# TRENDS IN *CHLAMYDIA TRACHOMATIS* INFECTION IN MARICOPA COUNTY ADOLESCENTS, 2006-2010

A Thesis submitted to the University of Arizona College of Medicine -- Phoenix
in partial fulfillment of the requirements for the Degree of Doctor of Medicine

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II. Abstract

*Objective and Hypothesis:*

*Chlamydia trachomatis* (CT) is the most common reportable sexually transmitted infection in the United States. Undiagnosed and untreated infection with the bacteria is known to contribute to sequellae involving high morbidity, including pelvic inflammatory disease, ectopic pregnancy, and tubal infertility. These negative outcomes are completely preventable by preventative screening and treatment. The purpose of this study is to illustrate and analyze the current picture of CT infection in Maricopa County, with the hope of reinforcing the need for targeted screening in high school and in populations of low socioeconomic status.

*Methods:*

A descriptive analysis was performed on state-reportable surveillance data for Maricopa County during 2006-2010.

*Results:*

CT infection is highest in young, adolescent females. CT incidence in adolescents remained between 1500 and 2000 cases per 100,000 population from 2006-2010 without a statistically significant trend upward or downward. Geographically, CT incidence was concentrated near central Phoenix. The most utilized provider types included private physicians, private clinics, and the public health department.

*Significance:*

Unfortunately, barriers exist that preclude adequate screening, including patients' access to healthcare, hesitancy to offer complete sexual histories, and lack of providers offering screening. Targeted preventative screening efforts, education, and counseling could be directed towards schools where teens would have enhanced access.

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V. Introduction/Significance

**Background**

*Chlamydia trachomatis* (CT) is an obligate intracellular bacteria responsible for more reportable sexually transmitted infections than any other agent nationwide. Over one million new cases were reported by the CDC in 2009, however estimates suggest the incidence is closer to 2.8 million, implying millions of undetected infections.[1] Untreated CT infection is associated with a significant and established risk of morbidity, including but not limited to pelvic inflammatory disease, ectopic pregnancy, and tubal factor infertility. Because CT infection is often asymptomatic, regular screening is integral to prevention and treatment. Additional attention is needed in adolescents especially due to a disproportionally high incidence in this age group.[2] The purpose of this study is to evaluate the incidence of CT among adolescents in support of the need for increased prevention strategies targeted to individuals aged 15-19 in Maricopa County.

Current United States Preventative Services Task Force (USPSTF) guidelines recommend annual CT screening for all sexually active females under the age of 25.[3] A report by Datta et al analyzed National Health and Nutritional Examination Survey (NHANES) data to show an overall decreasing national CT burden. However, the study also demonstrated no change in incidence among females aged 14-25, the population specifically targeted by current screening guidelines.[4] CT screening is one of the most valuable and effective efforts among all evidence-based clinical preventative services recommended by the USPSTF as found by the National Commission on Prevention Priorities. Unfortunately, this service is also one of the most underutilized among high-ranking preventative services. This may be a result of paradoxical emphasis on screening populations at lower risk for CT, such as older women.[5]

While 2013 national sex education legislation requires all Arizona school districts to provide "comprehensive, age appropriate and medically accurate" sex education, Title V federal funding for abstinence-only education in Arizona has fostered a culture resistant to implementation of prevention strategies for sexually transmitted diseases in adolescents.[6] As recently as 2009, Governor Jan Brewer announced her intention to accept additional federal money to fund abstinence-only education in Arizona schools.[7] In 2004, the Advocates for Youth committee published a 5-year follow-up article reporting the effectiveness of Title-V-funded abstinence-only education in 10 states, including Arizona. After 5 years, the report showed that in spite of over $1 million in Title V abstinence-only federal funds, that almost 50% of abstinent youth expected to be sexually active in one year and that 80% expected to be sexually active by age 20. In addition, 19% of Arizona program participants were already sexually active at follow-up.[8] Current attitudes regarding the acknowledgement of adolescent sexual behavior continue to be a significant and difficult barrier to screening young people for CT.

Challenges to offering CT screening following USPSTF guidelines are multifactorial. In addition to resistance to preventative education, failure to screen also stems from provider and even patient-centric issues. A study by Wiehe et al sought to analyze current CT screening levels in young Indianapolis women and attempted to explain low screening compliance. This retrospective cohort study compared data from roughly 23,000 women between the ages of 14-25 to see how effectively clinical practice adheres to USPSTF guidelines. This study found that biases exist in a provider's decision to offer screening to young sexually active female patients for CT. The results of this study reflect that other factors, which are not the focus of national guidelines, influence providers' decision to screen. These other factors include patient

age, race, ethnicity, and insurance status.[9] Because of these existing biases, many women infected with CT may be excluded from screening even if they are at high risk for infection. This publication demonstrated that nearly one half of sexually active young women did not receive indicated screening due to provider biases.[9] Although this article is based in Indianapolis, it is reasonable to infer that these biases also occur among Maricopa County providers.

Government policy and provider bias are not the only barriers to screening. Another significant challenge to offering screening in young people is collecting adolescent sexual histories. In addition to presenting physician's shortcomings of collecting sexual histories for the purposes of screening, a review article by Cooksey et al also places responsibility on the patients themselves. Barriers such as fear of social stigma, fear of abuse by a sexual partner, and the adolescent developmental mindset of invulnerability are all reasons adolescents may not seek screening on their own.[10] A study by Gaydos et al also cites reasons such as lack of insurance, privacy and confidentiality concerns.[11] Even though adolescents in all 50 states and DC may request screening without parental consent,[12] billing statements addressed to parental policy-holders may present a significant barrier to confidentiality for teens living at home. These patient-centered barriers to screening support the need for the availability of confidential, targeted screening opportunities for Maricopa County adolescents.

