Research Article

Knowledge of Sexually Transmitted Infections among High School Students

M. Jacques Nsuami, Ladatra S. Sanders, and Stephanie N. Taylor

ABSTRACT

Background: *It has not been determined conclusively whether greater knowledge of sexually transmitted infections (STIs) is associated with lower rates of STIs.* ***Purpose:*** *This study sought to determine STI knowledge among high school students and factors associated with such knowledge, and to determine whether poor STI knowledge is associated with chlamydia or gonorrhea infection.* ***Methods:*** *Students in an urban United States school district serving a predominantly African American student population participated in a urine-based chlamydia and gonorrhea screening. Participants (N=3563) were surveyed about their knowledge of selected basic facts concerning STIs. Point-scores were assigned to knowledge items.* ***Results:*** *The mean knowledge score was 3.65 (range: 0 to 6; median: 4.00). In a multiple regression analysis, knowledge score was significantly associated with female gender (P<0.001), upper grade level (P<0.001) and a past infection with chlamydia or gonorrhea (P=0.001). In logistic regressions, knowledge score was not significantly associated with current infections with chlamydia (P=0.22) or gonorrhea (P=0.74).* ***Discussion:*** *There was an insufficient basic knowledge of STIs among students and a lack of association between knowledge and current infections with chlamydia and gonorrhea.* ***Translation to Health Education Practice:*** *Health education curricula taught throughout the high school years should incorporate basic facts concerning STIs.*

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BACKGROUND

From the late 1980s to the early 1990s, the recognition of the primarily sexual transmission of human immunodeficiency virus (HIV) and the growing concerns about sexual exposure of American adolescents to HIV led to an increased provision of human immunodeficiency virus/acquired immune deficiency syndrome (HIV/AIDS) instruction to adolescents through sexuality education campaigns that resulted in adolescents' increased knowledge of HIV/AIDS.[1-7] Although HIV/AIDS has a significant impact on the health of adolescents, other pathogens that are transmitted through the same sexual behavior pathways such as *Chlamydia trachomatis* and *Neisseria gonorrhoeae* are more prevalent, presumably a result of their differential greater transmissibility compared to HIV.[8,9]

Infections with *C. trachomatis* and *N. gonorrhoeae* are the two most commonly reported notifiable diseases in the United States, and the highest rates of infections are among adolescents and young adults under the age of 25.[9] Untreated or inadequately treated infections may lead to severe complications, especially among women who

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may develop pelvic inflammatory disease, tubal infertility, ectopic pregnancy, or chronic pelvic pain.[10,11] Despite the greater prevalence and serious health consequences of sexually transmitted infections (STIs), knowledge and awareness of STIs other than HIV/AIDS among American adolescents remain poor.[7,12-14] Even among healthcare professionals, knowledge of STIs may at best be inadequate.[15]

In 1997, the Committee on Prevention and Control of Sexually Transmitted Diseases of the Institute of Medicine estimated that STIs in the United States were in epidemic proportions, and that the epidemic was partly due to the poor knowledge of Americans about STIs.[16] Because the rates of STIs are disproportionately higher among adolescents and young adults than in other age-groups,[9,16] the Committee recommended, as part of a national system to prevent STIs among adolescents, that clinicians utilize routine clinical encounters to educate all adolescents and screen for STIs those who are sexually active.[16] Implicit to this grim assessment of STIs by the Committee and its recommendation is the contention that the more Americans would know about STIs, the more likely they would protect themselves against and take appropriate actions to control STIs, which should contribute to drive the epidemic down.

But whether individuals with greater knowledge of STIs have lower rates of infections has not been determined conclusively. Studies conducted in the late 1980s through the 1990s to evaluate the effectiveness of education campaigns in response to the HIV/AIDS pandemic could not conclusively address this question because they focused on behavioral outcomes instead of laboratory evidence of STIs.[2,3,5,6] This was mainly because these education campaigns aimed at sensitizing adolescents about behaviors that increased or decreased their risk of acquiring HIV. Secondarily, STIs before the mid-1990s were diagnosed only in clinical settings using laboratory specimens obtained through pelvic examinations, urethral swabs, or venipuncture.

Research on STI/HIV/AIDS knowledge and sexual behaviors indicates that a greater knowledge of STI/HIV/AIDS is not necessarily associated with a positive change in behaviors that expose individuals to sexually transmitted pathogens. In a literature review commissioned by the World Health Organization's Global Programme on AIDS on the impact of HIV/sexuality education on youth's sexual behaviors, 25 out of 47 studies that evaluated interventions reported that HIV/sexuality education neither increased nor decreased sexual activity and related STI rates; 17 studies reported that HIV/sexuality education delayed sexual debut, reduced the number of sex partners, or reduced unintended pregnancy and STI rates; and three studies reported increases in sexual activity associated with sexuality education.[17]

