Epidemiology of Sexually Transmitted Infections

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Core Messages

- Sexually transmitted infections (STIs) are commonplace worldwide and may be caused by bacteria, fungi, protozoa, parasites, or viruses.
- Epidemiology involves the study of incidence and prevalence of disease in large populations as well as detection of the source and cause of epidemics of infectious disease.
- Acute diseases tend to have high incidence and low prevalence; chronic diseases may have high prevalence even if incidence is low.
- Developing nations have the largest proportion of STIs, while most industrialized countries have low or falling rates of infection.
- Prevention is the best tool to decrease morbidity and mortality of STIs.

2.1 Introduction

Sexually transmitted infections (STIs) are extraordinarily commonplace, with an estimated 340 million new cases of "curable" infections occurring each year (see Table 2.1) worldwide in men and women aged 15–49 years [1]. These infections include those caused by bacterial, mycological, and protozoal agents that have been treated by appropriate antibiotics and chemotherapeutic agents for more than 40 years (namely syphilis, gonorrhea, chlamydia, and trichomoniasis). In spite of adequate available therapy, such STIs have continued to be a public health problem in both industrialized and developing countries. In addition to the "curable" STIs, there are also millions of viral STIs that occur annually (including human immunodeficiency virus [HIV], herpesviruses, human papilloma viruses, and hepatitis B viruses) that cannot be eradicated through currently available medication.

The largest proportion of STIs occur in developing nations, led by South and Southeast Asia, followed by sub-Saharan Africa, Latin America, and the Caribbean [2]. An equilibrium has been reached in most industrialized countries with low (and often still falling) rates of infection. In contrast, the equilibrium reached in many developing countries has been with highly endemic levels of disease [3].

STIs are not only a cause of acute morbidity in adults, but may result in complications including male and female infertility, ectopic pregnancy, cervical cancer, premature mortality, congenital syphilis and fetal wastage, low birth weight, and prematurity and ophthalmia neonatorum [3].

Care for the sequelae of STIs accounts for a large proportion of tertiary healthcare costs in terms of screening and treatment of cervical cancer, management of liver disease, investigation for infertility

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Table 2.1 Worldwide incidence of common "curable" sexually transmitted infections

Infection	Worldwide Incidence/ Prevalence
Trichomonas	170–190 million incident cases
Chlamydia	Over 90 million incident cases
Gonorrhea	Over 62 million incident cases
Syphilis	12 million incident cases
Chanchroid	6–7 million incident cases

causes, care for perinatal morbidity, childhood blindness, pulmonary disease in children, and chronic pelvic pain in women [1]. The costs increase further when the cofactor effect of other STIs on HIV transmission is taken into consideration [1, 2]. The economic burden of STIs is huge, especially for developing countries where they account for 17% of economic losses caused by ill health [4].

Many STIs are asymptomatic and therefore can be difficult to recognize and control. Thus, the worldwide incidence of new cases of STIs may be even higher than the estimated 340 million mentioned above. For example, it is estimated that actual reported cases of STIs represent only 50–80% of reportable STIs in the United States, reflecting limited screening and low disease reporting [5].

Several risk factors exist that make certain populations more prone to STIs than others (see Table 2.2). While these risk factors are not shared by all STIs, there are many commonalities. Young age, for example, is a risk factor common to many STIs. Adolescents and young adults (15–24 years old) make up only 25% of the sexually active population, but represent almost 50% of all new acquired STIs [5]. This may be confounded by the fact that this age group is more prone to engage in high-risk sexual activity (another risk factor) than the older population. Other groups known to participate in high-risk sexual activity (such as sex with multiple partners and unprotected sex) include prostitutes, intravenous (IV) drug users, and prison inmates. Not surprisingly, these groups are also known to be at higher risk for STIs than the general population. Additional risk factors for several STIs include lack of male circumcision, low socioeconomic status, and poor hygiene.

Epidemiology is the branch of medicine dealing with the incidence and prevalence of disease in large

Table 2.2 Major risk factors of sexually transmitted infections

Infection	Young Age	High-Risk Sexual Behavior	Low Socioeconomic Status	Poor Hygiene	Other Specific Risk Factors
Trichomonas		X	X	X	Increased age
Chlamydia	X	X			Female gender
Gonorrhea	X	X	X		
Syphilis	X	X			MSM population
Chancroid	X	X		X	Lack of male circumcision
Donovanosis	X	X	X		
Herpes simplex		X	X		
Human papillomavirus		X	X		Bimodal age distribution, lack of male circumcision
HIV/AIDS		X	X		MSM population (in the United States), perinatal infection, IV drug use
Hepatitis B		X			Lack of childhood vaccination, vertical transmission, IV drug use
Molluscum contagiosum	X	X			
Scabies/pubic lice		X	X	X	

populations and with the detection of the source and cause of epidemics of infectious disease. The terms incidence and prevalence are often confused even in scientific literature. Technically, incidence refers to the number of new cases of a disease in a population over a period of time (usually a year). Prevalence, on the other hand, refers to the total number of cases of a disease in a given population at a specific time. Acute diseases or those with high mortality rates tend to have a high incidence and low prevalence, since those who acquire the disease either get better or expire; either way they are unlikely to be infected with the disease at any particular point in time. Chronic diseases may have high prevalence even if incidence is low, as those with the disease never get rid of it and are added to the number of incident cases each year. The remainder of this chapter will focus specifically on several of the most common STIs, for which the epidemiology is best described in previous literature.

2.2 Epidemiological Trends of Common Sexually Transmitted Infections

2.2.1 *Trichomonas Vaginalis*

2.2.1.1 Burden of Disease

Trichomonas vaginalis, a pathogenic protozoan, is the most common nonviral cause of STI worldwide. It is frequently asymptomatic in men, or may cause a short-lived course of nongonococcal urethritis, but it is significant because the parasite is easily transmitted to women during the short period of infection. Women infected with *T. vaginalis* may also be asymptomatic (up to 30% of cases), but the majority experience vaginitis. Additionally, *T. vaginalis* infection may be responsible for significant reproductive health sequelae including pelvic inflammatory disease and adverse outcomes of pregnancy (such as preterm labor and low birth weight) [6, 7]. Perhaps most importantly, *T. vaginalis* infection has been implicated as one of the most important cofactors in amplifying HIV transmission, particularly in the African American population of the United States [8].

2.2.1.2 Incidence and Prevalence

The World Health Organization (WHO) estimates an incidence of 170–190 million new cases of *T. vaginalis* infection worldwide each year. However, these estimates may be low, since they are based on wet mounts that are not as sensitive as new polymerase chain reaction (PCR) technology [9]. Extensive data are available regarding the prevalence of *T. vaginalis* infection but can be difficult to interpret due to variation in diagnostic technique, study settings, populations studied, and whether symptoms were present or absent in participants. Overall, prevalence rates have ranged from 5% to 10% in women in the general population to as high as 50–60% in high-risk populations such as prison inmates and commercial sex workers [10]. Prevalence in males similarly has a high degree of variation depending on the population studied, ranging between 0% in low-risk asymptomatic men to 58% among adolescent males at high risk for sexually transmitted diseases (STDs).

