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Sociodemogrpahic and Behavioral Correlates of STD Biomarker Outcomes

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Abstract

Young adults experience the highest rates of sexually transmitted diseases (STDs) in the United States and gender and racial/ethnic differentials in STD prevalence persist. Rich data are available to investigate an array of sociodemographic and behavioral risk factors that might explain variation in STD infection. These data also include biomarker test results enabling an investigation of *current* infection among a population-based sample of youth. We use data from Wave III of the National Longitudinal Study of Adolescent Health (Add Health) to examine sociodemographic and behavioral risk correlates of STDs, using nested binary logistic regression techniques. We consider whether respondents who refused or were unable to provide urine samples differ from those who provided urine samples. We also consider whether respondents whose specimens were not used, or whose specimens were used but for whom no definitive test result was obtained, differ from individuals for whom definitive test results were obtained. Finally, we explore sociodemographic and behavioral correlates of positive test results for those for whom definitive test results were obtained. All analyses are weighted and account for the complex study design of Add Health. Current STD infection is associated with a number of sociodemographic characteristics, including age, gender, and race/ethnicity, the effects of which differ depending on the specific pathogen. The effects of the sociodemographic characteristics remain even after accounting for differences in sexual risk behaviors. Future research should explore the contribution of partner characteristics and behaviors as well as sexual networks in explaining variation in STD infection.

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Introduction

Adolescents and young adults have the highest rates of sexually transmitted diseases (STDs), and comprise the target population of national public health strategies aimed at reducing transmission and acquisition of STDs (IOM, 1997). Recent estimates suggest that of the 18.9 million cases of STDs in 2000, 48 percent were among persons ages 15-24 (Weinstock, Berman, & Cates 2004), with the highest age-specific rates of chlamydia and gonorrhea occurring in this age group (CDC, 2000). Young women, racial and ethnic minorities, and the economically disadvantaged are disproportionately burdened by these diseases (CDC, 2000). A more comprehensive examination of the sociodemographic and behavioral risk factors that are associated with an increased risk of acquiring these pathogens will provide a better understanding of the reproductive health burden of young adults and aid in the development of appropriate intervention strategies aimed at this group.

Adolescents and young adults have been the subject of many STD-related studies. However, this research has been of limited generalizability or based on indirect information about STDs (i.e., self-reported histories). Clinical studies and population-based sample surveys are the primary sources of information for studying STD status and risk. Data obtained from clinical samples include biomarker results for STD outcomes, which are highly sensitive and specific, and most accurately assess STD status. Clinical samples, however, afford a highly limited basis for generalization to the population(s) from which the samples are drawn, despite the quality of the information. Clinical samples tend to be more homogeneous with respect to sociodemographic characteristics and reflect a different risk behavior profile than the general population. Results from clinical samples are often selective of infections among members of minority groups and

the economically disadvantaged, and individuals often seek treatment at clinics because they are symptomatic, resulting in an under-representation of asymptomatic infections (Brackbill, Sternberg, & Fishbein, 1999, Howards, Thomas, & Earp, 2002; Manhart et al., 2004). Population-based sample surveys are well-suited to the characterization of the distribution of STDs in the population and provide a comprehensive set of potential explanatory factors. Until recently, it has not been feasible to combine the sampling design advantage of surveys with biomarker measurement of STD presence. Instead, studies based on surveys have relied on self-reported STD histories obtained by interviewers, self-administered questionnaires, or CASI or audio-CASI methods. These types of reports are indirect reports of STD prevalence. The disadvantages of indirect reporting are the potential for random and especially nonrandom reporting error introduced by the respondent in addition to measurement error inherent in biomarker testing. Furthermore, many infections are asymptomatic (IOM, 1997) and data based on self-reports may underestimate the true prevalence in a population.

The objective of the current study is to examine the sociodemographic and behavioral risk correlates of STDs using a population-based sample survey *and* per-individual STD biomarker test results. This research is made possible by the inclusion of biomarker measurement in Wave III of the National Longitudinal Study of Adolescent Health (Add Health). In addition to the ability to investigate biomarker test results for STDs among a large, nationally representative sample of contemporary young adults, we are also able to utilize a more comprehensive and detailed set of individual sociodemographic and behavioral measures that are not usually available for data of this nature. Specifically, we examine the effects of age, gender, race/ethnicity, nativity status, education and school enrollment status, employment status, union status, and a number of

sexual risk behaviors, including number of sexual partners, condom use, and frequency of sexual activity, on STD biomarker test results. We utilize nested binary logistic regression techniques that are weighted and account for the complex study design of Add Health. First, we assess whether respondents who refused or were unable to provide urine samples differ from those who provided urine samples. Second, we consider whether respondents whose specimens were not used, or whose specimens were used but for whom no definitive test result was obtained, differ from individuals for whom definitive test results were obtained. Third, we explore sociodemographic and behavioral risk correlates of positive test results for those for whom definitive test results were obtained.

Background and Conceptual Approach

There are over three million estimated new STD cases per annum, and adolescents and young adults are disproportionately affected by the diseases (IOM, 1997). Chlamydia (*Chlamydia trachomatis*), gonorrhea (*Neisseria gonorrhoeae*), and trichomoniasis (*Trichomonas vaginalis*) account for the vast majority of curable STD cases in the United States (IOM, 1997). Chlamydia is the most commonly reported disease in the U.S. (CDC, 2000). Reports of chlamydia increased in the 1990s. This is most likely due to improvements in reporting and testing technology as well as expansions in screening programs. Untreated chlamydia can lead to pelvic inflammatory disease (PID), ectopic pregnancy, infertility, and chronic pelvic pain. The high degree of asymptomaticity (as much as 70 percent of cases (IOM, 1997)) makes these negative sequelae more likely. Although prevalence of gonorrhea has declined over the past few decades, high rates are a continuing concern for adolescents and young adults. Untreated gonorrhea can have similar adverse consequences (CDC, 2000), and approximately 50

percent of gonorrheal infections in women are asymptomatic (Hook & Handsfield, 1999). Although trichomoniasis is not a reportable STD, the prevalence of this infection is often higher than that of chlamydia and gonorrhea, and its occurrence in individuals is associated with pregnancy complications and an increased risk for HIV infection (Schwebke & Burgess, 2004).

Estimates of STD rates are improved by the inclusion of biomarker tests in population-based surveys not only because of the accuracy of the tests, but also because probability sampling is used to sample a known population. Other than Add Health, only a few population-based surveys have collected biomarker data on sexually transmitted pathogens. Data from the National Health and Nutrition Examination Survey (NHANES III) indicate that the seroprevalence of genital herpes simplex type 2 (HSV-2) was 22 percent among individuals aged 12 and older in the mid-1990s (Armstrong et al., 2001). The National Survey of Adolescent Males (NSAM 1995) reveals that 3.1 percent of men aged 18-19 and 4.5 percent of men aged 22-26 were infected with chlamydia at the time of interview, the majority of whom were asymptomatic and had not been diagnosed (Ku et al., 2002). Results from the Baltimore STD and Behavior Survey (BSBS) indicate an estimated prevalence of 5.3 percent for gonorrhea and 3.0 percent for chlamydia among 18-35 year olds (Turner et al., 2002). These data also suggest that there are differences in the determinants of self-reported STD ("ever had") compared to current gonorrhea and/or chlamydial infection based on biomarker tests (Rogers et al., 2002). In a small pilot study using a convenience sample of participants aged 12 to 39 years from NHANES III, investigators found that chlamydia prevalence was highest among non-Hispanic blacks (7 percent), followed by Hispanics (3 percent) and non-Hispanic whites (2 percent), higher

for women than men, and highest among those in the 15-19 and 20-24 age groups (Mertz et al., 1998).

Prevalence rates for chlamydia and gonorrhea by gender and race/ethnicity based on the Add Health Wave III biomarker test outcomes have been presented by Miller and colleagues (2004). Overall prevalence was 4.2 percent for chlamydia and 0.4 percent for gonorrhea, with a slightly higher prevalence of chlamydia observed for women (4.7 percent) than men (3.7 percent). The prevalence of chlamydial and gonorrheal infection significantly differed by race/ethnicity and was highest among black women and black men. We not only focus on gender and race/ethnicity, but other sociodemographic factors and risk behaviors that may affect STD variation and potentially explain some of the gender and racial/ethnic differentials in risk. This paper extends recent investigations by including men *and* women, a more diverse set of racial and ethnic groups, a number of important sociodemographic and behavioral risk factors, and using biomarker data for three epidemiologically significant pathogens (i.e., chlamydia, gonorrhea, and trichomoniasis).