Although STI knowledge and sexual behaviors have been defined differently across studies, making direct comparison between studies difficult,[17] many of these studies have shown that unsafe sexual practices are highly prevalent among individuals with greater knowledge of STIs.[18-20] This high prevalence of risky sexual behaviors among individuals with greater knowledge of STIs would indicate that many individuals who are at higher risk for STIs possess accurate information regarding STIs. Despite the inability to establish the directionality of these associations from existing studies, they may be explained in part by the fact that risky sexual behaviors, by increasing the probability of acquiring an STI or an STI-like syndrome, increase the likelihood that high-risk individuals would seek STI-related care, which creates the opportunity for them to learn about STIs through the recommended STI counseling component of the clinical management of patients with STIs.[21]

While individuals practicing high-risk sexual behaviors may increase their likelihood of learning about STIs firsthand through direct contact with healthcare professionals, the general population is less likely to have a history of an STI and less likely to have had a clinic visit that includes an in-depth discussion of STIs. The general adolescent and young adult population typically acquires knowledge of STIs through formal health education with schools being the primary source of such education.[6,12,13,22] Other sources of STI education commonly cited include parents, peers, and the media.[1,12,13,23] Because individuals who have had an STI may know more about STIs from their personal experience with the infection compared with individuals with no history of an STI,[20,24,25] the knowledge of STIs acquired from sources other than through personal experience should contribute to elucidating the relationship between STI knowledge and STIs at the individual level. Understanding this relationship remains important for STI control and the promotion of reproductive health as theoretical frameworks that currently guide behavioral interventions for STIs propose that knowledge of STIs would act toward prompting individuals to adopt safer sexual behaviors, which in turn would reduce the probability of infection.[16,26,27]

During the school year 1995-1996, a school-based screening for chlamydia using nucleic acid amplification tests (NAATs) in urine specimens was introduced in three southern urban United States public schools that served a predominantly African American student population.[28] This screening initially sought to determine the feasibility of providing a large-scale, population-based chlamydia screening outside of traditional clinical settings, as laboratory tests for detecting STIs in specimens that could be obtained without the performance of a pelvic examination or through urethral swabs became available in the mid-1990s.[29-31] After the feasibility, acceptability and high yield of such a screening in a high school student population were demonstrated,[28] the screening was repeated every year afterward until the school year 2004-2005, adding to the program a testing for gonorrhea and enlisting more schools in the school district to participate.[32]

In this program, each year before specimen collection, the screening staff provided all students in the participating schools with educational information about chlamydia, gonorrhea, STIs, STI prevention and the purpose of the chlamydia and gonorrhea screening. Specifically, students were told that: (1) chlamydia and gonorrhea are acquired through sexual intercourse from an infected sex partner; (2) each of the two infections can be cured with a single dose of antibiotic; (3) a person may have an STI without developing any sign or symptom; and (4) STIs can be prevented by abstaining from sexual relations, through monogamous relationships between uninfected sex partners, or by the use of condoms if abstinence and monogamy cannot be practiced. Because these information sessions had been integrated into the school-based chlamydia and gonorrhea screening over the course of several years, it had been assumed that the basic STI facts taught in school each year through this screening program had become common knowledge among students in the participating schools. Surprisingly, a survey of students who refused to participate in the screening revealed that some perceived themselves as not being susceptible to chlamydia and gonorrhea based on notions such as being too young to catch chlamydia or gonorrhea, being so healthy their body can fight off chlamydia and gonorrhea, taking a bath every day with soap and water, using a clean toilet seat, having sexual partners who use oral contraceptives or who are very clean, and not being susceptible to reinfection after being treated for chlamydia or gonorrhea.[33]

Upon documenting such misconceptions, the present study was undertaken to determine the basic knowledge of STIs among students in the participating schools. The longitudinal nature of this screening program that incorporated an information provision component in its design also offered the opportunity to assess the relationship between STI knowledge and biological evidence of infections with chlamydia and gonorrhea at the individual level.

PURPOSE

The purpose of this study was twofold: first, to determine the knowledge of the basic facts that chlamydia and gonorrhea are transmitted sexually, that chlamydia and gonorrhea can be cured, and that STIs can be asymptomatic and prevented, and to determine factors associated with such knowledge among students who participated in the chlamydia and gonorrhea screening; second, to determine whether poor (or alternatively greater) knowledge of these STI facts was associated with increased (or alternatively decreased) odds of infections with *C trachomatis* and *N gonorrhoeae*.