In addition to accessibility issues and compliance with guidelines, the morbidity of undetected and untreated CT infection also support the need for active, targeted screening efforts. The majority of genital CT infections both in males and females remain asymptomatic, which provides yet an additional reason why at-risk individuals do not seek care. Untreated CT can ascend to the upper genital tract leading to serious sequellae in females that can result in

permanent effects on reproductive health. According to the CDC, untreated CT infection can lead to pelvic inflammatory disease (PID), inflammation of the uterus, fallopian tubes, and ovaries, and increased incidence of ectopic pregnancy. CT infection is attributed as the leading cause of tubal factor infertility (TFI). Specifically CDC estimates suggest that 10-15% of CT infections result in PID, and once PID occurs, another 10-15% of cases will lead to TFI.[1] Another study by Price et al sought to elucidate the difference between TFI caused by previous CT infection and TFI with concurrent CT infection. The analysis corrected for the sensitivity and specificity of current testing and found that up to 45% of TFI can be reasonably attributed to CT infection.[13]

**Impact**

Addressing the need for increased targeted CT prevention in adolescents has a two-fold impact. First, the morbidity of untreated CT infection could be largely avoided. Second, the costly treatment of CT-related complications could be greatly reduced. In fact, the direct medical costs of CT, including diagnosis and treatment of CT-induced infertility amount to over $300 million annually.[14] Additionally, the cost of treating progression of untreated CT infection to PID is estimated at $1,995 per case.[15] In contrast, one Aptima NAAT screening test costs roughly $14.[16] The Arizona Department of Health Services (AZDHS) reported the cost of azithromycin, which is the first line treatment for CT between $2-10 in 2008.[17] Even a small reduction in the number of untreated CT infections through screening and treatment efforts could make a significant difference in this public health burden. With an estimated 1.6 million cases of CT going undiagnosed every year,[1] it is clear that additional efforts are needed to bolster screening in risk groups and among adolescent women in particular.

**Goals and Objectives**

The goal of this study is to increase support for more effective CT prevention strategies targeted to Maricopa County adolescents. The proposed project has several objectives. First, we would like to present current CT incidence in Maricopa County stratified by age, zip code and provider type. This will identify risk populations and possible locations in the county to focus targeted screening efforts. Our second objective is to compare current data to incidence over a 5-year period (2006-2010) to identify emerging risk areas and/or populations. Our third objective is to reinforce the need for targeted prevention screening in risk populations. Once incidence trends in Maricopa County have been established and risk zones have been assessed, focus can then be directed at increasing awareness of screening and sexual health in Maricopa County adolescents. Our fourth objective will utilize a thorough search of the literature to suggest a model for screening efforts in Maricopa County.

VI. Materials and Methods

**Data Source and Study Population**

Data for this study was sourced from the state surveillance system of reportable diseases at the County level with no personal or unique identifiers included. The study population consisted of all individuals reported with positive CT result from 2006-2010. Available variables included demographic data (age, sex, zip code) as well as provider type. The study population consisted of individuals in the 15-19 year age group at the time of their positive test result. An expedited IRB was approved through the University of Arizona.

**Analysis**

A descriptive analysis including positivity and rate was conducted to assess CT trends in Maricopa County over a 5-year span. Incidence was calculated by dividing reported positive cases for each year by population denominators published by AZDHS for each applicable year.[18] The outcome of interest was trends in CT incidence in Maricopa County adolescents (ages 15-19) specifically. The analysis was completed using JMP Pro statistical software, version 9.0.3 (SAS Institute Inc., Cary, NC).

VII. Results

From 2006-2010, 73,283 total positive CT test results were reported to the CDC from Maricopa County (Table 1). Of these, 54766 (75%) were female and 23,282 cases (32%) were reported among adolescents ages 15-19. Figure 1 shows a distribution of CT cases by gender for each year 2006-2010. The number of adolescent CT positive cases reported in individual years 2006-2010 were 3,866, 5,375, 4,506, 4,666, and 4,869, respectively. Positive CT results were reported from greater than 12 provider types. The top 3 provider types in Maricopa County were private facilities, the health department, and private physicians, respectively. Of the 73,283 total cases reported during the study time period, 60% were reported by a private provider or health care system, 14% by the health department, 7.7% by a public facility, 7.0% by a Planned Parenthood clinic, and 4.2% by Indian Health Services (Table 1).

A distribution of all cases for 2006-2010 demonstrates an increase in case numbers during adolescence with a peak in the early 20s and a progressive decline in older age groups (Figure 2). Reported CT cases in the adolescent age group remain stable from 2006-2010 when individual years are considered separately (Figure 3).

CT incidence in adolescents remained between 1500 and 2000 cases per 100,000 population from 2006-2010 without a statistically significant trend upward or downward (Table 2).

