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Sexually Transmitted Diseases Among Older People in Los Angeles County, 2000-2011

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Sexually Transmitted Diseases Among Older People in Los Angeles County, 2000-2011

A dissertation submitted in partial satisfaction of the requirements

for the degree Doctor of Philosophy in Epidemiology

by

Caleb Lyu

2018

ABSTRACT OF THE DISSERTATION

Sexually Transmitted Diseases Among Older People in Los
Angeles County, 2000-2011

by

Caleb Lyu
Doctor of Philosophy in Epidemiology
University of California, Los Angeles, 2018
Professor Roger Detels, Chair

Background: With the aging of the Baby Boomer population, sexually transmitted diseases (STD) are becoming an important issue among older people. Better physical health at older ages and changing psychosocial norms have led to sexual activity later in life. Despite engaging in high-risk sexual behavior, testing and treatment is still infrequent. With the paucity of information on STDs in older people, this study was undertaken to examine the risk in this demographic, challenge existing assumptions on the topic, inform surveillance and prevention strategies, and provide a basis for future research in the area.

Methods: Routine surveillance data that captures all cases of syphilis, gonorrhea, and chlamydia reported to the Los Angeles County Department of Public Health between January 1, 2000 and December 31, 2011 was utilized for analyses. The rate per 100,000 of STDs over time among older people (50 and over) was examined and compared to younger populations. Predictors of repeat infection were assessed to identify the high-risk groups among older people. Appropriate treatment documentation among older people was investigated to ascertain areas of need in STD case follow-up and treatment.

Results: During the study period, rates of early syphilis, gonorrhea, and chlamydia significantly increased for older people and at a rate similar to younger populations. Older men who have sex with men (MSM) and who have sex with both men and women (MSM/W) as well as those co-infected with other STDs were at highest risk for repeat infections. Documented, appropriate treatment of older gonorrhea and chlamydia cases increased over the study period but remained lower compared to younger populations. Neurosyphilis was significantly associated with older age and delayed treatment.

Conclusions: There is a need to improve STD screening among older people by educating both providers and the demographic of interest. Programmatic improvements such as quality improvement and implementation of electronic reporting mechanisms are necessary to ensure better treatment information of older cases, who tend to be low priority for health department investigations. Future studies on high-risk behaviors of older people and providers' knowledge and attitudes are necessary to inform additional STD prevention strategies for this demographic.

Key words: Older people; sexually transmitted diseases; repeat infections; co-infections; demographic predictors; treatment documentation; neurosyphilis

The dissertation of Caleb Lyu is approved.

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To my parents, who were unwavering in their love and support throughout this process; my friends, who provided emotional encouragement; and my supervisors at work, who gave me the flexibility to pursue this degree.

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LIST OF ABBREVIATIONS

CDC	Centers for Disease Control and Prevention
CI	Confidence Interval
CMR	Confidential Morbidity Report
DHSP	Division of HIV and STD Programs
DPH	Department of Public Health
HIV	Human Immunodeficiency Virus
HR	Hazard Ratio
LAC	Los Angeles County
MSM	Men Who Have Sex With Men
NAAT	Nucleic Acid Amplification Test
OR	Odds Ratio
PHI	Public Health Investigator
SPA	Service Planning Area
STD	Sexually Transmitted Disease
US	United States

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I thank the Children’s Medical Services Division at LAC DPH who provided the flexibility to pursue this degree as I was employed full-time with them. They allowed me to prioritize my dissertation work when necessary and offered helpful advice on refining the product.

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CHAPTER 1

BACKGROUND

1.1 BRIEF HISTORY AND THE EPIDEMIC OF STDs

There are records of STDs since ancient times (Waugh, 2011). The ancient Greek authorities described gonorrhea (Morton, 1977), while syphilis came to the forefront during the Renaissance because of arguments about its origin and influence on morality and measures towards public health. With the arrival of penicillin in the first half of the twentieth century it was observed that some men with urethral discharge did not respond to penicillin, leading to the discovery of non-gonoccocal urethritis (Harkness, 1950). In 1959, *Chlamydia trachomatis* was first isolated from genital material (Jones et al., 1959) and is now the most frequent bacterial STD in industrialized countries.

According to the World Health Organization (WHO), it is estimated that more than 1 million people acquire an STD infection every day around the world (WHO, 2013). Based on WHO estimates in 2008, there were nearly 500 million incident cases of chlamydia, gonorrhea, syphilis, and *Trichomonas vaginalis* infections globally (Rowley et al., 2012). This represented an 11.3% increase from global estimates in 2005. In the United States (US) in 2015, there were a total of 1,526,658 cases of chlamydia, 395,216 cases of gonorrhea, and 23,872 cases of primary and secondary syphilis (P&S syphilis) reported to the Centers for Disease Control and Prevention (CDC, 2016). From 2000-2015, there was an overall increase in the rate of chlamydia and all stages of syphilis infection. During the same period, there was an overall decrease in rate of gonorrhea infections until 2009, upon which there was a reversal of trend (Figure 1-1). These data, however, may underestimate the actual number of cases occurring in the US population because of incomplete diagnosis and reporting. In fact, one study (Satterwhite et al., 2008) estimated that there may be as many as 2.86 million incident chlamydia, 820,000 incident gonorrhea, and 55,400 incident syphilis cases in 2008; these figures are all higher than those reported to the CDC. In addition, the same study estimated that there were 110 million prevalent STDs among men and women in the US. STDs are a huge health challenge that account for significant health care costs (Owusu-Edusei et al., 2013), and is a potential threat to an individual's long-term health and well-being. It increases the risk of acquiring and transmitting human immunodeficiency virus (HIV) (Wasserheit, 1992; Peterman et al., 2015) and can lead to serious reproductive health complications such as infertility, ectopic pregnancy, and adverse birth outcomes (Cates Jr. et al., 1998; Coste et al., 1994).

As the most populous county in the United States, Los Angeles County (LAC) presents a unique snapshot of STD prevalence and incidence. There were a total of 70,494 STD cases reported to the LACDPH in 2014 (DHSP, 2016). The rate of chlamydia infection was highest among females, 20-24 year-olds, and African American race/ethnicity. For gonorrhea, the highest rates were among males, in the 20-24 year-old age group, who are of African American race/ethnicity. For P&S syphilis males, 25-29 year-olds, and African Americans have the highest rates. These results are all identical to the rates of each disease at the national level (CDC, 2016). The overall rates of chlamydia, gonorrhea, and P&S syphilis have increased from 2010-2014 in LAC, which is also the case on the national level. There are clearly many similarities between LAC and the US as a whole when it comes to the STD epidemic.

1.2 STDs AND OLDER PEOPLE

Given that younger populations (<50) represent an overwhelming majority of STD cases captured through surveillance, it is unsurprising that most of the literature focuses on STDs in younger people. For example, national STD and sexuality surveys tend to concentrate on younger populations (Datta et al., 2007; Grulich et al., 2003). Many STD prevention programs, such as the *GYT: Get Yourself Tested* campaign launched in 2009 and the *I Know* campaign in Los Angeles are targeted at sexually active youth 25 years and under. However, surveillance data also suggests that there has been an increase in STD rates among older people through the last twenty years or so (Bodley-Tickell et al., 2008; CDC, 2016; LACDPH, 2016). This may be attributed to several factors, one of which frequently goes unrecognized—that older adults engage in sexual activity. Thanks to increased longevity, healthy aging, higher rates of divorce, and the introduction and extensive uptake of erectile dysfunction medications for sexual functioning (Poynten et al., 2013), adults are engaging in sexual intercourse well beyond middle age. The most recent National Survey of Sexual Attitudes and Lifestyles (NATSAL III) in the United Kingdom (UK) found that even among the highest age group of participants (65-74 years) sexual activity was occurring (Mercer et al., 2013). In the US (Lindau et al., 2007), prevalence of sexual activity was 73% among respondents who were 57 to 64 years of age, 53% among those who were 65 to 74, and 26% among those who were 75 to 85. This is in spite of the fact that about half of both men and women reporting at least one bothersome sexual problem. The proliferation of internet dating sites such as “Our Time” targeted specifically at adults 50 and over also contribute to the high sexual activity among this demographic.

To compound the problem, older people are not necessarily practicing safer sex. A study (Amin, 2014) found that 87% of survey respondents aged 55 and older reported not using condoms during their last intercourse, and nearly 15% reported engaging in sexual risk behaviors such as casual sex, paid sex, male to male sex, and drug use. Similarly, a subgroup analysis of 120 older women 46 and older attending a UK genitourinary medicine (GUM) clinic showed that 70% had been sexually active and 59% never used condoms (Fish et al., 2012). In addition to unprotected sex, older adults are also traveling to foreign countries with easy to access sex industries as well as undergoing physiological changes leading to greater biological susceptibility to STD infections (Poynten et al., 2013).

Despite the increasing sexual activity of older adults, STD testing is still infrequent (Tillman et al., 2015). They also tended to visit clinics for testing due to genital symptoms rather than asymptomatic screening. Lack of communication between physician and older patients may contribute to the infrequent STD and HIV testing (Githens, 2010), as physicians may be reluctant to discuss such issues with them. Recommendations for treatment and management of STDs common to older adults have been described (Calvet, 2003; Wilson, 2006) but as with testing, STD treatment may be infrequent as well due to aforementioned barriers to testing. In one qualitative study (Gott et al., 2003), obstacles identified as inhibiting help being sought included demographic characteristics of their general practitioner (GP), GP attitudes towards later life sexuality, the attribution of sexual problems to 'normal aging', shame/embarrassment and fear, perceiving sexual problems as 'not serious', and lack of knowledge about appropriate services.

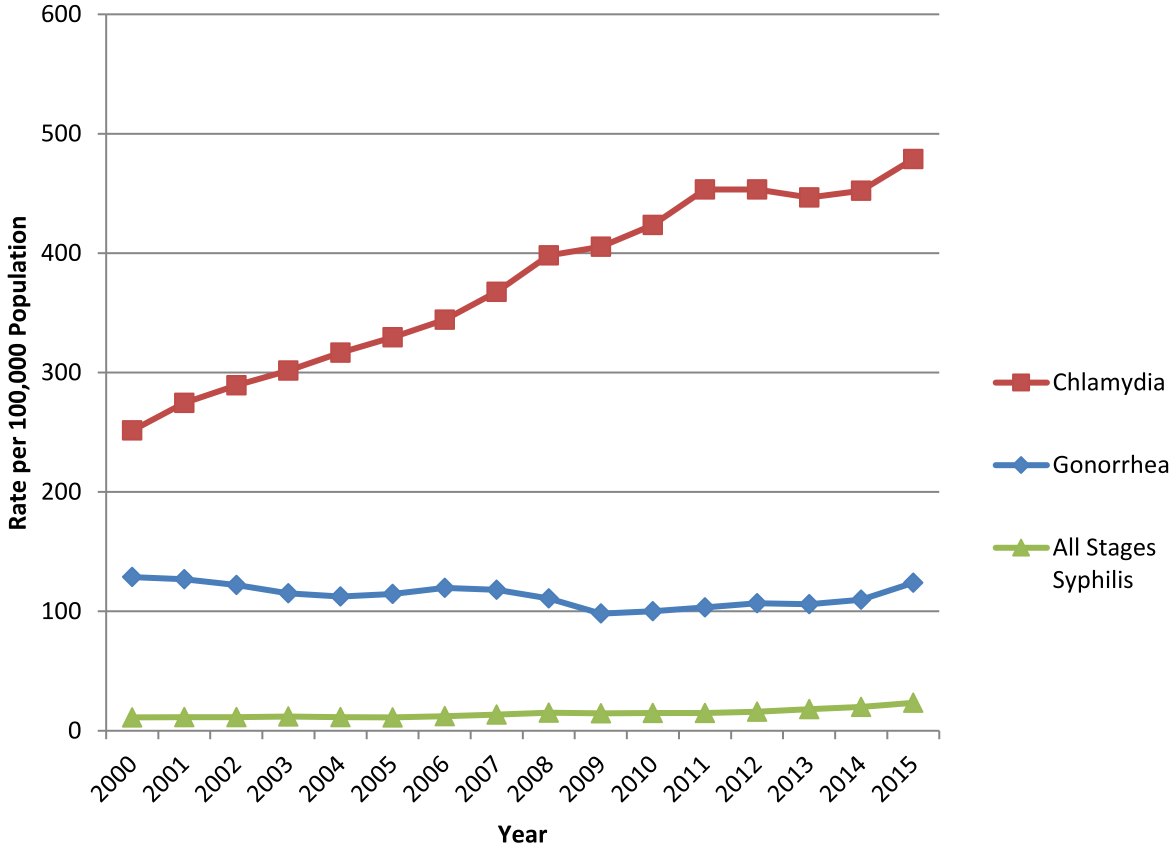
There are clearly challenges to addressing the issue of STDs in older adults. Complex psychosocial factors such as ageism and sexism (and both for older women) provide barriers to a healthy discussion of sexual health among older people (Minichiello et al., 2011). Nevertheless, with the aging of the "Baby Boomer" population it is increasingly difficult to ignore the problems associated with STDs in older populations as society now has to focus on the concern about capacity in health service provision and aged care as well as the recognition that older people have significant economic power—the “gray dollar”.

There have been some studies utilizing surveillance systems to assess incidence of STDs among older persons (Bodley-Tickell et al., 2008; Xu et al., 2000; Smith et al., 2002), but they represent a minority of studies on STDs and also only examine data up to the early 2000s. New studies on more recent data are needed due to the era of nucleic acid amplification tests (NAATs) and increasing numbers of Baby Boomers. While there appears to be increasing awareness of the need to monitor STDs among older people, there are still very few research studies focusing on a population-based surveillance system.

In light of the paucity of information on STDs in older people and challenges to discussing the topic even in a clinical setting, detailed analyses that are methodologically valid are needed to improve on knowledge of this public health issue. LAC, as mentioned already, provides a unique sample of the STD epidemic in the US. In addition, it is home to a substantial and diverse elderly population. According to the 2010 U.S. Census there were nearly three million persons age 50 or older in LAC, accounting for nearly 30% of the total population. This study leverages the defining population characteristics of LAC by examining STD cases reported to the LAC Department of Public Health (LACDPH) from 2000-2011. Specifically, it attempts to provide a clearer picture of how STDs are demographically distributed among older populations in order to help focus surveillance and prevention strategies that will prevent STD transmission among this so-called “low-risk” group.

TABLES AND FIGURES

Figure 1-1. Rates per 100,000 of chlamydia, gonorrhea, and all stages of syphilis infections reported to the CDC, 2000-2013



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CHAPTER 2

INCREASES IN REPORTED EARLY SYPHILIS, GONORRHEA, AND CHLAMYDIA CASES AMONG OLDER RESIDENTS OF LOS ANGELES COUNTY, 2000-2011

2.1 ABSTRACT

Background: Despite increased awareness of sexually transmitted diseases (STDs) among older people (50 and over) in recent years, the focus of much literature are still on younger populations. The aim of this study is to characterize STD morbidity over time among older adults, identify demographic groups at high risk, and compare them to younger populations.

Methods: I utilized routine surveillance data that captures all cases of syphilis, gonorrhea, and chlamydia reported to the Los Angeles County Department of Public Health between January 1, 2000 and December 31, 2011. Cases from Long Beach and Pasadena were excluded. I analyzed the trends over time in rate per 100,000 and rate ratios comparing younger to older cases.

Results: Rate of reported early syphilis, gonorrhea, and chlamydia cases increased for all age categories (15 to 29, 30 to 49, 50 and over) from 2000 to 2011, except among middle-aged (30 to 49) gonorrhea cases. Increases for the older (50 and over) cases were at similar pace to younger (15 to 29) cases of early syphilis and gonorrhea, but greater for chlamydia cases. Rate of all three STDs was highest among older cases in the 50 – 59 age group, although there were cases who were beyond 80 years of age. Rate of early syphilis was higher among older men compared to older women which was similar to the gender disparities among younger early syphilis cases. Rates of gonorrhea and chlamydia were higher among older men compared to older women, whereas younger women had higher rates compared to younger men. Rate was highest among older Black/African-Americans although increases were greatest among Whites. Most older early syphilis cases were in the Metro SPA while older gonorrhea and chlamydia cases were mostly in the South SPA, similar to the geographic distribution of younger cases.

Conclusion: The risk of STDs is not zero and is increasing among older adults. Both providers and older adults need to be educated and encouraged to communicate with each other about STDs. Successful public health interventions on older adults in other fields can be adapted to improve STD knowledge and testing for this population.

Keywords: Older people; sexually transmitted diseases; race and ethnicity; geographic distribution

2.2 INTRODUCTION

From July 2005 to March 2006 the first wave of the National Social Life, Health, and Aging Project (NSHAP) was conducted, marking the first time a nationally-representative sample of older adults was selected to provide information on sexual activity, behaviors, and problems of older adults (Lindau et al., 2007). The study seemed to finally raise awareness among the general public that older adults were engaging in sexual activity, thanks to reporting by prominent media such as *The New York Times* (Marchione, 2007). Sexually transmitted diseases (STDs) among older people, however, are not new and have been reported in national and local surveillance reports (CDC, 2016; LACDPH, 2016). But the special focus profiles in these reports have always been on younger populations (less than 50) because those represent the overwhelming majority of STD morbidity. Trends over time among the older age groups have not been addressed in these reports.

There have been some studies utilizing surveillance systems to assess rate of STDs among older persons (Bodley-Tickell et al., 2008; Smith et al., 2002; Xu et al., 2000), but represent a minority of studies on STDs and only examine data up to the early 2000s. New studies on more recent data are needed due to increased nucleic acid amplification tests (NAATs) utilization and increasing numbers of Baby Boomers. While there appears to be increasing awareness of the need to monitor STDs among older people, there are still very few research studies focusing on a population-based surveillance system.

Beyond looking at the overall burden of STDs among older adults, trends in comparisons between the morbidity among younger populations versus older adults are also important. If rate rates among older populations increase faster over time compared to younger populations, then there is evidence that older STD cases should warrant further attention and investigation. To this end, a couple of studies have examined temporal trends in age disparities (Chesson et al., 2008; Fang et al., 2010). However, the studies did not include older age groups (60 and above) and utilized national-level surveillance data, limiting its generalizability to local health jurisdictions where much of the field work on STDs occur. Thus, this study attempted to examine more recent data on STDs reported to a local health department (Los Angeles County Department of Public Health, LACDPH) to characterize morbidity among older adults and compare it with younger populations. This will inform public health action by identifying high-risk populations among older adults and encouraging providers to actively test and treat older STD cases.

2.3 METHODS

Data Source

To conduct my analyses, I utilized routine surveillance data that is collected and maintained by LACDPH's Division of HIV and STD Programs (DHSP). Health care providers and laboratories are required to report STDs such as chlamydia, gonorrhea, and all stages of syphilis pursuant to Title 17 of the California Code of Regulations (CCR), §§ 2500, 2505. The study includes all cases of chlamydia, gonorrhea, and early syphilis (primary, secondary, and early latent) reported to the health department between January 1, 2000 and December 31, 2011, excluding cases from Long Beach and Pasadena. Cases in Long Beach and Pasadena are excluded because they have their own health departments that will ensure treatment of STD cases.

When laboratory specimen results are positive for a specific infection, a laboratory report form is filled out and submitted via mail, fax, or electronically (note: during the time period of the dataset, electronic submission was not yet available) to DHSP. The laboratory specimen results are also sent to the clinician for diagnosis confirmation. At this point, the clinician must submit a confidential morbidity report (CMR) to DHSP via mail, fax, or electronic methods (again, electronic submission was not available during the time period of the dataset). Upon receiving the CMR and laboratory report, DHSP staff will enter the information into Casewatch, a case management and surveillance system. When entering the information for a particular patient, the first and last name, date of birth, and sometimes medical record number is used to check for a previous incidence within Casewatch. If the specified fields match, then the case is considered the same person.

Once information for an STD case is entered into Casewatch, a queue will be generated that assigns it to appropriate follow-up. The primary goals of follow-up are to ensure treatment of the index case, identify potential sexual partners, and treatment of those partners. If the case is a pregnant woman or child less than twelve years of age, it is assigned to a public health nurse (PHN). If the case falls under a "special projects" designation, it is assigned to the appropriate staff and investigators overseeing these special projects. Sometimes, these may include special projects examination settings such as schools and jails. Public health investigators (PHIs) are assigned the rest of the cases. Once the cases are followed-up by the appropriate DPH staff, the information obtained is entered back into the Casewatch system by each of the respective staff members. Due to the high volume of cases in LAC, follow-up is prioritized and not all STD cases can be investigated. Finally, there is ongoing, annual data verification by DHSP staff to ensure that data on the various dates collected (e.g. lab specimen collection dates, lab specimen test dates, treatment dates, etc.) are consistent. In addition, epidemiology unit staff may catch data errors during analysis that would prompt data entry/field staff to look through individual cases and investigate why there are errors.

Study Variables

My unit of analysis is a specific STD case-incidence. I defined a gonorrhea, chlamydia, and syphilis "case" according to case definitions from CDC Sexually Transmitted Disease Surveillance reports (CDC, 1997). An "incidence" is defined as the point in time when a morbidity date is assigned to a case reported to the surveillance system. The "morbidity date" is taken as the earliest of:

1. Lab specimen collection date,
2. Lab specimen test date,
3. Treatment date,
4. Earliest of the following two dates:
    a. Lab test report date -OR-
    b. Confidential Morbidity Report (CMR) date
5. STD lab receipt date
6. Earliest of the following two dates
    a. Date lab results entered -OR-
    b. Date CMR entered.

The patient's age is calculated as the difference between the disease morbidity date and the birth date. If the birth date is invalid (i.e. after the end of December 1, 2011) or the calculated age is greater than 110 years then the age is set to unknown. Patient's race/ethnicity is determined from two variables—Hispanic ethnicity and race. If the Hispanic variable is "Yes" then "Hispanic" is assigned to the patient's race/ethnicity. If the Hispanic variable is "No", then the race indicated is assigned to the race/ethnicity field. For example, if the race indicated is "White" and "Hispanic" is not already assigned then the race/ethnicity is "White." Service planning areas (SPAs) are derived from aggregations of health districts—geographic areas that were arbitrarily defined to enable management of infectious disease cases residing within the boundaries of these jurisdictions.

Data Analysis

Data are summarized in frequency tables as well as figures depicting the rate per 100,000 of reported STD case-incidences. I organized the results according to older (age 50 and above) cases, younger (15 to 29) cases, and middle-aged (30 to 49) cases to allow comparisons between age categories. The age categories were chosen to allow comparisons with other studies as well (Chesson et al., 2008; Fang et al., 2010; Smith et al., 2002). I further split the older cases into smaller age groups to demonstrate additional differences in burden within the broad age categories. Specifically, older cases were broken up in ten-year increments—50-59, 60-69, 70-79, etc.

I calculated the number of reported STD case-incidences per 100,000 persons (rate) using the following formula:

$$R_i = \frac{\text{number of reported cases}_i}{\text{population estimate}_i} \times 100{,}000$$

where *i* denotes the stratum-specific value for each combination of year and covariate of interest (e.g. age). The population estimates were obtained from unpublished data prepared by the Internal Services Department, County of Los Angeles. Because population estimates are only available for gender, age, race/ethnicity, and SPA, rate will be unavailable for other variables. In addition, the estimates for age are broken up by five-year increments, so at times when the number of reported cases covers an age group that is in the middle of the five-year increment, then I will have to under- or over-estimate the rate.

After calculating the rates, I obtained rate ratios comparing the rates among younger to older cases and younger to middle-aged cases. The formulas I used are:

$$RR_i = \frac{\mathrm{R}_{i,\text{younger}}}{\mathrm{R}_{i,\text{older}}} \text{ and } RR_i = \frac{\mathrm{R}_{i,\text{younger}}}{\mathrm{R}_{i,\text{middle-age}}}$$

In cases where the rate was zero among older or middle-aged cases, the rate ratio was undefined. These were excluded from subsequent analyses.

I conducted trend analyses on the rate and rate ratio of reported STD case-incidences over time by fitting a Poisson regression model to the aggregate data. Specifically, I regressed the outcome of interest (i.e. rate and rate ratio) on the year of rate. The Poisson regression model form is:

$$\ln[\lambda] = \beta_0 + \beta_1 \cdot \text{year}$$

Where λ denotes the expected number of STD case-incidences. To conduct trend analysis of rate per 100,000 I slightly adjusted the Poisson model to the following:

$$\ln\left[\frac{\lambda}{t}\right] = \beta_0 + \beta_1 \cdot \text{year}$$

Where the additional term *t* denotes the population estimate for the relevant year. Finally, for trend analysis of STD case-rate ratios I used the following Poisson model:

$$\ln\left[\frac{\lambda}{t}\right] = \beta_0 + \beta_1 \cdot \text{year} + \beta_2 \cdot \text{agegrp}_i + \beta_3 \cdot \text{year} \cdot \text{agegrp}_i$$

Where agegrp_i is the age category (younger, middle-aged, and older) and i denotes a particular category of a covariate of interest (e.g. gender, race/ethnicity).

To test for statistically significant changes in the rate per 100,000 over time, I utilized the annual percent change which is defined as:

$$\frac{m_{j+1} - m_j}{m_j} = \exp(\beta) - 1$$

Where m_{j+1} is the expected risk for year j+1 and m_j is the expected risk for year j. Because β is equivalent to the coefficient of the year covariate in the Poisson regression model, I can calculate the annual percent change and associated 95% confidence limits. For this analysis, I assumed that the rate of change is constant from year to year on the logarithmic scale. Because the Poisson regression model assumes that the mean is equal to the variance, I checked for overdispersion (variance > mean) or underdispersion (variance < mean). When there is overdispersion, I fit a negative binomial regression model instead. In the case of underdispersion, I used a generalized Poisson regression model (Consul et al., 1992).

For rate ratios, I tested the statistical significance of the coefficient for the interaction between year and age category. If the coefficient is statistically significant ($P < 0.05$) then I rejected the null hypothesis that the trend over time in the rate of STD cases does not differ between age categories.

For syphilis cases, I only assessed early syphilis cases (primary, secondary, early latent) because late syphilis does not have an associated time frame. It is difficult to assess trends over time when the unit of analysis is a year for late syphilis because by definition the associated infections were acquired at least 12 months prior, if not more. In addition, from a public health standpoint rate of early syphilis is more relevant to control of this disease in the population.

For trend analysis, I also excluded categories of variables where there is only one non-zero observation, because the regression models will not be able to produce any reliable estimates of annual percent change. This is because regression models are essentially the best fit line for a set of data points and thus require at least two non-zero points. All data analyses were performed using SAS Enterprise Guide 6.1 (SAS Institute, Cary, NC).

2.4 RESULTS

Syphilis

There were a total of 12,993 cases of early syphilis reported from 2000-2011, of which 1,348 (10.4%) were 50 and over. Figure 2-1 depicts the rate per 100,000 of reported early syphilis cases broken down by the three age categories. The middle-aged cases had the highest number per 100,000 at 21.5, followed by younger cases (14.2), and older cases (4.5). There was an overall increase in the rate for all three age categories: younger (15.00%; 95% CI, 11.33% to 18.79%), middle (7.97%; 95% CI, 5.27% to 10.74%), and older (12.00%; 95% CI, 7.25% to 16.96%). The rate ratio comparing younger to older cases changed from 2.0 to 3.4 but was not statistically significant (P = 0.80), and remained about the same for younger to middle-aged cases from 0.9 to 0.8 (P = 0.62) (Figure 2-2).

There was an 11.71% (95% CI, 7.30% to 16.30%) increase in the rate of early syphilis cases among older male cases while the rate of older female cases also increased but was not statistically significant (Table 2-1). Figures 2-3 and 2-4 depict the rate ratios of male and female early syphilis cases over time, respectively. The rate ratios comparing younger to older cases remained stable over time for both males (P = 0.67) and females (P = 0.55).

The rate of early syphilis was highest in the 50 to 59 year-olds among the older cases (Figure 2-5) and increased over time by 11.36% (95% CI, 7.14% to 15.74%). Among older cases, rate was also highest among Black/African-American race (Figure 2-6). However, rate per 100,000 increased the most among Hispanic older cases (16.30%; 95% CI, 10.11% to 22.84%). Rate among older cases were highest in the Metro SPA, although the greatest increase was observed among older cases in the East SPA with an annual percent change of 18.59% (95% CI, 9.68% to 28.22%) (Table 2-2).

