

ADOLESCENT SEXUAL HEALTH

Predictors of infection with *Trichomonas vaginalis*: a prospective study of low income African-American adolescent females

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Objectives: To identify psychosocial predictors of *Trichomonas vaginalis* infection among low income African-American adolescent females living in a high risk urban area of the United States.

Methods: Baseline plus 6 and 12 month follow up data collected as part of an HIV prevention intervention trial were utilised. The baseline sample consisted of 522 African-American females, 14–18 years of age. Recruitment sites were located in low income neighbourhoods of Birmingham, Alabama, characterised by high rates of unemployment, substance abuse, violence, teenage pregnancy, and sexually transmitted infections. Self administered vaginal swab specimens were cultured for *T vaginalis*. Baseline measures collected as part of a self administered survey and face to face interviews were used to predict subsequent infection with *T vaginalis* at any of the three assessment periods conducted over the span of 1 year.

Results: At baseline, 12.9% were diagnosed with *T vaginalis*. At the 6 and 12 month follow ups, *T vaginalis* was diagnosed in 8.9% and 10.2%, respectively. The strongest multivariate predictor of *T vaginalis* infection was biologically confirmed marijuana use; those using marijuana were more than six times as likely to test positive for *T vaginalis* (adjusted odds ratio (AOR) = 6.2, $p = 0.0003$). Other multivariate predictors were reporting that typical sex partners were at least 5 years older (AOR = 2.6; $p = 0.005$), reporting sex with non-steady partners (AOR = 1.9; $p = 0.02$), and history of delinquency (AOR = 1.3; $p = 0.02$). The odds of testing positive increased by 31% for every one unit increase on a six item scale measure of delinquency.

Conclusions: Infection with *T vaginalis* was common and significant multivariate predictors comprised a constellation of problem behaviours, each of which are potentially amenable to behavioural intervention.

Sexually transmitted infections (STIs) are a common source of adolescent morbidity, with their sequelae being especially problematic and costly in females.¹ Owing to a combination of biological factors (for example, cervical ectopy) and social factors (for example, greater prevalence of STIs among their sex partners), African-American adolescent females are particularly likely to be infected with an STI.^{1–3} Despite reporting greater frequency of condom use than their white and hispanic counterparts,⁴ African American adolescent females, especially those living in urban areas of the southern United States, experience disproportionately high rates of STIs, including HIV infection.^{1, 5, 6}

With the exception of human papillomavirus, trichomoniasis is the most common STI in the United States, accounting for one third of an estimated 15 million annual incident cases of STIs each year.⁷ Prevalence of *Trichomonas vaginalis* is particularly high among females⁸ and is frequently asymptomatic.¹ Evidence indicates that infection with *T vaginalis* causes chronic purulent vaginal discharge, vulvovaginal irritation, dysuria, dyspareunia, and predisposes pregnant females to preterm delivery, premature rupture of membranes, delivery of low birth weight neonates, and maternal puerperal morbidity.^{9–13} *T vaginalis* infection has also been implicated as a cofactor in the sexual transmission and augmentation of HIV infection^{14–16} and the development of cervical neoplasia.¹⁷

Previous investigations have identified the prevalence and predictors of *T vaginalis* infection in very specific populations of women. For example, a study of pregnant inmates in New York City identified *T vaginalis* by culture in 47% of the sam-

ple. Multivariate predictors of *T vaginalis* were “crack” cocaine use and a positive serological test for *T pallidum*.¹⁸ Other identified predictors of women’s infection with *T vaginalis* include African-American race, low income, multiple sex partners, multiparity, and infection with *Neisseria gonorrhoeae*.¹⁹ Unfortunately, studies have not been published that identify more specific predictors of *T vaginalis* infection (for example, douching, perceived barriers to condom use). Further, studies have not been published that report both the prevalence and predictors of *T vaginalis* infection among adolescent females. Although a recent study found that 15% of the adolescent females sampled tested positive for *T vaginalis* by culture, predictors specific for this infection were not reported.²⁰

Investigations designed to assess the prevalence and predictors of *T vaginalis* infection among high risk adolescent females are clearly needed. Factors that predict infection among adolescents are likely to be different from those that predict infection among adults (for example, family level influences and having older partners may be variables that are uniquely important among adolescent females). The identification of predictors can be especially informative for targeting and designing individual and group education sessions promoting behaviour change leading to reduced incidence of *T vaginalis*. Accordingly, the purpose of this study was to identify psychosocial predictors of *T vaginalis* infection among low income African-American adolescent females living in a high risk urban area of the southern United States.