Of the 4869 adolescent CT cases in 2010, 3697 (75%) included a zip code of residence. A geographical analysis of these data demonstrated that cases reported during 2010 are concentrated mostly in the central Phoenix zip codes. The zip codes with the highest numbers of positive CT tests were 85035 (103 cases), 85041 (121 cases), and 85301 (124 cases) (Figure

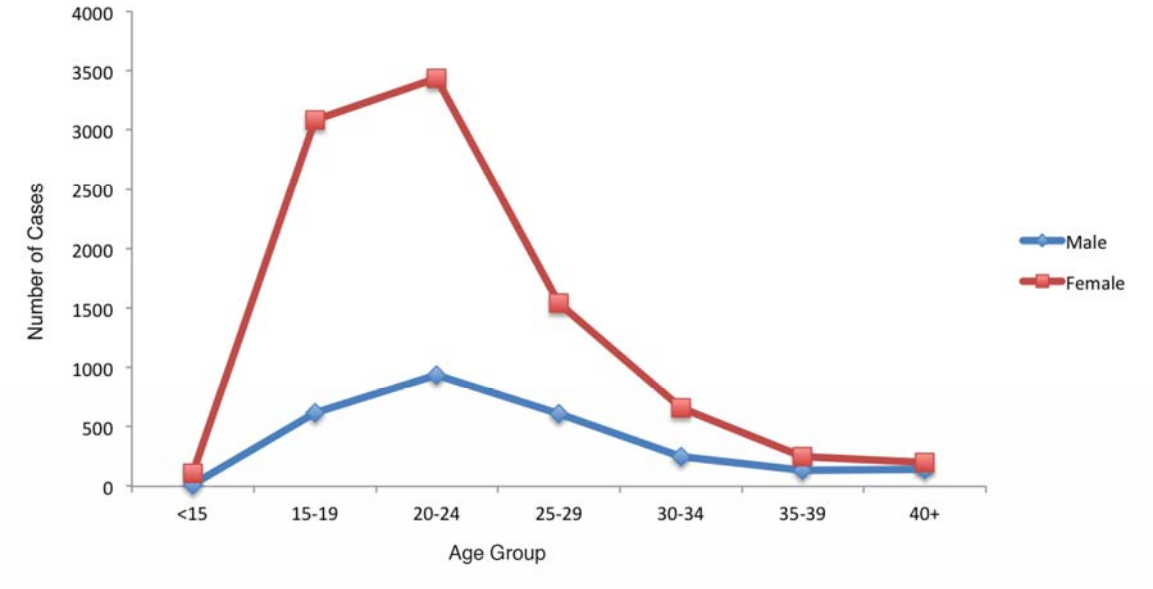
4). These three zip codes together account for almost 10% of all reported CT in Maricopa County.

**Table 1: CT cases 2006-2010, Maricopa County, AZ (N = 73,283)**

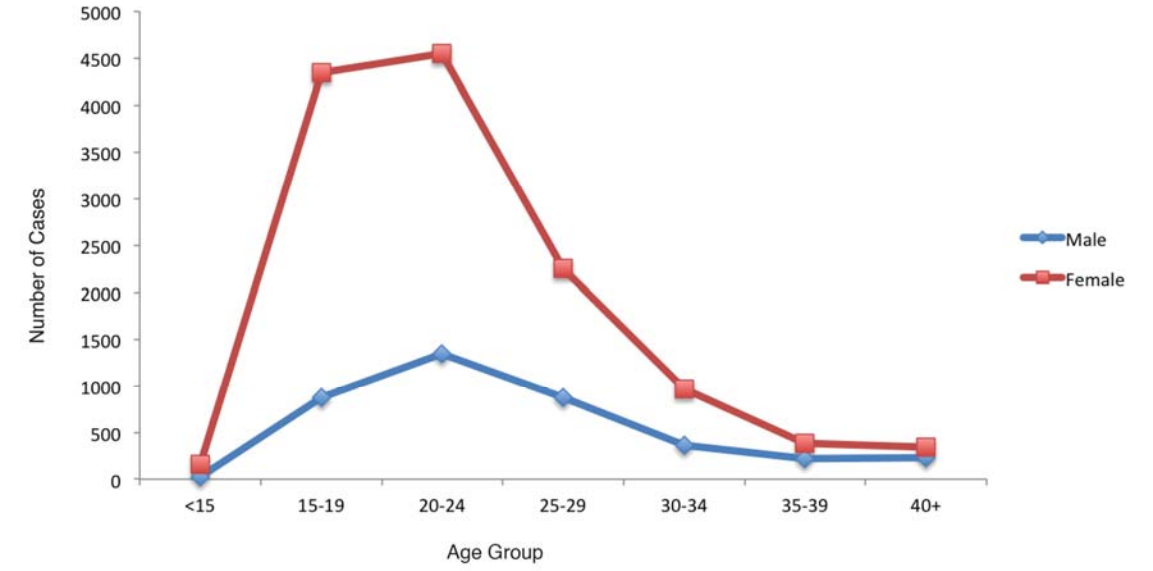
| | 2006 | 2007 | 2008 | 2009 | 2010 | 2006-2010 |
|---|---|---|---|---|---|---|
| **Gender** | | | | | | |
| Male | 2699 | 3934 | 3341 | 4078 | 4452 | 18504 |
| Female | 9283 | 13002 | 10321 | 10675 | 11485 | 54766 |
| Unknown/Transgender | 6 | 3 | 1 | 1 | 2 | 13 |
| | | | | | | 73283 |
| **Age Group** | | | | | | |
| <14 | 131 | 176 | 160 | 140 | 153 | 760 |
| 15-19 | 3704 | 5224 | 4439 | 4539 | 4761 | 22667 |
| 20-24 | 4372 | 5898 | 4861 | 5266 | 5896 | 26293 |
| 25-29 | 2152 | 3131 | 2284 | 2562 | 2679 | 12808 |
| 30-34 | 906 | 1329 | 999 | 1164 | 1267 | 5665 |
| 35-39 | 383 | 611 | 515 | 543 | 641 | 2693 |
| >40 | 340 | 570 | 405 | 540 | 542 | 2397 |
| **Provider Type** | | | | | | |
| Private Physician | 1552 | 2116 | 1687 | 1439 | 1718 | 8512 |
| Private Facility | 5871 | 8664 | 6513 | 6844 | 7610 | 35502 |
| Private PA/Nurse/Other | 15 | 4 | 1 | 3 | 1 | 24 |
| Public Facility | 780 | 1177 | 1039 | 1149 | 1495 | 5640 |
| Indian Health Services | 541 | 575 | 687 | 596 | 667 | 3066 |
| Health Department | 1318 | 1912 | 1723 | 2681 | 2642 | 10276 |
| Family Planning | 10 | 32 | 17 | 12 | 20 | 91 |
| Planned Parenthood | 970 | 1270 | 1130 | 1067 | 728 | 5165 |
| Correctional Facility | 527 | 595 | 416 | 383 | 414 | 2335 |
| Military | 83 | 162 | 113 | 222 | 187 | 767 |
| Public School | 190 | 203 | 122 | 154 | 130 | 799 |
| Private School | 0 | 1 | 0 | 0 | 0 | 1 |
| other/not specified | 131 | 228 | 215 | 204 | 327 | 1105 |

