

## Review Article

# Extragenital Infections Caused by *Chlamydia trachomatis* and *Neisseria gonorrhoeae*: A Review of the Literature

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In the United States, sexually transmitted diseases due to *Chlamydia trachomatis* and *Neisseria gonorrhoeae* continue to be a major public health burden. Screening of extragenital sites including the oropharynx and rectum is an emerging practice based on recent studies highlighting the prevalence of infection at these sites. We reviewed studies reporting the prevalence of extragenital infections in women, men who have sex with men (MSM), and men who have sex only with women (MSW), including distribution by anatomical site. Among women, prevalence was found to be 0.6–35.8% for rectal gonorrhea (median reported prevalence 1.9%), 0–29.6% for pharyngeal gonorrhea (median 2.1%), 2.0–77.3% for rectal chlamydia (median 8.7%), and 0.2–3.2% for pharyngeal chlamydia (median 1.7%). Among MSM, prevalence was found to be 0.2–24.0% for rectal gonorrhea (median 5.9%), 0.5–16.5% for pharyngeal gonorrhea (median 4.6%), 2.1–23.0% for rectal chlamydia (median 8.9%), and 0–3.6% for pharyngeal chlamydia (median 1.7%). Among MSW, the prevalence was found to be 0–5.7% for rectal gonorrhea (median 3.4%), 0.4–15.5% for pharyngeal gonorrhea (median 2.2%), 0–11.8% for rectal chlamydia (median 7.7%), and 0–22.0% for pharyngeal chlamydia (median 1.6%). Extragenital infections are often asymptomatic and found in the absence of reported risk behaviors, such as receptive anal and oral intercourse. We discuss current clinical recommendations and future directions for research.

## 1. Introduction

Sexually transmitted diseases (STDs) continue to be a significant cause of morbidity in the United States (US) with an estimated \$15.9 billion spent annually on healthcare costs related to their diagnosis and treatment [1]. The two most common reportable bacterial STDs in the US are gonorrhea and chlamydia [2]. Chlamydia is caused by the bacterium *Chlamydia trachomatis* and is the most commonly reported STD. In 2014, over 1.4 million cases of chlamydia were diagnosed in the US [2], a 2.8% increase from the prior year and the greatest number of cases ever reported for an STD. Of chlamydia cases in 2014, the majority were among younger adults age 15–24 and women (70%). Despite overall higher prevalence of chlamydia infection among women in the US, diagnoses among men increased by 6.8% from 2013 to 2014. The difference in chlamydia diagnoses by

gender can likely be attributed to routine screening practices among women [2]. The major primary care guidelines in the US recommend annual chlamydia screening of all sexually active young women (age 24 years and younger) as part of annual routine reproductive healthcare services [3]. Similar to chlamydia, gonorrhea also disproportionately impacts younger populations. Gonorrhea is caused by the bacterium *Neisseria gonorrhoeae* with over 350,000 cases reported in 2014, a 5.1% increase from the prior year and a 10.5% increase since 2010 [2]. Unlike chlamydia, gonorrhea is now more prevalent among men than women. The number of gonorrhea cases among men increased by 27.9% from 2010 to 2014, whereas the number of cases among women decreased by 4.1% during that time. The rising number of new chlamydia and gonorrhea cases among men is likely due to increased diagnoses among gay, bisexual, and other men who have sex with men (MSM) [4, 5].

Gonorrhea and chlamydia are often asymptomatic in men as well as women. In men, only 14% infected with chlamydia and 40% infected with gonorrhea may be symptomatic [6, 7]. In women, urogenital chlamydia initially infects the cervix, causing symptoms of cervicitis which can then spread to the upper reproductive tract and cause pelvic inflammatory disease (PID). Untreated urogenital infections can lead to other serious complications such as chronic pain, ectopic pregnancy, and infertility [8]. The presence of gonorrhea or chlamydia at any site also increases the risk of acquiring HIV in both men and women [9, 10]. Complications specific to men include epididymitis, prostatitis, and proctitis. Both men and women with symptomatic urogenital infection most commonly present with urethritis, characterized by dysuria and urethral discharge. Reactive arthritis may also occur, often as part of a triad of other symptoms including urethritis and conjunctivitis [11].

*N. gonorrhoeae* and *C. trachomatis* can also be detected in the pharynx and rectum [2]. Gonorrhea and chlamydia infection in the rectum can cause rectal pain, bleeding, and discharge, as well as proctitis. In the pharynx, these infections can cause symptoms, such as pharyngitis and lymphadenitis, but are most often asymptomatic. Given that extragenital testing is not always part of routine STD screening, particularly in the absence of symptoms, many extragenital infections are undiagnosed and untreated. These untreated extragenital infections are a potential reservoir for ongoing transmission and may also lead to increased risk of HIV acquisition. Extragenital testing for *N. gonorrhoeae* and *C. trachomatis* is an emerging area that should be considered in both men and women. We review current screening recommendations and evidence to support extragenital testing for *N. gonorrhoeae* and *C. trachomatis* and discuss areas where future research is needed.

## 2. Materials and Methods

Current guidelines related to extragenital screening for *N. gonorrhoeae* and *C. trachomatis* in men and women were reviewed. A literature review was performed of all studies listed in PubMed evaluating extragenital gonorrhea and chlamydia infections through December 1, 2015. Studies included those describing extragenital infections by *N. gonorrhoeae*, *C. trachomatis*, or both, conducted in the US as well as internationally. The goal of the review was to describe the current epidemiology and prevalence of extragenital infections in the setting of the latest recommendations for screening. We specifically examined extragenital infections in separate subgroups of populations, including women, men who have sex only with women (MSW), and MSM. Only studies in English were included. The search terms “extragenital,” “rectal,” “pharyngeal,” “chlamydia,” and “gonorrhea” were used in combination and individually. References were reviewed and subsequently excluded if the study did not include findings of extragenital *N. gonorrhoeae* or *C. trachomatis* infection. Additionally, citations within these studies were reviewed and included if relevant. Full texts of relevant studies were retrieved and reviewed.

## 3. Results and Discussion

**3.1. Current Screening Recommendations.** The Centers for Disease Control and Prevention (CDC) currently recommends that all sexually active women less than 25 years of age, as well as older women who have specific risk factors (e.g., new or concurrent sex partners), be tested annually for urogenital chlamydia and gonorrhea infection [12]. Per the guidelines, the clinical significance of pharyngeal chlamydia infection is unclear and routine pharyngeal screening for chlamydia is not recommended [12–14]. The US Preventive Services Task Force (USPSTF), the preeminent primary care guidelines in the US, recommends screening for chlamydia and gonorrhea in all sexually active women of age 24 years and younger, and in older women who are at increased risk for infection (e.g., due to another current STD, a previous STD, new or concurrent sex partners, inconsistent condom use, drug use, commercial sex work, certain demographic characteristics, or high community prevalence of STDs). The American Congress of Obstetricians and Gynecologists (ACOG) recommends annual urogenital screening for gonorrhea and chlamydia for sexually active women age 25 years and younger, as well as for women over age 25 reporting risk factors for infection [15].

