



Prevalence and correlates of cervical HPV infection in a clinic-based sample of HIV-positive Hispanic women



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ABSTRACT

Objectives: Puerto Rico (PR), is the fifth highest jurisdiction of the United States of America (US) with respect to HIV prevalence and the leading in cervical cancer incidence. This cross-sectional study describes the prevalence and correlates of cervical HPV infection among a clinic-based sample of 302 women living with HIV/AIDS in PR.

Methods: Data collection included questionnaires, blood and cervical samples. Multivariable logistic regression models were used to estimate the magnitude of association (adjusted Prevalence odds ratio [aPOR]) between HPV cervical infection and other covariates.

Results: Mean age of participants was 40.3 years (\pm 10.3 SD). The prevalence of HPV infection was 50.3%; 41.1% for low-risk types and 29.5% for high-risk types. Having \geq 10 lifetime sexual partners (aPOR = 2.10, 95% CI:1.02–4.29), an abnormal Pap (aPOR = 3.58, 95% CI:1.93–6.62), active genital warts (aPOR = 3.45, 95% CI:1.60–7.42), and CD4 counts \leq 200 (aPOR = 4.24, 95% CI: 1.67–10.78) were positively associated with any cervical HPV infection. Similar results were observed for HR HPV infection.

Conclusions: A high burden of HPV co-infection exists among women living with HIV/AIDS in this population. Given the high incidence of HIV in PR and the higher risk of cervical cancer among women living with HIV/AIDS, HPV vaccination should be promoted in this population.

1. Introduction

Among persons living with HIV/AIDS (PLWHA), the burden of HPV-related cancers is higher than in the general population [1,2]. The same has been documented in Puerto Rico (PR), the fifth highest jurisdiction of the United States of America (US) with respect to HIV prevalence (600.2 per 100,000) [1,3]. In PR, cervical cancer is the most common HPV-related cancer among women with AIDS, with an incidence rate of 299.6 per 100,000 [1]. Furthermore, the incidence rates of cervical cancer (11.7 per 100,000 females) are higher in Puerto Rico than in the other US states and territories [4].

Greater likelihood of HPV incidence, prevalence and persistence in female PLWHA due to increased susceptibility, lower ability to clear

infection and reactivation of infection due to immunosuppression, influences the increased risk of cervical cancer among them [5]. While the prevalence of cervical HPV DNA among US females enrolled in the 2003–2004 NHANES was 27% [6], the prevalence for cervical HPV infection among HIV positive women is higher (40–70%) [7]. In PR, prevalence estimates of HPV in women range from 29.4% to 45.5% in population and clinic-based studies, respectively [8,9]. Despite the higher burden of HIV in PR, no estimates of HPV infection in female PLWHA exist for this population. This study describes the prevalence, type distribution and correlates of cervical HPV infection among a clinic-based sample of female PLWHA in PR. This information is essential for understanding disease burden, efficacy of HPV vaccination programs and need for enforced cancer prevention strategies among Hispanic PLWHA.

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Table 1
Characteristics of a clinic-based sample of HIV positive women in Puerto Rico overall and by HPV status (n = 302).

