Syphilis prevalence and correlates of infection among Venezuelan refugees and migrants in Colombia: findings of a cross-sectional biobehavioral survey

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Summary

Background Population-based estimates of syphilis prevalence are critical to informing public health response. We aimed to measure syphilis prevalence among Venezuelan refugees and migrants in Colombia to inform public health programming.

Methods Between July 2021 and February 2022, we surveyed 6221 adult Venezuelan refugees and migrants in four cities in Colombia using respondent-driven sampling (RDS). Participants completed a survey and dual-rapid HIV/treponemal syphilis screening. Confirmatory laboratory-based rapid plasma reagin testing was conducted on whole blood samples. Active syphilis infection was defined as RPR titer ≥ 1:8 and no self-reported syphilis treatment. We used multivariable regression models to identify associations with active syphilis infection among subgroups by gender and history of pregnancy (cisgender men n = 2123, cisgender women n = 4044, transgender/nonbinary people n = 47, pregnant women n = 150).

Findings Population (RDS-weighted) prevalence of laboratory-confirmed syphilis was 5.1% (95% CI: 4.6–5.6). Syphilis prevalence was 5.8% (weighted) among men; lifetime sexually transmitted infections (STI) diagnosis, same-sex relationships, HIV infection, and partner number were independently associated with syphilis infection. Syphilis prevalence was 4.6% (weighted) in women; correlates of infection included: lifetime STI diagnosis, food insecurity, current engagement in sex work, current pregnancy, any unsafe night in Colombia, irregular migration status, and no healthcare utilization in Colombia. 14.9% (unweighted) of transgender participants had syphilis infection; correlates of infection included partner number and HIV infection. The prevalence of syphilis was 9.0% (weighted) among pregnant women, which was associated with lifetime STI diagnosis.

Interpretation Syphilis among Venezuelans in Colombia is high. Correlates of infection are distinct among demographic groups, spanning sexual and social vulnerabilities, suggesting tailored public health strategies.

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Keywords: Refugee; Migrant; Venezuela; Colombia; Syphilis; Humanitarian; Sexually transmitted infections

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Research in context

Evidence before this study

The displacement of Venezuelans outside of Venezuela continues to be an ongoing humanitarian issue. As host countries such as Colombia expand protections to this population and introduce new legislation to ensure they have access to healthcare and other necessities, it is crucial to understand this population's reproductive health needs. We searched PubMed, Google Scholar, LILACS, and Colombian and Venezuelan government websites for studies or reports on syphilis prevalence among Venezuelan adults, both in Venezuela and among those displaced outside of Venezuela. We used search terms in English and Spanish to find literature published between 2015 and 2023, then expanded our search to 2005 due to the low volume of available studies. Search terms included "refugee/refugiado", "migrant/inmigrante", and "displacement/desplazamiento". The vast majority of literature focused on antenatal care (ANC) data, which may not accurately represent the general adult population. There was no literature reporting estimates for syphilis prevalence among Venezuelan refugees and migrants in any country. Korenromp and colleagues report the most recent available estimates for syphilis infection in the general Colombian population at 1.3% in 2016, while López-Zambrano and co-authors report the most recent available estimate for syphilis infection in the general Venezuelan population at 1.4% in 2005. Kojima and colleagues use ANC data to estimate that 2.8% of Venezuelan ANC attendees had active syphilis infection, 1.4% of Colombian ANC attendees had active syphilis infection, and 2.6% of all ANC attendees in Latin America had active syphilis infection in 2018. The Colombian Ministry of Health and Social reported an increase in congenital syphilis cases in 2021 during the COVID-19 pandemic among both Colombians and Venezuelans. That the only recent estimates available use ANC data, for both Colombians and Venezuelans, limits knowledge of the epidemiology of syphilis in the wider population, underscoring the justification for this analysis.

Added value of this study

We conducted a cross-sectional survey among 6221 Venezuelans living in four urban settings of Colombia. The population prevalence of active syphilis infection was 5.1% and associated with behavioural risk but also associated with social factors among women. To our knowledge, this is the first study to estimate population syphilis prevalence among Venezuelan refugees and migrants in any country. These data are crucial to informing public health programming, especially as countries such as Colombia begin to expand this population's access to health services.

Implications of all the available evidence

Our findings, coupled with recent estimates from ANC services, suggest that syphilis is increasing and high among Venezuelan migrants and refugees. The lack of data on prevalence among the host community, outside of ANC services, limits our understanding of whether this is unique to Venezuelans, though anecdotal evidence suggests that syphilis is increasing across the region. Collectively, expanding access to syphilis testing and treatment for people of all genders and inclusive of host and migrant communities is critical to reducing syphilis transmission.

Introduction

Syphilis prevalence has steadily declined worldwide over the last several decades, with an estimated worldwide prevalence of 1.11% and 0.8% prevalence in the Latin American region in 2017.[1] At the national level, the most recent available data estimated 1.3% prevalence among adults in Colombia in 2016 and 1.4% among adults in Venezuela in 2005.[2,3] Most recent epidemiologic data regarding syphilis infection in Latin America are drawn from antenatal care (ANC) services in which syphilis testing is routine, and estimates for other populations are absent. Syphilis prevalence was estimated at 2.6% among pregnant women in Latin America in 2018.[4] Using ANC data, 2.8% of ANC attendees in Venezuela and 1.4% in Colombia were estimated to have syphilis infection in 2021 and 2019, respectively.[5] Major gaps remain in testing and care, as estimates by the Pan American Health Organization suggest that in 2020 only 59% of pregnant women in Latin America were offered a syphilis test.[6] In Colombia, testing coverage was slightly higher, with 74% of women tested for syphilis during ANC services in 2019[5,6] and 75% of those diagnosed with active syphilis received treatment.[5] These estimates, however, exclude women who were not engaged in ANC services. Understanding the epidemiology of syphilis among women not engaged in ANC services, however, is important given that they have economic and social vulnerabilities that may limit access to ANC services and may also create risk environments that could increase exposure to syphilis infection. One particularly vulnerable group may include Venezuelan refugees and migrants for whom there is little available health data.