We investigate STD risk during young adulthood applying a life course perspective that takes into account both the social organization of lives and the accumulation of sexual experiences. The sociodemographic characteristics of youth, particularly age, gender, and race/ethnicity, are often conceptualized as systems of stratification that generate economic and social inequalities. The resulting status differences have implications for social position and physical location. They determine opportunity structures and the types of available resources which could potentially influence individual attitudes and behaviors. Moreover, the meanings of attributes such as age, gender, and race/ethnicity are socially constructed and carry with them social

norms and expectations. Accordingly, these characteristics have a profound influence on STD risk. They determine how individuals behave in their social environment, what types of partners and relationships individuals form, and they reflect the social context and epidemiological conditions in which individuals are embedded. In turn, these behaviors influence the risk of acquiring an STD by affecting the probability of exposure to an infected individual and the probability of transmission of infection upon exposure to an infected individual.

Studies consistently indicate differentials in STD risk by sociodemographic characteristics. One of the most consistent findings is the racial/ethnic differentials in rates of STDs among young adults. In general, blacks, Hispanics, and Native Americans tend to have higher STD rates than whites, and Asians have lower rates, with blacks usually exhibiting the highest rates overall (Anderson, McCormick, & Fichtner, 1994; Buchacz et al., 2000; CDC, 2000; Ericksen & Trocki, 1994; Harawa, Greenland, Cochran, Cunningham, & Visscher, 2003; Miller, Cain, Rogers, Gribble, & Turner, 1999; Mertz et al., 1998; Tanfer, Cubbins, & Billy, 1995; Upchurch & Kusunoki, 2004; Upchurch, Mason, Kusunoki, & Kriechbaum, 2004). Young women have higher STD rates than young men (CDC, 2000; Mertz et al., 1998; Upchurch et al., 2004). Age is also an important marker of STD risk; STD risk tends to decrease with increasing age (CDC, 2000; Ericksen & Trocki, 1994; Mertz et al., 1998; Miller et al., 1999; Tanfer et al., 1995). Unmarried individuals are at higher risk of acquiring an STD than married individuals (Kost & Forrest, 1992; Rogers et al., 2002). Those with lower socioeconomic status tend to be at higher risk of STDs (Anderson et al., 1994; Buchacz et al., 2000; Ericksen & Trocki, 1994; Rogers et al., 2002). We conceptualize these sociodemographic factors as markers for exposure to a person infected with an STD. We

posit that individual characteristics, including gender, race/ethnicity, age, nativity status, education, income, and union status, are associated with differences in STD risk, in part because of between group differences in sexual and protective behaviors, sexual networks, and underlying disease prevalence (Cohen et al., 2000; Ellen, Aral, & Magder, 1998; Ford & Norris, 1997; IOM, 1997; Laumann & Youm, 1999; Miller et al., 1999; Tanfer et al., 1995; Zenilman, Ellish, Fresia, & Glass, 1999).

Engaging in risky sexual behaviors has been shown to affect individuals' risk of acquiring an STD. Number of sexual partners is an important behavioral indicator because it not only potentially increases the likelihood of exposure but may also be a proxy for other sexual risk behaviors and attitudes (IOM, 1997). Several studies have found that having a greater number of sexual partners (lifetime or recent) is associated with a higher risk of STDs (Anderson et al., 1994; Buchacz et al., 2000; Ellen et al., 1998; Finer, Darroch, & Singh, 1999; Kost & Forrest, 1992; Miller et al., 1999; Rogers et al., 2002; Tanfer et al., 1995; Upchurch & Kusunoki, 2004). A key protective behavior to reduce risk of STD transmission and acquisition is the use of condoms, when used correctly and consistently (CDC, 1993; NIAID, 2001). However, the relationship between condom use and STD infection is not straightforward. Some studies have found that condom use is negatively associated with STD infection (Ellen et al., 1998; Joffe et al., 1992; Manhart et al., 2004; Upchurch & Kusunoki, 2004; Warner et al., 2004), whereas others find either a positive or little relationship between condom use and STD infection (Peterman et al., 2000; Zenilman et al., 1995). Participating in high-risk behaviors, such as having paid for or been paid for sex, has also been found to be associated with a higher risk of STD (Buchacz et al., 2000; Rogers et al., 2002; Tanfer et al., 1995). Having had a prior STD is also associated with having had a recent infection

(Buchacz et al., 2000; Rogers et al., 2002; Upchurch et al., 2004). We conceptualize sexual and protective behaviors, which are more proximate determinants, as markers for exposure as well as transmission upon exposure. We posit that risky sexual behaviors, such as having multiple sexual partners and forming relationships with risky partners, increase the likelihood of being exposed to an infected person, whereas risky sexual behaviors, such as engaging in unprotected sexual intercourse, increase the probability of transmissibility of an infection when exposed to an infected person.

Research also indicates that some of the between group differences in risk of STDs are the result of differences in sexual risk behaviors. Compared to older adults, adolescents and young adults are at higher risk because they are more likely to have multiple partners and short-term relationships, to engage in unprotected intercourse, and to have high-risk partners (Finer, Darroch, & Singh, 1999; Miller, Cain, Rogers, Gribble, & Turner, 1999; Santelli, Brener, Lowry, Bhatt, & Zabin, 1998; Sonenstein, Ku, Lindberg, Turner, & Pleck, 1998). Union status is associated with STD risk with unmarried individuals being at elevated risk of STDs because of multiple partnerships (Finer et al., 1999; Kost & Forrest, 1992). Men and blacks are more likely to be sexually active and to have initiated sexual activity at earlier ages than are whites (Upchurch, Levy-Storms, Sucoff, & Aneshensel, 1998; Upchurch et al., 2004). Early sexual activity is associated with a greater number of recent and lifetime sexual partners, a lower likelihood of condom use, and a greater likelihood of a positive STD history (Greenberg, Madger, & Aral, 1992; IOM, 1997; Kost & Forrest, 1992; Miller et al., 1999; Santelli et al., 1998; Upchurch & Kusunoki, 2004; Upchurch et al., 2004). Men and blacks tend to report a greater number of sexual partners (Finer et al., 1999; Kost & Forrest, 1992; Tanfer et al., 1995) with black men, in particular, reporting a greater number of partners

(Ericksen & Trocki, 1994). Multiple partnerships are also more common among unmarried men than unmarried women (Kost & Forrest, 1992). Men and blacks are also more likely to have reported ever paying for sex than women and whites, respectively (Tanfer et al., 1995). Risk behaviors, such as number of lifetime sexual partners, do not appear to vary substantially between racial/ethnic groups for women. However, women, especially black women, more often report sexual partnerships with men who have multiple sexual partners (Ericksen & Trocki, 1994). This places them at increased risk as a function of their partners' behaviors and sexual networks. Compared to low-income women, high income women are less likely to report having had multiple sexual partners (Kost & Forrest, 1992) and poor women are also less likely to be sure of whether their partners are monogamous than are nonpoor women (Ericksen & Trocki, 1994). Young women also experience an increased biological susceptibility to some sexually transmitted infections (Berman & Hein, 1999; IOM, 1997), further affecting their risk. Consistent with these findings, our study examines the effects of both sociodemographic and behavioral risk factors. Our study extends existing literature by exploiting the unique biomarker data available in Add Health in order to investigate the extent to which these factors are associated with current infection among a nationally representative sample of contemporary youth.

Data

We use data from Waves I and III of the National Longitudinal Study of Adolescent Health. Wave I was collected between April and December of 1995, and Wave III was collected between August of 2001 and April of 2002. Our analysis uses information contained in self-reports from a parent questionnaire at Wave I, in in-home surveys at both Wave I and Wave III, and in tests of biomarker specimens at Wave III.

All respondents at Wave III were young adults who had originally participated in Wave I of the survey.

Sample

Wave I of Add Health is a school-based, national probability sample of adolescents in grades 7–12, with N = 20,745 individual respondents. Of these, 15,170, and 27 Wave II respondents, were re-interviewed at Wave III, with N = 15,197. To allow finite population inference with the Add Health data, several weight variables are supplied, as well as other sampling information. At Wave III, 14,322 respondents have a Wave III sampling weight. Wave I sampling weights are available only for those cases that were part of the original probability sample, and the Wave III weights are contingent on having a Wave I weight. Thus, Wave III weights could not be constructed for those cases that were missing a weight at Wave I.

Our baseline analysis sample consists of the 14,322 respondents with a Wave III sampling weight.[1] However, the sample used at each stage of the analysis differs. The sample for the attrition analysis is restricted to Wave I respondents who do not have extreme bad data at Wave I and have a valid Wave I weight, resulting in a final N of 18,720. We use the baseline sample at Wave III for the refusal analysis. The sample for the analysis of the "no results on all three tests" versus "results on at least one test" consists of respondents who consented to give a biomarker specimen and have a valid Wave III weight. An additional 22 observations that were missing information on metropolitan location were dropped by the analysis program because they predicted failure perfectly. The final N for this sample is 13,170. The sample for the analysis of

[1] For Wave I it is possible to carry out model based inference by incorporating design variables into the model. The design variables at Wave III were not provided to us. Because results vary depending on whether the weights are used, all of the work we present in this paper is based on the use of the Wave III weights.

the "no results on one or two tests" versus "results on all three tests" excludes respondents who refused to provide a biomarker specimen, those who had no results on all three tests, and those without a valid Wave III weight, resulting in a final *N* of 12,545. The sample for the vaginal sex analysis excludes respondents who are missing on ever had vaginal sex, who do not have a valid Wave III weight, and who are missing information on family structure at Wave I. The final *N* for this sample is 14,154.