The CDC does not recommend routine chlamydia or gonorrhea screening in men [12], with the exception of “considering” screening in high-prevalence clinical settings such as STD clinics or among high-prevalence populations such as MSM. The CDC recommends that MSM be screened at least annually for chlamydia infection at sites of sexual contact, including the rectum and urethra; for gonorrhea, the guidelines recommend screening at the urethra, rectum, and pharynx. Per these guidelines, screening should be based on risk behaviors. MSM who report insertive sex should be screened for urogenital *N. gonorrhoeae* and *C. trachomatis*. MSM who report receptive anal sex should be screened for rectal *N. gonorrhoeae* and *C. trachomatis*. MSM who report receptive oral sex should be screened for pharyngeal *N. gonorrhoeae* only; screening for *C. trachomatis* pharyngeal infection is not recommended. The USPSTF does not recommend screening for chlamydia or gonorrhea in MSW due to insufficient evidence to support this practice.

The majority of international STD treatment guidelines provide recommendations for extragenital testing in MSM. The International Union Against Sexually Transmitted Infections (IUSTI) recommends extragenital testing for both MSM and women at the rectum and pharynx if there is a reported history of sexual exposure [16, 17]. Similarly, the British Association for Sexual Health and HIV (BASHH) recommends that extragenital screening for chlamydia and gonorrhea infections be dependent on reported sexual behaviors among men and women [18]. The guidelines also recommend extragenital testing among specific groups of women, such as commercial sex workers [19, 20]. Other countries, such as South Africa, employ an algorithm-driven, syndromic approach to STD testing and treatment [21].

The group of women who have sex with women (WSW) encompasses a diverse set of individuals and sexual practices. The CDC addresses this unique group, recommending that

screening for *N. gonorrhoeae* and *C. trachomatis* be based on a detailed history of sexual practices [12]. The CDC also specifically addresses transgender men and women and recommends STD risk assessment and testing be based on current anatomy and sexual behaviors in this group [12].

**3.2. Overview of Existing Literature.** A total of 80 studies were reviewed focusing on extragenital infection with *N. gonorrhoeae* or *C. trachomatis*. Studies were published between 1981 and 2015 and included sites in North America ( $n = 37$ ), Europe ( $n = 29$ ), Australia ( $n = 9$ ), Asia ( $n = 4$ ), and Africa ( $n = 2$ ). Study settings included STD clinics ( $n = 38$ ), other outpatient clinics ( $n = 10$ ), genitourinary clinics ( $n = 7$ ), HIV clinics ( $n = 9$ ), gay men's health centers ( $n = 3$ ), community-based and outreach settings ( $n = 6$ ), and other settings ( $n = 3$ ); a minority of studies presented findings from multiple sites ( $n = 6$ ). Most studies evaluated a single population but some did include multiple populations of women, MSW, and MSM. The number of studies reporting specific populations included MSM ( $n = 54$ ), women ( $n = 33$ ), MSW ( $n = 9$ ), and mixed populations ( $n = 9$ ). The following sections describe extragenital *N. gonorrhoeae* and *C. trachomatis* infection in these different populations.

**3.3. Extragenital Infections in Women.** A total of 33 studies reported prevalence of extragenital infection in women due to *N. gonorrhoeae* or *C. trachomatis* infection [19, 22–52] (Table 1). The range of prevalence of extragenital infections reported was 0.6–35.8% for rectal gonorrhea (median 1.9%), 0–29.6% for pharyngeal gonorrhea (median 2.1%), 2.0–77.3% for rectal chlamydia (median 8.7%), and 0.2–3.2% for pharyngeal chlamydia (median 1.7%). Most study sites were STD clinics and other high-risk settings; few were primary care settings, clinics focusing on women's care, or centers focusing on transgender patient care.

Most extragenital infections in women are asymptomatic, with estimates including 93% of pharyngeal gonorrhea [39], 53–100% of rectal gonorrhea [39], 100% of pharyngeal chlamydia [39], and 36–100% of rectal chlamydia cases [29, 30, 39]. Furthermore, a significant number of women who test positive for rectal gonorrhea or chlamydia do not report anal sex [19, 29, 53]. Extragenital screening increases the yield of detection of either gonorrhea or chlamydia at pharyngeal or rectal sites by approximately 6–50% or greater in women compared to screening urogenital specimens alone [23–25, 27, 29–31, 39, 44–46]. Overall, reported risk factors for rectal infection in women include younger age ( $n = 2$  studies), sex with an injection drug user ( $n = 1$ ), exchanging sex for money ( $n = 2$ ), anonymous partners ( $n = 1$ ), a sex partner with gonorrhea or chlamydia ( $n = 1$ ), and sex while under the influence of drugs or alcohol ( $n = 1$ ) [23, 31, 48]. However, other studies have not found any associations with these risk factors [29, 30].

Based on prevalence data, universal screening for extragenital infection due to *N. gonorrhoeae* or *C. trachomatis* in settings which care for women who are at risk of these infections (e.g., those who are sexually active with concurrent or nonmutually monogamous partners, regardless of reported exposure sites) should be considered. Due to the frequency

of asymptomatic extragenital infections and the inaccuracy of testing based on self-reported behavior [19], the evidence supports routine screening in high-risk settings such as STD clinics. Universal screening for extragenital infection will certainly increase case finding, which in turn will likely have both clinical and public health benefits such as avoiding reproductive health sequelae and limiting HIV transmission. However, extragenital screening protocols among sexually active women are not currently widespread, and further study is needed to evaluate the impact on sexual health outcomes. Additionally, given the paucity of extragenital infection studies in other settings (e.g., primary care clinics), prevalence in these settings is largely unknown and merits further study.