Characteristics	Overall n(%)	HPV-positive n(%)	HPV-negative n(%)	P-value ^a
<i>Socio-demographics</i>				
Age (mean = 40.3 years ± 10.3 SD)				0.86
18–34 years	95 (31.5)	47 (30.9)	48 (32.0)	
35–49 years	151 (50.0)	78 (51.3)	73 (48.7)	
≥ 50 years	56 (18.5)	27 (17.8)	29 (19.3)	
<i>Education (n = 295)</i>				
High-school or less	187 (63.4)	94 (64.0)	93 (62.8)	0.84
More than high school	108 (36.6)	53 (36.0)	55 (37.2)	
<i>Marital status (n = 300)</i>				
Single	158 (52.7)	79 (52.7)	79 (52.7)	0.99
With partner	142 (47.3)	71 (47.3)	71 (47.3)	
<i>Lifestyle</i>				
<i>Age at first sexual intercourse</i>				
≤ 15 years	77 (25.5)	41 (27.0)	36 (24.0)	0.55
> 15 years	225 (74.5)	111 (73.0)	114 (76.0)	
<i>Lifetime no. of sex partners (n = 286)</i>				
1–2	56 (19.6)	22 (15.6)	34 (23.5)	0.10
3–4	104 (36.4)	52 (36.9)	52 (35.9)	
5–9	77 (26.9)	36 (25.5)	41 (28.3)	
≥ 10	49 (17.1)	31 (22.0)	18 (12.4)	
<i>No. of sex partners in the last 12 months (n = 294)</i>				
0	72 (24.49)	32 (21.6)	40 (27.4)	0.34
1	192 (65.31)	98 (66.2)	94 (64.4)	
≥ 2	30 (10.20)	18 (12.2)	12 (8.2)	
<i>Current smoking status (n = 301)</i>				
Yes	81 (26.9)	48 (31.8)	33 (22.0)	0.06
No	220 (73.1)	103 (68.2)	117 (78.0)	
<i>Oral Contraceptive use (n = 301)</i>				
No	190 (63.1)	91 (59.9)	99 (66.4)	0.24
Yes	111 (36.9)	61 (40.1)	50 (33.6)	
<i>Clinical</i>				
<i>Pap Results at baseline (n = 298)</i>				
Normal	207 (69.5)	87 (58.0)	121 (81.8)	< 0.0001
Abnormal	91 (30.5)	63 (42.0)	27 (18.2)	
<i>History of abnormal Pap test (n = 299)</i>				
No	176 (58.9)	72 (48.3)	104 (69.3)	< 0.0001
Yes	123 (41.1)	77 (51.7)	46 (30.7)	
<i>Active Genital Warts (n = 291)</i>				
No	235 (80.8)	105 (72.9)	130 (88.4)	0.001
Yes	56 (19.2)	39 (27.1)	17 (11.6)	
<i>History of genital warts (n = 291)</i>				
No	208 (71.5)	90 (62.5)	118 (80.3)	0.001
Yes	83 (28.5)	54 (37.5)	29 (19.7)	
<i>CD4 cell count (cells/mm³) (n = 301)</i>				
≤ 200	45 (15.0)	37 (24.3)	8 (5.4)	< 0.0001
201–499	113 (37.5)	60 (39.5)	53 (35.6)	
≥ 500	143 (47.5)	55 (36.2)	88 (59.0)	
<i>Viral load (n = 295)</i>				
< 75 copies	175 (59.3)	76 (51.0)	99 (67.8)	0.003
≥ 75 copies	120 (40.7)	73 (49.0)	47 (32.2)	
<i>Current use of HAART (n = 301)</i>				
No	71 (23.6)	33 (21.9)	38 (25.3)	0.48
Yes	230 (76.4)	118 (78.1)	112 (74.7)	

Count varies due missing information for all variables.

^a P-value from the chi-square test.

2. Methods

2.1. Study design and population

This cross-sectional study recruited 302 consecutive women aged ≥ 18 years receiving care at the Maternal-Infant Studies Center (CEMI-Spanish acronym) between October 2009 and January 2010. CEMI is a multidisciplinary longitudinal Ob/Gyn clinic at the University of Puerto Rico Medical Sciences Campus (UPR-MSC), dedicated to scientific research and offering clinical services to women living with or at risk for HIV. For this study, eligible women had to have a documented diagnosis of HIV infection, and have no prior history of cervical cancer. This study was approved by the Institutional Review Board (IRB) of the UPR-MSC.

2.2. Data collection procedures

Consecutive patients scheduled for routine clinical care and who met all eligibility requirements, were offered participation in the study. Upon signing the informed consent, participants completed two self-administered questionnaires that collected information on socio-demographics, lifestyles and clinical characteristics. The participants were then seen by the study clinician (Obstetrics and gynecology [OBGYN] specialist) who performed a pelvic exam for Pap test and took the HPV samples. A blood sample was also collected to determine viral load and CD4 cell counts. Study staff also collected and verified participant's clinical data within the medical record, including laboratory results, cytological results, CD4 cell count (≤ 200, 200–499 and ≥ 500) and HIV viral load (< 75 vs. ≥ 75) count, and current use of highly active

antiretroviral therapy (HAART) (yes vs. no). Cervical cytology results were determined to be either normal or abnormal; abnormal cytology included *atypical squamous cells of undetermined significance* (ASCUS), *atypical squamous cells-cannot exclude high grade squamous intraepithelial lesion* (HSIL), *low grade squamous intraepithelial lesion* (LSIL) and cancer. Active genital warts (yes/no) were assessed by an OBGYN specialist by visual inspection during the clinical examination.

