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Factors Associated with High Grade Anal Dysplasia Among Young MSM and TW with HIV in Atlanta

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Epidemiology

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An abstract of
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Abstract

Factors Associated with High Grade Anal Dysplasia Among Young MSM and TW with HIV in Atlanta

By Leah Loerinc

Men who have sex with men (MSM) and transgender women (TW) with HIV are disproportionately affected by anogenital human papillomavirus (HPV) infection with high rates of anal intraepithelial neoplasia (AIN) and subsequent anal cancer. However, there are no national guidelines for anal cancer screening and vaccination rates among men and TW remain low. There is a need to understand risk factors for high-grade anal dysplasia to better inform screening guidelines and preventative measures in these groups. In this study, we evaluated factors associated with high-grade anal dysplasia on anal biopsy among young MSM and TW with HIV in Atlanta, GA. Cross-sectional retrospective chart review was conducted for all cisgender MSM and TW with HIV aged 13-25 at the Grady Ponce and Family Youth Clinic in Atlanta, GA from 2009-2020. Participants who underwent anal biopsy over the study period were included. Data were collected on patient characteristics, sexual history, and anal histology results, with high-grade anal dysplasia defined as AIN 2, 3, or anal carcinoma. Associations between clinical and demographic factors with high-grade anal dysplasia were estimated using logistic regression. Adjusted odds ratios (aORs) and 90% confidence intervals (CIs) are reported. Statistical significance was assessed at the 0.10 alpha-level. 103 MSM and TW with HIV were included. The mean age was 19.7 (SD: ±1.9) years. 91% were Black and 98% were horizontally infected with HIV. 63% of participants had high-grade anal dysplasia on anal biopsy. Being incompletely or unvaccinated against HPV (0-2 doses) relative to being fully vaccinated (3 doses) (aOR 5.34, 90%CI 1.30-21.93, p=0.05) and having ever received surgical treatment for anogenital HPV (aOR 2.59, 90%CI 1.18-5.66, p=0.05) were associated with high-grade anal dysplasia, controlling for age and CD4 T-cell count at time of biopsy. Our study found a high prevalence of high-grade anal dysplasia on anal biopsy among young MSM and TW with HIV. Those who had ever received surgical treatment for anogenital HPV and those who were incompletely or unvaccinated against HPV were more likely to have high-grade disease. To our knowledge, this is the first study to show an association between vaccination status and high-grade anal dysplasia in this population. Our data emphasize the urgent need to improve HPV vaccination efforts and to pursue larger surveillance studies of high-grade anal disease among young MSM and TW with HIV.

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Table of Contents

Literature Review

Adolescents and young adults (AYAs) are disproportionately affected by sexually transmitted infections (STIs) in the United States (US), with half of all new STIs diagnosed each year occurring in individuals aged 15-24.[1] AYAs with HIV are at further risk of additional STIs[2-5] yet continue to engage in high-risk sexual activity.[3, 6, 7] HIV and STI co-infection has been associated with high HIV viral loads and lower CD4 T-cell counts,[8, 9] in addition to an increased risk of HIV and STI transmission.[10-13]

Anogenital human papillomavirus (HPV) infection is common among individuals with HIV in the US,[14] especially among AYAs younger than age 25.[15-17] Men who have sex with men (MSM) and transwomen (TW) with HIV are disproportionately affected by anogenital HPV,[18-20] even when compared to their HIV-negative counterparts.[21] Furthermore, it is well documented that MSM and TW with HIV have high rates of high-risk HPV (HR-HPV) infection,[22, 23] which is known to persist in these groups.[17, 24] Persistent anogenital infection with HR-HPV types increases the risk of anal intraepithelial lesions (ASIL)[25], particularly high-grade intraepithelial lesions (HSIL),[18] and subsequent anal cancer.[26, 27] MSM and TW with HIV have the highest burden of anal cancer in the US, with documented rates as much as 30-100 times higher than the general population.[23, 27-29] However, there are no national guidelines for anal cancer screening in this group.[29, 30]

Elucidating factors that may be associated with high-grade anogenital disease in young MSM and TW with HIV, such as HPV vaccination status, CD4 T-cell count at time of biopsy, smoking status, or number of co-STIs would have a profound impact on the care of these patients by

informing screening guidelines and preventative measures in this population. We aimed to describe the distribution of anal cytology and histology results among young MSM and TW with HIV in Atlanta, GA, in addition to evaluating factors associated with high-grade anal dysplasia in these groups.