An estimated 7.4 million new cases of *T. vaginalis* infection are reported in the United States each year. Prevalence ranges between 2.2% for young women (≤20 years) compared with 6.1% in women ≥25 years. Male prevalence was lower for both age categories, with a reported 0.8% among men≤ 20 and 2.8% in males ≥25 years [6]. In Northern Australia, a study of indigenous women found a similar increase in prevalence with age, although the overall prevalence (25%) was higher than that seen in US studies [6, 11].

Amongst pregnant women in Latin America and the Caribbean, trichomoniasis prevalence rates ranged from 2.1% in Brazil to 27.5% in Chile [12, 13]. In Africa, pregnant females had prevalence rates ranging from 9.9% in the Central African Republic to as high as 41.4% in South Africa [14, 15].

2.2.1.3 Risk Factors

Unlike chlamydia and gonorrhea, young age is not a risk factor for trichomoniasis. Prevalence of *T. vaginalis* infection appears to increase with age for both males and females, possibly due to its frequent asymptomatic nature of the infection and therefore persistence of untreated infections [6].

Studies in developed nations have found high prevalence of trichomoniasis in prison inmates, IV drug

users, and sex workers [6]. A common trend in these three risk groups is that they are more likely to engage in high-risk sexual behavior than the general population. Unprotected sex with multiple partners increases the chance of *T. vaginalis* infection, as with any STD. In a study by Tyndall et al. of IV drug users with high HIV prevalence, 57% of female participants reported more than 100 lifetime partners. Condoms were generally not used with regular partners, used about half of the time with casual partners, and used about 80% of the time with paying partners [16].

There is no doubt that protected sex with a condom helps prevent *T. vaginalis* infection as well as other STIs (see Chap. 55). Sex workers in countries such as Australia, where there is a decriminalized regulated system, have a much lower incidence of trichomoniasis than do street sex workers [17, 18]. This is likely because street sex workers are less likely to use protection than those who work in a regulated brothel.

Other risk factors that have been described include subjects with poor personal hygiene and low socioeconomic status [10].

2.2.2 *Chlamydia*

2.2.2.1 Burden of Disease

Chlamydia trachomatis is responsible for more cases of STD than any other bacterial pathogen, and is therefore an enormous worldwide public health problem. Since asymptomatic infection is common, it can easily be passed unknowingly between sexual partners. In addition to sexual transmission, the organism can be transmitted by droplets, hands, contaminated clothing, flies, and by passage through an infected birth canal.

In females, chlamydia primarily presents as a cervical infection following exposure to an infected partner. Initial infection may either be asymptomatic or cause a self-limited acute inflammatory response. However, repeated or untreated infection may cause chronic inflammation, irreversible tissue damage, and scarring (i.e., pelvic inflammatory disease) that may lead to infertility or increased risk of ectopic pregnancy. There is a four- to sixfold increased risk of pelvic inflammatory disease and a two- to fourfold increased risk of ectopic pregnancy associated with recurrent infections [19].

In men, chlamydia is the commonest cause of nongonococcal urethritis. Almost 50% of men with chlamydia experience urethritis associated with pain and penile discharge, but those with asymptomatic infection may serve as carriers of the disease. Men rarely suffer long-term health problems as a result of chlamydia infection.

Contamination of the hands with genital discharge may lead to a conjunctival infection following contact with the eyes. Babies born to mothers with infection of their genital tract frequently present with chlamydial eye infection within a week of birth (chlamydia "ophthalmia neonatorum"), and may subsequently develop pneumonia.

Worldwide, the most important disease caused by *C. trachomatis* is trachoma that affects the inner upper eyelid and cornea and is one of the commonest infectious causes of blindness (an estimated seven to nine million people are blind as a result of trachoma). The disease is particularly prevalent and severe in rural populations living in poor and arid areas of the world where people have limited access to water and personal hygiene is difficult. In the United States, Native Americans are most commonly infected.

Another disease caused by *C. trachomatis* is lymphogranuloma venereum (LGV), a condition characterized by painful lymphadenopathy. LGV is caused by the L1, L2, and L3 serovars of *C. trachomatis* and begins as a painless ulcer that is usually self-limited. The secondary stage of LGV is the painful lymphadenopathy, most commonly of the inguinal or femoral lymph nodes; these nodes may coalesce to form buboes that can rupture in as many as one third of patients. The tertiary stage of LGV is caused by fibrosis that can result in lymphatic obstruction, edema, abscesses, and strictures.

2.2.2.2 Incidence and Prevalence

The WHO estimates that over 90 million new cases of chlamydia are diagnosed each year [20]. Various studies have estimated that there are four to five million new cases of chlamydial infection each year in the United States alone. Prevalence varies greatly depending on the type of population studied, as several factors (to be discussed in detail below) greatly increase the risk for chlamydia. For example, in the US adolescent female population, prevalence varies from 5% among

suburban adolescent females to as high as 25–30% among urban adolescents, resulting in an overall prevalence of 12% in the adolescent population as a whole in the United States [20–22]. Worldwide prevalence rates are similar to that of the United States, ranging between 5% and 15% for most of Europe, Australia, Africa, and Japan [23–26]. In certain countries in which intensive chlamydia control programs have been instituted, significant reduction in prevalence has been observed. For example, the number of cases of chlamydia was reduced by over 50% over a 7-year period in Sweden with similar declines seen in the US Pacific Northwest and Wisconsin following the institution of control programs [27, 28].

2.2.2.3 Risk Factors

Young age is the strongest predictor of chlamydia. The highest rates have been consistently found among young sexually active women, particularly adolescents [29]. In a large surveillance study performed in Germany, the highest prevalence of chlamydia was found among 15–19-year-old females, with prevalence significantly decreased after 25 years of age [20].

Prevalence among females appears to be up to three or four times greater than that of males. This may be due to anatomical factors, as the cervix of adolescent females is not sufficiently developed and is therefore particularly susceptible to STIs [20, 30]. This would also partially explain the particularly high rate of chlamydia in adolescents. However, the reported gender disparity is likely at least partially due to the greater frequency that females access health care through routine Pap smear screening, family planning services, and other services related to reproductive health care.

In the United States, non-white race and Hispanic ethnicity have been associated with higher prevalence than in other groups. In the United States, the Center for Disease Control (CDC) data show that rates among African Americans are several-fold higher than other racial and ethnic groups [31]. Some of these data may be skewed due to confounding by socioeconomic status. As previously mentioned, urban adolescent females in the United States have a significantly higher prevalence of chlamydia infection when compared to their suburban counterparts. Worldwide, the greatest number of chlamydia infection cases was detected among individuals of the black Caribbean race [20].

As with most STIs, several sexual behavior risk factors exist. For chlamydia, these include frequency of intercourse, multiple partners, a new partner in the past 2 months, a partner with an STD diagnosis, young age at first intercourse, and failure to use barrier contraception [31–33]. Hormonal contraception use may be associated with a higher risk of chlamydia [34], perhaps due to a lesser likelihood of using barrier contraception in conjunction with hormonal contraception. The significantly greater prevalence of chlamydia among female prostitutes in Central Africa compared to that of male and female students in Africa (38.3% versus 3–7%, respectively) exemplifies the degree of risk that sexual behavior can have on the epidemiology of this disease [23, 25, 35]. Chlamydia and other inflammatory STDs are also associated with increased susceptibility to and transmission of HIV infection [36].