The mass displacement of Venezuelans, which began in 2015, is an ongoing humanitarian concern in Latin America. In 2015, Venezuela's population was estimated at 30.5 million[7,8]; however, as of August 2023 over 7.7 million Venezuelans are estimated to have been displaced outside of Venezuela.[9] Over 6.5 million, or 84%, remained in the Latin American and Caribbean region.[9] Colombia is the largest host of Venezuelan refugees and migrants with roughly 2.9 million

Venezuelans who reside within its borders as of August 2023.[10] This figure excludes "pendular" migrants, who live in Venezuela but cross into Colombia regularly to access work, food, or other services, nor does it include those within Colombia en route to another destination. Prior to October 2021, when the implementation of the 10-year Temporary Protection Statute for Venezuelans (ETPV) opened additional pathways for obtaining regular migration status, it was estimated that half of Venezuelans in Colombia had an irregular migration status - meaning they had arrived outside of regular pathways consistent with Colombia's migration laws.[11] As of March 2023, roughly 1.6 million ETPVs have been issued.[12] Having an irregular migration status limits access to formal employment, health insurance, and banking, and thus creates barriers to healthcare. While emergency care, and some preventive services such as vaccinations and ANC,[13,14] have been made available regardless of migration status, other types of care are cost-prohibitive without insurance. Structural vulnerabilities, such as low income, housing instability, food insecurity, and limited formal employment opportunities may increase vulnerability to infectious disease among this population through downstream effects on behaviour and interpersonal relationships, such as transactional sex, experiences of interfamilial and gender-based violence, and limited access to health care and preventive services.[15–17] The effects of structural vulnerabilities may, however, be mitigated by humanitarian and public health responses, as well as strong social support networks. While syphilis screening and treatment services are not available through the national health system to those without health insurance, except for pregnant women and rare urgent cases, some humanitarian organizations in cities with substantial Venezuelan populations such as Cúcuta and Bogotá provide syphilis screening and treatment to Venezuelan refugees and migrants regardless of migration status.

There is limited evidence on the prevalence of syphilis infection among Venezuelan refugees and migrants, with what exists mostly focused on populations engaged in ANC. One study examined Venezuelan forced migration and infectious diseases in Colombia using municipal data and reported that areas with larger forced migration flows had higher syphilis incidence rates.[18] In recent years, increases in congenital syphilis cases have been documented among both Colombian nationals and Venezuelans residing in Colombia. Cases increased sharply during the COVID-19 pandemic to reach 16.2 cases per 1000 births in 2021, compared to 11.1 cases per 1000 births in 2019 and 6.6 per 1000 births in 2016.[19] Between 2018 and 2019, during which time Venezuelan displacement to Colombia peaked, health care utilization related to gestational syphilis by the refugee and migrant population in Colombia increased by 249.5%.[20] Despite these indicators, estimates of syphilis prevalence among the general adult population of Venezuelan refugees and migrants in Colombia, as well as among Colombian nationals, are absent. Our objective for this study was to estimate the prevalence and correlates of syphilis infection among Venezuelan refugees and migrants in Colombia to inform national and regional public health and humanitarian strategies.

Methods

This study, BIENVENIR, or *Bienestar de Venezolanos que son Inmigrantes y Refugiados*, was a cross-sectional behavioural survey that included HIV and syphilis testing among Venezuelan refugees and migrants in two sites, comprised of four cities in two metropolitan areas: 1) Bogotá and Soacha, and 2) Barranquilla and Soledad. These locations were chosen for their high proportion of Venezuelan residents, access to health services, and low presence of "pendular" migrants or those in transit to another country. The study was implemented by a community-based organization, *Red Somos*; a research partner, the Johns Hopkins University, and the Colombian Ministry of Health and Social Protection. Study implementation began with a formative, qualitative phase to inform methods and design.[17] The study protocol, which details the study methods, has been previously published.[21] The primary objective of the study was to estimate HIV prevalence.[22]

The parent study employed respondent-driven sampling (RDS), a social network-based nonprobability sampling method, among Venezuelan refugees and migrants. Detailed results for RDS sampling have been reported elsewhere.[22] Briefly, we enrolled 21 seeds (10–11 per site) who reached a maximum recruitment depth of 17 waves and a median recruitment depth of 9 waves.[21,22] Convergence was met for key variables of interest. We enrolled participants between July 2021 and February 2022. Eligibility criteria included being aged ≥ 18 years; self-reported Venezuelan nationality; self-reported birth in Venezuela; migration to Colombia in 2015 or later; current residence in a study city; no intention to migrate outside of Colombia; no prior participation by an immediate family member; and possession of valid study RDS coupon. Screening and written consent processes were conducted in a private space.