Abstract

Background

Men who have sex with men (MSM) and transgender women (TW) with HIV are disproportionately affected by anogenital human papillomavirus (HPV) infection with high rates of anal intraepithelial neoplasia (AIN) and subsequent anal cancer. However, there are no national guidelines for anal cancer screening and vaccination rates among men and TW remain low. There is a need to understand risk factors for high-grade anal dysplasia to better inform screening guidelines and preventative measures in these groups. In this study, we evaluated factors associated with high-grade anal dysplasia on anal biopsy among young MSM and TW with HIV in Atlanta, GA.

Methods

Cross-sectional retrospective chart review was conducted for all cisgender MSM and TW with HIV aged 13-25 at the Grady Ponce and Family Youth Clinic in Atlanta, GA from 2009-2020. Participants who underwent anal biopsy over the study period were included. Data were collected on patient characteristics, sexual history, and anal histology results, with high-grade anal dysplasia defined as AIN 2, 3, or anal carcinoma. Associations between clinical and demographic factors with high-grade anal dysplasia were estimated using logistic regression. Adjusted odds ratios (aORs) and 90% confidence intervals (CIs) are reported. Statistical significance was assessed at the 0.10 alpha-level.

Results

103 MSM and TW with HIV were included. The mean age was 19.7 (SD: ±1.9) years. 91% were Black and 98% were horizontally infected with HIV. 63% of participants had high-grade anal dysplasia on anal biopsy. Being incompletely or unvaccinated against HPV (0-2 doses) relative to being fully vaccinated (3 doses) (aOR 5.34, 90%CI 1.30-21.93, p=0.05) and having ever received surgical treatment for anogenital HPV (aOR 2.59, 90%CI 1.18-5.66, p=0.05) were associated with high-grade anal dysplasia, controlling for age and CD4 T-cell count at time of biopsy.

Conclusion

Our study found a high prevalence of high-grade anal dysplasia on anal biopsy among young MSM and TW with HIV. Those who had ever received surgical treatment for anogenital HPV and those who were incompletely or unvaccinated against HPV were more likely to have high-grade disease. To our knowledge, this is the first study to show an association between vaccination status and high-grade anal dysplasia in this population. Our data emphasize the urgent need to improve HPV vaccination efforts and to pursue larger surveillance studies of high-grade anal disease among young MSM and TW with HIV.

Introduction

Adolescents and young adults with HIV are disproportionately affected by sexually transmitted infections (STIs) in the United States (US).[1] Anogenital human papillomavirus (HPV) infection is particularly common, demonstrated by consistently high rates of abnormal cytology in this group.[4, 15-17, 31] Men who have sex with men (MSM) and transgender women (TW) with HIV are particularly impacted by anogenital HPV infection,[18-20] even when compared to MSM and TW who are HIV-negative.[21]

It is well documented that MSM and TW with HIV have high rates of high-risk HPV (HR-HPV) infection,[22, 23] which is known to persist in these groups.[17, 24] Persistent anogenital infection with HR-HPV types increases the risk of anal intraepithelial lesions (ASIL)[25], particularly high-grade intraepithelial lesions (HSIL)[18] and anal intraepithelial neoplasia (AIN).[4, 24] Furthermore, MSM and TW with HIV remain the highest risk group for developing anal cancer in the US,[26, 27] with documented rates as much as 30-100 times higher than the general population.[23, 27-29] Silverberg et al. found that the incidence of anal cancer among MSM with HIV was nearly three times higher than that in other men with HIV, and more than 65 times higher than men who were HIV-negative.[32]

Despite exceedingly high rates of HSIL, AIN, and anal cancer among MSM and TW with HIV, there are no national guidelines for anal cancer screening in these groups.[29, 30] The timing and frequency of anal cytology remains controversial,[27, 33] and follow-up of abnormal anal cytology or positive HR-HPV testing with high-resolution anoscopy (HRA) and biopsy is recommended yet

underutilized.[18, 29, 34-36] Furthermore, preventative measures of anogenital HPV infection in this population are suboptimal. While the HPV vaccine has been routinely recommended for boys since 2011,[37] only half of boys aged 13-17 were fully vaccinated in 2019.[38] However, the HPV vaccine has been shown to be effective in reducing high-grade AIN and anal cancer in young MSM.[39] It is imperative to understand risk factors for high-grade anal dysplasia to better inform screening guidelines and preventative measures in these groups.