Gonorrhea

There was a total of 104,198 cases of gonorrhea reported from 2000-2011, of which 3,172 (3.0%) were 50 and over. Figure 2-7 depicts the number per 100,000 of reported gonorrhea cases broken down by the three age categories. The younger cases had the highest number per 100,000 at 262.5, followed by middle-aged cases (85.4), and older cases (10.4). While there was an overall increase in the rate for younger (2.11%; 95% CI, 0.02% to 4.24%), and older (2.11%; 95% CI, 0.02% to 4.24%) cases, the rate was stable for middle-aged cases (0.83%; 95% CI, -1.03% to 2.73%). The rate ratio comparing younger to older cases remained about the same (P = 0.99), as did the rate ratio comparing younger to middle-aged cases (P = 0.38) (Figure 2-8).

There was a slight increase in the rate of gonorrhea among older male cases (2.06%; 95% CI, -0.01% to 4.17%) while the rate of older female cases remained about the same (1.07%; 95% CI, -2.03% to 4.26%) (Table 2-3). Figures 2-9 and 2-10 depict the rate ratios of male and female gonorrhea cases over time, respectively. The rate ratios comparing younger to older cases remained stable over time for both males (P = 0.11) and females (P = 0.65).

The rate of gonorrhea was highest in the 50 to 59 year-olds among the older cases (Figure 2-11) and increased over time by 2.48% (95% CI, 0.40% to 4.60%). On the other hand, there was a decrease in the rate of gonorrhea among cases age 70 and above (-7.59%; 95% CI, -12.08% to -2.87%). Among older cases, rate was highest among Black/African-American race (Figure 2-12). However, rate increased the most among White older cases (13.84%; 95% CI, 10.64% to 17.14%). This increase was higher than among White younger cases, as the rate ratio decreased from 26.6 to 12.5 (P = 0.002). Rate among older cases were highest in the South SPA, although the greatest increase was observed among older cases in the San Fernando SPA with an annual percent change of 6.42% (95% CI, 3.55% to 9.36%) (Table 2-4).

Chlamydia

There were a total of 463,976 cases of chlamydia reported from 2000-2011, of which 5,840 (1.3%) were 50 and over. The younger cases had the highest number per 100,000 at 1,412.1, followed by middle-aged cases at 226.5, and older cases at 19.1. There was an overall increase in the rate for all three age categories: younger (3.30%; 95% CI, 2.83% to 3.78%), middle (3.32%; 95% CI, 2.54% to 4.10%), and older (5.94%; 95% CI, 4.65% to 7.24%). The rate ratio comparing younger to older cases decreased from 85.0 to 58.7 ($P < 0.001$), while remaining about the same for younger to middle-aged cases ($P = 0.97$) (Figure 2-13).

There was an increase in the rate of chlamydia among both older male cases (9.79%; 95% CI, 8.04% to 11.58%) and older female cases (1.49%; 95% CI, 0.35% to 2.65%) (Table 2-5). As opposed to younger age categories, the rate of chlamydia cases is higher in older males versus older females. Figures 2-14 and 2-15 depict the rate ratios of male and female chlamydia cases over time, respectively. The rate ratios comparing younger to older cases decreased over time from 40.2 to 23.7 for males ($P < 0.001$) and remained stable for females ($P = 0.18$).

The rate of chlamydia was highest in the 50 to 59 year-olds among the older cases (Figure 2-16) and increased over time by 6.48% (95% CI, 5.31% to 7.67%). Among older cases, rate was highest among Black/African-American race (Figure 2-17). However, rate increased the most among White older cases (21.24%; 95% CI, 18.14% to 24.42%). This increase was higher than among White younger cases, as the rate ratio decreased from 109.3 to 37.4 ($P < 0.001$). Rate ratios also decreased between younger and older Black/African-American cases ($P = 0.001$) and younger and older Asian cases ($P < 0.001$). Rate among older cases were highest in the South SPA, although the greatest increase was observed among older cases in the Metro SPA with an annual percent change of 10.34% (95% CI, 7.38% to 13.39%) (Table 2-6). The rate ratio of younger to older cases decreased from 75.4 to 53.8 in the San Fernando SPA (*P* = 0.002), from 59.8 to 24.5 in the Metro SPA (*P* < 0.001), and from 91.9 to 85.3 in the East SPA (*P* = 0.04).

2.5 DISCUSSION

This is, to the best of my knowledge, the first study to examine in detail trends over time of STDs among older people and compare with younger populations. I found that in general, the rate of reported cases increased among older adults from 2000 to 2011 for all three STDs in the analyses. These trends were also observed for younger age groups. This is consistent with trends on the national level in the US (CDC, 2016). Overall trends for early syphilis exhibited a decline in 2008 for all three age categories before increasing again from 2009 through 2011. This may be a result of increased efforts by the health department to address the rising STD morbidity within LAC beginning in 2007 with the Community-Embedded Disease Intervention Specialist (CEDIS) Program for Syphilis (Rudy et al., 2012) and the *Check Yourself* social marketing campaign (Plant et al., 2014). *Check Yourself* was able to create a very strong brand among MSM in LAC, which constitutes the majority of early syphilis cases (LACDPH, 2010). The CEDIS program was able to significantly improve partner notification outcomes as well as brought-to-treatment index (the number of contacts identified and treated for early syphilis by the number of cases interviewed) among MSM primary syphilis cases. Similarly, overall rate in reported gonorrhea cases declined in 2007 and 2008 before increasing again beginning 2009. This may be explained in part by the noted increases in gonorrhea rates from 2000 to 2005 in eight western states in the CDC Morbidity and Mortality Weekly Report (CDC, 2007) followed by renewed diligence and additional resources devoted to gonorrhea control.

Rate ratios comparing younger to older early syphilis cases did not change over time, suggesting that rate of change was comparable between the two age categories. This appears contrary to general findings from other studies (Chesson et al., 2008; Fang et al., 2010) that age disparities in syphilis have decreased. However, those studies did not compare adults 50 and over with the 15 to 29 year-olds, and also only utilized data up to 2005 (Chesson et al., 2008) and 2007 (Fang et al., 2010). Similarly, rate ratios comparing younger to older gonorrhea cases also did not change over time. On the other hand, rate ratios comparing younger to older chlamydia cases has decreased significantly over time, suggesting that increases in older chlamydia cases has been greater compared to that among younger cases.

Gender Differences

Rates of early syphilis are higher among men compared to women, and this is consistent across all age categories. It has been documented that there has been an outbreak of syphilis among MSM in Los Angeles and San Francisco (CDC, 2004), after the national rate of reported primary and secondary cases had declined to a historically low rate. Since then, the rate of primary and secondary cases has increased almost every year (CDC, 2016). Thus, it is unsurprising that the majority of early syphilis cases are male. In addition, the rate of cases has increased for males while remaining about the same for females over time. The fact that the trends are observed even in the older cases suggest that MSM make up the majority of those cases as well.

As opposed to early syphilis, rate of reported gonorrhea and chlamydia cases are higher among younger women compared to men. For older cases, however, the risk is higher among men. This may reflect a differential reporting bias between men and women. Men in general are more likely to suffer from symptoms of gonorrhea and chlamydia infection (Korenromp et al., 2002), but routine screening currently is not recommended by the U.S. Preventive Services Task Force

(USPSTF; LeFevre, 2014). Routine screening was also not recommended for women over the age of 25, unless they had high risk. Thus, for men and older women, most cases would be detected when they were symptomatic and presented to the clinician. There may also be a psychosocial aspect to this. Older adults in general are less likely to seek care for sexual problems due to a number of factors (Gott et al., 2003; Laumann et al., 2009), but women are less likely than men to discuss with a physician about sexual problems (Lindau et al., 2007). This may be due to negative societal attitudes about women's sexuality and sexuality at older ages (Lindau et al., 2006; Gott et al., 2004). As a result, older women may not even reveal to the clinician that they have or suspect an STD infection.

Characteristics of Older Cases

The highest rate of reported early syphilis, gonorrhea, and chlamydia cases were in the 50 to 59 age group, but all age groups over 50 had reported cases. This finding is similar to other studies (Bodley-Tickell et al., 2008; Smith et al., 2002) and demonstrates that there are no age limits to STD infection. This may be unsurprising as other studies have found that older adults are engaging in sexual activity well beyond age 50 into their 80s (Lindau et al., 2007; Schick et al., 2010). Despite the prevalence of sexual activity at old age, safe sex practices such as condom use is still lacking (Schick et al., 2010).

The highest rate of reported early syphilis, gonorrhea, and chlamydia cases was among Black/African-American race. This is similar to the racial/ethnic distribution in younger and middle-aged cases, and is observed on the national level as well (CDC, 2016). Particularly disturbing is the continual rise in risk of chlamydia among older Blacks/African-Americans. It is unclear exactly why such racial/ethnic disparities exist (Newman et al., 2008), although it has been posited that sexual network characteristics are a significant contributor (Laumann et al., 1999).

For older adults, this may also be explained by differences in where they go to seek care. It is possible that older Blacks/African-Americans are more likely to present for diagnosis and treatment at public STD clinics, which has been found to have better race/ethnicity reporting in general when compared with private providers, at least when it comes to gonorrhea (Ross et al., 2004). Nevertheless, rates of reported early syphilis cases increased the most among White and Hispanic older cases, which is consistent with the characteristics of the outbreak of syphilis among MSM in Los Angeles (CDC, 2004). Rates have also increased the most among White older gonorrhea and chlamydia cases, which coupled with the fact that risks are higher among older men compared to women seem to suggest that a similar phenomenon to early syphilis is occurring.

Rate of reported older early syphilis cases were highest in the Metro SPA, which contains the highest proportion of MSM in Los Angeles County (Beymer et al., 2014). This further supports the finding that outbreaks in the MSM community in LAC has included older men as well. However, rate appeared to increase the most in the East SPA, which may be correlated with the high increases observed among Hispanics as the majority of residents in this SPA are of that race/ethnicity (LACDPH, 2009; LACDPH, 2013). Rate of reported older gonorrhea and chlamydia cases were highest in the South SPA, similar to younger cases. Interestingly, those numbers decreased the most for older gonorrhea cases compared to other cases in other SPAs. Again, this may have been a result of increased awareness of the rise in gonorrhea risks in general during 2000 to 2005 and a subsequent renewed focus on reducing gonorrhea rate. For older chlamydia cases, the greatest increase in the risk was observed in the Metro SPA, which suggests that similar to older early syphilis cases the rise has been attributed to the MSM population.

Limitations

Several limitations may affect interpretation of findings of this study. Underreporting is a major issue when it comes to STD surveillance, with varying proportions for different diseases. Since syphilis surveillance includes both passive and active surveillance, with detailed follow-up of cases and their sexual partners, underreporting of early syphilis cases is minimized. For gonorrhea and chlamydia, underreporting because of asymptomatic cases is a significant issue. One study estimated that in general greater than 80% of incident chlamydia cases were asymptomatic among both men and women (Detels et al., 2011). The same study also found that greater than 75% of incident gonorrhea cases were asymptomatic. In addition, some healthcare providers may not be aware of their legal requirements to report STDs. However, these factors are probably present in all three age categories. What exacerbates underreporting among older adults are the barriers to seeking health care for sexual problems as mentioned before (Gott et al., 2003; Gott et al., 2004; Laumann et al., 2009). Because older adults and providers are less likely to discuss such issues, there is a greater likelihood of STD infections going undetected and thus not reported. Thus, reported risks are likely underestimates of the true STD burden among older adults.

There will be uncertainty in presentation of average rate and rate ratios due to uncertainty in population estimates especially during intercensal years. Population estimates during intercensal years are progressively more uncertain the further away from censal years (2000, 2010). The uncertainty will also vary by covariates of interest (i.e. demographics). This will result in an under- or over-estimation of the average rate depending on whether the actual population for a given year is higher or lower than the estimate. The reliability of reported incidences is also questionable when the number of cases used to calculate risks are small.

Therefore, caution needs to be used in interpreting results from stratified analyses containing small numbers of cases.

Place of acquisition of infection is uncertain from the dataset, as these are cases reported to the health department following a diagnosis. Thus, the data more accurately reflects the place of diagnosis. Nevertheless, as long as a case is reported in LAC, it is important to follow-up and ensure treatment to prevent further transmission of STDs in the population. In addition, mechanisms are in place for data sharing between LAC and other health jurisdictions through the Interstate Communication Control Record (ICCR) to ensure at-risk or infected individuals are offered STD prevention services outside of the initiating jurisdiction.

Temporal trends may not reflect an actual increase in disease burden in the population. Other factors that may influence observed increases in the rate of reported STDs include increases in screening coverage, use of more sensitive laboratory tests (e.g. broader use of nucleic acid amplification tests [NAATs]), and more complete reporting (CDC, 2016). This is especially problematic for chlamydia due to its large asymptomatic population, but may affect gonorrhea and syphilis as well to lesser extents. However, even if increases or decreases in rate reflect more of detection practices as opposed to actual changes in STD morbidity in the population, the data should prompt public health departments to review their STD control program practices.

Public Health Impact

In spite of these limitations, this is still an important study because it begins to characterize STDs among older people and demonstrates that even the oldest age groups are not immune to acquiring infections. The demographic breakdown of older cases indicates the need for further investigation and intervention on specific high-risk populations. This means prevention strategies aimed at older men, Black/African-Americans, and those who reside in the Metro and South SPAs. The fact that for all three diseases of interest the increases in rate over time was not greater in younger populations compared to older populations also suggests that the problem is growing at a similar pace between the age groups. This means there is a clear need to educate both providers and older adults on STD risk and encourage screening among this population. Several intervention approaches that have been successful in the field of cancer screening for older adults may be adapted for such purposes. One-on-one education has been proven to be effective in increasing screening for breast and cervical cancers. This involves conveying information to individuals by telephone or in-person about indications for, benefits of, and ways to overcome barriers to screening with the goal of informing, encouraging, and motivating people to seek recommended screening. Client reminders were also demonstrated to be effective in increasing screening for breast cancer, which involved letters, postcards, emails or telephone messages advising people that their screening is due or overdue. Reducing structural barriers, or non-economic obstacles that impede access to screening, have been proving effective in improving colorectal cancer screening among the elderly. This includes reducing the time/distance needed to access providers, modifying hours of service to meet client needs, offering services in alt or non-clinical settings, and eliminating/simplifying administrative procedures and other obstacles (Sabatino et al., 2012).

As internet use continues to increase even among older adults, another possible avenue of increasing STD testing and treatment-seeking behavior may be through online communications. One study on adults over age 40 demonstrated that a significant proportion were willing to use email and other e-communication methods (e.g. texting, Facebook, instant messaging, Internet-based or video chatting, Twitter, LinkedIn) to discuss routine health topics and colorectal cancer screening (Cutrona et al., 2013). Thus, physicians can email older patients with information on sexual health and STD testing and treatment and encourage them to disseminate that information to other older adults they know via any means of communication they choose. Developing and implementing these strategies are paramount to preventing potential future STD outbreaks among a growing at-risk population.

TABLES AND FIGURES

Figure 2-1 Reported rate per 100,000 of early syphilis cases by age category, Los Angeles County, 2000-2011

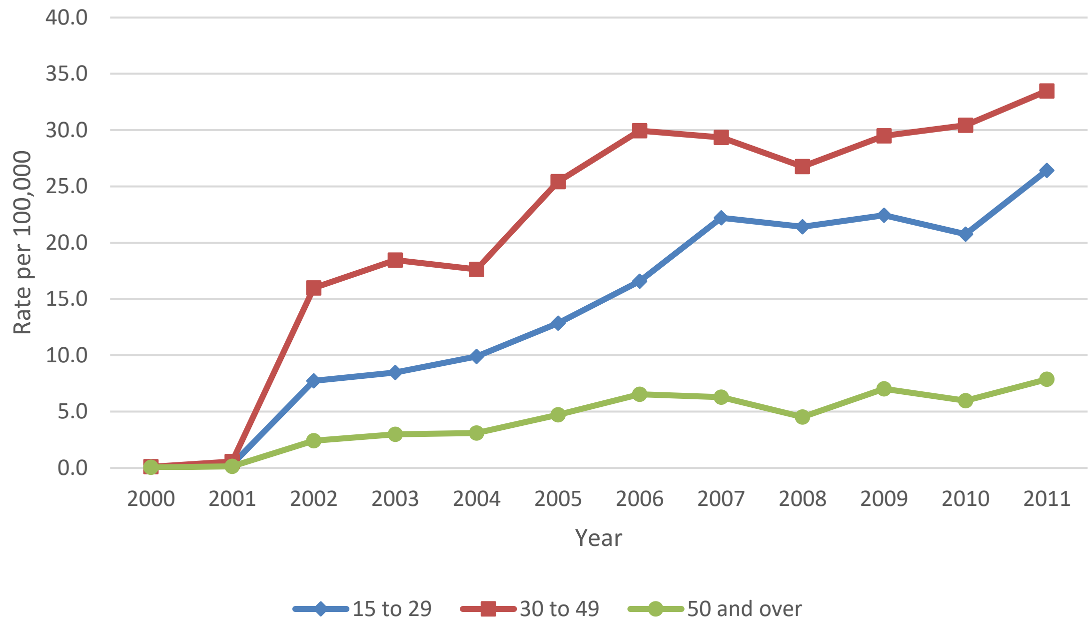


Figure 2-2 Rate ratios of early syphilis cases between age categories, Los Angeles County, 2000-2011

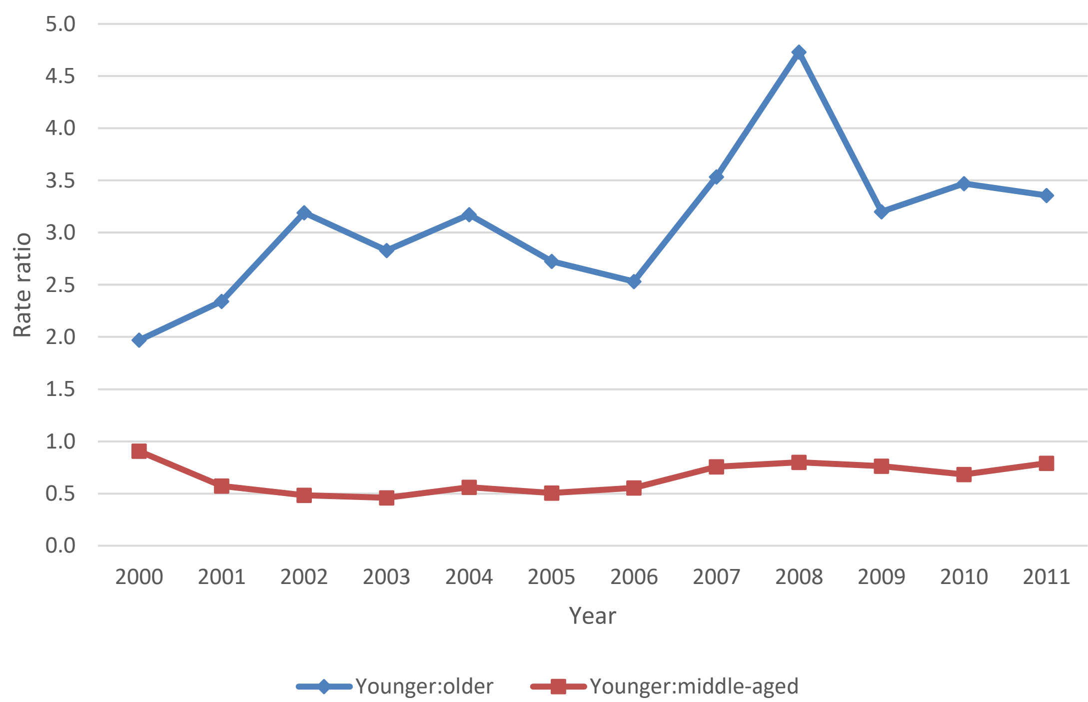


Table 2-1 Annual percent change in the reported rate per 100,000 of early syphilis cases by gender, Los Angeles County, 2000-2011

	Gender					
	Male			Female		
Age Category	Rate	Percent	95% CI	Rate	Percent	95% CI
15 to 29	24.5	16.91	13.23, 20.71	0.6	0.91	-5.66, 7.93
30 to 49	39.9	8.53	6.28, 10.82	2.6	-1.84	-10.66, 7.85
50 and over	9.1	11.71	7.30, 16.30	3.4	9.67	-2.44, 23.29

CI=Confidence interval

Figure 2-3 Rate ratios of male early syphilis cases between age categories, Los Angeles County, 2000-2011

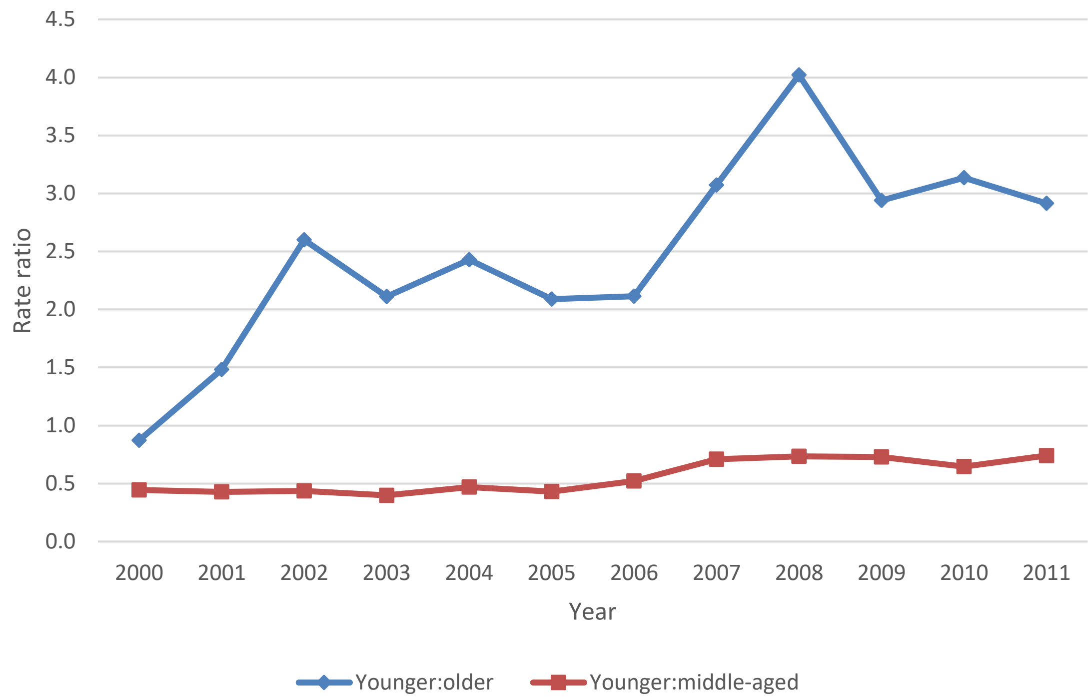
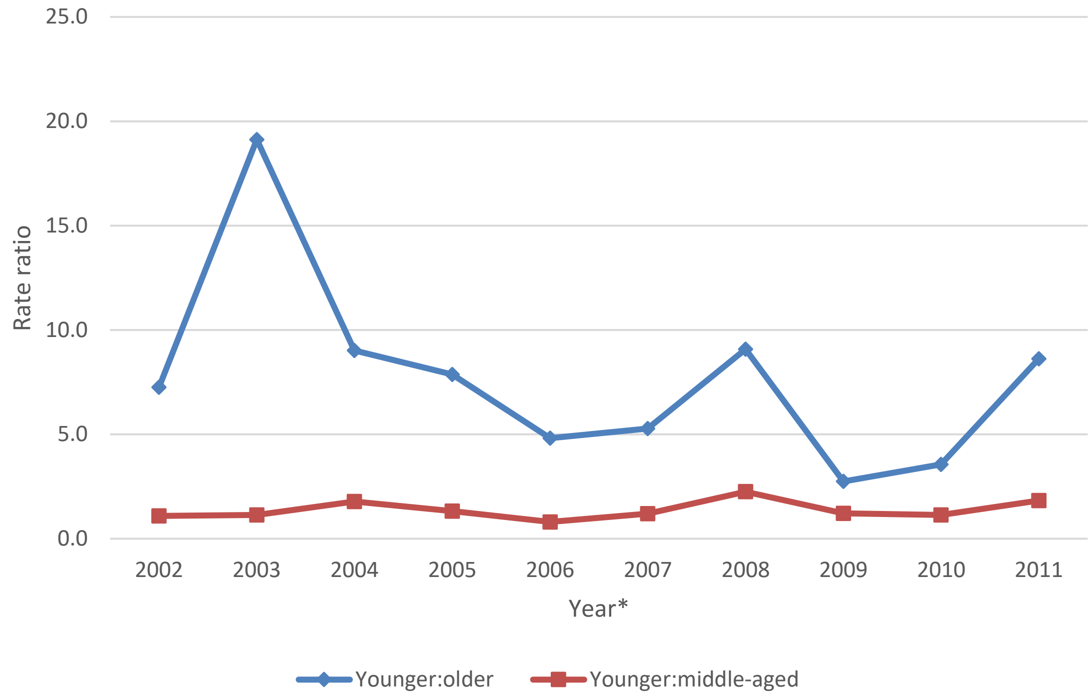


Figure 2-4 Rate ratios of female early syphilis cases between age categories, Los Angeles County, 2000-2011



*Rate ratio for years 2000 and 2001 was undefined

Figure 2-5 Reported rate per 100,000 of early syphilis cases ages 50 and over, Los Angeles County, 2000-2011

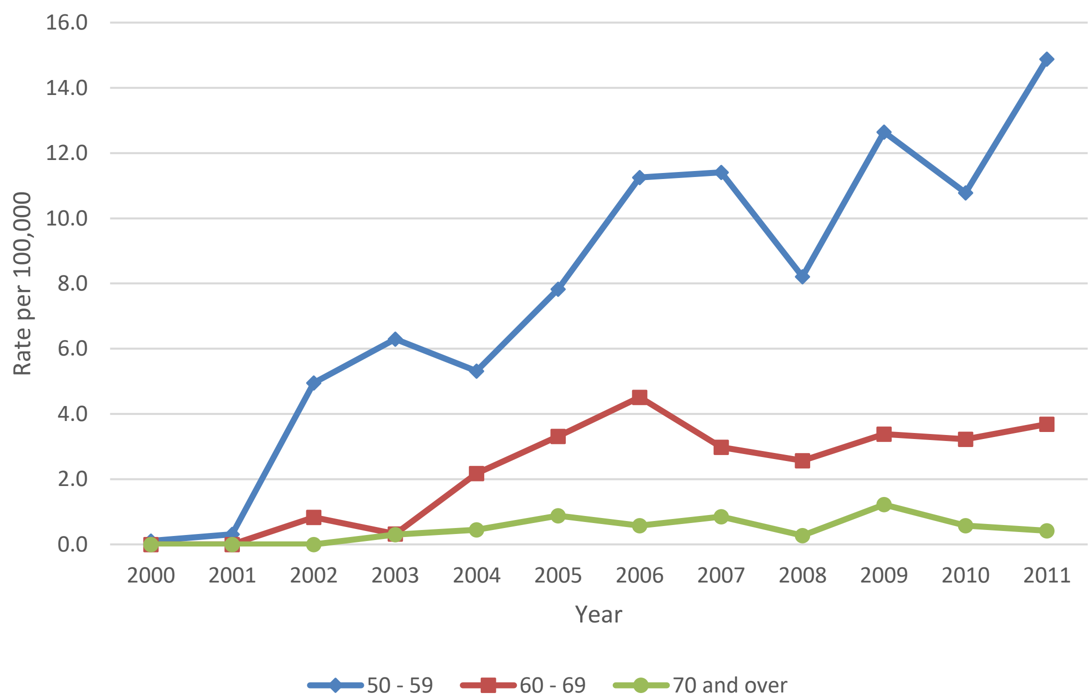


Figure 2-6 Reported rate per 100,000 of early syphilis cases ages 50 and over by race/ethnicity, Los Angeles County, 2000-2011