**Figure 1: Distribution of CT cases by Gender (A-E)**

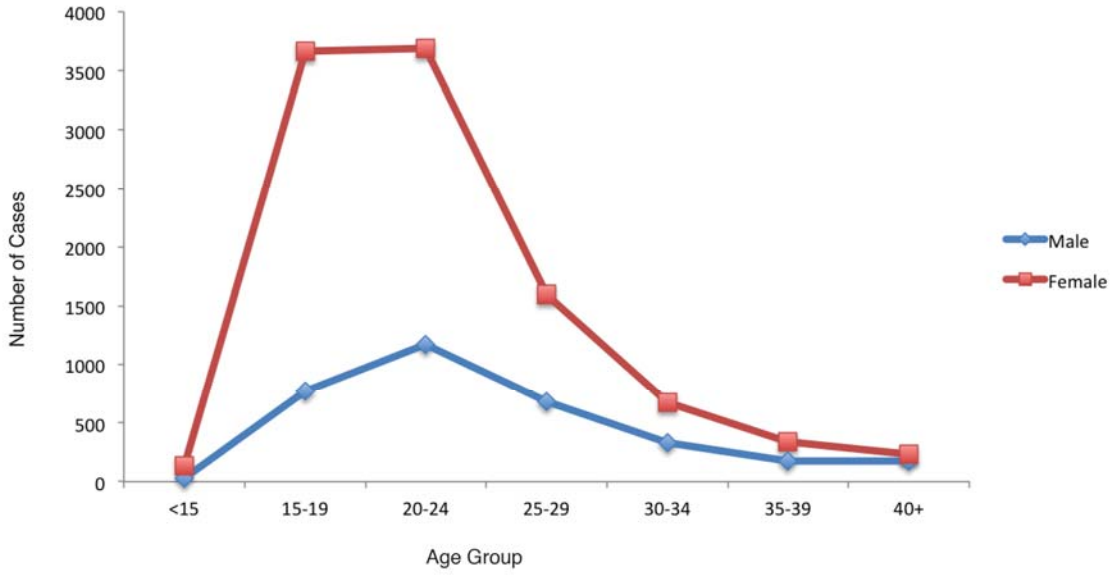
A. 2006



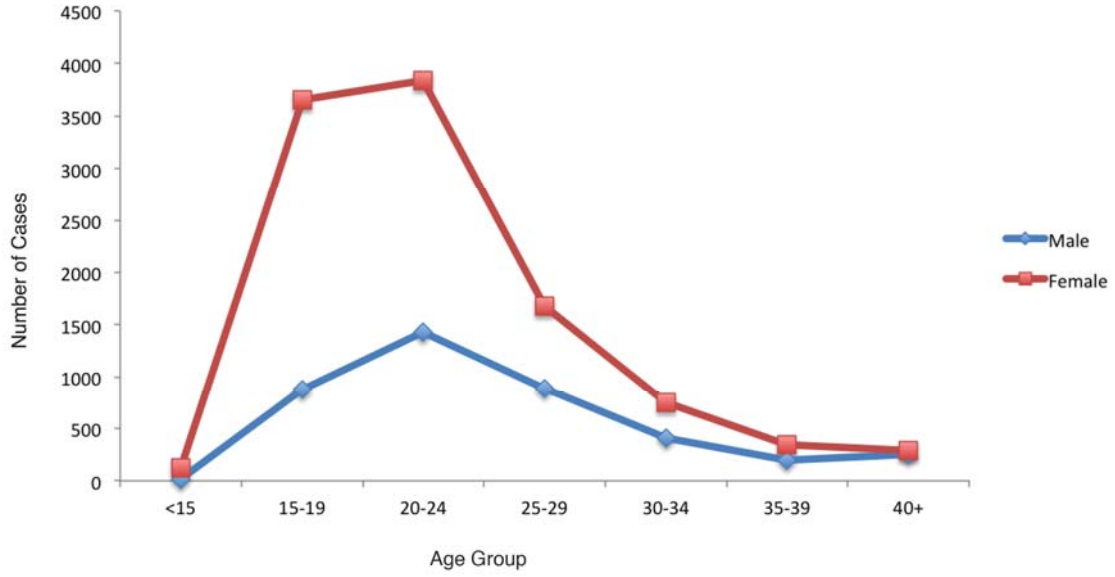

B. 2007



C. 2008


4000
3500
3000
2500
2000
1500
1000
500
0
Number of Cases
<15
15-19
20-24
25-29
30-34
35-39
40+
Age Group
Male
Female