In this cross-sectional study, we aimed to 1) determine the prevalence and distribution of abnormal anal cytology and histology among young MSM and TW with HIV in Atlanta, GA and 2) to evaluate factors associated with high-grade anal dysplasia on anal biopsy in this population.

Materials and Methods

Study participants

Retrospective chart review was conducted on all cisgender men and TW at the Grady Ponce and Family Youth Clinic (GPFYC), an exclusive HIV care clinic and the primary referral site for youth with HIV in Atlanta, GA, from January 1, 2009 to March 31, 2020. All cisgender men and TW with HIV aged 13-25 who self-identified as having sex with men, had at least once visit to GPFYC over the study period, and underwent anal biopsy were included. Anal biopsies were completed in HRA clinic or in the operating room during follow-up evaluation for an abnormal anal pap smear. Indication for biopsy was determined by the individual provider based on the extent of abnormality visualized at the time of follow-up. Patients who self-identified as not yet having

their sexual debut, in addition to those who did not self-report sex with men, were excluded. This study received approval from the Institutional Review Boards of both Emory University and Grady Health System prior to initiation.

Data collection

All data were collected using the electronic medical record (Epic) and entered directly into REDCap, a standardized online research database hosted at Emory University.[40] Data were collected on patient demographics and clinical characteristics, HIV infection, sexual history, HPV vaccination status, treatment history of anogenital HPV infection, and anal cytology and histology samples received. Additional STIs for each participant occurring within 3-months before or after their anal biopsy date were recorded, including infections with *Neisseria gonorrhoeae*, *Chlamydia trachomatis*, syphilis, herpes simplex virus, trichomonas, hepatitis C, lymphogranuloma venereum, bacterial vaginosis, and chancroid. CD4 T-cell count at time of biopsy was also collected.

Outcome and exposures of interest

High-grade anal dysplasia, defined as AIN 2, 3, or anal carcinoma on anal biopsy (staged by trained attending pathologists at GPFYC), was our outcome of interest. Those with AIN 1 or no intraepithelial lesions noted on anal biopsy were considered to have low-grade anal dysplasia. Categorical exposures of interest included race (black vs. other), gender (cisgender man vs. transgender woman), sexuality (gay vs. other), mode of HIV transmission (horizontal vs. vertical), history of tobacco use (yes vs. no), HPV vaccination status (incomplete (0, 1, or 2

doses) vs. complete (3 doses)), history of anogenital condyloma (yes vs. no), condom use (always or inconsistent vs. never), number of sexual partners at baseline (0-20 vs. >20), history of transactional sex (yes vs. no), history of sexual abuse (yes vs. no), history of receptive anal sex (yes vs. no), ever receiving medical treatment for anogenital HPV (yes vs. no) and ever receiving surgical treatment for anogenital HPV (yes vs. no). Of note, HPV vaccination status was originally looked at in three groups (3-doses, 1-2-doses, and 0-doses); however, due to relatively small sample sizes in each category, 0-, 1-, and 2-doses were combined into one group. Continuous exposures of interest included age at first observation, CD4 T-cell count at time of biopsy, and number of co-STIs diagnosed within 3-months before or after participants' biopsy.