**3.4. Extragenital Infections in MSM.** A total of 53 studies evaluated the prevalence of extragenital infections due to *N. gonorrhoeae* or *C. trachomatis* in MSM [13, 19, 22, 25–27, 36, 38, 44, 45, 47–49, 54–93] (Table 2). Extragenital infections among MSM have been studied more extensively compared to women. MSM experience high rates of both extragenital gonorrhea and chlamydia. The prevalence of extragenital infection among MSM in these studies ranged from 0.2–24% for rectal gonorrhea (median 5.9%), 0.5–16.5% for pharyngeal gonorrhea (median 4.6%), 2.1–23% for rectal chlamydia (median 8.9%), and 0–3.6% for pharyngeal chlamydia (median 1.7%); the differences are due to different clinical settings and methods of diagnosis. Several studies have evaluated the national prevalence of extragenital infections among MSM in the US [12, 24, 29, 30, 35, 43, 59, 63–65, 69–71, 73, 74, 76–78, 80, 82, 83]. In a large cohort of 3,034 MSM who attended a STD clinic in Seattle, Washington in 2011, extragenital infections were common and included pharyngeal gonorrhea (6.5%) and chlamydia (2.3%), and rectal gonorrhea (9.7%) and chlamydia (11.9%) [57]. Fifty-seven percent of cases were found in only extragenital sites (nonurogenital).

Similarly, among 21,994 MSM screened as part of the CDC STD Surveillance Network, composed of 42 STD clinics across the US, the prevalence of infection was 7.9% for pharyngeal gonorrhea, 2.9% for pharyngeal chlamydia, 10.2% for rectal gonorrhea, and 14.1% for rectal chlamydia. Over 70% of extragenital infections in this sample would have been missed with urogenital screening alone. In summary, urogenital testing alone misses a significant percentage of gonorrhea and chlamydia infections among MSM; if MSM were screened for urogenital infections alone, 14% to 85% of rectal and oropharyngeal gonorrhea and chlamydia infections would have been missed [22, 57, 63, 64, 68, 79, 80].

The majority of extragenital infections among MSM are asymptomatic, with estimates ranging from 25% to 100% from reported studies [68, 76, 80, 89, 92, 94]. Men with extragenital gonorrhea may be more likely to be symptomatic than those with chlamydia [25, 62, 71, 95, 96]. For example, in one large study of MSM with extragenital infection, only 5.1% of pharyngeal and 11.9% of rectal infections were symptomatic with the most common pharyngeal symptoms being pharyngitis (65%), localized lymphadenopathy (16%), and inflammation of the oral cavity (10%). The most common

TABLE 1: Characteristics of studies reporting extragenital infections due to *N. gonorrhoeae* and *C. trachomatis* among women.

| Author                       | Study year | Location             | Setting                         | Time period | Risk         | Sample    | Urogenital | Rectal    | Pharyngeal | Urogenital | Rectal | Pharyngeal | Chlamydia |
|------------------------------|------------|----------------------|---------------------------------|-------------|--------------|-----------|------------|-----------|------------|------------|--------|------------|-----------|
| Jones et al. [33]            | 1985       | Indiana (US)         | STD clinic                      | 1985        | Women        | 686/1,223 | —          | —         | —          | 28.00%     | 5.20%  | 3.20%      | —         |
| Ostergaard et al. [38]       | 1997       | Denmark              | STD clinic                      | 1995-1996   | Women        | 196       | —          | —         | —          | 3.60%      | 3.10%  | 1.50%      | —         |
| Linhart et al. [35]          | 2008       | Tel Aviv, Israel     | Sex worker outreach             | 2008        | Women        | 300       | 5.00%      | —         | 9.00%      | 6.30%      | —      | —          | —         |
| van der Helm et al. [49]     | 2009       | Netherlands          | STD clinic                      | 2006-2007   | Women        | 936       | —          | 2.00%     | —          | —          | 9.00%  | —          | —         |
| Barry et al. [24]            | 2010       | California (US)      | STD clinic                      | 2007-2008   | Women        | 1,308     | 1.80%      | 1.70%     | —          | 5.40%      | 4.70%  | —          | —         |
| Giannini et al. [28]         | 2010       | Ohio (US)            | STD clinic, childrens' hospital | 2003-2007   | Women        | 1,949     | 5.6-9.3%   | 2.9-13.4% | 2.5-6.8%   | —          | —      | —          | —         |
| Hunte et al. [30]            | 2010       | Florida (US)         | STD clinic                      | 2007        | Women        | 97        | 8.20%      | 13.40%    | —          | 16.50%     | 17.50% | —          | —         |
| Raychaudhuri and Birley [41] | 2010       | United Kingdom       | Genitourinary clinic            | 2005-2008   | Women        | 120       | 27.50%     | 35.80%    | —          | —          | —      | —          | —         |
| Sethupathi et al. [42]       | 2010       | United Kingdom       | Genitourinary clinic            | 2006-2008   | Women        | 152       | —          | —         | —          | 11.90%     | 12.50% | —          | —         |
| Peters et al. [39]           | 2011       | Netherlands          | STD clinic                      | 2007-2008   | Women        | 4,299     | 1.10%      | 1.70%     | 0.80%      | 10.00%     | 8.70%  | 1.90%      | —         |
| Javanbakht et al. [31]       | 2012       | California (US)      | STD clinic                      | 2008-2010   | Women        | 2,084     | 3.30%      | 3.00%     | —          | 12.00%     | 14.60% | —          | —         |
| Koedijk et al. [22]          | 2012       | Netherlands          | STD clinic                      | 2006-2010   | Women        | 207,134   | 1.00%      | 1.20%     | 1.20%      | 10.40%     | 9.30%  | 2.70%      | —         |
| Mayer et al. [36]            | 2012       | US (4 cities)        | HIV clinic                      | 2004-2006   | Women (HIV+) | 119       | 1.00%      | 1.00%     | 2.00%      | 3.00%      | 2.00%  | 2.00%      | —         |
| Diaz et al. [26]             | 2013       | Spain                | STD clinic                      | 2006-2010   | Women        | 318       | 0.90%      | 3.10%     | 29.60%     | —          | —      | —          | —         |
| Shaw et al. [43]             | 2013       | United Kingdom       | Genitourinary clinic            | 2013        | Women        | 2,808     | 0.50%      | 0.60%     | 0.30%      | 6.70%      | 7.10%  | 1.30%      | —         |
| van Liere et al. [45]        | 2013       | Netherlands          | STD clinic                      | 2010-2011   | Women        | 1,321     | 1.30%      | 0.90%     | 2.30%      | 5.40%      | 4.80%  | 1.40%      | —         |
| Dimech et al. [102]          | 2014       | Australia            | Surveillance system             | 2008-2010   | Women        | 415,069   | —          | —         | —          | 6.7-10%    | 5.20%  | 1.70%      | —         |
| Jenkins et al. [32]          | 2014       | Illinois (US)        | Emergency room                  | 2012-2013   | Women        | 301       | 1.00%      | —         | 0.70%      | 6.30%      | —      | 0.70%      | —         |
| Ladd et al. [34]             | 2014       | US (multiple cities) | Mail                            | 2009-2011   | Women        | 205       | —          | 2.50%     | —          | —          | 11.10% | —          | —         |
| Peters et al. [40]           | 2014       | South Africa         | Primary care clinic             | 2011-2012   | Women        | 604       | 10.00%     | 2.50%     | 0.00%      | 16.00%     | 7.10%  | 0.20%      | —         |
| van Liere et al. [46]        | 2014       | Netherlands          | STD clinic                      | 2012-2013   | Women        | 663       | —          | —         | —          | 11.20%     | 8.40%  | —          | —         |
| van Liere et al. [47]        | 2014       | Netherlands          | STD clinic                      | 2010-2012   | Women        | 1,321     | 1.30%      | 0.90%     | 2.30%      | 5.40%      | 4.80%  | 1.40%      | —         |
| Bazan et al. [23]            | 2015       | Ohio (US)            | STD clinic                      | 2012-2013   | Women        | 331       | 7.00%      | 6.00%     | —          | 13.00%     | 13.00% | —          | —         |