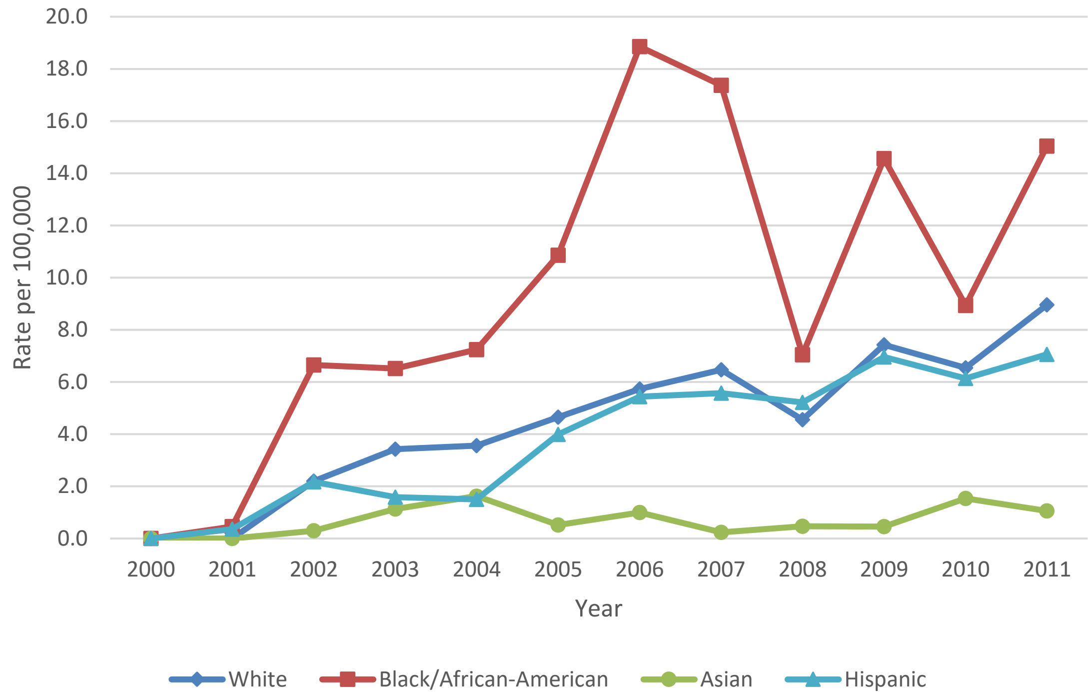


Table 2-2 Annual percent change in the reported rate per 100,000 of early syphilis cases ages 50 and over by Service Planning Area (SPA), Los Angeles County, 2000-2011

		Annual percent change	
SPA	Rate	Percent	95% CI
Antelope Valley	1.1	7.78	-28.98, 63.57
San Fernando	3.4	8.02	3.07, 13.22
San Gabriel	0.9	12.80	4.10, 22.22
Metro	18.3	12.90	9.25, 16.66
West	3.9	11.51	3.18, 20.51
South	7.1	9.99	2.46, 18.07
East	2.5	18.59	9.68, 28.22
South Bay	1.9	8.58	-0.21, 18.13

CI=Confidence Interval

Figure 2-7 Reported rate per 100,000 of gonorrhea cases by age category, Los Angeles County, 2000-2011

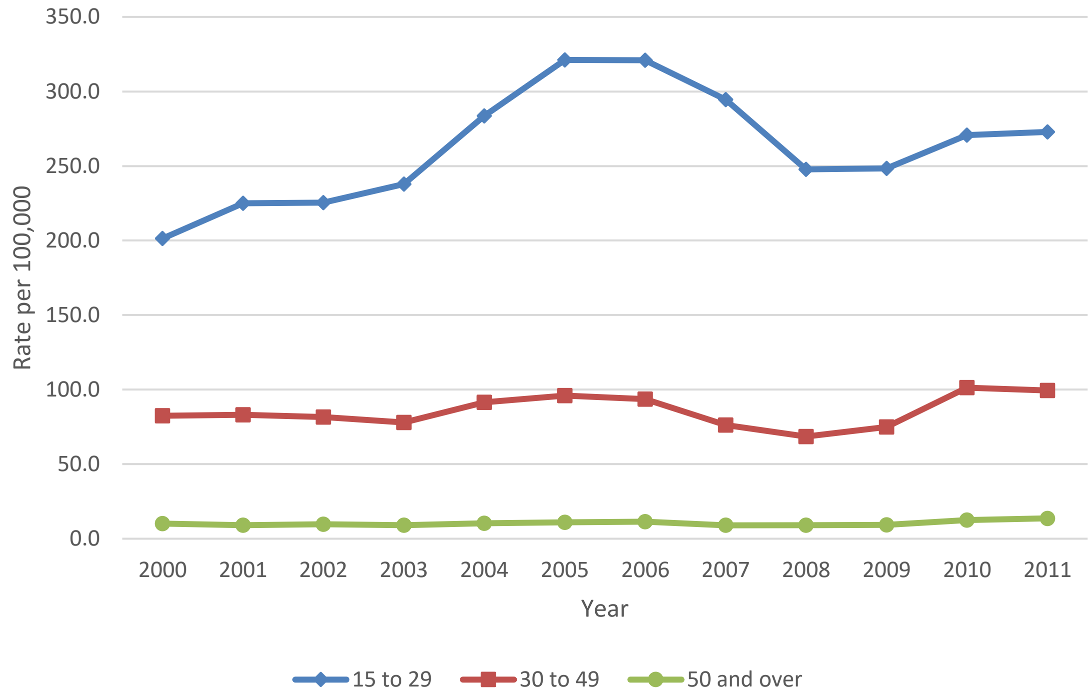


Figure 2-8 Rate ratios of gonorrhea cases between age categories, Los Angeles County, 2000-2011

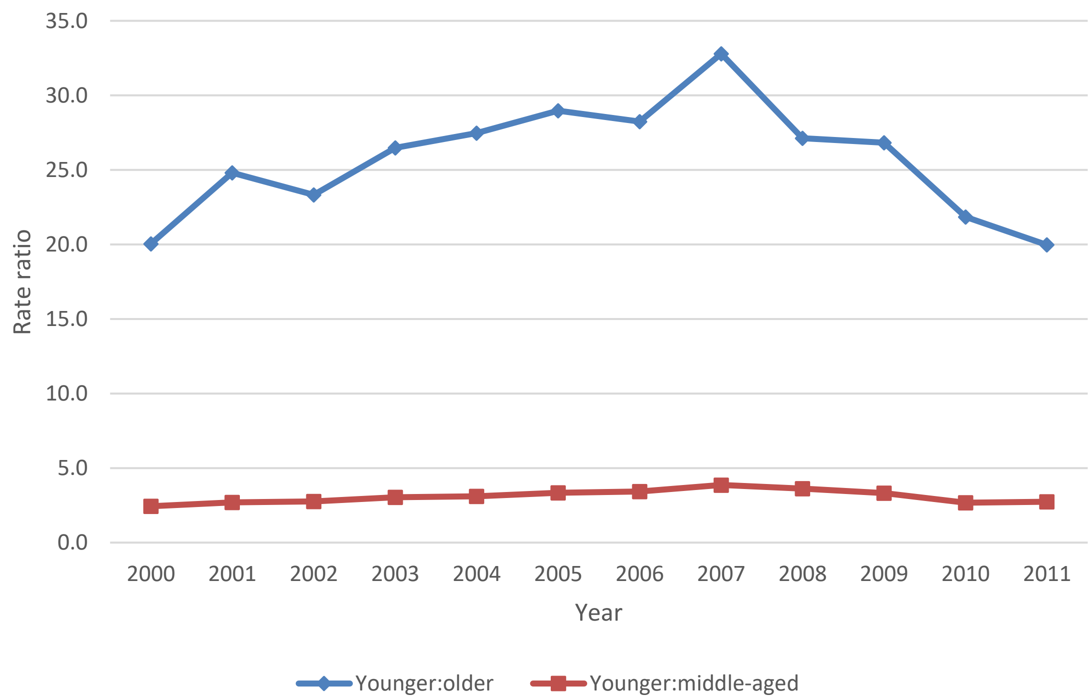


Table 2-3 Annual percent change in the reported rate per 100,000 of gonorrhea cases by gender, Los Angeles County, 2000-2011

	Gender					
	Male			Female		
Age Category	Rate	Percent	95% CI	Rate	Percent	95% CI
15 to 29	247.0	4.08	2.61, 5.57	277.4	0.07	-2.82, 3.04
30 to 49	127.9	1.36	-0.72, 3.49	41.6	-1.19	-3.32, 0.98
50 and over	18.9	2.06	-0.01, 4.17	3.2	1.07	-2.03, 4.26

CI=Confidence interval

Figure 2-9 Rate ratios of male gonorrhea cases between age categories, Los Angeles County, 2000-2011

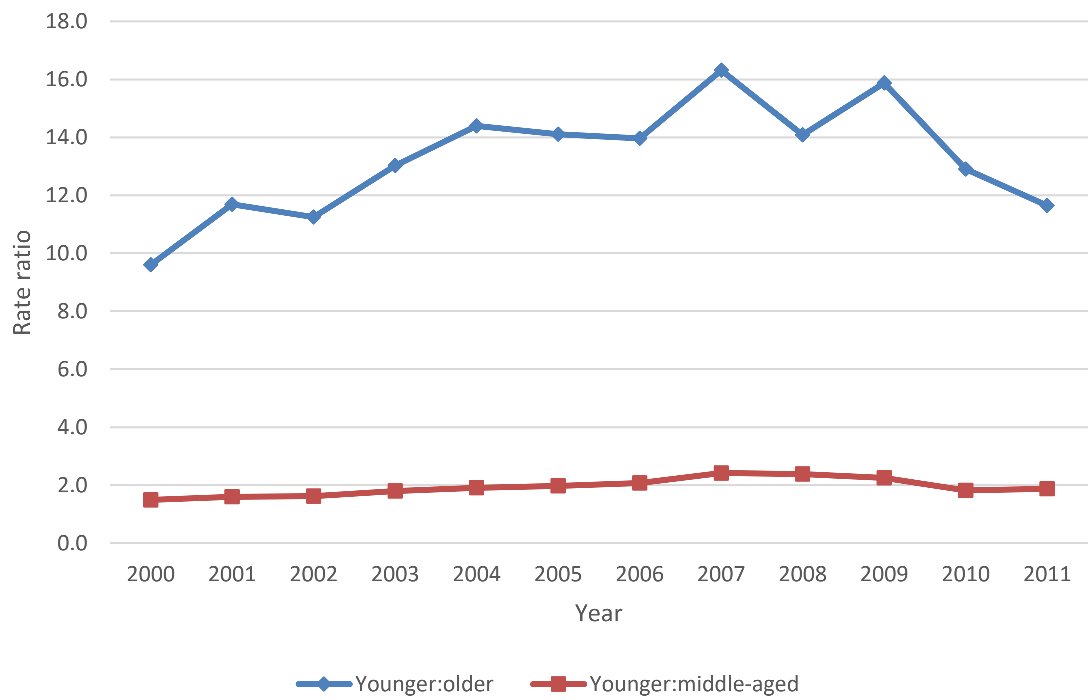


Figure 2-10 Rate ratios of female gonorrhea cases between age categories, Los Angeles County, 2000-2011

Figure 2-11 Reported rate per 100,000 of gonorrhea cases ages 50 and over, Los Angeles County, 2000-2011

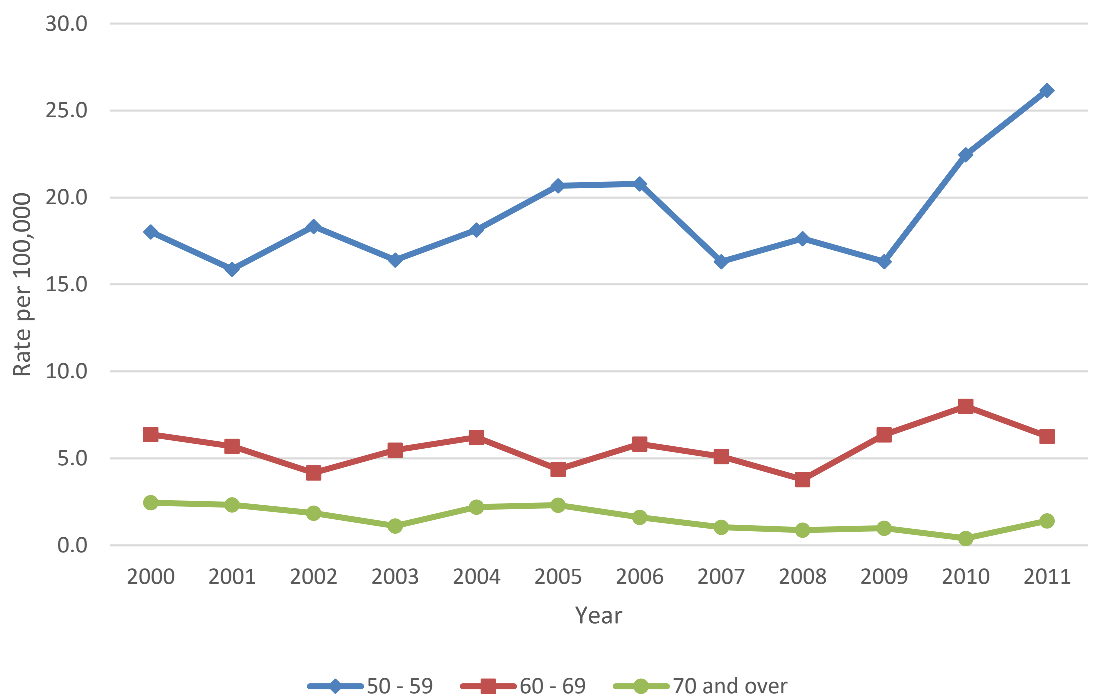


Figure 2-12 Reported rate per 100,000 of gonorrhea cases ages 50 and over by race/ethnicity, Los Angeles County, 2000-2011

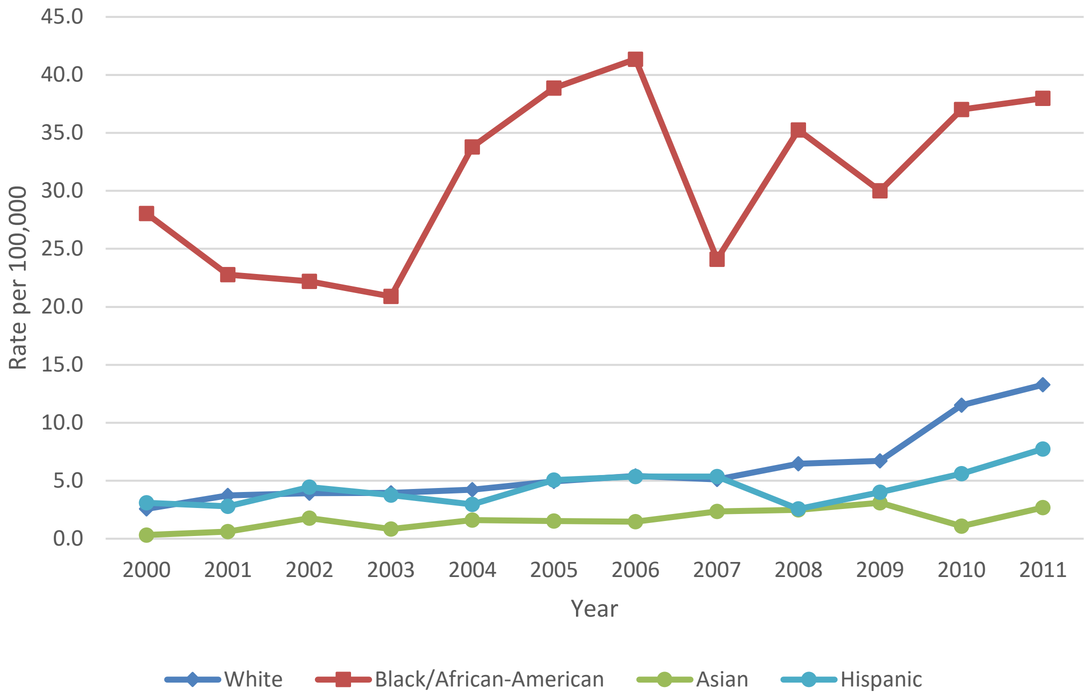


Table 2-4 Annual percent change in the reported rate per 100,000 of gonorrhea cases ages 50 and over by Service Planning Area (SPA), Los Angeles County, 2000-2011

		Annual percent change	
SPA	Rate	Percent	95% CI
Antelope Valley	4.3	-2.72	-10.84, 6.13
San Fernando	5.6	6.42	3.55, 9.36
San Gabriel	3.4	2.49	-1.32, 6.45
Metro	26.1	6.15	2.79, 9.61
West	9.8	5.13	1.68, 8.69
South	31.9	-3.51	-5.99, -0.98
East	4.9	1.69	-2.55, 6.12
South Bay	6.5	2.52	-2.46, 7.74

CI=Confidence Interval

Figure 2-13 Rate ratios of chlamydia cases between age categories, Los Angeles County, 2000-2011

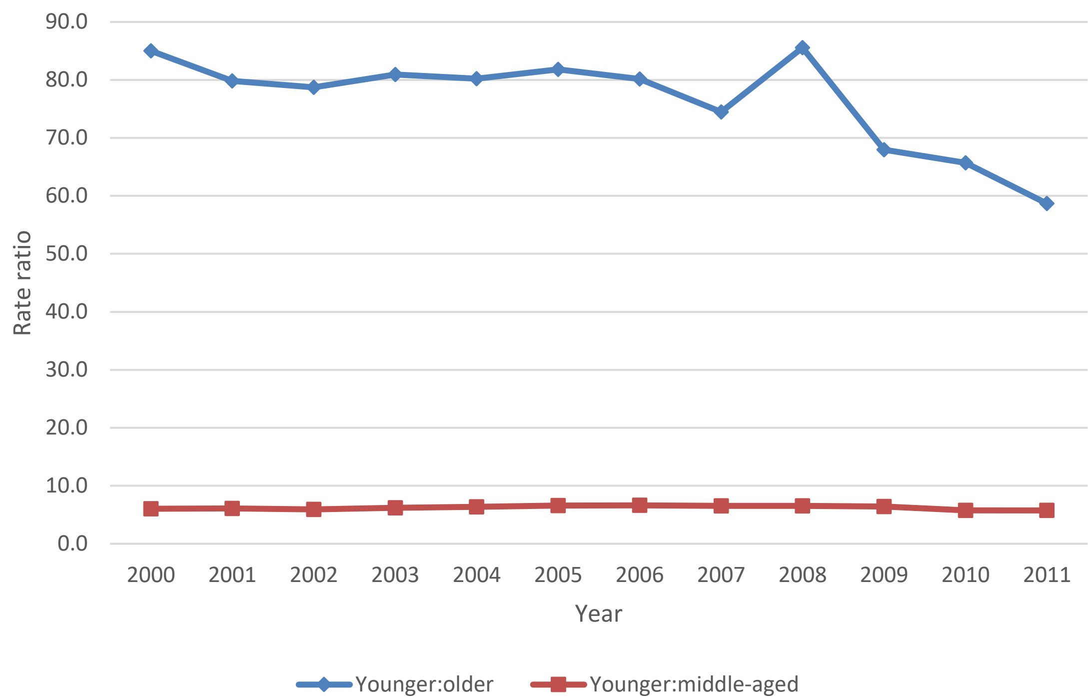


Table 2-5 Annual percent change in the reported rate per 100,000 of gonorrhea cases by gender, Los Angeles County, 2000-2011

			Gender			
		Male			Female	
Age Category	Rate	Percent	95% CI	Rate	Percent	95% CI
15 to 29	745.8	5.76	5.15, 6.37	2,102.9	2.39	1.90, 2.88
30 to 49	197.2	6.69	5.71, 7.69	254.5	0.71	0.00, 1.43
50 and over	23.3	9.79	8.04, 11.58	15.4	1.49	0.35, 2.65

CI=Confidence interval

Figure 2-14 Rate ratios of male chlamydia cases between age categories, Los Angeles County, 2000-2011

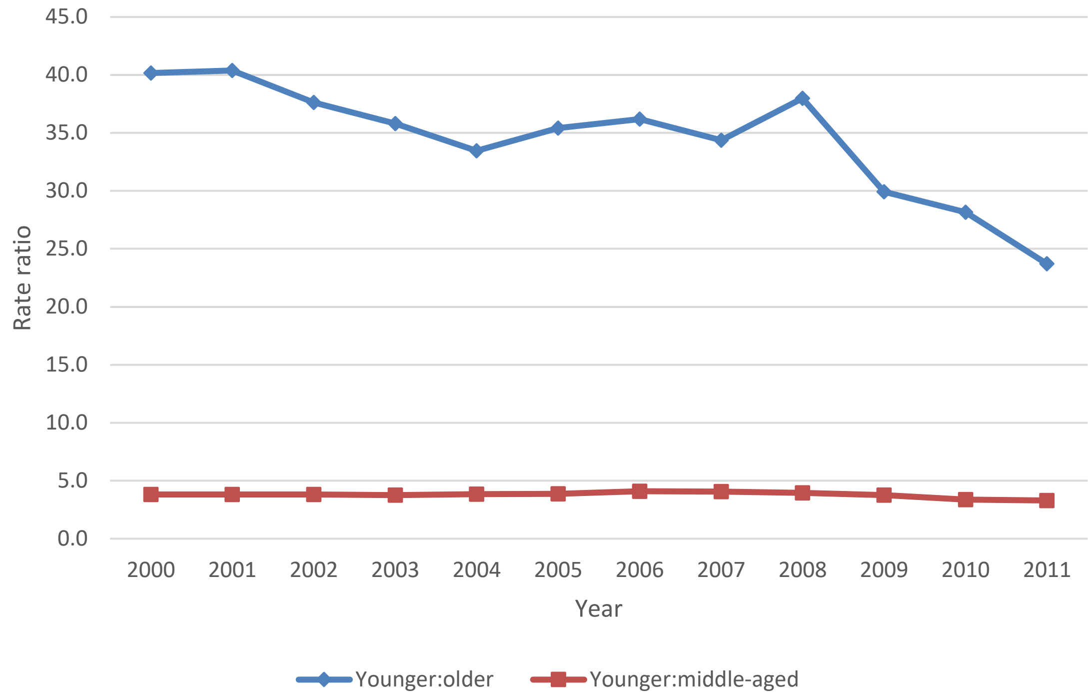


Figure 2-15 Rate ratios of female chlamydia cases between age categories, Los Angeles County, 2000-2011

Figure 2-16 Reported rate per 100,000 of chlamydia cases ages 50 and over, Los Angeles County, 2000-2011

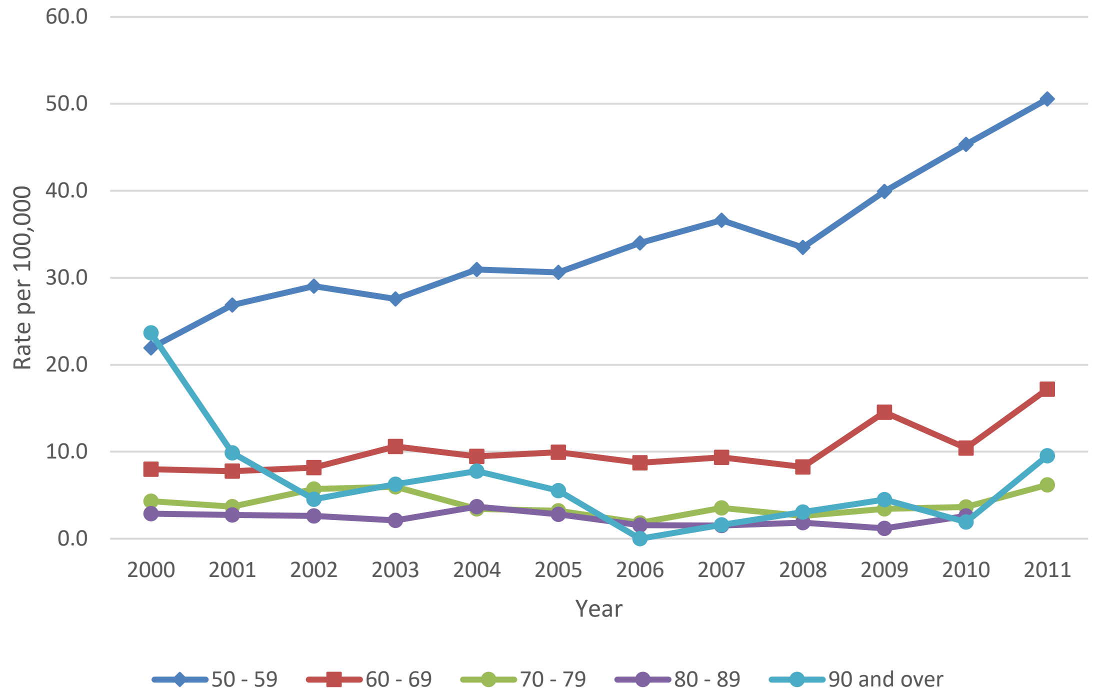


Figure 2-17 Reported rate per 100,000 of chlamydia cases ages 50 and over by race/ethnicity, Los Angeles County, 2000-2011

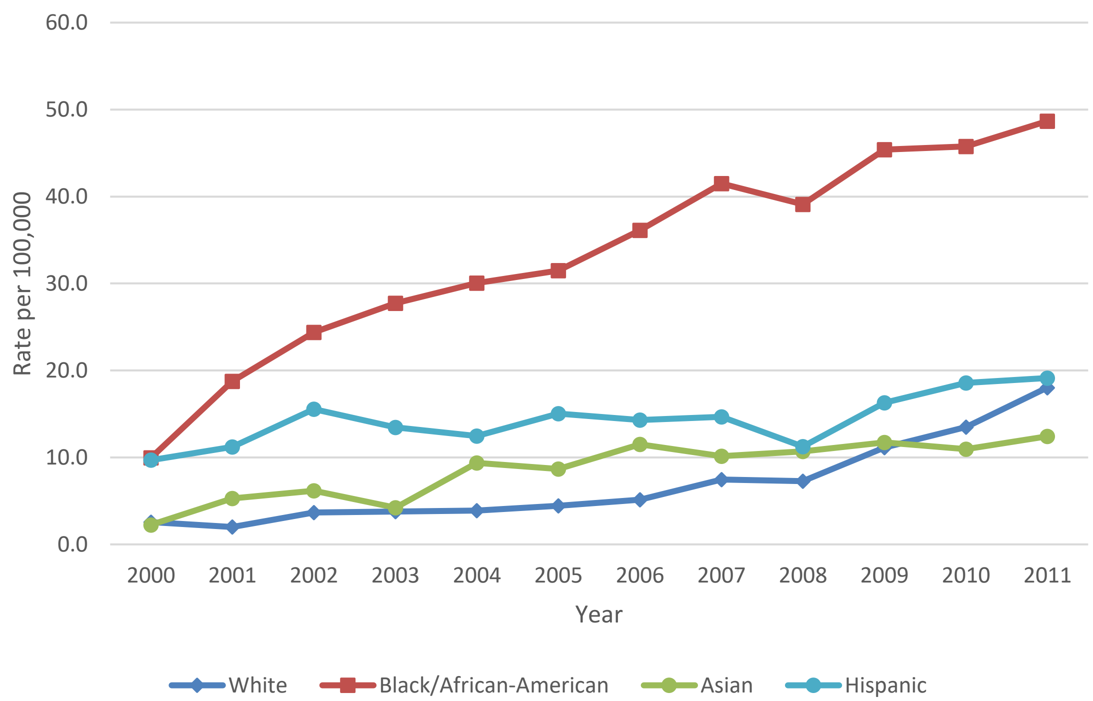


Table 2-6 Annual percent change in the reported rate per 100,000 of chlamydia cases ages 50 and over by Service Planning Area (SPA), Los Angeles County, 2000-2011

		Annual percent change	
SPA	Rate	Percent	95% CI
Antelope Valley	11.7	9.25	3.16, 15.70
San Fernando	13.6	7.03	4.79, 9.33
San Gabriel	11.0	3.46	1.30, 5.66
Metro	35.0	10.34	7.38, 13.39
West	14.3	9.04	6.04, 12.12
South	43.8	3.87	1.99, 5.79
East	14.0	6.26	2.72, 9.92
South Bay	11.3	6.58	3.84, 9.39

CI=Confidence Interval

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CHAPTER 3

TRENDS OVER TIME AND PREDICTORS OF REPORTED REPEAT SYPHILIS, GONORRHEA, AND CHLAMYDIA CASES AMONG OLDER RESIDENTS OF LOS ANGELES COUNTY, 2000-2011

3.1 ABSTRACT

Background: Rising rates of sexually transmitted diseases (STDs) in the twenty-first century may be attributed to numerous factors, including the continued presence of a "core" transmission group where individuals have repeat infections. Despite numerous studies on STD re-infection, none have focused on older adults. The aim of this study is to characterize repeat infections with early syphilis, gonorrhea, and chlamydia over time and identify predictors among older adults and compare with younger populations.