Statistical analysis

All demographic and clinical criteria were summarized using means and standard deviations (SD) for normally distributed continuous variables (age at first observation and CD4 T-cell count at time of biopsy), medians and interquartile ranges for non-normally distributed continuous variables (co-STIs within 3-months before or after biopsy), and frequencies and percentages for discrete characteristics, both for the entire study population in addition to by outcome designation. Chi-squared or Fisher's exact tests for categorical variables, Student's t-tests for normally distributed continuous variables, and Wilcoxon Mann-Whiney U-tests for non-normally distributed continuous variables were used for each covariate in relation to the outcome of interest with 2-tail *p*-values reported. Association of clinical and demographic factors with high-grade anal dysplasia were analyzed using univariate and multivariate logistic

regression. Univariate analysis was performed on all covariates, while the multivariate logistic regression model, based on *a priori* criteria and results of the univariate analysis, included age (per year increase), CD4 T-cell count at time of biopsy (per cell/μL increase), vaccination status (incomplete vs. complete), and having ever received surgical treatment for anogenital HPV infection (yes vs. no). Crude odds ratios (cORs) and adjusted odds ratios (aORs) with associated 90% confidence intervals (CI) are reported. All statistical analyses were conducted in SAS v.9.4. (Cary, NC) and statistical significance was assessed at the 0.10 alpha level.

Results

A total of 103 MSM and TW with HIV who received anal biopsies during the study period were included in analysis. Patient demographics and baseline characteristics, both for the entire group and by outcome designation, are demonstrated in **Table 1**. The mean age at first observation was 19.7 (SD: ± 1.9) years. The majority were cisgender men (n=100, 97%), Black (n=94, 91%), and horizontally infected with HIV (n=101, 98%). Twelve participants (12%) were completely vaccinated against HPV (3-dose series) and 67 (65%) had ever received surgical treatment for anogenital HPV infection.

Of the 103 MSM and TW included, 97 (94%) received a valid anal pap smear over the study period. Of these, the most common results on initial pap smear were low-grade anal intraepithelial lesion (LSIL, n=43, 42%) and atypical squamous cells of undetermined significance (ASCUS, n=33, 32%) (**Table 2**). **Figure 1** demonstrates the distribution of anal biopsy

results for all 103 participants. The majority (n=65, 63%) had high-grade anal dysplasia, including AIN 2, AIN 3, carcinoma in-situ, and squamous cell carcinoma.

Univariate logistic regression of all covariates is highlighted in **Table 3**. Age (cOR: 1.33, CI: 1.09–1.63, *p*-value 0.017), CD4 T-cell count at time of biopsy (cOR: 0.99, CI: 0.99–1.00, *p*-value 0.098), having ever received surgical treatment for anogenital HPV infection (cOR: 3.40, CI: 1.67–6.95, *p*-value 0.005), and being incompletely or unvaccinated against HPV (cOR: 11.25, CI: 2.98–42.44, *p*-value 0.003) were all significantly associated with high-grade anal dysplasia on anal biopsy.

A multivariate logistic regression model was built including age (per year increase), CD4 T-cell count at time of biopsy (per cell/μL increase), vaccination status (incomplete vs. complete), and surgical treatment for anogenital HPV infection (yes vs. no). Results are highlighted in **Table 4**. When controlling for age and CD4-T cell count at time of biopsy, having ever received surgical treatment for anogenital HPV infection (aOR: 2.59, CI: 1.18–5.66, *p*-value 0.046) and being incompletely or unvaccinated against HPV relative to being fully vaccinated (aOR: 5.34, CI: 1.30–21.93, *p*-value 0.051) were strongly associated with high-grade anal dysplasia on anal biopsy.

Discussion

To our knowledge, this is the first study to evaluate risk factors for high-grade anal dysplasia on anal biopsy among young MSM and TW living with HIV. Our study population was

predominantly Black, cisgender MSM who were horizontally infected with HIV, reflecting the current HIV epidemic in the US.[41] HPV infection and anogenital dysplasia remain highly prevalent among MSM and TW with HIV, with many individuals having persistent and progressive disease.[21] Furthermore, MSM and TW with HIV continue to be the highest risk group for developing anal cancer,[23, 32] yet no national screening guidelines exist.[29] It is imperative to further characterize risk factors for high-grade anal dysplasia to better inform screening practices and preventative measures in these groups.