TABLE 1: Continued.

| Author                  | Study year | Location          | Setting                | Time period | Risk               | Sample | Urogenital | Gonorrhea Rectal | Pharyngeal | Urogenital | Chlamydia Rectal | Pharyngeal |
|-------------------------|------------|-------------------|------------------------|-------------|--------------------|--------|------------|------------------|------------|------------|------------------|------------|
| Danby et al. [25]       | 2016       | Pennsylvania (US) | STD clinic             | 2014-2015   | Women              | 175    | 2.90%      | 2.30%            | 2.30%      | 10.30%     | 11.40%           | 1.70%      |
| Muijers et al. [19]     | 2015       | Netherlands       | STD clinic             | 2010-2013   | Women              | 7,419  | 0.60%      | 0.70%            | 2.70%      | 10.20%     | 6.50%            | 1.40%      |
| Garner et al. [27]      | 2015       | United Kingdom    | Sexual health clinic   | 2010        | Women              | 649    | 0.80%      | 1.10%            | 0.60%      | 13.30%     | 6.60%            | 2.50%      |
| Gratrix et al. [29]     | 2015       | Canada            | STD clinic             | 2012        | Women              | 3055   | —          | —                | —          | 9.40%      | 12.60%           | —          |
| Musil et al. [37]       | 2015       | Australia         | Sexual health clinic   | 2013-2014   | Women              | 56     | —          | —                | —          | 77.00%     | 57.00%           | —          |
| Trebach et al. [44]     | 2015       | Maryland (US)     | STD clinic             | 2011-2013   | Women              | 4,402  | 2.80%      | 3.00%            | 2.10%      | 10.00%     | 8.60%            | 2.60%      |
| van Liere et al. [48]   | 2015       | Netherlands       | STD clinic             | 2011-2012   | Women              | 11,113 | —          | 0.90%            | —          | —          | 9.50%            | —          |
| van Liere et al. [45]   | 2013       | Netherlands       | STD clinic             | 2010-2011   | Women ("swingers") | 461    | —          | 1.08%            | —          | —          | 6.72%            | —          |
| Ding and Challenor [50] | 2014       | United Kingdom    | STD clinic             | 2012-2013   | Women              | 97     | —          | —                | —          | 100%       | 77.3%            | —          |
| Cosentino et al. [51]   | 2012       | Pennsylvania (US) | HIV clinic             | 2009-2010   | Women              | 272    | —          | 2.6%             | —          | —          | 7.7%             | —          |
| Bachmann et al. [52]    | 2010       | US                | STD clinic, HIV clinic | 2003-2007   | Women              | 99     | 20.30%     | 23.10-54.30%     | 8.20%      | 27.40%     | 5.60-19.20%      | 1.90%      |

Note. STD: sexually transmitted diseases; US: United States.

TABLE 2: Characteristics of studies reporting extragenital infections due to *N. gonorrhoeae* and *C. trachomatis* among men who have sex with men.