METHODS

School-based Chlamydia and Gonorrhea Screening Protocol

Each year since the school year 1995-1996, trained clinical research data collectors (the STI screening staff) gave scripted 10-minute presentations to all students in individual classes or through assemblies, educating students about chlamydia, gonorrhea, STIs, STI prevention and the purpose of the chlamydia and gonorrhea screening. Because these educational sessions were introducing students to a chlamydia and gonorrhea screening program, students were being specifically told that chlamydia and gonorrhea are acquired through sexual intercourse from an infected sex partner; that each infection can be cured with a single dose of antibiotic; that a person may have an STI without developing any sign or symptom; and that STIs can be prevented by abstaining from sexual relations, through monogamous relationships between uninfected sex partners, or by the use of condoms if abstinence and monogamy cannot be practiced. Students were then encouraged to participate in open discussions, ask questions, or express themselves about STIs and the proposed screening. At the end of the discussions, consent forms were distributed to all students for parental signature for students younger than 18 or for personal signature for students aged 18 years or older. In the consent form, information about the purpose of the chlamydia and gonorrhea screening, STIs, and the consequences of untreated STIs was also provided. Students younger than 18 were instructed to return their consent form with their parent/guardian's signature to their homeroom teacher the following school day. Every school day after these presentations, the screening staff returned to school to collect signed consents, and to issue new forms to students who lost the ones they previously received or were absent the day the screening program was presented. They eventually filled students who had missed the 10-minute class presentations in with information about chlamydia, gonorrhea and the upcoming screening. Parents/guardians of students younger than 18 whose child did not return a signed consent form were called so a verbal consent could be obtained directly from them over the telephone. At each school, consents were collected during approximately one week before urine collection.

During the urine collection phase that lasted between four and five weeks at each school, entire classes of students were escorted throughout the day to the testing area, which could be a hallway near the restrooms, an auditorium, the gymnasium, or a vacant classroom. There, the screening staff first reminded the whole class that it was time for the chlamydia and gonorrhea testing for which they or their parents had been providing consent in recent days. Then, any questions or concerns students had at that time about chlamydia, gonorrhea, STIs, or their participation in the screening were addressed. Next, the screening staff met each student individually to assess their eligibility and willingness to be tested. Students younger than 18 whose parents had not provided consent and students aged 18 or older who had not signed a written consent were not allowed to participate.[28,32,33] Those who had consent and were willing to participate were asked to complete a confidential health survey before providing a urine specimen. Survey forms and urine specimen containers were labeled with preprinted barcodes so they could be linked. Specimens collected were placed in an ice chest and transported to the laboratory at the end of the day for *C. trachomatis* and *N. gonorrhoeae* testing using commercially available NAATs. Students whose urine specimen was tested for chlamydia and gonorrhea were considered to have participated in the screening. The laboratory made test results available approximately five working days after specimen collection. Students who received positive test results were considered infected. They were counseled and treated by the school nurse at school with a single dose of 1g oral azithromycin for chlamydia or 500mg oral ciprofloxacin for gonorrhea, administered under direct observation.[21] Before its removal from the market, cefixime 400mg in single oral dose was used for the treatment of gonorrhea. School nurses referred infected students to the city STI clinic for evaluation according to the clinic protocol, and encouraged them to refer their sex partners to the city STI clinic for treatment and STI evaluation. If a named sex partner attended the same school as the index-infected student, he/she was treated at school by the school nurse.

Each school year, our university Institutional Review Board reviewed and approved the school-based chlamydia and gonorrhea screening program.

Study Eligibility

During the school year 2003-2004, questions assessing students' knowledge of STIs were incorporated in the health survey that participants in the chlamydia and gonorrhea screening completed, after inaccuracies and misconceptions concerning STIs started to emerge among students in the participating schools.[33] Students were eligible for this study if they participated in the screening during the school year 2003-2004 or the school year 2004-2005, when participants were surveyed about their knowledge of STIs. Health surveys were not administered to students who were not participating, for any reason, in the chlamydia and gonorrhea screening.

Data Collection and Management

Participants in the screening in 2003-2004 and 2004-2005 were asked in a paper-and-pencil, self-administered questionnaire: (1) to indicate with a check mark whether they knew that chlamydia and gonorrhea were transmitted through sexual intercourse; (2) to indicate with a check mark among these infections the one(s) that can be cured; (3) whether a person infected with an STI could have no symptoms; and (4) whether STIs could be prevented. For questions 3 and 4, students could check "yes," "no," or "I don't know." This survey was adapted from the knowledge portion of the instrument developed by Gökengin and colleagues,[34] and built around the six basic facts that chlamydia and gonorrhea are transmitted sexually, that each of the two infections can be cured, and that STIs can be asymptomatic and prevented, a content that students were specifically told by the screening staff each year as part of the chlamydia and gonorrhea screening program, and that they were expected to know.

We assigned a score of 1 for each check mark on the facts that chlamydia and gonorrhea are transmitted sexually; that chlamydia and gonorrhea can be cured; and for "yes" answers to questions on whether STIs can be asymptomatic and prevented. A score of 0 was assigned to any skipped mark on the facts that chlamydia and gonorrhea are transmitted sexually, that each infection can be cured, and for unanswered, "no," or "I don't know" answers to questions on whether STIs can be asymptomatic and prevented. A composite knowledge score was computed by summing the scores of each knowledge item. For each respondent, the possible total knowledge score ranged from 0 to 6. The internal consistency of these six items to measure STI knowledge based on the average inter-item correlation (Cronbach's α) was 0.75.

Data collected the two school years were merged into the screening program database. This allowed the determination of students' previous attendance in schools where the screening had been conducted, their participation in previous screenings, and their chlamydia and gonorrhea test results during previous screenings.