2.2.3 Gonorrhea

2.2.3.1 Burden of Disease

Neisseria gonorrhoeae is a gram-negative diplococcus responsible for infection through contact with the penis, vagina, mouth, or anus regardless of ejaculation. Although gonorrhea can also spread from mother to baby during delivery it is commonly transmitted through sexual contact. The bacterium develops and multiplies in the cervix, uterus, and fallopian tubes of women, within the urethra of both males and females, and secondarily in the mouth, throat, eyes, and anus.

In females, gonorrhea is frequently asymptomatic, often misdiagnosed as bladder or vaginal infections [37]. Alternatively, infection may result in painful or burning urination, increased vaginal discharge, or vaginal bleeding. Further complications include pelvic inflammatory disease and increased risks of infertility, ectopic pregnancy, postpartum endometriosis, cystitis, and mucopurulent cervicitis.

Males experience epididymitis, urethritis, and white, yellow, or green penile discharge. Symptoms typically appear 2–5 days after infection, but the infection may lie dormant for up to 30 days. Similar to chlamydia, the effects of gonorrheal infection in males are commonly short term; however, infection is 1.5 times greater than in females [38].

Gonorrhea is more likely to transmit from asymptomatic carriers than people with evident infection. Approximately 1% of gonococcal occurrences begin as anorectal and pharyngeal infections in women who have sex with men as well as men who have sex with men (MSM). Disseminated gonococcal infections (DGIs) develop into a skin rash and asymmetrical septic polyarthritis.

Pregnant females with active infection may transmit the disease to the baby during delivery as it passes through the birth canal. This transmission may cause potentially fatal blood, joint, or conjunctival infections (gonococcal ophthalmia neonatorum), which result in rapid blindness [39]. Pneumonia may also occur and symptoms appear 5–12 days after birth. The transmission of HIV also increases in people with gonorrhea infection.

2.2.3.2 Incidence and Prevalence

Over 62 million people are infected worldwide annually with 700,000 incidences in the United States [40]. Gonorrhea is prevalent in both developed and developing nations and is frequently concomitant with chlamydia infection. In 1999 the greatest incidence of infection occurred in South Asia followed by sub-Saharan Africa and Latin America and the Caribbean. Per 1,000 people the rate of new infection was highest in sub-Saharan Africa, where pregnant women were infected with gonorrhea at rates ranging from 0.02% in Gabon to 3.1% in the Central African Republic and 7.8% in South Africa [41].

Throughout the 1990s the highest prevalence rates (3% or greater) in the Western Pacific were in Cambodia and Papua New Guinea [42]. Vietnam, China, and the Philippines reported rates of 1% or less [43]. A significant increase in gonorrhea incidence occurred in eastern Europe between 1995 and 1999 with highest rates in Estonia, Russia, and Belarus [44]. Western Europe reported a significant decline from 1980 to 1991 with the rate below 20 infections/100,000 people. Between 1981 and 1995 Canada experienced a tenfold reduction from 226 infections/100,000 persons to 19 infections/100,000 [45].

The US CDC estimates that only 50% of gonorrheal infections are actually reported since the disease often illustrates few or no symptoms. The CDC reported 358,366 cases of gonorrhea in the United States in 2006 with the rate of infection at 120.9/100,000 persons. Significant control programs throughout the 1970s resulted in a national decline from 1975 to 1997; however, 2006 marked the second consecutive year of increased incidence [37, 46].

In the United States infections are highest in young adults and African Americans; however, the rate of cases per 100,000 population declined by 7.7% in African Americans between 2002 and 2006 (from 713.7 to 658.4, respectively) [47]. Between 2005 and 2006 all racial and ethnic groups except Asian/Pacific Islanders saw slight increases in gonorrhea infections. American Indian/Alaska Natives experienced the greatest increase of 22.9%, followed by 17.7% among Caucasians, and 11.8% among Hispanics. A decrease of 1.4% was observed among Asian/Pacific Islanders [48, 49].

2.2.3.3 Risk Factors

Those with the highest rate of gonococcal infection tend to be of young age (<24), live in high-density urban communities, have multiple sex partners, and engage in unprotected sexual intercourse. Women contract gonorrhea 50% of the time they engage in sexual relations with an infected male although men only contract infections 20% of the time they have sexual relations with infected females [49].

In 2006, approximately 69% of total reported cases of gonorrhea in the United States occurred among African Americans with a rate 18 times greater than that among Caucasians. African American men and women aged 15–19 had increased incidences for the second consecutive year from 2005 to 2006. African American males were infected 25 times more than Caucasian males while African American females were infected 14 times more frequently than Caucasian females. Among all racial, ethnic, and age categories, African Americans aged 15–19 and 20–24 years experienced the highest rates of gonorrhea in 2006. The infection rate per 100,000 African Americans was 658.4, compared to 36.5, 77.4, and 138.3 for Caucasians, Hispanics, and American Indian/Alaska Natives, respectively [37, 39, 50]. These racial disparities are likely confounded by socioeconomic and cultural factors.

Social behavior significantly affects gonorrhea rates as multiple sexual partners and unprotected sexual activity contribute to higher rates of infection. Latex condoms and other barrier methods reduce the risk of spreading the infection through vaginal intercourse or

mouth-to-penis, oral–anal, and mouth-to-vulva contact. Ocular infection of gonorrhea occurs if discharge containing the disease meets the eye during sex or with direct hand-to-eye contact. Persons previously treated with gonorrhea can be reinfected if exposed again and sexual partners can continue to pass the disease back and forth if neither seeks adequate treatment. Although gonorrhea is commonly treated with fluoroquinolone antibiotics throughout the world, the CDC reports an increase of resistant *N. gonorrhoeae* and therefore recommends only administering cephalosporin antibiotics in the United States [51].

2.2.4 Syphilis

2.2.4.1 Burden of Disease

Syphilis is an STI caused by the spirochete *Treponema pallidum*. The infection has been frequently referred to as the "great imitator" due to the great variety of clinical presentations that arise in infected patients that may mimic or resemble a variety of other infectious and autoimmune etiologies. The infection is transmitted by sexual contact or through vertical transmission from an infected mother to her baby.

Syphilis passes through a series of frequently overlapping stages – primary, secondary, latency, and tertiary. Primary syphilis is characterized by a single, painless chancre that begins about 21 days after exposure as a macule that becomes a papule, which then ulcerates. The chancre frequently is overlooked by infected patients because it is temporary and painless. Secondary syphilis presents with an array of dermatological lesions and eruptions that can occur 4–10 weeks after exposure. Other symptoms include fever, meningismus, myalgias, weight loss, anorexia, hair loss, arthralgias, mucous patches, and condylomata lata. It is the secondary stage that gives syphilis the nickname the "great imitator" because of its wide array of presentations. In the latent stage of syphilis the *Treponema* spirochete is seemingly clinically silent and is detected only by serological testing. The tertiary stage involves other organ systems and may lead to devastating cardiovascular and neurological complications [52].

If left untreated during pregnancy, syphilis may contribute to stillbirth, preterm labor, and intrauterine growth restriction. Congenital syphilis, while rare in developed countries, may cause hepatosplenomegaly and failure to thrive in the newborn. A child infected with congenital syphilis may manifest a range of neurological disorders later in life [53].

Fortunately *T. pallidum* is sensitive to penicillin and its devastating consequences are largely avoidable if the diagnosis is made promptly. Despite the availability of effective treatment and the potential for prevention, syphilis remains a major scourge of the modern world.