Methods: I utilized routine surveillance data that captures all cases of syphilis, gonorrhea, and chlamydia reported to the Los Angeles County Department of Public Health between January 1, 2000 and December 31, 2011. Cases from Long Beach and Pasadena were excluded. Repeat infection rates and rate ratios were used to assess trends over time. An extension of the Cox proportional hazards regression model was utilized to analyze predictors of multiple repeat infections of STDs.

Results: Rate of reported repeat infections increased over time among older adults for early syphilis and chlamydia, but not for gonorrhea. The rates of repeat chlamydia have increased faster among the older age category compared to the younger. The majority of older adults had a similar number of repeat infections to younger populations. The statistically significant predictors of repeat early syphilis among older cases was being a man who has sex with men only (MSM) or who has sex with both men and women (MSM/W) and being co-infected with another STD. Older repeat gonorrhea cases tend to be male, White, and have a co-infection. Older repeat chlamydia cases tend to be male, reside within the Metro service planning area (SPA), and have a co-infection.

Conclusion: Older adults with repeat infections may be part of the STD "core" group that is a reservoir of disease in the population. Being MSM and MSM/W as well as having co-infections are useful indicators that will help targeted interventions toward these older populations for STD prevention.

Keywords: Older people; sexually transmitted diseases; multiple repeat infections; co-infections; demographic predictors

3.2 INTRODUCTION

Infection rates of reportable sexually transmitted diseases (STDs) such as syphilis, gonorrhea, and chlamydia have been increasing since the beginning of the twenty-first century (CDC, 2016). While numerous factors may contribute to this, including increases in screening coverage, use of more sensitive laboratory tests (e.g. broader use of nucleic acid amplification tests), and more complete reporting, a core group of individuals with repeat infections are also contributing to the rising trends by maintaining a disease reservoir in the community (Phipps et al., 2009). This core group tends to exhibit higher-risk sexual behaviors and may have other social and demographic similarities (Plummer et al., 1987). Thus, identifying this core group and bringing them to treatment is important to STD prevention in the population.

Many studies have been done investigating STD re-infections in general. There are literature reviews of studies examining gonococcal and chlamydial re-infection among men (Fung et al., 2007) and women (Hosenfeld et al., 2009). Syphilis re-infections have also been examined among both the general population (Brewer et al., 2011; Ogilvie et al., 2009) and the men who have sex with men (MSM) population (Cohen et al., 2011; Phipps et al., 2009). However, there have been very few, if any studies, that have focused on older adults. Older people are an increasingly important demographic when it comes to STDs, thanks to the rise of the Baby Boomer population and its accompanying biological, social, and psychological changes (Poynten et al., 2013). Studies have shown that STD rates have been increasing among older people as well (Bodley-Tickell et al., 2008; Smith et al., 2002; Xu et al., 2000), warranting increased attention to STD prevention efforts directed at this age category.

Assuming that STD transmission among older age groups are similar to younger populations, identifying the population of repeat infections among older people is crucial to STD prevention efforts. This is important as in many resource-constrained settings there may not be enough personnel to identify and follow-up on all cases of older adults with STD infections reported to the local health department, due to a need to focus on younger populations where the majority of the STD burden lies. This study sought to investigate repeat infections of early syphilis, gonorrhea, and chlamydia among older adults in Los Angeles County. Specifically, I wanted to assess trends in repeat infections over time to ascertain whether there have been increases in the STD core group among older adults. I also examined the demographic predictors of repeat infections in order to identify these higher risk older adults who may be contributing to a reservoir of disease in the population. This will inform targeted interventions towards older adults to prevent further STD transmission to others.

3.3 METHODS

Data Source

To conduct my analyses, I utilized routine surveillance data that is collected and maintained by LACDPH's Division of HIV and STD Programs (DHSP). Specifically, I identified all cases of chlamydia, gonorrhea, and early syphilis (primary, secondary, and early latent) reported to the health department between 2000 and 2011. Health care providers and laboratories are required to report STDs such as chlamydia (CT), gonorrhea (GC), and all stages of syphilis pursuant to Title 17 of the California Code of Regulations (CCR), §§ 2500, 2505. Data collection procedures have been detailed previously (see Chapter 2).

Study Variables

An individual was defined as having a "repeat infection" if there was a second morbidity date at least 30 days following the first morbidity date for gonorrhea and chlamydia, provided there was documented, appropriate treatment. If there was no documented, appropriate treatment, then a repeat infection was defined as two morbidity dates at least 90 days apart. For syphilis, an individual had a repeat infection if the second morbidity date was at least 365 days after the first morbidity date for primary, secondary, and early latent syphilis cases. If two morbidity dates were at least 180 days apart for primary and secondary syphilis cases and there was documented, appropriate treatment at the first morbidity date, then the case was also considered a repeat. For cases with more than one repeat infection, each subsequent infection can only be considered a repeat case if the prior infection was a repeat infection. For example, if the second infection had an unknown status as to whether it was a repeat infection or not, then the third infection could not be a repeat infection despite meeting the definition of repeat infection. Time to repeat infection was calculated as the time from the first morbidity date to the second morbidity date of a single individual. A "co-infection" was defined as having at least two or more diseases during the same infection report.

Trend Analyses of Repeat Cases Over Time

The first set of data analyses assessed changes over time in the rate of repeat infections per 100,000 population. To better reflect year-to-year public health burden of repeat infections, I generated cohorts for every single year of the dataset. For early syphilis, I ascertained the number within each annual cohort that had a second infection within two years. For an individual that had multiple repeat infections, each subsequent infection was included in each cohort for which the new infection occurred within the subsequent two-year period. Years 2010 and 2011 were excluded in the trend analysis because there will be insufficient time to determine whether a repeat infection occurred or not (due to lack of data after 2011). For gonorrhea and chlamydia, I calculated the number within each cohort that had a repeat infection within a year. I excluded year 2011 due to lack of data for the year after to determine whether the case had a second infection within a year. I calculated the number of reported repeat STD infections per 100,000 persons (rate) using the following formula:

$$R_i = \frac{\text{number of reported repeat cases}_i}{\text{population estimate}_i} \times 100{,}000$$

where *i* denotes the stratum-specific value for each combination of year and age category: younger (15 to 29), middle-aged (30 to 49), and older (50 and older). The population estimates were obtained from unpublished data prepared by the Internal Services Department, County of Los Angeles.

After calculating the repeat infection rate, I obtained rate ratios comparing the repeat infection rate of younger to older cases and younger to middle-aged cases. The formulas I used were:

$$RR_i = \frac{\mathrm{R}_{i,\text{younger}}}{\mathrm{R}_{i,\text{older}}} \text{ and } RR_i = \frac{\mathrm{R}_{i,\text{younger}}}{\mathrm{R}_{i,\text{middle-age}}}$$

In cases where the rate was zero among older or middle-aged cases, the rate ratio was undefined. These were excluded from subsequent analyses.

I conducted trend analyses on the rate and rate ratio of reported repeat STD infections over time by fitting a Poisson regression model to the aggregate data. Specifically, I regressed the outcome of interest (i.e. rate of repeat infection cases and rate ratio of repeat infection cases) on the year of infection report. The following Poisson regression model was used for rate of repeat infections:

$$\ln\left[\frac{\lambda}{t}\right] = \beta_0 + \beta_1 \cdot \text{year}$$

Where λ denotes the expected number of repeat STD infections and *t* denotes the population estimate for the relevant year. For trend analysis of rate ratios, I used the following Poisson model:

$$\ln\left[\frac{\lambda}{t}\right] = \beta_0 + \beta_1 \cdot \text{year} + \beta_2 \cdot \text{agegrp} + \beta_3 \cdot \text{year} \cdot \text{agegrp}$$

Where agegrp is the age category (younger, middle-aged, and older).

To test for statistically significant changes in the rate of repeat infections over time, I utilized the annual percent change which is defined as:

$$\frac{m_{j+1} - m_j}{m_j} = \exp(\beta) - 1$$

Where m_{j+1} is the expected infection rate for year j+1 and m_j is the expected rate for year j. Because β is equivalent to the coefficient of the year covariate in the Poisson regression model, I calculated the annual percent change and associated 95% confidence limits. For rate ratios, I tested the statistical significance of the coefficient for the interaction between year and age category. If the coefficient is statistically significant ($P < 0.05$) then I rejected the null hypothesis that the trend over time in the rate of repeat STD infections does not differ between age categories.

Predictors of Repeat STD Cases

The second set of analyses examined predictors of repeat infection. To do so, I set my outcome as time between infections (days) for individuals within my data period. The cohort at baseline was all individuals with at least one infection of STD diagnosis. If an individual had a second infection prior to December 31, 2011, then he was considered to be a repeat infection case. Due to my definitions for repeat infection, gonorrhea or chlamydia cases whose first morbidity date was 30 days or less prior to December 31, 2011 and had documented, appropriate treatment were excluded from the cohort because they had insufficient time to have a new infection. If no documented, appropriate treatment was available then cases whose first morbidity date was 90 days or less prior to December 31, 2011 were excluded. For primary and secondary syphilis, cases 180 days or less prior to December 31, 2011 were excluded if there was documented, appropriate treatment and 365 days or less prior if there was not. Early latent syphilis cases 365 days or less prior to December 31, 2011 were also excluded.

I then conducted a survival analysis using Cox proportional hazards regression to model the risk of being a repeat case versus a non-repeat case. The hazard model is defined as:

$$h(t, X) \ = \ h_0(t) exp(\beta_1 X_1 + \beta_2 X_2 + \cdot\cdot\cdot + \beta_P X_P)$$

Where $h_0(t)$ is the baseline hazard function that is dependent on t or time. On the other hand, $X_1 \ldots X_P$ are covariates that do not depend on time. The "hazard" is defined as the rate at which individuals will have a repeat infection at time t, given that they have "survived" up to that time t without having a repeat infection. The hazard ratio is then defined as the following:

$$HR = \frac{h(t,1)}{h(t,0)}$$

Where $h(t,1)$ denotes the hazard rate of being a repeat infection at time t for the index group of a covariate and $h(t,0)$ denotes the hazard rate of being a repeat infection at time t for the reference group.

I obtained adjusted hazard ratios from the simultaneous entry of covariates of interest into the regression model. I excluded individuals whose repeat infection status was unknown. For syphilis cases, I included sexual orientation and not gender in the model because sexual orientation was defined as the gender of the case and the gender of the sex partners in the last twelve months. Age at event time was used in the analyses to assess the demographic risk factors at repeat infection.

Separate models were fitted for cases who were 50 and older, those who were 15 to 29, and those who were 30 to 49 in order to identify risk factors for repeat infection for each group separately. Then, I made a comparison of the three age groups directly to see if there were any differences in risk of repeat infection. I checked the assumption that the hazard of repeat case-infection for subgroups within a covariate will be proportional to each other over time using graphical methods.

To account for multiple recurrences of the outcome (repeat infection), I used a generalization of the Cox regression called the Andersen and Gill (AG) counting process model (Andersen et al., 1982). The AG model is indicated because the risk of repeat STD infections remains constant regardless of the number of previous STD infections and there are time-varying covariates (Amorim et al., 2015). Due to sparse data, I excluded transgender cases and collapsed the Asian, Native Hawaiian/Pacific Islander, Native American/Alaskan Native, and Multiple race cases into a single category in the multivariate models for each separate age category. This was done for the early syphilis cases. For gonorrhea and chlamydia cases, I collapsed the Native Hawaiian/Pacific Islander, Native American/Alaskan Native, and Multiple race cases into a single "Other" category. For syphilis cases, I also excluded women who have sex with women only and women who have sex with women and men from the age category-specific models. The reason I do not collapse across categories is due to known differences in risk of STD infection for these demographic groups (CDC, 2016; Workowski et al., 2015). In all multivariate models, the issue of missing covariate information was handled by using the fully conditional specification multiple imputation method that is more appropriate when there is a need to impute categorical variables (Liu et al., 2015). For this study, the imputed and non-imputed results were comparable, so the non-imputed findings are reported here. All data analyses were performed using SAS Enterprise Guide 6.1 (SAS Institute, Cary, NC).

3.4 RESULTS

Median Time to Repeat Infection

The median times to repeat infection did not differ between age groups for early syphilis (Table 3-1). Overall, the median time to repeat infection was 808 days (IQR = 521 to 1,310 days) for all age groups and 839 days (IQR = 576 – 1,386 days) for older cases. The median time to repeat infection was 448 days (IQR = 192 – 953 days) for gonorrhea cases of all age groups and 474 days (IQR = 210 – 881 days) for older cases. The median time to repeat infection was 416 days (IQR = 190 – 883 days) for chlamydia cases of all age groups and 321 days (IQR = 144 – 750 days) for older cases.

Trends in Repeat Cases Over Time

The incidence per 100,000 of reported repeat early syphilis infections increased over time for all three age categories (Figure 3-1). The overall rate of repeat early syphilis was 0.6 per 100,000 among younger cases and increased 34.46% (95% CI, 25.68% to 43.85%), 1.1 per 100,000 among middle-aged cases and increased 34.83% (95% CI, 4.23% to 74.40%), and 0.2 per 100,000 among older cases and increased 26.48% (95% CI, 11.81% to 43.08%). The rate ratios comparing younger to older cases and younger to middle-aged cases are depicted in Figure 3-2. The changes over time in rate ratios were not statistically significant for younger to older cases (P = 0.39) or younger to middle-aged cases (P = 0.49).

The incidence per 100,000 of repeat gonorrhea increased over time for younger cases (7.78%; 95% CI, 4.28% to 11.40%) but has remained relatively stable for middle-aged cases

(3.92%; 95% CI, -0.20% to 8.22%) and older cases (3.64%; 95% CI, -1.83% to 9.43%) (Figure 3-3). The rate ratios comparing younger to older cases has fluctuated over time resulting in no statistically significant changes ($P = 0.26$) while remaining relatively stable for younger compared to middle-aged cases ($P = 0.17$) (Figure 3-4).

Figure 3-5 depicts the changes in rate per 100,000 of repeat chlamydia infections over time. There was an 8.00% (95% CI, 6.75% to 9.27%) increase in the rate of repeat chlamydia cases for the younger age category, an 8.81% (95% CI, 6.64% to 11.02%) increase for the middle-age category, and a 16.71% (95% CI, 10.33% to 23.47%) increase for the older age category. The rate ratios comparing younger to older cases decreased from 344.1 to 92.4 ($P = 0.001$) while remaining relatively stable for younger to middle-age cases ($P = 0.50$) (Figure 3-6).

Predictors of Repeat Cases

The total number of cases with repeat early syphilis infections was 1,237, and the maximum number of infections was 5 (Table 3-2). For older cases, 87% had 2 infections of early syphilis and 13% had 3 infections. The total number of cases with repeat gonorrhea infections was 12,938, with a maximum of 14 infections per individual (Table 3-3). Among older cases, the maximum number of infections was 6 although 98% had 3 infections or less. A total of 65,542 chlamydia cases had repeat infections, and the maximum number of infections was 16 (Table 3-4). The maximum number of chlamydia infections among older cases was 6 and 98% had 4 infections or less.

The hazard of repeat infection was not statistically different by age category among early syphilis cases for both middle-aged cases (adjusted hazard ratio [aHR]: 1.10; 95% CI, 0.96 to 1.27) and older cases (aHR: 1.04; 95% CI, 0.82 to 1.33) (Table 3-5). The hazard of repeat gonorrhea infection among middle-aged cases was 0.78 times (95% CI, 0.75 to 0.82) that among younger age cases. Among older cases, the hazard of repeat infection was 0.61 times (95% CI, 0.54 to 0.70) that among younger cases. For chlamydia, the hazard of repeat infection among middle-aged cases was 0.56 times that among younger cases (95% CI, 0.54 to 0.58) while the hazard among older cases was 0.46 times that among younger cases (95% CI, 0.41 to 0.53).

Among older early syphilis cases, the hazard of repeat infection was lower among those 60 and over (aHR: 0.42; 95% CI, 0.19 to 0.90) compared to those ages 50 to 59, and higher among men who have sex with men only (MSM) and men who have sex with both men and women (MSM/W) compared to those who were heterosexual (aHR: 8.64; 95% CI, 3.43 to 21.80) (Table 3-6). The hazard of repeat infection was also higher for those who had a co-infection with another STD (aHR: 3.17; 95% CI, 1.13 to 8.88). The hazard of repeat infection was higher among younger early syphilis cases who were MSM and MSM/W compared to those who were heterosexual (aHR: 5.84; 95% CI, 3.76 to 9.06) and lower among those who lived in West SPA compared to those who lived in Metro SPA (aHR: 0.34; 95% CI, 0.16 to 0.75). For middle-aged cases, the hazard of repeat infection was higher among those who were MSM and MSM/W compared to those who were heterosexual (aHR: 6.92; 95% CI, 4.60 to 10.41) and those who had a co-infection with another STD (aHR: 1.36; 95% CI, 0.99 to 1.88). The hazard of repeat infection was lower among those who lived in West (aHR: 0.61; 95% CI, 0.43 to 0.87) and East SPAs (aHR: 0.61; 95% CI, 0.43 to 0.87) compared to those who lived in Metro SPA in this age group.

The hazard of repeat gonorrhea infection was lower among those 60 and over compared to those 50 to 59 years of age (aHR: 0.49; 95% CI, 0.32 to 0.75) (Table 3-7). For gender, it was higher among older males compared to females (aHR: 2.26; 95% CI, 1.35 to 3.77). The hazard was lower among Blacks (aHR: 0.64; 95% CI, 0.47 to 0.87), Asians (aHR: 0.13; 95% CI, 0.03 to

0.53), and Hispanics (aHR: 0.37; 95% CI, 0.23 to 0.61). The hazard of repeat infection was also higher among older cases with co-infections (aHR: 1.59; 95% CI, 1.20 to 2.10). Among younger cases, the hazard of repeat infection was higher among males compared to females (aHR: 1.75; 95% CI, 1.67 to 1.83), Black/African-Americans versus Whites (aHR: 1.17; 95% CI, 1.08 to 1.26), those living in Metro SPA versus those in the South SPA (aHR: 1.13; 95% CI, 1.06 to 1.21), and those with a co-infection (aHR: 1.08; 95% CI, 1.04 to 1.13). Among middle-aged cases, the hazard of repeat infection was higher among males (aHR: 4.39; 95% CI, 3.83 to 5.03), those living in the Metro SPA (aHR: 1.39; 95% CI, 1.24 to 1.55), and those with a co-infection (aHR: 1.16; 95% CI, 1.08 to 1.25). Similar to older cases, Blacks (aHR: 0.84; 95% CI, 0.76 to 0.93), Asians (aHR: 0.46; 95% CI, 0.33 to 0.64), and Hispanics (aHR: 0.76; 95% CI, 0.68 to 0.85) all had lower hazards compared to Whites.

Among older chlamydia cases, the hazard of repeat infection was higher among men compared to women (aHR: 1.83; 95% CI, 1.43 to 2.33), among those who lived in the Metro versus South SPA (aHR: 1.49; 95% CI, 1.07 to 2.09), and among those with a co-infection (aHR: 1.41; 95% CI, 1.08 to 1.85) (Table 3-8). Asians (aHR: 0.54; 95% CI, 0.35 to 0.83) and Hispanics (aHR: 0.69; 95% CI, 0.52 to 0.91) had lower hazards of repeat infection compared to Whites. Among younger cases, the hazard of repeat infection was lower among males compared to females (aHR: 0.58; 95% CI, 0.57 to 0.59), Asians (aHR: 0.92; 95% CI, 0.86 to 0.98), and all of the SPAs compared to South SPA. All of the other race/ethnicities and those with co-infections had higher hazards of repeat infection. For middle-aged cases, the hazard of repeat infection was higher among men (aHR: 1.31; 95% CI, 1.24 to 1.38), residents of the Metro SPA (aHR: 1.15; 95% CI, 1.06 to 1.25), and those with co-infections (aHR: 1.45; 95% CI, 1.34 to

1.56). Similar to the older cases, the hazard of repeat infection was lower among Asians (aHR: 0.62; 95% CI, 0.53 to 0.71) and Hispanics (aHR: 0.79; 95% CI, 0.73 to 0.86).

3.5 DISCUSSION

This is, to the best of my knowledge, the first study to examine in detail trends over time and predictors of repeat STDs among older people and compare with younger populations. I found that in general, the rate of reported repeat infections increased among all age categories from 2000 to 2011 for early syphilis and chlamydia. However, for gonorrhea only the younger age category had statistically significant increases in the rate of repeat infections. These trends mirror those of the overall rate of reported infections (see Chapter 2), a pattern that was also found in another study that assessed temporal trends in the population rate of repeat gonorrhea (Gunn et al., 2004). Repeat STD cases have been suggested as being part of an STD transmission "core" group (Thomas et al., 1996), and increasing trends over time indicate that this core group is growing. The fact that those trends were also observed for older cases reinforce the increasing high risk of STD infection among older people. This increasing risk does not fall behind that of younger populations as well, as the rate ratios indicate lack of statistically significant changes over time, except for chlamydia where the repeat infection risks among older cases actually increased faster than among younger cases.

Older people with a first infection and have repeat infections of STDs also have similar numbers of infections when compared to younger populations. For syphilis, 99% of older cases with a first infection at baseline had three reported infections or less, compared to 97% for middle-aged cases and 98% for younger cases. Similarly, 99% of older gonorrhea cases had five reported infections or less, compared to 98% for middle-aged cases and 98% for younger cases. For chlamydia, 99% of the older repeat cases had five reported infections or less, which was the same percentage for younger age categories as well. It is not uncommon for an individual with a repeat infection of STD to have multiple infections (De et al., 2007; Mehta et al., 2003; Ogilvie et al., 2009), and are thus an important group to target for public health interventions. They contribute to the persistence of disease in the population given that reinfection is a marker of high-risk sexual behavior (Ellen et al., 1997; Gunn et al., 2000).

It is unsurprising that the risk of repeat infection decreases as age increases, as evidenced by the lower hazards for middle-aged and older age categories. For early syphilis, however, the risk of repeat infections did not statistically differ between age categories. This suggests that early syphilis is not primarily being transmitted among younger populations only and that older adults are also at high risk for infection. One explanation for this finding may be that there is a growing number of HIV-infected individuals who are 50 and over (Levy-Dweck, 2005) and that syphilis is frequently found as a co-infection with HIV in men who have sex with men (MSM) populations (Phipps et al., 2009). In other words, these older early syphilis cases may be those who are MSM and are co-infected with HIV.

Demographic Characteristics of Repeat Infection Cases

Older repeat early syphilis cases, for the most part, were MSM and MSM/W and had a reported co-infection with another STD. No other demographic characteristics (race/ethnicity, marital status, and geographic area of residence) had subgroups where the risk of repeat infection was statistically significantly different from the null. It is unsurprising that MSM had much higher risk of repeat infection as it is well documented to be a high-risk group for STD transmission in general (CDC, 2016; Cohen et al., 2011; Ogilvie et al., 2009; Phipps et al., 2009) and has been a major contributor to the resurgence of syphilis since the early 2000s (CDC, 2004). The study findings demonstrate that sexual orientation is still a significant risk factor among older age groups and is useful as a marker for targeted interventions. This is very important because MSM are also known to be at increased risk of human immunodeficiency virus (HIV) infection (CDC 2004; Cohen et al., 2011) as well, and reducing STD transmission in this population may also prevent increases in HIV infection.

Those who were 60 and over had a lower risk of repeat infection compared to the 50 to 59 age group, which is expected due to lower levels of sexual activity (Lindau et al., 2007; Schick et al., 2010). The lack of statistically significant findings for race/ethnicity was contrary to findings by other studies (Brewer et al., 2011; Ogilvie et al., 2009). However, comparisons to other studies are difficult due to different study populations (e.g. focusing on early vs. all stages syphilis; Brewer et al., 2011), different definitions of repeat syphilis infection, and consideration of multiple repeat infections versus just a single repeat infection.

Older gonorrhea cases were more likely to have repeat infections if they were male, and had a reported co-infection with another STD. On the other hand, Blacks, Hispanics, and Asians all had lower risk of repeat infections, which is different than from younger cases who are 15 to 29 years of age. In the younger cases, Blacks were more likely to have repeat infections compared to Whites. The findings among older cases may be a result of reporting bias, where racial/ethnic minority groups with repeat infections are less likely to be seen by a clinician and will not be reported. This may be due to a combination of racial/ethnic disparities in health care utilization among older adults (Dunlop et al., 2002) and stigma as a barrier to sexual health seeking behavior (Gott et al., 2003).

Given that women are disproportionately affected by chlamydia infection in the US (CDC, 2016), it is notable that among older cases the risk of repeat infection is actually higher among men. This is different from younger cases and may reflect a shift in high-risk groups with increasing age. In another study that examined infection of recurrent diagnoses of chlamydial infections among soldiers of the US army, there was a decreasing gender disparity with increasing age group as well (Barnett et al., 2001). The shift is also noted with other demographic characteristics as the risk of repeat infection is no longer higher among Black, Hispanic, and Other race/ethnicity cases as in the younger age category. In addition, older chlamydia cases who lived in the Metro SPA were more likely to have repeat infections compared to the South SPA. This suggests that the MSM population may be contributing to the high risks of repeat infection among older cases due to a high concentration of this demographic in this geographic region (Beymer et al., 2014). Similar to gonorrhea cases, older chlamydia cases with documented co-infections were also more likely to have repeat infections. Most of these cases were co-infected with gonorrhea and thus supports CDC recommendations for concurrent treatment gonorrhea and chlamydia even among older cases (Workowski et al., 2015).

Limitations

Several limitations may affect interpretation of findings of this study. Underreporting is a major issue when it comes to STD surveillance, with varying proportions for different diseases. Given that underreporting may be greater among older adults, the incidence of repeat STD infections may be underestimated. There is also uncertainty in presentation of infection incidence and incidence ratios of repeat STD infections due to uncertainty in population estimates especially during intercensal years. Population estimates during intercensal years are progressively more uncertain the further away from censal years (i.e., 2000 and 2010). The uncertainty will also vary by covariates of interest (i.e. demographics). This will result in an under- or over-estimation of the infection risk depending on whether the actual population for a given year is higher or lower than the estimate. The reliability of reported risks is also questionable when the number of cases used to calculate risks are small, which is the norm for repeat infections. Therefore, it is difficult to draw definitive conclusions from the results of analyses on trends in STD repeat infections over time.

Due to the nature of the data source, very few covariates were usable in multivariate regression analyses of repeat STD infections. This meant that uncontrolled confounding would be present, as other potential predictors such as behavioral factors (e.g. condom use, injection drug use, number of sex partners) also influence the likelihood of having repeat STD infections (Mehta et al., 2003; Ogilvie et al., 2009). For gonorrhea and chlamydia, this problem is exacerbated by poor quality of data on marital status and sexual orientation in addition to the aforementioned behavioral variables. The best inferences can only be made from a combination of gender and geographic distribution due to correlations between those two variables and sexual orientation (Beymer et al., 2014).

Due to the specific definition of repeat infection applied, there may be difficulties in comparing the study to other studies of similar nature. In addition, there may be a misclassification bias present—a repeat infection may or may not reflect an actual new infection. However, due to the relatively conservative definition of repeat infection, the biases are more likely to result in an underestimation of the risk of re-infection. An additional concern is that the definition of repeat infection depends on the availability of treatment information and the duration between two infections. If treatment information was not available and insufficient time had passed between two infections, then a subsequent infection was classified as "unknown" as to its status of repeat infection or not. Because these cases where repeat infection status is unknown cannot be included in multiple imputation models (Allison, 2010), they were excluded from the analyses and thus becomes of a source of missing data bias. However, in this study the "unknown" proportion was relatively small (<10%) and thus were expected to minimally bias the results.