HPV sampling and analysis. Following the routine pap-smear of their scheduled clinical visit, women received a standard pelvic examination to collect cells for HPV. Testing was done using one Digene's cervicovaginal sampler. The OBGYN specialist took the swab and inserted it into the endocervical/ectocervical canal (or vaginal canal) and turned it for two full rotations to maximize cell collection. After specimen collection, the swab was placed in a 5-mL vial containing 1 mL sample transport medium (Digene Corp.). All samples were stored ambient; and shipped for HPV typing to the laboratory of Dr. Yamamura at the Ponce Health Sciences University. Here samples were analyzed using a Linear Array PCR-DNA to identify each participant's HPV positivity and genotypes (37 sub-types). As in previous research, HPV infection was divided into high-risk (HR, oncogenic) and low-risk (LR, non-oncogenic) categories [9]. All specimens had β -globin detected and thus were considered adequate for analysis.

2.3. Statistical analysis

Contingency table analysis and chi-square statistics were used to determine factors associated to any type of HPV cervical infection. Descriptive statistics were used to describe the prevalence of HPV infection (overall and type specific) and of other related characteristics of the study population. Variables significantly associated with any type of HPV cervical infection ($p < 0.05$) in the simple logistic regression models were included in the multivariable model. Multivariable logistic regression models were fitted to determine the unadjusted [POR] and adjusted prevalence odds ratio [aPOR] with 95% confidence intervals (95% CI) for (1) any type of HPV and for (2) HR-HPV cervical infection. The likelihood ratio test was used to determine if there were significant interaction terms within the models. Data was analyzed with STATA version 14.

3. Results

Table 1 describes the demographic and clinical characteristics of the study population overall and by cervical HPV infection status. Mean age of study participants was 40.3 years (± 10.3 SD); 36.6% had beyond high-school education, 47.3% had a sexual partner at the time of the study (**Table 1**), and 89.3% had acquired HIV heterosexually (data not shown). Regarding lifestyles, 10.2% of women had ≥ 2 sexual partners in the past 12 months, 26.9% were current smokers, and 76.4% were in HAART. Regarding other clinical characteristics, at the time of clinical evaluation, 30.5% had an abnormal pap test result, 15.0% had CD4 counts below 200 *cells/mm³*, 59.3% had an HIV viral load < 75 copies/per millilitre, and 19.2% had active genital warts (**Table 1**). Pap test results at baseline, history of abnormal Pap test, history of genital warts and CD4 cells counts were associated with cervical HPV infection ($p < 0.05$). Current smoking status was marginally associated to cervical HPV infection ($p = 0.06$).

The prevalence of HPV infection was high overall (50.3%), and for LR (41.1%) and HR (29.5%) types (**Table 2**); 20.5% of women were co-infected with HR and LR types, 18.2% had one HPV type and 32.1% had multiple HPV types (data not shown). The leading HR types detected were 52 (8.3%), and 16 (6.0%), while the leading LR types were 61 (10.3%), 53 (7.6%), 66 (6.6%), 6 (6.3%) and 62 (6.3%) (**Table 2**). Meanwhile, 10.6% were positive to HPV types included in the bivalent HPV vaccine (16 and 18), 16.2% were positive to HPV types included in the quadrivalent vaccine (6,11,16 and 18) and 26.2%

to HPV types included in the nonavalent vaccine (6, 11, 16, 18, 31, 33, 45, 52, and 58) (**Fig. 1**). Differences were observed by age group, where prevalence of HPV types included in the quadrivalent vaccine was 15.8% among women aged 18–34, 20.5% among women aged 35–49 and 5.4% among women aged 50+ years ($p < 0.05$). Similar results were seen for HPV types included in the bivalent and in the nonavalent HPV vaccines, although differences were not statistically significant for HPV types included in the nonavalent vaccine ($p > 0.05$) (**Fig. 1**).

