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NAAT–Identified and Self-Reported Gonorrhea and Chlamydial Infections

Different At-Risk Population Subgroups?

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Background: **Information on the characteristics and behaviors of persons at high risk for gonorrhea and chlamydial infection has typically been derived from studies of sexually transmitted disease (STD) clinic populations. The Baltimore STD and Behavior Survey (BSBS) used urine-based nucleic acid amplification testing (NAAT) to assess the prevalence and behavioral correlates of gonorrhea and chlamydial infection in a population-based cross-sectional survey of adults in Baltimore, Maryland.**

Goal: **The goal of this study was to examine the demographic characteristics and behavioral markers of gonorrhea and chlamydial infection as reported by adults with a self-reported history of gonorrhea and chlamydial infection and to compare these to the characteristics and behaviors of individuals with current NAAT-identified gonorrhea and/or chlamydial infection.**

Study Design: **A probability sample of adults aged 18 to 35 years residing in Baltimore was evaluated with collection of urine specimens and administration of a health and behavior survey. Data and specimens were collected between January 1997 and September 1998.**

Results: **Respondents with NAAT-detected gonorrhea and/or chlamydial infection (7.9%) did not report a history of high-risk behaviors or more recent occurrences of those behaviors, and the majority were asymptomatic. However, adults in our study who self-reported a history of infection (26.0%) were more likely than those with no history of infection to report multiple partners, paid sex, partners with prior STDs, and STD symptoms—a pattern consistent with findings described in previous clinic-based reports.**

Conclusion: **The risk profile generated from studies of clinic populations, with a focus on symptomatic disease, may not characterize the broader population with current, untreated, largely asymptomatic infection.**

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BEHAVIORAL INTERVENTIONS to prevent the acquisition and transmission of sexually transmitted diseases (STDs) focus on modifying sexual and health behaviors. Information on the behaviors of individuals at greater risk of exposure and transmission has typically been generated from studies of STD, family planning, or other clinic populations. Clinic-based studies, which include diagnostic STD testing, have identified correlates of infection such as recent symptoms, young age, multiple sex partners, new partners, and inconsistent condom use. Results of these studies, however, may not be generalizable beyond the defined clinic population. Furthermore, individuals with asymptomatic infection or limited access to health care may not be adequately represented.

Population-based studies permit inferences to a broader population and may provide insights into the epidemiology of STDs that complement our understanding of infection prevalence and transmission behaviors from clinic studies.[1–3] However, because of the costs and logistical difficulties associated with obtaining clinical measures of current infection status, most population-based studies have involved assessment of self-reports of previously diagnosed STDs and associated risk behaviors.

Self-reports of previous STDs underestimate the true

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prevalence of infection. Many infections are asymptomatic. Clinicians outside of public health STD clinics frequently fail to evaluate their patients routinely for these infections and rarely assess patients' risk for STDs.[4] The social stigma attached to sexually transmitted infections may inhibit some individuals from seeking health care or reporting a diagnosis in a survey.[5] Furthermore, respondents may not recall or may misunderstand a previous diagnosis. Among 905 adult patients attending an STD clinic in Baltimore during 2000 to 2001, for example, 18.6% reported they had heard of genital phlemoria, a fictitious disease, and two patients reported a history of this disease (unpublished data). Consequently, our knowledge of the distribution of sexually transmitted infections (both symptomatic and asymptomatic) in the general population and of the behaviors that cause their transmission is far from complete.

The Baltimore STD and Behavior Survey (BSBS) used urine-based nucleic acid amplification testing (NAAT) for *Neisseria gonorrhoeae* infection and *Chlamydia trachomatis* infection to assess prevalence of current infection in a population-based study while simultaneously collecting information on health, STD-related risk behaviors, and previous STD history. We examined correlates of gonorrhea and chlamydial infection as reported by respondents with a self-reported history of gonorrhea and chlamydial infection and compared these with the characteristics and behaviors of individuals with a current NAAT-identified infection.