2.2.4.2 Incidence and Prevalence

The WHO estimated that in 1999 there were approximately 12 million new cases of syphilis [2]. Of these new cases of syphilis, over two-thirds occurred in sub-Saharan Africa and Southeast Asia. Recent outbreaks have been described in several countries across the world. For example, in the United States rates of syphilis have increased from 2.9/100,000 in 2005 to 3.3/100,000 in 2006.

WHO estimates of syphilis incidence in 1999 (in millions)

Region	Males	Females	New cases in 1999
Australia/ New Zealand	0.004	0.004	0.008
North America	0.054	0.053	0.107
Eastern Europe and Central Asia	0.053	0.052	0.105
Western Europe	0.069	0.066	0.136
North Africa and Middle East	0.167	0.197	0.364
Latin America and Caribbean	1.294	1.634	2.928
Sub-Saharan Africa	1.683	2.144	3.828
Southeast Asia	1.851	2.187	4.038
Total	5.29	6.47	11.76

There was a steady decline in the incidence of syphilis in both Europe and the United States during the second half of the last century, leading to suggestions that endemic syphilis might even be eradicated in these countries. The past few years, however, have seen an upsurge in syphilis in Europe and North America. The reasons underlying this reversal are complex but include migration of people from high-prevalence countries, population mixing, and changes in risk behavior including the use of the Internet to meet partners, use of recreational drugs, and a reduction in safe sex practices in gay men [54].

The prevalence of syphilis varies widely depending on the type of population being studied and associated risk factors. The National Health and Nutrition Examination Surveys showed that the prevalence of syphilis seroreactivity was low (0.71%) in the general US population of 18–49-year-olds while epidemiological studies in parts of Africa reveal prevalence rates in pregnant women of 4–15% [53, 55].

2.2.4.3 Risk Factors

In the United States the most frequent age group to be infected with syphilis is the 25–29 range. Men (5.7/100,000) are infected more frequently than women (1.0/100,000) in the United States and this has been linked to the rising prevalence of MSM-associated syphilis. In fact, the CDC estimates that 64% of new cases in the United States are linked to MSM. Epidemiological studies in other countries, however, have shown women to be at greater risk of becoming infected [54].

Syphilis in pregnant women can have devastating consequences. In Africa, the prevalence rate in pregnant women has been estimated to be as high as 15%. In pregnancy, untreated early syphilis will result in a stillbirth rate of 25% and will be responsible for 14% of neonatal deaths. This results in a perinatal mortality rate of about 40%.

2.2.5 Chancroid

2.2.5.1 Burden of Disease

Chancroid is the soft chancre caused by *Haemophilus ducreyi* and is endemic in many developing and resource-poor countries. It presents as an acute ulcerative disease, usually of the genitals, and is often associated with inguinal adenitis or buboes [56]. It is differentiated from syphilis by the soft, irregular borders of the ulcerations that are painful [57]. Most infections are clinically apparent (few asymptomatic carriers). Chancroid is easily spread; it is estimated that the probability of transmitting chancroid from an infected to an uninfected person during a single sexual exposure is between 35% and 70% [56, 58]. From a public health perspective, the most important consequence of *H. ducreyi* is not the ulcerative disease itself, but the strong association between chancroid and HIV infection.

2.2.5.2 Prevalence and Incidence

Worldwide estimates range between six and seven million new cases of chancroid each year [57, 58]. However, due to the lack of availability of diagnostic tests, these numbers are often based on the prevalence of syphilis and are therefore not entirely accurate. When determined by multiplex PCR (the most accurate diagnostic test, although not commercially available), the prevalence of chancroid in cases of genital ulcerative disease ranged between 23% and 56% in endemic areas of Asia, Africa, and the Caribbean. This compares to 0.9% of the ulcers from an STD clinic in the Netherlands and similarly low prevalence in other European countries [58]. In a test of genital ulcer etiology in ten US cities, chancroid was found to be the cause of 12% of ulcers in Chicago and 20% in Memphis, whereas no cases were found in any of the other eight cities [59].

2.2.5.3 Risk Factors

The major risk factors for chancroid transmission are unprotected sex, lack of male circumcision, and poor hygiene. While use of antibiotics has certainly been a boon to the decline of chancroid in developed nations, it is not solely responsible for the 80-fold decrease seen in the US population between 1947 and 1997 [57]. Social factors including shifting patterns of prostitution, more frequent condom use, and better hygiene have decreased the potential reservoir of *H. ducreyi* and thus prevented its spread.

There is no nonhuman reservoir for *H. ducreyi* and therefore the organism is not sustainable outside the most active human sexual networks [57]. This is due to the relatively short duration of infectivity (about 5 weeks on average), which requires frequent contacts to spread within a population. It is estimated that the sexual partner change rate required to maintain *H. ducreyi* in a population is 15–20/ year when using an average duration of infection of 5 weeks and a transmission rate of 70% [57, 58]. Therefore, sex trade workers are often responsible for the continued presence of chancroid in the population. This is exemplified by the decreased prevalence of chancroid in Thailand. Through the 100% condom campaign, a multifactorial intervention that included promotion of condom use for commercial sex acts (as well as treatment services and other modalities), the annual prevalence of chancroid fell from over 30,000 cases to fewer than 2,000 cases [58, 60].

Circumcision has been found to decrease the spread of multiple STDs, including chancroid, syphilis, and HIV. A recent systematic review found circumcision to be protective against chancroid in six out of seven studies [61]. There is a plausible reason for the protective effect of circumcision from a biological standpoint. Pathogens can replicate within the warm, moist area under the foreskin, allowing for an increased load of the pathogenic organism. Additionally, uncircumcised men may be at increased risk as the result of entry of pathogens through the inner surface of the foreskin and frenulum, or through micro-abrasions occurring during intercourse [61].

Lack of hygiene is another potential risk factor in the spread of chancroid. During World War I, simple washing with soap and water within a few hours of sexual exposure was effective in reducing risk of chancroid [57, 62]. Troops exposed to prostitutes were encouraged to attend post-coital centers where local prophylaxis was applied, including soap and water (which is effective even in the presence of skin abrasions). Omission of soap and water was identified as the cause of failed prophylaxis for chancroid amongst the American Expeditionary Forces in Paris during the World War I [62]. The ideal hygienic regimen involves both pre-exposure application of soap and water (including beneath the foreskin in uncircumcised males) as well as post-exposure washing.

2.2.6 Donovanosis (Granuloma Inguinale)

2.2.6.1 Burden of Disease

Donovanosis (Granuloma inguinale, GI) is caused by the gram-negative bacillus *Klebsiella granulomatis*. The primary mode of transmission is through sexual contact, although a fecal route and vertical transmission by passing through an infected birth canal have also been described. The disease is characterized by chronic genital ulceration that usually affects the genital region (90% of cases) or inguinal region (10%). There are four classic presentations of donovanosis: (a) ulcerogranulomatous (the most common type) resulting in beefy red, non-tender ulcers that bleed readily to the touch; (b) hypertrophic or verrucous ulcers that may resemble warts; (c) necrotic deep ulcers that cause tissue destruction; and (d) cicatricial lesions that are dry and sclerotic [63].