Overall, the prevalence of any, HR and LR HPV types was higher in women with abnormal cervical cytology results; similar results were observed for various specific HR (HPV types 18, 52, 58 and 59) and LR (53, 55, 81 and 83) types ($p < 0.05$). The most common HPV types in women with abnormal cervical cytology included HR HPV types 52 (17.6%), 58 (11.0%), 59 (11.0%), 16 (9.9%) and 18 (9.9%) (**Table 2**). Meanwhile, any, HR and LR HPV types were also more common in women with active genital warts. For specific HPV types, the prevalence of HR HPV types 16 and 59 was higher in women with active genital warts, whereas the prevalence of LR HPV types 6, 53, 61, 62, and 71 was also higher in women with active genital warts than in their counterparts ($p < 0.05$). The most common LR HPV types identified among women with active genital warts included types 61 (17.9%) 6 (16.1%), 53 (16.1%) and 62 (14.3%); only 3.6% of women with active genital warts had infection with HPV 11 (**Table 2**). It is also important to highlight that there was an association between abnormal cervical cytology at baseline and genital warts. The prevalence of history of genital warts was 24.8% among women with normal cytology results, but 37.1% among women with abnormal cervical cytology results ($p = 0.032$). Meanwhile, 17.2% of women with normal cervical cytology had active genital warts, as compared to 23.6% of women with abnormal cervical cytology; this difference was not statistically significant ($p > 0.05$) (data not shown).

Number of lifetime sexual partners, abnormal pap test results at baseline, having active genital warts, history of abnormal pap test results and of genital warts, CD4 cells counts and viral load, were all associated with cervical HPV infection in bivariate analyses ($p < 0.05$), while HAART use was not. Results from the multivariate logistic regression model showed that women with ≥ 10 lifetime sexual partners (adjusted POR[aPOR] = 2.10, 95% CI:1.02–4.29), those with an abnormal Pap (aPOR = 3.58, 95% CI:1.93–6.62) and those with active genital warts (aPOR = 3.45, 95% CI:1.60–7.42) were more likely to have cervical HPV infection. CD4 counts also continued to be strongly associated to cervical HPV infection in multivariate analysis, as women with CD4 counts ≤ 200 were 4-fold (aPOR = 4.24, 95% CI: 1.67–10.78) more likely to have cervical HPV infection (**Table 3**). Similar results were seen for factors associated to HR HPV types (**Table 4**).

4. Discussion

This is the first study to describe the burden and correlates of cervical HPV infection in a clinic-based sample of women living with HIV in PR. The prevalence of HPV infection was high overall (50.3%), and for LR (41.1%) and HR (29.5%) types. In addition, 32.1% had multiple HPV types and 30.5% had abnormal cervical cytology. These findings are consistent with studies world-wide. HPV positivity in HIV + women ranges from 31% in Asia and the US, 57% in South and Central America and 57% in Africa [5]. Our study results of HPV and abnormal cytology are also consistent with more recent studies among female PLWHA in Brazil, Belgium, and Nigeria [10–12].

The leading HR types detected among women in our study were 52 and 16, followed by 58 and 59, results also similar to those from a meta-analysis among women living with HIV, were the most common high-risk HPV types detected were 16, 58, 18, 52, 31 and 33 [5]. Meanwhile, positivity to any HPV type included in the bivalent, quadrivalent and nonavalent HPV vaccines was 10.6%, 16.2% and 26.2%, respectively, highlighting the impact that these vaccines could

Table 2
Prevalence of the HPV types among a clinic-based sample of HIV positive women in Puerto Rico overall, by status of cervical cytology and of genital warts.

