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Factors associated with incident bacterial vaginosis in an HIV sero-discordant couple cohort, Zambia, 1994-2012

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By

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Bachelor of Arts

University of Virginia

2010

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An abstract of
A thesis submitted to the Faculty of the
Rollins School of Public Health of Emory University
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Master of Public Health
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2016

Abstract

Factors associated with incident bacterial vaginosis in an HIV sero-discordant couple cohort, Zambia, 1994-2012

By Catherine Lanchi Nguyen

Background: Previous studies have shown a strong association between various genital abnormalities such as bacterial vaginosis and increased risk of transmission of HIV. However, few studies have examined the predictors of bacterial vaginosis in the context of sero-discordant, heterosexual couples. This study seeks to address the gap in knowledge by determining predictors of bacterial vaginosis.

Methods: Data were obtained from a longitudinal cohort study with open enrollment that lasted from 1994 to 2012. This study involved married or co-habituating heterosexual HIV sero-discordant couples who participated in couples' voluntary HIV counseling and testing (CVCT) in Lusaka, Zambia. Multivariate analyses were run to determine predictors of bacterial vaginosis among this population.

Results: In HIV-negative women, factors associated ($p<0.05$) with incident BV included having a partner with HIV stage I-III (versus IV) disease, male partners having foreskin smegma, and the woman testing positive for trichomonas; use of implant (versus non-hormonal methods), sperm presence on a vaginal swab wet prep, and breastfeeding were protective for BV. In HIV-positive women, factors associated ($p<0.05$) with incident BV included use of implant (versus non-hormonal methods), increasing number of unprotected sexual acts with the partner, and the woman testing positive for trichomonas; sperm presence on a vaginal swab wet prep and breastfeeding were protective for BV.

Conclusion: Women infected with trichomonas appear to have increased susceptibility to BV, and male circumcision status and hygiene may also play a role in BV risk. The interesting finding that breastfeeding was protective for BV could indicate lack of sexual activity, and this finding warrants further exploration. The role of unprotected sex is unclear, and we did not have enough implant users to draw conclusions about that finding.

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Acknowledgements

This secondary data analysis would not have been possible without Kristin Wall, who was the best thesis advisor a student could have asked for. Thank you for patiently answering my endless questions over chips and guacamole in your office at the Emory University Rollins School of Public Health.

I am incredibly thankful to my classmates, especially my GH 501 group (Aniruddha Deshpande, Caitlin Donato, and Ruvani Jayaweera), my HPM 500 "group" (Zachary Heth, Tiffany Lemon, and Marion Rice), my roommate (Gelsey Hughes), my community garden volunteers (Lauren Cunningham, Leila Heidari, and Allegra Pincus), and my other friends in the environmental health department (Kirsten Fagerli and Jennifer Head). Thank you for your unrelenting, unconditional love during our time in graduate school.

"Health is a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity." I first learned the WHO definition of health in Peace Corps, during Pre-Service Training in Bafia, Cameroon, in September 2010, yet I never fully appreciated its meaning until this semester. Thank you to the medical professionals at Emory Student Health and Emory Orthopedics and Spine Center for keeping me healthy.

Furthermore, I would like to thank my Assistant Director of Academic Programs (ADAP), Nicole Regan, for your assistance after my first semester at Rollins as I transferred from the Hubert Department of Global Health to my ultimate home in the Epidemiology Department, and for your guidance as I completed my thesis.

I am grateful to my former supervisors and colleagues with the Field Epidemiology Training Program (FETP) at the Centers for Disease Control and Prevention (CDC) for their support during my second year of graduate school: Nausheen Ahmed. Pascale Krumm, and David Sugerman. Finally, I would like to thank my current supervisor, Cesar Romero, for being an enthusiastic force in my life and for your flexibility in scheduling my work during my final semester of school.

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CHAPTER I: BACKGROUND AND LITERATURE REVIEW

HIV in Zambia

HIV is a major public health problem in Zambia. Among people in Zambia between 15-49 years old, the prevalence of HIV infection among women is 18% and 13% among men (1). Even though some people may have access to antiretroviral therapy (ART) programs, there is often high non-adherence among participants (2).

Non-STI genital inflammation and HIV transmission

Non-STI genital inflammation have been shown to play a role in transmission of HIV (3). Unfortunately, the majority of previous studies involving genital inflammation in HIV- partners fail to involve the role of HIV+ donor genital inflammation (4).