2.2.6.2 Incidence and Prevalence

Prior to the antibiotic era, donovanosis was prevalent worldwide, but nowadays significant numbers are found in only a few developing countries, with the main foci being Papua New Guinea, KwaZulu-Natal, Transvaal, Zimbabwe, parts of India and Brazil, and among the Aboriginal population of Australia [63–65].

Papua New Guinea was previously among the worst-affected regions; in 1980 donovanosis accounted for 46% of genital ulcers in women and was the second most common cause of genital ulcer disease after herpes in 1989–1990 [63, 64]. However, a 2000 WHO report found that donovanosis has become rare in Papua New Guinea, with only infrequent cases reported [66].

In Durban (KwaZulu-Natal), case reports of donovanosis increased from 212 in 1988 to 3,153 in 1997, accounting for 11–16% of cases of genital ulcers [63, 64]. A similar percentage (14%) of genital ulcer cases due to donovanosis has been seen in South India. However, in Brazil (0.3%) and Jamaica (4.1%), donovanosis is responsible for a much small percentage of cases seen at STI clinics [63].

2.2.6.3 Risk Factors

Like many STIs, the most frequent age range of patients who acquire donovanosis is 20–40 years, most likely

due to sexual practices. Unprotected sex and multiple sexual partners are both risk factors for donovanosis. There appears to be a racial predilection in several countries, but this is thought to be due mostly to socioeconomic status rather than a true racial susceptibility. For example, the incidence is higher in blacks than in whites in the United States, higher in natives than in Europeans in New Guinea, and higher in the Aboriginal population than in whites in Australia.

2.2.7 Herpes Simplex

2.2.7.1 Burden of Disease

Genital herpes is one of the most common ulcerating diseases of the genital mucosa. It results from infection with herpes simplex virus (HSV), more commonly HSV-2 but also HSV-1. The virus is transmitted through skin-to-skin contact, especially through sexual contact with new partners. The initial presentation is accompanied by genital ulcers, tender local inguinal lymphadenopathy, dysuria, fever, and malaise. Alternatively, the infection may be mild or asymptomatic. Patients with genital HSV infection can suffer considerable morbidity with frequent painful recurrences that may be associated with significant psychosocial distress [67].

Ulcerating genital diseases such as those resulting from HSV-2 infection have also been linked to a higher risk of HIV infection due to mucosal breakdown [68]. Vertical transmission from an infected mother to her baby at delivery can result in meningitis, disseminated infection, or death of the infant. Studies consistently show that less than a quarter of infected people know that they have genital herpes. Therefore, most people are infected when they have sexual contact with asymptomatic, unsuspecting carriers who are shedding the virus [69].

2.2.2.2 Incidence and Prevalence

The prevalence of HSV-2 seropositivity varies widely with generally higher rates in developing countries. The National Health and Nutrition Examination Survey (NHANES) III, which was conducted between 1988 and 1994, collected serological data on over 40,000 individuals in the United States. HSV-2 antibody was assessed with an immunodot assay specific for glycoprotein gG-2 of HSV-2 [70]. This survey showed a 30% increase in prevalence over the previous survey, the NHANES II, which spanned 1976–1980. The overall prevalence of HSV-2 among study participants was 21.9%, which corresponds to over 45 million people in the general US population.

Prevalence in other countries can vary from 2% to 74% according to the country, age, gender, and urban versus rural areas. In sub-Saharan Africa, for example, 30–80% of women and 10–50% of men were found to be seropositive for HSV-2. Central and South America had rates from 20% to 40%. Developed countries typically had lower rates of HSV-2 seropositivity. France, for example, had a rate of 17.2% while the United Kingdom had even lower rates of around 3.3% in males and 5.1% in females [71]. The yearly incidence in the United States has been estimated to be 4.6/1,000 to 8.4/1,000 [72].

2.2.7.3 Risk Factors

In the United States, overall prevalence is higher in women (25.6%) compared with men (17.8%) and in blacks (45.9%) compared to non-Hispanic whites (17.6%). Seroprevalence increases rapidly in younger age groups and then stabilizes around age 30. Additional contributing variables include increased number of lifetime partners, early age of sexual debut, poverty, cocaine abuse, and less education. Other populations with a higher prevalence include those attending an STD clinic, those testing positive for HIV, and sex workers [73].

2.2.8 Human Papillomavirus

2.2.8.1 Burden of Disease

At present, human papillomavirus (HPV) infections are the most commonly diagnosed STD worldwide.

HPVs are species-specific and are only known to infect humans. The viruses are spread by person-to-person direct contact and infect epithelial tissues of skin and mucous membranes. Viral transmission may occur even in the absence of visible lesions and many patients may be unaware that they are infected.

Manifestations of infection occur as cutaneous disease such as common, plantar, and flat warts. Sexual contact may result in condylomata acuminata, or genital warts, which are painless, fleshy lesions that have a predilection for warm, moist surfaces. Other presentations of the viral infection may also occur such as respiratory papillomatosis and focal epithelial hyperplasia of the oral cavity. The infection may be obvious clinically or completely asymptomatic [74].

HPV is recognized as a causal agent in the pathogenesis of cervical cancer, the second most common malignancy in women and representing 9.8% of all female cancers [75]. It has also proven to be the cause of other anogenital cancers. Colonization with certain subtypes of HPV is associated with high-grade squamous intraepithelial lesions (HSIL). These lesions are associated with an increased risk of invasive cervical cancer.

It is estimated that around 290 million women are infected with HPV [74, 76]. Guidelines recommend commencement of screening at 21 years of age or within 3 years of onset of sexual activity, whichever comes first. Despite no currently available cure for HPV infection, colonization may be reversed by normal immune processes.

2.2.8.2 Incidence and Prevalence

Multiple world surveys and population studies reveal a greater than tenfold variation in the worldwide prevalence of HPV. A meta-analysis conducted by de Sanjosé et al. estimated a worldwide HPV prevalence in women with normal cervical cytology to be approximately 10%. Africa had the highest estimated prevalence (31.6%) while Southeast Asia (6.2%) and southern Europe (6.8%) had the lowest estimated HPV prevalence [76].

HPV prevalence adapted by Sanjosé et al. meta-analysis

Location	HPV prevalence
Global	10.4%
Africa	*22.1%*
Eastern	31.6 %
Northern	21.5%
Southern	15.5%
Western	17%
Americas	*13%*
Central	20.4%
South	12.3%
North	11.3%
Europe	*8.1%*
Eastern	29.1%
Northern	7.9%
Southern	6.8%
Western	8.4%
Asia	*8%*
Eastern	13.6%
Japan/Taiwan	7.0%
Southeast	6.2%
South-central	7.5%

2.2.8.3 Risk Factors

There is a clear age-specific pattern of HPV prevalence for all the major world regions. Prevalence is highest in women younger than 34 and then decreases in the 35–44 age group. An increase in prevalence also occurs in older women, aged 45–54 [76]. This rise in prevalence occurring in the post-menopausal age group has an unclear etiology. It is postulated that changes in hormonal and immunological status facilitate the detection of previously unidentified latent infections. However, studies have indicated that an additional number of sexual partners in middle age or changes in sexual habits may also play a role in the upward trend of HPV prevalence in this age group [77].