METHODS

Study sample

Baseline plus 6 and 12 month follow up data collected as part of an HIV prevention intervention trial were utilised for this study. Recruitment sites were located in low income neighbourhoods of Birmingham, Alabama, characterised by high rates of unemployment, substance abuse, violence, teenage pregnancy, and STIs. From December 1996 through April 1999 project recruiters screened 1130 female teenagers in adolescent medicine clinics, health department clinics, and school health classes to assess eligibility for participating in an HIV/STD prevention study. Adolescents were eligible to participate if they were African-American females, 14–18 years old, unmarried, and reported sexual activity in the previous 6 months. Of those screened, 609 adolescents were eligible to participate in the study. Of those adolescents not eligible to participate, the majority (98%) were not sexually active.

The study achieved an 85.7% baseline participation rate ($n = 522$). The majority of eligible teenagers who did not participate in the study were unavailable because of conflicts with their employment schedules. At baseline, tests for *T vaginalis* were successfully completed for 98% of the adolescents ($n = 512$). At the 6 month follow up, 88% ($n = 459$) of the adolescents completing baseline assays returned and provided usable specimens. At the 12 month follow up, 85% of the adolescents returned and provided a third usable specimen for testing. The University of Alabama at Birmingham institutional review board approved the study protocol before implementation.

Data collection

Data collection was conducted at the University of Alabama family medicine clinic and consisted of a self administered questionnaire followed by a face to face interview and, lastly, biological specimen collection. The self administered questionnaire was developed for adolescents with a sixth grade reading level. The self administered questionnaire was administered in a group setting with monitors providing assistance to adolescents with limited literacy and helping to assure confidentiality of responses. Adolescents were assured that outside the study their names could not be linked to the codes used to identify documents containing their responses. Subsequently, adolescents completed the face to face interview. Interviewers were trained graduate students in their early 20s. We employed young adult African-American female graduate students to maximise adolescents' sense of comfort and trust with the interviewer.

Laboratory assessment of the outcome measure

Adolescents were instructed in the correct procedure for collecting a vaginal swab specimen that was subsequently evaluated for *T vaginalis*. The swab was used to inoculate culture medium for *T vaginalis* (InPouch TV test; BioMed Diagnostics, Inc, Santa Clara, CA, USA). Upon receipt in the laboratory, cultures for *T vaginalis* were incubated at 37°C and read daily until the fifth day after inoculation. Cultures were considered positive based upon the identification of motile trichomonads within the pouch. Adolescents who tested positive were notified within 1 week and asked to return for treatment. Treatment consisted of a single oral dose (2 g) of metronidazole, as recommended by the Centers for Disease Control and Prevention.²¹ Identical procedures were repeated at the 6 and 12 month follow up assessments. Adolescents were compensated \$20 for their participation in each of these assessment periods.

Study design

Baseline measures collected as part of the self administered survey and face to face interview were used to predict subsequent infection with *T vaginalis* at any of the three assessment

periods conducted over the span of 1 year. Because adolescents were informed of their test results for *T vaginalis* approximately 1 week after baseline data collection, the temporal ordering of the predictor and outcome variables was preserved—that is, the test results could not have possibly influenced adolescents' responses to the questionnaire or face to face interview. Thus, baseline test results for *T vaginalis* were included in the 1 year period.

Selection and measurement of variables

Variables were selected based on evidence obtained from other studies that identified predictors of *T vaginalis* or infection with any other STI among adolescents. Thus, parental monitoring and parent-adolescent communication about sex related issues such as STI prevention were assessed.²² Parental monitoring was assessed by two questionnaire items that asked adolescents if their parents (or parent figure) knew where they were and with whom they were when not at school and away from home. Adolescents responded to each item using a five point Likert scale ranging from (1) "never" to (5) "almost always." Parent-adolescent communication was assessed using a five item questionnaire scale that asked adolescents how frequently they talked with their parents about sexuality related issues such as pregnancy, STI prevention, and how to use condoms. Adolescents responded to each scale item using a four point Likert scale, ranging from (1) "never" to (4) "often." Inter-item reliability of this measure was adequate ($\alpha = 0.88$).