D. 2009


4500
4000
3500
3000
2500
2000
1500
1000
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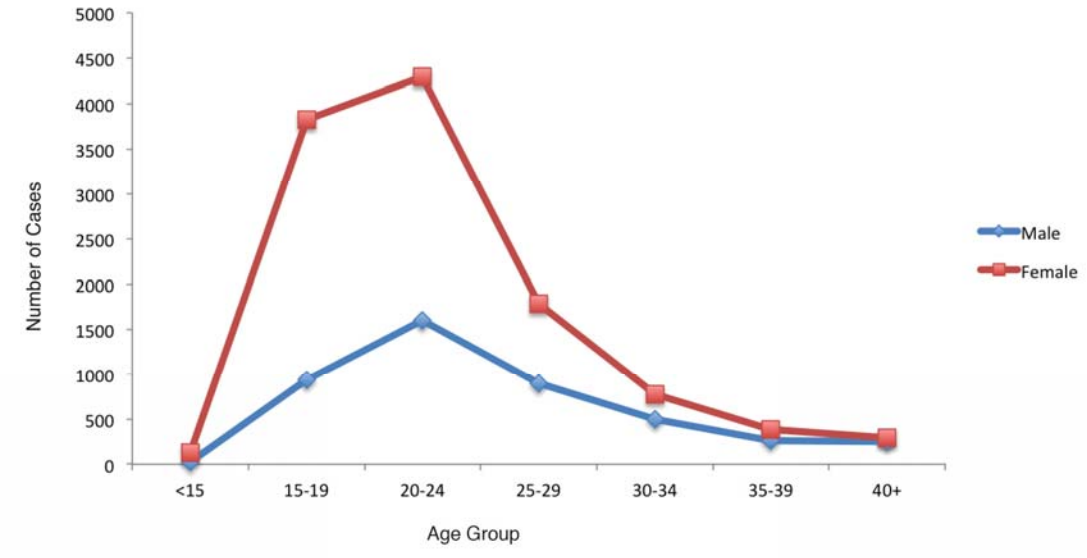
0
Number of Cases
<15
15-19
20-24
25-29
30-34
35-39
40+
Age Group
Male
Female

E. 2010


5000
4500
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Number of Cases
<15
15-19
20-24
25-29
30-34
35-39
40+
Age Group
Male
Female