Data Analysis

To determine students' knowledge of STIs, participants' responses to the six selected knowledge items were tabulated and reported as proportions. Differences between proportions were considered statistically significant at P values of less than 0.05 using χ^2 tests.

Factors associated with STI knowledge were assessed first by bivariate associations with knowledge score using t tests, analysis of variance and correlation procedures as appropriate. Variables associated with knowledge score at a P value of less than 0.05 in bivariate analyses were entered into multiple regression equations to determine factors that independently predicted STI knowledge. Because some students could have been exposed to our screening program before the implementation of the knowledge survey, multiple regression analyses for determining factors associated with STI knowledge were performed at three levels: first, among all respondents, to assess the independent contribution of any variable for which data were available on all respondents and that was associated with knowledge in bivariate analysis; second, among students who previously attended a school where screening had been conducted, whether they had participated in the screening or not, in order to assess the independent contribution of their previous school enrollment in predicting their STI knowledge; third, among students who had participated in our previous screening, in order to assess the independent contribution of their previous STI test results in predicting their STI knowledge. For students who participated in the screening both in 2003-2004 and in 2004-2005, only knowledge scores recorded in 2003-2004 (first participation) were used in these descriptive, bivariate, and multiple regression analyses.

To determine whether poor knowledge of STIs was associated with increased odds of infection at the individual level, logistic regression analyses were performed with chlamydia and gonorrhea as dependent variables and knowledge score as independent variable, adjusting for gender, age, chlamydia and gonorrhea co-infection, and a history of previous chlamydia or gonorrhea infection. For students who participated in the screening both in 2003-2004 and in 2004-2005, only knowledge scores and STI test results recorded during their first participation (2003-2004) were used in these logistic regression analyses.

Among students who participated in the screening in 2003-2004 and in 2004-2005, their knowledge scores and their chlamydia and gonorrhea test results at both participations were reexamined using paired samples and independent samples *t* tests as appropriate. In particular, knowledge scores and chlamydia and gonorrhea test results in 2003-2004 (baseline) and in 2004-2005 (rescreening) were examined to determine whether uninfected students at baseline who became infected at rescreening have had lower knowledge scores at baseline.

RESULTS

Characteristics of Study Participants

There were 9,736 students who cumulatively enrolled in nine schools that participated in the screening program in 2003-2004 (8 schools, $N = 7,117$) and 2004-2005 (9 schools, $N = 6,614$). Among students enrolled, consent to participate was obtained for 4,641 students (47.7%). Overall, 3,791 participated in the screening at least during one of the two school years (81.7% of those who had consent and 38.9% of the school population), of them 3,563 (94.0%) completed the survey and are the subjects of this analysis. Among study subjects, 531 participated the two school years.

Almost all study subjects (99.0%) were African Americans and the majority (53.9%) was male, with approximately an even distribution by grade (Table 1). They were between 14 and 21 years olds (mean: 16.84 ± 1.41 years, median: 17.00 years); males were significantly older than females and age linearly increased with grade ($P < 0.001$). Of the 228 participants excluded from analysis (6.0%), 224 participated in 2003-2004 before the survey questionnaire was finalized. Excluded participants were 97.4% African American ($N = 222$), 48.2% male ($N = 110$) and aged 14 to 20 (mean: 16.93 ± 1.40 years, median: 17.00 years).

Eligible students in the nine schools who did not participate in the screening ($N = 5,945$) were similar to those who participated with regard to gender (52.4% male) and race/ethnicity (98.8% African American); they were however significantly younger (mean age: 16.56 ± 1.44 years; median: 16.00 years) than participants ($P < 0.0001$).

Table 1. Demographic Characteristics of Respondents (*N* = 3563)

	Total Participants	Age in years Mean (SD)
Gender		
Male	1919 (53.9%)	16.94 (1.43)**
Female	1644 (46.1%)	16.73 (1.36)
Race/ethnicity		
African American	3529 (99.0%)	16.84 (1.40)
Other	34 (1.0%)	16.56 (1.69)
Grade[a]		
9th	955 (26.8%)	15.52 (1.01)**
10th	833 (23.4%)	16.33 (0.97)
11th	836 (23.5%)	17.29 (0.92)
12th	937 (26.3%)	18.24 (0.84)

Notes: **$P < 0.001$ for comparison of mean age between males and females ($t_{3561} = 4.382$) and for comparison of mean age between 9th, 10th, 11th and 12th graders ($F_{3, 3557} = 1483.3$); [a]2 students had missing grades.

Knowledge of Selected STI Facts

Students' knowledge of the selected six STI facts is summarized in Table 2. Overall, 70.5% of respondents identified gonorrhea and 54.1% identified chlamydia as infections that were transmitted sexually ($P < 0.0001$). Gonorrhea and chlamydia were identified as curable by 65.7% and 49.9% of respondents, respectively ($P < 0.0001$). Less than one-half of males (43.4%) and 51.9% of females correctly indicated that STIs can be asymptomatic, and 75.0% of males and 80.5% of females were aware that STIs could be prevented.

