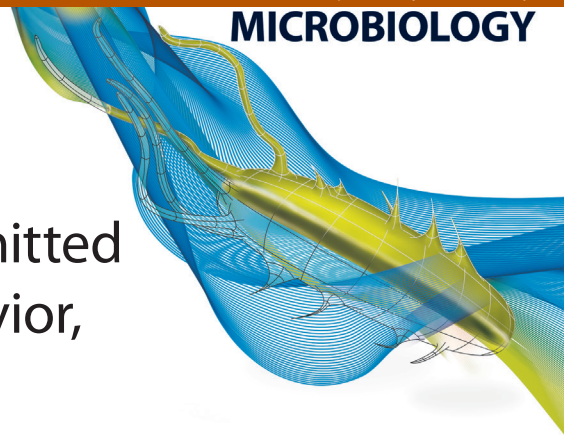


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MICROBIOLOGY



The epidemiology of sexually transmitted infections in the UK: impact of behavior, services and interventions

Gwenda Hughes*¹ & Nigel Field²

ABSTRACT Sexually transmitted infections (STIs) are a major public health concern. The UK has some of the most advanced STI surveillance systems globally. This article uses national surveillance data to describe remarkable changes in STI epidemiology in the UK over the last century and explores the behavioral and demographic shifts that may explain these trends. The past 10 years have seen considerable improvements in STI service provision and the introduction of national public health interventions. However, sexual health inequalities persist and men who have sex with men, young adults and black ethnic minorities remain a priority for interventions. Technological advances in testing and a shift in sexual health service commissioning arrangements will present both opportunities and challenges in future.

Sexually transmitted infections (STIs) are a major public health concern. They are etiologically, clinically and epidemiologically diverse: over 30 bacterial, viral and parasitic pathogens have been associated with sexual transmission. The WHO has estimated that, globally in 2008, there were almost 500 million new cases of four common curable STIs: *Chlamydia trachomatis* (chlamydia), *Neisseria gonorrhoeae* (gonorrhoea), *Treponema pallidum* (syphilis) and *Trichomonas vaginalis* (trichomoniasis) [1]. STIs are often considered stigmatizing and may seriously impact on the health and well-being of affected individuals, as well as being costly to healthcare services. Complications, which vary by infecting organism, include pelvic inflammatory disease (PID), epididymitis, infertility, ectopic pregnancy, cervical cancer, cardiovascular and neurological damage, adult mortality and fetal and neonatal morbidity and mortality [2]. Increasing resistance and decreased susceptibility to antimicrobials are emerging concerns, especially for gonorrhoea [3–5].

Population characteristics, including population size, age structure, ethnic makeup and net migration, affect the epidemiology of STIs. In mid-2012, as context for this article, the UK population numbered an estimated 63.7 million across four constituent countries (England: 53.5 million; Scotland: 5.3 million; Wales: 3.1 million; and Northern Ireland: 1.8 million) [6]. The UK population is aging, with a median age of 39 years [7], is growing due to net immigration and births exceeding deaths (0.7% growth in 2012), and is largely urban (82% in England and Wales). The largest ethnic group is white (86% in England and Wales), although the 8.2 m residents of London show far greater ethnic diversity, with 40% of the population being nonwhite and 37% born outside the UK [8,9]. In common

KEYWORDS

- epidemiology • sexual behavior • sexual health interventions • sexually transmitted infections • sexual health services • UK

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with other western European countries, the UK has also seen a dramatic rise in the proportion of adults who are single (35% in 2011 from 30% in 2001 in England and Wales) [10], a change in social circumstances that may underpin some of the changes in sexual behavior described below.

Overall, the epidemiology of STIs in the UK over the last century has been influenced by major social, economic and demographic shifts in society. Trends in reported STI diagnoses need to be interpreted with caution as their causes are multifactorial, reflecting changes in sexual attitudes and behaviors, as well developments in service provision, treatment, interventions, diagnostic technologies and surveillance. Biological factors, such as transmission probability, infection duration and protective immunity, also contribute to infection incidence and prevalence. In this article, we discuss historic and recent trends in the epidemiology of STIs (other than HIV) between 1922 and 2012 that are of particular public health concern in the UK. We focus on the population groups at greatest risk, direct and contextual factors associated with transmission and recent developments in STI intervention and control.

STI service provision in the UK

The provision of sexual health services in the UK has evolved considerably over the past 20 years. The cornerstone of STI service provision is the network of NHS genitourinary medicine (GUM) clinics – free, confidential and open-access sexual health services distributed across the UK that offer comprehensive, specialist STI testing and management services. However, an increasing proportion of STI-related care is provided by nonspecialist sexual health services, including general practice [11]. An important component of this shift has been the English National Chlamydia Screening Programme (NCSP), phased in across England from 2003 [12]. The aim of the NCSP has been to reduce the prevalence of asymptomatic, undiagnosed chlamydial infections and associated infection sequelae by testing sexually active men and women under 25 years of age who attend a range of primary and community-based healthcare and nonhealthcare facilities. The proportion of STIs diagnosed outside the GUM clinic setting varies by STI and the complexity of management required: in England, just over 50% of genital chlamydial infections are diagnosed in primary care and other community-based

services [13], but it is likely that almost all syphilis is diagnosed and managed by GUM clinics.

Surveillance of STIs in the UK

The UK has some of the most advanced systems of STI surveillance globally. While specific systems vary across the four countries of the UK, all use similar approaches and sources of data. Data in this article are presented for the UK wherever possible but, where not available, they are presented for specific countries within the UK.

GUM clinics are an important source of STI surveillance data. They provide pseudonymized, patient-level data on STI-related services and diagnoses for local and national surveillance, often including patient-level sociodemographic and some behavioral information. For example, the GUM Clinic Activity Dataset (GUMCAD) is a mandatory national statistical return that collects data on all patient attendances at GUM clinics in England every calendar quarter, and similar systems exist in Scotland (the National Sexual Health System [NaSH]) and Wales (the Sexual Health in Wales Surveillance System [SWS]) [14–18]. These data provide unique insights, particularly into the incidence and distribution of STIs in the UK and risk factors associated with their acquisition. The availability of linked patient records enables longitudinal analyses in order to assess sexual health outcomes in specific population groups.

Disaggregated data reports from laboratories are another important source of information on STI diagnoses [16,18–21]. While laboratory reports provide more limited information on patient risk factors, they provide a more comprehensive picture of diagnoses made regardless of the service provider. Efforts to collect more detailed clinical data from nonspecialist settings offering sexual health services, such as contraceptive and reproductive health services and ‘enhanced’ general practices, are also underway across most of the UK [15,16,18].