The analysis for chlamydia, gonorrhea, and trichomoniasis begins with the same baseline sample. The sample for each disease-specific analysis excludes respondents who are missing on vaginal sex or have never had vaginal sex and those who do not have a valid Wave III weight. It also excludes those who are missing on metropolitan location and those who refused to provide a biomarker specimen. Each sample was further restricted to respondents who had a valid result on the test for the specific STD. The final sample for the chlamydia analysis is 10,910. Additional observations were dropped from the gonorrhea analysis because they predicted failure perfectly (i.e., Asian, Native American, and single, not sexually active), resulting in a final *N* of 8,706. The final sample size for the analysis of trichomoniasis is 10,837.

Variables

STDs. Chlamydia (*Chlamydia trachomatis*), gonorrhea (*Neiserria gonorrhoeae*), and trichomoniasis (*Trichomonas vaginalis*) are measured using laboratory tests of biomarker specimens provided by respondents. The tests and data collection procedures are described in detail by the Add Health Biomarker Team (The Add Health Biomarker Team, 2003). Urine samples were collected by interviewers at the end of the in-home interview and were shipped overnight in containers with ice packs via Federal Express to the testing facility. Specimens were not necessarily shipped immediately after the

interviews; the delivery window was no more than 96 hours. Both chlamydia and gonorrhea were assayed using Ligase Chain Reaction (LCR™) technology. Trichomoniasis was assayed using a PCR-ELISA. Note, however, that the PCR-ELISA used for detecting trichomoniasis was not FDA approved. Of the 14,322 Wave III respondents with Wave III weights, 1,130 refused to provide biomarker specimens. An additional 647 specimens could not be tested because they were not received or because of shipping or processing errors. These errors included lost specimens, inadequate amounts of urine to carry out tests, and spillage during shipping. The data provided to us do not include variables that would enable us to separate these 647 cases into separate categories based on the reasons they were not tested. Another 859 gonorrhea assays produced no results due to test defects. In addition, 99 trichomoniasis assays produced no results for reasons unknown to us.

Age. Age is measured using respondents' self-reports. At Wave III, the age range is 18-27 years. Although we have explored alternative specifications for age, in the results reported in this paper, age is categorized as 18-19, 20-21, 22-23, and 24-27 years. We use dummy coding and treat the youngest group as the reference category.

Gender. Gender is measured using respondents' self-reports. Male is coded one and female is coded zero.

Race/Ethnicity. *Ra*ce/ethnicity is measured using respondents' self-reports. Respondents providing unusable information on race/ethnicity were coded to the interviewer's perception of the respondent's race. This analysis is based on five racial/ethnic categories using Hispanic priority: *(i)* Non-Hispanic white, *(ii)* Non-Hispanic Black/African American, *(iii)* Hispanic, *(iv)* Non-Hispanic Asian, and *(v)* Non-

Hispanic Native American. In our logistic regressions with dummy variables, Non-Hispanic whites are the reference category.

Union Status. Union status is based on respondents' self-reports. Individuals are categorized as *(i)* married, *(ii)* cohabiting, *(iii)* single—sexually active in the past 12 months, and *(iv)* single—not sexually active in the last 12 months.[2] In the regressions, married is the reference category.

Education. Education is measured using respondents' reports of highest grade of completed schooling. We categorize education as *(i)* less than a high school degree, *(ii)* high school degree or equivalent, *(iii)* some college, and *(iv)* college degree or greater. In the regressions, "less than high school degree" is the reference category.

Enrollment Status. Enrollment status is based on respondent self-reports. The variable is coded 1 if enrolled in regular school, and 0 otherwise.

Employment Status. Information on employment status was obtained using respondents self-reports of whether they were currently employed and the number of hours worked per week. Individuals working 35 hours or more per week are coded as working full-time, consistent with the Census Bureau's definition of full-time work. Respondents working 10 to 34 hours per week are coded as working part-time. All others are coded as not working. In the regressions, "full-time work" is the reference category.

Nativity Status. Respondents indicating they were not born United States citizens are coded one for foreign born; all others are coded zero.

[2] Respondents were considered sexually active in the past 12 months if they reported that they had had vaginal intercourse in the last 12 months. Thus, the single not sexually active category may contain people who are not married or cohabiting who have had other types of sexual experiences in the last 12 months, but have not had vaginal intercourse in the last 12 months.

Age at first sex. Age at first sex is based on respondent reports of age at first vaginal intercourse.[3] We categorize the variable as *(i)* never had sex, *(ii)* first sex at age 14 or earlier, *(iii)* first sex between ages 15 and 17, *(iv)* first sex at age 18 or later, and *(v)* currently unusable information on age at first sex. In the regressions, first sex at age 18 or later is the reference category.

Type of place of residence. This variable is merged from Wave I. We were not provided with a contemporaneous type of place of residence variable in the Wave III data. The categorization is urban, suburban, and rural. In the regressions, "urban" is the reference category.

Region. Region of residence was provided with the Wave III data, but is in fact Wave I region. The categories are West, Midwest, South, and Northeast. In the regressions, West is the reference category.

Ever had vaginal intercourse. This variable is measured using respondent's self-reports of whether they had ever had vaginal intercourse. Respondents indicating that they had ever had vaginal intercourse are coded one; - all others are coded zero.

Family Structure. Family structure is measured using respondents' self-reports of their family living situations at Wave I. We use an eight-category classification: *(i)* Two biological parents, *(ii)* biological mother, stepfather, *(iii)* biological father, stepmother, *(iv)* biological mother, cohabiting partner, *(v)* biological father, cohabiting partner, *(vi)* biological mother only, *(vii)* biological father only, and *(viii)* other family type. Two biological parents is the reference category.

Risk Behavior

All indicators of risk behavior are obtained from respondents' self-reports.

[3] Other types of sexual activity are not captured by this measure. Some respondents in the "never had sex" category may have engaged in other kinds of sexual activity.

Number of lifetime partners. Number of lifetime partners refers to vaginal sex partners only and is entered as a five-category classification. We categorize the variable as *(i)* one partner, *(ii)* two to three partners, *(iii)* four to six partners, *(iv)* seven partners or greater, and *(v)* missing, with one partner as the reference category.

Number of partners in the past 12 months. Number of partners in the past 12 months refers to vaginal sex partners only and is entered as a five-category classification. We categorize the variable as *(i)* zero partners, *(ii)* one partner, *(iii)* two to three partners, *(iv)* four partners or greater, and *(v)* missing. In the regressions, zero partners is the reference category.

Number of times had vaginal intercourse in the past 12 months. The number of times the respondent has vaginal intercourse in the past 12 months is entered as a six-category classification. We categorize the variable as *(i)* zero times, *(ii)* one to ten times, *(iii)* eleven to forty times, *(iv)* forty-one to ninety-nine times, *(v)* one hundred to nine hundred times, and *(vi)* missing. In the regressions, zero times is the reference category.

Condom use at last vaginal intercourse. Condom use at last vaginal intercourse is entered as a four-category classification. The categories are *(i)* did not use a condom, *(ii)* used a condom, *(iii)* no sex in the past 12 months, and *(iv)* missing, with did not use a condom as the reference category.

Paid for/been paid for sex. The paid for/been paid for sex variable indicates whether the respondent has ever paid another person for vaginal intercourse or been paid by another person for vaginal intercourse. We categorize the variable as *(i)* never, *(ii)* yes, ever, and *(iii)* yes, in the past 12 months, with never as the reference category.

Sex with an IV drug user. This variable indicates whether the respondent has ever had sex with someone who uses intravenous (IV) drugs. The categories for this variable

are *(i)* never, *(ii)* yes, ever, and *(iii)* yes in the past 12 months, with never as the reference category.

Sex with a person who had an STD. This variable indicates whether the respondent has ever had vaginal sex with someone who has ever had an STD. We categorize this variable as *(i)* no, *(ii)* yes, and *(iii)* no sex in the past 12 months, with no as the reference category.

Condom use for vaginal sex in the past 12 months. We enter this variable into the regressions as a seven-category classification. We categorize this variable as *(i)* none, *(ii)* some, *(iii)* half, *(iv)* most, *(v)* all, *(vi)* no sex in the past 12 months, and *(vii)* missing. None is used as the reference category.