Among all respondents, 21.8% ($N = 776$) correctly answered all six knowledge items, and respectively 18.7% ($N = 667$), 15.6% ($N = 555$), 15.3% ($N = 544$), 12.3% ($N = 439$), 8.0% ($N = 286$) and 8.3% ($N = 296$) correctly answered five, four, three, two, one, and none of the six knowledge items. The proportions of respondents who correctly answered all six items were 10.5% (100/955) among 9th graders, 19.7% (164/833) among 10th graders, 26.4% (221/836) among 11th graders, and 31.1% (291/937) among 12th graders. The mean knowledge score for all respondents was 3.65 (standard deviation: 1.91; median: 4.00).

Bivariate Associations of STI Knowledge and Participant Characteristics

In bivariate analyses, knowledge score increased linearly with age (Pearson correlation coefficient $r = 0.092$, $P < 0.001$) and the number of years respondents attended schools where screening was conducted ($r = 0.060$, $P = 0.014$). Additionally (Table 3), the mean knowledge score among all respondents was significantly greater among females ($P < 0.001$), among upper classmen ($P < 0.001$), among students currently infected with chlamydia ($P = 0.003$) and gonorrhea ($P=0.012$), and among students who previously attended schools where screening was conducted ($P < 0.001$). Among students who previously attended schools where screening was conducted ($N = 1,669$), the mean knowledge score was significantly greater among students previously tested compared to students never tested previously ($P = 0.001$). Among students tested previously ($N = 959$),

Table 2. Knowledge of Chlamydia, Gonorrhea and Sexually Transmitted Infection Facts among Respondents (*N* = 3563, 1919 males and 1644 females)

	Males (%)	Females (%)	Total (%)
Infection is transmitted through sexual intercourse			
Gonorrhea	66.1	75.6	70.5
Chlamydia	45.1	64.7	54.1
Infection can be cured			
Gonorrhea	61.5	70.6	65.7
Chlamydia	41.0	60.3	49.9
Sexually transmitted infections can be without symptoms			
Yes	43.4	51.9	47.3
No	15.5	17.9	16.6
I don't know	36.0	27.1	31.9
Did not answer	5.1	3.0	4.1
Sexually transmitted infections can be prevented			
Yes	75.0	80.5	77.5
No	5.8	4.6	5.2
I don't know	13.0	11.4	12.3
Did not answer	6.1	3.5	4.9

the mean knowledge score was significantly higher among students previously infected with chlamydia or gonorrhea than that of students with no previous infection with either STI ($P < 0.001$).

Multiple Regression Analyses for Predicting STI Knowledge

Table 4 summarizes findings of multiple regression analyses for predicting knowledge score. In a first multiple regression predicting STI knowledge among all 3,563 participants with gender, grade, current chlamydia and gonorrhea test results, and previous enrollment in schools where screening was conducted as predictor variables (model 1), gender ($P < 0.001$) and grade ($P < 0.001$) independently predicted knowledge score. Previous enrollment in schools where screening was conducted was only weakly associated with knowledge score ($P = 0.07$). The five predictors in this model explained only 8.4% of the variance in knowledge score (Adjusted $R^2 = 0.084$). A second multiple regression was performed among the 1,669 students who previously attended schools where screening was conducted, with gender, grade, current chlamydia and gonorrhea test results, the number of years students attended schools where screening had been conducted, and participation in at least one of our previous screenings as predictor variables (model 2). In this model, gender ($P < 0.001$), grade ($P<0.001$) and participation in at least one of our previous screenings ($P = 0.007$) significantly predicted knowledge score. The number of years students attended schools where screening had been conducted did not significantly predict knowledge score ($P = 0.49$). The six predictors in this model explained only 4.5% of the variance in knowledge score (Adjusted $R^2 = 0.045$). A third multiple regression was performed among the 959 students tested at least once during our previous screenings, with gender, grade, current chlamydia and gonorrhea test results, and their previous chlamydia and gonorrhea test results as predictor variables (model 3). In this model, gender ($P < 0.001$), grade ($P<0.001$), and a previous infection with chlamydia or gonorrhea during any of our previous screenings ($P = 0.001$) were the significant independent predictors of knowledge score. The five predictors in this model explained only 4.7% of the variance in knowledge score (Adjusted $R^2 = 0.047$). In the three multiple regression models, current infection with chlamydia or gonorrhea did not independently significantly predict knowledge score.

