doi.org/10.18845/tm.v29i4.3033>.
 76. Ham C, Guardado M, Nieto A, et al. Factors associated with HIV among men who have sex with men in 2 cities in el Salvador: the importance of other stis. *Sex Transm Dis.* 2014;41:S82–3.
 77. Ham D, Northbrook SY, Morales-Miranda S, et al. HIV and STIs among transgendered populations: Four country survey from central America. *Top Antivir Med.* 2015;23:475–6.
 78. Hernandez F, Arambú N, Alvarez B, et al. High incidence of HIV and low HIV prevention coverage among men who have sex with men in Managua, Nicaragua. *Sex Transm Infect.* 2011;87:A146.
 79. Hernandez-Martinez F, Hernandez-Garcia JA, Martinez-Pena MD, et al. Aetiology and frequency of cervico-vaginal infections among Mexican women. *Afr J Microbiol Res.* 2013;7(1):27–34.
 80. Hoagland B, Veloso VG, De Boni RB, et al. Pre-exposure prophylaxis uptake and associated factors among MSM and TGW in the PrEP Brasil demonstration project. *J Int AIDS Soc.* 2015;18:48–50.
 81. Hobbs M, Anderson C, Hylton-Kong T, et al. Syndromic management of cervicitis and vaginal discharge at a STI clinic in Jamaica: low cure rates for chlamydial infection and trichomoniasis. *Sex Transm Infect.* 2011;87:A272–3.
 82. Huneeus A, Schilling A, Fernandez MI. Prevalence of *Chlamydia trachomatis*, *Neisseria gonorrhoeae*, and *Trichomonas vaginalis* infection in Chilean adolescents and young adults. *J Pediatr Adolesc Gynecol.* 2018;31(4):411–5.
 83. Jean Louis F, Galbaud G, Leonard M, et al. Prevalence of *Neisseria gonorrhoeae* and *Chlamydia trachomatis* in men having sex with men in Port-au-Prince, Haiti: a cross-sectional study. *BMJ Open.* 2020;10(3):e033976. <https://doi.org/10.1136/bmjopen-2019-033976>.
 84. Lima LDM, Hoelzle CR, Simoes RT, et al. Sexually transmitted infections detected by multiplex real time PCR in asymptomatic women and association with cervical intraepithelial neoplasia. *Rev Bras Ginecol Obstet.* 2018;40(9):540–6.
 85. Luchiari HR, Ferreira CST, Golim MA, Silva MG, Marconi C. Cervicovaginal bacterial count and failure of metronidazole therapy for bacterial vaginosis. *Int J Gynaecol Obstet.* 2016;132(3):297–301.
 86. Luppi CG, de Oliveira RLS, Veras MA, et al. Early diagnosis and correlations of sexually transmitted infections among women in primary care health services. *Rev Bras Epidemiol.* 2011;14(3):467–77.
 87. Manca MF, Rochat-Stettler L, Carod JF, Agostini C, Jolivet A. High prevalence of *Chlamydia trachomatis* and *Neisseria gonorrhoeae* in Western French Guiana. *Braz J Infect Dis.* 2020;24(3):256–60.
 88. Marchezini R, Rosângela M, Aparecida Machado de Oliveira D, et al. Sexually transmitted infections in specialized service: who they are and who has them? *J Nurs UFPE Rev de Enfermagem UFPE.* 2018;12(1):137–49.
 89. Melo MGD, Sprinz E, Gorbach PM, et al. HIV-1 heterosexual transmission and association with sexually transmitted infections in the era of treatment as prevention. *Int J Infect Dis.* 2019;87: 128–34.
 90. Mendizabal-Burastero R, Vargas C, Galindo-Arandi C, et al. Anal and oropharyngeal STI surveillance among men who have sex with men in Guatemala. *Sex Transm Infect.* 2015;91:A176.
 91. Mendoza L, Mongelos P, Paez M, et al. Human papillomavirus and other genital infections in indigenous women from Paraguay: a cross-sectional analytical study. *BMC Infect Dis.* 2013;13:531.
 92. Miranda AE, Silveira MF, Travassos AG, et al. Prevalence of *Chlamydia trachomatis* and *Neisseria gonorrhoea* and associated factors among women living with Human Immunodeficiency Virus in Brazil: a multicenter study. *Braz J Infect Dis.* 2017;21(4):402–7.