Previous research has demonstrated a strong link between non-STI genital inflammation and HIV transmission among a longitudinal cohort stud in Lusaka, Zambia (5). A composite measure of inflammation plays a role in HIV acquisition and transmission in HIV sero-discordant couples.

Bacterial vaginosis

Bacterial vaginosis is a common genital abnormality. Bacterial vaginosis involves a decrease in the typical, healthy vaginal flora (especially *Lactobacillus spp.,*) and an increase in other types of numerous facultative and anaerobic bacteria in vaginal fluid (6).

Most women with bacterial vaginosis do not have symptoms, but some women with bacterial vaginosis may experience odor, as well as some discharge.

A one-year prospective longitudinal study in Birmingham, AL found that women who use hormonal contraceptives are less likely to be diagnosed with bacterial vaginosis (7). Similarly, another study in an STD clinic in Baltimore, MD, demonstrated that the use of hormonal contraceptives were correlated with a lowered risk of bacterial vaginosis (8). There are two mechanisms through which hormonal contraceptives can affect the risk of bacterial vaginosis. First, the increase in glycogen production in vaginal epithelial cells leads to increased lactic acid, which prevents the growth of bacteria that may cause bacterial vaginosis. Second, because progestin and other hormonal contraceptives limit uterine bleeding, there may be lowered persistence of bacterial vaginosis, as well as lowered presence of abnormal vaginal microbiota. The researchers found that women who were in the luteal phase of their cycle were less likely to have bacterial vaginosis, compared to women who were in the menstruation or follicular phases.

Previous studies have shown that having bacterial vaginosis can lead to various health problems, such as an increased risk of miscarriage and preterm labor and delivery (6). More importantly, bacterial vaginosis has consistently shown to lead to an increased risk in acquiring HIV, which is a significant public health concern (9).

Researchers have found that there are certain risk factors that may increase the risk of bacterial vaginosis. Researchers in Pittsburg-area health care facilities found that strong predictors included sexual activity (engaging increased vaginal intercourse), having a male, uncircumcised sexual partner, and Herpes simplex virus 2 (HSV-2) (10). Further research is needed to determine additional predictors for bacterial vaginosis.

CHAPTER II: MANUSCRIPT

INTRODUCTION

Bacterial vaginosis is associated with an increased risk for the transmission of HIV. While some studies have determined that certain predictors are more likely to lead to bacterial vaginosis, there has been limited research on predictors of bacterial vaginosis in HIV transmission among sero-discordant couples.

METHODS

Ethics

This study was approved by the Office of Human Research Protections-registered Institutional Review Boards at Emory University and the University of Zambia.

Study participants and staff

The longitudinal cohort study with open enrollment lasted from 1994 to 2012. This study involved married or co-habituating heterosexual HIV sero-discordant couples who participated in couples' voluntary HIV counseling and testing (CVCT) in Lusaka, Zambia. These services were provided by the Emory-based Rwanda Zambia HIV Research Group (RZHRG). Zambian medical professionals (registered nurses, clinical officers, and physicians, as well as specialists in internal medicine, obstetrics and gynecology, and laboratory diagnostics) provided free outpatient health care to study participants.

Outcome of interest

The outcome of interest was bacterial vaginosis as it related to the transmission of HIV among sero-discordant couples. The health care staff conducted HIV testing using rapid serologic tests on HIV- partners at every one to three months. Laboratory staff tested plasma from the most recent antibody negative sample by p24 ELISA and RNA polymerase chain reaction (PCR), when it was feasible.

Exposures of interest

The exposures of interest included demographics, behavioral, family planning, sexual history, and clinical exposures, both baseline and time-varying. There were several time-varying measures of bacterial vaginosis, including acute genital or perianal ulcers and treatment of HSV-2.

Other covariates

Additional covariates including baseline age, income level, literacy, stage and viral load (VL) of HIV+ partners, male circumcision, HSV-2 positivity, STI in the past year, number of sexual partners, and time-varying number of unprotected sex acts with the study partner, sperm present on a wet mount from a vaginal swab, use of contraceptive method, and pregnancy.