| Author                   | Study year | Location           | Setting                             | Time period | Risk       | Sample       | Gonorrhea                   | Chlamydia                   |            |        |            |            |
|--------------------------|------------|--------------------|-------------------------------------|-------------|------------|--------------|-----------------------------|-----------------------------|------------|--------|------------|------------|
|                          |            |                    |                                     |             |            |              | Urogenital                  | Rectal                      | Urogenital | Rectal | Pharyngeal | Pharyngeal |
| McMillan et al. [73]     | 1981       | United Kingdom     | STD clinic                          | 1981        | MSM        | 150          | —                           | —                           | 6.70%      | 4.00%  | —          | 1.30%      |
| Rompalo et al. [83]      | 1986       | Washington (US)    | STD clinic                          | 1983        | MSM        | 1,429        | —                           | 8.00%                       | —          | 5.00%  | —          | —          |
| Ostergaard et al. [38]   | 1997       | Denmark            | STD clinic                          | 1995-1996   | MSM        | 39           | —                           | —                           | —          | 2.60%  | —          | 0.00%      |
| Tabet et al. [87]        | 1998       | Washington (US)    | Community                           | 1995        | MSM        | 578          | 0.00%                       | 0.20%                       | 0.70%      | —      | —          | —          |
| Kim et al. [69]          | 2003       | California (US)    | STD clinic                          | 2000        | MSM (HIV+) | 564          | —                           | 7.10%                       | —          | —      | —          | —          |
| Manavi et al. [72]       | 2004       | United Kingdom     | Genitourinary clinic                | 1999-2002   | MSM        | 443          | —                           | —                           | —          | 7.20%  | —          | —          |
| Kent et al. [68]         | 2005       | California (US)    | STD clinic, gay men's health center | 2003        | MSM        | 6,434        | 6.00%                       | 6.90%                       | 9.20%      | 5.20%  | 7.90%      | 1.40%      |
| Currie et al. [60]       | 2006       | Australia          | Sexual health clinic                | 2001-2003   | MSM        | 314          | 6.8% (Did not specify site) | 9.6% (did not specify site) | —          | —      | —          | —          |
| Hocking and Fairley [65] | 2006       | Australia          | STD clinic                          | 2002-2003   | MSM        | 1,248        | —                           | —                           | —          | 5.10%  | 6.20%      | 1.30%      |
| Morris et al. [76]       | 2006       | California (US)    | Community                           | 2001-2003   | MSM        | 2,475        | —                           | —                           | 5.50%      | —      | —          | —          |
| Benn et al. [58]         | 2007       | United Kingdom     | Genitourinary clinic                | 1999-2001   | MSM        | 613          | 7.20%                       | 7.30%                       | 7.30%      | 4.30%  | 6.50%      | 1.20%      |
| Alexander et al. [54]    | 2008       | United Kingdom     | Genitourinary clinic                | 2005-2007   | MSM        | 272          | —                           | 14.90%                      | 6.50%      | —      | 13.60%     | —          |
| Gunn et al. [64]         | 2008       | California (US)    | STD clinic                          | 1997-2003   | MSM        | 7,333        | 10.80%                      | 9.80%                       | 4.00%      | —      | —          | —          |
| Lister et al. [71]       | 2008       | Australia          | Sexual health clinic                | 2002-2003   | MSM        | 366          | —                           | 5.00%                       | —          | —      | 7.00%      | —          |
| Mimiaga et al. [74]      | 2008       | Massachusetts (US) | Gay men's health center             | 2007        | MSM        | 114          | 1.00%                       | 1.70%                       | 0.00%      | 2.60%  | 6.10%      | —          |
| Rieg et al. [82]         | 2008       | California (US)    | HIV clinic                          | 2004-2006   | MSM (HIV+) | 212          | 1.50%                       | 4.30%                       | 3.30%      | 1.50%  | 2.90%      | 1.40%      |
| Templeton et al. [89]    | 2008       | Australia          | Community                           | 2003        | MSM        | 1,427        | —                           | —                           | —          | —      | —          | 1.10%      |
| Annan et al. [55]        | 2009       | United Kingdom     | HIV/genitourinary clinic            | 2005-2006   | MSM        | 3,076        | —                           | 4.10%                       | 1.30%      | 5.40%  | 8.20%      | —          |
| Baker et al. [56]        | 2009       | Washington DC (US) | Outpatient clinic                   | 2006-2007   | MSM        | 147          | 0.00%                       | 1.40%                       | 2.80%      | 0.00%  | 2.10%      | 0.70%      |
| Dang et al. [61]         | 2009       | Switzerland        | HIV clinic                          | 2007-2008   | MSM (HIV+) | 147          | —                           | —                           | —          | —      | 10.90%     | —          |
| Klausner et al. [70]     | 2009       | US (5 cities)      | Outpatient clinic                   | 2007-2008   | MSM        | 3,410/14,189 | —                           | 5.40%                       | 5.30%      | —      | 8.90%      | 1.60%      |
| Mimiaga et al. [75]      | 2009       | Massachusetts (US) | Gay men's health center             | 2003-2004   | MSM        | 21,927       | 13.40%                      | 8.80%                       | 1.90%      | 5.70%  | —          | —          |
| Ota et al. [77]          | 2009       | Canada             | Gay men's health center             | 2006-2008   | MSM        | 248          | —                           | 11.70%                      | 8.10%      | —      | 7.70%      | 2.00%      |
| van der Helm [49]        | 2009       | Netherlands        | STD clinic                          | 2006-2007   | MSM        | 1,458        | —                           | 7.00%                       | —          | —      | 11.00%     | —          |
| Templeton et al. [90]    | 2010       | Australia          | Community                           | 2003        | MSM        | 1,427        | —                           | —                           | 0.60%      | —      | —          | —          |
| Marcus et al. [172]      | 2011       | California (US)    | STD clinic                          | 2008-2009   | MSM        | 3,398        | 0.40%                       | 3.60%                       | 5.00%      | 2.30%  | 7.80%      | 1.90%      |
| Peters et al. [39]       | 2011       | Netherlands        | STD clinic                          | 2007-2008   | MSM        | 1,455        | 2.80%                       | 6.00%                       | 4.20%      | 4.00%  | 8.20%      | 1.50%      |
| Soni and White [86]      | 2011       | United Kingdom     | HIV clinic                          | 2009-2010   | MSM (HIV+) | 634          | 1.30%                       | 4.20%                       | 3.90%      | 2.60%  | 9.80%      | 1.70%      |
| Vodstrcil et al. [93]    | 2011       | Australia          | Sexual health clinic                | 2002-2009   | MSM        | 8,328/7,133  | —                           | 3.10%                       | 1.80%      | —      | 5.40%      | —          |
| Koedijk et al. [22]      | 2012       | Netherlands        | STD clinic                          | 2006-2010   | MSM        | 69,506       | 3.40%                       | 5.50%                       | 3.90%      | 4.30%  | 10.10%     | 1.70%      |

TABLE 2: Continued.