 93. Montano MA, Alfaro R, Ness T, et al. Sexual behavior and sexually transmitted infection outcomes among men who have sex with men and transgender women participating in a study of the

- timing of antiretroviral therapy in Lima, Peru. *Sex Transm Dis.* 2020;47(12):825–31.
94. Morales-Miranda S, Alvarez B, Manzanero M. Prevalence of HIV/STIs and risk behavior in men who have a sex with men, Belize, 2012. *Sex Transm Infect.* 2013;89:A193.
95. Morales-Miranda S, Manzanero M, Loya I, et al. Risk behavior and sexually transmitted infections among people living with HIV/AIDS in Belize, 2012. *Sex Transm Infect.* 2013;89:A241.
96. Moriarty KE, Segura ER, Gonzales W, et al. Assessing sexually transmitted infections and HIV risk among transgender women in Lima, Peru: beyond behavior. *LGBT Health.* 2019;6(7):370–6. <https://doi.org/10.1089/lgbt.2018.0087>.
97. Nuñez-Forero L, Moyano LF, Angel-Müller E, et al. Diagnostic accuracy of rapid tests for *C. trachomatis*, *N. gonorrhoeae* and syphilis at the Point of care in women with symptoms of lower genital tract infection. *Int J Gynaecol Obstet.* 2012;119:S353–4. [https://doi.org/10.1016/s0020-7292\(12\)60695-x](https://doi.org/10.1016/s0020-7292(12)60695-x).
98. Mucci MJ, Cuestas ML, Cervetto MM, Landaburu MF, Mujica MT. A prospective observational study of vulvovaginitis in pregnant women in Argentina, with special reference to candidiasis. *Mycoses.* 2016;59(7):429–35.
99. Occhionero M, Paniccía L, Pedersen D, et al. Prevalencia de disfunción vaginal en mujeres de la ciudad de Bahía Blanca (Argentina) Vaginal dysfunction prevalence in women of the city of Bahía Blanca (Argentina) A prevalência de disfunção vaginal em mulheres da cidade de Bahía Blanca (Argentina). *Acta Bioquím Clín Latinoam.* 2018;52(4):429–39.
100. Ovalle A, Martínez MA, de la Fuente F, et al. Prevalence of sexually transmitted infections in pregnant women attending a public hospital in Chile. *Rev Chil Infectol.* 2012;29(5):517–20.
101. Pantoja M, Campos EA, Pitta DR, Gabiatti JE, Bahamondes MV, Fernandes AM. Prevalence of *Chlamydia trachomatis* infection among women candidates for in vitro fertilization at a public institution of the State of São Paulo, Brazil. *Rev Bras Ginecol Obstet.* 2012;34(9):425–31. <https://doi.org/10.1590/s0100-72032012000900007>.
102. Paredes MC, Gómez YM, Torres AM, Fernández M, Tovar MB. Prevalencia de infecciones por *Chlamydia trachomatis* y *Neisseria gonorrhoeae* en adolescentes de colegios de la provincia de Sabana Centro, Cundinamarca. Colombia *Biomédica (Bogotá).* 2015;35(3):314–24.
103. Passaro RC, Segura ER, Perez-Brumer A, et al. Body parts matter: social, behavioral, and biological considerations for urethral, pharyngeal, and rectal gonorrhea and chlamydia screening among MSM in Lima, Peru. *Sex Transm Dis.* 2018;45(9):607–14. <https://doi.org/10.1097/olq.0000000000000816>.
104. Patterson TL, Strathdee SA, Semple SJ, et al. Prevalence of HIV/STIs and correlates with municipal characteristics among female sex workers in 13 Mexican cities. *Salud Publica Mex.* 2019;61(2):116–24. <https://doi.org/10.21149/8863>.
105. Paz-Bailey G, Shah N, Creswell J, et al. Risk behaviors and STI prevalence among people with HIV in El Salvador. *Open AIDS J.* 2012;6(1):205–12. <https://doi.org/10.2174/1874613601206010205>.
106. Peña-Toribio A, Aguilera-Arreola M, García-Mendiola R, et al. Factores de riesgo para uretritis de transmisión sexual en hombres que tiene sexo con hombres. *Rev de Infectol y Microbiol Clín.* 2019;39:C64.