Longitudinal data collection

Health care staff began testing VL in 1999. Screening of p24 ELISA started in 2003. Study participants were seen every three months and participated in routine genital exams, including screening for *T. pallidum and T. vaginalis*. Staff began conducting

physical exams and STI screenings at baseline, annually, and when it became symptomatic, in 2003. Consequently, from 2007 to 2008, HIV- participants were seen at months 0, 1, 2, 3, as well as quarterly, and staff assessed sexual exposures (self-reported unprotected sex, sperm or *T. vaginalis* on a vaginal swab wet mount, or incident STI or pregnancy). Staff conducted monthly HIV testing for HIV- participants with at least one exposure, up until the next quarterly visit, where staff completed the assessment again. Beginning in 2008, all study participants were tested for HIV on a monthly basis.

Data analysis

Researchers analyzed the data using SAS v9.4. If a partner was lost to follow-up or died, if the couple was no longer together, or if the HIV+ participant began using ART, then the couple was censored (5). Couples that had unlinked seroconversion were excluded from the study.

HIV incidence

The number of incident HIV infections per couple-year (CY) of follow-up time from enrollment until the couple was censored or until the outcome occurred, otherwise known as HIV incidence rates, were calculated from enrollment (5). Researchers used log-rank tests to observe linear trend. The data was dichotomized (months 0-3 versus > 3), and researchers used mid-p exact tests to study the differences.

Exposures

For categorical variables, researchers reported counts and percentages to explain exposures stratified by HIV transmission status. Continuous variables were analyzed using means and standard deviations. Unadjusted Cox models were used to evaluate bivariable associations. Researchers examined crude hazard ratios (HRs), 95% confidence intervals (CIs), and p-values.

Multivariable model for BV

A model was built using Multivariate Anderson-Gill models. Variables that were expected to be collinear based on the literature were excluded.

RESULTS

Baseline Exposures, Unadjusted (Tables 1 and 2)

Among M+/F- couples, there was a significant association for bacterial vaginosis between women who were literate in Nyanja compared to the women who did not read well (cHR = 1.42, 95% CI: 1.02, 1.97). Additional exposures included fertility intentions of either partner and HIV stage. Among M-/F+ couples, the significant exposures included woman's literacy and fertility intentions of either partner.

Time-varying exposures associated with bacterial vaginosis and HIV transmission among M+/F- couples, included contraceptive method, sperm on vaginal swab wet mount, breastfeeding, discharge among women, candida, Trichomonas vaginalis, and foreskin smegma. Among M-/F+ couples, there as a significant association for bacterial vaginosis for contraceptive method, number of times of self-reported unprotected sex with the study partner, sperm on vaginal swab wet mount, breastfeeding, genital

inflammation composite among men, discharge among women, inguinal adenopathy among men, Trichomonas vaginalis, and active genital ulcer among woman.

Multivariable Model (Tables 3 and 4)

Controlling for the other covariates in the model, among M+/F- couples, compared to participants with Stage IV HIV, the chance of having bacterial vaginosis were 2.3 times higher for participants with Stage I HIV (aHR = 2.276; 95% CI : 1.358, 3.814), 1.9 times higher for participants with stage II HIV (aHR = 1.919; 95% CI: 1.185, 3.107), and 1.9 times higher for participants with stage III HIV (aHR = 1.899; 95% CI: 1.144, 3.151).

Among M-/F+ couples, those with Trichomonas Vaginalis were 1.5 times as likely to have bacterial vaginosis (aHR = 1.494; 95% CI: 1.219, 1.83).

For both sets of couples, participants who had sperm present on vaginal wet prep were less likely to have bacterial vaginosis (among M+/F- couples: aHR = 0.718; 95% CI: 0.571, 0.903. among M-/F+ couples: aHR = 0.651; 95% CI: 0.547, 0.774).

DISCUSSION

This study is important in demonstrating the predictors of bacterial vaginosis for HIV transmission both HIV+ and HIV- women in sero-discordant couples. This study found that several predictors were significantly associated, including sperm present on vaginal wet swab and Trichomonas Vaginalis.

Many couples in sub-Saharan Africa are sero-discordant (11). Furthermore, the majority of new HIV infections in urban Zambia happen within married or cohabitating couples; therefore, these couples are a key target population in preventing transmission of HIV (12).

While the majority (two-thirds) of HIV incidence in sub-Saharan Africa happen among married or co-habiting couples, only half of the incidence is caused by the HIV+ partner transmitting the virus to the HIV- person (11). The other major source of HIV infection is through a sexual partner outside of marriage or co-habitation; therefore, education and prevention efforts (including voluntary couples counselling and testing) should also target extra partners (12).