Self-reported STD. This variable indicates whether the respondent has ever been told by a doctor or nurse that they had an STD. We use a three-category classification, with the following categories: *(i)* no, *(ii)* yes, and *(iii)* missing. Respondents who answer yes to any of the following STDs are coded into the "yes" category: chlamydia; gonorrhea; trichomoniasis; syphilis; genital herpes; genital warts; human papilloma virus (HPV); bacterial vaginosis; pelvic inflammatory disease (PID); cervicitis or mucopurulent cervicitis (MPC); urethritis (NGU); vaginitis; HIV infection or AIDS; and other.

Condom use for any type of sex in the past 12 months. This variable indicates whether the respondent used a condom for any type of sexual intercourse in the past 12 months. If the respondent used a condom, this variable also indicates how successfully the respondent used the condom. That is, whether or not the condom broke or slipped off during intercourse. We use a five-category classification and categorize the variable as

(i) none, *(ii)* successful condom use, *(iii)* unsuccessful condom use, *(iv)* used condom, unsure of success, and *(v)* missing. In the regressions, "none" is the reference category.

Doctor's visit for possible STD. This variable indicates whether the respondent visited a doctor because they thought they might have an STD. We categorize this variable as *(i)* visited in the past year, *(ii)* visited one or more years ago, *(iii)* never visited, and *(iv)* missing. In the regressions, visited in the past year is the reference category.

Derived operationalizations of the outcome variables are presented in context.

Analysis

In public distribution form, the outcome categories for the chlamydia, gonorrhea, and trichomoniasis test results are "refused," "no results" "positive," and "negative." As noted above, the "refusal" category includes respondents who chose not to provide specimens as well as those who were unable to. The "no results" category characterizes specimens for which no test result was obtainable because the specimen itself was not received at the testing laboratory or was not usable upon receipt, because the test kit was defective, or for other reasons unknown to us.

Since sample selectivity in the prevalence of positive test outcomes could have occurred with refusals or with those specimens from which no results were obtained, our analysis is nested[4]. We first carry out an analysis of refusals. Conditional on the presence of a urine specimen, we next analyze whether the test results are decisive (positive or negative vs. no result). Finally, conditional on a decisive result having been obtained, we analyze positive vs. negative test outcomes. The analysis of positive versus

[4] Sample selectivity might also have occurred because of attrition between Wave I and Wave III. We investigated the quality of the weighting to account for this possibility. To the extent that we could check, the weights provided at Wave III by the Add Health team adequately account for attrition between waves.

negative test outcomes is conducted using only respondents who have ever had vaginal intercourse. Although possible, it is highly unlikely that a person who is not sexually active will contract an STD. Thus, we restrict our sample to those who are at risk of contracting an STD. To facilitate understanding of the sexually active sample, we also analyze whether the respondent has ever had vaginal intercourse.

In the early stages of the analysis, we used a binary variable indicating "positive on any STD" as an outcome in addition to the disease-specific outcomes. We eventually dropped this outcome because of differences in the effect of the sociodemographic variables on each disease, which render the analysis inappropriate.

In all instances, we use the Stata version 8.2 (Statacorp, 2003) survey command for weighted logistic regression. Since all covariate dimensions are treated as categorical, we report results of tests of significance of regression coefficients based on within-dimension multiple comparison adjustments.

The use of nested binary logistic regression is attractive when the response variable is polytomous and the categories are defined through a staged process. The presumed independence of likelihoods of the separate nested regressions, however, depends on the completeness of the specification. The existence of common omitted covariates could lead to inconsistent coefficient estimates across regressions.

We hypothesize that the process by which no results were generated is essentially random with respect to respondent characteristics. If so, then concerns of misspecification are most appropriate for the "refusal" and "decisive test result" regressions (stages 1 and 3). It may be that the extent of sexual risk-taking affects both the likelihood of refusal and the likelihood of a positive test outcome. Specifically, those who are not risk-takers or who are low risk-takers, as well as those who are high risk-

takers, may be most likely to refuse to provide a specimen. And, non- or low risk-takers should be least likely to have positive test results, while high-risk takers should be most likely to have positive test results.

In work we have carried out using Wave I of the Add Health survey, we have found that age at first sex is a proxy for risky sexual behavior. We thus include age at first sex in the regressions for "refusals". Initially, we also included age at first sex in the regressions for "decisive test results." It did not significantly predict a positive result and we subsequently removed it from the model. However, we include a host of other variables intended to measure and account for risky behavior. Remaining covariates include the variables described in the preceding section, the first of which is age. CDC surveillance rates display unimodal distributions peaking in the early twenties, indicating differences in infection rates by age. We also include gender and race/ethnicity. There is evidence of gender and racial/ethnic differences for chlamydia in the CDC surveillance rates, as well as some indication of interaction. We expect union status to be associated with the probability of infection. Specifically, we expect sexually active singles to be most likely to test positive. We expect an inverse association between education and testing positive. Both because of self-selection, and because educational environments confer informational and behavioral advantages, we anticipate enrollment status to confer protection against positive test outcomes. The foreign born may be at lower risk. In earlier research, we have found no effect on self-reports of positive outcomes. We have no strong priors on the effect of type of place of residence, and include it to check for potential differences. We also have no strong priors on the effect of Wave I region, but CDC surveillance rates show some regional differentials in STD prevalence.

Results

The univariate distributions of the covariates at Wave III are presented in Table 1. Column 1 in Table 1 corresponds to the sample for the analysis of ever had vaginal intercourse. Columns 2-4 correspond to the samples for the disease-specific biomarker analyses.

[insert Table 1 here]

Refusals

Table 2 presents the results of a logistic regression of refusal on all of the covariates. The dimensions that are associated with refusal include age, union status, and education for women but not men. Age at first sex is not associated with refusal. The null result for age at first sex is thus consistent with the use of nested binary logistic regressions, inasmuch as the result is consistent with the assumption of independence across regressions.

[insert Table 2 here]

That sexually inactive singles would be most likely to refuse testing is plausible. In the absence of sexual activity there is little motivation to be tested for sexually transmitted diseases. The results for age and education raise the possibility that there is design confounding in the form of structural zeroes in the gender by age by education configuration. However, there are no structural or sampling zeroes in this configuration. Furthermore, an examination of a percentage table of refusal by gender by age by education (not shown), reveals that for both genders the oldest age group is most likely to refuse, and for women, college graduates are most likely to refuse.[5] We speculate that older and more highly educated individuals are more likely than younger and less well educated individuals to be circumspect in their sexual behavior, and thus less likely to see

[5] For women, we cannot reject the null hypothesis that years of schooling is linearly related to the logit of refusal. There is no linear education trend for men.

a personal need to participate in STD testing. Why the education result appears to hold for women but not men is not obvious.

In sum, it appears that refusal to participate in the Add Health Wave III STD testing is not random, although it is surprising how little is significant. Age and education for women, but not men, make a difference. Refusals among women aged 22 to 23 ranged from five percent for those who did not complete high school, to 12 percent for college graduates. For women aged 24 to 27, refusals ranged from five percent to 13 percent. For men, there is essentially no trend. The departure from randomness could have a modest impact on the distributions of positive test outcomes.

No Results

Of the 14,322 respondents who supplied a urine sample, 642 specimens were never received, too warm, spilled, of insufficient quantity, or were otherwise unable to be assayed. For the chlamydia test, all of the "no result" outcomes were of this nature. That is, on all samples to which the chlamydia test was applied, there was a decisive (positive or negative) outcome. For the gonorrhea and trichomoniasis tests, there were additional instances of "no results." In particular, a disproportionate number of gonorrhea test kits were found to be defective, and the Add Health investigators chose not to retest with new kits.

It is possible to analyze "no result" on a disease-specific basis. However, "no result" on the chlamydia test implies no result on *any* test. For this reason, we characterize the problem as follows: Among all individuals supplying a urine sample, the possibilities are zero, one, two, or three decisive test results. We dichotomize this as zero vs. one, two, or three decisive test results (Y_1). In essence, we ask the question, "Do individuals who provided urine samples, but for whom we have no test results, differ

from those for whom there is at least one decisive test result?" In addition, for those individuals with at least one decisive test result, we also ask whether those for whom one or two of the test outcomes were indecisive differ from those for whom all three test results were decisive. Alternatively stated, we dichotomize using one or two vs. three decisive test results (Y_2).

Lack of a decisive test result is simply missing data on the test outcome. We are unsure of the pattern of missingness on test outcome. We hypothesize that this pattern is "MCAR"—missing completely at random. If this is correct, the sociodemographic characteristics we include should not be associated with the lack of a decisive result. In "no result" regressions on sociodemographic characteristics there should be no associations. Table 3 presents multivariable regressions, but zero-order regressions would be equally plausible in this setting. We have carried out both, although we show only the multivariable regressions.

