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Age-Specific Distribution and Factors Associated with High-Risk HPV Infection and Cervical Lesions Among HIV-Positive and -Negative Women in Maputo, Mozambique: Findings from the HPV-ISI Study (2021–2022)

Alberto Sineque [1,2,*], Célia Nhambe [3], Júlia Sebastião [3], Nilza Cossa [3], Cacilda Massango [3], Zita Sidumo [3], Susanna Ceffa [4], Fausto Cicacci [5], Jahit Sacarlal [6] and Maria Clara Bicho [7]

[1] Department of Biological Sciences, Eduardo Mondlane University, Maputo, Mozambique
[2] CFE – One Health, Department of Life Sciences, University of Coimbra, Coimbra, Portugal
[3] DREAM Program, Community of Sant'Egidio, Mozambique
[4] DREAM Program, Community of Sant'Egidio, Rome, Italy
[5] University of Rome Tor Vergata, Department of Biomedicine and Prevention, Rome, Italy
[6] Department of Microbiology, Faculty of Medicine, Eduardo Mondlane University, Maputo, Mozambique
[7] Institute for Preventive Medicine and Public Health, Institute of Environmental Health (ISAMB), Faculty of Medicine, University of Lisboa, Portugal
* Correspondence: sineque.alberto@uem.ac.mz; https://orcid.org/0000-0003-2468-9925

Abstract

Background/Objective: High-risk Human papillomavirus (hrHPV) is the leading cause of premalignant lesions and cervical cancer (CC), affecting disproportionally women living with HIV. Mozambique is among the countries with a heavy triple-burden of HIV, hrHPV infections and CC which accounts for more than 5300 new cases and 3800 deaths each year. In this study, we assessed the age-specific distribution and factors associated with hrHPV and cervical lesions among HIV-positive and -negative women from HPV-ISI (HPV Innovative Screening Initiative) study in Maputo, Mozambique. **Methods**: This cross-sectional study included 1,248 non-pregnant women aged ≥18 years who attended CC screening at the DREAM Sant'Egídio Health Center between July 2021 and April 2022. Screening involved visual inspection with acetic acid (VIA) and high-risk HPV DNA testing. Sociodemographic, lifestyle, and reproductive data were collected through a routine questionnaire. Logistic regression assessed associations between risk factors and hrHPV infection or cervical lesions. Age-specific hrHPV prevalence, partial HPV16/18 genotyping, and abnormal cytology rates were further analyzed by HIV status. **Results**: The mean age was 43.0±8.6 years. The hrHPV prevalence was 28%, higher in HIV-positive (46.8%) than HIV-negative (23.8%) women. Non-16/18 hrHPV types predominated across all ages. VIA positivity was 11.1%, mostly involving <75% cervical area, and was more frequent in younger (30–45 years) and HIV-positive women. Older age (OR 0.98, 95% CI 0.97–1.00, p=0.017) and higher parity (≥3 vs nulliparous: OR 0.58, 95% CI 0.36–0.94, p=0.029) showed protective effects against hrHPV infection. Contraceptive use (OR 1.65, 95% CI 1.15–2.38, p=0.007) and partially/non-visible SCJ (OR 2.88, 95% CI 1.74–4.79, p<0.001) were associated with VIA positivity. **Conclusions:** hrHPV infection and cervical lesions were more frequent in younger and HIV-positive women, highlighting the need for strengthened targeted screening within HIV care services in Mozambique.

Keywords: women; HPV; cervical cancer; risk factors; human immunodeficiency virus

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1. Introduction

Human papillomavirus (HPV) is one of the most common sexually transmitted infection (STI) worldwide [1,2]. Infections with HPV have a high negative impact on women social life in Sub-Saharan Africa, as they are responsible for a significant proportion (ranging from 20% to 26%), of all cancers diagnosed [3], mainly cervical cancer (CC) – the most common female cancer and leading cause of morbidity and mortality in the region [4,5].