Participants were asked to complete a self-administered survey questionnaire using a tablet or were offered an interviewer-administered survey if literacy was low, as determined by a staff-administered literacy screener. All surveys took place in a private study office. Survey items drew from existing measures when appropriate and covered a range of topics including demographic characteristics, experiences during displacement, experiences of discrimination while in Colombia, health history and health service utilization, food insecurity, employment status,

experiences of interpersonal or gender-based violence, and sexual behaviour.

Participants completed rapid HIV and syphilis screening using Standard Diagnostics (SD) BIOLINE HIV/Syphilis Duo with finger-prick blood specimens for qualitative detection of antibodies specific to HIV-1/2 and/or *Treponema pallidum* (TP). Participants with a reactive result on either or both tests were asked for an additional venous specimen for laboratory-based confirmatory testing following the most recently available national guidelines.[23] Laboratory-based rapid phase reagin (RPR) testing was conducted using HUMAN Diagnostics Syphilis RPR test and titer. Results were interpreted by study staff. Active syphilis was defined as a reactive treponemal test, an RPR titer of ≥1:8, and no history of prior treatment completion. Latent or resolved syphilis was defined as a reactive treponemal test and RPR titer of <1:8 (latent) or a reactive treponemal test, regardless of RPR titer, and report of completing a course of treatment for syphilis (resolved).

Study activities were reviewed and approved by the Ethical Review Committee at the Universidad El Bosque in Bogotá, Colombia, and the Institutional Review Board at Johns Hopkins School of Public Health in Baltimore, Maryland, USA. The protocol was also reviewed per CDC human research protection procedures. Participants were provided with referrals and care navigation as needed for HIV and syphilis care complying with national guidelines,[23,24] as well as referrals for mental health, violence, health, and humanitarian services. *Red Somos* is a leading expert in Colombia on HIV care navigation for those with irregular migration status and provided care navigation services; all other referrals were to community partners known to be appropriate for those with irregular migration status as well. To mitigate risks associated with the ongoing COVID-19 pandemic, study implementation followed approved biosecurity protocols and local COVID-19 policies.

Statistical analyses

Statistical analyses were performed using Stata (StataCorp) version 17. Descriptive analyses included unweighted sample and weighted population estimates of active syphilis prevalence, as well as demographic and other relevant characteristics. Population estimates were weighted using the RDS-II estimator, which weights for participant network size, and have been previously described.[21,22] Some variables were collapsed for analysis, including food insecurity (collapsed to high insecurity vs. low or very low food insecurity) and to reduce the risk of sparse data bias.

We examined correlates of laboratory-confirmed active syphilis infection among the study sample using multivariable logistic regression models. We modelled active infection specifically for each gender group and pregnant women, recognizing that there are potential differences in pathways associated with syphilis infection for each gender group. For pregnant women and transgender participants, the Firth bias adjustment was employed, which reduces bias associated with small samples.[25] Independent variables were selected for analysis based on conceptual relationships. We tested the following covariates based on prior STI research among general population, and ANC covariates for pregnant women were hypothesized: behaviour or identity that aligned with key populations (e.g., MSM, sex work or transactional sex, injecting drug use), experiences of gender-based violence, condom use, HIV infection, migration status, food security, housing security, year of migration, lifetime STI infection, migration with family, age, site, income, partner number, education, employment, literacy level, experiences of discrimination, partner HIV status, humanitarian service utilization, receipt of medical care in Colombia, social network size, history of paid sex, current pregnancy, pregnancy in Colombia, number of ANC visits, denied ANC care, witnessed discrimination in ANC setting, witnessed empathy in ANC setting, experienced empathy in ANC setting, forced sex, and relationship status.

Variables that were associated in bivariate regression at $p \leq 0.1$ were examined for inclusion in the multivariate models for men and women. Variables were selected to be retained in the final multivariable model based on a $p \leq 0.05$ in the multivariable models and absence of evidence of collinearity based on variance inflation factor. For regression models that were restricted to subgroups with smaller samples, including pregnant women and transgender or non-binary participants, a p-value of ≤0.1 was used to identify evidence of association in bivariate and multivariable models. Variables that were no longer significant in the multivariable model were omitted for model parsimony. All multivariable models were adjusted for site and age regardless of whether they were associated in bivariate or multivariable models, except for the model for transgender and non-binary people in which age was not significant and was omitted from the model for parsimony.

For interpretation, we reviewed not only p value but direction and magnitude of association in accordance with the American Statistical Association's guidelines on p-values.[26] Data missingness was minimal, with missingness less than 10% across all variables included in the models; thus, no additional imputation was performed.

Role of the funding source

The funders of this study provided limited technical support and had no role in the study design, data collection, analysis, interpretation, or writing of the manuscript.

Results

6506 people were recruited through RDS, 6221 (95.6%) of whom were eligible and consented to participate and completed study activities. Table 1 displays sample (unweighted) and population (RDS-weighted) characteristics. 65% of the sample was comprised of cisgender women, 34% of cisgender men, and 0.8% of transgender or nonbinary participants. 71% of the sample was estimated to have irregular migration status at the time of the study visit. 96% of the sample was estimated to be sexually active, with a median of 1 partner (IQR: 1–1) in the last year.

HIV prevalence among Venezuelan refugees and migrants was estimated at 0.9% (unweighted: 1.1). 3.2% of the sample was estimated to have a lifetime STI diagnosis; of these participants, HPV, syphilis, and gonorrhoea were most commonly reported. 81% of participants who reported a lifetime STI diagnosis were estimated to have been treated for the infection in Venezuela or Colombia.