Data and Methods

Study Population

The target population for the BSBS was defined as English-speaking adults 18 to 45 years of age residing in households in the city of Baltimore, Maryland.[6,7] The sample was derived from a probability sample of residences selected from a real estate property registry compiled by the city for tax purposes. Interviewers successfully screened 2727 (85.7%) of the 3182 eligible households. Of the 1224 adults between the ages of 18 and 45 years identified as eligible for interviewing, 1014 consented to participate and to complete the survey questionnaire. According to study protocol, respondents aged 18 to 35 years were also asked to provide a urine sample for NAAT testing for gonorrhea and chlamydial infection; 579 (79.5%) of the 728 age-eligible respondents completed the survey questionnaire and provided a urine specimen, 119 (16.3%) refused to provide a urine specimen, and 30 (4.1%) provided a specimen that was untested because of inadequate volume or logistical complications.

Survey Administration

Verbal and written consent was obtained from all subjects aged 18 to 45 years who completed the survey interview. The questionnaire collected information on sexual behavior, STD history, STD symptoms, drug and alcohol use, and individual background characteristics. Survey data were collected by a trained interviewer in a private location in the respondent's home. Respondents were randomly assigned to receive either an audio computer-assisted self-interview (audio-CASI) or computer-assisted personal interview (CAPI) that included some questions to be completed on a self-administered questionnaire.[8] For the current analyses, data are aggregated from both interview modes. The entire survey was designed to take approximately 30 minutes to complete.

Additional details of the sample design and survey execution are published elsewhere.[6]

Urine Collection and STD Testing

Individuals between the ages of 18 and 35 years who completed the interview were asked to provide a urine specimen to be tested for gonorrhea and chlamydial infection. In this second stage of the informed consent process, it was made explicit that the urine was not to be used for drug testing and that, in compliance with state law, specimens found positive for gonorrhea and/or chlamydial infection would be reported to the Baltimore City Health Department.

Urine specimens were processed at The Johns Hopkins University School of Medicine. Ligase chain reaction (LCR) assays for both pathogens were performed according to the manufacturer's instructions (Abbott Laboratories, Abbott Park, IL). For nearly all positive tests, results were confirmed by means of retesting of the same assay. Retest findings were not available for three persons who initially tested positive; these cases were considered positive on the basis of the initial testing.

Respondents were provided a telephone number to call to learn of their test results. Study staff members successfully contacted 69% of positive respondents (via telephone or registered letter signed by respondent). If telephone contact was not made and a registered letter was returned undelivered, a first class letter was sent. Free treatment at one of the city's public health STD clinics was offered to all contacted participants.

The study protocol was approved by the Institutional Review Board of Research Triangle Institute and the Joint Committee on Clinical Investigations of the Johns Hopkins Medical Institutions.

Data Analysis

We compared the sexual and health-related risk behaviors associated with two primary gonorrhea/chlamydial infection outcomes: current NAAT-identified infection and a self-reported history of infection. Current gonorrhea/chlamydial infections were identified at the time of participation in the survey by the urine LCR assay. History of gonorrhea/chla-

mydial infection was determined from self-reported information gathered on the survey questionnaire. Specifically, respondents were asked, "Have you ever heard of a disease called gonorrhea?" and if so, "Has a doctor or nurse ever told you that you had gonorrhea, or 'clap'?" An identical set of questions was asked for chlamydial infection. For each infection recognized, respondents were asked to provide information on the number of times an infection had been detected, when the most recent infection occurred (within the past week, between 1 and 4 weeks ago, between 1 and 6 months ago, between 7 and 12 months ago, or >1 year ago) and whether medical treatment was obtained. From these responses, it was possible to generate self-reported estimates of previous gonorrhea and/or chlamydial infection, as well as to determine when the most recent diagnosis had been made (and thus when treatment had occurred). In deriving these estimates, we assumed that respondents who had never heard of the disease had never had it diagnosed. Alternatively, we could have assumed that infection rates were equivalent between respondents who had and had not heard of the infection. This alternative procedure—treating the information from respondents who had never heard of gonorrhea and chlamydia as missing in our analyses—produced nearly identical results in our statistical analyses. Tabulations derived from this procedure are not presented.