Genital infection with HPV is substantial high during the individuals lifetime, with an estimated risk of 60%–84.6% among sexually active women; howevwer, without necessarily developing any symptoms [1,6]. Most (80-90%) of these infections are cleared spontaneously within 12–24 months [7], some, particularly by oncogenic types – well known as high-risk HPV (hrHPV), persist and induce the development of premalignant lesions and CC over time [5,7,8]. To date, the hrHPV include fifteen genotypes (HPV 16, 18, 31, 33, 35, 39, 45, 51, 52, 56, 58, 59, 68, 73, and 82), classified as oncogenic, and three genotypes (HPV 26, 53, and 66), considered probably carcinogenic [9,10].

HPV infection varies depending on whether it is estimated in the open population or in sites with case concentration, and influenced by different factors, leading to different prevalence patterns in different areas. The worldwide prevalence of HPV infection in women with no cervical abnormalities is 11%–12%, with higher age-standardized rates in sub-Saharan Africa (24%), compared to other region (16%-21%)[1,2]. The most significant factor for the prevalence patterns of HPV infection and CC disease is immunodeficiency [11]; hence, women living with HIV are at a disproportionate risk of acquiring HPV infections, harbouring multiple HPV infections, and developing persistent hrHPV infections that results in a six times likehood of developing premalignant lesions and CC [11–13]. On the other hand, the exposure and acquisition of HPV infection relay primarly on sexual lifestyle-related factors, including early age of sexual debut, the number of lifetime sexual partners, history of STIs, and others. Besides these, other factors such as smoking, diet/malnutrition, parity, use of hormonal contraceptives, alcohol consumption, and concomitant STIs (specially *Chlamydia trachomatis*, *Neisseria gonorrhoeae*, *Mycoplasma* spp, and Herpes virus), have been associated, beyond the acquisition of the infection, with a higher probability of hrHPV persistence, and further development of premalignant lesions and CC [14–16]. Additionally, an older age, lower socioeconomic and educational status [17–19] have also been associated with an increased risk of disease in HPV-seropositive women.

Mozambique is among the countries with a heavy burden of HPV infection, HIV, and cervical cancer [11,20]. The prevalence of HPV infection among Mozambican women is alarmingly high, with studies indicating significant rates of hrHPV (HPV 16, 18, 31, 33, 35, 45, 51, 52, and 58), either among women with normal cytology (1) or among those diagnosed with cervical precancerous lesions and cancer; varying from 20% to 75.9% [21–26]. Every year, more than 5300 cervical cancer new cases and more than 3800 deaths are registered [20], affecting particularly women living with HIV/AIDS [27,28]. It is estimated that in the general population, around 8.6% of Mozambican women of reproductive age (>18 years old) have had a cervical hrHPV infection at some point in their lives, with HPV types 16 and 18 accounting for over 51.0% of invasive cervical cancer cases [20,29].

In the overall picture of HPV infection and CC incidence in Mozambique, the key contributing factors include the high rates of HIV infection (between 15.1%–26.6%) among sexually active women or those of reproductive age [30,31], and the strikingly low availability and uptake of annual cervical cancer screening [28,32]. Meanwhile, although the prevalence and distribution of HPV genotypes in Mozambique have been considerably elucidated, little is known about age-related differences and the sociodemographic, lifestyle, and gynecological factors associated with hrHPV infection and cervical lesions within the context of HIV care in the country.

Knowledge of risk factors, combined with early detection of high-risk HPV infection and precancerous lesions, provides essential information for identifying at-risk populations and preventing CC [7,33,34]. In this study, we present the age-specific distribution and factors associated with high-risk HPV infection and cervical lesions, stratified by HIV status, among Mozambican

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women. The objective was to identify determinants of hrHPV infection and cervical abnormalities to inform the implementation of HPV-based screening programs in Mozambique [28,35,36].