Questionnaire scales also assessed adolescents' attitudes towards condom use²³ and their perceived barriers to achieving condom use.²⁴ Inter-item reliability of the former scale was $\alpha = 0.70$ and reliability of the latter scale was $\alpha = 0.87$. Because low self esteem has been identified as a potential antecedent of adolescents' sexual risk behaviour, we included a scale measure of self esteem in the questionnaire ($\alpha = 0.79$).²⁵ Finally, we included a six item scale measure of delinquency in the questionnaire ($\alpha = 0.53$). This scale assessed whether adolescents had ever been in a gang, arrested, sentenced by a judge, convicted of shoplifting, in a fight, or if they had ever hit a teacher. For each scale, higher scores represent greater levels of the construct (that is, more favourable attitudes, higher self-esteem, and more delinquency).

Evidence also suggests that adolescent females who have sex with older male partners may experience inflated risk of STI acquisition.^{26–28} Thus, as part of the interview, adolescents were asked about the age of their typical sex partner in comparison to their own ages. Recent sex (past 6 months) with a partner who the adolescent considered to be a non-steady partner (that is, a casual sex partner) was also assessed by interview. Evidence also suggests that problem behaviours such as heavy drinking or marijuana use may be associated with adolescents' sexual risk behaviours,²⁹ thus the interview assessed recent alcohol and drug use.

We also included a toxicological assessment for the presence of cannabinoids in adolescents' urine. Adolescents provided urine samples that were tested using the Emit II assay for the presence of cannabis.³⁰ The Emit II assays can detect the presence of marijuana use, even very small amounts, for up to 30 days. Specimen collection was conducted using standardised procedures. Emit II assays were performed at the University of Alabama toxicology laboratories.

In addition, the interview assessed adolescents' age of sexual debut and their self reported history of diagnosis with trichomoniasis, gonorrhoea, and chlamydia. Finally, repeated administrations of the interview allowed us to create a variable that indicated whether the adolescent changed steady sex partners over the 1 year period.

Data analysis

Bivariate associations

All continuous variables were assessed for normality by calculating their degree of skewness. Skewness scores exceeding an absolute value of 1.0 were considered to be an indication of a non-normal distribution. Subsequently, all non-normal continuous variables were dichotomised by performing a median split. Associations between dichotomous predictor variables and the outcome measure were assessed by the use of relative risk ratios. Associations between continuous predictor variables and the outcome measure were assessed by independent groups *t* tests. Significance was defined by an α level of 0.05 or less.

Identification of covariates

To control for the potentially confounding effects of the HIV prevention intervention trial, assignment to condition (that is, experimental *v* control group) was entered into the multivariate analyses as a covariate. Because unprotected vaginal sex (UVS) and multiple partners were expected to predict positive test results, we examined these variables (each in the 30 days before each of three testing periods) as potential covariates of the analysis. Contrary to our expectation, UVS with steady or non-steady partners and having more than one sex partner were not significantly associated with testing positive at any of the three assessments. Thus, the only covariate included in the analysis was assignment to condition. This variable was direct entered in the first block of a hierarchal multiple logistic regression model.

Multivariate associations

Variables testing significant ($p < 0.05$) at the bivariate level were entered into the second block of the hierarchal multiple logistic regression model by using a forward stepwise method. This step was also repeated using a backward stepwise procedure to check for suppressor variables. The logistic regression model was used to calculate adjusted odds ratios (AOR), and their 95% confidence intervals for the predictors that remained significant in the multivariate analysis.

RESULTS

Characteristics of the sample

Average age of the adolescents was 16.0 (SD 1.2) years. The majority (81.2%) were full time students; 9.4% were part time students, and the remainder were not enrolled in school. Less

than one fifth (17.8%) of the sample reported having a paying job. Past STI infection was reported by 25.7% of the adolescents and a history of pregnancy was reported by 40.0% of the adolescents. The majority (81.8%) reported having sex only with a steady partner in the past 6 months. A minority (8.2%) reported sex with only a casual partner(s) and 10% reported sex with both steady and casual partners in the past 6 months.