[insert Table 3 here]

For no result on all three tests vs. results on at least one (Y_1), the white-Native American, the enrolled-not enrolled, and the rural-urban contrasts differ significantly from zero. These results hold in "bivariate" logistic regressions as well.[6] For results on one or two vs. results on all three tests (Y_2), age, gender, enrollment status employment status, and Wave I type of place of residence are all significantly associated with the outcome. Qualification is called for. There is a clear bivariate association between Y_2 and age. The bivariate gender difference exists, but it is no more than two percent. The bivariate enrollment contrast is no more than three percent. There is *no* bivariate

[6] That is, regressions using only one covariate dimension at a time.

association between Y_2 and employment status. There is a bivariate association between Y_2 and Wave I type of place of residence, but it is quite modest: The mean of Y_2 for rural is .06 (six percent), for suburban it is .07, and for urban it is .10.

Considering both Y_1 and Y_2, there is very little association between "no results" and the sociodemographic covariates. Because Y_2 is nested in Y_1, the regressions are independent under the assumption of no common omitted, and relevant, covariates. Thus, the two regressions amount to independent replications on "no results." In any such exploration, some statistically significant results could appear by chance even if there were no associations in the population. Chance occurrences would be unlikely to replicate across the Y_1 and Y_2 regressions. With the exception of the school enrollment contrast, no association is present in both regressions. We have no explanation for the statistical significance of this contrast. Conceivably there is an aspect of field procedure that is plausibly related to the lack of test results, but we are skeptical. In short, if the "no results" pattern is not MCAR, we claim that it is very nearly so.

Ever had sex

We restrict our analysis of the "positive versus negative test results" to those who had ever had vaginal intercourse, necessitating an investigation of the sexually active sample. Approximately 87% of the respondents have ever had vaginal intercourse by Wave III. Table 4 presents a logistic regression for ever had vaginal intercourse. At least one category in each of the sociodemographic characteristics significantly predicts whether the respondent has ever had vaginal intercourse. Being in any age category but the youngest age category is positively related to ever having had vaginal sex. Being black, living in suburban or rural areas, living in the Midwest, and growing up in a non-

intact family positively and significantly predict ever having had vaginal sex. Gender, education, enrollment status, employments status, and nativity status are all significantly and negatively related to ever having had vaginal intercourse[7].

Positive vs. Negative Biomarker Test Results

Table 5 is a three-way table of chlamydia by gonorrhea by trichomoniasis test results. Table 6 presents logistic regressions for chlamydia, gonorrhea, and trichomoniasis.

[insert Tables 5-6 here]

Chlamydia. Column 1 in Table 6 shows that with the exception of Hispanics, men are less likely than women to have chlamydia. Blacks and Native Americans are more likely than Hispanics, and Hispanics are more likely than whites and Asian Americans to have chlamydia. Union status is positively associated with chlamydial infection. Those who are single and sexually active are more likely to test positive than those who are married, cohabiting, or are single but not sexually active. Education is inversely associated with chlamydial infection: The higher the education level the less likely an individual is to test positive for chlamydia. Those enrolled in school are also less likely to test positive. None of the following are associated with the probability of chlamydial infection: employment status, nativity status, Wave I metropolitan location, and Wave I region.

Gonorrhea. As is well known, rates for gonorrhea are much lower than those for chlamydia. This is reflected in the regression constants for the chlamydia and gonorrhea equations in Table 6. Moreover, Table 6 reveals that no gonorrhea cases were detected for Asian/Pacific Islanders or Native Americans/Alaskan Natives. It is clear that there is

[7] We tested for significant gender by race interactions, but found no evidence supporting their presence.

no gender by race/ethnicity interaction, although there is a racial/ethnic differential to the extent that blacks are more likely than any other group to experience gonorrhea. About two percent of blacks in this sample have gonorrhea, while prevalence for whites and Hispanics is virtually undetectable. Indeed, the overall gonorrhea rate is so low that we would expect little determination by sociodemographic characteristics. The results in Table 6 are consistent with this expectation. There are neither education nor employment differentials. Those who are enrolled in school are less likely to test positive for gonorrhea than those who are not enrolled in school. The foreign born are similarly advantaged, as are those who were living in the West relative to residents of the Northeast, at Wave I.

Trichomoniasis. Table 6 shows that blacks are far more likely than any other racial/ethnic group to have trichomoniasis. Apart from blacks, there is no consistent gender differential. However, the gender differential for blacks is so large that it needs to be modeled. Thus, the trichomoniasis regression includes a term to capture it. Female blacks are much more likely than any other group to have trichomoniasis. This regression also shows that older respondents and sexually active singles are more likely to have trichomoniasis. There is an inverse association between education and having tested positive for trichomoniasis. Respondents with higher levels of education are less likely to have trichomoniasis than those with lower levels of education. Similarly, those not working are more likely to have trichomoniasis than those who are working full-time, controlling for school enrollment. There is a clear socioeconomic gradient for trichomoniasis.

Risk Behaviors. Our results reveal stark differences between groups in the likelihood of having an STD. For example, differences in STD infection between blacks

and whites remain, even when controlling for a host of sociodemographic characteristics. One possible explanation is the extent to which groups engage in risky sexual behavior. Can the differentials we see above be explained by differences in risky behavior? We test for this by including measures of sexual risk-taking in our baseline chlamydia, gonorrhea, and trichomoniasis regressions. Table 7 presents weighted proportions of each of the 11 risk behaviors that we investigated. Note that overall a small percentage of people have engaged in the riskiest behaviors.

Table 8 shows coefficients of bivariate regressions of chlamydia, gonorrhea, and trichomoniasis on each risk behavior and regressions including the sociodemographic variables from Table 6.

[insert Tables 7-8 here]

Bivariate regressions of the positive versus negative results for chlamydia, gonorrhea, and trichomoniasis produce several significant results. Most of these significant effects disappear once we control for the sociodemographic characteristics, but a few remain. This is most notable in the chlamydia regressions. The number of lifetime partners and number of partners in the past 12 months is positively related to the likelihood of testing positive for chlamydia in both the bivariate and full regressions. For gonorrhea, respondents who have had sex with an IV drug user in the past 12 months and those who have ever had sex with someone who has had an STD are more likely to test positive for gonorrhea in both the bivariate and full regressions. The effect of doctor visits for an STD on gonorrhea also remains when the sociodemographic variables are included in the model. Respondents who have never visited a doctor because they thought they might have an STD are less likely to test positive for gonorrhea than those who have visited within the past year. The effects for gonorrhea must be interpreted

carefully, however, because prevalence of gonorrhea is very small. None of the significant effects of risky behavior remain for trichomoniasis when the sociodemographic characteristics are controlled. Risky sexual behavior is associated with the sociodemographic characteristics, but the sociodemographic characteristics hold the predictive power. The effects of the sociodemographic characteristics on STD infection remain relatively unchanged with the addition of risky behavior (results not shown), but the effects of risky behavior disappear when controlling for the sociodemographic characteristics.

Discussion

Our findings highlight the differentials in STD risk by young adults' sociodemographic characteristics. Even after controlling for behavioral risk factors that have been shown to be associated with the risk of STDs in both clinical and population-based samples, we find significant independent effects of age, gender, race/ethnicity, union status, education, school enrollment, and employment status, confirming the continued disproportionate burden of disease among women, blacks, and the socioeconomically disadvantaged. Additionally, we find little association between behavioral risk factors, such as number of sexual partners, frequency of sexual activity, condom use, and risky partnerships and STDs, net of these sociodemographic characteristics. Further, the effects of both sociodemographic and behavioral risk correlates vary depending on the pathogen examined suggesting the need for additional pathogen-specific investigation.

We find that sociodemographic characteristics are associated with the risk of STDs and that the effects of these factors are similar to findings from other data, both clinical- and survey-based. We also find that the effect of these characteristics differ by

pathogen. Age is associated with risk of gonorrhea and trichomoniasis but not chlamydia. Gender is associated with risk of chlamydia, with women at higher risk than men. This is consistent with patterns found in STD data from the CDC (CDC, 2000). However, gender is not associated with risk of gonorrhea or trichomoniasis. Black, Hispanic, and Native American youth are at an increased risk of chlamydia with an observed gender differential for Hispanics only. Black youth are also at higher risk of gonorrhea and trichomoniasis with an observed gender differential for Blacks for trichomoniasis only. These patterns are also consistent with CDC data (CDC, 2000). Being single and sexually active is associated with an increased risk for chlamydia and trichomoniasis but not gonorrhea. Education is negatively associated with risk of chlamydia and trichomoniasis, but is not associated with risk of gonorrhea. There is also a negative association between school enrollment and risk of gonorrhea and chlamydia. Unemployed individuals are at higher risk of gonorrhea and trichomoniasis compared with individuals who are working full-time. Individuals born outside of the United States are at lower risk of gonorrhea than native born individuals; nativity status does not affect risk for the other two pathogens.