Statistical Procedures

The analyses are based on cross-sectional data from the 579 respondents who completed the survey questionnaire and provided a urine specimen for gonorrhea and chlamydial infection testing. Analyses examined demographic and behavioral risk factors separately for each gonorrhea/chlamydial infection outcome, i.e., current NAAT-detected infection and self-reported treated infection. Independent variables analyzed as possible predictors of infection included sexual risk practices, partner selection, STD-related symptoms, condom use, and health care behaviors, including antibiotic use. Prevalence odds ratios (ORs) and their 95% CIs were obtained for each bivariate relationship. We subsequently calculated adjusted ORs by means of multiple logistic regression to control for demographic characteristics (race, sex, education, marital status, and age) and interview mode. Additional multivariate logistic regression analyses were conducted to model the likelihood of each outcome measure, on the basis of a range of sociodemographic and behavioral predictors collected in the survey interview.

Our household survey utilized a complex sample design that oversampled subpopulations known to have higher rates of infection. Poststratification adjustments were applied to align the survey estimates with the 1997 census population estimates (by age, sex, and race). Sample weights were then used during analysis to adjust for the differing probabilities of sample selection and survey nonresponse. In all bivariate tests and multivariate regression analyses, we used software (Stata 6.0; Stata Corp., College Station, TX)[9] that adjusts the variances of our survey estimates to take into account our complex sample design.

Results

The study population was predominantly African American and had an approximately equal distribution of males and females (Table 1). The majority of respondents were never married, and a substantial proportion of respondents reported some education beyond high school.

Of the 579 respondents, 49 were positive by urine-based LCR for gonorrhea or chlamydial infection, yielding an overall weighted prevalence estimate of 7.9% (SE = 1.6). Of the 49 positive assays, 33 were positive for *N gonorrhoeae* (5.3%; SE = 1.4), 18 were positive for *C trachomatis* (3.0%; SE = 0.8), and 2 were positive for both gonorrhea and chlamydial infection (0.4%; SE = 0.3).

The estimate of self-reported lifetime gonorrhea or chlamydial infection, as determined by interview, was 26.0% (SE = 2.5). Previous gonococcal infections were reported by 15.2% of respondents (SE = 2.2); 15.1% reported prior chlamydial infection (SE = 1.9). More respondents had heard of gonorrhea (89.7%) than had heard of chlamydial infection (79.7%; $P < 0.001$). Only 4.1% of adults in our sample had never heard of either infection.

Twelve respondents with a positive NAAT assay also reported prior gonorrhea and/or chlamydial infection. One respondent with a currently identified chlamydial infection reported previous gonorrhea, diagnosed within the past 6 months; for the remaining 11 subjects, previous infections with a different pathogen occurred >1 year ago. Reinfections were more common among those with current gonorrhea (n = 9) than among those with current chlamydial infection (n = 3).

Race, marital status, and education were significantly associated with self-reported infection. Race and sex were associated with NAAT-identified infections. Age and interview mode were not associated with our gonorrhea/chlamydial infection outcomes in this sample of study respondents.

Correlates of Prior Treated Infection

In comparison with respondents who reported no prior infection, adults with a self-reported history of gonorrhea and/or chlamydial infection were more likely to report several classic STD risk behaviors (Table 2). Nearly two thirds of respondents (61.8%) with a prior gonorrhea/chlamydial infection reported six or more lifetime partners, compared with 45.8% of those who had never had one of these infections (adjusted OR = 1.8; 95% CI, 1.0–3.1). Respon-

TABLE 1. Characteristics of Respondents (1) Completing the Survey Interview and Providing a Urine Specimen for NAAT Testing, (2) Self-Reporting a History of Gonorrhea or Chlamydial Infection, and (3) With a Current NAAT-Identified Infection

Characteristic	All Respondents: Base N	All Respondents: Population Estimate (%)	Self-Reported History of Infection* (Pop. Est. [%])	NAAT-Identified Infection† (Pop. Est. [%])
Age (y)				
18–20	76	16.8	13.3	23.2
21–25	138	23.9	20.1	19.1
26–30	158	26.2	28.9	13.2
31–35	207	33.2	37.7	44.4
Sex				
Female	335	52.0	52.0	69.2[b]
Male	244	48.0	48.0	30.8
Race				
African American	319	65.7	89.8[a]	91.1[a]
Other	260	34.3	10.2	8.9
Marital status				
Married	123	21.1	10.5[c]	31.6
Cohabitating	80	15.6	18.9	7.8
Widowed/divorced/separated	71	9.7	10.6	3.1
Never married	305	53.6	59.9	57.6
Education‡				
< High school	146	22.1	33.6[b]	30.7
Completed high school	183	36.6	35.5	41.9
Some college/trade school	158	27.8	26.9	25.0
College +	90	13.5	4.0	2.4
Mode of survey interview§				
Audio-CASI	294	50.6	56.3	38.5
CAPI	285	49.4	43.7	61.5
Current NAAT-identified gonorrhea/chlamydial infection†	49	7.9		
Self-reported history of treated gonorrhea/chlamydial infection*	130	26.0		
Current identified infection and prior treated gonorrhea/chlamydial infection	12	1.8		
Unweighted n	579			