STRENGTHS

The study had many strengths. The cohort was quite large, leading to a high confidence level. Furthermore, the study period of eighteen years allowed researchers to follow discordant couples over a long period of time in spite of the number of censored couples. Researchers also gathered a large dataset regarding many different variables and covariates that could play a contributing role in HIV transmission.

LIMITATIONS

There were several limitations in the study. One significant concern was that there was selection bias, which led to participants who may be healthier than the general population (5). Another issue was information bias. Since several of the variables were self-reported, such as number of times of unprotected sex, there could be bias in the

results. Furthermore, researchers were unable to gather information on intravaginal practices or genital schistosomiasis.

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TABLES

Table 1. Descriptive, and crude analyses of time-to-BV among Zambian men and women in HIV discordant relationships (M+F- couples)

	Non-BV	BV intervals	cHR	95% CI		p-value
	N (%)	N (%)				
Demographics						
Woman age (per year increase)*	28.5 (6.8)	27.6 (7.9)	1.00	0.98	1.02	0.78
Man age (per year increase)*	35.3 (7.6)	33.9 (8.2)	0.99	0.97	1.00	0.12
Monthly family income (per USD	86.1 (107.4)	57.8 (62.5)	1.00	1.00	1.00	0.56
Man reads Nyanja	4502 (46)	272 (47)	ref			
Yes, easily	5303 (54)	308 (53)	1.10	0.85	1.41	0.48
With difficulty/not at all						
Woman reads Nyanja	3104 (24)	103 (18)	ref			
Yes, easily	9785 (76)	485 (82)	1.42	1.02	1.97	0.04
With difficulty/not at all	3.7 (2.5)	3.9 (2.9)	1.00	0.95	1.06	1.00
Number of previous pregnancies (per						
Fertility intentions of man	606 (13)	0 (0)	1.00	0.20	4.96	1.00
Yes, next year	1445 (31)	0 (0)	ref			
Yes, but not next year	2561 (56)	1 (100)	80429755	10880850	594530000	<.001
Don't know/No						
Fertility intentions of woman	909 (17)	0 (0)	1.00	0.46	2.16	1.00
Yes, next year	1067 (21)	0 (0)	ref			
Yes, but not next year	3221 (62)	1 (100)	83699589	11374956	615880000	<.001
Don't know/No	28.5 (6.8)	27.6 (7.9)	1.00	0.98	1.02	0.78
Clinical						
HIV stage of positive partner	3667 (28)	144 (24)	1.91	1.18	3.09	0.01
Stage I	4742 (36)	251 (43)	1.77	1.12	2.78	0.01
Stage II	3484 (27)	162 (28)	1.88	1.16	3.05	0.01
Stage III	1137 (9)	31 (5)	ref			
Stage IV	4.7 (0.9)	4.9 (0.8)	1.05	0.86	1.28	0.66
Log viral load (per log10 copies/ml						
HSV-2 status of woman	6674 (76)	264 (79)	1.34	0.87	2.06	0.19
Positive	1277 (15)	44 (13)	ref			
Negative	821 (9)	27 (8)	1.40	0.72	2.72	0.32
Discrepant						
HSV-2 status of man	6595 (73)	267 (79)	1.05	0.67	1.63	0.84
Positive	1471 (16)	44 (13)	ref			
Negative	954 (11)	27 (8)	1.02	0.54	1.95	0.94
Discrepant	3667 (28)	144 (24)	1.91	1.18	3.09	0.01