Enhanced surveillance systems have also been developed in order to monitor specific arising public health concerns. For example, England, Wales and Scotland have established systems for monitoring resistance and the emerging decreased susceptibility of gonorrhoea to antimicrobials, which is now considered to be a global public health priority [5,22,23]. These systems enable the detection of emerging antimicrobial resistance patterns and the demographic and behavioral risk characteristics associated with

their spread. An enhanced UK-wide national surveillance system for *Lymphogranuloma venereum* (LGV) was established in 2004 following outbreaks in western Europe among men who have sex with men (MSM) and has been used to understand the groups affected by LGV and to develop infection control programs [24–27].

However, all of these surveillance systems monitor trends in diagnosed infections in those attending services for care. Many STIs are frequently asymptomatic and may not be diagnosed or may not result in people seeking care, such that case-based surveillance systems can underestimate the underlying prevalence of STIs in the population and how this relates to behavioral risk. Our understanding of sexual behavior and STI prevalence in the UK at a population level has been uniquely informed by three consecutive National Surveys of Sexual Attitudes and Lifestyles (Natsal) performed a decade apart since 1990, which represent some of the largest, most comprehensive studies of sexual behavior anywhere in the world and include over 45,000 participants born between 1930 and 1990 [28,29]. As well as monitoring changes in sexual behavior and access to sexual health services, the Natsal studies have used biological sampling to provide robust prevalence estimates for key STIs in the general population [28–31].

STIs of public health importance in the UK

STIs warrant particular public health attention. Untreated infection can result in serious long-term morbidity and mortality, can impact on female fertility and can facilitate HIV transmission. While some infections are relatively prevalent and geographically widespread, others are rare in the general population but can be locally prevalent in specific population core groups. The following section provides a public health summary for the most important STIs in the UK.

• Chlamydia

Genital chlamydial infection is the most commonly diagnosed bacterial STI in the UK and is caused by infection with *C. trachomatis*. Infection is readily treated with antibiotics. There were almost 240,000 diagnoses in the UK in 2012 [13] and, despite considerable increases in chlamydia testing in recent years [16,18,32], it is likely that many infections are undiagnosed and untreated. Younger adults aged under 25 years are most affected, in whom estimated prevalence ranges

between 2 and 3% in the general population [30,31] and up to 10% in those attending chlamydia testing services [33,34]. Most infections are asymptomatic and an estimated 16% of untreated cases may result in clinical PID [35], which may lead to infertility and other complications.

• Human papillomavirus

There are more than 30 types of sexually transmitted human papillomavirus (HPV), which is the most prevalent STI in the UK. Infection with high-risk HPV types, particularly 16, 18, 31 and 45, may lead to the development of invasive cervical cancer and other cancers of the anogenital tract [36], while infection with low-risk HPV types, particularly 6 and 11, can cause genital warts. Among those aged 10–49 years, the prevalence of HPV types 6 and 11 has been estimated to be approximately 16% and 6% in women and 8% and 2% in men, respectively [37]. The prevalence of high-risk HPV types is approximately 16% in women and 8% in men aged 16–44 years, but can be considerably higher in high-risk groups, such as HIV-positive MSM [30,38]. There are just under 90,000 diagnoses of first episodes of genital warts made in GUM clinics in the UK each year [13,16,18,19]. Although warts are readily treatable, recurrent presentations are common and make up over 40% of total diagnoses of genital warts [13].

• Genital herpes

Genital herpes is the most common ulcerative STI in the UK, with approximately 34,000 first episodes diagnosed and reported in the UK each year [13,16,18–19]. It is caused by infection with herpes simplex virus (HSV) types 1 and 2. Approximately half of genital HSV in women and a third in men is caused by type 1, which also causes oral herpes [39,40]. HSV-2 antibody prevalence in England and Wales has been estimated to be approximately 5% in women and 3% in men [41]. As with genital warts, recurrent presentations are common and make up over 40% of the total diagnoses of genital HSV [13], although their frequency and severity wanes over time [42]. Although antiviral treatment can reduce the duration and severity of herpetic symptoms and daily prophylaxis may control recurrences, HSV infection is lifelong.

• Gonorrhoea

Gonorrhoea, caused by infection with the Gram-negative diplococcus *N. gonorrhoeae*, is the