Table 2 presents the prevalence of active syphilis by subgroup. A total of 325 (5.2%) participants were identified with an active syphilis infection, yielding a population prevalence of 5.1% (95% CI: 4.6–5.6). The prevalence of latent or resolved syphilis infection was 0.3% (unweighted; n = 21).

Active syphilis infection was elevated among cisgender men (5.8%, [95% CI 4.9–6.9]; unweighted: 6.0%), compared to cisgender women (4.6%, [95% CI 4.0–5.2]; unweighted: 4.7%), though with overlapping confidence intervals. Syphilis infection was also high, at 14.9% (unweighted), among transgender or non-binary participants. Syphilis prevalence was estimated at 16.5% among cisgender men who have sex with men (MSM) ([95% CI 12.1–22.1]; unweighted: 16.9%). Based on observations of confidence intervals, there was no statistical difference in syphilis prevalence across age, site, or migration status.

Syphilis prevalence was 4.3% ([95% CI 3.4–5.4]; unweighted: 4.4%) among those who were pregnant at any point while living in Colombia and 9.0% among the 150 participants who were pregnant at the time of study participation ([95% CI 5.4–14.6]; unweighted: 9.2%). Among cisgender women, current pregnancy was associated with a 2.18-fold increased odds of syphilis infection in bivariate analysis.

Tables 3–6 display descriptive characteristics and results of the bivariate and multivariable regression models for cisgender men, cisgender women, transgender/non-binary participants, and pregnant women.

Key population identity, including identifying as MSM or reporting current transactional sex among women, was independently associated with increased odds of active syphilis infection for men and women (aOR 3.54 [95% CI 2.2–5.7] and 4.08 [95% CI 1.5–11.4], respectively). Self-reported lifetime history of STI diagnosis was associated with increased odds of syphilis infection among cisgender men (aOR: 3.49, 95% CI: 1.7–7.1), and cisgender women (aOR: 12.70, 95% CI: 8.3–19.3). HIV infection was independently associated with syphilis infection among men and transgender persons, but not among women. The number of sexual partners in the past 12 months was also associated with syphilis infection among men and transgender persons wherein each increase in partners was associated with a 1.01 increased odds of syphilis infection among men (95% CI:1.00–1.02) and 1.31 increase among transgender persons (95% CI: 1.0–1.7). Among men, condom use at last intercourse, earning below the minimum wage, and receipt of healthcare in Colombia were associated with syphilis infection in bivariate models but were no longer associated in adjusted models.

Among transgender and non-binary participants, there was an association between current engagement in sex work and active syphilis infection in bivariate models (OR 11.97; 95% CI:1.3–109.3, p-value 0.028); however, the association did not persist once the number of sexual partners was included in the model and was therefore omitted from the final model.

Lifetime history of STI infection was independently associated with a 24-fold increased odds of active syphilis infection among pregnant women. In bivariate analysis, 4 or more ANC visits were associated with a 2.55 increased odds of syphilis infection but did not persist in the adjusted model and was ultimately excluded from the regression models.

Discussion

In this biobehavioral survey of more than 6200 Venezuelan refugees and migrants in Bogotá/Soacha and Barranquilla/Soledad metropolitan areas, we estimated that the population prevalence of primarily active syphilis infection was 5.1%. This estimate is comparatively higher than those most recently reported for the Colombian adult population, which in 2016 was estimated at 1.3%[2] and 1.4% among the Venezuelan adult population in 2005.[3]

We found that the prevalence of active syphilis was higher than the prevalence of latent or resolved syphilis of 0.3%, which is atypical and suggests a rapid increase in syphilis infection, non-treatment access for previously acquired infection or high rates of reinfection among this population. Of note, high titer syphilis (RPR titer of ≥1:8) is less likely to represent old untreated infections, as titers decline over time even without treatment. High rates of recurrence of sexually transmitted infections, including syphilis, have recently been reported among the Colombian population as well.[27]

The prevalence of active syphilis infection was particularly elevated for key populations known to have greater vulnerability to STIs, including transgender