Contraceptive method	8442 (65)	475 (81)	ref			8442 (65)
Non-hormonal^	1838 (14)	31 (5)	0.60	0.41	0.90	1838 (14)
DMPA	972 (7)	3 (1)	0.74	0.32	1.71	972 (7)
Implant	1762 (14)	79 (13)	1.10	0.79	1.54	1762 (14)
OCPs	2.3 (7.9)	5.3 (16.4)	1.01	1.00	1.01	2.3 (7.9)
No. unprotected sex acts with study						
Any self-reported unprotected sex with	3822 (30)	256 (44)	1.20	0.99	1.45	3822 (30)
Yes	9111 (70)	332 (56)	ref			9111 (70)
No						
Sperm present on wet prep	687 (6)	103 (23)	1.51	1.21	1.89	687 (6)
Yes	11661 (94)	354 (77)	ref			11661 (94)
No						
Pregnant	1067 (9)	66 (11)	1.00	0.76	1.30	1067 (9)
Yes	10417 (91)	520 (89)	ref			10417 (91)
No						
Breastfeeding	2814 (22)	151 (26)	0.76	0.61	0.95	2814 (22)
Yes	10216 (78)	437 (74)	ref			10216 (78)
No						
Interval since enrollment	12234 (94)	569 (97)	0.80	0.51	1.25	12234 (94)
0-3 months	796 (6)	19 (3)	ref			796 (6)
>3 months						
Circumcised male partner	1284 (10)	54 (9)	ref			1284 (10)
Yes	11723 (90)	534 (91)	0.96	0.62	1.50	11723 (90)
No	8442 (65)	475 (81)	ref			8442 (65)
Other genital abnormalities						
Genital inflammation composite men						
Yes	2789 (26)	401 (69)	1.14	0.90	1.44	0.27
No	7925 (74)	183 (31)	ref			
Genital ulceration composite women						
Yes	667 (5)	69 (12)	1.09	0.84	1.40	0.53
No	12363 (95)	519 (88)	ref			
Genital ulceration composite men						
Yes	1561 (15)	130 (22)	1.00	0.81	1.22	0.96
No	9160 (85)	454 (78)	ref			
Discharge women						
Yes	502 (5)	76 (13)	1.50	1.18	1.91	0.00
No	9421 (95)	512 (87)	ref			
Discharge men						
Yes	190 (2)	11 (2)	0.78	0.44	1.39	0.40
No	10523 (98)	573 (98)	ref			
IA women						
Yes	381 (7)	64 (11)	1.09	0.80	1.47	0.60
No	4798 (93)	520 (89)	ref			
IA men						
Yes	2788 (55)	405 (70)	1.12	0.89	1.42	0.33
No	2278 (45)	171 (30)	ref			
Candida						
Yes	595 (5)	123 (21)	1.26	1.03	1.54	0.02
No	12435 (95)	465 (79)	ref			
Trichomonas Vaginalis						

Yes	360 (3)	59 (10)	2.18	1.64	2.91	<.001
No	12623 (97)	529 (90)	ref			
Erosion/friability of cervix/vagina						
Yes	193 (4)	22 (4)	0.88	0.58	1.35	0.57
No	4975 (96)	563 (96)	ref			
Incident Syphilis (RPR) woman						
Yes	290 (2)	35 (6)	1.40	0.99	2.00	0.06
No	12233 (98)	553 (94)	ref			
Incident Syphilis (RPR) man						
Yes	370 (4)	42 (7)	1.14	0.84	1.53	0.40
No	9773 (96)	531 (93)	ref			
Active genital ulcer woman						
Yes	713 (6)	73 (12)	0.98	0.75	1.27	0.85
No	12147 (94)	515 (88)	ref			
Active genital ulcer man						
Yes	1917 (18)	134 (23)	1.02	0.84	1.25	0.84
No	8610 (82)	449 (77)	ref			
Foreskin smegma						
Yes	390 (7)	68 (12)	1.41	1.06	1.88	0.02
No	5258 93)	509 (88)	ref			

Table 2. Descriptive and crude analyses of time-to-BV among Zambian men and women in HIV discordant relationships (M-F+ couples)

	Non-BV	BV intervals	cHR	95% CI		p-value
	N (%)	N (%)				
Demographics						
Woman age (per year increase)*	28.8 (6.6)	26.5 (6.9)	0.98	0.96	0.99	0.00
Man age (per year increase)*	35.4 (8.4)	33.9 (9.3)	0.99	0.98	1.00	0.06
Monthly family income (per USD	77.4 (93.6)	52.9 (53.3)	1.00	1.00	1.00	0.59
Man reads Nyanja	4049 (42)	311 (38)	ref			
Yes, easily	5544 (58)	509 (62)	1.09	0.88	1.35	0.42
With difficulty/not at all						
Woman reads Nyanja	2893 (24)	205 (25)	ref			
Yes, easily	8955 (76)	617 (75)	0.97	0.76	1.22	0.76
With difficulty/not at all	3.5 (2.2)	2.9 (2.3)	0.91	0.86	0.95	<.0001
Number of previous pregnancies (per						
Fertility intentions of man	904 (17)	1 (17)	12353216	1896309	80473124	<.001
Yes, next year	2088 (39)	0	ref			
Yes, but not next year	2361 (44)	5 (83)	21067768	7073267	62750474	<.001
Don't know/No						
Fertility intentions of woman	1293 (22)	0	0.00	0.00	0.00	<.001
Yes, next year	1461 (25)	3 (50)				
Yes, but not next year	3091 (53)	3 (50)	0.49	0.06	3.72	0.49
Don't know/No	28.8 (6.6)	26.5 (6.9)	0.98	0.96	0.99	0.00