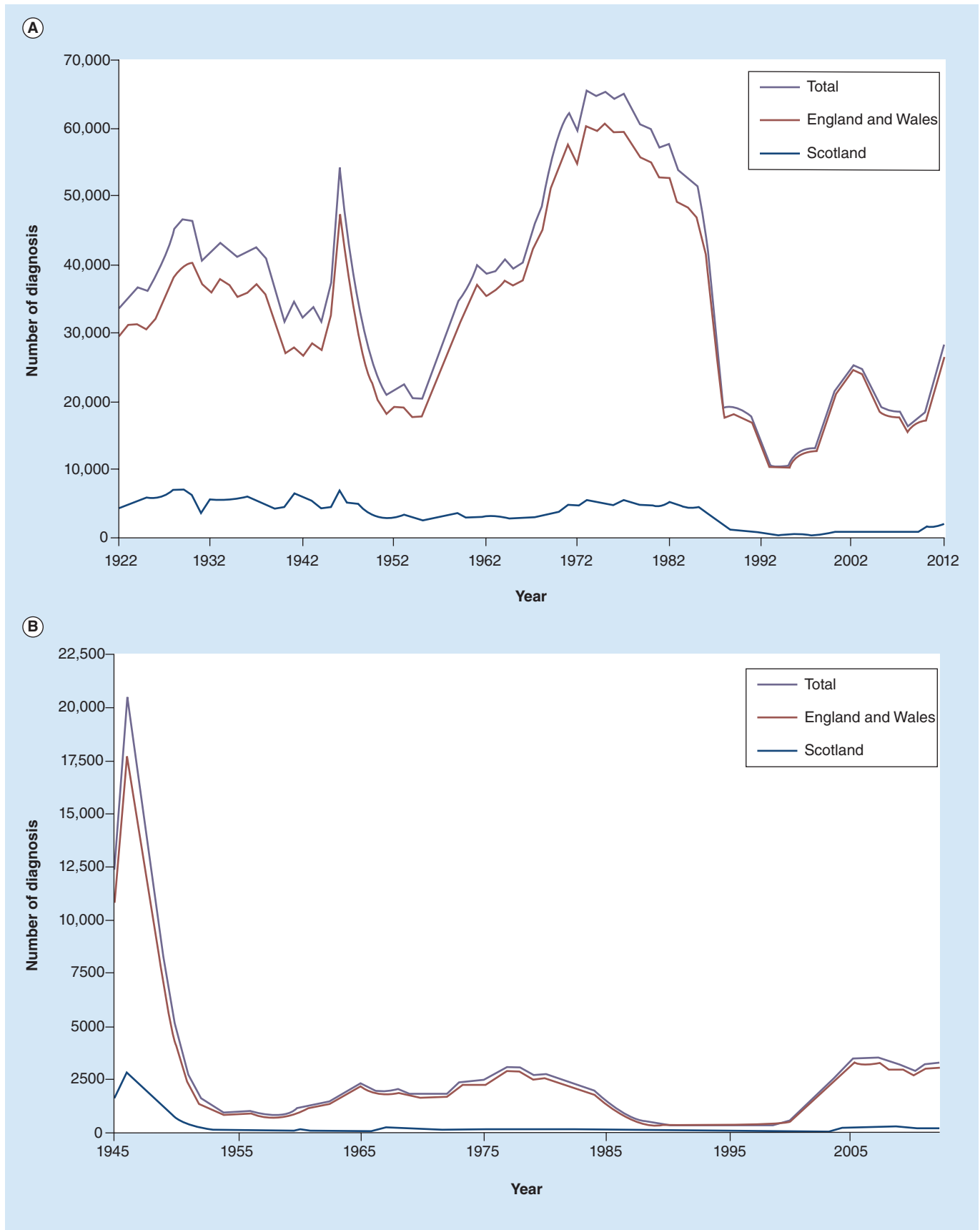


Figure 1. Diagnoses of gonorrhoea and syphilis in England, Wales and Scotland (see facing page). (A) Diagnoses of gonorrhoea 1922 to 2012. (B) Diagnoses of syphilis 1945 to 2012.

Data from GUM service returns. Data taken from Public Health England © Crown copyright 2014.

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second most common bacterial STI in the UK, with nearly 29,000 diagnoses in 2012 [13]. It is the most commonly diagnosed STI among MSM and rates are highest in black ethnic minorities. Genital infection in men is usually symptomatic, but approximately half of cases in women are asymptomatic. In contrast to chlamydial infection, gonorrhoea is rare in the general population (prevalence below 0.1%) [30]. Due to its relatively short duration of infectiousness, gonorrhoea is concentrated geographically in specific subgroups of the population that have higher rates of partner change, partnership concurrency or where there is particularly poor access to treatment [43]. Although treatable with antibiotics, the emergence of resistance and reduced susceptibility to successive antimicrobial agents is of global concern, requiring two revisions to the UK national gonorrhoea treatment guideline in the past 10 years [44].

• Syphilis

Syphilis is a relatively rare bacterial infection in the UK that is caused by the spirochaete *T. pallidum*. Early infectious syphilis is readily treated with antibiotics. Although rare, it has been associated with localized outbreaks among those in high-risk sexual networks. There were 3300 diagnoses of early infectious syphilis in the UK in 2012, of which 91% were in men, the majority of whom were MSM [13,32]. However, a significant proportion of syphilis cases are diagnosed late [13]. Due to comprehensive antenatal screening for syphilis infection in the UK, cases of congenital syphilis remain rare, although reported cases have been increasing in recent years [45,46].

• Lymphogranuloma venereum

LGV is caused by infection with the 'L' biovars (L1, L2 and L3) of *C. trachomatis*. LGV was rare across western Europe, including in the UK, until the early 2000s. However, a series of outbreaks of LGV emerged among MSM in Europe in 2003 [47]. By 2013, almost 3000 LGV diagnoses had been made in the UK, which now has the largest documented outbreak globally [26]. The great majority of cases present with proctitis, which is readily treatable with antibiotics;

however, late-presenting cases have led to severe complications [25].

• Trichomoniasis

Trichomoniasis, caused by the protozoan *T. vaginalis*, is a relatively uncommon infection in the UK, and infection tends to be clustered in specific urban areas, especially London and Birmingham, and among black ethnic minorities [48]. In England in 2012, there were 6600 diagnoses, over 90% of which were in women, reflecting the longer duration of infection in women [49]. It is readily treated with anti-protozoals. However, because many infections are subclinical, it is likely that infections remain undiagnosed in some population groups.

• Other STIs

Other STIs commonly diagnosed in GUM clinics include molluscum contagiosum (a pox-virus), pediculosis pubis (caused by infection with the pubic louse *Phthirus pubis*) and scabies (caused by infection with the mite *Sarcoptes scabiei*). There are approximately 14,000 diagnoses of these infections made in GUM clinics in England every year [13]. In addition, sexual transmissions of hepatitis B (HBV) virus, hepatitis C virus (HCV) and gastrointestinal infections such as *Shigella flexneri* and *Shigella sonnei* are reported periodically among MSM, often detected through outbreak investigations [50–54]. However, HBV infection is now less common in UK MSM due to high vaccination coverage at GUM clinics [55].

Historical trends

There have been remarkable changes in the epidemiology of STIs in the UK over the past century (Figure 1). While data were unreliable in the early 1900s, the morbidity and mortality associated with syphilis in particular were likely to be considerable. In 1913, this led the Government to set up a Royal Commission on Venereal Diseases, which recommended the establishment of a network of a free, open-access treatment services, implemented through the Public Health (Venereal Diseases) Act of 1917 [56]. Between 1918 and 1919, diagnoses of syphilis rose from 27,000 to 42,000, and those

of gonorrhoea from 17,000 to 38,000, reflecting the return of the armed forces at the end of the First World War. Following a period of modest decline and stability, numbers increased again at the end of the Second World War, reaching 18,000 syphilis and 54,000 gonorrhoea diagnoses by 1946. The mass production and availability of penicillin at the end of the 1940s and a return to social stability probably led to the rapid decline in diagnoses immediately thereafter, to 900 syphilis and 20,000 gonorrhoea diagnoses by 1954 [56].

However, this decline was short lived. During the 1960s, major social changes led to greater sexual liberation, facilitated by the availability of the oral contraceptive pill and the decriminalization of homosexual acts in men that occurred in the UK in 1967. These changes coincided with a steady rise in STIs, and by 1969, numbers of diagnoses of gonorrhoea exceeded the postwar peak (Figure 1). In contrast to gonorrhoea diagnoses, which rose sharply in both men and women, diagnoses of syphilis increased only in men, suggesting sex between men was the primary driver of syphilis transmission during this period.

Extensive media coverage and national public health campaigns following the emergence of HIV and AIDS during the 1980s, which likely led to behavioral modification and a significant reduction in STI transmission [57]. Between 1985 and 1988, diagnoses of gonorrhoea fell by 63% and those of syphilis by two-thirds (Figure 1). Over the same period, diagnoses of genital herpes and genital warts, which had been steadily rising since recording began in 1972, also stabilized or declined [57]. Numbers of gonorrhoea and syphilis diagnoses remained at historically low levels until the mid-1990s, suggesting that the impact of the HIV epidemic and associated changes in sexual behavior may have been sustained for at least 10 years.

Recent epidemiology & trends

• Distribution

STIs are highly unequally distributed in populations and geographically, reflecting variations in the distributions of populations at risk, sexual behavior and activity, access to diagnosis and treatment services, healthcare-seeking behavior and biological factors, including transmission probability and infection duration. Those who are affected often belong to more marginalized populations in society, often termed 'core groups'. In the UK, as in many western

industrialized countries, STIs disproportionately affect young people aged under 25 years, MSM and certain black ethnic minority populations.