	Sample proportion		Population estimate	
	n	%	n	%
Demographics				
Mean age in years (Std. Dev) (n = 6219)	34.5	(11.3)	–	–
Gender (n = 6217)				
Man	2124	34.2	**33.9**	**(31.8–36.0)**
Woman	4046	65.1	**65.6**	**(63.5–67.7)**
Transgender or Nonbinary	47	0.8	–	–
Education (n = 6218)				
No formal education	127	2.0	**2.3**	**(1.7–3.1)**
Primary	1256	20.2	**19.7**	**(18.8–21.5)**
Secondary	3429	55.2	**54.3**	**(52.0–56.5)**
Higher	1352	21.7	**22.3**	**(20.5–24.2)**
Other	54	0.9	**1.4**	**(0.9–2.2)**
Employment (n = 6219)				
Formal full-time	465	7.5	**8.8**	**(7.6–10.3)**
Formal part-time	284	4.6	**4.9**	**(4.1–5.9)**
Informal/under the table	3028	48.7	**41.2**	**(39.0–43.4)**
Full-time student	28	0.5	**0.5**	**(0.3–1.0)**
Retired	35	0.6	**0.7**	**(0.4–1.1)**
Unemployed	2283	36.7	**41.9**	**(39.7–44.2)**
Other	96	1.5	**2.0**	**(1.4–2.9)**
Income (n = 6220)				
Less than minimum wage (908,526 pesos)	4905	78.9	**76.3**	**(74.3–78.1)**
Minimum wage (908,526 pesos)	988	15.9	**18.2**	**(16.5–20.1)**
Between 908,526 and 1,817,052 pesos	288	4.6	**4.7**	**(3.8–5.8)**
More than 1,817,052 pesos	39	0.6	**0.8**	**(0.5–1.3)**
Relationship status (n = 6220)				
Never married	2287	36.8	**42.2**	**(40.0–44.5)**
Married or cohabitating	2991	48.1	**44.5**	**(42.3–46.7)**
Divorced or separated	812	13.1	**11.2**	**(10.0–12.6)**
Widowed	130	2.1	**2.0**	**(1.5–2.6)**
Food security (USDA measure; past 12mo; n = 6221)				
Secure	414	6.7	**7.9**	**(6.7–9.2)**
Low food security	1407	22.6	**26.5**	**(24.5–28.5)**
Very low food security	4400	70.7	**65.7**	**(63.5–67.8)**
Number of unsafe sleep nights (past 6mo; n = 6220)				
None	5375	86.4	**86.3**	**(84.7–87.8)**
1–10	565	9.1	**9.3**	**(8.1–10.6)**
11–30	161	2.6	**2.6**	**(1.9–3.4)**
31–60	46	0.7	**0.6**	**(0.4–0.9)**
More than 60	73	1.2		
Migration status at time of the study (n = 6221)				
Regular	1779	28.6	**29.3**	**(27.3–31.4)**
Irregular	4442	71.4	**70.7**	**(68.6–72.7)**
Sexual behaviors and sexual health				
Ever sexually active (ref: no; n = 6220)	6028	96.9	**96.3**	**(95.2–97.1)**
Median # of sexual partners in past 12mo (IQR) range 0–750 (n = 6028)	1	(1–1)	–	–
Condom use at last sex (ref: no; n = 6028, regardless of partner gender, does not include sex work)	1727	28.7	**31.2**	**(29.1–33.3)**
Man who has sex with men (among men n = 2124; ref: no)	207	9.8	**12.0**	**(9.6–15.0)**
Ever paid for sex (ref: no; n = 6220)	82	1.3	**1.2**	**(0.8–1.8)**
Lifetime transactional sex (ref: no; n = 6219)	106	1.7	**1.5**	**(1.1–2.2)**
Ever diagnosed with STI (ref: no; n = 6171)	191	3.1	**3.2**	**(2.4–4.3)**
Pathogen of STI (among those diagnosed; n = 152)				

(Table 1 continues on next page)

	Sample proportion		Population estimate	
	n	%	n	%
(Continued from previous page)				
Syphilis	38	22.0	–	–
Gonorrhoea	20	11.6	–	–
Chlamydia	1	0.6	–	–
Herpes	8	4.6	–	–
HPV	65	37.6	–	–
Ever treated for an STI in Venezuela or Colombia (among those diagnosed ref: no; n = 173)	134	77.5	**81.3**	**(68.1–89.8)**
HIV Status (n = 6220)				
Negative	6131	98.8	**99.3**	**(99.1–99.5)**
Newly diagnosed at study visit	37	0.5	**0.4**	**(0.2–0.5)**
Previously diagnosed	34	0.5	**0.3**	**(0.2–0.4)**

Notes: Sample proportions are unweighted estimates; population proportions are weighted for the complex sampling design using the RDS-II estimator. Population estimates were not weighted for some subgroups with small numbers (e.g., transgender participants) or calculated for continuous variables.

Table 1: **Demographics characteristics of Venezuelan refugees and migrants in four cities of Colombia (N = 6221).**

participants and MSM, and was also elevated among women who were pregnant at the time of the study. Our findings of syphilis infection among MSM and transgender people are consistent with other reports from the region, in which prevalence ranged from 9 to 17%.[28–30] Notably, syphilis infection within these groups has been attributed to sexual network composition, rather than individual behavioural risk.[31]

We observed that 9.2% of 150 women who were pregnant at the time of our study had active syphilis infection. While the small sample limits population inference, these estimates do appear to be higher than

	Sample proportion		Population estimate	
	n	%	%	95% CI
Overall syphilis prevalence	325	5.2	**5.1**	**(4.6–5.6)**
Gender				
Male (n = 2123)	127	6.0	**5.8**	**(4.9–6.9)**
Female (n = 4044)	190	4.7	**4.6**	**(4.0–5.2)**
Transgender/Nonbinary (n = 47)	7	14.9	–	–
Migration status				
Regular (n = 1778)	82	4.6	**4.5**	**(3.6–5.5)**
Irregular (n = 4441)	243	5.5	**5.3**	**(4.7–6.0)**
Site				
Bogotá/Soacha (n = 3102)	158	5.1	**5.0**	**(4.2–5.7)**
Barranquilla/Soledad (n = 3117)	167	5.4	**5.2**	**(4.5–6.0)**
Age				
18–30 (n = 2470)	124	5.0	**4.9**	**(4.1–5.8)**
30–39 (n = 1978)	101	5.1	**5.0**	**(4.1–6.0)**
40–49 (n = 1023)	59	5.8	**5.6**	**(4.4–7.2)**
50+ (n = 748)	41	5.5	**5.3**	**(3.9–7.2)**
Currently pregnant (n = 150)	14	9.2	**9.0**	**(5.4–14.6)**
Pregnant at any point in Colombia (n = 1439)	66	4.4	**4.3**	**(3.4–5.4)**
PLHIV (n = 71)	17	23.9	–	–
MSM (n = 207)	35	16.9	**16.5**	**(12.1–22.1)**
Lifetime transactional sex (n = 105)	13	12.4	**12.0**	**(7.1–19.7)**
Ever paid for sex (n = 82)	9	11.0	**10.7**	**(5.7–19.3)**

Notes: Sample proportions are unweighted estimates; population proportions are weighted for the complex sampling design using the RDS-II estimator. Population estimates were not weighted for some subgroups with small numbers (e.g., transgender participants and people living with HIV).