Clinical						
HIV stage of positive partner	5043 (42)	231 (28)	0.75	0.48	1.17	0.20
Stage I	3807 (31)	288 (35)	0.87	0.56	1.36	0.55
Stage II	2716 (22)	253 (31)	0.93	0.60	1.42	0.72
Stage III	549 (5)	52 (6)	ref			
Stage IV	4.3 (0.9)	4.5 (0.8)	1.09	0.94	1.26	0.26
Log viral load (per log10 copies/ml						
HSV-2 status of woman	7404 (86)	450 (92)	1.61	0.85	3.08	0.15
Positive	740 (9)	21 (4)	ref			
Negative	454 (5)	16 (3)	1.13	0.47	2.71	0.78
Discrepant						
HSV-2 status of man	3668 (45)	213 (45)	0.78	0.58	1.04	0.09
Positive	3082 (38)	201 (42)	ref			
Negative	1389 (17)	59 (12)	0.74	0.49	1.12	0.16
Discrepant	5043 (42)	231 (28)	0.75	0.48	1.17	0.20
Sexual behavior and family planning characteristics						
Contraceptive method	7864 (65)	683 (83)	ref			
Non-hormonal^	1755 (15)	44 (5)	0.66	0.44	0.99	0.05
DMPA	711 (6)	11 (1)	1.99	0.95	4.15	0.07
Implant	1716 (14)	86 (10)	0.82	0.61	1.10	0.19
OCPs	3.4 (11.5)	5.9 (16.7)	1.01	1.00	1.01	<.001
No. unprotected sex acts with study						
Any self-reported unprotected sex with	4214 (35)	411 (50)	1.30	1.12	1.50	<.001
Yes	7715 (65)	413 (50)	ref			
No						
Sperm present on wet prep	664 (6)	172 (25)	1.55	1.30	1.84	<.001
Yes	10762 (94)	515 (75)	ref			
No						
Pregnant	778 (7)	67 (8)	1.07	0.82	1.40	0.61
Yes	9957 (93)	753 (92)	ref			
No						
Breastfeeding	1628 (13)	121 (15)	0.70	0.55	0.89	<.001
Yes	10487 (87)	703 (85)	ref			
No						
Interval since enrollment	11532 (95)	800 (97)	0.78	0.54	1.13	0.19
0-3 months	583 (5)	24 (3)	ref			
>3 months						
Circumcised male partner	1983 (16)	176 (21)	ref			
Yes	10109 (84)	648 (79)	0.89	0.67	1.17	0.40
No	7864 (65)	683 (83)	ref			

Other genital abnormalities						
Genital inflammation composite men						
Yes	2789 (26)	401 (69)	1.14	0.90	1.44	0.27
No	7925 (74)	183 (31)	ref			
Genital ulceration composite women						
Yes	667 (5)	69 (12)	1.09	0.84	1.40	0.53
No	12363 (95)	519 (88)	ref			
Genital ulceration composite men						
Yes	1561 (15)	130 (22)	1.00	0.81	1.22	0.96
No	9160 (85)	454 (78)	ref			
Discharge women						
Yes	502 (5)	76 (13)	1.50	1.18	1.91	0.00
No	9421 (95)	512 (87)	ref			
Discharge men						
Yes	190 (2)	11 (2)	0.78	0.44	1.39	0.40
No	10523 (98)	573 (98)	ref			
IA women						
Yes	381 (7)	64 (11)	1.09	0.80	1.47	0.60
No	4798 (93)	520 (89)	ref			
IA men						
Yes	2788 (55)	405 (70)	1.12	0.89	1.42	0.33
No	2278 (45)	171 (30)	ref			
Candida						
Yes	595 (5)	123 (21)	1.26	1.03	1.54	0.02
No	12435 (95)	465 (79)	ref			
Trichomonas Vaginalis						
Yes	360 (3)	59 (10)	2.18	1.64	2.91	<.001
No	12623 (97)	529 (90)	ref			
Erosion/friability of cervix/vagina						
Yes	193 (4)	22 (4)	0.88	0.58	1.35	0.57
No	4975 (96)	563 (96)	ref			
Incident Syphilis (RPR) woman						
Yes	290 (2)	35 (6)	1.40	0.99	2.00	0.06
No	12233 (98)	553 (94)	ref			
Incident Syphilis (RPR) man						
Yes	370 (4)	42 (7)	1.14	0.84	1.53	0.40
No	9773 (96)	531 (93)	ref			
Active genital ulcer woman						
Yes	713 (6)	73 (12)	0.98	0.75	1.27	0.85
No	12147 (94)	515 (88)	ref			
Active genital ulcer man						
Yes	1917 (18)	134 (23)	1.02	0.84	1.25	0.84
No	8610 (82)	449 (77)	ref			
Foreskin smegma						
Yes	390 (7)	68 (12)	1.41	1.06	1.88	0.02
No	5258 93)	509 (88)	ref			