107. Perez-Brumer AG, Konda KA, Salvatierra HJ, et al. Prevalence of HIV, STIs, and risk behaviors in a cross-sectional community- and clinic-based sample of men who have sex with men (MSM) in Lima, Peru. *PLoS ONE.* 2013;8(4):e59072. <https://doi.org/10.1371/journal.pone.0059072>.
108. Piazzetta RCPS, de Carvalho NS, de Andrade RP, Piazzetta G, Piazzetta SR, Carneiro R. Prevalência da infecção por *Chlamydia trachomatis* e *Neisseria gonorrhoea* em mulheres jovens sexualmente ativas em uma cidade do Sul do Brasil. *Rev Bras Ginecol Obstet.* 2011;33(11):328–33.
109. 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):957–61.
110. Pinto VM, Tancredi MV, Silva RJ, Khoury Z, Buchalla CM. Prevalence and factors associated with *Chlamydia trachomatis* infection among women with HIV in São Paulo. *Rev Soc Bras Med Trop.* 2016;49(3):312–8. <https://doi.org/10.1590/0037-8682-0169-2016>.
111. Piscopo R, Ueno J, Guimaraes R, Ikeda F, Jarmy-Di Bella Z, Girao M, Samama M. Bacterial infection other than Chlamydia associated to tubal factor of infertility suggests new approach. In: *Human Reproduction*, vol 33. Oxford University Press, England, pp 306–306 (2018). <https://doi.org/10.26226/morressier.5af300b0738ab10027aa9619>.
112. Pollett S, Calderon M, Heitzinger K, Solari V, Montano SM, Zunt J. Prevalence and predictors of cervicitis in female sex workers in Peru: an observational study. *BMC Infect Dis.* 2013;13(1):195. <https://doi.org/10.1186/1471-2334-13-195>.

-
113. Rahman G, Ocampo D, Rubinstein A, Risso P. Prevalencia de vulvovaginitis y su relación con hallazgos físicos en niñas evaluadas por sospecha de abuso sexual infantil. *Arch Argent Pediatr*. 2015;113(5):390–6.
114. Reyes RT, Villanueva H, Bórquez BC, et al. Prevalencia de *Neisseria gonorrhoeae*, en reclusos del Centro de Detención Preventiva de Arica. *Rev Chil Infectol*. 2020;37(1):32–6.
115. Ribas CBR, Cunha MGS, Schettini APM, Ribas J, Santos JE. Perfil clínico-epidemiológico das doenças sexualmente transmissíveis em crianças atendidas em um centro de referência na cidade de Manaus, Amazonas, Brasil. *An Bras Dermatol*. 2011;86(1):80–6. <https://doi.org/10.1590/s0365-05962011000100010>.
116. Rocha DA, Filho RA, Mariño JM, dos Santos CM. “Hidden” sexually transmitted infections among women in primary care health services, Amazonas, Brazil. *Int J STD AIDS*. 2014;25(12):878–86.
117. Rodrigues LLS, Hardick J, Nicol AF, et al. Sexually transmitted infections among HIV-infected and HIV-uninfected women in the Tapajós region, Amazon, Brazil: self-collected vs clinician-collected samples. *PLoS ONE*. 2019;14(4):e0215001. <https://doi.org/10.1371/journal.pone.0215001>.
118. Rodrigues MM, Fernandes PÁ, Haddad JP, et al. Frequency of *Chlamydia trachomatis*, *Neisseria gonorrhoeae*, *Mycoplasma genitalium*, *Mycoplasma hominis* and *Ureaplasma* species in cervical samples. *J Obstet Gynaecol*. 2011;31(3):237–41. <https://doi.org/10.3109/01443615.2010.548880>.
119. Rodríguez I, Hernández Y. Sexually transmitted diseases during the COVID-19 pandemic: a focus on syphilis and gonorrhoea in Cuba. *Public Health Pract (Oxf)*. 2020;2:100072. <https://doi.org/10.1016/j.puhip.2020.100072>.
120. Rojas AM, Duran SM, Perdomo FC. Enfermedades de transmisión sexual en la población urbana de Mitu, Vaupes, 2005 a 2009. *Inf Quinc Epidemiol Nac*. 2012;17(11):125–40.
121. Sabidó M, Lahuerta M, Montoliu A, et al. Human immunodeficiency virus, sexually transmitted infections, and risk behaviors among clients of sex workers in Guatemala: are they a bridge in human immunodeficiency virus transmission? *Sex Transm Dis*. 2011;38(8):735–42. <https://doi.org/10.1097/OLQ.0b013e31821596b5>.