Logistic Regression Analyses of Chlamydia and Gonorrhea Infections

In logistic regression of chlamydia with knowledge score, gender, age, gonorrhea co-infection, previous chlamydia infection and previous gonorrhea infection as independent variables, chlamydia was independently significantly associated with female gender ($P = 0.04$), gonorrhea co-infection ($P < 0.001$), and a previous chlamydia infection ($P < 0.001$). In logistic regression of gonorrhea with knowledge score, gender, age, chlamydia co-infection, previous chlamydia infection and previous gonorrhea

Table 3. Bivariate Associations of STI Knowledge and Participant Characteristics

	Total evaluated	Knowledge score Mean (SD)	P value[a]
Gender (*N* = 3563)			
Female	1644	4.04 (1.82)	< 0.001
Male	1919	3.32 (1.92)	
Race/ethnicity (*N* = 3563)			
African American	3529	3.65 (1.91)	0.172
Other	34	3.21 (2.00)	
Grade (*N* = 3561)[b]			
9th	955	3.03 (1.88)	< 0.001
10th	833	3.54 (1.88)	
11th	836	3.92 (1.89)	
12th	937	4.15 (1.79)	
Current chlamydia test (*N* = 3563)			
Positive	435	3.90 (1.90)	0.003
Negative	3128	3.62 (1.91)	
Current gonorrhea test (*N* = 3563)			
Positive	83	4.17 (1.77)	0.012
Negative	3480	3.64 (1.91)	
Attended school where screening was conducted previously (*N* = 3563)			
Yes	1669	3.96 (1.85)	< 0.001
No	1894	3.38 (1.92)	
Participated in previous screenings (*N* = 1669)			
Yes	959	4.09 (1.82)	0.001
No	710	3.77 (1.87)	
Previous chlamydia positive test (*N* = 959)			
Yes	113	4.76 (1.59)	< 0.001
No	846	4.00 (1.83)	
Previous gonorrhea positive test (*N* = 959)			
Yes	30	4.60 (1.69)	0.119
No	929	4.07 (1.82)	
Previous chlamydia or gonorrhea positive test (*N* = 959)			
Yes	126	4.71 (1.60)	< 0.001
No	833	4.00 (1.83)	

Notes: [a]All *P* values are by *t* tests except for grade where ANOVA test was used; [b]2 students had missing grade.

infection as independent variables, gonorrhea was only independently significantly associated with chlamydia co-infection ($P < 0.001$). For both STIs, knowledge score was not significantly associated with current infection ($P = 0.22$ for chlamydia and $P = 0.74$ for gonorrhea).

STI Knowledge among Students Surveyed in 2003-2004 and in 2004-2005

Among the 531 students surveyed in 2003-2004 and resurveyed in 2004-2005 after a median time of 11.56 months (mean: 11.66 months; range: 7 to 18 months), the mean knowledge score increased from 3.64 to 4.09, respectively (difference=0.45; 95% confidence interval: 0.29 to 0.61; paired samples $t = 5.65$; $P < 0.001$). The mean knowledge score in 2004-2005 was 4.87 among 53 students who tested positive for chlamydia or gonorrhea in 2003-2004 compared with 4.00 among 478 students who tested negative for both STIs in 2003-2004 (independent samples $t = 3.283$; $P = 0.001$). Subtracting 263 students enrolled before 2003-2004 in schools where the screening had been conducted, there were 268 students who enrolled in participating schools for the first time in 2003-2004 (baseline) who were rescreened in 2004-2005. At baseline, 23 tested positive for chlamydia or gonorrhea and 245 tested negative for both STIs. Their mean knowledge scores were 3.83 and 3.50, respectively (independent samples *t*

Table 4. Multiple Regression Analyses for Predicting Knowledge Score

	Models *P* values		
	Model 1 (*N* = 3563)	Model 2 (*N* = 1669)	Model 3 (*N* = 959)
Predictor variables			
Gender	< 0.001	< 0.001	< 0.001
Grade	< 0.001	< 0.001	< 0.001
Current chlamydia infection	0.509	0.301	0.253
Current gonorrhea infection	0.235	0.869	0.868
Attended school previously screened	0.070	-	-
Years of previous school enrollment	-	0.486	-
Participated in previous screenings	-	0.007	-
Previous chlamydia or gonorrhea infection	-	-	0.001
R^2	0.085	0.048	0.052
Adjusted R^2	0.084	0.045	0.047

Note: A dash ("-") indicates that the variable was not included in the model.

= 0.774; *P* = 0.44). Of the 23 students infected, 20 (87.0%) had documentation of treatment through our screening program before they were rescreened in 2004-2005. At rescreening, the knowledge score among the 23 baseline-infected students (mean: 4.96) became significantly higher (independent samples *t* = 2.366; *P* = 0.019) than the knowledge score for the 245 uninfected students at baseline (mean: 3.99).

When the 245 students uninfected at baseline were rescreened in 2004-2005, 25 became infected with chlamydia or gonorrhea and 220 remained uninfected. Their mean knowledge scores remained statistically similar both at baseline (3.96 vs. 3.45, respectively; independent samples *t* = 1.248; *P* = 0.213) and at rescreening (4.16 vs. 3.97, respectively; independent samples *t* = 0.470; *P* = 0.639).