**Figure 2: Age Distribution of CT Cases in Maricopa County 2006-2010**

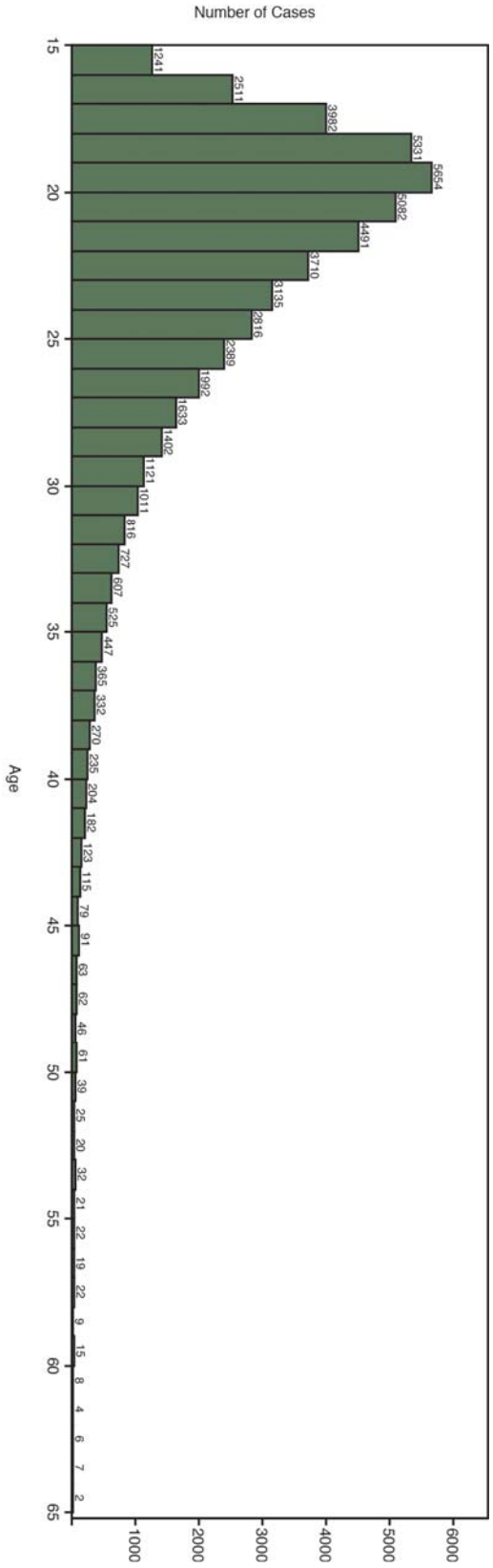


**Figure 3: Adolescent CT Cases by Age, Maricopa County 2006-2010**

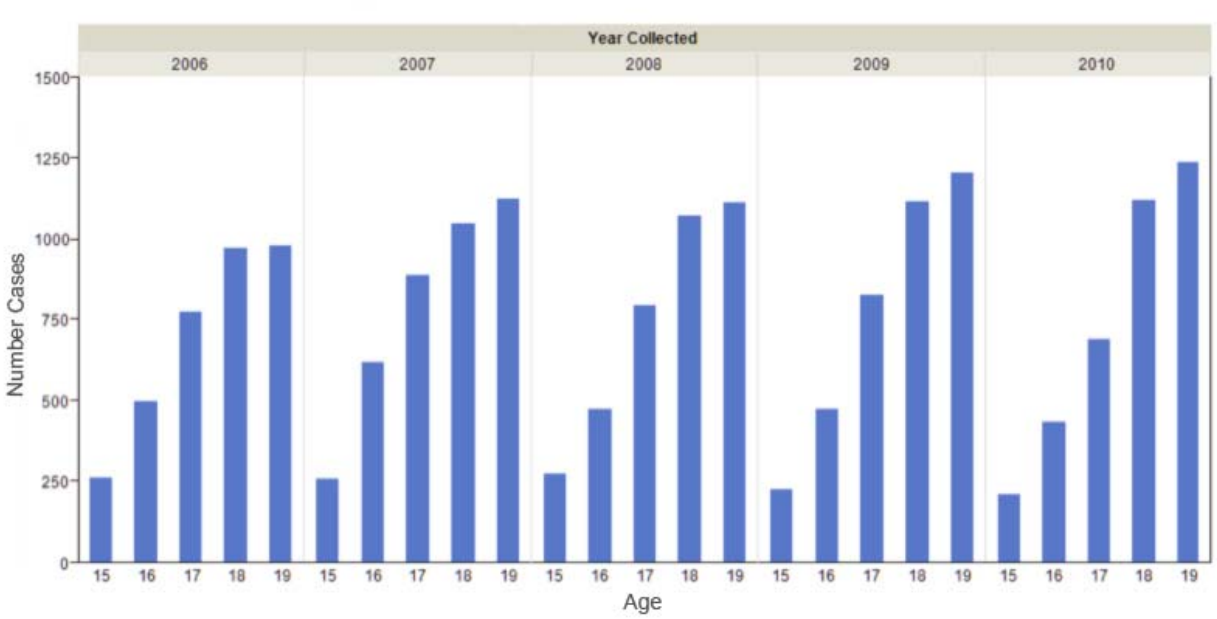
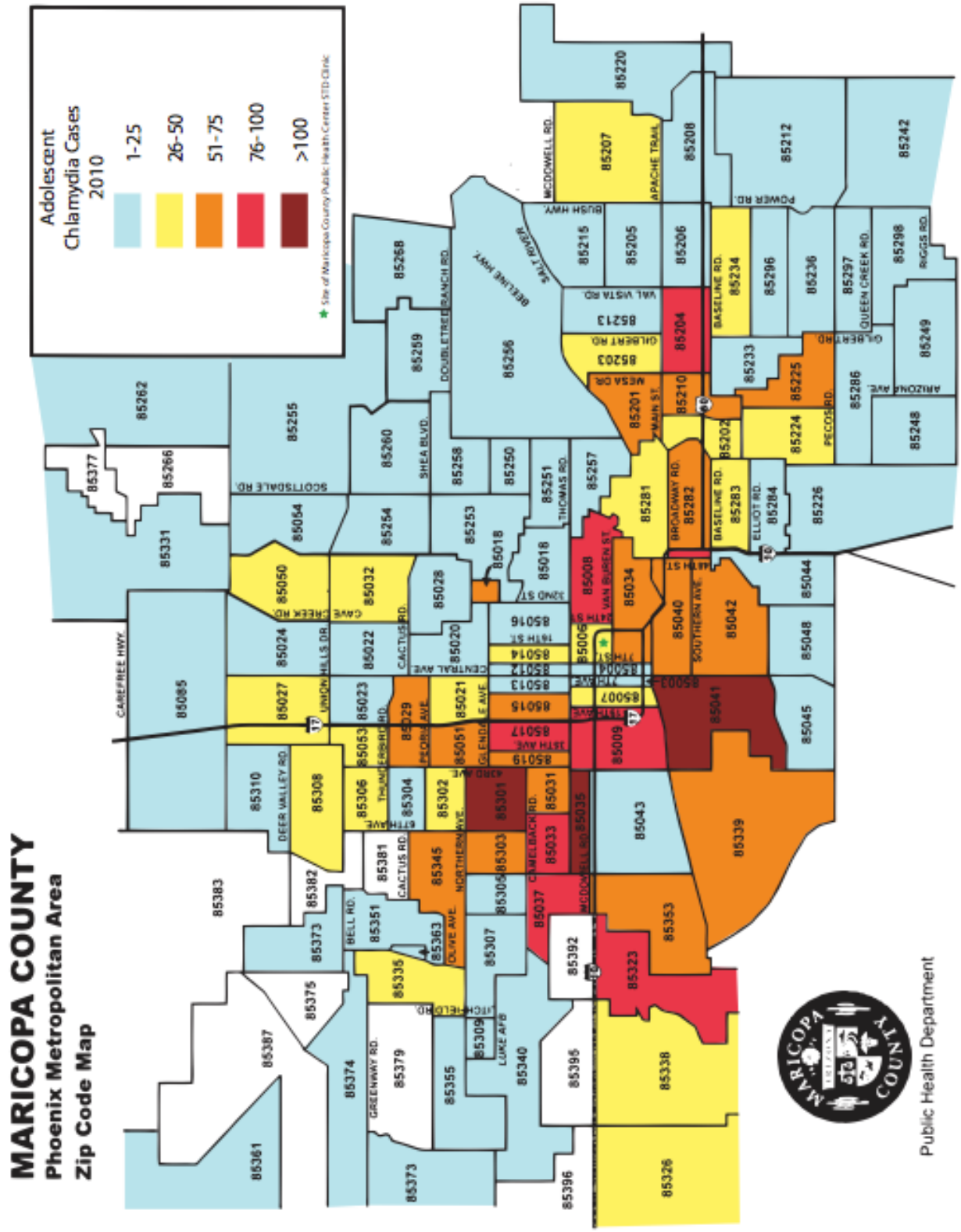