Table 2: **Estimated syphilis prevalence among Venezuelan refugees and migrants and key subgroups in four cities of Colombia (N = 6221).**

Characteristic	Active syphilis infection				Characteristics associated with active syphilis infection					
	No		Yes		Bivariate model			Multivariable model		
	n	Col %	n	Col %	OR	95% CI	p-value	aOR	95% CI	p-value
Age (continuous)	34 (mean)		35 (mean)		1.01	(0.99–1.02)	0.28	1.02	(0.99–1.03)	0.057
Site										
Bogotá/Soacha	1146	94.2%	70	5.8%	Reference			Reference		
Barranquilla/Soledad	850	93.7%	57	6.3%	1.10	(0.76–1.57)	0.61	1.07	(0.73–1.58)	0.71
MSM										
No	1824	95.2	92	4.8%	Reference			Reference		
Yes	172	93.1	35	16.9%	4.03	(2.65–6.14)	<0.0001	3.54	(2.19–5.71)	<0.0001
Lifetime STI diagnosis										
No	1926	94.6%	109	5.4%	Reference			Reference		
Yes	41	71.9%	16	28.1%	6.90	(3.75–12.68)	<0.0001	3.49	(1.71–7.14)	0.0006
Laboratory-confirmed HIV infection										
Negative	1968	94.5%	114	5.5%	Reference			Reference		
Positive	28	68.3%	13	31.7%	8.02	(4.04–15.89)	<0.0001	2.74	(1.18–6.36)	0.019
Number of sexual partners in last 12 months	2 (mean)		6 (mean)		1.01	(1.00–1.02)	0.017	1.01	(1.00–1.02)	0.030
Income										
Minimum wage or higher	521	96.0%	22	4.1%	Reference			–	–	–
Less than minimum wage	1475	93.4%	105	6.7%	1.69	(1.05–2.70)	0.030	–	–	–
Condom use at last intercourse										
No	1215	94.9%	65	5.1%	Reference			–	–	–
Yes	700	92.2%	59	7.8%	1.58	(1.09–2.27)	0.015	–	–	–
Any healthcare utilization in Colombia										
Yes	436	91.4%	41	8.6%	1.70	(1.16–2.51)	0.0070	–	–	–
No	1557	94.8%	86	5.2%	Reference			–	–	–

Table 3: **Estimated syphilis prevalence among Venezuelan refugee and migrant men in four cities of Colombia (n = 2123).**

the 2.8% prevalence reported for ANC attendees in Venezuela[5] and regional estimates of 2.6% prevalence among all pregnant women in Latin America as well.[4] The early testing and treatment of pregnant women for syphilis is crucial to syphilis control strategies and is standard in ANC programming, including in Colombia, which is available to all Venezuelan women regardless of migration status. However, we found no evidence of association between history of any ANC service utilization nor the number of ANC visits and syphilis infection. It should be noted that this study was carried out amidst the ongoing COVID-19 pandemic. Throughout 2021 and 2022, the epidemiological effects of COVID-19 persisted, resulting in diverse social consequences, such as exacerbated social inequities by which the Venezuelan refugee and migrant population have been severely impacted.[17] Notably, cases of congenital and gestational syphilis increased substantially in Colombia in this period.[19] Anecdotal reports from healthcare providers serving refugee and migrant communities in Colombia have described challenges in having pregnant women and their sexual partners initiate and complete the standard 3-course treatment of benzathine penicillin, though the barriers are not yet fully understood. This suggests that innovative strategies that are integrated into ANC services may be needed to support syphilis treatment for Venezuelan refugee and migrant women and ultimately achieve comparable successes in gestational syphilis treatment as observed among citizens in Colombia.[5]

We observed both similar and unique correlates of syphilis across gender categories. Correlates of syphilis infection among cisgender men tended to reflect known behavioural risks for STIs, such as same-sex relationships, lifetime STI infection, and HIV infection. Among cisgender women, however, correlates of syphilis infection reflected social and structural vulnerabilities, including food insecurity and access to health services, as well as behavioural risk including transactional sex and lifetime history of STI infection. These differences should inform tailored prevention strategies.

Lifetime STI infection, regardless of the pathogen, was the single correlate that was universally associated with syphilis infection among men and women. Because 3% of Venezuelans had a lifetime history of STI and 80% of those had been treated, this association suggests ongoing sexual exposure after past diagnoses and treatment and indicates an opportunity for increased counselling and testing for people with past STIs, as well as increased opportunities for STI testing and treatment.