DISCUSSION

Among these predominantly African American high school students who were participating in a school-based chlamydia and gonorrhea screening, we found an insufficient knowledge of basic facts concerning STIs, consistent with the poor knowledge of STIs reported among adolescents.[7,12-14] Because survey respondents in this study were exposed to repeated calls for participation in a chlamydia and gonorrhea screening for which they were providing a urine specimen at the time of the survey, the knowledge level for the two STIs could have been higher than observed, as all 3,563 respondents could conceivably be expected to indicate that chlamydia and gonorrhea are transmitted sexually.

Several studies show that gonorrhea is usually better known than chlamydia.[7,34,35] In this study, however, students participated in a screening that was introduced primarily and referred to in the school district as a chlamydia screening program[28] in which participants were also tested for gonorrhea.[32] Reasons remain unclear for a significantly lower knowledge among students that chlamydia is transmitted sexually and is curable, like gonorrhea.

Females were significantly more knowledgeable than males, and STI knowledge significantly increased with grade. Whereas, Benson et al.[36] found that gender and grade did not affect students' ability to learn sex-related issues, Ateka and Selwyn[37] found that high school females knew more about STIs than high school males who participated in the same knowledge-based adolescent sexuality program. Research also shows that female adolescents may be more likely than males to receive formal reproductive health education.[1] Hence, gender differences in STI knowledge in this study may be explained by gender differences in prior exposure to formal reproductive health education, as reported by Lindberg et al.,[1] and by differences in males and females levels of interest in the subject of STIs, as found by Ateka and Selwyn.[37] Regarding grade differences in STI knowledge, upper classmen were likely to have benefited from multiple exposures to our screening educational sessions and from prior exposures to formal reproductive health education such as through health classes.[1,12,13,22] Additionally, high school upper classmen are more likely than under classmen to have ever had sex and to have multiple sex partners.[38] Upper classmen may therefore be more motivated to learn and retain sex-related issues, as these issues may have become more relevant and more of a necessity to them.

In addition to gender and grade, students with a past infection with chlamydia or gonorrhea detected during our previous screenings knew more about STIs than students previously screened but not infected with either STI. This was found both in multivariate analysis and in an analysis of knowledge among students infected with chlamydia or gonorrhea in 2003-2004 and reassessed in 2004-2005. A greater knowledge of STIs among individuals with a history of an STI has been reported in clinical populations of adolescents.[20,24,25] For example, two studies of predominantly African American female adolescents aged 12 to 21 who were attending primary care clinics found knowledge of gonorrhea and chlamydia to be significantly higher among respondents with a personal history of each STI compared to respondents who never had an STI.[24,25] Like in clinical populations, our findings indicate that in-school adolescents who are not seeking care but who have had an STI do learn about STIs from personal experience compared with those who have never had an STI.

Among students who were uninfected in 2003-2004, those who became infected in 2004-2005 did not know more about STIs before receiving treatment for their newly acquired infection compared to students who remained uninfected in 2004-2005. In our screening program, infected students received STI counseling as part of the treatment protocol,[28,32] and 87% of students who tested positive for chlamydia or gonorrhea in 2003-2004 were treated for their infection through our screening program. Before treatment, their knowledge of STIs was similar to that of uninfected students. At retesting approximately one year after their baseline infection, they knew significantly more about STIs than students who were uninfected in 2003-2004. In a similarly designed assessment and reassessment of chlamydia knowledge and infections, adolescents who had chlamydia at baseline were referred for treatment, but the actual treatment was not controlled for when knowledge was reassessed at rescreening six months after baseline.[25] However, at rescreening, the relationships between knowledge of chlamydia and never having had chlamydia, a prior diagnosis of chlamydia and a new diagnosis of chlamydia were strikingly similar[25] with findings we report. Our findings indicate that having an STI by itself does not confer knowledge of STIs; instead, treatment and counseling are the learning moment when adolescents who have had an STI do learn about STIs at a more personal level.

However, the knowledge gained, from personal experience or otherwise, does not protect adolescents from subsequent infections, as demonstrated in our study by the lack of association between STI knowledge and current infections with chlamydia and gonorrhea. This finding corroborates earlier reports showing that adolescents' knowledge of selected STI facts does not necessarily lead to sustained change in protective sexual behavior,[19,39-41] and adolescents' high rates of re-infections with STIs[41-44] that are direct consequences of continuing risky sexual behaviors. In our screening program, data on sexual behavior were not obtained because of school district policies,[28] but chlamydia re-infection was a significant factor in this analysis.

In addition to the lack of significant association of STI knowledge with current chlamydia and gonorrhea infections in logistic regression analyses, our examination of students screened twice showed that uninfected students at baseline who became infected at rescreening had not known less at baseline compared to students who remained uninfected at rescreening. These analyses clearly indicate that lower knowledge of STIs was not associated with an increased probability of STI in our population. Our findings therefore challenge the contention that poor knowledge of STIs at the patient level is a significant contributor to the STI epidemic at the population level.[16]

The main goal of information sessions provided to students by the clinical staff of the school-based chlamydia and gonorrhea screening program was to encourage students' participation and to provide students with the knowledge base that would assist them in making an informed decision about participating in an STI screening initiative. It was also assumed that the acquired knowledge would outlast students' participation or non-participation in the STI testing. Because the assessment of STI knowledge was undertaken as an adjunct to the ongoing STI screening in response to the surprising lack of knowledge students were expressing regarding basic facts they were supposed to know,[33] this study was limited in terms of which variables we were able to obtain.