Base sample Ns are unweighted numbers of adults providing urine samples. Percentage estimates are weighted; statistical analyses use algorithms that take into account the impact of the complex sample design on variance estimates. *P* values estimated from weighted data with chi-square test of independence in cross-tabulation of respondent characteristic by each gonorrhea/chlamydial infection outcome: [a] $P < 0.001$, [b] $P < 0.01$, [c] $P < 0.05$.

*Respondents were asked a sequence of questions regarding their history of gonorrhea and chlamydial infection: (1) whether they had ever heard of gonorrhea or chlamydia, (2) whether a doctor or nurse told them that they had either disease, and, if applicable, (3) the last time they had been told they had the disease. For these analyses, respondents who reported that they had never heard of gonorrhea or chlamydia were assumed to have never had the infection diagnosed. Excludes 3 cases with missing data.

‡Includes 16 persons who were 18 years of age at the time of the interview. Some of these respondents may have still been in school. N does not total 579 because of missing observations.

†As determined from urine-based ligase chain reaction (LCR) assay.

§Survey respondents were randomly assigned to one of two interview modes: audio-CASI (audio computer-assisted self-interview) or CAPI (computer-assisted personal interview). Respondents randomly assigned to the CAPI mode also completed some paper-and-pencil questionnaires.

dents with a history of gonorrhea/chlamydial infection were also more likely to report having a main partner with an STD than were those with no such previous infection (adjusted OR = 4.7; 95% CI, 1.9–11.3). Self-reported gonorrhea and/or chlamydial infection was positively associated with several measures of risky sexual practices. Compared with respondents without a prior infection, respondents with a previously detected infection were significantly more likely to report anal sex (adjusted OR = 2.3; 95% CI, 1.2–4.3), a one-night stand (adjusted OR = 2.8; 95% CI, 1.5–5.0), forced sex (adjusted OR = 2.5; 95% CI, 1.4–4.5), and paid sex (adjusted OR = 3.7; 95% CI, 1.9–7.4).

Douching after sex (adjusted OR = 2.3; 95% CI, 1.2–4.3) was more frequently reported by women with a

TABLE 2. Estimates of Reported Risk Behaviors for Self-Reported Gonorrhea and Chlamydial Infections

Variable	Self-Reported History of Gonorrhea/Chlamydial Infection*				
	History of Infection (%)	No History of Infection (%)	Odds Ratio	Adjusted Odds Ratio	(95% CI)
Partner characteristics					
≥ 6 Lifetime partners	61.8	45.8	1.9	1.8	(1.0–3.1)
≥1 New partners last year	44.1	34.2	1.5	1.6	(0.9–2.8)
≥ 2 Partners last year	35.9	27.8	1.5	1.5	(0.8–2.7)
≥ 6 Lifetime partners *or* ≥ 2 partners last year	70.4	51.8	2.2	2.0	(1.1–3.5)
Main partner in past year had an STD	18.9	4.1	5.4	4.7	(1.9–11.3)
Concurrent sexual relationship	23.1	13.2	2.0	1.4	(0.7–2.8)
Sexual practices					
Anal sex	43.8	26.8	2.1	2.3	(1.2–4.3)
Anal sex within past 6 months	20.4	9.7	2.4	2.3	(1.1–5.1)
One-night stand	55.9	36.8	2.2	2.8	(1.5–5.0)
One-night stand within past 4 weeks	8.7	3.3	2.8	2.2	(0.7–6.4)
Forced sex	39.2	21.4	2.4	2.5	(1.4–4.5)
Sex with a prostitute	24.8	12.1	2.4	1.9	(0.8–4.3)
Been paid for sex	23.0	5.5	5.1	3.7	(1.9–7.4)
Never used condom in past year	43.3	37.4	1.3	1.5	(0.8–2.8)
Health/STD symptoms					
Taken an antibiotic within the past 6 months	32.8	39.2	0.8	0.7	(0.4–1.3)
Females : douche after sex	66.4	36.7	3.4	2.3	(1.2–4.3)
Females : ever had pelvic inflammatory disease	13.9	3.6	4.4	3.3	(1.0–11.1)
Dysuria within past 6 months	10.9	10.0	1.1	1.4	(0.5–3.7)
Dripping/discharge within past 6 months	11.6	5.3	2.4	2.1	(0.8–5.2)
Ever dysuria or dripping/discharge	74.0	33.0	5.8	6.6	(3.5–12.3)
Unweighted n	130	446			