Characteristic	Active syphilis infection				Characteristics associated with active syphilis infection					
	No		Yes		Bivariate model			Multivariable model		
	n	Col %	n	Col %	OR	95% CI	p-value	aOR	95% CI	p-value
Age	34 (mean)		35 (mean)		1.01	(0.99–1.02)	0.304	1.01	(1.00–1.02)	0.13
Site										
Bogotá/Soacha	1776	95.6%	82	4.4%	Reference			Reference		
Barranquilla/Soledad	2079	95.1%	108	4.9%	1.13	(0.84–1.51)	0.43	1.05	(0.77–1.43)	0.77
Migration Status										
Regular	1016	9.6%	36	3.4%	Reference			Reference		
Irregular	2839	94.9%	154	5.2%	1.53	(1.06–2.16)	0.024	1.46	(0.99–2.14)	0.053
Lifetime STI diagnosis										
No	3746	96.2%	149	3.8%	Reference			Reference		
Yes	92	69.2%	41	30.1%	11.20	(7.49–16.76)	<0.0001	12.70	(8.35–19.30)	<0.0001
Food security										
Secure	212	98.6%	3	1.4	Reference			Reference		
Insecure	3643	95.1%	187	4.9%	3.63	(1.14–11.45)	0.028	3.22	(1.00–10.37)	0.050
Recent sex work (last 7 days)										
No	3827	95.4%	185	4.6%	Reference			Reference		
Yes	27	84.4%	5	15.62%	3.83	(1.46–10.07)	0.0064	4.08	(1.46–11.41)	0.0073
Ever accessed health care in Colombia										
Yes	1387	96.2%	55	3.8%	Reference			Reference		
No	2468	94.8%	135	5.2%	1.37	(1.00–1.90)	0.049	1.59	(1.13–2.24)	0.0085
Currently pregnant										
No	3719	95.5%	176	4.5%	Reference			Reference		
Yes	136	90.1%	14	9.3%	2.18	(1.23–3.85)	0.0076	2.39	(1.29–4.42)	0.0056
Any unsafe night in Colombia										
No	3385	95.5%	159	4.5%	Reference			Reference		
Yes	470	93.8%	31	6.2%	1.40	(0.94–2.09)	0.094	1.51	(1.00–2.28)	0.050

Table 4: **Estimated syphilis prevalence among Venezuelan refugee and migrant women in four cities of Colombia (n = 4044).**

Notably, 23.9% of participants who were living with HIV were co-infected with syphilis. HIV and syphilis coinfection is believed to alter the natural history of syphilis and increase the risk of treatment failure and neurosyphilis.[32] From a clinical perspective, elevated rates of active syphilis prevalence among pregnant women and PLHIV are troubling given the adverse outcomes associated with syphilis infection in these populations. These findings suggest the necessity of prioritizing testing and treatment for these groups while strengthening ANC and HIV testing services. In Colombia, a randomized control trial of single versus

Characteristic	Active syphilis infection				Characteristics associated with active syphilis infection					
	No		Yes		Bivariate model			Multivariable model		
	n	Col %	n	Col %	OR	95% CI	p-value	aOR	95% CI	p-value
Site										
Bogotá/Soacha	19	79.2%	5	20.8%	Reference			Reference		
Barranquilla/Soledad	21	91.3%	2	8.7%	0.41	(0.08–2.07)	.28	0.65	(0.10–4.21)	0.65
Laboratory-confirmed HIV infection										
Negative	38	88.4%	5	11.6%	Reference			Reference		
Positive	2	50.0%	2	50.0%	7.00	(0.98–50.07)	.053	6.98	(0.82–59.66)	0.076
Number of sexual partners in last 12 months	1 (mean)		7 (mean)		1.37	(1.04–1.81)	.026	1.31	(1.04–1.67)	0.024
Recent transactional sex (last 7 days)										
No	39	88.6%	5	11.4%	Reference			–	–	–
Yes	1	33.3%	2	66.7%	11.97	(1.31–109.34)	.028	–	–	–

Table 5: **Estimated syphilis prevalence among transgender and nonbinary Venezuelan refugees and migrants in four cities of Colombia (n = 47).**

Characteristic	Active syphilis infection				Characteristics associated with active syphilis infection					
	No		Yes		Bivariate model			Multivariable model		
	n	Col %	n	Col %	OR	95% CI	p-value	aOR	95% CI	p-value
Age	25 (mean)		27 (mean)		1.06	(0.97–1.16)	0.20	1.07	(0.98–1.18)	0.15
Site										
Bogotá/Soacha	75	90.4%	8	9.6%	Reference			Reference		
Barranquilla/Soledad	63	91.3%	6	8.7%	0.91	(0.31–2.67)	0.86	1.05	(0.33–3.36)	0.93
Lifetime history of STI diagnosis										
No	136	93.2%	10	6.9%	Reference			Reference		
Yes	2	33.3%	4	66.7%	23.40	(4.41–124.13)	<0.0001	24.14	(4.42–131.91)	<0.0001
ANC visits in most recent pregnancy										
4 or more	46	85.2%	8	14.8%	2.55	(0.86–7.50)	0.090	–	–	–
3 or fewer	90	93.8%	6	6.3%	Reference			–	–	–

Table 6: **Estimated syphilis prevalence among pregnant Venezuelan refugees and migrants in four cities of Colombia (n = 150).**

dual rapid diagnostic test (RDT) for HIV and syphilis testing in ANC services found that costs were elevated for the dual RDT, compared to the single RDT arm, largely due to associated health professional costs.[33] However, subsequent mathematical modelling found that the use of the dual RDT during the first ANC visit was cost saving and retesting during late ANC with the RDT was cost-effective in Colombia.[34] Using a dual RDT in settings serving Venezuelans and host communities may be one strategy to improving diagnosis and treatment and employing the dual RDT may also be cost-effective when integrated into services for key populations in Colombia.