Public Health Impact

In spite of these limitations, this is still an important study because it helps identify an STD "core" transmission group among older adults. For early syphilis, this group tends to be MSM and MSM/W and are co-infected with another STD. This was very similar to younger populations and justify the efforts of organizations such as the Los Angeles Gay and Lesbian Center (LAGLC) and its Community-Embedded Disease Investigation Specialist (CEDIS) partner notification program (Rudy et al., 2012) in targeting such high-risk groups. Because of the CEDIS's relative success in bringing in contacts of index cases for diagnosis and treatment, an additional effort in ensuring that older adults who may be potential contacts are brought in and thoroughly interviewed will result in reaching a large proportion of the core transmission group. For private providers, older adults who self-identify as MSM or MSM/W should prompt a brief sexual history taking using an approach such as that proposed by Andrews (Andrews, 2000). Because targeted interventions will not differ much between older and younger populations, any additional strategies implemented to reach the high-risk older adults would not require much additional resources.

For gonorrhea and chlamydia, older men appear to be at greater risk for repeat infection as opposed to women, and should be educated about their risks for acquiring the infection again. They should also be educated on practices that will prevent a repeat STD infection. However, because women are less likely to have symptoms of the two diseases than men, this may signal a greater need to screen older women as opposed to target prevention efforts at men. To do so efficiently, one strategy would be to inquire men who are at high-risk of repeat gonorrhea or chlamydia infection about their older female sex contacts, if applicable, and bring them in for diagnosis and treatment. For older adults, Black race/ethnicity appears to be less of a factor when it comes to repeat infections compared to younger populations, so there may not be a need to focus additional resources on this demographic. However, as mentioned previously the differential access to care among older adults of different racial/ethnic groups is a concern and needs to be taken into consideration. Older adults of minority groups should be directed to the appropriate resources that will improve their ability to see a clinician and get tested for STDs if they are identified as high-risk through other demographic and behavioral attributes.

Regardless of the STD and age, co-infection status is always an indicator of high-risk and may also be part of the “core” group that has high transmission potential (van Veen et al., 2010). This means two things: 1) Older individuals presenting for a repeat infection should always be screened for other potential STDs and 2) Older individuals testing positive for multiple STDs at the same time should be assessed regarding their sexual history, including the identification of sexual partners.

In conclusion, older adults are not only at risk for STDs; they may also be a part of an STD core group that continues to perpetuate transmission in the general population. Certain demographic risk factors such as being an MSM or MSM/W should be markers for active investigation and follow-up to ensure that these individuals are properly treated and educated to prevent further transmission of STDs to others.

TABLES AND FIGURES

Table 3-1 Median time to repeat infection (days) by age group, Los Angeles County, 2000-2011

	Age Group at Repeat Infection							
	All Age Groups		15 to 29		30 to 49		50 and over	
Disease	Median (days)	IQR	Median (days)	IQR	Median (days)	IQR	Median (days)	IQR
Early syphilis	808	521 – 1,310	771	515 – 1,263	810	514 – 1,323	839	576 – 1,386
Gonorrhea	448	192 – 953	435	189 – 934	470	197 – 992	474	210 – 881
Chlamydia	416	190 – 883	417	191 – 882	404	181 – 881.5	321	144 – 750

IQR = Interquartile range

Figure 3-1 Rate of reported repeat early syphilis cases per 100,000 by age category, Los Angeles County, 2000-2011

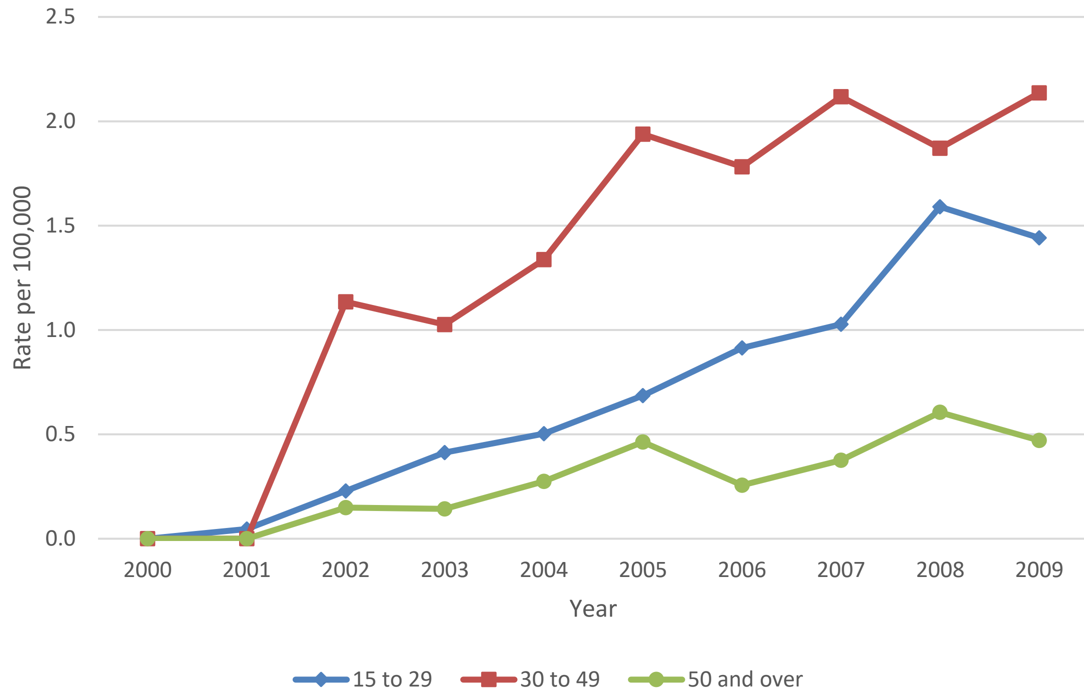
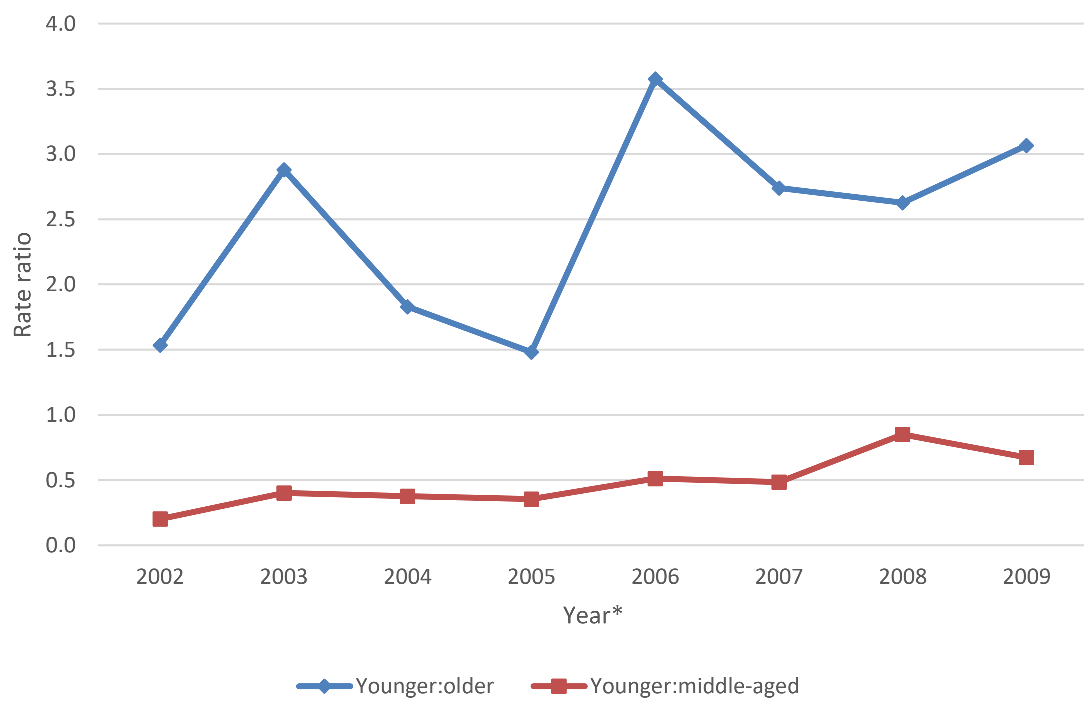


Figure 3-2 Rate ratios of repeat early syphilis cases between age categories, Los Angeles County, 2000-2011



*Rate ratio for years 2000 and 2001 was undefined

Figure 3-3 Rate of reported repeat gonorrhea cases per 100,000 by age category, Los Angeles County, 2000-2011

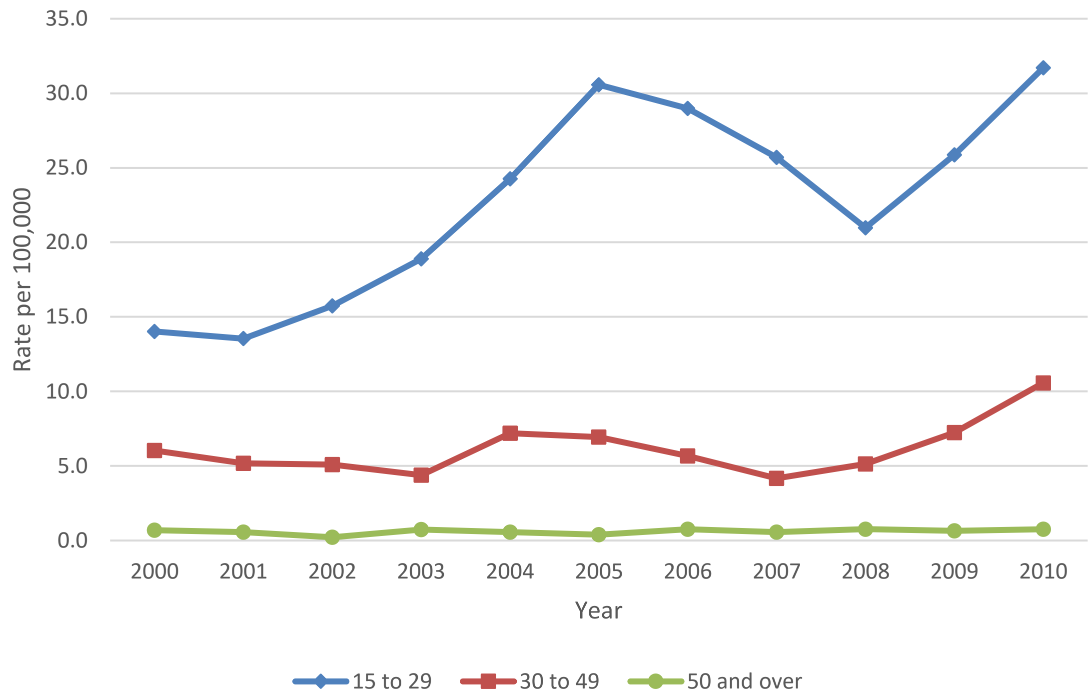


Figure 3-4 Rate ratios of repeat gonorrhea cases between age categories, Los Angeles County, 2000-2011

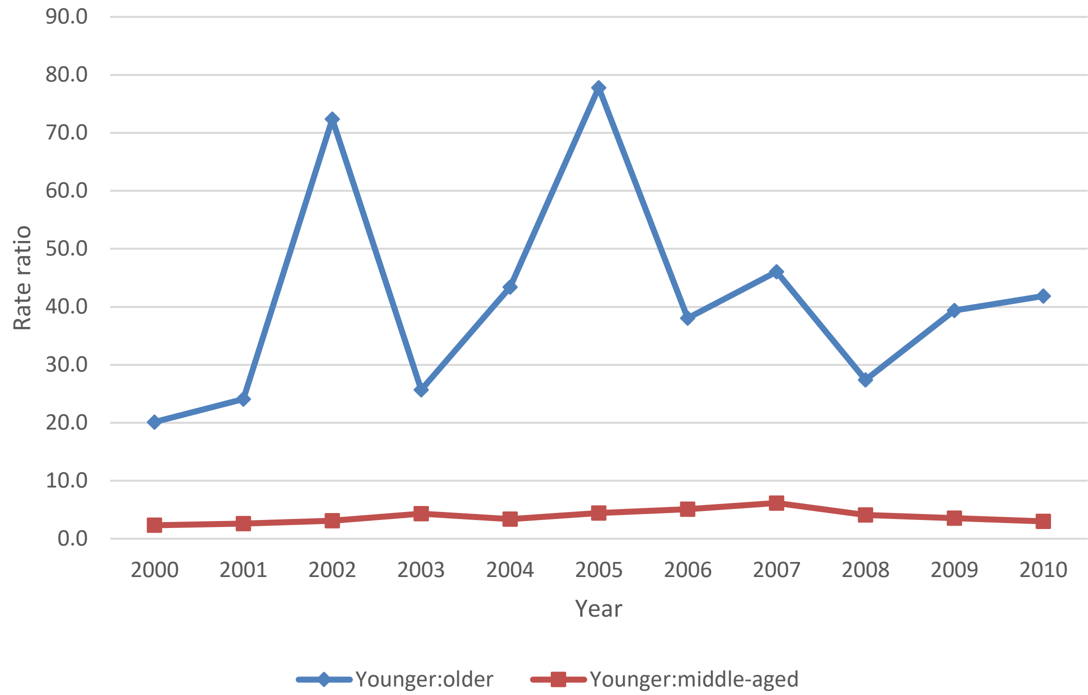


Figure 3-5 Rate of reported repeat chlamydia cases per 100,000 by age category, Los Angeles County, 2000-2011

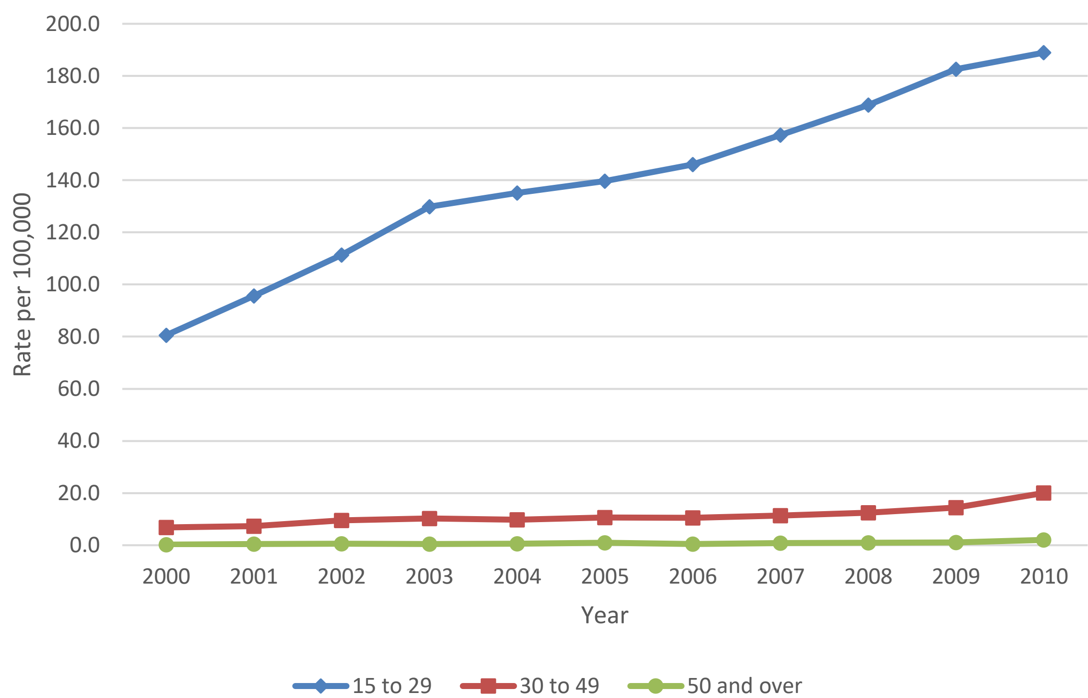


Figure 3-6 Rate ratios of repeat chlamydia cases between age categories, Los Angeles County, 2000-2011

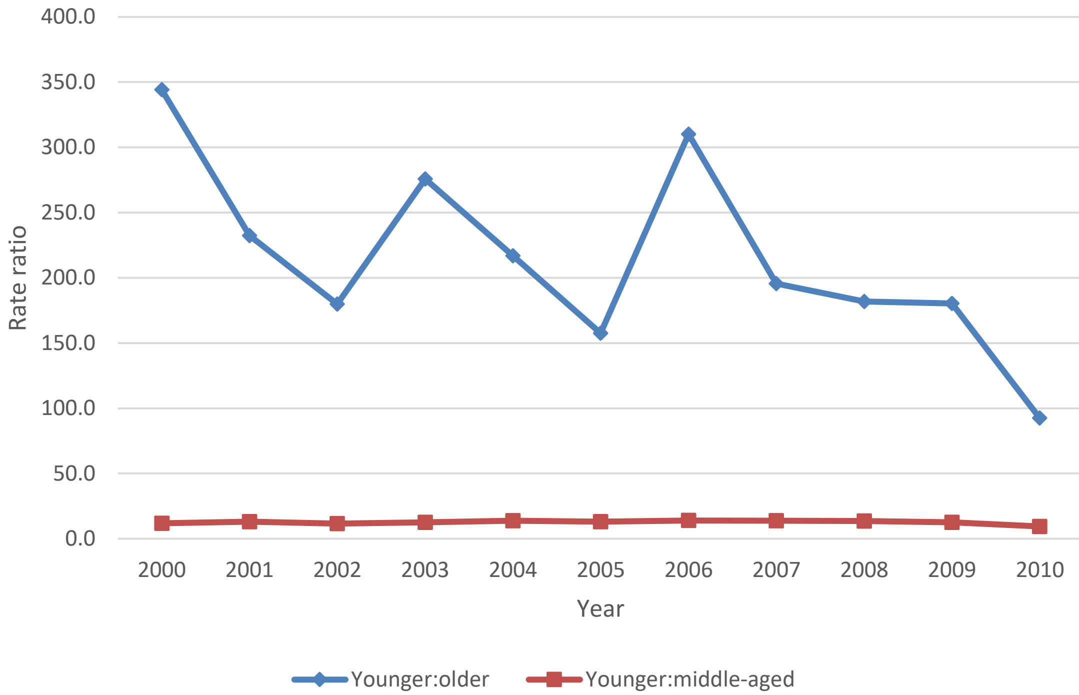


Table 3-2 Number of repeat early syphilis infections by age group, Los Angeles County, 2000-2011

	Age Group at Baseline															
	All Age Groups				15 to 29				30 to 49				50 and over			
Number of incidences	n	%	Cumulative	%	n	%	Cumulative	%	n	%	Cumulative	%	n	%	Cumulative	%
Total	1,237	100	1,237	100	328	100	328	100	813	100	813	100	96	100	96	100
2	1,009	82	1,009	82	273	83	273	83	653	80	653	80	83	87	83	87
3	195	16	1,204	97	47	14	320	98	136	17	789	97	12	13	95	99
4	30	2	1,234	99	8	2	328	100	21	3	810	100	1	1	96	100
5	3	<1	1,237	100	0	0	328	100	3	<1	813	100	0	0	96	100

Table 3-3 Number of repeat gonorrhea infections by age group, Los Angeles County, 2000-2011

	Age Group at Baseline															
	All Age Groups				15 to 29				30 to 49				50 and over			
Number of incidences	n	%	Cumulative	%	n	%	Cumulative	%	n	%	Cumulative	%	n	%	Cumulative	%
Total	12,938	100	12,938	100	9,265	100	9,265	100	3,175	100	3,175	100	231	100	231	100
2	9,236	71	9,236	71	6,681	72	6,681	72	2,215	70	2,215	70	177	77	177	77
3	2,366	18	11,602	90	1,694	18	8,375	90	570	18	2,785	87	36	15	213	92
4	832	6	12,434	96	557	6	8,932	96	233	7	3,018	95	14	6	227	98
5	257	2	12,691	98	165	2	9,097	98	84	3	3,102	98	3	1	230	99
6	126	1	12,817	99	84	1	9,181	99	39	1	3,141	99	1	<1	231	100
7	61	<1	12,878	100	43	<1	9,224	100	17	1	3,158	99	0	0	231	100
8	27	<1	12,905	100	22	<1	9,246	100	5	<1	3,163	100	0	0	231	100
9	12	<1	12,917	100	9	<1	9,255	100	2	<1	3,165	100	0	0	231	100
10	10	<1	12,927	100	3	<1	9,258	100	7	<1	3,172	100	0	0	231	100
11	6	<1	12,933	100	5	<1	9,263	100	1	<1	3,173	100	0	0	231	100
12	2	<1	12,935	100	0	0	9,263	100	2	<1	3,175	100	0	0	231	100
13	1	<1	12,936	100	1	<1	9,264	100	0	0	3,175	100	0	0	231	100
14	2	<1	12,938	100	1	<1	9,265	100	0	0	3,175	100	0	0	231	100

Table 3-4 Number of repeat chlamydia infections by age group, Los Angeles County, 2000-2011

	Age Group at Baseline															
	All Age Groups				15 to 29				30 to 49				50 and over			
Number of incidences	n	%	Cumulative	%	n	%	Cumulative	%	n	%	Cumulative	%	n	%	Cumulative	%
Total	65,542	100	65,542	100	57,006	100	57,006	100	6,482	100	6,482	100	329	100	329	100
2	47,902	73	47,902	73	41,408	73	41,408	73	5,316	82	5,316	82	268	81	268	81
3	12,040	18	59,942	91	10,720	19	52,128	91	823	13	6,139	95	50	15	318	96
4	3,663	6	63,605	97	3,230	6	55,358	97	229	4	6,368	98	6	2	324	98
5	1,227	2	64,832	99	1,065	2	56,423	99	67	1	6,435	99	4	1	328	99
6	401	1	65,233	100	337	1	56,760	100	21	<1	6,456	100	1	<1	329	100
7	205	<1	65,438	100	175	<1	56,935	100	11	<1	6,467	100	0	0	329	100
8	60	<1	65,498	100	39	<1	56,974	100	9	<1	6,476	100	0	0	329	100
9	22	<1	65,520	100	14	<1	56,988	100	5	<1	6,481	100	0	0	329	100
10	8	<1	65,528	100	7	<1	56,995	100	1	<1	6,482	100	0	0	329	100
11	7	<1	65,535	100	7	<1	57,002	100	0	0	6,482	100	0	0	329	100
12	4	<1	65,539	100	2	<1	57,004	100	0	0	6,482	100	0	0	329	100
13	1	<1	65,540	100	1	<1	57,005	100	0	0	6,482	100	0	0	329	100
14	1	<1	65,541	100	1	<1	57,006	100	0	0	6,482	100	0	0	329	100
15	0	0	65,541	100	0	0	57,006	100	0	0	6,482	100	0	0	329	100
16	1	<1	65,542	100	0	0	57,006	100	0	0	6,482	100	0	0	329	100

Table 3-5 Comparison of the risk of repeat early syphilis, gonorrhea, and chlamydia cases by age category, Los Angeles County, 2000-2011

	Early Syphilis		Gonorrhea		Chlamydia	
Characteristic	aHR[1]	95% CI	aHR[1]	95% CI	aHR[1]	95% CI
Age Group						
15 to 29 (ref.)	----	----	----	----	----	----
30 to 49	1.10	0.96, 1.27	0.78	0.75, 0.82	0.56	0.54, 0.58
50 and over	1.04	0.82, 1.31	0.61	0.54, 0.70	0.46	0.41, 0.53

[1]Obtained using the Andersen and Gill counting process model with simultaneous entry of the following covariates: age category, gender (gonorrhea and chlamydia), race/ethnicity, marital status (early syphilis only), sexual orientation (early syphilis only), service planning area, and co-infection status

aHR = adjusted hazard ratio; CI = confidence interval

Table 3-6 Predictors of reported repeat early syphilis cases by age category, Los Angeles County, 2000-2011

	15 to 29		30 to 49		50 and over	
Characteristic	aHR[1]	95% CI	aHR[1]	95% CI	aHR[1]	95% CI
Age Group						
50 – 59 (ref.)	----	----	----	----	----	----
60 and over	----	----	----	----	0.42	0.19, 0.90
Race/Ethnicity						
White (ref.)	----	----	----	----	----	----
Black	1.19	0.80, 1.76	1.17	0.91, 1.50	1.30	0.69, 2.47
Asian and Other[2]	0.98	0.52, 1.84	1.03	0.70, 1.52	0.55	0.07, 4.65
Hispanic	1.14	0.82, 1.57	1.18	1.01, 1.39	1.21	0.75, 1.93
Marital Status						
Single	1.37	0.68, 2.77	1.21	0.85, 1.73	0.94	0.47, 1.87
Married/Domestic Partnership/ Cohabitation (ref.)	----	----	----	----	----	----
Formerly Married	1.01	0.13, 7.96	0.63	0.31, 1.28	1.31	0.45, 3.82
Sexual Orientation[3,4]						
MSM and MSM/W	5.84	3.76, 9.06	6.92	4.60, 10.41	8.64	3.43, 21.80
Heterosexual (ref.)	----	----	----	----	----	----
Service Planning Area						
Antelope Valley	0.43	0.11, 1.67	0.59	0.21, 1.66	0.88	0.15, 5.14
San Fernando	0.69	0.48, 0.99	0.84	0.69, 1.03	0.81	0.48, 1.36
San Gabriel	0.61	0.38, 0.98	0.77	0.56, 1.08	0.32	0.08, 1.24
Metro (ref.)	----	----	----	----	----	----
West	0.34	0.16, 0.75	0.61	0.43, 0.87	0.61	0.28, 1.30
South	1.00	0.71, 1.40	0.92	0.68, 1.23	1.03	0.44, 2.42
East	0.64	0.41, 1.00	0.61	0.43, 0.87	0.35	0.12, 1.02
South Bay	1.00	0.65, 1.54	0.76	0.52, 1.12	0.46	0.12, 1.82
Co-infection						
Yes	1.00	0.67, 1.50	1.36	0.99, 1.88	3.17	1.13, 8.88
No (ref.)	----	----	----	----	----	----

[1]Obtained using the Andersen and Gill counting process model with simultaneous entry of covariates listed in the table

[2]Other race includes American Indian/Alaskan Native, Native Hawaiian/Pacific Islander, and Multiple Race
[3]Determined from gender of patient and gender of reported sex partner in last 12 months
[4]MSM=Men who have sex with men and men only; MSM/W=men who have sex with both men and women; Heterosexual includes men who have sex with women and women who have sex with men
aHR = adjusted hazard ratios; CI = confidence interval

Table 3-7 Predictors of reported repeat gonorrhea cases by age category, Los Angeles County, 2000-2011

	15 to 29		30 to 49		50 and over	
Characteristic	aHR[1]	95% CI	aHR[1]	95% CI	aHR[1]	95% CI
All subjects	----	----	----	----	----	----
Age Group						
50 – 59 (ref.)	----	----	----	----	----	----
60 and over	----	----	----	----	0.49	0.32, 0.75
Gender						
Male	1.75	1.67, 1.83	4.39	3.83, 5.03	2.26	1.35, 3.77
Female (ref.)	----	----	----	----	----	----
Race/Ethnicity						
White (ref.)	----	----	----	----	----	----
Black	1.17	1.08, 1.26	0.84	0.76, 0.93	0.64	0.47, 0.87
Asian	0.70	0.58, 0.86	0.46	0.33, 0.64	0.13	0.03, 0.53
Hispanic	0.70	0.64, 0.76	0.76	0.68, 0.85	0.37	0.23, 0.61
Other[2]	1.19	0.92, 1.53	1.42	0.87, 2.32	1.21	0.30, 4.90
Service Planning Area						
Antelope Valley	0.69	0.61, 0.77	0.50	0.34, 0.72	0.53	0.13, 2.18
San Fernando	0.81	0.75, 0.89	1.03	0.88, 1.20	1.05	0.65, 1.72
San Gabriel	0.58	0.52, 0.65	0.64	0.52, 0.80	0.40	0.18, 0.86
Metro	1.13	1.06, 1.21	1.39	1.24, 1.55	1.05	0.72, 1.53
West	0.74	0.65, 0.83	0.99	0.82, 1.20	1.02	0.63, 1.67
South (ref.)	----	----	----	----	----	----
East	0.69	0.63, 0.77	0.78	0.64, 0.96	0.86	0.42, 1.76
South Bay	0.87	0.82, 0.93	0.82	0.70, 0.96	0.99	0.62, 1.58
Co-infection						
Yes	1.08	1.04, 1.13	1.16	1.08, 1.25	1.59	1.20, 2.10
No (ref.)	----	----	----	----	----	----

[1]Obtained using the Andersen and Gill counting process model with simultaneous entry of covariates listed in the table

[2]Other race includes American Indian/Alaskan Native, Native Hawaiian/Pacific Islander, and Multiple Race

aHR = adjusted hazard ratios; CI = confidence interval

Table 3-8 Predictors of reported repeat chlamydia cases by age category, Los Angeles County, 2000-2011

	15 to 29		30 to 49		50 and over	
Characteristic	aHR[1]	95% CI	aHR[1]	95% CI	aHR[1]	95% CI
All subjects	----	----	----	----	----	----
Age Group						
50 – 59 (ref.)	----	----	----	----	----	----
60 – 69	----	----	----	----	0.90	0.67, 1.22
70 and over	----	----	----	----	0.58	0.27, 1.23
Gender						
Male	0.58	0.57, 0.59	1.31	1.24, 1.38	1.83	1.43, 2.33
Female (ref.)	----	----	----	----	----	----
Race/Ethnicity						
White (ref.)	----	----	----	----	----	----
Black	2.28	2.19, 2.37	0.99	0.90, 1.08	0.88	0.66, 1.18
Asian	0.92	0.86, 0.98	0.62	0.53, 0.71	0.54	0.35, 0.83
Hispanic	1.26	1.21, 1.30	0.79	0.73, 0.86	0.69	0.52, 0.91
Other[2]	1.58	1.40, 1.79	1.35	0.98, 1.87	0.34	0.05, 2.41
Service Planning Area						
Antelope Valley	0.90	0.87, 0.94	0.61	0.49, 0.77	0.53	0.16, 1.69
San Fernando	0.81	0.78, 0.83	0.88	0.80, 0.97	1.34	0.92, 1.95
San Gabriel	0.76	0.74, 0.78	0.85	0.76, 0.95	0.97	0.60, 1.56
Metro	0.83	0.80, 0.85	1.15	1.06, 1.25	1.49	1.07, 2.09
West	0.69	0.66, 0.73	0.85	0.74, 0.98	1.34	0.85, 2.13
South (ref.)	----	----	----	----	----	----
East	0.90	0.87, 0.92	0.78	0.70, 0.87	0.96	0.59, 1.59
South Bay	0.87	0.85, 0.90	0.83	0.75, 0.92	0.82	0.52, 1.30
Co-infection						
Yes	1.36	1.32, 1.39	1.45	1.34, 1.56	1.41	1.08, 1.85
No (ref.)	----	----	----	----	----	----

[1]Obtained using the Andersen and Gill counting process model with simultaneous entry of covariates listed in the table
[2]Other race includes American Indian/Alaskan Native, Native Hawaiian/Pacific Islander, and Multiple Race
aHR = adjusted hazard ratios; CI = confidence interval

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CHAPTER 4

TRENDS OVER TIME AND PREDICTORS OF SYPHILIS, GONORRHEA, AND CHLAMYDIA TREATMENT AMONG OLDER RESIDENTS OF LOS ANGELES COUNTY, 2000-2011

4.1 ABSTRACT

Background: Treatment of individuals infected with sexually transmitted diseases (STDs) is crucial to prevention and control efforts. There are limited studies on how well local health departments carry out their responsibility to verify treatment among reported STD cases, especially among older people. As the risk of STDs are increasing among this demographic, this study was undertaken to examine whether there is a corresponding improvement in efforts to ensure treatment, identify barriers to doing so, and characterize potential consequences of failing to perform such duties as required.