2. Material and Methods

2.1. Study Design, Participants and Ethical Approval

This is a cross-sectional study in wich we analysed data of 1248 women aged over 18 years who were recruited and screening for hrHPV during a larger research project named HPV innovative screening approach (HPV-ISI), that took place at DREAM Sant'Egidio health center in Zimpeto, Maputo, Mozambique [26]. The DREAM Sant'Egidio health center is an HIV-focused primary care facility affiliated within the DREAM program, a health initiative run by the Community of Sant'Egidio across 11 African countries and providing care to over 500,000 patients. This program implements multiple health projects in sub-Saharan Africa, serving as a model for addressing diverse health challenges and is actively engaged in laboratory research [26,37–41]. *At the* DREAM Sant'Egidio health center cervical cancer (CC) screening is routinely conducted for a mix of women living in urban and rural settings, using a combined visual inspection with acetic acid (VIA)–hrHPV testing approach.

The HPV-ISI research project was conducted between July 2021 and May 2022 , and evaluated the feasibility of hrHPV DNA testing compared to the screen-and-treat visual inspection with acetic acid (VIA) approach (VIA was used as a screen and not as a triage for hrHPV-positive women) (26), preceding the launch of national pilot program of hrHPV screen, triage and/or treat in Mozambique, introduced in 2023 [42].

Figure 1 ilustrates the flow diagram of women screened and included in the study analysis. Approximately 1,323 women aged over 18 years were voluntarily recruited from within the DREAM program HIV care health centers, as well as referred from other public health facilities in Maputo region. Of these total hrHPV screeneed women, 1,248 were elegible and included in this study (n=75 were excluded). The inclusion criteria were: (1) women aged ≥18 years old, with known results for genital hrHPV infection and VIA (visual inspection with acetic acid); and (2) women who were not pregnant. Exclusion criteria were: (1) women with missing data in more than three study data and variables (Table 1); and (2) women with an indeterminate or invalid result for genital high-risk HPV infection. All the women willing to participate freely signed informed consent. We have obtained approval from the Mozambican National ethical committee (ref. 688/CNBS/20) and from the Institutional Health Bioethics Committee of the Faculty of Medicine, Eduardo Mondlane University, and Maputo Central Hospital (ref. CIBS FM&HCM/019/2023). All data were anonymized with a numerical code before creating the database for the study.

Table 1. Participants data and variables analysed in this study.

	Group	Variables
Factors	Sociodemographic	Healthcare referral facility; Age (years; ≤29, 30-45, ≥46; ≤24, 25-29, 30-35, 36-40, 41-45, 46-50, 51-55, 56-60, ≥61).
	Sexual and lifestyle behavior	Age at first intercourse - sexual debut [years; ≤17 (adolescent), 18-25 (young), ≥26 (adult)]; Use of contraceptives [no/yes (condom use, oral pills, intrauterine device, implant, injectable, other); smoking habit (no/yes).
	Clinical, gynecological and reproductive history	HIV status (negative/positive); Screening or consultations history (1st/Follow-up 1 year/ Follow-up 3 year); Pregnancies history (number; nulligravida, 1-2, ≥3); Full-term pregnancies or deliveries history (number; nulliparous, 1-2, ≥3); History of STI or vaginal descharge (yes/no); Close family/relative with history of cervical cancer (yes/no); Gynecological findings [vaginal/uterus related (normal/abdnormal - cervicitis,

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		bleeding, condylomas, polyps, others); SCJ related (Totally visible/Partially or not visible)].
Main outcomes	Clinical-laboratory	VIA result [negative/positive (<75%; ≥75% or worse)]; hrHPV result [negative/positive (HPV-16, HPV-18 and Other hrHPV)

HIV – human immunodeficiency virus; STI – sexually transmitted infections; SCJ – squamocolumnar junction; VIA – visual inspection with acetic acid; hrHPV – high-risk human Papilomavirus.