Percentages are weighted. Odds ratios and 95% confidence intervals were estimated with statistical algorithms that account for the impact of the complex sample design on variance estimates. Adjusted odds ratios were calculated with logistic regression models including controls for race, sex, education, marital status, and interview mode; an additional control for age, as a continuous variable, was included in the model with a quadratic spline smoothing procedure.

*History of gonorrhea/chlamydial infection if respondent reported yes to either or both of the following questions: "Has a doctor or nurse ever told you that you had [chlamydia] [gonorrhea, or 'clap']?" Respondents who had never heard of them were assumed to have never had such infection. Three cases are excluded because of missing data.

history of gonorrhea/chlamydial infection than by women who did not report such a history. A history of pelvic inflammatory disease (adjusted OR = 3.3; 95% CI, 1.0–11.1) was marginally associated with self-reported gonorrhea or chlamydial infection after adjustments for respondent characteristics and interview mode. Recent use of antibiotics and use of alcohol or drugs (data not shown) were not significantly associated with a history of gonorrhea and/or chlamydial infection. Nearly three fourths (74%) of respondents with previous gonorrhea or chlamydial infection reported a history of dysuria or discharge, versus 33% of those with no previous infection (adjusted OR = 6.6; 95% CI, 3.5–12.3).

Multivariate analyses. African American men and women and individuals with less than a high school education were more likely to report a history of gonorrhea and/or chlamydial infection when other risk factors or markers were controlled for in multivariate analyses (Table 3, Model 1). Respondents (1) whose main sexual partner within the past year had a previous STD infection, (2) who had engaged in paid sex, and (3) who had symptoms of infection, dysuria, or discharge were also significantly associated with self-reported infection in multivariable models.

Multiple self-reported infections. To assess further the associations between reported risk behaviors and previous infections, we examined the behavioral characteristics of respondents reporting a history of multiple (two or more) episodes of gonorrhea and/or chlamydial infection. Multiple or repeated STDs may indicate persistent risky sexual behaviors. We compared estimates of reported risk behaviors among respondents with two or more previous gonococcal or chlamydial infections to those for persons who reported a single previous diagnosis. Among respondents with a

TABLE 3. Estimates of Demographic and Behavioral Characteristics of (1) Self-Reported and (2) NAAT-Identified Gonorrhea/Chlamydial Infection

	Model 1: Self-Reported Infection*		Model 2: NAAT-Identified Infection†	
Characteristic	OR	95% CI	OR	95% CI
Race/sex				
African American female	8.5	(2.2–33.3)	7.8	(2.2–27.6)
African American male	13.4	(3.4–52.3)	3.6	(0.9–13.9)
Other female	2.4	(0.5–12.4)	0.5	(0.1–1.7)
Other male	1.0		1.0	
Education				
Less than high school	2.8	(1.4–5.4)	1.7	(0.7–4.1)
High school or beyond	1.0		1.0	
Current marital status				
Married	0.6	(0.2–1.7)	2.3	(0.7–7.0)
Cohabitating	1.2	(0.5–2.6)	0.3	(0.1–1.3)
Widow/divorced/separated	0.8	(0.2–2.6)	0.3	(0.1–1.3)
Never married	1.0		1.0	
Interview mode				
Interviewer-assisted questionnaire	1.2	(0.6–2.2)	0.7	(0.3–1.6)
Audio computer-assisted self-interview	1.0		1.0	
Multiple partners				
≥ 6 Lifetime or ≥ 2 in past year	1.7	(1.1–6.9)	0.8	(0.3–1.8)
< 6 Lifetime and < 2 in past year	1.0		1.0	
Main partner had an STD				
Yes	2.8	(1.1–6.9)	0.6	(0.1–2.9)
No	1.0		1.0	
Paid for sex				
Yes	2.5	(1.0–6.1)	1.4	(0.5–4.1)
No	1.0		1.0	
Ever dysuria or discharge				
Yes	6.4	(3.2–12.7)	NA	
No	1.0		NA	
Discharge within past 6 months				
Yes	NA		0.4	(0.1–2.2)
No	NA		1.0	
Dysuria within past 6 months				
Yes	NA		0.2	(0.04–1.3)
No	NA		1.0	
Antibiotic use within past 6 months				
Yes	NA		0.4	(0.2–1.1)
No	NA		1.0	
Previous gonorrhea/chlamydial infection				
Yes	NA		0.8	(0.3–1.8)
No	NA		1.0	