**Table 2: Adolescent CT Incidence by Year**

| | Cases per 100,000 population |
|---|---|
| 2006 | 1,520 |
| 2007 | 2,080 |
| 2008 | 1,720 |
| 2009 | 1,770 |
| 2010 | 1,760 |

**Figure 4: Adolescent CT Cases by Zip Code**



VIII. Discussion

Our analysis demonstrates that reported CT cases in adolescents in the 15-19 year age group has not changed significantly during 2006-2010 in Maricopa County. The majority of cases were diagnosed among adolescent women. These findings are consistent with analyses conducted on other national databases. Private providers and private health care systems reported the majority of infections in our sample. Certain zip codes had higher case numbers, which were primarily located in central parts of the Phoenix area. These findings will be used to target high morbidity areas and diagnosing providers with outreach testing and education interventions.

Data collected through the NHANES from 1999-2008 showed that overall CT incidence is decreasing on a national level, but positivity in adolescents remains unchanged at around 2.5%.[4] The Infertility Prevention Project, a national CT screening program, also reported that CT positivity is remaining stable at about 7.0% in the 14-25 year age group.[19] CDC reported data, in contrast, suggest that CT incidence in Arizona is increasing, contributing to a common conception that CT rates are continuing to rise.[20] Increasing reports of CT incidence may be related to higher utilization of Nucleic Acid Amplification Test (NAAT) technology, which is much more sensitive than previous methods used for screening, such as cell cultures, enzyme immunoassays or DNA hybridization probes.[21] In 2000, 24% of all CT tests by participating public health laboratories were NAATs.[22] By 2004, this number increased to 64%.[23]

CT incidence among adolescents in Maricopa County has held steady between 1500 and 2000 cases per 100,000 population from 2006-2010. The fact that adolescent CT incidence in Maricopa County remains unchanged in spite of the enhanced use of higher sensitivity testing is

indicative that targeted screening and treatment is not occurring. Access to care is a significant issue to teens, who encounter additional barriers to obtaining STD testing. Some of these barriers have already been discussed and include privacy issues, provider bias, and access to transportation. Analysis of positive tests among all provider types in Maricopa County showed highest reporting from private clinics and physicians as well as the public health department. Public and private schools are among the least likely institutions to report positive CT results, likely because screening is not offered in this venue.

The proportion of adolescent female positive cases during 2006-2010 was significantly higher than that of adolescent male cases. This gender disparity is also shown when all age groups are considered together. CT is transmitted almost exclusively by sexual intercourse, with a small number of cases arising from vertical transmission from mother to infant during birth. An article by Chen et al suggests that the reason for this reported gender difference is likely because of focused research and screening strategies targeting women despite knowledge that infection among males and females is similar.[24] Women are more likely to develop the most severe complications from CT infection and so they are more targeted for testing. This is supported by current USPSTF screening guidelines, which only recommend regular screening in females, specifically under the age of 25.[3]

An analysis of adolescent positives by zip code showed the highest concentration near the center of Phoenix. The zip codes with the highest number of reported cases range from 3 to 10 miles from the Maricopa County Public Health Service (MCPHS), where STD testing is provided for free or a reduced cost of $20.[25] Adolescents living in high-risk zip codes may have difficulty obtaining screening if transportation to this provider is unavailable. Thus, a potential

benefit could come from enhancing screening efforts at institutions to which teens have more direct access, such as their school nurse's office, a family planning clinic, or Planned Parenthood.

Maricopa County is not the first region that has considered implementing increased screening opportunities for young people. A Baltimore study found that adolescent CT prevalence was higher than the national estimated prevalence. The authors of this study specifically suggest implementing school-based screening programs in order to address the problem.[26]

Many jurisdictions have made confidential STD testing and treatment available to high school students resulting in decreased CT infection rates. For example, in 2002 Philadelphia began a school-based education, screening, and treatment initiative including all publicly funded high schools in Philadelphia County. A 2008 analysis by Fisman, et al sought to determine the cost effectiveness of the Philadelphia screening model. Fisman's group constructed a dynamic transmission model to simulate CT infection trends after the introduction of the Philadelphia public school screening program. The model found that screening high-school aged males and females is "extremely" cost effective.[27] Ultimately, the Fisman model supported Philadelphia screening efforts as effective several years after implementation.

Washington DC also announced its plans to offer STD screening services to all high school students in 2010. No publications have yet analyzed DC's new program. However, DC council member David Catania reported that the new program had met with little community opposition in spite of an environment that does not condone sexual activity in teens.[28] The fact

that additional regions are following Philadelphia's example shows an emerging trend in examining the screening and treatment of high school students as a strategy for decreasing the public health burden of CT infection. Several strategies are available to increase access to screening in high school age populations. The Philadelphia and Washington DC programs allowed students to confidentially provide urine samples at school with results reported by telephone.