| Author                      | Study year | Location           | Setting                                 | Time period | Risk       | Sample | Urogenital | Gonorrhea Rectal | Pharyngeal | Urogenital | Chlamydia Rectal | Pharyngeal |
|-----------------------------|------------|--------------------|---|-------------|------------|--------|------------|------------------|------------|------------|------------------|------------|
| Mayer et al. [36]           | 2012       | US (4 cities)      | HIV clinic                              | 2004–2006   | MSM (HIV+) | 365    | 0.00%      | 2.00%            | 3.00%      | 2.00%      | 7.00%            | 1.00%      |
| Park et al. [78]            | 2012       | California (US)    | HIV/STD clinic, gay men's health center | 2010        | MSM        | 12,454 | —          | —                | 5.80%      | —          | —                | 1.70%      |
| Pinsky et al. [81]          | 2012       | New York (US)      | University health center                | 2007–2010   | MSM        | 200    | —          | 0.50%            | 3.50%      | —          | 3.00%            | 0.50%      |
| Diaz et al. [26]            | 2013       | Spain              | STD clinic                              | 2006–2010   | MSM        | 1,320  | 58.30%     | 21.10%           | 5.20%      | —          | —                | —          |
| Jiménez et al. [66]         | 2013       | Spain              | HIV clinic                              | 2011–2012   | MSM (HIV+) | 264    | —          | —                | 9.50%      | —          | —                | —          |
| Sexton et al. [85]          | 2013       | Washington DC (US) | Primary care clinic, HIV/STD clinic     | 2009–2011   | MSM        | 374    | —          | 8.00%            | 9.30%      | —          | 12.70%           | 1.30%      |
| Turner et al. [92]          | 2013       | Ohio (US)          | STD clinic                              | 2010–2011   | MSM        | 125    | —          | 24.00%           | —          | —          | 23.00%           | —          |
| Barbee et al. [57]          | 2014       | Washington (US)    | STD clinic                              | 2011        | MSM        | 3,034  | 5.50%      | 9.70%            | 6.50%      | 4.40%      | 11.90%           | 2.30%      |
| Dudareva-Vizule et al. [62] | 2014       | Germany            | STD clinic                              | 2009–2010   | MSM        | 2,247  | 1.90%      | 4.60%            | 5.50%      | 3.40%      | 8.00%            | 1.50%      |
| Gratrix et al. [63]         | 2014       | Canada             | STD clinic                              | 2012        | MSM        | 972    | 2.40%      | 5.90%            | —          | 4.30%      | 14.10%           | —          |
| Keaveney et al. [67]        | 2014       | Ireland            | HIV clinic                              | 2012        | MSM (HIV+) | 121    | 0.00%      | 4.10%            | 3.30%      | 1.70%      | 6.60%            | 0.80%      |
| Patton et al. [79]          | 2014       | US (42 sites)      | STD clinic                              | 2011–2012   | MSM        | 21,994 | 11.10%     | 10.20%           | 7.90%      | 8.40%      | 14.10%           | 2.90%      |
| Sanders et al. [84]         | 2014       | Kenya              | Medical clinic                          | 2011        | MSM        | 244    | 1.60%      | 5.70%            | —          | 6.10%      | 8.10%            | —          |
| van Liere et al. [47]       | 2014       | Netherlands        | STD clinic                              | 2010–2012   | MSM        | 2,436  | 1.50%      | 3.70%            | 3.40%      | 3.30%      | 7.90%            | 1.10%      |
| Chow et al. [59]            | 2015       | Australia          | Sexual health clinic                    | 2007–2013   | MSM        | 12,873 | 2.30%      | 2.90%            | 1.70%      | 3.00%      | 5.60%            | —          |
| Danby et al. [25]           | 2016       | Pennsylvania (US)  | STD clinic                              | 2014–2015   | MSM        | 224    | 5.40%      | 11.60%           | 16.50%     | 4.50%      | 17.40%           | 2.20%      |
| Dukers-Muijers et al. [19]  | 2015       | Netherlands        | STD clinic                              | 2010–2013   | MSM        | 2,349  | 1.40%      | 4.00%            | 3.40%      | 3.20%      | 7.30%            | 0.70%      |
| Garner et al. [27]          | 2015       | United Kingdom     | Sexual health clinic                    | 2010        | MSM        | 365    | 4.70%      | 9.00%            | 5.20%      | 5.30%      | 6.50%            | 2.20%      |
| Taylor et al. [88]          | 2015       | Arizona (US)       | HIV clinic                              | 2011–2013   | MSM        | 1,591  | —          | 19.60%           | —          | —          | 18.60%           | —          |
| Tongfuyai et al. [91]       | 2015       | Thailand           | Medical clinic                          | 2006–2010   | MSM        | 1,744  | 1.80%      | 6.10%            | 0.50%      | 4.50%      | 9.50%            | 3.60%      |
| Trebach et al. [44]         | 2015       | Maryland (US)      | STD clinic                              | 2011–2013   | MSM        | 769    | 8.90%      | 17.90%           | 11.00%     | 1.50%      | 14.30%           | 2.50%      |
| Van Liere et al. [167]      | 2015       | Netherlands        | STD clinic                              | 2011–2012   | MSM        | 9,549  | —          | 4.20%            | —          | —          | 9.80%            | —          |
| van Liere et al. [45]       | 2013       | Netherlands        | STD clinic                              | 2010–2011   | MSM        | 926    | —          | 3.46%            | —          | —          | 7.88%            | —          |
| Bachmann et al. [52]        | 2010       | US                 | STD clinic, HIV clinic                  | 2003–2007   | MSM        | 297    | 5.10%      | 7.90%            | 8.30%      | 2.00%      | 10.30%           | 1.70%      |

Note. STD: sexually transmitted diseases; US: United States; MSM: men who have sex with men.

rectal symptoms were pruritus (36%) anal discharge (17%), burning (13%), inflammation (11%), pain (11%), and erythema around the anus (6%) [62]. Symptom-based screening may miss up to 60% of extragenital infections [30, 39, 45].

Extragenital infections may also be increasing in prevalence [59, 77, 95], as several studies have reported higher prevalence of extragenital infections among MSM in recent time periods. However, this could also reflect more thorough screening practices or improved testing methods [97, 98]. Extragenital infections among MSM are associated with concurrent partners, existing HIV infection ( $n = 2$  studies), condomless anal sex ( $n = 3$ ), and drug use during sex ( $n = 1$ ) [62, 65, 69, 89, 91]. Concurrent infections with other STDs are common [99]. The overwhelming evidence indicates a high prevalence of extragenital *N. gonorrhoeae* and *C. trachomatis* infections among MSM, the asymptomatic nature of most of these infections, and the prevalence of extragenital infection without concurrent urogenital infection, all of which support the need for routine screening at extragenital sites.

**3.5. Extragenital Infections in MSW.** A total of nine studies evaluated the prevalence of extragenital infections due to *N. gonorrhoeae* or *C. trachomatis* in MSW [19, 26, 27, 33, 36, 38, 44, 45, 100] (Table 3). Overall, there are limited prevalence data of extragenital infections among MSW. The prevalence of extragenital infections among MSW in the studies reviewed ranged 0–5.7% for rectal gonorrhoea (median 3.4%), 0.4–15.5% for pharyngeal gonorrhoea (median 2.2%), 0–11.8% for rectal chlamydia (median 7.7%), and 0–22.0% for pharyngeal chlamydia (median 1.6%). These data represent studies that evaluated heterosexually identified men, some of whom may have engaged in sex with other men [44], a distinction which emphasizes the need to consistently focus on sexual behavior rather than identity. Other studies which did not evaluate for or stratify by specific risk behaviors further support the prevalence studies in individual populations [32, 100–107] (Table 3).

**3.6. Diagnoses of Extragenital Infections.** The gold standard for diagnosis of urogenital infection due to *N. gonorrhoeae* and *C. trachomatis* is the nucleic acid amplification test (NAAT). However, NAAT assays are not approved by the US Food and Drug Administration (FDA) for detecting *N. gonorrhoeae* and *C. trachomatis* from pharyngeal or rectal specimens [108]. Culture is still the only approved method for diagnosis at these sites. However, NAAT is the most sensitive test for detecting *C. trachomatis* and *N. gonorrhoeae* and is recommended for this purpose by the CDC [12]. NAAT has demonstrated higher sensitivity and specificity compared to culture for detecting extragenital infections [52, 74, 109, 110]. At the present time, laboratories must validate these tests in-house based on Clinical Laboratory Improvement Amendments (CLIA) regulatory requirements before performing NAAT testing on rectal and pharyngeal specimens; many large commercial laboratories have performed this validation and offer this testing option. The main disadvantages of performing NAAT testing over culture is the inability to determine antimicrobial susceptibilities and bacterial viability. Potentially lower sensitivity of NAAT for

*N. gonorrhoeae* in the pharynx and rectum may be linked to substantial colonization of these extragenital sites by a wide range of other organisms, including other *Neisseria* species, possibly leading to interference with *N. gonorrhoeae* isolation [111]. For suspected or documented treatment failure, *N. gonorrhoeae* cultures should be obtained and antimicrobial susceptibilities performed.