Methods: I utilized routine surveillance data that captures all cases of syphilis, gonorrhea, and chlamydia reported to the Los Angeles County Department of Public Health between January 1, 2000 and December 31, 2011. Cases from Long Beach and Pasadena were excluded. Trends in the proportion with appropriate treatment documentation over time was assessed using the Cochran-Armitage test for trend. I identified predictors of undocumented or inappropriate treatment and delayed treatment using repeated measures logistic regression. The same method was used to determine the association between delayed treatment and neurosyphilis.

Results: The proportion of reported cases with documented and appropriate treatment increased over time for gonorrhea and chlamydia. Early syphilis cases had nearly 100% appropriate treatment documentation. Older gonorrhea (aOR: 1.53; 95% CI, 1.41 to 1.66) and chlamydia (aOR: 2.14; 95% CI, 2.03 to 2.25) cases were more likely to have undocumented treatment. Men and those with co-infections tended to have better treatment documentation among gonorrhea and chlamydia cases. Men who have sex with men only (MSM) and men who have sex with men and women (MSM/W) as well as those with co-infections tended to have lower odds of delayed treatment among early syphilis cases. Neurosyphilis was associated with both older age and delayed treatment.

Conclusion: While efforts to ensure appropriate treatment has improved over time, it remains a problem among older cases of gonorrhea and chlamydia. Delayed treatment is an issue for older early syphilis cases, who are also more likely to have neurosyphilis. Thus, multiple strategies are needed to address such issues especially at the local health department level.

Keywords: Older people; sexually transmitted diseases; treatment delay; demographic predictors; neurosyphilis; treatment documentation

4.2 INTRODUCTION

Incidence rates of reportable sexually transmitted diseases (STDs) such as syphilis, gonorrhea, and chlamydia have been increasing since the beginning of the twenty-first century (CDC, 2016). Numerous factors may contribute to this, including increases in screening coverage, use of more sensitive laboratory tests (e.g. broader use of nucleic acid amplification tests), more complete reporting, and high-risk core groups of individuals who maintain a disease reservoir in the community (Plummer et al., 1987). Whatever the catalyst for the observed trends, treatment of those infected with STDs is crucial to prevention and control efforts. The Centers for Disease Control and Prevention (CDC) regularly publish treatment guidelines based on latest empirical evidence available (Workowski et al., 2015). These guidelines are meant to assist providers and other personnel who encounter and manage patients infected with STDs. Treatment administration can occur when 1) patient presents with or without symptoms and tests positive for infection or 2) individual has been found to be exposed to STDs and may possibly be infected (but not confirmed) (JAMA, 1964; Steen et al., 2003).

Local health departments have a responsibility to verify appropriate treatment for patients with STDs and the elicitation, testing, and treatment of their contacts (field services) (Murphy et al., 2015). Studies on measuring how well these responsibilities are carried out are limited. There is research that focus on treatment delay to identify whether there are gaps in services needed by infected patients (Wong et al., 2005; Chen et al., 2009; Robinson et al., 2016). One finding was that time to treatment appeared to be higher for non-public STD clinic providers. This is concerning as the majority of cases are seen by non-STD clinic providers (CDC, 2016).

In Los Angeles County, the problems of either lack of information on appropriate treatment or delayed treatment may be amplified in the older population due to a variety of factors. First, due to large caseloads and resource constraints, there is a focus on younger populations where the burden of STDs is much greater—a practice recommended by the CDC (CDC, 2008). In addition, health seeking behavior and discussion with physicians are hampered by negative attitudes toward sexuality among older adults (Laumann et al., 2009). Thus, it is unknown the extent that older adults with STDs are being appropriately treated in a timely fashion. With the increasing incidence of STDs in the older population as well as risk of more severe complications of infection such as neurosyphilis (Calvet, 2003), there is a need to assess treatment information in this demographic and compare it to younger populations. It is also important to identify any demographic disparities within older adults and whether those correspond with high-risk groups in order to ascertain potential sources of ongoing transmission in the general population. This would inform public health intervention strategies that will reduce the overall burden of STDs in the population.

Thus, this study was undertaken to assess whether appropriate treatment documentation differed between older adults and younger populations with STDs, and if there has been improvement over time. In addition, it sought to identify predictors of inappropriate or undocumented treatment for gonorrhea and chlamydia, and treatment delay for syphilis. Finally, the associations between treatment delay, age, and neurosyphilis was investigated to characterize the impact of timely treatment on potential complications of syphilis among the older population.

4.3 METHODS

Data Source

To conduct my analyses, I utilized routine surveillance data that is collected and maintained by LACDPH's Division of HIV and STD Programs (DHSP). Specifically, I identified all cases of chlamydia, gonorrhea, and early syphilis (primary, secondary, and early latent) reported to the health department between 2000 and 2011. Health care providers and laboratories are required to report STDs such as chlamydia (CT), gonorrhea (GC), and all stages of syphilis pursuant to Title 17 of the California Code of Regulations (CCR), §§ 2500, 2505. Data collection procedures have been detailed previously (see Chapter 2). Data are stored in a case management system known as STD Casewatch.

Study Variables

STD Casewatch contains a text field indicating treatment regimen administered to an individual infected with a STD. These individual regimens were summarized into three indicator variables: CDC treatment, non-CDC treatment, and undocumented treatment. Undocumented treatment was the equivalent of missing treatment information for a given case-incidence. If a case-incidence had a CDC treatment regimen indicated, then documented, appropriate treatment was "Yes." To determine whether a regimen was a CDC treatment or not, the drug and dosage must be identical to the recommendations in the treatment guidelines. If the drug or dosage was different, the treatment was no longer recommended due to antibiotic resistance (frequently for gonorrhea cases), or the treatment indicated was only part of the recommended regimen, then I classified the indicated regimen as non-CDC treatment and called it inappropriate treatment. These three treatment categories were the outcomes for analysis of gonorrhea cases. Because the occurrence of inappropriate treatment was very rare for chlamydia cases, I combined it with undocumented treatment to form a single category for outcomes analysis. Other variables used in this study were age, gender, race/ethnicity, service planning area (SPA) of residence, marital status, sexual orientation, and co-infection status.

Given that greater than 95% of syphilis cases had documented and appropriate treatment, I examined prevalence of delayed treatment as the study outcome instead. This was defined as any case where the interval between specimen collection and treatment was greater than zero days for primary and secondary syphilis and greater than seven days for early latent infections (Chen et al., 2009), provided there was documented and appropriate treatment. The interval was calculated as the difference in number of days between the earliest of specimen collection dates and earliest of treatment dates, as a case-incidence may have multiple specimen collection and treatment dates. For cases where the calculated interval was either missing or greater than 365 days, delayed treatment status was "unknown". For cases where the earliest of treatment dates was 365 days or less before the earliest of specimen collection dates, I assumed that there was no treatment delay.

For syphilis, I also examined the prevalence of neurosyphilis diagnosis. A case had neurosyphilis if the diagnosis code indicating neurosyphilis was assigned, regardless of the stage of syphilis disease (e.g. primary, secondary, early latent). If the diagnosis code was not assigned, then the neurosyphilis status was "No."

Trend Analyses of Documented and Appropriate Treatment Over Time

The first set of data analyses assessed changes over time in the proportion of cases with documented and appropriate treatment. To do so, I calculated a *p*-value using the Cochran-Armitage test for trend, which is appropriate when analyzing data where the binary response in ordered categories is of interest (Salanti et al., 2003). This was done on each age category of interest: younger (15 to 29 year-olds), middle-aged (30 to 49), and older (50 and over) cases.

Multivariate Regression Analyses

The second set of analyses examined predictors of undocumented or inappropriate treatment (gonorrhea and chlamydia) and delayed treatment (early syphilis). I also assessed the association between neurosyphilis and age category as well as neurosyphilis and delayed treatment. To do so, I set my outcomes as 1) having undocumented treatment (gonorrhea), 2) having inappropriate treatment (gonorrhea), 3) having undocumented or inappropriate treatment (chlamydia), 4) having delayed treatment (early syphilis), and 5) having neurosyphilis. The cohort at baseline was all individuals with at least one incidence of STD diagnosis. To determine the odds of the outcome, I utilized the logistic regression model:

$$\ln(odds) = \alpha + \beta_1 X_1 + \beta_2 X_2 + \cdots + \beta_P X_P$$

Where ln (odds) denotes the natural logarithm of the odds. The odds is defined as:

$$\text{odds} = \frac{R}{S}$$

Where *R* is the incidence proportion and *S* is the survival proportion. It then follows that the odds ratio is:

$$\text{odds ratio} = \frac{R_1/S_1}{R_0/S_0}$$

Where R_1/S_1 is the odds among the index group and R_0/S_0 is the odds among the reference group.

I obtained adjusted odds ratios from the simultaneous entry of covariates of interest into the regression model. For syphilis cases, I included sexual orientation and not gender in the model because sexual orientation is defined as the gender of the case and the gender of the sex partners in the last twelve months.

Separate models were fitted for cases who were 50 and older, those who were 15 to 29, and those who were 30 to 49 to identify risk factors for undocumented or inappropriate treatment and delayed treatment for each group separately. Then, I made a comparison of the three age groups directly to see if there were any differences in risk of undocumented or inappropriate treatment or delayed treatment. A single model including all age categories was run to ascertain the association between neurosyphilis and age as well as neurosyphilis and delayed treatment for the early syphilis cases.

Because a single individual could have repeat infections (i.e., more than one case-incidence during the study period), I applied hierarchical regression models, using generalized estimating equations to account for within-subject correlations (Zeger et al., 1988). An adjustment to the Quasi-Likelihood Information Criterion (QICu) was used as fit statistics to compare four models with different working correlation matrix structures: unstructured, exchangeable, first-order autoregressive, and Toeplitz. The model with the lowest QICu was selected as the final model for estimating odds ratios of interest. Due to sparse data, I collapsed the Asian, Native Hawaiian/Pacific Islander, Native American/Alaskan Native, and Multiple race cases into a single category in the multivariate models for each separate age category. This was done for the early syphilis cases and gonorrhea cases. For chlamydia cases, I collapsed the Native Hawaiian/Pacific Islander, Native American/Alaskan Native, and Multiple race cases into a single "Other" category. For sparse data in gender, I excluded transgender because it did not fit into either the male or female categories. In all multivariate models, the issue of missing covariate information was handled by multiple imputation as previously described by Rubin (Rubin, 1987). For this study, the imputed and non-imputed results were slightly different, so the imputed findings are reported here. All data analyses were performed using SAS Enterprise Guide 6.1 (SAS Institute, Cary, NC).

4.4 RESULTS

Trends in Documented and Appropriate Treatment Over Time

Figures 4-1, 4-2, and 4-3 illustrate the proportion of reported early syphilis cases with documented and appropriate treatment from 2000 to 2011. Overall, 97% of cases 15 to 29, 96% of cases 30 to 49, and 96% of cases 50 and over had documented and appropriate treatment. The proportion remained relatively stable over time for the younger cases ($P = 0.83$), while increasing from 96% to 98% for middle-aged cases ($P < 0.001$). Similar, the proportion increased from 91% to 97% for older cases during 2002 to 2011 ($P = 0.02$).

The proportions of reported gonorrhea cases with documented and appropriate treatment were 68% for younger cases, 60% for middle-aged cases, and 60% for older cases. The proportion increased from 54% to 83% for younger cases ($P < 0.001$) (Figure 4-4), from 42% to 84% for middle-aged cases ($P < 0.001$) (Figure 4-5), and from 34% to 83% for older cases ($P < 0.001$) (Figure 4-6) during the study period. Inappropriate treatment accounted for around 8% of the reported cases, and this was similar across the different age categories. Undocumented treatment accounted for 25% of younger cases, 32% of middle-aged cases, and 32% of older cases.

The proportion of reported chlamydia cases 15 to 29 with documented and appropriate treatment is depicted in Figure 4-7. The overall proportion was 73% and increased from 62% to 74% during the study period for this age category ($P < 0.001$). The overall proportion of middle-aged cases with documented and appropriate treatment was 63% and increased from 43% to 73% ($P < 0.001$) (Figure 4-8). For older cases, the overall proportion was 58% and had increased from 33% to 66% ($P < 0.001$) (Figure 4-9). Inappropriate treatment was very uncommon for chlamydia cases of all age categories (<1%) while undocumented treatment occurred in 27% of younger cases, 37% of middle-aged cases, and 42% of older cases.

Predictors of Undocumented or Inappropriate Treatment

Age category was a statistically significant predictor of undocumented treatment for gonorrhea cases and of undocumented or inappropriate treatment for chlamydia cases (Table 4-1). The odds of undocumented treatment for gonorrhea among middle-aged cases was 1.53 times that among younger cases (95% CI, 1.48 to 1.58) and among older cases was 1.53 times that among younger cases (95% CI, 1.41 to 1.66). For middle-aged chlamydia cases, the odds of undocumented or inappropriate treatment were 1.69 times that among younger cases (95% CI, 1.66 to 1.72) and for older chlamydia cases it was 2.14 times that among younger cases (95% CI, 2.03 to 2.25).

Table 4-2 depicts the results of evaluating predictors of inappropriate treatment among reported gonorrhea cases by age category. The odds of inappropriate treatment were lower among older male cases (aOR: 0.58; 95% CI, 0.41 to 0.82) and were higher among older cases residing in the Antelope Valley (aOR: 3.10; 95% CI, 1.29 to 7.48), East (aOR: 2.05; 95% CI, 1.14 to 3.67), and South Bay (aOR: 1.55; 95% CI, 0.93 to 2.56) SPAs.

Cases 60 and over had higher odds of undocumented treatment compared to cases 50 to 59 (aOR: 1.56; 95% CI, 1.28 to 1.89) (Table 4-3). Older male cases had lower odds of the undocumented treatment compared to female cases (aOR: 0.63; 95% CI: 0.51 to 0.78), which was similar to younger age categories. Older cases reporting a co-infection also had lower odds of undocumented treatment compared to female cases (aOR: 0.63; 95% CI: 0.51 to 0.78), which is again similar to younger age categories.

Chlamydia cases ages 70 and over had higher odds of undocumented or inappropriate treatment compared with cases 50 to 59 years of age (aOR: 2.92; 95% CI: 2.29 to 3.74) (Table 4-4). The lower odds of the undocumented or inappropriate treatment among older male compared to that among female cases (aOR: 0.77; 95% CI: 0.69 to 0.87) was similar to findings among younger cases. The odds were higher among Hispanic older cases compared to that among White cases (aOR: 1.41; 95% CI: 1.12 to 1.77), and among older chlamydia cases residing in the Metro SPA (aOR: 1.21; 95% CI: 0.98 to 1.48). Older chlamydia cases with reported co-infections also had lower odds of the outcome (aOR: 0.41; 95% CI: 0.33 to 0.50). These findings were all similar to that among chlamydia cases in the 15 to 29 age category.

Predictors of Delayed Treatment and Association with Neurosyphilis

Table 4-5 breaks down predictors of delayed treatment among early syphilis cases by age category. The odds of delayed treatment were higher among older cases who identified as men who have sex with women only (MSW) compared to those who identified as men who have sex with men only (MSM) and men who have sex with both men and women (MSM/W) (aOR: 1.47; 95% CI: 1.04 to 2.06). The odds of delayed treatment among older cases who reported co-infections with other STDs had 0.40 times the odds among older cases who did not report co-infections (95% CI: 0.20 to 0.83). These findings were very similar to younger cases, although being single (aOR: 1.57; 95% CI: 1.15 to 2.14), and identifying as women who have sex with men only (WSM) (aOR: 1.66; 95% CI: 1.30 to 2.11) were also associated with delayed treatment. Race/ethnicity was predictive of delayed treatment among middle-aged early syphilis cases, as both Blacks (aOR: 1.23; 95% CI: 1.05 to 1.45) and Hispanics (aOR: 1.22; 95% CI: 1.10 to 1.36) had higher odds compared to Whites. The odds of delayed treatment were also higher among residents of several SPAs, most notably Antelope Valley (aOR: 2.09; 95% CI: 1.13 to 3.88) for middle-aged cases.

The odds of delayed treatment among early syphilis cases ages 30 to 49 were 0.90 times the odds among cases 15 to 29 (95% CI: 0.82 to 0.98) (Table 4-6). This was similar to the odds of delayed treatment among cases ages 50 and over compared to that among younger cases (aOR: 0.87; 95% CI: 0.76 to 0.99). After adjusting for other covariates, age category was also significantly associated with having neurosyphilis (Table 4-7). The odds of having neurosyphilis was higher among both middle-aged cases (aOR: 2.84; 95% CI: 1.71 to 4.73) and older cases (aOR: 2.73; 95% CI: 1.40 to 5.32) when compared to younger cases. Finally, the odds of having neurosyphilis among those with delayed treatment was 2.25 times that among those without delayed treatment (95% CI: 1.56 to 3.25) (Table 4-8).

4.5 DISCUSSION

This is, to the best of my knowledge, the first study to examine in detail trends over time and predictors of treatment documentation of reported older gonorrhea and chlamydia cases and compare it with younger cases. It is also the first study to investigate predictors of treatment delay among older early syphilis cases, compare it to younger cases, and examine its associations with neurosyphilis. I found that in general, treatment documentation has improved over time for older early syphilis, gonorrhea, and chlamydia cases. The same is true of almost all age categories. The only exception was younger early syphilis cases, but given that the prevalence of appropriate documentation was nearly 100% to begin with, it was difficult to see significant improvements over time. The trends over time are encouraging, given that appropriate treatment of STDs is crucial to prevention of further transmission and development of serious conditions (Workowski et al., 2015). Prevalence of appropriate treatment documentation was highest among early syphilis cases, which is unsurprising given that they are prioritized for follow-up and interviews compared to gonorrhea and chlamydia cases as recommended by the Centers for Disease Control and Prevention (CDC, 2008). Older syphilis cases also had high prevalence of documented and appropriate treatment, which is important given that older adults may be more likely to suffer from more serious forms of the disease (Calvet, 2003). While appropriate treatment documentation was prevalent among early syphilis cases, gonorrhea and chlamydia cases were a different story. By 2011, there were still about 13% of reported gonorrhea cases that did not have documented treatment and about 4% without appropriate treatment for all age categories. This is especially concerning due to the history of antibiotic resistance towards gonorrhea and the fact that inappropriate treatment is hypothesized as a contributor towards emergence of antimicrobial resistant gonorrhea (Unemo et al., 2012). For chlamydia cases, undocumented treatment continues to be a significant problem, especially for older cases with a third of them missing treatment information in the database. It is notable, however, that improvements have been greatest for older cases—possibly a reflection of increased awareness about STDs among older adults (Poynten et al., 2013), resulting in more treatment-seeking behavior among this age group.

Older gonorrhea and chlamydia cases were still more likely to have undocumented treatment overall when compared to younger cases. For gonorrhea cases, those who were middle-aged cases (30 to 49) and those who were older cases (50 and over) were similar in the odds of having undocumented treatment compared to younger cases. For chlamydia cases, the older age category had an even greater association with the outcome compared with the middle age category when compared to younger cases. Arguably younger people are at greater risk of acquiring STDs and one of the reasons for the focus on treatment is to prevent serious complications of infection such as infertility and ectopic pregnancy in younger women (Minkin, 2010). Nevertheless, older men and women may still present with symptoms of gonorrhea and chlamydia, even more so than younger populations (Xu et al., 2001). In addition, it is becoming increasingly recognized that age-disparate relationships may contribute to increased risk of HIV acquisition (Anema et al., 2013). Since infection with gonorrhea and chlamydia may facilitate the transmission of HIV (Fleming et al., 1999), it is important to identify and treat the older population who are infected by gonorrhea and chlamydia to prevent its spread to younger populations in an age-disparate relationship. This would also help prevent the more serious health complications of the diseases in the younger populations.

Demographic Predictors of Undocumented or Inappropriate Treatment

It is interesting that the odds of inappropriate treatment of gonorrhea was higher in certain SPAs compared to the South SPA. It is difficult to ascertain the precise reason for this based on the data alone, but a possible explanation may be found in the fact that there are differences in provider adherence to CDC treatment recommendations (Lechtenberg et al., 2014). Specifically, non-STD clinic providers are more likely to administer a non-CDC treatment compared to STD clinic providers. Thus, if residents of the Antelope Valley, East, and South Bay SPAs were more likely to seek care at non-STD clinic providers, then that may account for the higher prevalence of inappropriate treatment administration at these geographic areas.

Older gonorrhea cases 60 years of age and older had higher odds of undocumented treatment compared to those 50 to 59 years of age. This is expected as prioritization of case investigation are on younger populations. Nevertheless, as the STD rate increases among older populations it will be increasingly important to devote some resources to ensuring proper treatment and documentation by providers and local health departments (CDC, 2016). It is reassuring that men of all age categories were less likely to have undocumented treatment since they are more likely to be a high-risk group for gonorrhea transmission (Gunn et al., 2004). Co-infection with STDs were also associated with lower odds of the outcome, which suggests that proper follow-up on treatment is being conducted on this high-risk group. Treatment of individuals with co-infections is important as they may also facilitate ongoing STD transmission (van Veen et al., 2010).

Because of large caseloads in Los Angeles County, local health department staff are unable to ensure that all chlamydia cases reported have documented or appropriate treatment. Thus, it is unsurprising that the demographic subpopulations with the largest numbers of cases would have higher odds of undocumented or inappropriate treatment. This is fairly consistent between age categories—even among the older cases. It is notable that older cases in the Metro SPA had higher odds of undocumented or inappropriate treatment, given that this area tends to have a greater concentration of resources devoted to STD prevention such as the Community-Embedded Disease Intervention Specialist (CEDIS) partner-notification program (Rudy et al., 2012). In addition, it is known that high-risk groups may reside in this region (Beymer et al., 2014). Therefore, additional efforts are needed to improve the surveillance and treatment of reported cases in the region.

Predictors of Delayed Treatment Among Early Syphilis Cases

The odds of delayed treatment appeared to be slightly lower for increasing age category, although statistical significance is close to the null. This is unexpected as it has been documented that older adults report barriers to seeking treatment for sexual problems in primary care (Gott et al., 2003), but may be a reflection of differences in definition of treatment delay. For this analysis, treatment delay was defined using the time period between specimen collection and treatment regimen administration, so older adults can still delay in seeking treatment but get tested and treated relatively promptly once they speak to a provider. It is encouraging that older adults who self-identify as either MSM or MSM/W had lower odds of treatment delay, as this is a high-risk group for STDs such as HIV/AIDS, syphilis, and gonorrhea (Ciesielski et al., 2003). The less time it takes for these individuals to receive treatment, the greater the likelihood of prevention from further transmission and mitigation of more serious complications (Chen et al., 2009). Having co-infections was also associated with lower odds of delayed treatment, which reinforces that the high-risk groups are being treated promptly.

Neurosyphilis and Delayed Treatment

Neurosyphilis has long been recognized as a possible cause of dementia and delirium in the elderly (NIA, 1980) and clinicians are recommended to evaluate elderly patients with such symptoms for the disease. The findings that odds of neurosyphilis increase with increasing age among reported early syphilis cases appear to support such recommendations. The fact that delayed treatment is associated with neurosyphilis emphasizes the need for prompt treatment of syphilis cases.

Limitations

Several limitations may affect interpretation of findings of this study. Due to the nature of the data source, very few covariates were available for multivariate regression analyses of both undocumented or inappropriate treatment for gonorrhea and chlamydia cases and delayed treatment for early syphilis cases. This meant that it was not possible to assess other potential predictors of the outcomes that might be important risk factors for STD infection, such as condom use, substance abuse, and number of sex partners (Hughes et al., 2000; Tapert et al., 2001; Warner et al., 2006). For gonorrhea and chlamydia, this problem is exacerbated by poor quality of data on marital status and sexual orientation in addition to the aforementioned behavioral variables. Inclusion of these potential risk factors is important because these are the populations that have greatest need for prompt and appropriate treatment for STDs. For early syphilis, an important covariate that needed to be included in the models was whether the patient was tested and treated at a publicly funded STD clinic, as it has been found that median time to treatment was significantly shorter if he or she was (Robinson et al., 2016).

Because I used documented and appropriate treatment as a proxy for assessing whether a chlamydia or gonorrhea case had been treated or not, there may be misclassification bias present if a case had been treated but was not documented. This would underestimate the true prevalence of treatment in the study population and potentially the effect estimates if this differed between the different subpopulations. However, the findings are still relevant because they reinforce the need for improved data quality regarding treatment documentation. For early syphilis cases, misclassification of treatment delay may be present due to my specific definition of the outcome. Because there is no universal definition of treatment delay, I had to choose one that could be compared to other studies (Chen et al., 2009). The definitions used may not correlate with clinical significance and thus caution is needed when making inferences about adverse outcomes resulting from delayed treatment. Misclassification of predictors in the multivariate models may also be present as there was a need to collapse across categories where cell sizes were too small for analysis. This may have resulted in biased effect estimates if there were actual differences in the collapsed categories' associations with the outcome. It is difficult to remedy this bias, as the alternative is sparse data bias if the categories remained separate.