Prevalence and incidence of *T vaginalis*

At baseline, *T vaginalis* was diagnosed in 66 of 512 adolescents tested, yielding a prevalence of 12.9%. At the 6 month follow up, *T vaginalis* was diagnosed in 41 of 459 adolescents who returned for testing, yielding an incidence rate of 8.9%. At the 12 month follow up, *T vaginalis* was diagnosed in 41 of 401 adolescents who returned for testing, yielding an incidence rate of 10.2%. Twenty one repeat infections were observed over the course of the two follow up assessments. Thus, 127 adolescents tested positive for *T vaginalis* during at least one of the three assessments.

Bivariate associations

Table 1 displays the percentage of adolescents testing positive for *T vaginalis* based on whether they were exposed to the predictor listed. For example, nearly 30% of those that reported less parental monitoring tested positive, whereas just under 19% who did not report this risk factor tested positive. Table 1 also displays the corresponding prevalence ratios, and their 95% confidence intervals. As shown, the majority of the predictors were significantly associated with results of testing for *T vaginalis*.

Table 1 does not show the bivariate associations corresponding to two predictor variables that were continuous rather than dichotomous measures: self esteem and delinquency. Adolescents' self esteem was significantly associated with the outcome measure. The mean self esteem score among those testing positive was 32.7 compared to 33.8 among those who tested negative ($t = 2.2$, $df = 434$, $p = 0.03$). Likewise, adolescents' self reports of delinquency were significantly associated with the outcome measure. The mean delinquency score among those testing positive was 1.53 compared to 1.16 among those who tested negative ($t = 3.0$, $df = 434$, $p = 0.003$).

Table 1 Bivariate associations between dichotomous predictor variables and a positive test result for *Trichomonas vaginalis* (n=442)

Baseline predictor	% Positive			
	Exposed to risk?		RR*	95% CI†
	Yes	No		
Less parental monitoring	29.5	18.8	1.57	1.09 to 2.25
Less parent-adolescent communication	25.7	25.0	1.03	0.75 to 1.42
Typical sex partner is ≥ 5 years older	42.9	23.5	1.82	1.23 to 2.70
Sex with non-steady partners	34.5	23.1	1.50	1.05 to 2.1
Less favourable attitudes toward condom use	24.1	26.0	0.93	0.67 to 1.28
Greater barriers to condom use	30.0	19.5	1.53	1.09 to 2.15
Consumes ≥ 3 drinks when using alcohol‡	39.1	23.7	1.65	1.10 to 2.46
Biologically confirmed marijuana use	61.9	23.4	2.65	1.81 to 3.86
Self reported history of gonorrhoea	39.4	24.2	1.63	1.03 to 2.57
Self reported history of chlamydia	25.4	25.3	1.00	0.64 to 1.56
Self reported history of trichomoniasis	26.7	25.2	1.06	0.63 to 1.77
Changed steady sex partners over 12 months	27.5	25.2	1.09	0.75 to 1.58
First sexual intercourse occurred ≤ 13 years of age	26.0	25.0	1.04	0.71 to 1.53
Has been pregnant	24.0	27.0	0.89	0.62 to 1.29

*Relative risk ratio.

†Confidence interval.

‡Although the use of other substances (eg, heroin, cocaine, tranquillisers) was also assessed, the number of adolescents reporting use of these substances was far too low for meaningful analyses.

Table 2 Significant multivariate associations between baseline predictor variables and a positive test result for *Trichomonas vaginalis* (n=442)

Baseline predictor	AOR*	95% CI†
Typical sex partner is ≥ 5 years older	2.64	1.33 to 5.24
Sex with non-steady partners	1.92	1.17 to 3.30
Biologically confirmed marijuana use	6.20	2.31 to 16.60
Delinquency	1.31	1.04 to 1.64

*Adjusted odds ratio—adjusted for intervention effects and the influence of all other variables in the model.

†Confidence interval.

Multivariate associations

Table 2 displays the predictors of *T vaginalis* infection that remained significant in the multivariate model. The model correctly classified 76% of the cases, was significant (χ^2 with 5 df = 34.1, $p < 0.00001$), and achieved satisfactory fit with the data (goodness of fit χ^2 with 6 df = 5.4, $p = 0.50$). Backward stepwise entry yielded nearly identical results, suggesting the absence of suppressor variables.