Extragenital specimens are collected via a swab of the rectum or pharynx, by either a clinician or a self-collected swab. Self-collected swab as a means of collecting pharyngeal and rectal specimens is supported by the CDC guidelines [12] and has been found to be an acceptable means of obtaining specimens among women [112, 113] and MSM [49, 54, 85, 114–117], which may lead to an increase in extragenital diagnoses [118] due to the noninvasive nature of the procedure. Self-collected swabs may also reduce the workload for clinic staff who obtain them and promote screening when clinicians are not available for collection.

**3.7. Treatment of Extragenital Infections.** Current US guidelines regarding treatment of extragenital infections due to *N. gonorrhoeae* and *C. trachomatis* are similar to those for the treatment of urogenital infections [12]. Treatment guidelines from the United Kingdom and Europe both recommend similar regimens for both urogenital and extragenital infections [17, 18, 119]. Extragenital pharyngeal and rectal gonorrhoea and chlamydia infections may spontaneously clear even in the absence of treatment among MSM and high-risk women [120, 121]. If extragenital sites are a reservoir for ongoing transmission, then suboptimal treatment of extragenital infections could lead to the spread of any existing resistant organisms. Care should be taken with extragenital treatment and retesting should be performed if persistent infection or treatment failure is suspected.

The recommended treatment for urogenital chlamydia infection is azithromycin 1000 milligrams orally in a single dose or doxycycline 100 milligrams orally twice daily for seven days. Due to the ease of administration, the ability for directly observed therapy in a single dose, and the high rates of adherence, azithromycin is the usual treatment option in many clinics. Earlier reports demonstrated similar results with both regimens for treatment of urogenital infection, with high (>96%) cure rates [122]. In contrast, recent analyses have suggested a potential small advantage of doxycycline compared to azithromycin for urogenital chlamydia infection; the efficacy of doxycycline has been reported as being 100% compared to 97% for azithromycin [123, 124].

Efficacy of chlamydia treatments may differ for extragenital infections at rectal and pharyngeal sites [19]. Doxycycline may have slightly greater efficacy compared to azithromycin for both rectal [125–132] and pharyngeal [133] chlamydia infection, as single-dose azithromycin may not lead to sustained drug concentrations capable of curing extragenital infection [134]. For example, treatment failure was significantly more common with azithromycin (10% of patients) compared to doxycycline (2%) in a small study for treatment of pharyngeal chlamydia. In a meta-analysis of azithromycin and doxycycline for the treatment of rectal chlamydia, azithromycin was 83% effective compared to



TABLE 3: Characteristics of studies reporting extragenital infections due to *N. gonorrhoeae* and *C. trachomatis* among men who have sex with women and populations with mixed behaviors.

| Author                      | Study year | Location          | Setting                                     | Time period | Risk             | Sample     | Gonorrhea  |        |            | Chlamydia  |        |            |
|-----------------------------|------------|-------------------|---|-------------|------------------|------------|------------|--------|------------|------------|--------|------------|
|                             |            |                   |   |             |                  |            | Urogenital | Rectal | Pharyngeal | Urogenital | Rectal | Pharyngeal |
| Jones et al. [33]           | 1985       | Indiana (US)      | STD clinic                                  | 1985        | MSW              | 706        | —          | —      | —          | —          | —      | 3.70%      |
| Ostergaard et al. [38]      | 1997       | Denmark           | STD clinic                                  | 1995-1996   | MSW              | 169        | —          | —      | —          | 0.60%      | —      | 0.00%      |
| Mayer et al. [36]           | 2012       | US (4 cities)     | HIV clinic                                  | 2004-2006   | MSW (HIV+)       | 73         | 1.00%      | 0.00%  | 1.00%      | 0.00%      | 0.00%  | 1.00%      |
| Wada et al. [173]           | 2012       | Japan             | Urology clinic                              | 2007-2008   | MSW              | 42         | 47.60%     | —      | 11.90%     | 26.20%     | —      | 2.40%      |
| Diaz et al. [26]            | 2013       | Spain             | STD clinic                                  | 2006-2010   | MSW              | 747        | 92.90%     | 0.00%  | 0.90%      | —          | —      | —          |
| Dukers-Muijters et al. [19] | 2015       | Netherlands       | STD clinic                                  | 2010-2013   | MSW              | 5,007      | 0.60%      | 0.40%  | 2.20%      | 11.70%     | 0.90%  | 0.20%      |
| Garner et al. [27]          | 2015       | United Kingdom    | Sexual health clinic                        | 2010        | MSW              | 553        | 0.90%      | —      | 0.40%      | 12.40%     | —      | 0.70%      |
| Trebach et al. [44]         | 2015       | Maryland (US)     | STD clinic                                  | 2011-2013   | MSW              | 5,218      | 4.30%      | 5.70%  | 2.50%      | 2.30%      | 9.10%  | 1.60%      |
| van Lier et al. [45]        | 2013       | Netherlands       | STD clinic                                  | 2010-2012   | MSW ("swingers") | 303        | —          | 0.33%  | —          | —          | 1.32%  | —          |
| Ivens et al. [103]          | 2007       | United Kingdom    | Genitourinary clinic                        | 2003-2005   | Mixed            | 1187       | —          | 4.70%  | —          | —          | 8.50%  | —          |
| Tipple et al. [107]         | 2010       | United Kingdom    | Sexual health clinic                        | 2006-2007   | Mixed            | 2,406      | —          | —      | —          | —          | —      | 1.90%      |
| Chan et al. [100]           | 2012       | Rhode Island (US) | Hospital system                             | 2011-2012   | Mixed            | 178/21,201 | 0.90%      | 5.30%  | 3.40%      | 5.70%      | 11.80% | 1.70%      |
| Rodriguez-Hart et al. [106] | 2012       | US                | Primary care/adult film                     | 2010        | Mixed            | 168        | 2.40%      | 2.40%  | 1.20%      | 18.50%     | 11.30% | 22.00%     |
| Dimech et al. [102]         | 2014       | Australia         | Surveillance system                         | 2008-2010   | Men (mixed)      | 177,557    | —          | —      | —          | 12.2-17.4% | 5.20%  | 1.30%      |
| Jenkins et al. [32]         | 2014       | Illinois (US)     | Emergency room                              | 2012-2013   | Men (mixed)      | 192        | 4.70%      | —      | 2.10%      | 4.70%      | —      | 1.00%      |
| Oda et al. [104]            | 2014       | Japan             | Otorhinolaryngology clinic                  | 2012        | Mixed            | 225        | —          | —      | 2.20%      | —          | —      | 0.90%      |
| Patterson et al. [105]      | 2014       | US                | Military STD clinic,                        | 2013-2014   | Mixed (HIV+)     | 316        | 0.80%      | 4.30%  | 15.50%     | 1.00%      | 6.90%  | 6.50%      |
| den Heijer et al. [101]     | 2016       | Netherlands       | STD clinic, gynecology, primary care clinic | 2006-2010   | Mixed            | 246/22,029 | —          | —      | —          | 8.20%      | 10.10% | 1.60%      |

Note. STD: sexually transmitted diseases; US: United States; MSW: men who have sex with women.