Geographic distribution

STIs are geographically concentrated. In 2012, overall STI rates in Local Government Authorities in England ranged from <90 to >3000 per 100,000 of the population. Rates of diagnosis are typically higher in more urban areas, with rates highest in London, largely reflecting the distribution of core groups of the population who are at greatest risk of infection (Figure 2). There is also a strong positive association between STI rate and area-level deprivation [58,59]. These patterns are suggestive of enhanced STI transmission among geographically clustered, densely connected sexual networks [58,59].

Young adults

Young adults, typically those aged 15–24 years, experience the highest rates of infection. These age distributions reflect sexual mixing patterns and levels of sexual activity in the population. Young adults report higher numbers of partners than older adults, and may also be less skilled at negotiating and maintaining effective condom use [29,60]. The third Natsal study (Natsal-3) showed that, in Britain between 2010 and 2012, approximately 9% of women and 15% of men aged 16–74 years reported two or more partners in the past year, but this proportion was 27% of women and 34% of men among those aged under 25 years [29]. Similarly, having two or more sexual partners without condoms in the past year, a key risk factor for STI acquisition and a measure of unsafe sex used in Natsal-3, was reported by 16% of men aged 16–24 years compared with 7% of those aged 16–74 years, and by 14% of women aged 16–24 years compared with 5% of those aged 16–74 years [29]. STI rates in women increase sharply from 15 years of age and, for chlamydia, genital warts and gonorrhoea, peak at approximately 19 years of age, declining sharply in women by their early- to mid-thirties (Figure 3) [18]. The age distribution in men is similar, although rates tend to peak in men in their early- to mid-twenties and with higher rates persisting into older ages, partly reflecting diagnoses among MSM (Figure 3) [18]. In 2012, between a half and two-thirds of heterosexuals diagnosed with chlamydia, genital warts and gonorrhoea in GUM clinics in England were aged 15–24 years.

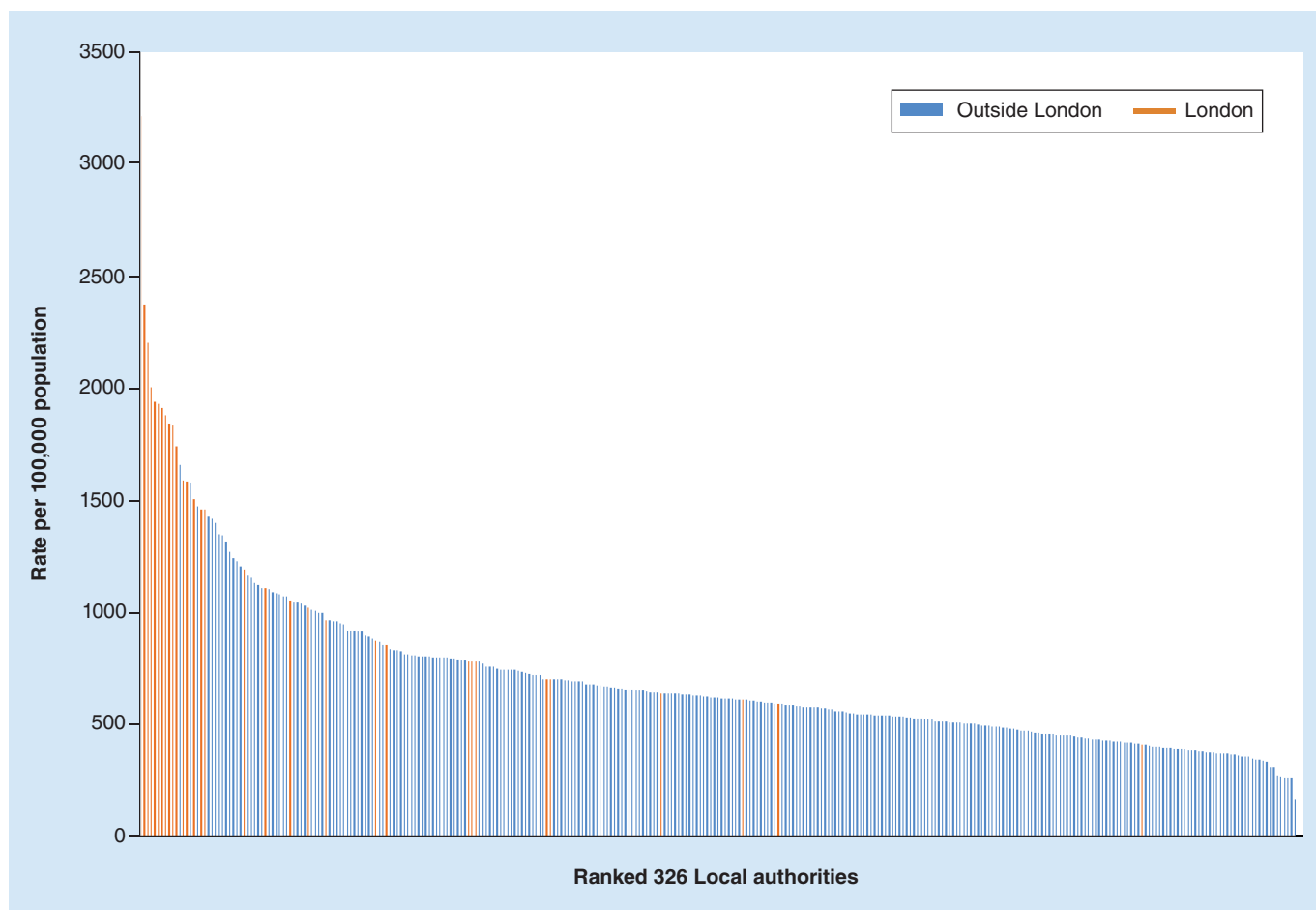


Figure 2. Range in rates of sexually transmitted infection diagnoses in 326 local government authority areas of residence in England, 2012.

Data from GUM service returns. Data taken from Public Health England © Crown copyright 2014.

In the same year in Scotland, approximately three-quarters of genital chlamydia and gonorrhoea diagnoses in women were made in those aged under 25 years [39].

Repeat infection can contribute significantly to infection persistence in a population and is particularly common among adolescents and young adults [61]. Approximately 11% of 16–19-year-old women and 12% of 16–19-year-old men with a STI become reinfected within 1 year [62].

Men who have sex with men

MSM are disproportionately affected by STIs. MSM tend to report higher rates of partner change than heterosexual populations and they are more likely to belong to complex, densely connected sexual networks that facilitate rapid STI transmission [63]. Although only 2.6% of the male British population reported a male partner

in the past 5 years [29], in England in 2012, approximately 79% of syphilis, 58% of gonorrhoea and 17% of chlamydia diagnoses in men in GUM clinics were in MSM [32]; in the UK, LGV is diagnosed almost exclusively in MSM [26]. STI diagnoses in MSM are concentrated in urban areas, especially London, Manchester and Brighton [26,32]. In 2010–2012, over a half of syphilis diagnoses and two-thirds of LGV diagnoses among MSM were in London [13,26].