As shown, the strongest predictor of *T vaginalis* infection was the biological measure assessing whether adolescents had used marijuana recently. Those using marijuana were more than six times as likely to test positive for *T vaginalis*. Adolescents who reported at baseline that their typical sex partners were at least 5 years older than themselves were about 2.6 times as likely to test positive than those reporting sex with partners who were less than 5 years older than themselves. Similarly, adolescents who reported sex with non-steady partners at baseline were nearly twice as likely to test positive. Finally, adolescents' reports of their delinquency were significantly associated with testing positive. The odds of testing positive increased by 31% for every one unit increase in the six item scale measure of delinquency.

DISCUSSION

Observed prevalence of *T vaginalis* at baseline was relatively high and incidence figures at the 6 and 12 month follow up periods were only somewhat lower. This prospective analysis identified several important predictors of infection with *T vaginalis* among African-American adolescent females. Biologically confirmed marijuana use was a particularly strong predictor of testing positive. Reporting that typical sex partners were at least 5 years older, reporting sex with non-steady partners, and reporting a greater number of delinquent activities were also important predictors of infection with *T vaginalis*.

The findings suggest that marijuana use and sexual risk behaviours (for example, selection of risky partners) may co-occur among African-American adolescent females. Thus, marijuana use may serve as a useful indicator of potential risk for *T vaginalis* infection. These findings are unique in that they provide prospective evidence based on a biologically assessed predictor variable rather than relying exclusively on adolescents' self reports of marijuana use which may be subject to inaccurate recall, dishonest responding, retrospective contamination, and other reporting biases.

The practices of having sex with older partners, having sex with non-steady partners, and engaging in delinquent acts may also be important indicators of infection or high risk for infection. It is noteworthy that engaging in these identified risk behaviours implies a relative degree of departure from socially normative behaviour (for example, recent marijuana use, delinquent acts, sex with non-steady and older partners) thereby suggesting that a constellation of problem behaviours may be associated with risk for *T vaginalis* infection among African-American adolescent females. Thus, the findings suggest that clinic, community, and school based STI prevention

education programmes may benefit African-American adolescent females by addressing this constellation of risk factors for *T vaginalis* infection. In addition, the findings support the concept of STI prevention education for adolescent females who have been detained for violations of the law (for example, marijuana use and delinquent acts). Clearly, further study is needed to establish how interventions can effectively impact the identified psychosocial predictors and to establish whether changing these factors would lead to a corresponding decrease in the incidence of *T vaginalis* infection.

Of particular interest is the finding that adolescents having sex with older partners were especially likely to acquire *T vaginalis*. Clearly, this finding may reflect a greater prevalence of *T vaginalis* among older males as described in a recent study by Joyner and colleagues.³¹ Thus, older males may serve as a potentially important bridge between populations of men with high prevalence of *T vaginalis* and adolescent populations.

Contrary to expectations, adolescents' reports of low parental monitoring did not achieve significance in the multivariate model. However, it should be noted that this measure approached multivariate significance ($p < 0.07$) and that its failure to achieve significance was probably a consequence of collinearity with the identified constellation of risk factors. Also noteworthy is that adolescents' self reported history of STI was not predictive of incident *T vaginalis* infection. In addition, adolescents' reports of their condom use behaviours and their reports of multiple sex partners (with assessment of these variables preceding each of three tests for *T vaginalis*) were not significantly associated with infection. Also contrary to previous evidence, parity and age of sexual debut were not associated with incidence of *T vaginalis* infection.

Limitations

These findings are limited by the validity of the self reported measures. Also, the study was based on a sample of economically disadvantaged African-American adolescents. Therefore, the findings may not apply to other African-American adolescent females or adolescent females from other racial/ethnic groups or different socioeconomic strata. Further research is needed with diverse adolescent populations. In addition, the study did not enrol male partners of the adolescent females; therefore we were unable to assess the risk behaviours of these partners. A more complete analysis would include interviews and testing of sex partners. Further studies with more refined measures of delinquency are warranted.

Conclusions

Infection with *T vaginalis* was common among a sample of African-American adolescent females living in the southern United States. Independent predictors of this infection were marijuana use, sex with older partners, sex with non-steady partners, and delinquency. Because these factors are all potentially amenable to intervention, the findings from this study may contribute to the design of effective behavioural intervention programmes that serve high risk African-American adolescent females.

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