Some studies have found that a portion of the variation in STD risk might be explained by between group differences in sexual and protective practices (Ericksen & Trocki, 1994; Finer et al., 1999; Kost & Forrest, 1992; Tanfer et al., 1995). To assess the contributions of sexual behaviors to STD risk we include a number of indicators of behavioral risk. Many of the bivariate relationships between risk of infection and risky sexual behaviors are significant, the magnitude and direction of which are comparable to other research findings. This is especially true for chlamydia. The number of lifetime vaginal sex partners, the number of vaginal sex partners in the past 12 months, and the

number of times the person engaged in vaginal intercourse in the past 12 months are all positively related to risk of chlamydial infection. There is also a strong positive relationship between paid sex and risk of infection for all three pathogens. Having sex with someone who has ever had an STD increases risk of both chlamydia and gonorrhea, but not trichomoniasis. Self-report of STD is also associated with increased risk of chlamydia and trichomoniasis.

Overall, however, the significance of most of the behavioral correlates disappears once we control for sociodemographic characteristics. This finding is consistent with the conclusions drawn from several recent studies of STD risk (Bunnell et al., 1999; Peterman et al., 2000; Rogers et al., 2002; Slavinsky, Rosenberg, DiCarlo, & Kissinger, 2000). Rogers and colleagues (2002) found different correlates for STD infection based on self-report history compared to biomarker test results. In fact, they found that typical risk behaviors, such as multiple partners, new recent partners, and other recent sexual risk practices, were not associated with NAAT-detected infection after controlling for sociodemographic characteristics. Halpern and colleagues (2004) find significant differences in youth risk behavior patterns but conclude that these are not necessarily associated with STD prevalence; for example, although black females are the most likely to report STDs, they are least likely to have exhibited high-risk behaviors. Peterman and colleagues (2000) found that demographic characteristics are associated with incidence of STD but that sexual behaviors such as number of sexual partners and number of unprotected sexual acts are only slightly associated with incidence. One possible explanation for our lack of significant findings is the risk profile of the Add Health sample. Unlike clinical populations and some population-based samples in high risk communities, the Add Health sample reflects a fairly low-risk population, as evidenced

by the low percentages exhibiting the high risk behaviors of interest. High risk individuals, such as those using drugs, those who are or were incarcerated, and those involved in the sex work industry, may be under-represented in this sample, resulting in little variation in risky sexual behaviors.

Furthermore, even when accounting for these important sexual risk behaviors, the independent effects of the sociodemographic characteristics remain. This too is confirmed by other research (Ellen et al., 1998; Harawa et al., 2003; Peterman et al., 2000; Manhart et al., 2004). Gender and racial/ethnic differentials in particular remain, with blacks being at higher risk than whites for all three pathogens, women being at higher risk than men for chlamydia, and significant gender differentials exhibited for both chlamydia and trichomoniasis. These patterns might exist despite accounting for differences in behaviors because of a number of other factors not reflected in the examined behaviors, such as underlying disease prevalence, sexual networks, partner characteristics and behaviors, and concurrency (Aral et al., 1999; Ford, Sohn, & Lepowski, 2002; Garnett et al., 1996; Gorbach, Drumright, & Holmes, 2005; Katz, Fortenberry, Tu, Harezlak, & Orr, 2001; Laumann & Youm, 1999; Stoner et al., 2000). Blacks tend to be involved in homogeneous and closed networks (Laumann & Youm, 1999), which might result in the spread of infection staying within the black population. Sexual mixing patterns have been shown to be an important factor in the transmission of STDs (Aral et al., 1999; Garnett et al., 1996; Gorbach et al., 2005). A higher risk of gonorrhea and chlamydia is associated with discordant partnerships by sociodemographic as well as behavioral indicators (Aral et al., 1999). The sociodemographic characteristics and behaviors of gonococcal and chlamydial network members as well as their mixing patterns differ significantly (Stoner et al., 2000). This suggests the importance of sexual

networks as well as partners' behaviors, such as concurrency. Men tend to engage in riskier behaviors such as concurrency more frequently than women (Manhart et al., 2001). Black women's risk of STDs is associated with their greater risk of engaging in sexual relations with men who have multiple partners and this behavior is a greater risk than their own degree of partner change (Ericksen & Trocki, 1994). Disease prevalence in a sexual network also matters. In a network with a low prevalence of disease, the probability of interaction with an infected person is low, whereas interaction with an infected person is much more likely in a network with high disease prevalence. Thus, an individual with multiple partners in a low-prevalence network is at lower risk than a similarly behaved individual in a high prevalence network. An individual with only one sexual partner may still be at risk if that partner recently had multiple partners or is currently involved in other sexual relationships. Moreover, if the individual knows that his or her partner is engaging in other sexual relationships, protective measures may be used. If it is unknown that the partner is engaging in other sexual relationships, however, protective measures may not be used because the individual assesses him or herself to be at little risk. Macro-level factors such as residential segregation, an imbalance in the sex ratio, and unequal health care services and access may also explain the persistent differentials in STD risk by gender and race/ethnicity (Adimora & Schoenbach, 2005).

While this study provides valuable information on the associations between sociodemographic and behavioral risk factors and current STD infection using a unique population-based sample that includes per-individual biomarker test results, there are limitations. The patterns of association between sociodemographic characteristics and risk of STD are consistent with the literature. However, given the limited significance of many theoretically relevant behavioral risk correlates, it is difficult to assess the

mechanisms by which these sociodemographic characteristics influence the risk of STDs. The lack of significant findings for the types of behavioral risk factors we included net of sociodemographic factors may reflect reality and other studies find similar results. Nevertheless, we may not have found strong effects of behavioral risk factors because our risk measures were imprecise or inaccurate. While we included measures for condom use, we lack detailed information on whether condoms were used correctly. Having more information about partners' infection status may improve our ability to explain variation in behaviors and thus STD risk. Consistent condom use has been shown to be associated with a reduction in gonorrhea and chlamydia and has an even greater protective effect among participants who knew that they had been exposed to an infection (Warner et al., 2004). We also do not know whether having multiple partners is the result of serial monogamy (and if so, what the duration is between relationships) or concurrent sexual partnerships. Concurrency is a stronger indicator of chlamydial infection than number of sexual partners (Potterat et al., 1999). If the gap between successive relationships is short or the relationships overlap in time, transmission of infection can occur depending on duration of infection and efficiency of transmission of a specific pathogen. This suggests the need for more detailed information than simply the number of sexual partners an individual has had. Temporal differences between behavioral measures and actual exposure to infection may also matter. We attempted to resolve this by examining both recent and lifetime measures, but some of the risk behaviors we examined may have occurred after infection or much earlier than infection and thus are too far removed from exposure to an infection to be related. We have also not accounted for antibiotic use. This may result in an underestimate of true prevalence in this population because we have missed those who were recently treated for an STD or were given antibiotics for some

other reason. This could also explain our lack of significant findings for behavioral risk factors. Those who were recently treated for an STD may have sought treatment because they or their partners engaged in behaviors that placed them at risk for infection. These individuals may still be engaging in risky behaviors but their recent treatment makes them less likely to have tested positive for an STD at the time of interview.

Despite these limitations, our findings regarding the continued presence of sociodemographic differentials in STD risk even when controlling for behavioral risk factors are noteworthy. These findings are based on data from a nationally representative sample of contemporary young adults that include biomarker test results for three epidemiologically significant pathogens (i.e., chlamydia, gonorrhea, and trichomoniasis). This type of data has not been previously available at the population level. The richness of these data allows us to examine an array of sociodemographic and behavioral risk factors for a diverse sample of young adults, to examine each pathogen separately, and to generalize to the overall population. Given that sociodemographic differentials in STD risk persist despite controls for risky behavior, behavioral interventions customized for high-risk populations may not be sufficient for this population. Preventing the spread of infection in low-risk populations may require an extension of traditional behavior-based interventions. In particular, interventions that target, educate, and empower women, certain racial and ethnic groups, and people of lower SES may be most efficacious. Recent research indicates that partner characteristics and behaviors, as well as the extent to which these are associated with bridging between high- and low-risk sexual networks are key indicators of STD risk (Gorbach et al., 2005). Future research in this area should take these factors into account and recognize that STD risk is dependent not only upon

individuals' own characteristics and behaviors but also those of their partner(s) and the nature of their sexual networks.