Syphilis, when diagnosed, is highly treatable. However, the highly mobile nature of this study population complicates treatment; especially in the context of experiences of discrimination, barriers to accessing care, lack of knowledge, and other factors.[17] Most syphilis treatments require multiple clinical visits, complicating effective treatment in mobile and economically disadvantaged populations. Doxycycline is effective for the treatment of syphilis in nonpregnant persons.[35] Unlike other syphilis treatments, which must be administered in a clinical setting and require multiple visits, Doxycycline is an oral treatment and thus is uniquely appropriate for treating syphilis in mobile populations or among those who otherwise may not be able to return to a clinical setting multiple times. Treatment not only for the person found to have active syphilis infection but also for any sexual partners, is crucial to both treating syphilis infection on a patient level and controlling the potential for spread on a population level. Even if access to syphilis treatment is improved for refugees and migrants residing in Colombia, those with partners who remain untreated (e.g., partners who remain in Venezuela) are likely to become reinfected even if they receive timely and effective treatment. Our efforts to link those we identified with active syphilis infection to care underscore these concerns; a small number of participants had already returned to Venezuela before delivery of syphilis results, and others were planning to visit partners in Venezuela in the near future. While partner notification and contact tracing services are labour intensive, expedited partner therapy with Doxycycline (wherein the patient is provided with courses of Doxycycline for both themselves and their partner[s]) should be considered and has been previously advocated for in the Colombian context.[36] It is important to note that treatment in adherence to clinical guidelines is a documented challenge among Colombian nationals as well.[27]

Colombia's recent establishment of the ETP for Venezuelan refugees and migrants will make more Venezuelans eligible to register for health insurance, supporting the linkage of Venezuelans with active syphilis to treatment. It may also reduce vulnerabilities which predispose the population to syphilis exposure and increase their utilization of general health services.[37] Between the establishment of the ETP in October 2022 to March 2023, roughly 1.6 million Venezuelans, or slightly over half of the estimated 2.8 Venezuelans residing in Colombia, had registered for the ETP.[12] Nevertheless, our finding that there was no evidence of an association between engagement in ANC services and syphilis infection among pregnant women suggests that many Venezuelans will likely remain vulnerable if complementary measures are not introduced into both regular health services as well as syphilis treatment planning. The unique needs of this population, owing to their mobility and other structural vulnerabilities, must be met through rigorous patient navigation services to ensure continuity of care. In the case of syphilis, partner services are also crucial to lower the risk of reinfection. For those with partners living in Venezuela, creative solutions must be employed to avoid reinfection.

Our findings are not without limitations. Although RDS reduces selection bias, our sample may still be skewed towards persons who are willing to volunteer for

research. Our sample size is sufficiently large to estimate population prevalence among Venezuelan refugees and migrants; however, the study was not powered to estimate prevalence among all subgroups, thus, subgroup analyses should be interpreted with caution. Our samples of participants who were pregnant women and transgender individuals were small, so we may not have identified associations which would be observed with a larger sample size. It is also important to note that our sample was restricted to those residing in Bogotá, Soacha, Barranquilla, and Soledad metropolitan areas and results may not be generalizable to other cities or rural locations. Additionally, while extensive efforts were made to increase the participation of men, women were more likely to participate, likely as a result of the restriction to one participant per household. However, our large sample size and use of RDS to reach underlying networks limits the impact that disproportionate enrollment among men and women may have had on findings. Lastly, the clinical staging of syphilis is imperfect without prior serology; however, the use of a high titer RPR and history of prior treatment maximizes the likelihood of accurate identification of active infection.

Conclusions

Syphilis prevalence is elevated among the general adult population of Venezuelan refugees and migrants in Colombia, as well as among key populations and pregnant women, and consists of primarily active cases. Regression models suggest that sexual exposure as well as social and structural vulnerabilities are associated with syphilis infection and highlight important areas for intervention. Our findings underscore the importance of ensuring access to preventative services, as well as improved access to syphilis diagnosis and treatment, strategies to support testing and treatment for partners in neighbouring countries, and the need for integration of refugees and migrants into regular health services with the host community.

Contributors

ALW, JRG, MS, KRP, RLN, and PBS designed the study protocol and data collection tools. JRG and MÁBT led the study implementation. JO, JJL, and JFRC supervised data collection at study sites and laboratory procedures. RLN and JAFN contributed their expertise in public health policy. ALW oversaw the study with coordination by MS. ALW, MS, and JRG accessed and verified the data. MS and ALW conducted the statistical analysis. MS wrote the first draft of the manuscript. All authors had full access to all the data in the study, reviewed the manuscript, were responsible for the decision to submit the manuscript for publication, and approved the manuscript for publication.

Data sharing statement

Data sharing requests should be sent to the corresponding author and will be reviewed by lead investigators (ALW, PBS, MÁBT, and RLN) from the collaborating organisations (ie, Johns Hopkins University, Red Somos, and the Colombian Ministry of Health and Social Protection). Deidentified individual participant data and a data dictionary defining each field in the set are available upon request after a proposal is approved and the data use agreement is signed. The survey and consent form will be provided with study data upon approval of the data request and signed data use agreement. The study protocol has previously been published.[21]

Declaration of interests

AW receives separate funding from ViiV Healthcare to her institution for unrelated research. All authors declare no competing interests.

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Appendix A. Supplementary data

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