Table 3. Adjusted analyses of time-to-BV among Zambian men and women in HIV discordant relationships (M+F- couples)

Variable	aHR	95% CI		p-value
Woman reads Nyanja	1.419	0.982	2.052	0.0626
HIV stage of positive partner				
Stage I	2.276	1.358	3.814	0.0018
Stage II	1.919	1.185	3.107	0.0081
Stage III	1.899	1.144	3.151	0.0131
Stage IV	ref			
Contraceptive method				
Non-hormonal	ref			
Implant	0.587	0.407	0.848	0.0046
DMPA	0.695	0.462	1.043	0.079
OCPs	1.278	0.909	1.798	0.1586
No. unprotected sex acts with study partner since last visit	1.004	0.999	1.01	0.1265
Sperm present on wet prep	0.718	0.571	0.903	0.0046
Breastfeeding	0.739	0.57	0.958	0.0222
Candida	1.243	0.993	1.554	0.0574
Trichomonas Vaginalis	1.584	1.065	2.355	0.023
Foreskin smegma	1.549	1.145	2.094	0.0045

Table 4. Adjusted analyses of time-to-BV among Zambian men and women in HIV discordant relationships (M-F+ couples)

Variable	aHR	95% CI		p-value
Woman reads Nyanja	0.855	0.667	1.097	0.2185
HIV stage of positive partner				
Stage I	0.693	0.419	1.148	0.1544
Stage II	0.804	0.487	1.328	0.3946
Stage III	0.853	0.525	1.384	0.5189
Stage IV	ref			
Contraceptive method				
Non-hormonal	ref			
Implant	2.497	1.43	4.362	0.0013
DMPA	0.699	0.456	1.072	0.1009
OCPs	0.8	0.589	1.087	0.1536
No. unprotected sex acts with study partner since last visit	1.005	1.001	1.008	0.012
Sperm present on wet prep	0.651	0.547	0.774	<.0001
Breastfeeding	0.749	0.564	0.996	0.0467
Candida	1.179	0.982	1.417	0.078
Trichomonas Vaginalis	1.494	1.219	1.83	0.0001
Foreskin smegma	1.011	0.723	1.415	0.9473

CHAPTER III: SUMMARY, PUBLIC HEALTH IMPLICATIONS, FUTURE STUDIES

This analysis sought to address a gap in the current literature concerning the predictors of bacterial vaginosis as it relates to HIV transmission among heterosexual, sero-discordant couples in Zambia. Through multivariable modeling, a statistically significant association was found between certain predictors (including hormonal contraceptive method, especially implants, and sperm present on a wet mount from a vaginal swab) for bacterial vaginosis and HIV transmission among sero-discordant, heterosexual couples, regardless of which partner was seropositive.

This study has significant public health implications. Researchers need to determine how to reduce genital abnormalities in target populations. The reduction of genital inflammation will lead to reduction of HIV transmission; therefore, public health professionals should determine how to reduce genital inflammation. Because genital abnormalities such as bacterial vaginosis usually show no symptoms, women are generally unaware that they have it. Some genital abnormalities have such mild symptoms that most people prefer to self-treat (5). Therefore, health care workers should encourage regular screenings as a strategy to prevent HIV, especially among HIV sero-discordant couples. There are significant opportunities for health education in these target communities.

In future studies, researchers should analyze predictors for other genital abnormalities, in addition to bacterial vaginosis. Researchers may also wish to conduct similar studies with populations in other parts of East Africa or other parts of the world. In addition, it may be interesting to study predictors of genital abnormalities in HIV transmission among same-sex couples.