HPV Types	Overall (n = 302)	Abnormal cervical cytology at baseline (n = 298)			Active genital warts (n = 291)		
		Yes (n = 91)	No (n = 207)	p-value ^a	Yes (n = 56)	No (n = 235)	p-value ^a
Any HPV	n (%)	n (%)	n (%)		n (%)	n (%)	
HR Types	150 (50.3)	64 (70.3)	86 (41.6)	< 0.0001	39 (69.6)	105 (44.7)	0.001
Any HR	89 (29.5)	44 (48.4)	43 (20.8)	< 0.0001	25 (44.6)	60 (25.5)	0.005
16	18 (6.0)	9 (9.9)	9 (4.4)	0.06	7 (12.5)	11 (4.7)	0.03
18	17 (5.6)	9 (9.9)	8 (3.9)	0.04	5 (8.9)	11 (4.7)	> 0.10
31	11 (3.6)	6 (6.6)	5 (2.4)	0.08	1 (1.8)	10 (4.3)	> 0.10
33	6 (2.0)	4 (4.4)	2 (1.0)	0.07	4 (7.1)	2 (0.9)	> 0.10
35	3 (1.0)	2 (2.2)	1 (0.5)	> 0.10	0 (0.0)	3 (1.3)	> 0.10
39	6 (2.0)	1 (1.1)	5 (2.4)	> 0.10	2 (3.6)	3 (1.3)	> 0.10
45	8 (2.7)	4 (4.4)	4 (1.9)	> 0.10	2 (3.6)	5 (2.1)	> 0.10
51	7 (2.4)	4 (4.4)	3 (1.5)	> 0.10	3 (5.4)	4 (1.7)	> 0.10
52	25 (8.3)	16 (17.6)	8 (3.9)	< 0.0001	8 (14.3)	17 (7.2)	0.09
56	4 (1.3)	3 (3.3)	1 (0.5)	0.086	1 (1.8)	3 (1.3)	> 0.10
58	17 (5.6)	10 (11.0)	6 (2.9)	0.004	5 (8.9)	12 (5.11)	> 0.10
59	17 (5.6)	10 (11.0)	6 (2.9)	0.004	7 (12.5)	10 (4.3)	0.018
68	7 (2.3)	4 (4.4)	3 (1.5)	> 0.10	1 (1.8)	4 (1.7)	> 0.10
LR Types							
Any LR	124 (41.1)	47 (51.7)	75 (36.2)	0.013	33 (58.9)	84 (35.7)	0.001
6	19 (6.3)	6 (6.6)	13 (6.3)	> 0.10	9 (16.1)	8 (3.4)	< 0.0001
11	4 (1.3)	1 (1.1)	3 (1.5)	> 0.10	2 (3.6)	2 (0.9)	> 0.10
26	1 (0.3)	0 (0.0)	1 (0.5)	> 0.10	0 (0.0)	0 (0.0)	–
40	0 (0.0)	–	–	–	–	–	–
42	11 (3.6)	6 (6.6)	5 (2.4)	0.078	2 (3.57)	9 (3.83)	> 0.10
53	23 (7.6)	11 (12.1)	11 (5.3)	0.04	9 (16.1)	13 (5.5)	0.007
54	16 (5.3)	3 (3.3)	11 (5.3)	> 0.10	4 (7.1)	10 (4.3)	> 0.10
55	7 (2.3)	5 (5.5)	2 (1.0)	0.029	2 (3.6)	5 (2.1)	> 0.10
61	31 (10.3)	10 (11.0)	21 (10.1)	> 0.10	10 (17.9)	21 (8.9)	0.05
62	19 (6.3)	6 (6.6)	13 (6.3)	> 0.10	8 (14.3)	10 (4.3)	0.005
64	0 (0.0)	–	–	–	–	–	–
66	20 (6.6)	10 (11.0)	10 (4.8)	0.05	5 (8.9)	10 (4.3)	> 0.10
67	1 (0.3)	–	–	–	1 (1.8)	0 (0.0)	> 0.10
69	1 (0.3)	1 (1.1)	0 (0.0)	> 0.10	1 (1.8)	0 (0.0)	> 0.10
70	12 (4.0)	5 (5.5)	7 (3.4)	> 0.10	2 (3.6)	10 (4.3)	> 0.10
71	8 (2.7)	1 (1.1)	7 (3.4)	> 0.10	4 (7.1)	4 (1.7)	0.047
72	6 (2.0)	3 (3.3)	3 (1.5)	> 0.10	3 (5.4)	3 (1.3)	0.053
73	1 (0.3)	0 (0.0)	1 (0.5)	> 0.10	0 (0.0)	1 (0.4)	> 0.10
81	17 (5.6)	10 (11.0)	7 (3.4)	0.009	5 (8.9)	12 (5.1)	> 0.10
82	2 (0.7)	1 (1.1)	1 (0.5)	> 0.10	1 (1.8)	1 (0.4)	> 0.10
83	11 (3.6)	7 (7.7)	4 (1.9)	0.034	3 (3.4)	8 (3.4)	> 0.10
84	11 (3.6)	4 (4.4)	7 (3.4)	> 0.10	3 (5.4)	6 (2.6)	> 0.10
IS39	0 (0.0)	–	–	–	–	–	–
cp6108	17 (5.6)	9 (9.9)	8 (3.9)	0.04	2 (3.6)	12 (5.1)	> 0.10

^a Fishers exact test was used for analyses with observed or expected cell counts < 5.