One consequence of this limitation is that the variables we obtained left over 90% of the variance in STI knowledge unexplained. Our determination of factors associated with STI knowledge is therefore very limited. For example, as students were being tested and some were receiving chlamydia or gonorrhea positive test results and treated accordingly, they could possibly impact their uninfected friends' knowledge of STIs. However, such an influence could not be controlled for in this study. Also, because we did not ask respondents whether they have had an STI detected and treated outside of our screening program, such history of an STI may be associated with greater knowledge that was not accounted for in our analysis. If many respondents had learned about STIs from personal experience among students we categorized as not having a history of an STI (misclassification), their knowledge would have regressed our association of STI knowledge and a history of an STI towards the null. Our results instead indicate that if such a confounding did occur in our analyses, its effect is likely to be minimal. The less than 40% participation rate, with nonparticipants being similar in terms of gender and race/ethnicity but significantly younger than participants, may have resulted in our assessment of STI knowledge among all eligible students to be biased. Because older students significantly knew more about STIs and participants were significantly older than nonparticipants, our findings may have overestimated the overall level of STI knowledge in the nine participating schools.

Despite the inability to make direct comparisons with findings from other studies of STI knowledge due to differences in operational definitions of STI knowledge across studies, the present study adds to the existing evidence that knowledge of STIs other than HIV among American adolescents, remains poor[7,12-14] and that adolescents who have had an STI may know more about STIs compared with those with no history of an STI.[20,24,25] In addition, this study clarifies that the high knowledge of STIs among adolescents with a history of an STI is a result, not of the STI itself, but of adolescents interacting with the health care system for the clinical management of their infection. The study also provides empirical evidence that poor knowledge of STIs is not associated with increased probability of STI at the individual level.

Theoretical models applied to STI interventions usually incorporate knowledge as a variable in a complex framework of STI transmission dynamic.[26,27] For example, psycho-educational theories emphasize education and information provision and postulate that accurate information will influence recipients' attitudes and behaviors so they will translate their knowledge into behavior change, that would result in a reduction in the number of infections.[27] Our study, that examined the direct relationships of STI knowledge and chlamydia and gonorrhea infections, does not provide evidence to support the proposition that knowledge of chlamydia and gonorrhea was being translated into a reduction in the number of infections among adolescents. We found instead that infection, if brought to treatment, leads to increased knowledge, but knowledge was not prospectively related to infection.

TRANSLATION TO HEALTH EDUCATION PRACTICE

The educational information provided to students by the screening staff—and that focused on chlamydia, gonorrhea, transmission and prevention of STIs, and the asymptomatic nature of STIs—was not intended to replace, but rather to supplement the content of sexuality education in the participating schools. In the school district, sexuality education was provided as part of a comprehensive health education curriculum including a variety of topics, such as personal health, family health, community health, substance use and abuse among others. The content of sexuality education varied between schools within the school district, but topics covered, depending on grade level, generally included HIV/AIDS, STIs, abstinence, sexual anatomy and physiology, sexual development, pregnancy and birth. Although knowledge of STIs as measured by the six selected items in our study increased with grade, only 31% of 12th graders knew all of the most basic facts that chlamydia and gonorrhea—the two most commonly reported infectious diseases in the United States—are transmitted sexually, that both can be cured, and that STIs can be asymptomatic and prevented. Such insufficient knowledge among high school graduates suggests that health education curricula taught throughout the high school years should incorporate basic facts concerning STIs. As is the case with other class subjects, the teaching should have evaluation components to regularly assess students' accumulated knowledge concerning STIs. Because policy decisions concerning sexuality education are sometimes left to individual schools, even within the same school district,[45] selection of topics concerning specific STIs can even be guided by local or regional STI epidemiology.

Students may additionally benefit from repeated exposures to other STI educational opportunities, and screening programs utilizing NAATs in self-collected specimens provide one of these opportunities for disseminating STI information to high school students.

The strength of the association of STI knowledge with a history of treated infection with chlamydia or gonorrhea compared with the mere students' exposure to our screening program on the one hand, and the lack of association of STI knowledge with the number of years students enrolled in the participating schools on the other hand, indicate that clinical encounters may be more effective in capturing the attention of adolescents concerning STIs than didactics in non-clinical settings. This study demonstrates that routine adolescent clinical encounters offer unique opportunities for educating adolescents about STIs. NAATs currently make it possible to screen large numbers of adolescents for STIs without the need to perform clinical examinations.[32,46] Although these screenings can be conducted outside of traditional clinical settings, the clinical aspect of these encounters may become the best moments for adolescents to personally learn and acquire lasting knowledge about STIs. These teaching moments should also be used to address misconceptions and misinformation many adolescents may have concerning STIs.[7,13,33]

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