A survey conducted in the United States, the NHANES, found a 26.8% overall prevalence of HPV infection in self-collected vaginal samples from women 14–59 years old [78]. Race and socioeconomic

status seem to be risk factors for HPV acquisition. One US study found that 39% of black women, compared with 24% of Mexican American and 24% of white women, were positive for any HPV. In that same study, women who were identified to be living in poverty were twice as likely to be infected with HPV as women of higher socioeconomic status. Marriage appears to be a protective factor. Women who were married had noticeably lower rates of HPV infection than unmarried women. Higher rates were identified in women who were widows, divorcees, separated, or living with a partner [79].

The prevalence of HPV infections is believed to be lower in men than in women, but one study of 18–70-year-old men attending an STD clinic found a 28.2% prevalence of HPV infection [80]. Circumcision may be an independent protective factor in men. One study revealed a prevalence of penile HPV colonization of 20% in uncircumcised men while the prevalence in circumcised men was 5.5% [81].

The distribution of various HPV types has also been studied. Certain subtypes of HPV are known to be of higher risk for inducing malignant transformation such as types 16 and 18. HPV subtype 16 is the most frequently isolated type in the world. It is present in 12.3%, 18.4%, 21.4%, and 25.5% of HPV-positive women from Africa, Asia, South America, and Europe, respectively [82].

2.2.9 HIV/AIDS

2.2.9.1 Burden of Disease

HIV is a Group VI retrovirus with four stages that evolves into acquired immunodeficiency syndrome (AIDS). HIV begins as a primary infection, becomes clinically asymptomatic, and then symptomatic before advancing to AIDS. HIV attacks the immune system by destroying critical CD4 cells and AIDS significantly increases the risk of life-threatening opportunistic infections [42, 83]. HIV infection is a pandemic in humans that has claimed more than 25 million people worldwide since first recognized in December 1981 according to the WHO and the Joint United Nations Program on HIV/AIDS (UNAIDS) [44, 84]. AIDS is a collection of symptoms and infections that progressively destroy the immune system and create susceptibility for opportunistic infections and malignancies. HIV evolves to AIDS after 10–15 years of infection in 90% of cases [85].

HIV/AIDS affects both genders and all racial/ethnic groups similarly in terms of virology but infects genders, races/ethnicities, and inhabitants of industrialized versus developing nations at disproportionate rates. HIV destroys T cells, macrophages, and dendritic cells by viral killing of infected cells, increasing rates of apoptosis in infected cells or through CD8 cytotoxic lymphocytes, all of which eventually result in loss of cell-mediated immunity [47].

HIV is transmitted through sexual contact with an infected person, sharing needles/syringes with an infected person, or through HIV-infected blood given through transfusions, though this medium is less common as donated blood is frequently screened for HIV antibodies. Babies born to HIV-infected women may acquire the disease before or during birth or through breastfeeding [86]. In significantly fewer instances healthcare workers acquire HIV from needle sticks containing HIV-infected blood.

The opportunistic infections in HIV/AIDS-infected people include bacterial, protozoal, fungal, and viral diseases in addition to HIV-associated malignancies as defined in the various stages by the WHO. Persistent generalized lymphadenopathy occurs in Stage I, and weight loss, respiratory tract infections (sinusitis, tonsillitis, otitis media, pharyngitis), herpes zoster, oral ulcerations, and pruritic eruptions are evident in Stage II. Severe weight loss (over 10% of body weight), chronic diarrhea, persistent fever, oral candidiasis, tuberculosis, and oral hairy leukoplakia occur in Stage III along with more severe conditions. Pneumonia, empyema, meningitis, acute necrotizing stomatitis, and bacteremia are also characteristic in this stage. The progression from HIV to AIDS is associated with chronic herpes simplex infection, Kaposi sarcoma, central nervous system toxoplasmosis, disseminated mycosis, recurrent septicemia, and nephropathy [83]. In women, HIV/AIDS produces recurrent vaginal yeast infections, severe pelvic inflammatory disease, and cervical cancer [83, 87]. The fungal infection *Pneumocystis jiroveci* that causes pneumonia is the most prevalent opportunistic infection in persons with AIDS and the leading cause of death [87].

2.2.9.2 Incidence and Prevalence

As of November 2007, 33.2 million people worldwide were infected with HIV/AIDS and the virus claimed approximately 2.4–3.3 million lives in 2005 alone. HIV/AIDS infections have increased from 8 million in 1991 to the current total [2]. Sub-Saharan Africa experiences one third of all HIV/AIDS-related deaths with 21.6–27.4 million persons infected. The WHO noted that 2.9 million people became HIV/AIDS-infected in 2007 of which 2.5 million were adults and 0.42 million children. Over 2.1 million people succumbed to AIDS including 1.7 million adults and 0.33 million children [15, 87, 88]. Women account for 50% of all HIV infections and persons under 25 years total half of all new HIV infections [14].

Statistics vary based on region, gender, age, race/ethnicity, and social behaviors (including sexual preferences). South/Southeast Asia is second to sub-Saharan Africa with four million HIV/AIDS-infected people and 270,000 deaths in 2007. Latin America and eastern Europe/Central Asia both host 1.6 million infected with 58,000 and 55,000 deaths, respectively. Western and Central Europe and East Asia both have between 750,000 and 800,000 persons infected although East Asia's deaths were significantly greater at 32,000 compared to 12,000 in European nations [42, 89]. Over 1.3 million HIV/AIDS-infected people lived in North America as of 2007 with a reported 21,000 deaths [90]. HIV/AIDS is the leading cause of death in African American women aged 25–34 years [91].

2.2.9.3 Risk Factors

Age is a significant factor in HIV/AIDS incidences worldwide with persons aged 25–34 comprising the largest proportion of newly diagnosed cases in the United States [92]. Persons aged 50 or older total 15% of new diagnoses but comprise 35% of all AIDS-related deaths [93]. Young adults transmit the virus at greater rates than average due to sexual risk behavior and insufficient testing or diagnosis. Prevalence in the United States is greatest among MSM followed by 80% of people engaging in high-risk heterosexual contact [94]. Almost 75% of HIV/AIDS diagnoses in 2006 were of adolescent and adult males; however, 9,708 women were infected in the United States [21].

African Americans are disproportionally infected, accounting for 55% of all HIV infections among persons aged 13–24 [95]. The infection rate for black women (45.5/100,000) is 23 times greater than of white women (2/100,000) and 4 times greater than Hispanic women (11.2/100,000) [39]. Factors attributed to higher rates suggest that overall greater amount of poverty, STDs, and social stigma create more illnesses (49% of all HIV/AIDS cases in the United States) and shorter survival rates among African Americans [96].

Hispanics and Latinos comprised 18% of new HIV/AIDS diagnoses in 2006 and 17% of total people living with HIV/AIDS infection [97]. Lack of access to adequate health care and antiviral therapies contributes to their increase in transmission and conversion. Sexual contact between males, injection drug use, and high-risk heterosexual contact are the three most common methods of transmission for Hispanic and Latino males.

MSM, regardless of their sexual identity, have comprised 500,000 AIDS infections with over 300,000 deaths since the beginning of the epidemic [98]. Two-thirds of all men living with HIV contracted the infection from sex with men although only 5–7% report sexual relations with other males [99]. Research is unclear as to whether statistics are higher in this population due to increased testing or an actual increase in HIV infections since 53% of new HIV/AIDS cases are MSM-related.