Odds ratios were obtained from multivariate logistic regression models using statistical algorithms that take into account the complex survey design on variance estimates. An additional control for age was included in each model with a quadratic spline. Recent symptoms and behaviors were included as explanatory variables in the model of current NAAT-identified infection only.
*History of infection if respondent reported yes to either or both of the following questions, "Has a doctor or nurse ever told you that you had [chlamydia] [gonorrhea, or 'clap']?" Respondents who had never heard of them were assumed to have never had such infection.
†As determined from urine-based ligase chain reaction assay.
NA = not applicable.

history of infection, 35 (26.8%) reported at least two diagnoses and treatments for gonorrhea and/or chlamydial infection. In comparison with respondents with a single previous infection, respondents with multiple previous infections were more likely to report paid sex (OR = 4.1; 95% CI, 1.5–11.4), forced sex (OR = 3.1; 95% CI, 1.2–8.3), and antibiotic use within the past 6 months (OR = 3.2; 95% CI, 1.2–8.3). No differences were observed in reports of number of sex partners, other sexual practices, or related symptoms.

Correlates of Current NAAT-Identified Infection

In contrast to findings from the analysis of self-reported infections, current NAAT-diagnosed infections were not associated with classic risk behaviors or more recent such behaviors in bivariate analyses (Table 4). Multiple partners,

TABLE 4. Estimates of Reported Risk Behaviors for Current NAAT-Identified Gonorrhea and Chlamydial Infections

Variable	NAAT-Identified Infection*				
	Positive (%)	Negative (%)	Odds Ratio	Adjusted Odds Ratio	95% CI
Partner characteristics					
≥ 6 Lifetime partners	42.5	50.6	0.7	0.8	(0.3–1.9)
≥ 1 New partners last year	24.7	37.9	0.5	0.7	(0.3–1.6)
≥ 2 Partners last year	23.1	30.6	0.7	0.9	(0.3–2.3)
≥ 6 Lifetime partners *or* ≥ 2 partners last year	47.6	57.3	0.7	0.7	(0.3–1.6)
Main partner in past year had an STD	4.3	8.2	0.5	0.4	(0.1–2.2)
Concurrent sexual relationship	18.0	15.8	1.2	1.6	(0.6–4.1)
Sexual practices					
Anal sex	25.7	31.6	0.8	0.9	(0.4–1.9)
Anal sex within past 6 months	10.0	12.7	0.8	1.0	(0.3–2.9)
One-night stand	31.8	42.9	0.6	0.8	(0.3–2.0)
One-night stand within past 4 weeks	4.7	4.7	1.0	1.0	(0.2–4.6)
Forced sex	16.9	26.7	0.6	0.5	(0.2–1.2)
Sex with a prostitute	11.5	15.8	0.7	1.1	(0.3–3.5)
Been paid for sex	11.5	10.1	1.2	1.0	(0.4–2.7)
Never used condom in past year	46.7	38.2	1.4	1.4	(0.5–3.6)
Health/STD symptoms					
Taken an antibiotic within the past 6 months	20.2	39.0	0.4	0.4	(0.2–1.1)
Females : douche after sex	46.0	44.2	1.1	0.7	(0.2–1.7)
Females : ever had pelvic inflammatory disease	9.9	5.8	1.8	1.3	(0.2–8.2)
Dysuria within past 6 months	2.1	10.9	0.2	0.2	(0.04–1.1)
Dripping/discharge within past 6 months	3.2	7.2	0.4	0.3	(0.1–1.3)
Ever dysuria or dripping/discharge	33.4	44.6	0.6	0.5	(0.2–1.0)
Unweighted n	49	530			