Data published earlier this year on all sexually active youth with HIV in Atlanta demonstrated that HPV was the most common incident STI, with an overall incidence rate of 19.38 cases per 100 person years.[31] The overwhelming majority of our cohort had an abnormal pap smear at baseline, with LSIL and ASCUS being the most common diagnoses (42% and 32%, respectively). This is consistent with previously reported data on this group of young MSM and TW with HIV in Atlanta,[4] in addition to other reports in the literature.[16, 20] Furthermore, 63% had high-grade disease on anal biopsy, indicating clinically advanced anogenital disease in the majority of our cohort. Previous studies of MSM and TW in the literature reveal a similar burden of high-grade disease.[14, 19, 24] However, risk factors for developing high-grade dysplasia in these groups remain poorly understood.

Multivariate logistic regression analysis on our cohort revealed having ever received surgical treatment for anogenital HPV and being incompletely or unvaccinated against HPV were associated with high-grade anal dysplasia on anal biopsy when controlling for age and CD4 T-

cell count at time of the procedure (aOR: 2.59, CI: 1.18–5.66 and aOR: 5.34, CI: 1.30–21.93, respectively). Participants in our study received surgical treatment predominantly for treatment or removal of extensive anal condyloma. Extensive anal condyloma, when present, may be useful in identifying who is at highest risk for developing high-grade anal dysplasia and prompt earlier referral for biopsy.

Furthermore, our study demonstrated that individuals who were incompletely or unvaccinated against HPV were more likely to have high-grade disease on anal biopsy. This is both intuitive and congruent with the literature. A large, randomized, double-blind clinical trial assessing the safety and effectiveness of the quadrivalent HPV vaccine in MSM showed the vaccine successfully reduced both persistent anal infection with HR-HPV types and rates of high-grade AIN in study participants.[39] Additionally, Nyitray et al. found that 93% of MSM with HIV in their cohort were infected with at least one HR-HPV type, and 92% had at least one type found in the 9-valent vaccine.[22] Our data, combined with other reports in the literature, suggest an urgent need to prioritize and increase HPV vaccination efforts among young MSM and TW living with HIV. Additionally, those who remain incompletely or unvaccinated should be monitored closely for anal dysplasia through early referral for anal biopsy.

There are several limitations in our study. First, because this study was retrospective in nature, we were limited to information already documented in the medical chart. Therefore, several exposures had occasional missing values. Second, this study was conducted at a single HIV care center and included predominantly young Black MSM living with HIV, which may limit

generalizability to other populations. Lastly, and importantly, this study was done on a small sample size. Many exposures of interest had few observations, including vaccination status. There is a need for further studies with larger sample sizes to validate the association between vaccination status and high-grade anal dysplasia in young MSM and TW with HIV.

In conclusion, young MSM and TW with HIV in Atlanta have a high prevalence of high-grade anal dysplasia on anal biopsy. Furthermore, those who had ever received surgical treatment for anogenital HPV infection and those who were incompletely or unvaccinated against HPV were more likely to have high-grade disease. Our data emphasize the urgent need to improve HPV vaccination efforts and pursue larger surveillance studies of high-grade anal dysplasia among young MSM and TW with HIV.

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Tables and Figures

Table 1: Demographic and Clinical Characteristics of Young MSM and TW with HIV by Anal Biopsy Result

	Total N=103		High-grade dysplasia[1] N=65		Low-grade dysplasia[2] N=38		*p*-value (2-tail)
Characteristic	**No.**	**%**	**No.**	**%**	**No.**	**%**	
Age at first observation (years), mean ± SD	19.71 ± 1.89		20.06 ± 1.85		19.12 ± 1.83		0.014
Race							
Black	94	91	58	89	36	95	0.479
Other	9	9	7	11	2	5	
Gender							
Cisgender male	100	97	64	98	36	95	0.553
Transgender female	3	3	1	2	2	5	
Sexuality, N=101							
Gay	80	79	51	81	29	76	0.578
Other	21	21	12	19	9	24	
Mode of HIV transmission							
Horizontal	101	98	63	97	38	100	0.530
Vertical	2	2	2	3	0	0	
History of tobacco use							
Yes	38	37	24	37	14	37	0.993
No	65	63	41	63	24	63	
Vaccination status							
Complete (3-doses)	12	12	2	3	10	26	0.001
Not complete (0, 1, 2 doses)	91	88	63	97	28	74	
History of anogenital condyloma							
Yes	85	83	56	86	29	76	0.205
No	18	17	9	14	9	24	
Condom use, N=93							
Always	23	25	15	25	8	25	0.997
Inconsistent	61	66	40	66	21	66	
Never	9	10	6	10	3	9	
Number of sexual partners at baseline, N=90							
0-20	53	59	30	54	23	68	0.188
>20	37	41	26	46	11	32	
History of transactional sex, N=50							
Yes	15	30	11	33	4	24	0.474
No	35	70	22	67	13	76	
History of sexual abuse, N=74							