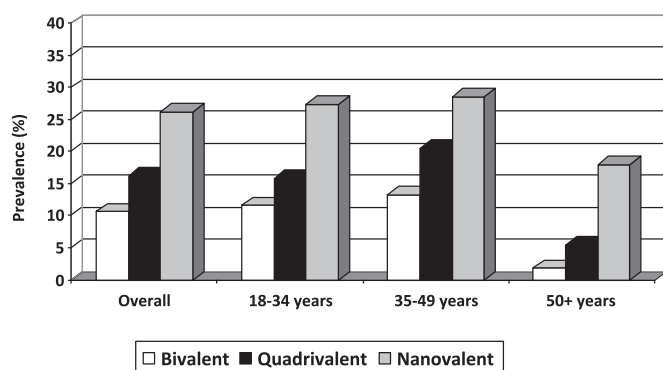


Fig. 1. Prevalence of cervical infection with HPV vaccine types among a clinic-based sample of HIV positive women in Puerto Rico overall and by age-group.

have in cervical cancer prevention in this population. Nonetheless, information on HPV types present in cervical cancer tumors of women in this population should also be assessed, in order to further determine the potential impact of these vaccines on cervical cancer prevention. In other populations, HPV 16 and/or 18 have been

identified in 53.6–86.0% of HIV-positive women with HPV-positive cervical cancer [5]. In our study, the most common HPV types in women with abnormal cytology were HPV 18, 52, 58 and 59, while HPV 61, 6 and 53, and not 11, were more common among women with active genital wart.

Regarding factors associated to cervical HPV positivity, also consistent with previous studies, results showed that HPV prevalence increased with increased lifetime sexual partners and decreased CD4 cells counts [5,7,11]. In fact, studies have shown that higher CD4 counts reduce the risk of persistent infection with HR-HPV types among HIV positive women [13,14]. HPV infection among women in our study was also strongly associated with having active genital warts and an abnormal pap test result. This association is consistent with the body of literature in this area [11]. Meanwhile, both HR and LR types were more commonly found in women with abnormal paps than among those with normal cytology, a finding consistent with the literature [12]. Finally, results for viral load in multivariate analysis were marginally significant (p < 0.10), suggesting that CD4 counts are a stronger predictor of HPV positivity than viral load, a finding also consistent with some [5,11,13] but not all research [12,15,16].

Study limitations include limited sample size to further evaluate differences in specific HPV types between women with abnormal and

Table 3
Logistic regression models of factors associated to any type of cervical HPV infection among a clinic-based sample of HIV positive women in Puerto Rico.

Characteristics	POR _{unadjusted} (95% CI)	P-value	POR _{adjusted} [*] (95% CI)	P-value
<i>Age</i>				
≥ 50 years	1.0		1.0	
18–34 years	1.05 (0.54–2.03)	0.88	0.53 (0.23–1.23)	0.14
35–49 years	1.15 (0.62–2.12)	0.66	0.76 (0.36–1.58)	0.46
<i>No. of sex partners (lifetime)</i>				
< 10	1.0		1.0	
≥ 10	2.03 (1.09–3.77)	0.03	2.10 (1.02–4.29)	0.05
<i>Pap Results at baseline</i>				
Normal	1.0		1.0	
Abnormal	3.34 (1.97–5.65)	< 0.0001	3.58 (1.93–6.62)	< 0.0001
<i>Active genital warts</i>				
No	1.0		1.0	
Yes	2.84 (1.52–5.31)	0.001	3.45 (1.60–7.42)	0.002
<i>CD4 cell count (cells/mm³)</i>				
≤ 200	7.40 (3.21–17.06)	< 0.0001	4.24 (1.67–10.78)	0.002
201–499	1.81 (1.10–2.99)	0.02	1.33 (0.75–2.37)	0.33
≥ 500	1.0		1.0	
<i>Viral load</i>				
< 75 copies	2.02 (1.26–3.25)	0.003	1.69 (0.92–3.11)	0.09
≥ 75 copies	1.0		1.0	