Percentages are weighted. Odds ratios and 95% confidence intervals were estimated with statistical algorithms that account for the impact of the complex sample design on variance estimates. Adjusted odds ratios were calculated with logistic regression models including controls for race, sex, education, marital status, and interview mode; an additional control for age, as a continuous variable, was incorporated using a quadratic spline.

**Chlamydia trachomatis* or *Neisseria gonorrhoeae* positivity determined by urine ligase chain reaction assay.

new partners within the past year, and other measures of recent sexual practices were not significantly associated with current infection, after statistical adjustments for mode of interview and demographic characteristics. Recent use of antibiotics was less frequently reported by respondents with a current infection, although the difference was of borderline significance (adjusted OR = 0.4; 95% CI, 0.2–1.1).

The majority (94.7%) of NAAT-identified infections were asymptomatic. Only 2.1% of subjects with a current infection reported dysuria (adjusted OR = 0.2; 95% CI, 0.04–1.1), and only 3.2% reported discharge within the past 6 months (adjusted OR = 0.3; 95% CI, 0.1–1.3). Recent symptoms were reported by respondents with current gonorrhea only; all of the respondents with a current chlamydial infection were asymptomatic within the past 6 months. Nearly 9 in 10 respondents (88.7%) with current NAAT-identified infections reported no symptoms within the past year.

A history of dysuria or discharge was negatively associated with a positive NAAT assay (adjusted OR = 0.5, 95% CI = 0.2–1.0). One possible explanation of this finding is that respondents with symptoms are more likely to seek treatment and therefore would be less likely to test positive by the NAAT assay.

Adding controls for measures of recent behavioral risk had no discernible impact on the detection of a current, untreated infection in multivariate analyses (Table 3, Model 2). The protective effect of recent antibiotic use remained of borderline significance (OR = 0.4; 95% CI, 0.2–1.1), a finding suggesting that the use of antibiotics may have inadvertently treated or cured an asymptomatic or undiagnosed infection.

Recently treated infections. Respondents with a history of recently diagnosed and treated infection may be more likely to report recent symptoms or behaviors associated with that infection than those with no history of infection. To control for this possibility, we examined the relationship between reported risk behaviors and NAAT-identified infections, excluding from the tabulations any persons receiving treatment for gonorrhea and/or chlamydial infection within the past year (n = 559). Adjusted ORs were similar to those presented in Table 4 and are not shown. None of the behavioral characteristics we measured were significantly associated with current untreated infection in these analyses.

Discussion

This study is one of the first to assess the performance of classic STD risk factors in predicting the prevalence of

NAAT-identified gonococcal and chlamydial infections in a probability sample of the general population. Our results suggest that the risk profile generated from clinic studies may not characterize the broader population with current, untreated, largely asymptomatic gonorrhea and chlamydial infection. Studies of clinic or other high-risk populations typically include individuals seeking care for symptoms of recently acquired infection.[10,11] In those studies, recent at-risk behaviors have been associated with symptomatic disease. Our data suggest that respondents with NAAT-detected infections did not have a history of high-risk behaviors, nor did they report more recent occurrences of those behaviors, and very few reported symptoms. Nearly 95% of adults with NAAT-identified infection reported no symptoms within the past 6 months. Only 11.3% reported dysuria or discharge within the past year. The absence of a history of risk and symptoms leaves few—if any—cues to stimulate treatment-seeking behavior. In contrast, self-reports of past infection were associated with multiple partners, paid sex, partners with prior STDs, and STD symptoms–a pattern consistent with previous clinic-based reports. These data suggest that there are at least two adult populations that we need to target to better understand factors contributing to the sustained prevalence of *C trachomatis* and *N gonorrhoeae* in American communities.