Yes	24	32	15	31	9	35	0.768
No	50	68	33	69	17	65	
History of receptive anal sex, N=102							
Yes	102	100	64	100	38	100	NA
No	0	0	0	0	0	0	
CD4 count at time of biopsy (cells/μL), mean ± SD, N=101	441.93 ± 243.33		410.4 ± 241.7		494.1 ± 240.0		0.094
Medical treatment for anogenital HPV ever							
Yes	51	50	31	48	20	53	0.629
No	52	50	34	52	18	47	
Surgical treatment for anogenital HPV ever							
Yes	67	65	49	75	18	47	0.004
No	36	35	16	25	20	53	
Number of co-STIs within 3-months of biopsy[3]							
Median (IQR)	0 (1.00)		1 (1.00)		0 (1.00)		0.159
By category							
0	54	52	30	46	24	63	0.084
1	34	33	25	38	9	24	
2	10	10	7	11	3	8	
3	3	3	3	5	0	0	
4	2	2	0	0	2	5	

Abbreviations: MSM, men who have sex with men; TW, transgender women; SD, standard deviation; HPV, human papillomavirus; co-STI, co-sexually transmitted infections; IQR, interquartile range

[1]High-grade anal dysplasia defined as anal intraepithelial lesion 2, 3, or anal carcinoma

[2]Low-grade anal dysplasia defined as anal intraepithelial lesion 1 or no intraepithelial lesion present

[3]Within 3-months before or after biopsy date

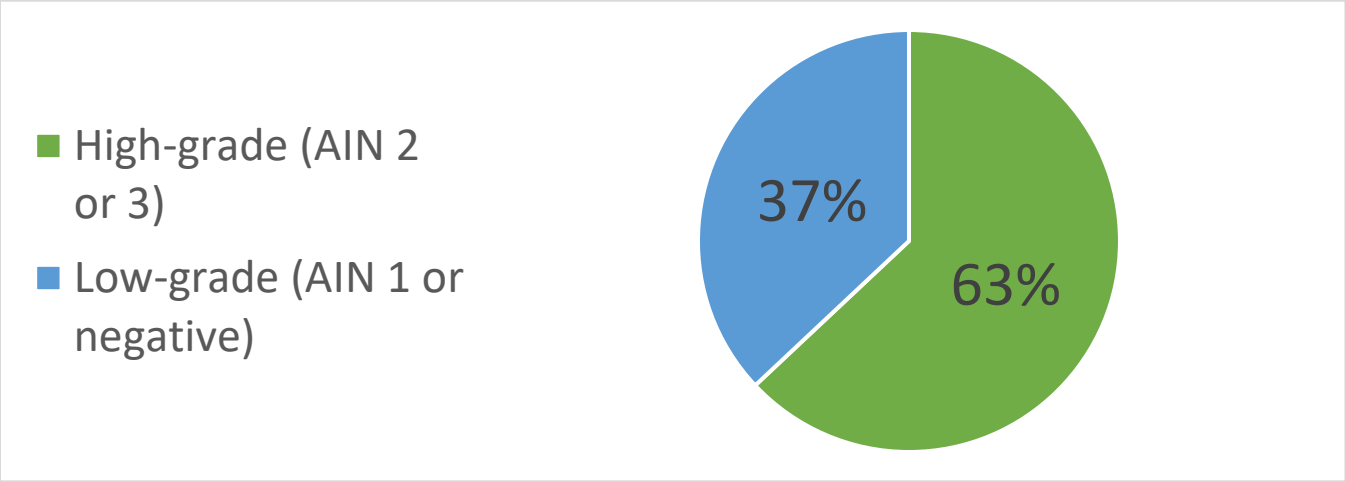
Table 2: Anal Cytology Results on Initial Pap Smear Among Young MSM and TW with HIV