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Table 1. Weighted Proportions of Wave III Sociodemographic Characteristics

Covariates	Wave III Full sample	Wave III Chlamydia Sample	Wave III Gonorrhea Sample	Wave III Trichomoniasis Sample
Age				
18-19	.1269	.1203	.1244	.1203
20-21	.3240	.3199	.3231	.3197
22-23	.3212	.3308	.3298	.3313
24-27	.2278	.2290	.2227	.2288
Male	.5084	.5000	.4942	.5008
Race/Ethnicity				
White	.6785	.6789	.6839	.6786
Black	.1596	.1672	.1659	.1672
Hispanic	.1171	.1139	.1102	.1140
Asian	.0368	.0316	.0315	.0318
Native American	.0079	.0084	.0086	.0085
Union status				
Married	.1678	.1909	.1904	.1913
Cohabiting	.1651	.1868	.1857	.1864
Single, sexually active	.4770	.5478	.5486	.5479
Single, not sexually active	.1901	.0745	.0753	.0744
Education				
< High School graduate	.1445	.1559	.1550	.1560
High School graduate	.3300	.3425	.3414	.3424
Some college	.3859	.3699	.3721	.3699
College graduate or more	.1396	.1316	.1314	.1317
Enrolled in school	.3608	.3404	.3466	.3396
Employment status				
Working full-time	.4952	.5315	.5105	.5148
Working part-time	.2014	.1943	.1964	.1933
Not employed	.3033	.2922	.2931	.2918
Foreign born	.0504	.0446	.0436	.0445
Wave I residence place				
Urban	.2673	.2611	.2553	.2607
Suburban	.5743	.5733	.5773	.5733
Rural	.1566	.1655	.1674	.1660
Missing on residence place	.0018	-	-	-

Table 1.—Continued

Wave I region of residence				
West	.1615	.1539	.1516	.1540
Midwest	.3068	.3197	.3228	.3196
South	.3926	.3937	.3946	.3937
Northeast	.1391	.1327	.1311	.1327
Chlamydia				
Refusals	.0818	-	-	-
No results	.0414	-	-	-
Negative	.8398	.9546	-	-
Positive	.0370	.0454	-	-
Gonorrhea				
Refusals	.0818	-	-	-
No results	.1035	-	-	-
Negative	.8111	-	.9953	-
Positive	.0035	-	.0047	-
Trichomoniasis				
Refusals	.0818	-	-	-
No results	.0473	-	-	-
Negative	.8510	-	-	.9759
Positive	.0198	-	-	.0241
N	14,154	10,910	10,161	10,837

Note: Proportions may not sum to 1.00 due to rounding. See text for full description of samples.

Log file: 050504_stdprops.log; 050613_sexprops.log; 050623_biomrkpprfnlcks.log

Table 2. Weighted logistic regression of STD test refusal on sociodemographic characteristics

Covariates	Coefficients
Age	
18-19 (ref.)	–
20-21	.0576
22-23	.2648
24-27	.4387*
Race/Ethnicity	
White (ref.)	–
Black	–.3856
Hispanic	–.1024
Asian	–.2306
Native American	.1179
Union Status	
Married (ref.)	–
Cohabiting	–.0185
Single, sexually active	.2532
Single, not sexually active	.7274***
Education—Female	
< High School graduate (ref.)	–
High School graduate	.5193
Some college	.6710
College graduate or more	.7809*
Education—Male	
< High School graduate	.6404
High School graduate	.1962
Some college	.5241
College graduate or more	.5779
Enrolled in school	–.1090
Employment status	
Working full-time (ref.)	–
Working part-time	–.0806
Not working	–.0267
Foreign born	.1524

Table 2.—Continued

Wave I residence place	
Urban (ref.)	–
Suburban	.2045
Rural	–.0755
Missing on residence place	–.4142
Wave I region of residence	
West (ref.)	–
Midwest	–.1268
South	–.1648
Northeast	.2539
Age at first sex	
18 years or greater (ref.)	–
Never had sex	.2629
14 years or less	–.2189
15-17 years	.0371
Missing on age at first sex	1.2536***
Constant	–3.4078***
F-value (31 df)	10.21

* $p \leq .05$ ** $p \leq .01$ *** $p \leq .001$

Note: N = 14,322. P-values are adjusted for multiple comparisons.

Log file: 040324_refusals.log

Table 3. Nested binary logistic regressions of "no results" vs. "results"

Covariates	No results on all 3 tests vs. results on ≥ 1 test: (Y_1)	No results on 1 or 2 tests vs. results on all 3 tests: (Y_2)
Age		
18-19 (ref.)	–	–
20-21	.2152	.2799
22-23	.2970	.4766*
24-27	.3816	.7817***
Male	.0677	.2555*
Race/Ethnicity		
White (ref.)	–	–
Black	.2180	.1050
Hispanic	.2719	.1846
Asian	.3004	–.2189
Native American	–1.0260**	–.3465
Union Status		
Married (ref.)	–	–
Cohabiting	.0375	.1111
Single, sexually active	.0433	.0948
Single, not sexually active in past 12 mos	.0438	.2709
Education		
< High School graduate (ref.)	–	–
High School graduate	–.1939	.1792
Some college	–.1175	.1120
College graduate or more	–.1765	–.0149
Enrolled in school	–.4163**	–.2810*
Employment status		
Working full-time (ref.)	–	–
Working part-time	–.0116	.2588*
Not working	–.0060	.2161*
Foreign born	–.3763	–.0432

Table 3.—Continued

Wave I residence place		
Urban (ref.)	–	–
Suburban	–.0097	–.3186*
Rural	–.4476*	–.4662*
Missing on residence place	–	–.0492
Wave I region of residence		
West (ref.)	–	–
Midwest	–.5154	–.2925
South	.0760	–.2369
Northeast	–.1731	–.0101
Constant	–2.9916***	–2.9060***
F-value	2.79	3.16
Df	23	24
N	13,170	12,545

$^{*}\ p \le .05 \quad ^{**}\ p \le .01 \quad ^{***}\ p \le .001$

Note: *P*-values are adjusted for multiple comparisons.

Log file: 050509_norslts.log

Table 4. Coefficients of a weighted logistic regression of ever had vaginal sex on the sociodemographic characteristics

Covariates	Coefficients
Age	
18-19 (ref.)	–
20-21	.2958*
22-23	.8158***
24-27	.7137***
Male	-.2993***
Race/Ethnicity	
White (ref.)	–
Black	.2996**
Hispanic	.0313
Asian	-.1329
Native American	.0445
Education	
< High School graduate (ref.)	–
High School graduate	-.5797***
Some college	-.7137***
College graduate or more	-1.0510***
Enrolled in school	-.2625**
Employment status	
Working full-time (ref.)	–
Working part-time	-.3899***
Not employed	-.6069***
Foreign born	-.5200***
Wave I residence place	
Urban (ref.)	–
Suburban	.3119**
Rural	.2840*
Wave I region of residence	
West (ref.)	–
Midwest	.3576***
South	.2077
Northeast	.2343

Table 4. – Continued

Wave I family structure	
Two biological parents (ref.)	–
Biological mother, stepfather	.4497**
Biological father, stepmother	.2637
Biological mother, cohabiting partner	1.1783***
Biological father, cohabiting partner	1.0650
Biological mother only	.2678*
Biological father only	.6729**
Other family structure	-.0903
Constant	2.0421***
F-value/Chi-square	18.89
Df	27
N	14,154

$^{*}\ p \leq .05 \quad ^{**}\ p \leq .01 \quad ^{***}\ p \leq .001$

Log file: 050613_sexregress.log

Table 5. Weighted test outcome cell frequencies for Chlamydia (*C*) by Gonorrhea (*G*) by Trichomoniasis (*T*)

	T-		*T*+	
	G-	*G*+	*G*-	*G*+
C+	449	25	29	6
C-	9,331	19	232	0

Source: Wave III, Add Health Study. Table $N = 10{,}091$.

Log file: 050504_stdprops.log

Table 6. Coefficients of weighted logistic regressions of Chlamydia, gonorrhea, and trichomoniasis on sociodemographic characteristics among those who have had vaginal intercourse[†]

	Coefficients		
Covariates	Chlamydia	Gonorrhea	Trichomoniasis
Age			
18-19 (ref.)	–	–	–
20-21	.2052	1.8413**	.5231
22-23	.0719	1.6648*	.7866*
24-27	.0193	1.0007	.9737*
Male	-.4976***	.0101	.0235
Race/Ethnicity			
White (ref.)	–	–	–
Black	1.6985***	2.7199***	2.0472***
Hispanic	.6192*	.9320	.2379
Asian	.1170	dropped	.3254
Native American	1.6602***	dropped	1.2553
Male*Hispanic Interaction	.9475*	–	–
Male*Black Interaction	–	–	-1.4638***
Union status			
Married (ref.)	–	–	–
Cohabiting	.1848	.2870	.5045
Single, sexually active	.7262***	1.1437	.7643*
Single, not sexually active in past 12 mos	-.1880	dropped	.7743
Education			
< High School graduate (ref.)	–	–	–
High School graduate	-.2705	.7106	-.3445
Some college	-.3312	-.8465	-.6159**
College graduate or more	-.7038**	.6137	-1.3308**
Enrolled in school	-.5325**	-1.2450*	-.1522
Employment status			
Working full-time (ref.)	–	–	–
Working part-time	.0672	1.1830	-.2551
Not employed	.1540	1.1634*	.4063*
Foreign born	.1580	-1.8037*	.4777