Diagnosing neurosyphilis in older adults may be difficult due to possible false-positive laboratory results as cerebral spinal fluid (CSF) protein levels increase with age (Bharwani et al., 1998). This problem is compounded by the fact that if an older patient presents with symptoms consistent with dementia, a neurosyphilis test is considered as a routine procedure (Naughton et al., 1992). Thus, detection bias may be present if a clinician is less likely to consider and test for neurosyphilis when a younger patient presents with neurological abnormalities, resulting in increased odds of neurosyphilis diagnosis with increased age.

Public Health Impact

Despite these limitations, this is still an important study because it helps identify potential areas of need for improvement on a local health department level in its interactions with providers. While the documentation of treatment for gonorrhea and chlamydia cases has improved over the years, there are still a substantial portion of reported cases who may be 1) administered an inappropriate treatment regimen, 2) administered a treatment that was not reported to the local health department, or 3) not treated at all. Due to lack of staff and the need to prioritize certain diseases (such as early syphilis) and age groups (i.e. younger cases), it has been difficult for DHSP to ensure that the appropriate treatment is entered into the database especially for the older adult population. Addressing these issues requires a multi-faceted approach. One approach is to implement a quality improvement project that assesses root causes of poor performance on treatment documentation, introduce a simple intervention targeted at a specific root cause, measure the changes in the performance before and after the intervention, and determine whether the intervention is to be adopted moving forward. These “plan-do-study-act” (PDSA) cycles have shown promise in improving compliance with performance measures (Van Tiel et al., 2006).

Another approach is to collaborate with other divisions and/or departments within the County to assist with case investigation and treatment follow-up. For example, DHSP can partner with the Office of Senior Health (OSH) to educate both providers and older patients about obtaining treatment for STDs and reporting it to the local health department. This utilizes the potentially more positive rapport that OSH may have with various health care providers or other organizations who are directly in contact with many potential STD cases in the older population. It would also allow more effective communication of policies and clinical guidelines to the local health providers. This strategy is also applicable to the problem of treatment delay among older adults with early syphilis.

A third approach is to implement an automated electronic confidential morbidity report (CMR) system, similar to the automated electronic laboratory reporting system that has been integrated over the years into DHSP. The idea would be that clinicians can fill out the CMRs electronically which are then submitted directly to the local health department. This can be done concurrently as the clinician is seeing the patient, if the clinic or hospital has an electronic health records system. A similar possibility would be for providers to be able to automatically generate a report containing the data elements required in a CMR by extracting pertinent information from patients' electronic health records. This approach would dramatically reduce the extra effort that a clinician needs to fill out a CMR and sending it to the local health department. The apparent success of automated electronic laboratory reporting in improving the completeness and timeliness of disease surveillance presents evidence that such an information systems approach may be effective (Overhage et al., 2008). Though there are costs and resources associated with implementing such a system, the potential long-term benefits may outweigh the initial investments. Such a system would 1) reduce the need for local health department staff to spend time on calling providers to solicit CMRs and other pertinent information for STD surveillance, 2) reduce the extra time required for providers to fill out a CMR and submit it to the health department, and 3) enable action that lead to public health benefits such as earlier interventions due to improved timeliness of reporting, fewer direct medical care costs, and decreased STD morbidity and mortality.

In conclusion, there has been an improvement in appropriate treatment documentation for gonorrhea and chlamydia over time for all age categories, including older adults. Nevertheless, middle-aged and older cases are still more likely to have undocumented treatment—a problem that needs to be addressed in multiple ways. In addition, efforts to address inappropriate treatment of gonorrhea need to be reinforced among all age categories. Appropriate treatment documentation is very high for early syphilis cases, but delayed treatment remains an issue for all age categories. This may translate to a greater prevalence of neurosyphilis in older adults and thus requires additional efforts by the local health department to educate providers and the older population on the importance of timely treatment.

TABLES AND FIGURES

Figure 4-1 Proportion of reported early syphilis cases aged 15 to 29 with documented and appropriate treatment, Los Angeles County, 2000-2011

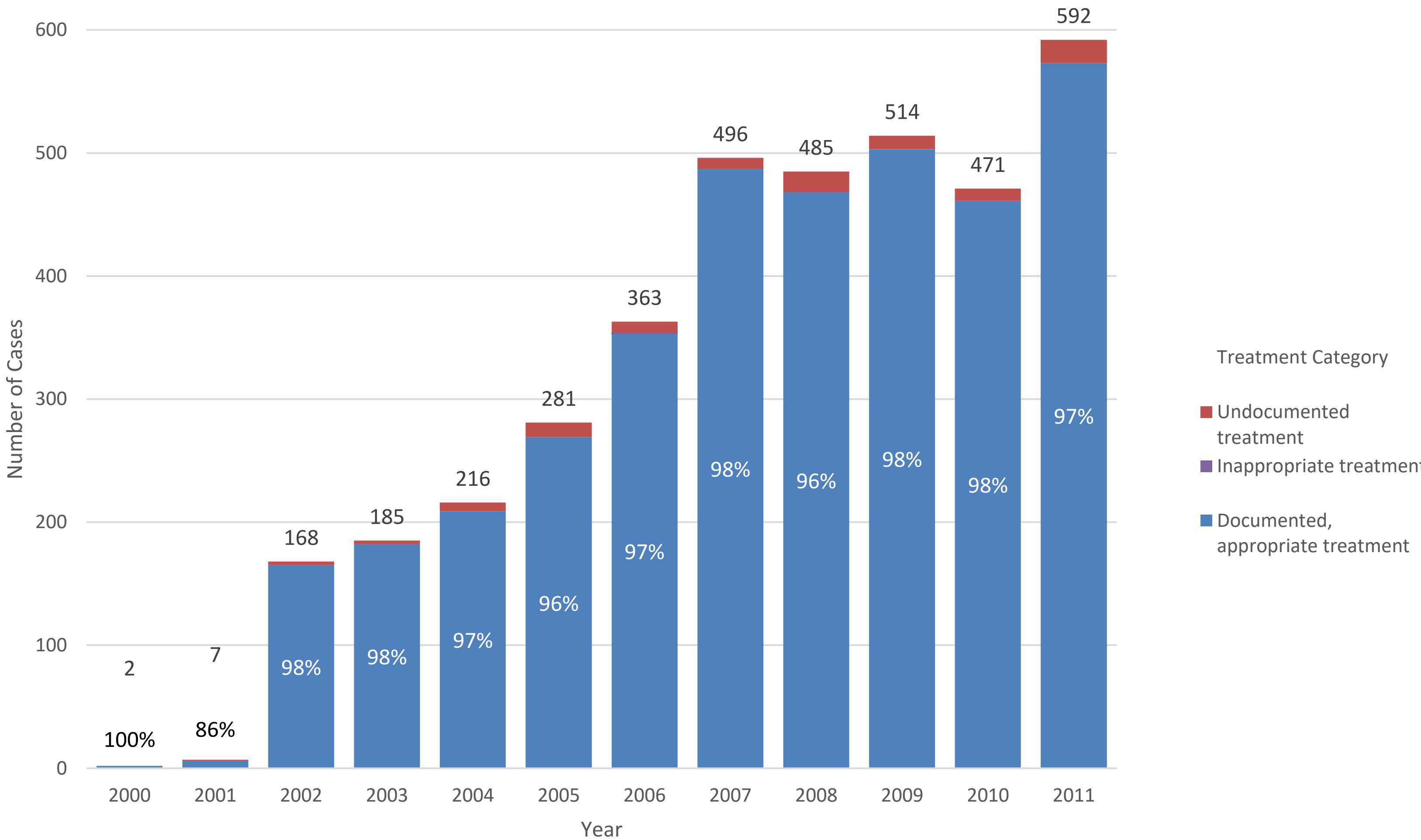

Figure 4-2 Proportion of reported early syphilis cases aged 30 to 49 with documented and appropriate treatment, 2000-2011

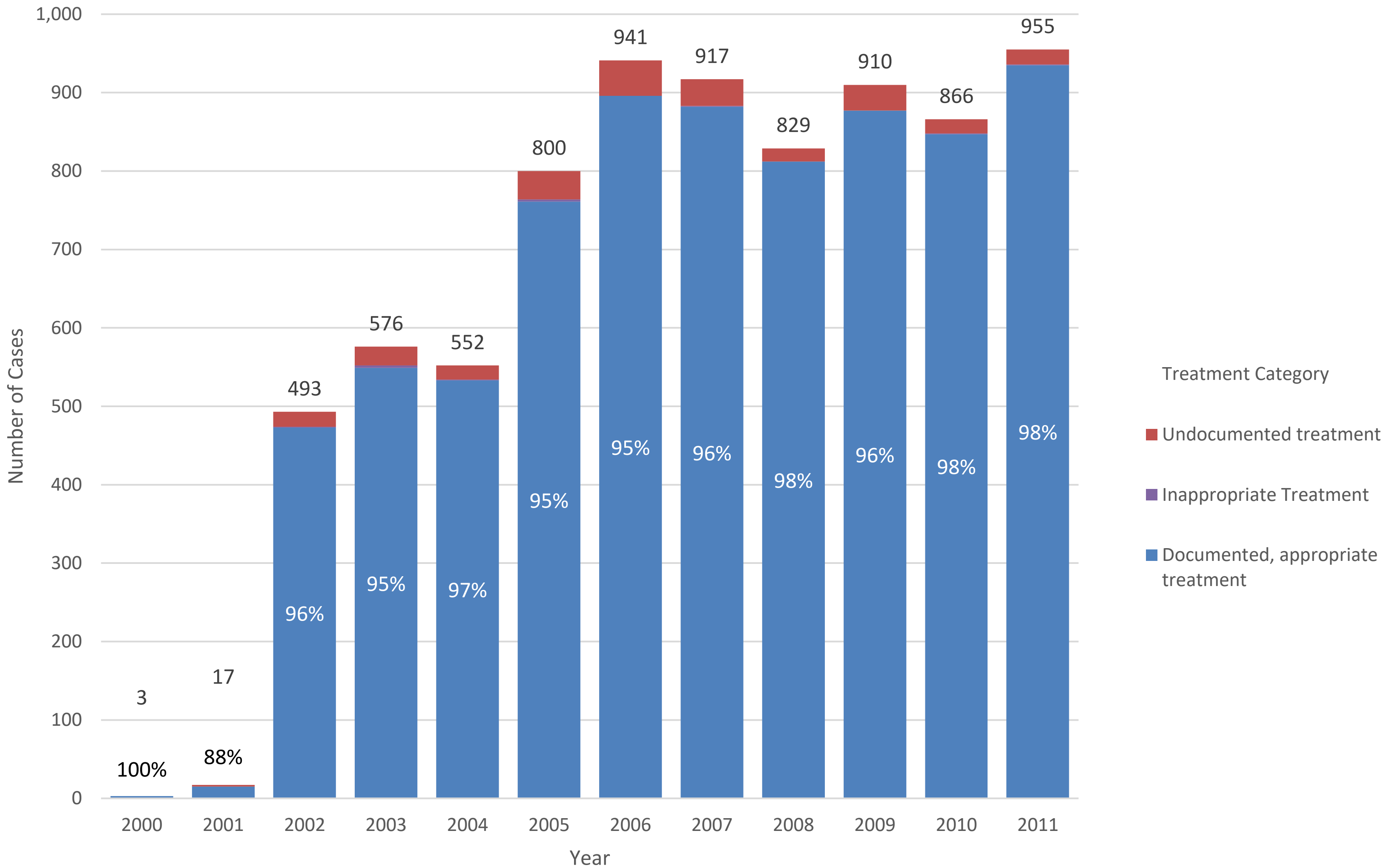

Figure 4-3 Proportion of reported early syphilis cases aged 50 and over with documented and appropriate treatment, 2000-2011

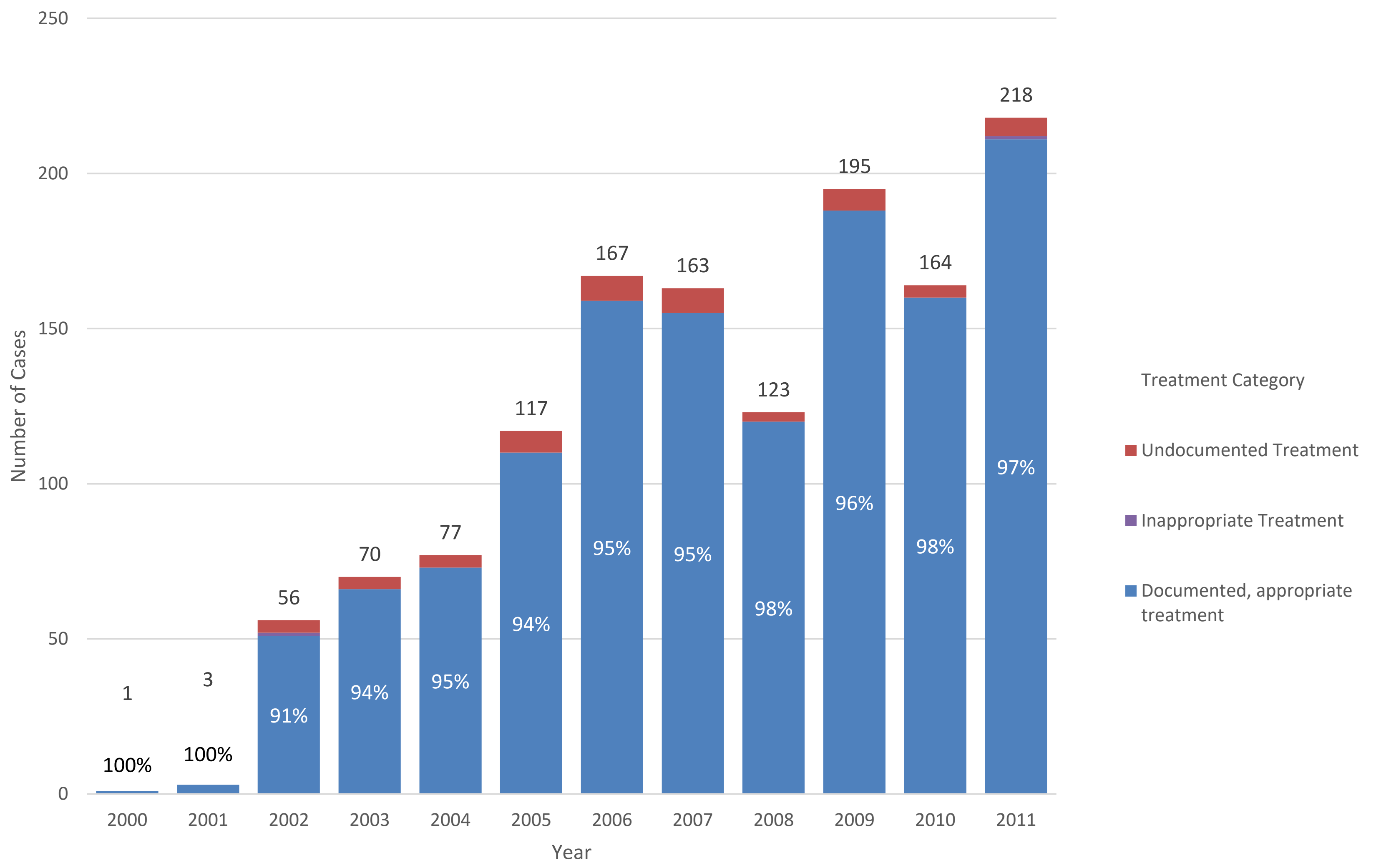

Figure 4-4 Proportion of reported gonorrhea cases aged 15 to 29 with documented and appropriate treatment, Los Angeles County, 2000-2011

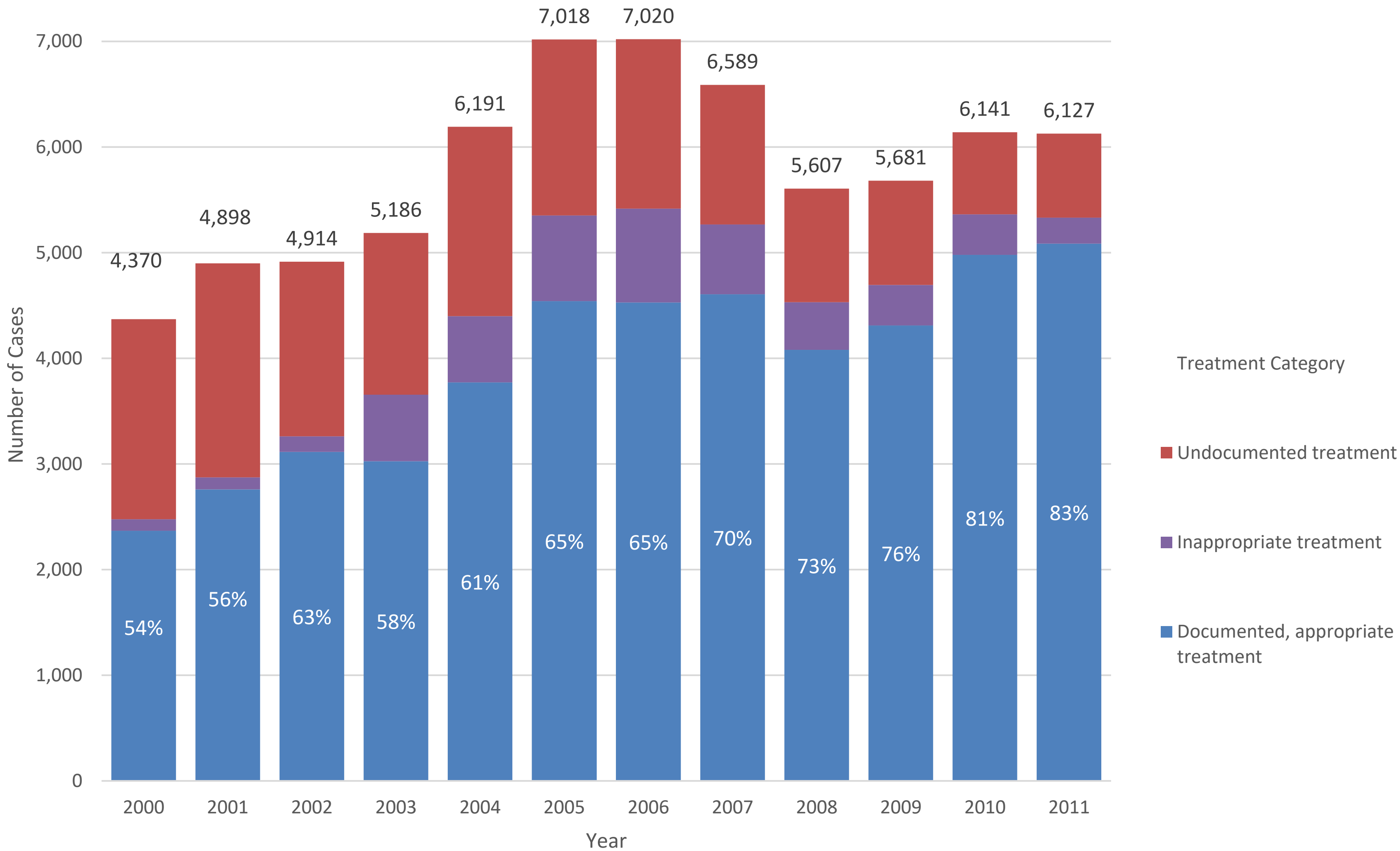

Figure 4-5 Proportion of reported gonorrhea cases aged 30 to 49 with documented and appropriate treatment, 2000-2011

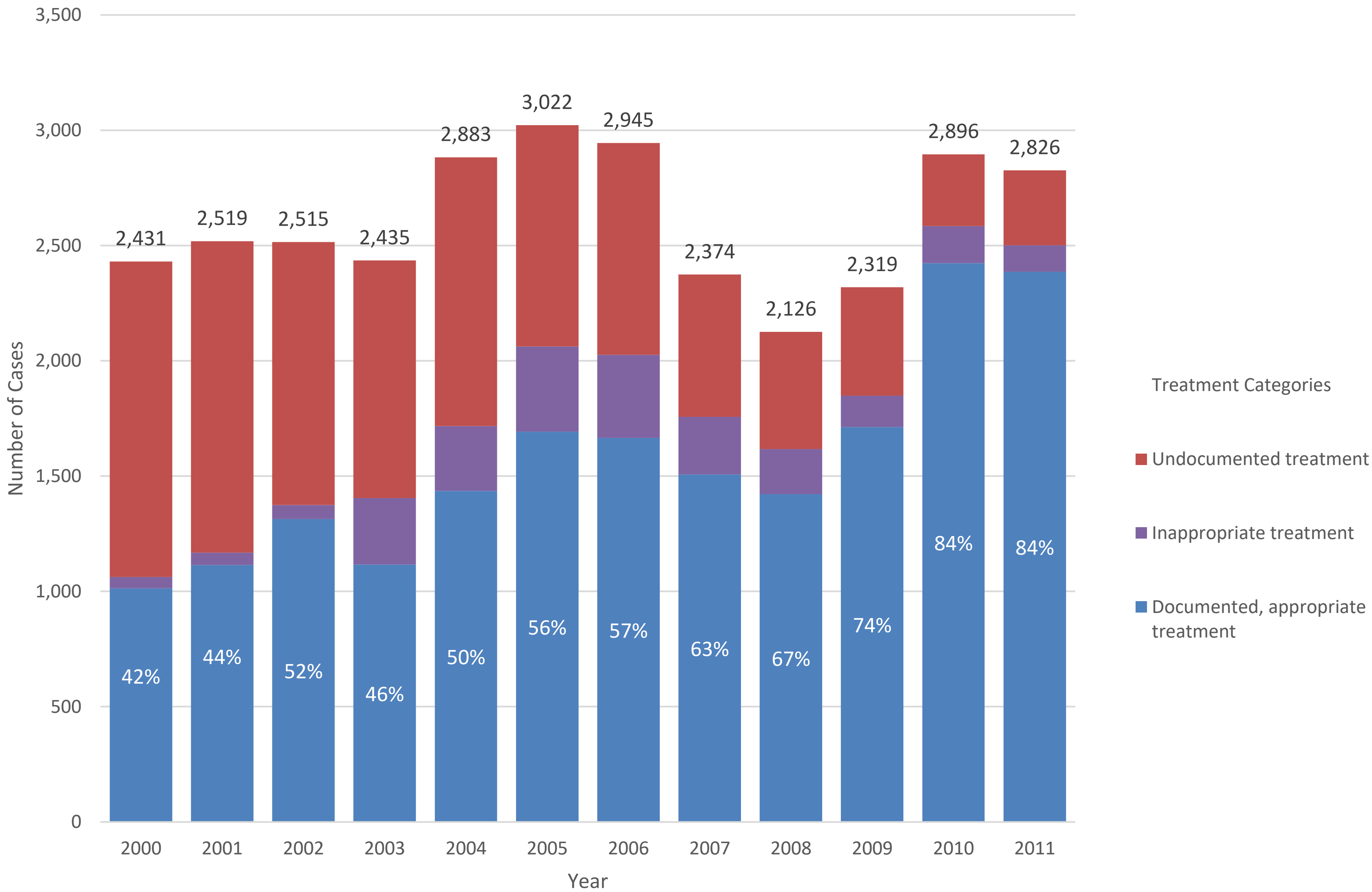

Figure 4-6 Proportion of reported gonorrhea cases aged 50 and over with documented and appropriate treatment, 2000-2011

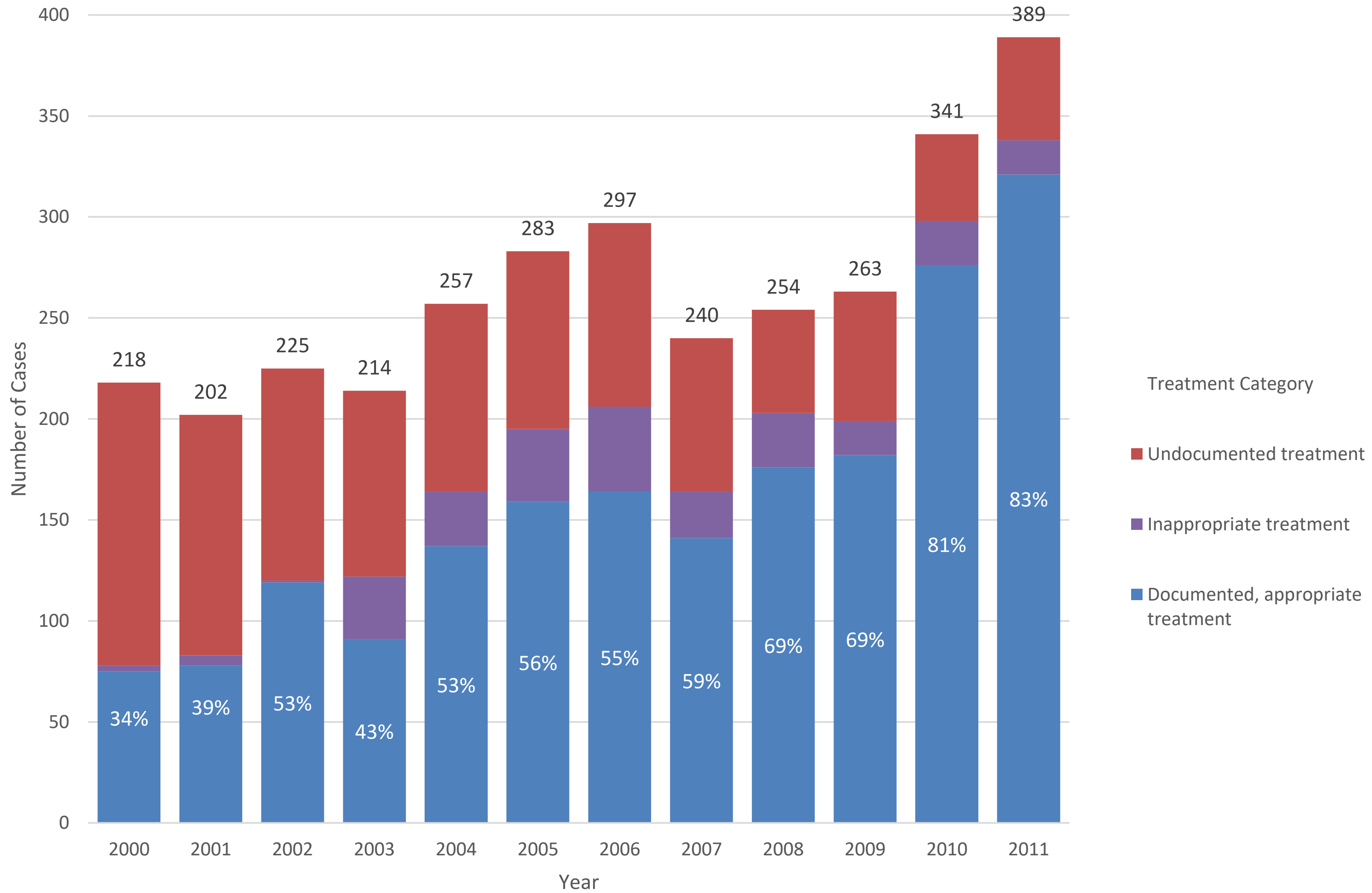

Figure 4-7 Proportion of reported chlamydia cases aged 15 to 29 with documented and appropriate treatment, Los Angeles County, 2000-2011