Some MSM may also adopt HIV seroadaptive behavioral strategies, whereby men choose to have unprotected sex (sex without condoms) with partners according to their perceived HIV infection status, with the intention of reducing HIV transmission risk [63]. Seroadaptive behaviors increase exposure to STIs (as well as lead to unintended HIV transmission) and have been associated with recent STI epidemics in MSM in the UK, including LGV, HCV and *S. flexneri*

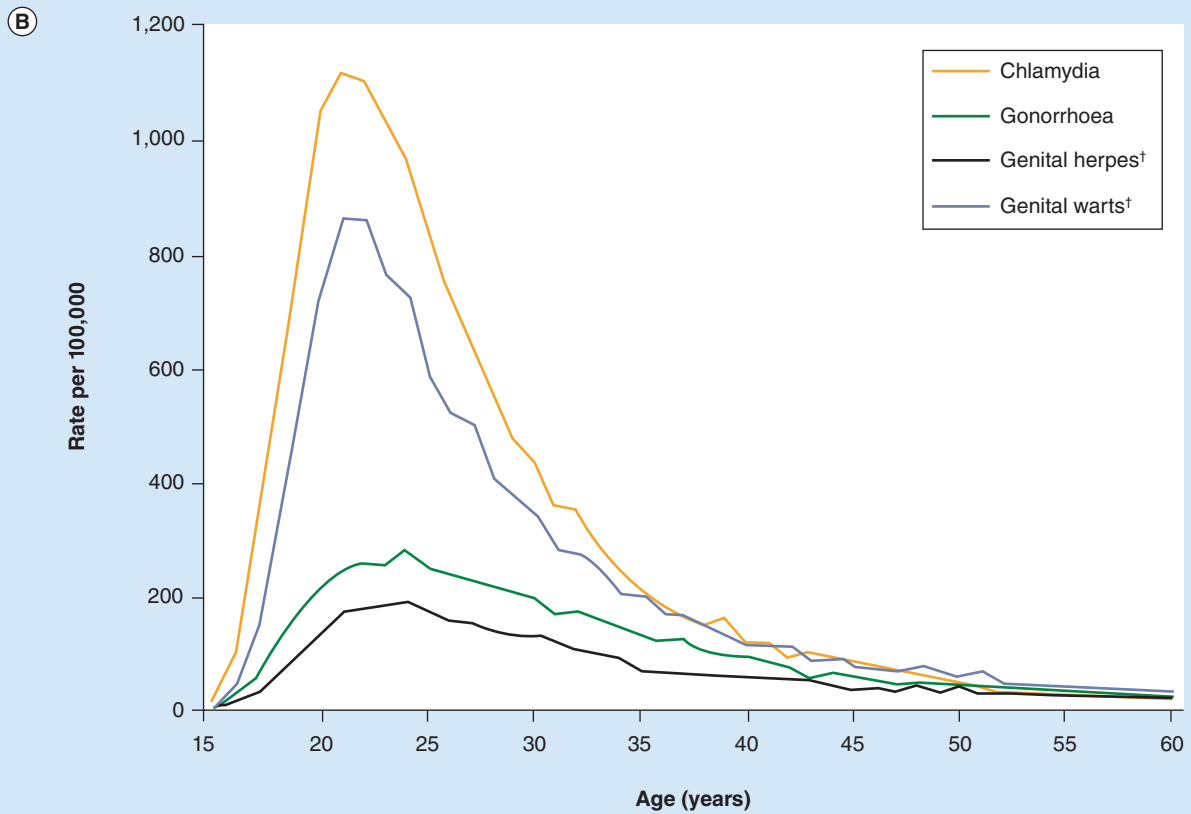
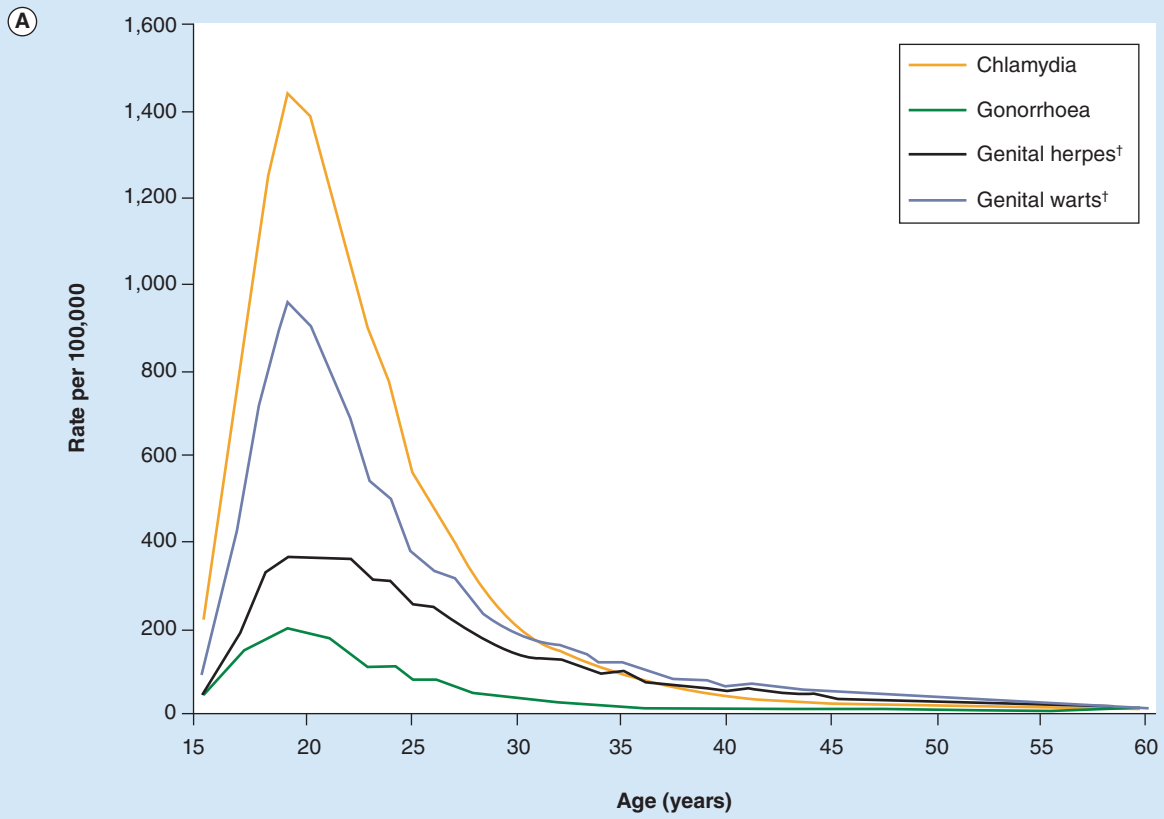


Figure 3. Age distribution of selected sexually transmitted infections (rate/100,000) diagnosed in England, 2012 (see facing page). (A) Women. (B) Men.