Table 6.—Continued

Wave I residence place			
Urban (ref.)	–	–	–
Suburban	.1680	.5724	-.5456*
Rural	-.1337	.1137	-.4555
			–
Wave I region of residence			
West (ref.)	–	–	
Midwest	.1895	1.6912*	.2878
South	.1070	1.3350	.3320
Northeast	-.2895	2.2306*	.0940
Constant	-3.8703***	-11.5745***	-5.0567***
F-value	9.39	5.54	8.53
df	24	20	24
N	10,910	8,706	10,837

$^{*}\ p \leq .05 \quad ^{**}\ p \leq .01 \quad ^{***}\ p \leq .001$

[†]All regressions exclude observations missing on ever had vaginal intercourse

Log file: 050510_riskregress.log

Table 7. Weighted proportions of risk variables in the Wave III vaginal sex sample

Risk Variable	Chlamydia Sample	Gonorrhea Sample	Trichomoniasis Sample
# lifetime partners			
1 partner	.2049	.2061	.2050
2-3 partners	.2442	.2425	.2448
4-6 partners	.2334	.2347	.2336
7+ partners	.3039	.3033	.3034
Missing	.0135	.0134	.0132
# partners in the past 12 months			
0 partners	.0805	.0810	.0804
1 partner	.5803	.5793	.5804
2-3 partners	.2336	.2349	.2333
4+ partners	.0958	.0955	.0961
Missing	.0098	.0093	.0097
# vaginal sex times - 12 mos			
0 times	.0884	.0890	.0882
1-10 times	.2025	.2022	.2027
11-40 times	.2161	.2179	.2162
41-99 times	.1443	.1445	.1438
100-900 times	.2402	.2393	.2409
Missing	.1084	.1071	.1081
Condom use at last vaginal sex			
No	.5350	.5369	.5352
Yes	.3755	.3738	.3754
No sex past 12 months	.0805	.0810	.0804
Missing	.0090	.0083	.0090
Paid for/been paid for sex			
Never	.9492	.9509	.9490
Yes – ever	.0266	.0253	.0266
Yes – past 12 months	.0242	.0238	.0244
Sex with IV drug user			
Never	.9813	.9818	.9813
Yes – ever	.0110	.0105	.0109
Yes – past 12 months	.0077	.0077	.0078

Table 7. – Continued

Sex with person who had STD			
No	.8469	.8457	.8468
Yes	.0726	.0733	.0728
No sex past 12 months	.0805	.0810	.0804
Condom use vag sex- past 12 mos			
None	.2749	.2745	.2743
Some	.1936	.1961	.1940
Half	.0798	.0807	.0797
Most	.1658	.1653	.1662
All	.1947	.1924	.1947
No sex past 12 months	.0805	.0810	.0804
Missing	.0107	.0100	.0106
Self-report of STD – past 12 mos			
No	.8928	.8909	.8929
Yes	.0910	.0925	.0909
Missing	.0162	.0167	.0162
Condom use all sex – past 12 mos			
None	.3685	.3650	.3676
Successful condom use	.4531	.4562	.4536
Unsuccessful condom use	.1736	.1737	.1739
Used condom, success unsure	.0022	.0023	.0022
Missing	.0027	.0028	.0027
Visited Dr. b/c thought had STD			
Past year	.0955	.0952	.0956
1+ years ago	.1079	.1080	.1078
Never visited	.7946	.7946	.7946
Missing	.0020	.0021	.0020
N	10,910	10,161	10,837

Note: Proportions may not sum to 1.00 due to rounding.

Log file: 050504_stdprops.log

Table 8. Coefficients of each risk behavior from weighted logistic regressions of chlamydia, gonorrhea, and trichomoniasis on risk behaviors among those who have had vaginal intercourse (Wald statistic in parentheses)[†]

	Chlamydia		Gonorrhea		Trichomoniasis	
Risk Variables	Bivariate	Net of SD	Bivariate	Net of SD	Bivariate	Net of SD
Total # vaginal sex partners						
1 partner	(5.40**)	(3.56*)	(2.34)	(2.52*)	(1.62)	(1.19)
2-3 partners	.5839**	.5408**	-1.1606	-1.1454	.2207	.2159
4-6 partners	.7242***	.6431**	-.0288	-.1123	.3627	.3026
7+ partners	.7522***	.6183**	-1.1014	-1.4878*	.0818	-.0028
Missing	1.0566*	.8737	-1.2307	-.8856	1.0454*	.8904
# vaginal sex partners - 12 mos						
0 partners	(7.73***)	(2.58*)	(0.71)	(1.13)	(1.71)	(1.14)
1 partner	.7716**	.5264	1.5288	-.6656	.3311	.7814
2-3 partners	1.3214***	.8785*	1.3214	-1.3990	.5077	.8031
4+ partners	1.3324***	.8441*	.8921	-2.0175	.4862	.8106
Missing	.7437	.2575	.9787	-.0547	1.3073*	1.1625
# vaginal sex times - 12 mos						
0 times	(4.97***)	(0.87)	(2.67*)	(1.24)	(3.24**)	(0.85)
1-10 times	1.3116***	.7946	2.3462*	-.0302	.4693	.4259
11-40 times	1.1151***	.7768	1.3285	-.8994	.1734	.2349
41-99 times	.9250**	.8739*	1.0191	-.7168	-.4973	-.1861
100-900 times	.5911*	.7358	1.0266	-.2681	-.2795	.2415
Missing	1.1393***	.7870	.6066	-1.5470	.4870	.5036
Condom use at last vaginal sex						
No	(5.55**)	(1.05)	(1.86)	(0.36)	(2.62)	(2.70*)
Yes	.2432*	-.0383	.7364	.3677	-.0026	-.2316
No sex past 12 months	-.8963**	-.6038	-1.0559	.9349	-.3892	-.8787
Missing	.0243	-.4709	.0414	.0780	1.2450*	.4411
Paid for/been paid for sex						
Never	(3.79)	(1.06)	(1.28)	(1.10)	(4.43*)	(1.83)
Yes – ever	.3129	-.1067	1.0968	.2898	.0705	-.3235
Yes – past 12 months	1.0848***	.3121	2.1807**	1.3441*	1.1313***	.4165
Sex with IV drug user						
Never	(0.50)	(0.10)	–	–	(1.39)	(1.99)
Yes – ever	-.1911	-.0740	–	–	.9018	.9764
Yes – past 12 months	.4384	.2102	2.2753**	2.3979*	-.4445	-.5808

Table 8. – Continued

Sex with person who had STD						
No	(8.88***)	(1.42)	(8.40***)	(4.65*)	(3.00)	(2.11)
Yes	.6189**	.2601	1.7147***	1.2750**	.4324	.0543
No sex past 12 months	-.9391**	-.4981	-1.1162	1.1354	-.3696	-.9508*
Condom use vag sex- past 12 mos						
None	(2.84*)	(0.73)	(0.52)	(0.23)	(1.54)	(2.07)
Some	.0508	-.1258	.4526	.4170	-.5063	-.7094**
Half	.2243	-.0211	.0803	-.1457	.0383	-.2403
Most	.2692	.0162	.4072	.0456	-.0247	-.2082
All	.3377*	-.0103	.4467	-.0267	.1217	-.2013
No sex past 12 months	-.8442**	-.6297	-1.1328	.8970	-.4651	-1.2610*
Missing	-.0928	-.5554	-.2209	-.6037	.4066	-.5534
Self-report of STD – past 12 mos						
No	(1.53)	(1.92)	(1.48)	(1.61)	(0.70)	(0.69)
Yes	.6362***	.1569	.5147	-.0904	.5391**	.0216
Missing	.1352	-.4106	-.6196	-1.3683	.9496*	.4844
Condom use all sex – past 12 mos						
None	(1.73)	(0.68)	(0.38)	(0.54)	(0.97)	(0.61)
Successful condom use	.0196	-.1703	.2934	-.0347	-.0961	-.1779
Unsuccessful condom use	.1955	-.1632	-.0989	-.5732	.1115	-.0382
Used condom, success unsure	.5728	-.3345	–	–	1.2393	.7292
Missing	1.4717	1.1758	–	–	–	–
Visited Dr. b/c thought had STD						
Past year	(0.90)	(0.04)	(3.64)	(2.03)	(0.11)	(0.34)
1+ years ago	-.5814*	-.3794	-.8786	-.5222	-.2945	-.1517
Never visited	-.7576***	-.3447	-1.8285***	-1.2086*	-.3768	.0009
Missing	.2511	.3717	–	–	-1.8226*	-2.2790*

* $p \leq .05$ ** $p \leq .01$ *** $p \leq .001$

†All regressions exclude observations missing on ever had vaginal intercourse

Log file: 050510_riskregress.log