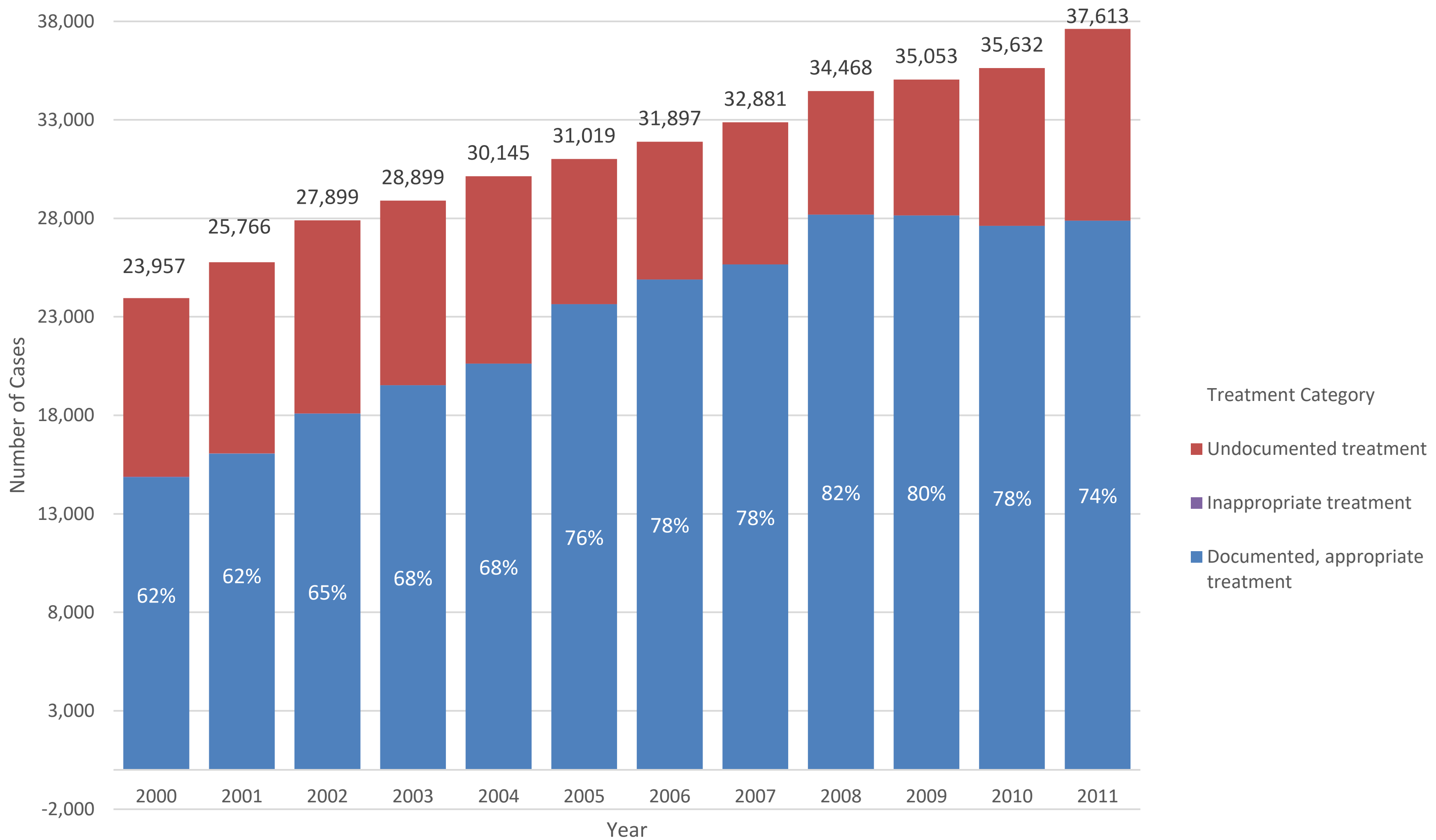

Figure 4-8 Proportion of reported chlamydia cases aged 30 to 49 with documented and appropriate treatment, 2000-2011

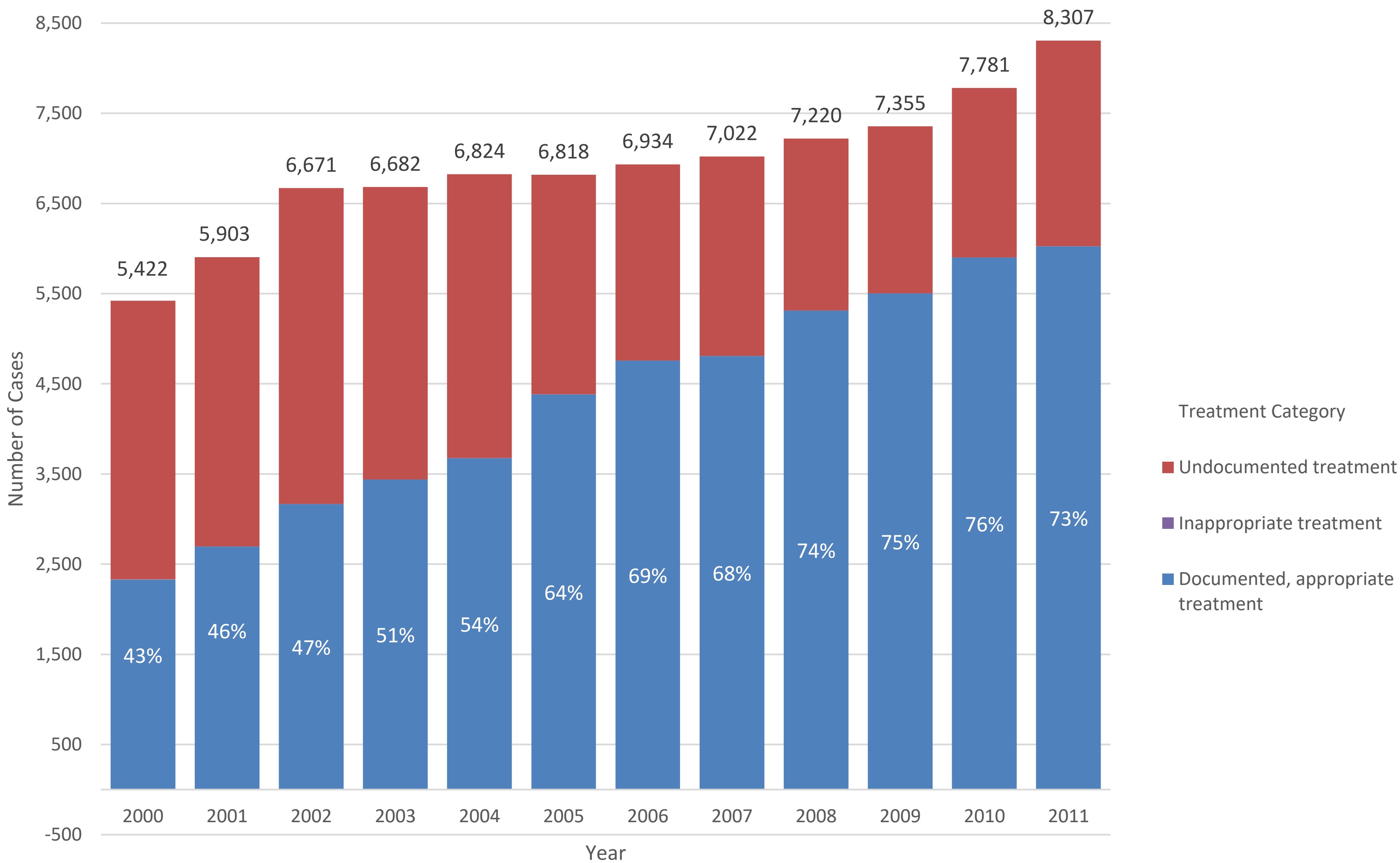

Figure 4-9 Proportion of reported chlamydia cases aged 50 and over with documented and appropriate treatment, 2000-2011

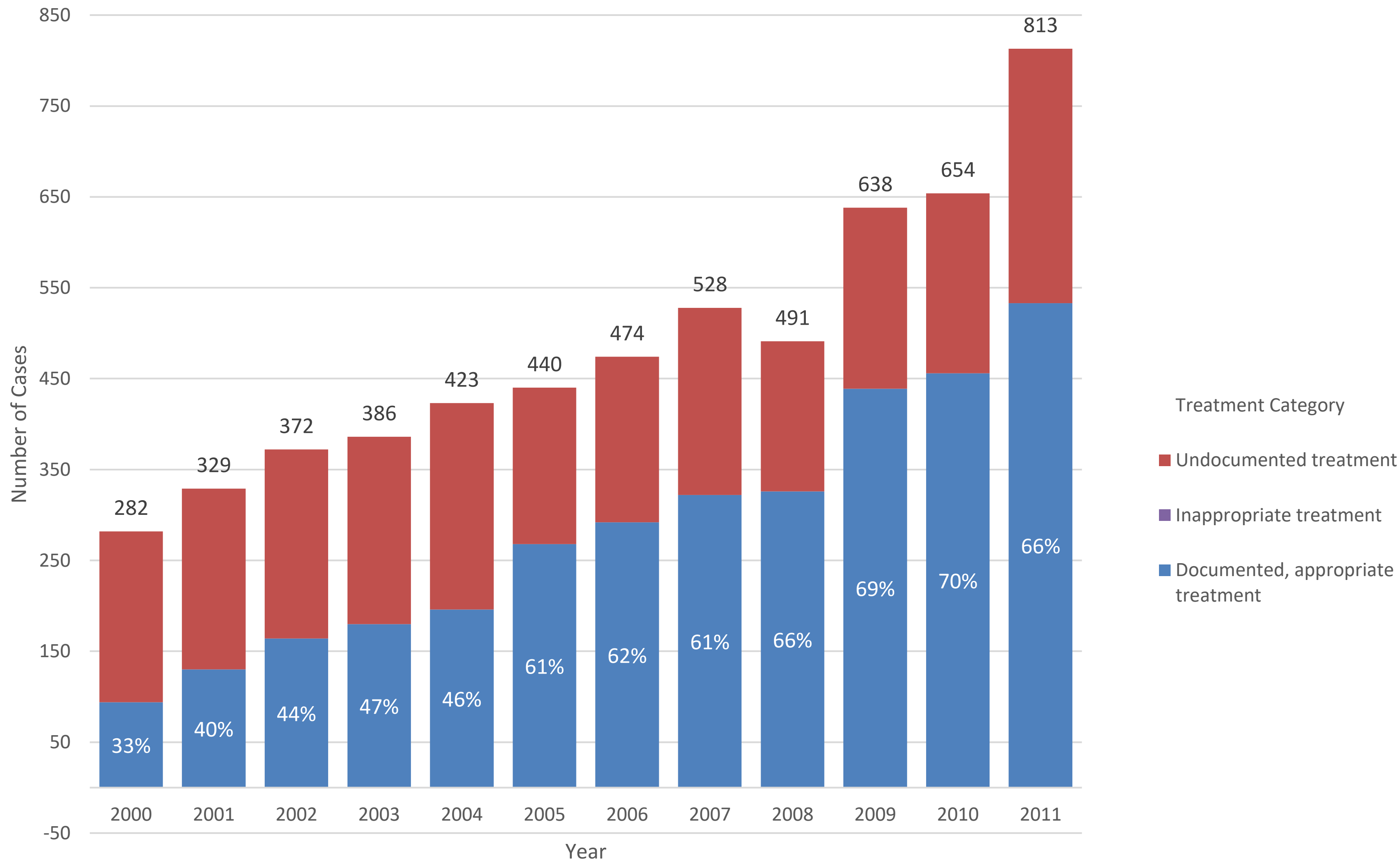

Table 4-1 Association between age category and undocumented or inappropriate treatment among reported gonorrhea and chlamydia cases, Los Angeles County, 2000-2011

	Inappropriate Treatment, Gonorrhea		Undocumented Treatment, Gonorrhea		Undocumented or Inappropriate Treatment, Chlamydia	
Characteristic	aOR[1]	95% CI	aOR[1]	95% CI	aOR[1]	95% CI
Age Category						
15 to 29 (ref.)	----	----	----	----	----	----
30 to 49	1.05	0.99, 1.11	1.53	1.48, 1.58	1.69	1.66, 1.72
50 and over	1.13	0.99, 1.30	1.53	1.41, 1.66	2.14	2.03, 2.25

[1]Obtained using generalized estimating equations with simultaneous entry of the following covariates: age category, gender, race/ethnicity, service planning area, and co-infection status

aOR = adjusted odds ratio; CI = confidence interval

Table 4-2 Predictors of inappropriate treatment among reported gonorrhea cases by age category, Los Angeles County, 2000-2011

	15 to 29		30 to 49		50 and over	
Characteristic	aOR[1]	95% CI	aOR[1]	95% CI	aOR[1]	95% CI
Age Group						
50 – 59 (ref.)	----	----	----	----	----	----
60 and over	----	----	----	----	1.29	0.92, 1.81
Gender						
Male	0.79	0.75, 0.84	0.64	0.58, 0.71	0.58	0.41, 0.82
Female (ref.)	----	----	----	----	----	----
Race/Ethnicity						
Black	0.72	0.65, 0.79	0.77	0.67, 0.89	0.71	0.48, 1.06
Asian and Other[2]	0.83	0.70, 1.00	1.04	0.83, 1.31	0.84	0.42, 1.71
Hispanic	0.87	0.79, 0.95	0.92	0.81, 1.05	0.82	0.54, 1.27
White (ref.)	----	----	----	----	----	----
Service Planning Area						
Antelope Valley	1.42	1.24, 1.64	1.65	1.22, 2.24	3.10	1.29, 7.48
San Fernando	1.83	1.65, 2.03	1.88	1.58, 2.23	1.41	0.83, 2.42
San Gabriel	1.73	1.54, 1.93	1.75	1.43, 2.14	1.17	0.61, 2.25
Metro	1.29	1.16, 1.44	1.11	0.94, 1.30	0.90	0.57, 1.44
West	1.75	1.51, 2.02	1.65	1.34, 2.03	1.54	0.84, 2.83
East	1.46	1.30, 1.64	1.40	1.12, 1.74	2.05	1.14, 3.67
South Bay	1.08	0.98, 1.19	1.10	0.91, 1.33	1.55	0.93, 2.56
South (ref.)	----	----	----	----	----	----
Co-infection						
Yes	0.88	0.83, 0.93	0.93	0.83, 1.03	0.94	0.67, 1.33
No (ref.)	----	----	----	----	----	----

[1]Obtained using generalized estimating equations with simultaneous entry of covariates listed in the table

[2]Other includes Native Hawaiian/Pacific Islander, American Indian/Alaskan Native, and Multi-race

aOR = adjusted odds ratios; CI = confidence interval

Table 4-3 Predictors of undocumented treatment among reported gonorrhea cases by age category, Los Angeles County, 2000-2011

	15 to 29		30 to 49		50 and over	
Characteristic	aOR[1]	95% CI	aOR[1]	95% CI	aOR[1]	95% CI
Age Group						
50 – 59 (ref.)	----	----	----	----	----	----
60 and over	----	----	----	----	1.56	1.28, 1.89
Gender						
Male	0.79	0.77, 0.82	0.63	0.59, 0.66	0.63	0.51, 0.78
Female (ref.)	----	----	----	----	----	----
Race/Ethnicity						
Black	1.02	0.95, 1.10	0.98	0.90, 1.05	0.83	0.63, 1.08
Asian and Other[2]	0.87	0.76, 0.99	0.77	0.66, 0.90	1.09	0.58, 2.05
Hispanic	1.06	0.99, 1.13	0.95	0.86, 1.03	0.90	0.65, 1.25
White (ref.)	----	----	----	----	----	----
Service Planning Area						
Antelope Valley	0.91	0.81, 1.01	0.75	0.61, 0.93	0.89	0.42, 1.85
San Fernando	1.06	0.99, 1.14	1.11	1.00, 1.23	1.00	0.72, 1.39
San Gabriel	0.83	0.75, 0.92	1.10	0.97, 1.25	0.83	0.57, 1.22
Metro	1.19	1.11, 1.27	1.04	0.95, 1.14	0.92	0.72, 1.17
West	0.81	0.71, 0.92	1.06	0.93, 1.21	1.10	0.77, 1.57
East	1.16	1.07, 1.25	1.13	0.99, 1.29	0.87	0.57, 1.33
South Bay	0.90	0.85, 0.96	1.00	0.91, 1.10	1.09	0.82, 1.46
South (ref.)	----	----	----	----	----	----
Co-infection						
Yes	0.84	0.81, 0.87	0.69	0.65, 0.74	0.63	0.51, 0.78
No (ref.)	----	----	----	----	----	----

[1]Obtained using generalized estimating equations with simultaneous entry of covariates listed in the table

[2]Other includes Native Hawaiian/Pacific Islander, American Indian/Alaskan Native, and Multi-race

aOR = adjusted odds ratios; CI = confidence interval

Table 4-4 Predictors of undocumented or inappropriate treatment among reported chlamydia cases by age category, Los Angeles County, 2000-2011

	15 to 29		30 to 49		50 and over	
Characteristic	aOR[1]	95% CI	aOR[1]	95% CI	aOR[1]	95% CI
Age Group						
50 – 59 (ref.)	----	----	----	----	----	----
60 – 69	----	----	----	----	1.13	0.97, 1.31
70 and over	----	----	----	----	2.92	2.29, 3.74
Gender						
Male	0.90	0.88, 0.91	0.74	0.72, 0.77	0.77	0.69, 0.87
Female (ref.)	----	----	----	----	----	----
Race/Ethnicity						
Black	1.16	1.12, 1.20	0.88	0.83, 0.94	1.08	0.81, 1.44
Asian	0.88	0.80, 0.96	0.67	0.61, 0.74	1.09	0.80, 1.48
Hispanic	1.11	1.07, 1.16	1.00	0.95, 1.05	1.41	1.12, 1.77
Other[2]	1.01	0.90, 1.13	0.77	0.57, 1.06	0.70	0.29, 1.71
White (ref.)	----	----	----	----	----	----
Service Planning Area						
Antelope Valley	1.03	0.98, 1.07	0.78	0.70, 0.87	0.75	0.47, 1.18
San Fernando	1.18	1.15, 1.21	0.92	0.87, 0.97	1.18	0.95, 1.47
San Gabriel	0.73	0.71, 0.76	0.99	0.93, 1.05	1.01	0.78, 1.29
Metro	1.39	1.35, 1.43	1.04	0.99, 1.10	1.21	0.98, 1.48
West	0.87	0.83, 0.92	0.93	0.86, 1.01	1.13	0.84, 1.51
East	1.41	1.37, 1.44	1.11	1.04, 1.17	1.06	0.80, 1.41
South Bay	0.90	0.87, 0.93	0.80	0.75, 0.85	0.95	0.76, 1.19
South (ref.)	----	----	----	----	----	----
Co-infection						
Yes	0.69	0.67, 0.72	0.62	0.58, 0.65	0.41	0.33, 0.50
No (ref.)	----	----	----	----	----	----

[1]Obtained using generalized estimating equations with simultaneous entry of covariates listed in the table
[2]Other includes Native Hawaiian/Pacific Islander, American Indian/Alaskan Native, and Multi-race
aOR = adjusted odds ratios; CI = confidence interval

Table 4-5 Predictors of delayed treatment among reported early syphilis cases by age category, Los Angeles County, 2000-2011

	15 to 29		30 to 49		50 and over	
Characteristic	aOR[1]	95% CI	aOR[1]	95% CI	aOR[1]	95% CI
Age Group						
50 – 59 (ref.)	----	----	----	----	----	----
60 and over	----	----	----	----	1.00	0.74, 1.36
Race/Ethnicity						
White (ref.)	----	----	----	----	----	----
Black	1.11	0.88, 1.41	1.23	1.05, 1.45	1.16	0.82, 1.65
Asian and Other[2]	1.23	0.86, 1.76	0.90	0.71, 1.15	0.91	0.46, 1.79
Hispanic	1.15	0.95, 1.39	1.22	1.10, 1.36	1.06	0.79, 1.43
Marital Status						
Single	1.57	1.15, 2.14	0.93	0.76, 1.14	0.71	0.46, 1.10
Married/Domestic Partnership/ Cohabitation (ref.)	----	----	----	----	----	----
Formerly Married	1.99	0.72, 5.50	0.86	0.62, 1.20	0.85	0.46, 1.56
Sexual Orientation[3,4]						
MSM and MSM/W (ref.)	----	----	----	----	----	----
MSW	1.57	1.22, 2.03	1.42	1.18, 1.70	1.47	1.04, 2.06
WSM	1.66	1.30, 2.11	1.39	1.08, 1.79	1.56	0.90, 2.71
Other	1.72	0.80, 3.72	1.06	0.58, 1.93	1.51	0.26, 8.62
Service Planning Area						
Antelope Valley	0.43	0.23, 0.82	2.09	1.13, 3.88	1.34	0.34, 5.29
San Fernando	1.00	0.82, 1.23	1.29	1.12, 1.49	0.91	0.66, 1.25
San Gabriel	1.14	0.88, 1.49	1.37	1.09, 1.72	0.97	0.53, 1.78
Metro (ref.)	----	----	----	----	----	----
West	0.84	0.59, 1.19	1.05	0.86, 1.28	1.43	0.89, 2.29
South	1.05	0.84, 1.32	1.06	0.89, 1.27	0.80	0.53, 1.22
East	1.07	0.84, 1.37	1.26	1.03, 1.54	1.37	0.84, 2.23
South Bay	1.04	0.79, 1.37	1.00	0.80, 1.24	1.04	0.64, 1.68
Co-infection						
Yes	0.41	0.33, 0.51	0.46	0.37, 0.57	0.40	0.20, 0.83
No (ref.)	----	----	----	----	----	----

[1]Obtained using generalized estimating equations with simultaneous entry of covariates listed in the table
[2]Other includes Native Hawaiian/Pacific Islander, American Indian/Alaskan Native, and Multi-race
[3]Determined from gender of patient and gender of reported sex partner in last 12 months
[4]MSM=Men who have sex with men and men only; MSM/W=men who have sex with both men and women; MSW=men who have sex with women only; WSM=women who have sex with men only; Other includes women who have sex with women (WSW), women who have sex with both women and men (WSW/M), and transgenders who have sex with men, women or other transgenders (TG/STG)
aOR = adjusted odds ratios; CI = confidence interval

Table 4-6 Association between age category and delayed treatment among reported early syphilis cases, Los Angeles County, 2000-2011

Characteristic	n[1]	%	aOR[2]	95% CI
All subjects with delayed treatment	7,332	100.0	----	----
Age Category				
15 to 29 (ref.)	2,238	30.5	----	----
30 to 49	4,345	59.3	0.90	0.82, 0.98
50 and over	749	10.2	0.87	0.76, 0.99

[1]Totals for each covariate may not sum to 100 percent due to missing values
[2]Obtained using generalized estimating equations with simultaneous entry of the following covariates: age category, race/ethnicity, marital status, sexual orientation, service planning area, and co-infection status
aOR = adjusted odds ratio; CI = confidence interval

Table 4-7 Association between age category and neurosyphilis among reported early syphilis cases, Los Angeles County, 2000-2011

Characteristic	n[1]	%	aOR[2]	95% CI
All subjects with neurosyphilis	171	100.0	----	----
Age Category				
15 to 29 (ref.)	19	11.1	----	----
30 to 49	128	74.9	2.84	1.71, 4.73
50 and over	24	14.0	2.73	1.40, 5.32

[1]Totals for each covariate may not sum to 100 percent due to missing values
[2]Obtained using generalized estimating equations with simultaneous entry of the following covariates: delayed treatment, age category, White race (Yes/No), marital status, sexual orientation, Metro service planning area (Yes/No), and co-infection status
aOR = adjusted odds ratio; CI = confidence interval

Table 4-8 Association between delayed treatment and neurosyphilis among reported early syphilis cases, Los Angeles County, 2000-2011

Characteristic	n[1]	%	aOR[2]	95% CI
All subjects with neurosyphilis	171	100.0	----	----
Delayed treatment				
Yes	115	67.3	2.25	1.56, 3.25
No (ref.)	39	22.8	----	----

[1]Totals for each covariate may not sum to 100 percent due to missing values
[2]Obtained using generalized estimating equations with simultaneous entry of the following covariates: delayed treatment (Yes/No), age category (15 to 29/30 to 49/50 and over), White race (Yes/No), marital status (Single/Heterosexual/Formerly Married), sexual orientation (MSM/Heterosexual/Other), Metro service planning area (Yes/No), and co-infection status (Yes/No)
aOR = adjusted odds ratio; CI = confidence interval

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CHAPTER 5

DISCUSSION

This study is one of the first to characterize STDs among the older age demographic compared to younger age groups over time. It is one of the few to explore the extent of the burden among older people and to examine current efforts at controlling the diseases through appropriate treatment. There are several implications to the general findings of this research. First, the fact that the rate of STDs such as early syphilis, gonorrhea, and chlamydia are continuing to increase among older adults means that medical costs will surge as well. STDs are already a “billion-dollar” industry in the US (Owusu-Edusei Jr. et al., 2013) and the price tag will continue to increase thanks to the burgeoning older adult demographic. While the rates of disease are still much lower compared to younger populations, the costs of medical care may not necessarily be proportionately lower. Older adults may be more likely to suffer from more serious complications of infections, such as human papillomavirus (HPV)-related dysplasia or carcinoma (Calvet, 2003), cognitive impairment from neurosyphilis (Wilson, 2006), reactive arthritis from chlamydia (Carter et al., 2011), and disseminated gonococcal infection (Holmes et al., 1971). Treatment for these sequelae are costlier than treatment for an uncomplicated chlamydia, gonorrhea, or syphilis infection. Hence it is imperative that older adults and providers are educated about the risks of STDs among older people and conduct careful screening of high-risk patients. In addition, cost-benefit analyses need to be conducted to assess the potential long-term impact of expanding STD screening procedures for older adults similar to a study done on HIV screening in patients 55 and older (Sanders et al., 2008). There is no doubt that Baby Boomers will have an influence on the future economy, especially in the healthcare sector (Knickman et al., 2002), and STDs will be an increasingly important contributor to the public health burden.

Second, identifying repeat infections among older people was important as it was the first step in characterizing the high-risk groups for this demographic. This means that targeted public health intervention is possible in order to prevent STD transmission. For example, the efforts to improve screening and treatment in the MSM population is clearly justified even for older men as they tend to be at high risk for repeat infection for early syphilis. However, additional studies are needed to identify behavioral characteristics of these high-risk groups as well. Questions that are still unanswered include:

1. Is injection drug-use an important indicator for high-risk among older populations?
2. What are the types of sexual intercourse (e.g. anal insertive, anal receptive, oral, vaginal) most common among older populations?
3. What are the venues for sex (e.g. bars and clubs, motels/hotels, home) for older adults?

Investigating the behavioral risk factors will enable additional behavioral interventions that can be implemented in targeted communities identified through this study (e.g. White, MSM, Metro SPA).

Finally, assessing the current state of treatment efforts for the older STD cases was important to detect gaps in care and follow-up prevention efforts. For a local jurisdiction such as Los Angeles County, it is not feasible to conduct field investigations on all of the reported STD cases. This means that health department staff will tend to lapse on case investigation of lower risk groups such as the older cases, leading to uncertainty as to whether they are being treated or not. Given that budget cuts are a constant challenge for STD programs (CDC, 2016), it is unlikely that more staff will be available to conduct thorough investigation of these neglected cases. Thus, creative solutions are needed such as upgrading the infrastructure for STD reporting to the health department as with lab reporting and collaborations with internal and external partners. Health care providers are the ones diagnosing and treating older patients, so outreach efforts targeted at the clinicians are essential. An example of the outreach effort would be to conduct a baseline survey assessing providers in a local jurisdiction (e.g. LAC) to see: 1) which are "high-volume" when it comes to patients 50 and older, 2) providers attitudes toward discussing sexual problems with older patients, and 3) current screening, diagnosing, treating, and reporting practices. The results of the survey can then be utilized to formulate and implement interventions targeted at the identified shortcomings. For example, STD education of providers and their patients can take place at the identified "high-volume" locations because that would reach the largest intended audience.

As the new generation of older adults lives longer, there is a need to take advantage of advances in medicine and behavioral health in order to keep them as healthy and active as possible. Improvements are needed in identifying cases of STDs in older people as there may be potential serious health consequences due to continued disease transmission, particularly among age-discordant relationships. These long-term health complications may arise more frequently among older adults because they may be less likely to be treated when first infected for various reasons including lack of symptoms and psychosocial barriers. Serious sequelae of STDs will contribute to rising health care costs among the elderly. Coupled with sexual behavior and attitude changes among this subpopulation, the issue of STDs in older people will become a significant public health burden if left unaddressed. Thus, it is important to continue studying and identifying gaps in knowledge regarding STD epidemiology among older persons. There will be more elderly people in the future who will continue to be sexually active, and thus research is needed in order to better prepare the health system to deal with this emerging issue.

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