Pregnant women with HIV/AIDS infection risk transmission to their child during pregnancy, birth, or afterwards through breastfeeding. An estimated 142 children under 13 years of age were diagnosed with HIV/AIDS from perinatal infections in 2006 [100]. Over 6,051 perinatally infected people were living with HIV/AIDS at the end of 2005 [86]. Early detection and treatment are critical and highly effective in preventing transmission of HIV/AIDS from infected mothers to their children [101].

Social behavior factors are the single greatest indicator of variations in HIV/AIDS infections. MSM, high-risk heterosexual intercourse, injection drug usage, and sexual intercourse with multiple partners without protection are all significant risk factors for transmission. The use of latex condoms, mutual monogamy with an uninfected partner, clean needle/syringe usage without sharing, and frequent testing can minimize transmission rates [102].

2.2.10 Hepatitis B

2.2.10.1 Burden of Disease

Hepatitis B virus (HBV) is one of the most serious and common causes of viral hepatitis. HBV infections can lead to the development of acute fulminate hepatitis, chronic hepatic insufficiency, cirrhosis, hepatocellular carcinoma, and death due to liver failure. It is estimated that chronic HBV infection is associated with 60–80% of the world's hepatocellular carcinomas, the fifth most common cancer that is responsible for 300–500,000 deaths/year [103, 104].

The WHO estimates that approximately 2 billion people have been infected with HBV worldwide and more than 350 million are chronic HBV carriers. It is the tenth leading cause of death worldwide and results in 500,000–700,000 deaths annually [105, 106]. The virus is very resilient, resists breakdown outside of the human body, and is transmitted through infected body fluids such as blood, saliva, and semen. HBV may be transmitted through sexual contact, contact with bodily fluids such as through contaminated injections and transfusions, or through perinatal transmission [107].

2.2.10.2 Incidence and Prevalence

The prevalence of HBV infection varies widely in different areas of the world. The highest prevalence of HBV infection is found in areas of sub-Saharan Africa, Southeast Asia, eastern Mediterranean countries, the interior of the Amazon basin, and certain parts of the Caribbean. In these areas it is estimated that greater than 8% of the population is seropositive for HBsAg and up to 20% of the population may be chronically infected. A moderate prevalence of 2–8% is found in many areas of Asia, eastern and southern Europe, Russia, and Central and South America. A lower prevalence of less than 2% HBsAg seropositivity is found in developed areas of North America, western Europe, Australia, and New Zealand [106, 108].

Incidence rates vary widely but frequently are correlated with the local prevalence rates. The CDC reports that there were an estimated 46,000 new infections in the United States in 2006 [109]. HBV vaccination of children has reduced incidence to a large extent among younger age groups. However, higher incidence rates continue among adults, particularly males aged 25–44 years, reflecting the need to vaccinate adults at risk for HBV infection [110].

2.2.10.3 Risk Factors

In areas with high prevalence rates, the majority of infections occur from mother to child vertical transmission and horizontal transmission such as from child-to-child contact in household settings. Since the introduction of childhood HBV vaccination programs in most developed countries, areas with lower prevalence rates have exhibited more cases due to sexual contact and contaminated needles rather than prenatal or childhood transmission [105, 107]. The pattern of transmission is directly correlated with geographical prevalence because prenatal or early childhood acquired HBV infection has a greater risk of chronicity than infection acquired later in life due to drug abuse or sexual contact. The most common risk factors are sexual exposure (sexual contact with a person known to have hepatitis B, multiple sex partners, and MSM) and injection drug use.

2.2.11 Molluscum Contagiosum

2.2.11.1 Burden of Disease

Molluscum contagiosum is caused by the poxvirus Molluscipox (MCV) which was previously a disease primarily in children but has now evolved into an STI in adults. MCV has four types (MCV-1 to MCV-4) with MCV-1 the most prevalent and MCV-2 sexually transmitted in adults [111, 112]. The infection affects the skin and mucous membranes, producing a benign self-limited papular eruption of multiple umbilicated cutaneous tumors present on the thighs, buttocks, groin, lower abdomen, and occasionally external genital or anal region. It is transmitted by skin-to-skin contact of lesions in addition to sexual contact, although MCV may also pass through water (swimming pools and baths) occupied by infected persons or touching towels/clothing in contact with lesions [112]. Persons already infected risk autoinoculation if they touch lesions and then touch unaffected body parts. The incubation period averages 2–3 months and may last 1 week to 6 months. Untreated lesions generally remain

between 2 weeks to 4 years although the average is 2 years [113, 114].

2.2.11.2 Incidence and Prevalence

Molluscum infections are not limited to any geographical region but are more common in warm, humid climates with high-density populations. Since 1966 there is a reported increase of cases in the United States; however, incidences are not routinely monitored since infections typically resolve without treatment [115].

AIDS-infected or other immune-compromised people are subject to frequent, extensive outbreaks. Approximately 10–20% of symptomatic HIV/AIDS-infected people experience progressive molluscum symptoms although the exact incidence remains unknown. The range is higher (25–35%) in HIV-infected persons with a CD4 count less than 200 cells/mm^3 [116, 117].

2.2.11.3 Risk Factors

Age is a significant factor for MCV infection as transmission between children is common due to frequent contact in communal areas (school, daycare centers, parks, pools, etc.) and lack of proper hygiene. Any person is susceptible to molluscum contagiosum regardless of sexual activity [118]. The CDC recommends that infected persons refrain from contact sports, swimming, shaving areas with active lesions, sharing personal items including hair brushes and soap, and abstain from sexual contact [119, 120].

The highest incidence of molluscum contagiosum infection is in HIV-infected patients and characterized by larger size, greater number, more rapid growth, and atypical locations. The lesions are uncharacteristic from the usual dome-shaped molluscum evident in healthy children. Central umbilication is unapparent as patients with advanced HIV disease experience giant, tumor-like, nodular lesions exceeding 1 cm in diameter, often causing significant deformation and even necrosis [121, 122]. Disseminated molluscum develops as several hundred lesions in a pattern resembling disseminated cryptococcal disease [123]. The unusual manifestation of molluscum in persons with immune suppression is only cosmetic and proves no systemic effect.

People engaging in sexual activity risk infection with skin-to-skin contact; therefore latex condoms and other moisture barriers used for vaginal, oral, and anal sex greatly reduce transmission. MCV does not require mucous membrane contact in order for the virus to spread and moisture barriers do not protect contact from all potentially infected areas including the scrotum [124]. Abstinence from sexual activity and mutual monogamy with one uninfected partner are significant preventable measures. Typically as with other skin-to-skin STIs (scabies and pubic lice) molluscum contagiosum incidences are greater in people who engage in unprotected sex with one or multiple partners [125].

2.2.12 Scabies/Pubic Lice

2.2.12.1 Burden of Disease

Scabies, the microscopic mite *Sarcoptes scabiei*, is prevalent worldwide affecting all ages and racial/ethnic groups. Common areas of infection are webs of fingers/toes, pubic/groin area, axillae, umbilicus, breasts, palms of hands, and soles of feet [126]. Fewer than ten mites typically infest unless a person has crusted (Norwegian) scabies, which is highly infectious and generates thousands of mites; however, these incidences are reported in the elderly, HIV-infected, and other immune-compromised people [127, 128]. Female parasites burrow under the skin, lay eggs within a few hours following infestation, and continue to lay two to three eggs daily. Scabies eggs hatch and become adults after 10 days, when the cycle restarts; however, symptoms do not appear until 4–6 weeks following new infection. Persons previously exposed experience symptoms 1–4 days after infection and both new and recurrent infections are active until successfully treated. Mites only survive between 48 and 72 h unattached from humans, but adult females live up to 1 month [128]. Sexual transmission is through close physical contact and more likely when partners share a bed or spend the night together rather than through sexual activity [129]. Crowded conditions are ideal for rapid infection including hospitals, institutions, childcare facilities, and nursing homes where skin-to-skin contact is frequent. Scabies spreads within households due to prolonged contact with infested objects including linens, furniture, and clothing [130].