Empirical data on the duration of untreated asymptomatic infection are limited, but some untreated gonorrhea and chlamydial infections are believed to persist for months, or even years, particularly in women.[12–14] Without knowing the duration of infection, recent behaviors may or may not be indicative of risk for asymptomatic infections currently detected by NAAT in cross-sectional analyses. One possible interpretation of our results is that some infections identified by NAAT may reflect persistent infections. The lack of symptoms and the insignificant correlation between the likelihood of NAAT-identified infection and recent risk behaviors support this possibility. It is conceivable that such infections may be associated with low organism burden or perhaps amplifiable DNA from previous infections that have not been cleared. This interpretation is derived from the same factors that account for the increased sensitivity of the assay—extremely low limits of detection (approximately 1–10 organisms in a milliliter of sample) and the ability to detect DNA from nonviable organisms. Alternatively, undetected asymptomatic infection may suggest partial resolution or incomplete clearance of infection associated with suppression of an immune response[15] or infection by a particular organism strain that produces symptoms less often.[16]

Whether these results may be replicated in other populations with different characteristics, STD risk, and levels of infection remains to be determined. Our study was restricted to data collection in one city, and results must be confirmed in other urban populations. Data from the 1995 National Survey of Adolescent Males (NSAM), however, tend to corroborate our findings. The NSAM collected both urine specimens for gonorrhea and chlamydial testing and self-reported STD and behavioral data on a representative sample of young men in the United States.[3] In that study, 3.1% of young males aged 18 to 19 years and 4.5% of those aged 22 to 26 years tested positive for chlamydial infection on the basis of urine-based polymerase chain reaction. Ninety-two percent of infected subjects reported no symptoms in the past year. Preliminary analyses of NSAM suggest that the behavioral determinants of infection were clearly different for respondents testing positive for chlamydial infection and respondents with a self-reported history of STD infection. Among males not living with a partner, certain factors (having frequent and more recent one-night stands, multiple partners, concurrent partnerships in the past year, and STD symptoms) were significantly associated with a previous STD but were not associated with NAAT-identified chlamydial infection in multivariate analyses.[17]

The intervals chosen for assessing behavioral contributions to the risk of gonorrhea and chlamydial infection may have influenced the associations we observed in this study. We attempted to minimize effects of differences between the timing of a reported behavior and the timing of infection by restricting our assessment of potential risk factors to behaviors occurring within the past year or, if such measurements were available, the past 6 months. Ideally, measures would have been collected on behaviors occurring within the recent past, i.e., 1 to 2 years, when some of the NAAT-identified infections may have occurred. It also was not possible to examine multivariable models of behavioral risk among respondents with infection diagnosed and treated within the past year, because we were limited by small sample sizes.

Given a larger sample, it may have been possible to investigate differences in reported behaviors for gonorrhea and chlamydial infections separately. It is generally believed that chlamydial infections are more often asymptomatic than gonorrhea. None of the respondents with an NAAT-identified chlamydial infection in our sample reported symptoms within the past 6 months.

Similarly, it must be recognized that our ability to detect differences in behavioral risk could be related to the statistical power available. Because the prevalence of gonorrhea and chlamydial infection within the general population is low, the statistical power to detect an association between our modeled behavioral variables and current, NAAT-identified infection status is attenuated. We note, however, that most of the estimated ORs in analyses of current infection are opposite in direction from those found for past infection status, and the remaining ORs are clustered around 1.0 (range, 0.2–1.6).

The BSBS collected limited information on respondents' sex partners. Although information was obtained on the num-

ber of partners and a respondent's relationship with the most recent partner, survey data did not indicate whether the respondent's partners had current or recent gonorrhea or chlamydial infection, nor did the survey investigate the partners' sexual activities. Ideally, urine specimens would have been collected and tested and behavioral information (on their own sexual and STD history) would have been gathered from the partners.

Although the enhanced diagnostic capabilities of amplification tests are well-recognized,[18] the epidemiologic significance of certain infections detected by NAAT remains less well understood. As use of NAAT becomes more widespread, our knowledge of the behavioral epidemiology associated with risk for these infections will undoubtedly improve. Understanding the significance of infections detected by nucleic acid amplification has important public health implications, including defining the burden of disease within a community and refining our efforts to detect and treat infection beyond clinical settings that rely on symptomatic individuals to seek diagnosis and treatment.

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