>99% efficacy of doxycycline [125]. Treatment guidelines in Europe [16] and Australia [135] recommend doxycycline as the treatment of choice for rectal infections. However, care should be taken when interpreting these smaller studies, and the potential small benefits must be weighed against the ease of administration, ability for directly observed therapy, and adherence for the single dose azithromycin therapy option. No randomized controlled trials have evaluated treatment regimens for extragenital chlamydia infection and further studies are needed to determine optimal management of these infections [136].

The current treatment recommendations for urogenital *N. gonorrhoeae* infections involve a dual regimen of ceftriaxone 250 milligrams intramuscularly as a single dose in addition to azithromycin 1000 milligrams orally in a single dose [12]. Uncomplicated rectal infections with *N. gonorrhoeae* should be treated in the same manner. Given that both ceftriaxone and azithromycin are administered as a single dose, these drugs should be administered together and under direct observation. These recommendations are based on a number of treatment failures with ceftriaxone alone and an increasing minimum inhibitory concentration (MIC) to oral cephalosporins which has been observed mostly outside of the US [137–148]. The dual therapy also has the advantage of treating *C. trachomatis* infection, which frequently accompanies *N. gonorrhoeae* infection. Doxycycline can be considered in place of azithromycin, but azithromycin is strongly preferred given increased resistance to doxycycline [144]. This regimen has a high (>98%) treatment efficacy for rectal infections [149, 150]. Pharyngeal infections with *N. gonorrhoeae* are more difficult to treat and have demonstrated ceftriaxone resistance and treatment failure in a number of countries outside the US [138–141, 143, 145, 146, 151, 152]. In both pharyngeal and rectal gonorrhea, persistence of the organism after treatment may be due to reinfection but can also reflect an elevated MIC to antibiotic regimens [153]. At this time, guidelines still recommend treating pharyngeal infection by *N. gonorrhoeae* with ceftriaxone and azithromycin [12]. The addition of azithromycin may improve treatment efficacy for pharyngeal infections [154, 155].

In general, test of cure is not recommended except in cases where there are persistent symptoms, therapy was not completed, or reinfection is suspected. Retesting for both urogenital and extragenital infections less than three weeks after treatment is not recommended and can result in false positive results due to the highly sensitive nature of NAAT and the possibility of detection of nonviable organisms [156, 157]. Furthermore, due to NAATs not being FDA-cleared at this time for the purpose of testing for cure, culture is the only retesting method that can be used to properly assess the efficacy of antibiotic treatments. The significance of positive NAAT at extragenital sites during this time is unclear and should be interpreted after a detailed clinical interview including presence or absence of symptoms, potential risk for reinfection, and adherence to treatment [158]. Men and women who are positive for *N. gonorrhoeae* and *C. trachomatis* should generally be tested for reinfection three to six months after treatment [12, 16].

#### 4. Conclusions

Several key questions exist regarding screening for and management of extragenital infections. Urogenital screening for *N. gonorrhoeae* and *C. trachomatis* infection is generally performed to reduce complications in women and to decrease the risk of HIV infection in MSM [159–162]. However, there is a lack of data on clinical outcomes associated with rectal and pharyngeal infections, including impact on overall morbidity. Two major questions are whether routine screening and treatment for extragenital gonorrhea and chlamydia infections in women prevent sequelae observed in urogenital infection (such as PID, ectopic pregnancy, and infertility), and whether routine screening and treatment reduces the risk of HIV transmission in MSM. With regard to management, optimal treatment regimens for rectal and pharyngeal extragenital infections is unknown. Asymptomatic extragenital infections may be a reservoir of ongoing transmission and antibiotic resistant strains from these reservoir sites may go undetected and promote the spread of resistance.

The contribution of extragenital infections to overall transmission of gonorrhea and chlamydia, including the transmission potential between different anatomic sites, is also unclear. In women, evidence suggests that rectal infections can be spread to urogenital sites [163]. It is also likely that pharyngeal infections can be spread to the male urethra [13, 14, 164] and rectum [165]. Contributing to potential transmission risk may be bacterial load at different anatomic sites [166, 167]. These data suggest that the prevalence and associated morbidity of extragenital infections caused by *N. gonorrhoeae* and *C. trachomatis*, especially among women, may be reduced by thorough extragenital screening and early treatment of extragenital infections, although this is unproven. Screening and treatment for rectal infections, especially among populations at high risk of HIV (e.g., MSM), may be a cost-effective intervention to prevent HIV [168]. Optimal screening strategies for extragenital infections are largely unknown. Further studies are needed in settings other than reproductive health and STD clinics, especially in primary care clinics and resource-limited settings.

Extragenital infections due to *N. gonorrhoeae* and *C. trachomatis* are common, especially in settings which provide services to higher-risk men and women. In general, MSM demonstrate a higher prevalence of extragenital infection compared to women and MSW [22, 25–27, 44, 47–49]. Despite the accumulating data on the prevalence of these infections, screening at extragenital sites remains uncommon [101, 102, 169]. STD and other sexual health clinics should consider implementing routine, universal extragenital screening for *N. gonorrhoeae* and *C. trachomatis* infection among high-risk men and women. Importantly, guidelines suggest screening based on reported risk behaviors; however, this may miss a significant amount of extragenital infection [19, 22, 45, 47, 49, 52, 59, 62, 68, 77–79, 90, 103, 107, 120, 133, 170, 171]. In addition to targeting those with symptoms and those reporting condomless anal or oral sex, screening should also include those without symptoms and those who do not report condomless sex at a specific extragenital site, as the

nature of the infections are often asymptomatic, and high-risk behaviors are not consistently reported by patients.

## Competing Interests

The authors report no conflict of interests.

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