Several other under-utilized strategies could be implemented to increase screening opportunities. A study by Hoover et al found that CT screening by OB-GYNs was missed 69% of the time during pelvic exam visits and 71% of the time during Pap-exam visits.[29] This study also found that 99% of the time, screening was not done in primary care settings where urinalysis was performed, another missed opportunity.[29] Each of these three settings are great opportunities for improvement for CT screening. If CT screening was paired with a routine reproductive health procedure such as pelvic or Pap exams, or in the primary care setting with urinalysis, it is possible that more providers would be compliant with guidelines. Missed opportunities such as this are also likely occurring in Maricopa County, supported by the finding that private providers are the highest reporters for CT infections. This is an indicator that offering alterative testing sites and testing modalities could improve adherence to screening guidelines and access to treatment.

An additional testing modality to urinalysis screening would be implementation of a vulvo-vaginal swab kit. Vaginal swabs have the advantage of being easily self-collected, minimally invasive, and discretely transported to the laboratory. A study by Geisler et al found that NAAT testing performed on self collected vaginal swabs were actually more sensitive than

that performed on first-catch urine.[30] An additional study by Schoeman et al compared vaginal swabs to endocervical swabs combined with NAAT testing. The study found that endocervical swabs could miss up to 10% of infections, which were later identified from vaginal swabs.[31] This is significant because a speculum exam is not necessary to perform CT screening. Accurate, sensitive screening efforts can be implemented resulting in increased compliance with national guidelines without a Pap exam or urinalysis.

Self-collection for CT screening has been utilized with optimistic results. In the study by Gaydos, et al, differences in CT infection prevalence among participants of an internet-based home specimen collection request system in Baltimore, MD were compared to those that visit family planning clinics. The results of this study demonstrate that an internet-based system could serve as an additional tool that may appeal to high-school age women who either do not have access to health care or who do not wish to go to a clinic.[11] The study also suggests that adolescents may benefit from an internet-based request system to avoid privacy or confidentiality concerns. This innovative approach could even be applied in areas of low socioeconomic status where internet access is not guaranteed. If home testing kits were available to pick up at school, teens could still benefit from the increased perception of privacy. In contrast, a study by Jenkins, et al tested the utilization of self-obtained sample kits and found that this method has the potential to be highly effective if target populations can be adequately informed an engaged. In this study, testing kits were made available at three dormitories at a small liberal arts college in Illinois and through internet request. Unfortunately, participation by students proved poor at under 3%. Lack of awareness of test availability was cited as a major

reason for underutilization of this screening method.[15] This study underlines the need for targeted efforts that also adequately inform teens of available testing measures.

Another important factor to consider is the psychosocial impact of CT testing. The USPSTF gives an "A" recommendation to screening sexually active women under the age of 25. This indicates that the benefits outweigh the potential harms, but the harms have not been formally assessed. Since testing is non-invasive, inexpensive, and treatment can prevent many serious complications, it is easy to overlook possible harms. A prospective study by Gottlieb et al sought to consider and weigh potential harms associated with CT screening. Gottlieb et al found that positive test results do have increased negative psychosocial consequences including anxiety, disruption in relationships, and the possibility of falsely negative results. Ultimately, the authors do not suggest that harms associated with testing should deter screening. Rather, their assessment highlights the need for appropriate counseling and educational efforts on STD transmission and treatment in conjunction with screening tests in order to minimize psychosocial impact and relationship break-ups.[32] This is especially important in low prevalence areas where false positives are more likely to occur.

There are several limitations to our study. Interpretation of state surveillance data for STDs including CT is complicated by multiple variables. Since up to 80% of women have no symptoms, those infected with CT remain unaware and might not seek preventative care. Individuals with symptoms might still not pursue testing due to access to care issues. This leads to incomplete reporting and an underestimation of true positive rate. Even though NAAT is widely accepted as the most effective test for detecting CT, other screening modalities and collection methods are still utilized which all have varying levels of sensitivity and specificity.

The nature of surveillance data also precludes a full statistical analysis of collected results. State reported data only include positive tests, which cannot account for infected people who are not tested. Since negative results are not reported, positive proportions are not known, thus only allowing for basic descriptive analyses. Population denominators used to calculate incidence assume that anyone without a positive result has been tested and has received a negative result, which further contributes to underestimation of true CT prevalence. Thus, data trends presented in this report should be interpreted with caution.

Finally, current screening guidelines only recommend screening in young women, which leaves a significant untested male reservoir of infection.

## IX. Future Directions

The data presented here represents the adolescent CT trends for Maricopa County for 2006-2010. Future directions in this project could include analysis of additional years of surveillance data to update trends. Ideally, this study could serve as a reference in support of implementation of additional or enhanced screening opportunities for adolescents. A program tailored to the needs of Maricopa County adolescents could increase screening and compliance. One such method to accomplish this would be to make self-collected vaginal swab kits, as well as disease education and counseling, available in public high schools. Other effective venues could include Planned Parenthood and family planning clinics.

## X. Conclusions

CT incidence is disproportionately high in the adolescent population, especially females. Infection can remain undetected and asymptomatic while simultaneously causing permanent and irreversible reproductive morbidity. CT is readily detectable and curable, yet rates among adolescents in Maricopa County remain disproportionately high due to a wide range of barriers to care. Sexually transmitted infections such as CT are a continuing public health problem that will not resolve without additional intervention. Screening and treatment is cost effective and reduces associated morbidity. Enhanced screening is consistent with current national guidelines. Maricopa County adolescents are likely not receiving adequate screening as recommended by the USPSTF. Compliance with national screening recommendations can be improved by addressing accessibility and ease of testing. Making CT screening available and increasing awareness in public schools is one way to accomplish this.

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