†First episode.

Data from GUM service returns. Data taken from Public Health England © Crown copyright 2014.

[26,53,64]. Among MSM, approximately 80% of those diagnosed with LGV, 60% diagnosed with *S. flexneri* and almost a third diagnosed with syphilis are HIV positive [14,26,64]. HIV-positive MSM are also at greatly increased risk of HPV-related disease, including anal cancer [65]. In one UK study of immunosuppressed HIV-positive MSM, 84% had high-risk HPV types and 11% had associated cytological abnormalities detected [66].

Black ethnic minorities

Recent surveillance data from England indicate that black ethnic minorities and especially black Caribbean populations are at much greater risk of STIs, especially for gonorrhoea and trichomoniasis, for which they have a 12- to 20-fold greater risk compared with the general population (**Figure 4**) [48,67]. Black Caribbean populations also experience the highest rates of repeat gonococcal infection, with approximately 12% of those diagnosed with gonorrhoea presenting with a reinfection within 1 year [59]. Among other factors, this inequitable distribution is probably influenced by health service provision and access, health awareness and health-care-seeking behavior [68]. Although somewhat reduced, the inequity persists after adjustment for socioeconomic deprivation, suggesting that other cultural influences on sexual behavior are likely to contribute to STI risk [48,67]. Natsal-2, but not Natsal-3, included additional sampling of ethnic minority groups and found strong evidence of higher numbers of lifetime partners among black ethnic minorities, who were also more likely to report STI diagnoses in the past 5 years when compared with white men and women [69]. Concurrent sexual partnerships and cultural barriers to condom use may contribute to high STI rates among black Caribbeans [70].

Sex workers

Sex workers (SWs) are often considered to be at particular risk of STIs, although in England, female SWs attending GUM clinics are only at marginally higher risk of an STI than other female attendees [71]. This is despite a high proportion being migrants and potentially 'harder-to-reach'. However, there is evidence

of geographic variation in access to services, and street-based SWs in particular may experience considerable health inequalities, drug- and alcohol-dependency problems and poor access to testing services [72]. Furthermore, STI outbreaks can easily emerge and spread in this vulnerable population [73]. Male SWs are also likely to be at increased risk of STIs, HIV and mental ill health [74]. In 2011, 2704 female and 488 male SWs attended a GUM clinic in England [74,75].

• Recent trends

By the late 1990s, rates of STI diagnoses were again increasing rapidly and, with few exceptions, have continued to rise until 2012. In the last 10 years, numbers of new STI diagnoses in England rose by 47%, from 305,000 to 448,000 [13]. Almost half a million STI diagnoses are now made in the UK annually [62].

The most remarkable changes were observed for diagnoses of genital chlamydial infection, which have more than doubled in the last 10 years and now comprise 46% of all STI diagnoses in England [32]. Diagnoses of genital HSV also nearly doubled over the same period [32]. In the last 5 years, gonorrhoea diagnoses in the UK rose by 74%, and by 24% in the last year alone [13]. While diagnoses of most other STIs also rose during this period, the changes were far less pronounced; for example, reported cases of infectious syphilis rose by 14% in the UK between 2008 and 2012 [13]. In the case of genital warts, between 2011 and 2012, new diagnoses declined in England by 3%, but increased in Wales by 10% [18,32].

While numbers of diagnoses of most STIs have been increasing in men and women, the most notable increase in numbers has been among MSM in the last 5 years, especially for chlamydia and gonorrhoea (**Figure 5**). In parallel, new diagnoses of LGV in MSM and reports of nontravel-related *S. flexneri* 3a infections in adult males, which is suggestive of transmission among MSM, grew exponentially [26,51]. Of particular concern has been the recent rapid emergence of decreased susceptibility of gonorrhoea to cefixime in MSM in England and Wales, which precipitated a change in the national gonorrhoea treatment guideline in 2011 [44,76]. Prior to this,

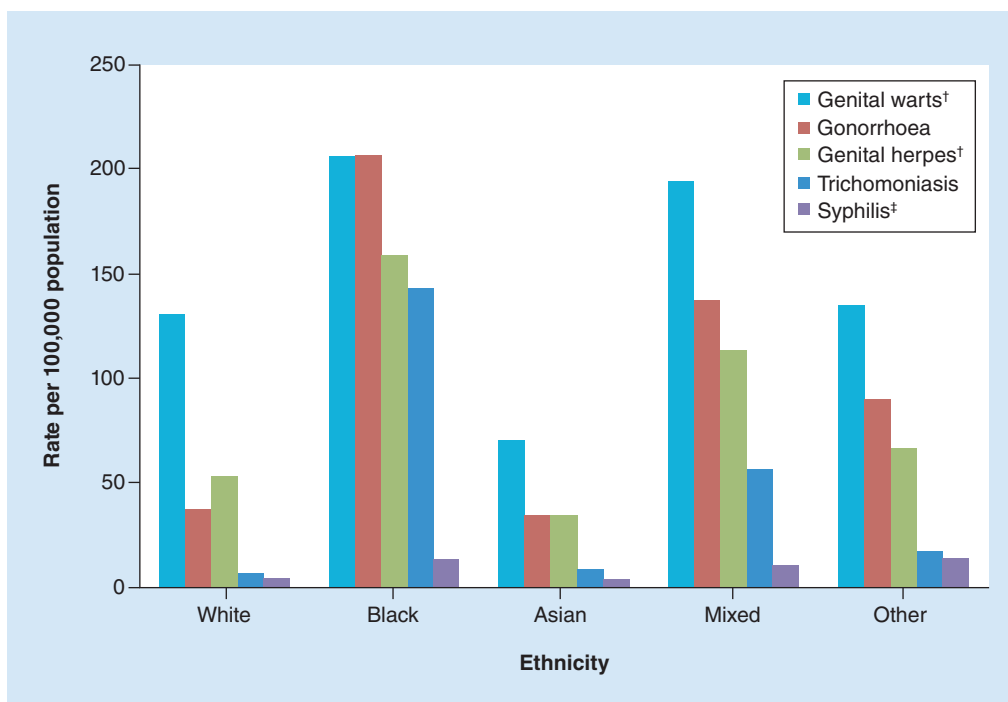


Figure 4. Rates of selected sexually transmitted infections diagnosed in England stratified by ethnic group, 2012.

[†]First episode.

[‡]Primary, secondary and early latent.

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the rapid emergence of quinolone resistance among MSM in the early 2000s had resulted in a treatment guideline change in 2005 [77].

The drivers of these recent trends in STI diagnoses are complex and multifactorial. In part, they reflect increased infection incidence and prevalence associated with changes in sexual behavior and exposure to infection, influenced by intrinsic biological factors [43,78]. However, they are also associated with improvements in service access, STI testing interventions and testing technologies that have facilitated better infection detection. The drivers of STI trends are discussed in detail below.