	No. (%)
Pap smear result	N=103
LSIL	43 (41.75)
ASCUS	33 (32.04)
Negative	11 (10.68)
ASC-H	8 (7.77)
HSIL	2 (1.94)
None[1]	6 (5.83)

Abbreviations: MSM, men who have sex with men; TW, transgender women; LSIL, low-grade squamous intraepithelial lesion; ASCUS, atypical squamous cells of undetermined significance; ASC-H, atypical squamous cells, cannot rule out high-grade; HSIL, high-grade squamous intraepithelial lesion

[1]No valid pap smear obtained during the study period

Figure 1: Distribution of Anal Biopsy Results Among Young MSM and TW with HIV



Abbreviations: MSM, men who have sex with men; TW, transgender women; AIN, anal intraepithelial neoplasia

Table 3: Unadjusted Associations Between Clinical Characteristics and High-Grade Anal Dysplasia on Anal Biopsy Among Young MSM and TW with HIV

Characteristic, N=103	Crude Odds Ratio (Exact 90% CI)	*p*-value (2-tail)
Age at first observation (per year increase)	1.33 (1.09, 1.63)	0.017
Race		
Black vs. other	0.46 (0.12, 1.80)	0.350
Gender		
Cisgender male vs. TW	3.55 (0.46, 27.42)	0.307
Sexuality		
Gay vs. other	1.32 (0.58, 3.00)	0.579
Mode of HIV transmission		
Horizontal vs. vertical	0.00 (0.00, 999.99)	0.981
History of tobacco use		
Yes vs. no	1.00 (0.50, 2.01)	0.993
Vaccination status (complete vs. not complete)		
Not complete (0, 1, 2 doses) vs. complete (3-doses)	11.25 (2.98, 42.44)	0.003
History of anogenital condyloma		
Yes vs. no	1.93 (0.82, 4.57)	0.209
Condom use		
Always vs. never	0.94 (0.24, 3.68)	0.945
Inconsistent vs. never	0.95 (0.27, 3.31)	0.974
Number of sexual partners at baseline		
0-20 vs. >20	0.55 (0.26, 1.17)	0.191
History of transactional sex		
Yes vs. no	1.63 (0.53, 4.98)	0.476
History of sexual abuse		
Yes vs. no	0.859 (0.37, 2.01)	0.768
CD4 count at time of biopsy (per cell/µL increase), N=101	0.99 (0.99, 1.00)	0.098
Medical treatment for anogenital HPV ever		
Yes vs. no	0.82 (0.42, 1.61)	0.629
Surgical treatment for anogenital HPV ever		
Yes vs. no	3.40 (1.67, 6.95)	0.005
Number of co-STIs within 3-months of biopsy (per 1 co-STI increase)[1]	1.19 (0.80, 1.75)	0.472

Abbreviations: MSM, men who have sex with men; TW, transgender women; CI, confidence interval
[1]Within 3-months before or after biopsy date

Table 4: Adjusted Associations Between Clinical Characteristics and High-Grade Anal Dysplasia on Anal Biopsy Among Young MSM and TW with HIV

Characteristic, N=103	Adjusted Odds Ratio (Exact 90% CI)	*p*-value (2-tail)
Age (per year increase)	1.22 (0.98, 1.53)	0.135
CD4 count at time of biopsy (per cell/μL increase)	1.00 (0.99, 1.00)	0.734
Vaccination status (not complete (0, 1, 2 doses) vs. complete (3-doses))	5.34 (1.30, 21.93)	0.051
Surgical treatment for anogenital HPV ever (yes vs. no)	2.59 (1.18, 5.66)	0.046

Abbreviations: MSM, men who have sex with men; TW, transgender women; CI, confidence interval; HPV, human papillomavirus