* POR_{adjusted} by all the variables in the model simultaneously. We found no significant interactions in the multivariate model (likelihood ratio $X^2 = 28.47$, p-value = 0.34).

normal cervical cytology, and the fact that prevalence estimates of HPV are not generalizable to the general population of female PLWHA in PR. Also, although our prevalence estimates of HPV infection may be affected by HPV vaccination status, data collection for this study was performed in 2010, when HPV vaccination rates were still very low in PR. In fact, a population-based study among women in Puerto Rico from 2010 to 2013 showed that only 4.7% of women in the recommended catch-up vaccination age range (16–26 years) had received at least one dose of the HPV vaccine [17]. Furthermore, women included in this study are most beyond vaccination recommended age groups. Thus, we expect this to have had limited impact on our study results. Among the strengths of this investigation, this study included biological measures that strengthen the validity of our study results regarding correlates of cervical HPV infection in this group, and generates the first data of HPV co-infection among female PLWHA in PR and the first among an exclusively Hispanic population in the US.

We conclude that consistent with previous studies, our findings document a high prevalence of HPV infection in the study population.

Despite the high prevalence of HPV vaccine types observed in this study, other high risk HPV types were also observed, warranting further investigation regarding their role in cervical abnormalities in female PLWHA. Meanwhile, consistent with previous studies, HPV co-infection was negatively correlated with CD4 cell counts, and strongly positively associated with having multiple sexual partners, active genital warts and abnormal Pap test results.

Given the high incidence of HIV in PR and the higher risk of cervical cancer among HIV-positive women, HPV vaccination should be promoted among young girls, and among HIV-positive women, as effective cervical cancer prevention strategies. Indeed, the Centers for Disease Control and Prevention (CDC) recommends HPV vaccination for young adults with HIV and other immunocompromising conditions through age 26 [18]; this recommendation is also followed in Puerto Rico. Although data on HPV vaccine coverage for this population in Puerto Rico is scant, it has been evidenced that particularly young women with HIV may benefit from the HPV vaccine; despite having already been exposed to HPV, close to half of them have not been exposed to

Table 4
Logistic regression models of factors associated to HR-HPV of cervical HPV infection among a clinic-based sample of HIV positive women in Puerto Rico.

Characteristics	POR _{unadjusted} (95% CI)	P-value	POR _{adjusted} [*] (95% CI)	P-value
<i>Age</i>				
≥ 50 years	1.0		1.0	
18–34 years	2.28 (1.04–4.98)	0.04	1.94 (0.71–5.29)	0.20
35–49 years	1.68 (0.80–3.55)	0.17	1.33 (0.52–3.40)	0.55
<i>No. of sex partners (lifetime)</i>				
< 10	1.0		1.0	
≥ 10	3.35 (1.80–6.24)	< 0.0001	3.19 (1.56–6.54)	0.002
<i>Pap Results at baseline</i>				
Normal	1.0		1.0	
Abnormal	3.57 (2.10–6.07)	< 0.0001	2.73 (1.46–5.10)	0.002
<i>Active genital warts</i>				
No	1.0		1.0	
Yes	2.35 (1.29–4.30)	0.005	2.00 (0.97–4.15)	0.06
<i>CD4 cell count (cells/mm³)</i>				
≤ 200	7.14 (3.40–14.98)	< 0.0001	6.29 (2.53–15.66)	< 0.0001
201–499	2.86 (1.59–5.16)	< 0.0001	2.15 (1.10–4.22)	0.03
≥ 500	1.0		1.0	
<i>Viral load</i>				
< 75 copies	1.64 (0.97–2.66)	0.07	0.79 (0.40–1.57)	0.51
≥ 75 copies	1.0		1.0	

* POR_{adjusted} by all the variables in the model simultaneously. We found no significant interactions in the multivariate model (likelihood ratio $X^2 = 14.73$, p-value = 0.96).

the most common high-risk HPV types, according to a study from the National Institutes of Health research network [18,19].

Longitudinal HIV care may improve access to cancer care, however, Pap test is still underutilized among HIV-positive women [20–23]. Thus, efforts should continue to increase Pap test screening in this population, as well as the compliance with recent screening guidelines for female PLWHA from the American College of Obstetricians and Gynecologists [24], which include HPV testing. Research in this area should include the understanding of barriers to cervical cancer screening including the role of the health care providers and the health system.

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