Sexual behavior

In common with other western European countries, in Britain, there has been a fall in the age at first sex over many decades, from a median of 18 years of age in men and 19 years of age in women born in the 1940s, to 16 years of age in men and women born in the 1990s [29]. At the same time, there have been substantial increases for men and women in the time between each of first sex, first live-in relationship and having

children, with the result that young adults are likely to spend longer at risk of STIs [79]. In part, this may explain the rise in the number of lifetime partners reported by men and women [29].

In 2000, Natsal-2 documented dramatic increases in many reported behaviors compared with 1990 [80]. It is likely that these changes in sexual behavior between 1990 and 2000 facilitated STI transmission and contributed to the substantial increases in STI diagnoses recorded during this period. The early 1990s probably represented a period of low sexual risk behavior coinciding with wide public concern regarding HIV. However, the most recent Natsal-3 study found only moderate changes in reported sexual behaviors in Britain between 2000 and 2010, and the increases in STI diagnosis rates in heterosexuals during this period are more difficult to explain [29].

For MSM, however, a rather different and more complex picture is evident. Approximately 3% of the male population in Britain report at least one male sexual partner in the past 5 years, and this proportion has not changed since 2000 [29]. Unfortunately, national probability samples

contain insufficient numbers of MSM to reliably explore behaviors within this population, such as the proportion reporting unprotected anal intercourse. Surveys of gay commercial venues and gyms in London, Glasgow and Edinburgh suggest complex patterns of behavior, but provide evidence of overall increases in the proportion reporting unprotected anal intercourse with partners of unknown or discordant HIV status [81,82]. These changes are consistent with the adoption of HIV seroadaptive behaviors among a growing population of HIV-positive MSM on antiretroviral therapy [63,83], facilitated through web-based apps for meeting sexual partners [26]. The rapid increase in the number of chlamydia and (especially rectal) gonorrhoea diagnoses, the emergence of gonococcal isolates with decreased susceptibility to cefixime, the evidence

of sexually transmitted HCV and the ongoing LGV and *S. flexneri* epidemics strongly suggest that these changes in behavior and practices are leading to greater STI incidence among MSM, and especially HIV-positive MSM, in dense sexual networks [14,26,27,44,51,53,54]. Intensive recreational drug use may also be facilitating increased STI transmission in some cases [64].

Service access & interventions

Sexual health services in the UK have evolved considerably since the beginning of the 21st century. This has enabled improved access to a broader range of services offering STI testing and sexual healthcare and has led to an increase in diagnoses of many STIs.

There has been a dramatic rise in the number of people accessing sexual health clinics. By

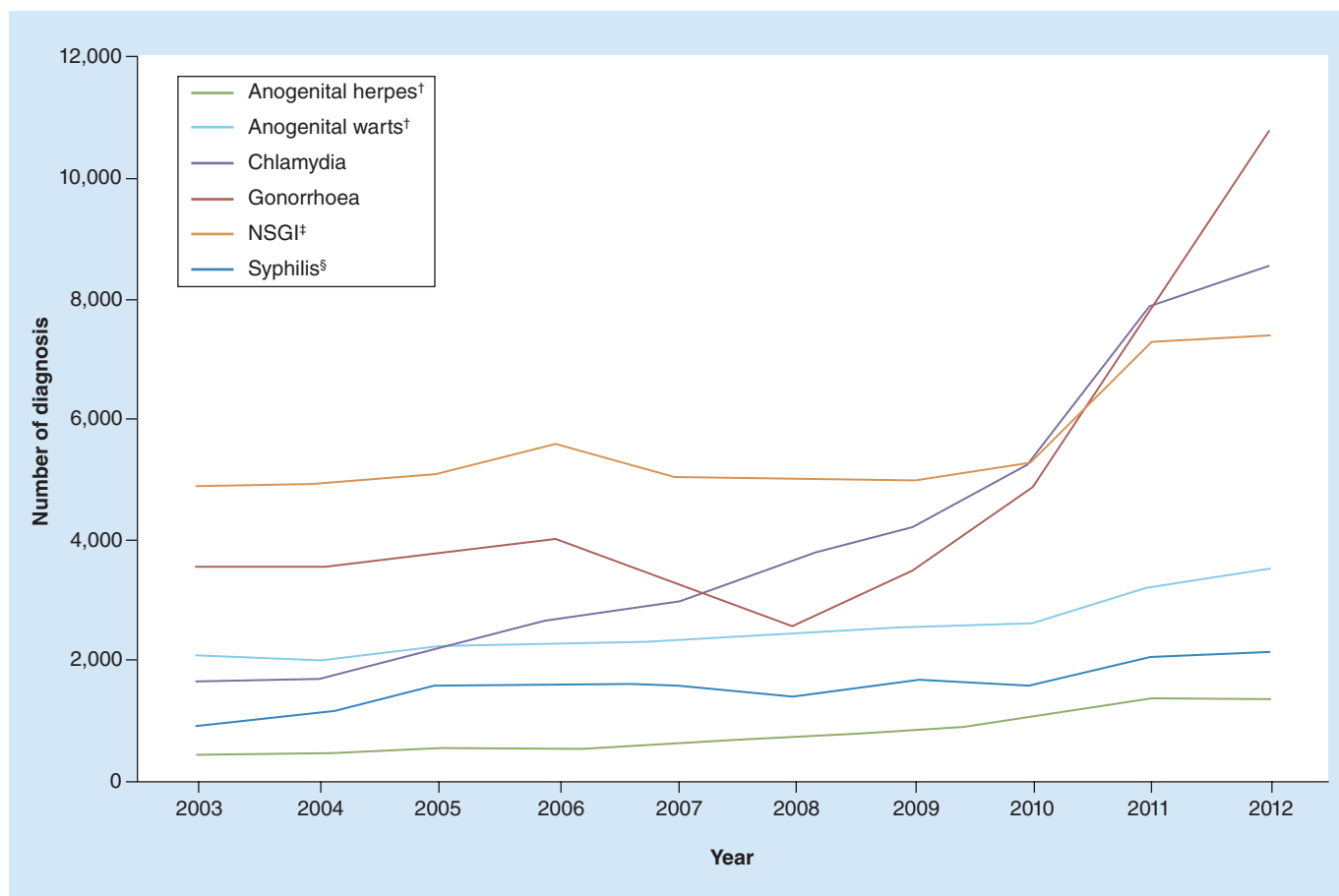


Figure 5. Diagnoses of selected sexually transmitted infections in men who have sex with men in England, 2003–2012.

†First episode.

‡Nonspecific genital infection.

§Primary, secondary and early latent.

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2010, approximately one in five Britons aged 16–44 years reported clinic attendance in the previous 5 years, an increase from approximately one in 14 in 2000 [30]. Improvements in service availability and choice, including enhancement of sexual health services offered through primary care, have likely facilitated better access to care [11,84–86]. In parallel, the introduction of government targets to reduce waiting times at GUM clinics to 48 h in England is likely to have increased patient throughput [87].