122. Sánchez Palencia L, Acosta Cáceres J. Mutaciones en la región determinante de resistencia a quinolonas (QRDR) del gen gyrA de *Neisseria gonorrhoeae* presente en muestras clínicas de hombres que tienen sexo con hombres. *Rev Peru Biol*. 2017;24(3):283. <https://doi.org/10.15381/rpb.v24i3.13905>.
123. 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):626–31. <https://doi.org/10.1097/olq.0000000000000861>.
124. Scheidell J, Khan M, Maurelli A. Sexually transmitted infection prevalence and associated sexual risk behaviors among adult Haitian men and women. *Sex Transm Dis*. 2016;43(10):S188.
125. Silveira MF, Bruni MP, Stauffert D, Golparian D, Unemo M. Prevalence and risk factors associated with *Chlamydia trachomatis*, *Neisseria gonorrhoeae*, and *Mycoplasma genitalium* among women in Pelotas, Southern Brazil. *Int J STD AIDS*. 2020;31(5):432–9. <https://doi.org/10.1177/0956462419898982>.
126. Snead MC, Wiener J, Ewumi S, et al. Prevalence and risk factors associated with STIs among women initiating contraceptive implants in Kingston, Jamaica. *Sex Transm Infect*. 2017;93(7):503–7. <https://doi.org/10.1136/sextrans-2016-052963>.
127. Souza RP, De Abreu ALP, Ferreira ÉC, et al. Short report: Simultaneous detection of seven sexually transmitted agents in human immunodeficiency virus-infected Brazilian women by multiplex polymerase chain reaction. *Am J Trop Med Hyg*. 2013;89(6):1199–202.
128. Strathdee SA, Lozada R, Martinez G, et al. Social and structural factors associated with HIV infection among female sex workers who inject drugs in the Mexico-US border region. *PLoS ONE*. 2011;6(4):e19048. <https://doi.org/10.1371/journal.pone.0019048>.
129. Tinajeros F, Miller WM, Castro L, et al. Declining sexually transmitted infections among female sex workers: the results of an HIV and sexually transmitted infection prevention strategy in Honduras, 2006–08. *Int J STD AIDS*. 2012;23(2):88–93. <https://doi.org/10.1258/ijsa.2011.011047>.
130. Travassos AG, Xavier-Souza E, Netto E, et al. Anogenital infection by *Chlamydia trachomatis* and *Neisseria gonorrhoeae* in HIV-infected men and women in Salvador, Brazil. *Braz J Infect Dis*. 2016;20(6):569–75. <https://doi.org/10.1016/j.bjid.2016.09.004>.
131. Veloso VG, Vega-Ramírez EH, Hoagland B, et al. Factors associated with early continuation (EC) of preexposure prophylaxis (PrEP) among young MSM (YMSM) in Brazil, Peru and Mexico: the ImPrEP Study. *J Int AIDS Soc*. 2020;23(Suppl 4):44.
132. Villaran M, Iglesias D, Sanchez J. Prevalence and bio behavioral correlates of carcinogenic HPV infection among HIV infected men who have sex with men (MSM) in Lima, Peru. *Am J Trop Med Hyg*. 2013;89(5):373.
-

133. Villegas A, McEwen J, Martínez A, et al. Prevalencia y caracterización molecular de *Chlamydia trachomatis* y *Neisseria gonorrhoeae* en habitantes de calle y población vulnerable de la ciudad de Medellín. *Infectio*. 2018;22:212.
134. Villegas-Castaño A, Tamayo-Acevedo LS. Prevalence of sexually transmitted infections, and risk factor for sexual health of adolescents, Medellín, Colombia, 2013. *Iatreia*. 2016;29(1):5–17.
135. Weir SS, Figueroa JP, Byfield LL, et al. “Do you think your main partner has other sex partners?” A simple question provides insight into sexual risk in Jamaica. *Int J STD AIDS*. 2015;26(1):37–41.
136. Wohlmeister D, Vianna DR, Helfer VE, et al. Association of human papillomavirus and *Chlamydia trachomatis* with intraepithelial alterations in cervix samples. *Mem Inst Oswaldo Cruz*. 2016;111(2):106–13. <https://doi.org/10.1590/0074-02760150330>.