Pubic lice, also known as crabs, is the parasite *Phthirus pubis*, which infests the human genital area and undergoes a life cycle in three stages [131]. They are spread through sexual contact although they can rarely infest through linens or clothing, similar to scabies. Pubic lice attach to pubic hair but can transmit to other coarse body hair on legs, axillae, mustache, beard, eyelashes, or eyebrows [132]. Lice eggs or nits are not visible to the naked eye, but are whitish in color and attach firmly to the hair shaft, taking 6–10 days to hatch and laying 30–90 eggs during their lifetime. Nymphs are baby lice that survive off blood and reproduce approximately 2–3 weeks after hatching. Adult lice resemble ocean crabs with six legs and are tan to grayish white in color. Female lice are larger than males but all fully grown lice are as large as 4.5 mm long; however, 1.25–2 mm is common. Lice only survive 1–2 days upon detaching from humans or losing access to a blood supply [131]. Although body lice may transmit typhus, relapsing, or trench fevers, which have high mortality rates especially in colder climates or in overcrowding, pubic lice infection results only in severe itching. Upon injecting saliva into the host during feeding, pubic lice may also cause pruritus resulting in severe scratching [133].

2.2.12.2 Incidence and Prevalence

Once considered a "disease of the poor" in industrialized nations, scabies affects 300 million people worldwide in all socioeconomic classes and in all climates [134]. Poverty, sanitation, poor water supply, and densely populated regions attribute to scabies epidemics. Personal hygiene and adequate clean water supply are critical to prevent and control the spread of scabies [135]. Numerical data are scarce because scabies is frequently unreported and predominately treated using home remedies.

Due to mandatory reporting of scabies in Slovenia since 1969, a study observing epidemic trends for 30 years until 1999 proved major peaks of infection during World War II and post-war years (1941–1946), 1972, and 1982 until stabilizing [136]. There were 432 cases/100,000 in 1972 and 220 cases/100,000 in 1982 until the steady decline toward approximately 50 cases/year as reported in 1993 and thereafter [137]. The demographics with greatest incidence are alcoholics, drug addicts, homeless persons, refugees, small children in day care centers, disabled persons, and the elderly in nursing homes [136, 138].

Other statistics are available as a result of military documentation of soldiers' health conditions and various studies indicate higher incidences associated with communal living quarters including shared personal items/toiletries as well as close physical contact during missions [139]. An observation of 2,481 soldiers in Skopje, Yugoslavia, during 1969–1971 reported 15% overall infection within the initial month of service, 42.2% after 2 months, and 72.5% of soldiers infected with scabies after 6 months [140]. From 1968 to 1981 the Army Health Branch Epidemiology Department of the Israeli Defense Force documented occurrences based on routine screenings (in addition to mandatory reporting) and observed two epidemics from 1973 to 1985 and 1972 to 1987 with increases of 17.7- and 3.9-fold, respectively. Sharp declines were noted in studies between 1981 and 1999 and 1984 and 1999 with morbidity decreasing 113.6- and 13.6-fold, respectively. The Israeli–Lebanese War of 1982 is partially attributed as the cause of the first epidemic [140, 141].

Pubic lice affect millions worldwide and the American National Institute for Allergy and Infectious Diseases (NIAID) estimates three million new cases annually in the United States. More than 1% of the population acquires pubic lice infection although the figure could be much higher if reporting were mandatory [135, 142]. Over 10–12 million Americans are infested with lice each year with head and pubic as the most reported forms. Case reports observe pubic lice in sexually active persons between ages 14 and 40 [143]. A study published in 2006 indicated a decreasing trend in pubic lice attributed to the increase of hair depilatory in many Western nations. The lack of habitat for lice to attach and survive in lowered rates of transmission to women and subsequently incidences in males decreased too [144].

2.2.12.3 Risk Factors

The general population of any geographical region is at risk for scabies and pubic lice although increased awareness of personal hygiene and specific social behavior may reduce the risk of exposure [126]. Early detection of both STIs is critical in order to receive effective treatment and halt potential transmission.

The CDC advises persons with scabies infection to notify all sexual partners and household members, discontinue intimate or sexual contact until the condition resolves, and quarantine/disinfect all infested articles including clothing, linens, and furniture [143]. All standard guidelines for safe sex and STD/STI prevention apply; however, mutual monogamy will not alter the risk of contracting or spreading scabies, but can result in recurrent infection. Condoms also prove ineffective as sexual intercourse or ejaculation is irrelevant to scabies transmission [131, 145]. Pubic lice prevention follows similar guidelines to that of scabies in order to reduce transmission or recurrent infection. Abstaining from sexual contact entirely or abstaining until the infestation is treated or resolved is the only effective method of prevention.

2.3 Summary

STIs are widespread throughout the world. These infections range from minor nuisances (e.g., pubic lice or molluscum) to life-threatening or deadly diseases (e.g., HIV). Many infections, such as those caused by bacteria for which antibiotics are known and effective, are curable while viral diseases such as HSV, HPV, and HIV have no current cure. Prevention is the best tool to decrease the morbidity and mortality of STIs. Understanding the epidemiology of each infection, particularly modifiable risk factors, is imperative in order to aid prevention and eradication efforts. The epidemiology of STIs will continue to change in our era of easy travel and economic globalization and therefore needs to be updated constantly in order to keep up with disease trends worldwide.

Take-Home Pearls

- Several infectious caused by bacterial, mycological, and protozoal agents can be treated successfully, whereas viral STIs cannot be eradicated with currently available medications.
- Many STIs are asymptomatic and can be difficult to recognize and control.
- Risk factors such as age, socioeconomic status, and high-risk sexual behavior make certain populations more prone to STIs than others.
- Adolescents and young adults are responsible for almost 50% of all newly acquired STIs.
- Groups known to participate in high-risk sexual activity are at higher risk for STI.
- *Trichomonas vaginalis*, a protozoa, is the most common non-viral cause of STI worldwide.
- *Chlamydia trachomatis* is the most common bacterial cause of STI.
- Gonorrhea is frequently concomitant with Chlamydia infection.
- Over two-thirds of worldwide syphilis infections occur in sub-Saharan Africa and Southeast Asia, although there has been an upsurge in cases in the United States and Europe over the past few years.
- HPV infections are the most commonly diagnosed STIs worldwide. In addition to cutaneous manifestations such as warts and condyloma, HPV is recognized as a causal agent in the pathogenesis of cervical cancer.
- Most HSV infections are spread through sexual contact with asymptomatic, unsuspecting carriers who shed the virus.
- Ulcerating genital disease such as HSV-2 is a risk factor for HIV infection due to mucosal breakdown.
- Condom use, mutual monogamy with an uninfected partner, and clean needle/syringe use can minimize transmission rates of HIV/AIDS.

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