This increased service capacity enabled more STI testing, and the numbers of STIs tests reported in England, Wales and Scotland have risen sharply in recent years [16,18,32]. Between 2003 and 2012 in England, STI tests conducted in GUM clinics almost doubled from 633,000 to 1,241,000 [88], while between 2007 and 2012 in Wales, STI tests conducted in sexual health clinics rose by nearly two-thirds to reach 41,000. Most notable has been the increase in testing for genital chlamydial infection. While this has occurred across the UK, it has been most pronounced in England following the introduction of the English NCSP [32]. As a result of this program, national surveillance data indicated over 1.7 million young adults in England were tested for chlamydia, which is equivalent to a testing coverage of 35% of young women and 16% of young men and with a positivity of between 7 and 9% [32]. Data from Natsal-3 suggest that among those who were sexually active, 54% of women and 35% of men aged 16–24 years had a chlamydia test in the past year [30] and that testing was broadly higher in those reporting risky behaviors [89]. Nevertheless, 54% of men and 30% of women aged 16–24 years with two or more partners in the past year had not been tested and a substantial proportion of infections remained undiagnosed [30,89].

These increases in testing frequency have occurred alongside and have been facilitated by rapid developments in molecular testing technology, especially for chlamydia, gonorrhoea and genital HSV, which have improved test sensitivity and specificity while using less invasive specimens [90–92]. Increased detection of asymptomatic infection has made a significant contribution to the rapid increase in diagnoses made among young adults, MSM and those attending GUM clinics in general. More testing of specimens from the rectum and pharynx have further improved the detection of gonococcal

and chlamydial infections in MSM, leading to higher numbers of diagnoses [32].

However, the earlier detection and treatment of STIs following these improvements in service provision should, in time, lead to reduced STI transmission and fewer numbers of diagnosed infections and associated morbidity [93]. Diagnoses of PID among women in the UK have declined rapidly in recent years, but particularly in the youngest age groups [94]. Although a matter of some debate, the sharp reduction in PID diagnoses in young adults may in part be associated with increased chlamydia testing coverage in this age group [95].

In contrast to other STIs, diagnoses of genital warts in teenagers have begun to decline in the last few years. In England, diagnoses among women aged 15–19 years fell by 22% between 2009 and 2012 [32]. The UK introduced a school-based HPV immunization program in September 2008 targeting 12-year-old girls and initially including a catch-up program for girls aged up to 18 years [96]. Coverage of over 80% among 12-year-olds has been achieved and the prevalence of high-risk HPV types 16 and 18 is already in decline [97]. However, unlike many countries, the UK's program initially used the bivalent vaccine that only targets HPV types 16 and 18, and was not expected to impact on genital warts diagnoses. In fact, there is now increasing evidence that the HPV-16/18 vaccination program has been moderately protective against genital warts [98,99]. A further, more rapid decline in genital warts is now anticipated, as the UK program has recently switched to the quadrivalent vaccine, which also targets HPV types 6 and 11 [96].

Conclusion

Infectious disease epidemiology is complex and this is especially so for STI epidemiology, which is uniquely linked to sexual contact. The dynamic interplay between underlying STI prevalence, sexual behavior, service access and public health interventions drives trends in STI diagnoses and complicates their interpretation. It may take several years for the effects of an intervention or changes in population-level behavior to become apparent, and routine and regular assessments of STI epidemiology using high-quality surveillance systems supported by population-based surveys and mathematical modeling have been vital to understanding their impact in the UK. While sexual behavior has not

changed significantly at the general population level in recent years, the persisting high incidence of STIs in young adults, MSM and black Caribbean populations requires a continuing

public health focus and further research in order to develop effective, evidence-based interventions. Across the UK, the last decade has seen a strengthening of sexual health and STI services,

EXECUTIVE SUMMARY

Sexually transmitted infection service provision in the UK

- The provision of sexual health services in the UK has evolved considerably over the past 20 years.
- Genitourinary medicine clinics offer comprehensive, specialist sexually transmitted infection (STI) testing and management services; however, an increasing proportion of STI-related care is provided by nonspecialist sexual health services.

Surveillance of STIs in the UK

- Disaggregated genitourinary medicine clinic data provide insights into the incidence and distribution of STIs in the UK and the risk factors associated with their acquisition.
- STI surveillance is being improved by the increased collection of data from nonspecialist settings, including general practice.
- Surveillance data have been complemented by three consecutive National Surveys of Sexual Attitudes and Lifestyles studies, which have monitored changes in sexual behavior and access to sexual health services and used biological sampling in order to provide robust estimates of STI prevalence in the general population.

STIs of public health importance in the UK

- Human papillomavirus is the most prevalent STI, with high-risk types detected in 16% of women and 8% of men aged 16–44 years.
- Genital chlamydia is the most common bacterial STI, with a prevalence in adults aged under 25 years of between 2 and 3% in the general population and up to 10% in those attending testing services.
- Gonorrhoea and syphilis are relatively rare in the UK, but can be locally common in high-risk populations.
- *Lymphogranuloma venereum* has emerged alongside other sexually transmissible infections, such as hepatitis C virus and *Shigella flexneri*, as a significant public health concern in men who have sex with men (MSM).

Historical trends

- Cases of gonorrhoea and syphilis rose sharply at the end of the Second World War with the return of the armed forces, but declined rapidly with the availability of penicillin and the return to social stability.
- Major social, medical and legal changes during the 1960s coincided with a steady rise and subsequent stabilization in STI diagnoses, which persisted until the mid-1980s.
- The emergence of the HIV and AIDS during the 1980s led to behavioral modification and a sharp decline in diagnoses, which persisted until the mid-1990s.

Recent epidemiology & trends

- Young people aged under 25 years, MSM and certain black ethnic minority populations experience the highest rates of infection.
- STI diagnoses have risen considerably in the last 10 years, and almost half a million STI diagnoses are now made in the UK annually.
- This rising trend partly reflects major improvements in service access and testing interventions, such as the implementation of the National Chlamydia Screening Programme in England, which have led to greater numbers of infections being diagnosed.
- Changes in sexual behavior among MSM, especially HIV-seroadaptive behaviors, have probably led to the increased incidence and prevalence of STIs in this population.

which will have brought significant improvements in service access and to sexual health in the population.

Future perspective

In the future, new molecular testing technologies, such as multiplex and point-of-care tests, may improve access and facilitate prompt treatment, but their use will require appropriate stewardship in order to discourage unnecessary testing, false-positive results and consequent harm [100]. Major revisions to the commissioning and provision of sexual health services, especially in England, raise opportunities for STI control to be prioritized by local government, but equally present challenges, such as the potential fragmentation of services [101]. The effects of these changes on service access, service provision and quality of care, the size and behavior of at-risk

populations, the impact of population-level interventions and evolving testing technologies will shape STI epidemiology in the UK over the coming decade.

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