137. Yeganeh N, Kreitchmann R, Leng M, Nielsen-Saines K, Gorbach PM, Klausner J. High prevalence of sexually transmitted infections in pregnant women living in southern Brazil. *Sex Transm Dis*. 2021;48(2):128–33. <https://doi.org/10.1097/OLQ.0000000000001276>.
138. Zotta MC, Layayen S, Galeano G, et al. Infección por neisseria gonorrhoeae y fenotipos de resistencia antimicrobiana, Mar del Plata, 2005–2010. *Acta bioquím clín latinoam*. 2014;48(4):475–83.
139. Burgos JL, Gaebler JA, Strathdee SA, Lozada R, Staines H, Patterson TL. Cost-effectiveness of an intervention to reduce HIV/STI incidence and promote condom use among female sex workers in the Mexico-US border region. *PLoS ONE*. 2010;5:e11413.
140. Medeiros MIC, Silva JO, Carneiro AMM, et al. Antimicrobial resistance in *Neisseria gonorrhoeae* isolates from Ribeirão Preto, São Paulo, Brazil. *DST J Bras Doenças Sex Transm*. 2013;25(1):31–5. <https://doi.org/10.5533/DST-2177-8264-201325107>.
141. Ministerio de Salud Argentina. Boletines ITS, TBC y Lepra. 2023. <https://bancos.salud.gob.ar/bancos/materiales-para-equipos-de-salud/tags/boletines-its-tbc-y-lepra/>. Accessed 5 Mar 2023.
142. Dirección de Estadística e Información en Salud (DEIS) del Ministerio de Salud de la Nación. Defunciones. 2023. <https://www.argentina.gob.ar/salud/deis/datos/defunciones>. Accessed 5 Mar 2023.
143. DATASUS. Informações de Saúde (TABNET). 2023. <http://www2.datasus.gov.br/DATASUS/index.php?area=02>. Accessed 5 Mar 2023.
144. Departamento de Estadísticas e Información de Salud (DEIS) del Ministerio de Salud de Chile. DEIS. 2023. <https://deis.minsal.cl/sistemas-de-informacion/>. Accessed 5 Mar 2023.
145. SISPRO. Misiterio de Salud Colombia. 2023. <https://www.sispro.gov.co/Pages/Home.aspx>. Accessed 5 Mar 2023.
146. Secretaría de Salud de la Dirección General de Información en Salud (DGIS) de México. Sistema Nacional de Información en Salud (SINAIS). 2023. <http://sinaiscap.salud.gob.mx:8080/DGIS/>. Accessed 5 Mar 2023.
147. Global Burden of Disease Collaborative Network. Global Burden of Disease Study 2019. Results. Seattle, United States: Institute for Health Metrics and Evaluation (IHME). 2020. <http://ghdx.healthdata.org/gbd-results-tool>. Accessed 5 Mar 2023.
148. Kularatne RS, Niit R, Rowley J, et al. Adult gonorrhoea, chlamydia and syphilis prevalence, incidence, treatment and syndromic case reporting in South Africa: estimates using the spectrum-STI model, 1990–2017. *PLoS ONE*. 2018;13(10):e0205863. <https://doi.org/10.1371/journal.pone.0205863>.
149. Su S, Chow E, Muessig K, et al. Sustained high prevalence of viral hepatitis and sexually transmissible infections among female sex workers in China: a systematic review and meta-analysis. *BMC Infect Dis*. 2016;2. <https://doi.org/10.1186/s12879-015-1322-0>.
150. Kassa ZY, Hussen S, Hadra N, Moges Y, Bonja F. Prevalence of *Neisseria gonorrhoeae* infection among women of reproductive age in sub-Saharan Africa: a systematic review and meta-analysis. *Eur J Contracept Reprod Health Care*. 2020;25(5):365–71. <https://doi.org/10.1080/13625187.2020.1779688>.
151. Vallejo-Ortega MT, Gaitan Duarte H, Mello MB, Caffè S, Perez F. A systematic review of the prevalence of selected sexually transmitted infections in young people in Latin America. *Rev Panam Salud Publica*. 2022;46:73. <https://doi.org/10.26633/RPSP.2022.73>.
152. Public Health Agency of Canada. Report on sexually transmitted infections in Canada. 2018. <https://www.canada.ca/en/public-health/services/publications/diseases-conditions/report-sexually-transmitted-infections-canada-2018.html>. Accessed 5 Mar 2023.

Publisher's Note

Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.