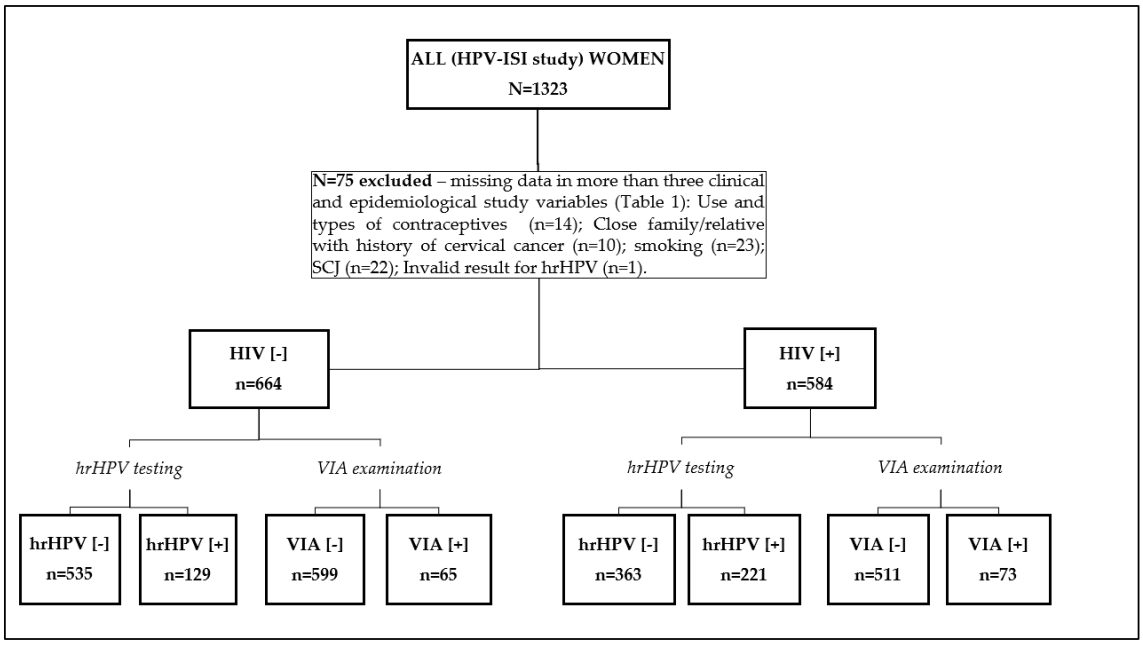

Figure 1. Consort flow diagram of women screened and included in the study analysis. HIV – human immunodeficiency virus; SCJ – squamocolumnar junction; VIA – visual inspection with acetic acid; hrHPV – high-risk human Papilomavirus; [-] Negative results; [+] Positive results.

2.2. Data Collection, Samples and Screening Tests

In this study, the outcome variables of interest were hrHPV and VIA cervical screening results of the participants. We considered as potential factors, the variables (Table 1) found to be related to testing hrHPV and VIA positive in previous studies or otherwise biologically plausible.

In summary, to obtain the data used in this study, all participants responded a brief routine structured questionnaire that included questions on sociodemographic information, lifestyle, sexual and reproductive behavior, and clinical data (Table 1). After the brief questionnaire, a cervical sample was collected and placed into a 20 mL Liquid Media (Roche Cell Collection Medium), and then sent to the local Molecular laboratory for hrHPV-DNA testing. After sampling for HPV testing women were screened with the current national recommendations based on VIA [43]. For all VIA-positive cases, a digital colposcopy (DC) was performed for lesion confirmation. Cryotherapy was subsequently performed on-site if VIA tested positive with lesions <75% of the cervix; and Women with confirmed for major lesions were referred for biopsy.

The hrHPV testing was performed using the Cobas HPV DNA test, in the Cobas 4800 system (Roche Molecular Systems). The Cobas® 4800 HPV DNA test is a qualitative assay that allows the detection of 14 hrHPV types by polymerase chain reaction (PCR) and nucleic acid hybridization, giving a partial genotyping by separately identifying HPV16 and HPV18, and 12 other hrHPV types (including HPV types 31, 33, 35, 39, 45, 51, 52, 56, 58, 59, 66, and 68) “pooled” in the same channel. The assay utilizes a human beta-globin gene as internal control to assess the quality of the sampling and the efficiency of the PCR amplification. If internal control was not amplified, samples were referred as invalid. Only samples with a valid test result on Cobas 4800 were included in the analysis of this study.

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2.3. Statistical Analyses

Data were analyzed using STATA 15.1 (StataCorp LP, College Station, TX – USA, 2017). Descriptive analyses including means, standard deviations, and interquartile ranges were performed for continuous variables, and the number and percentages for categorical variables. The detection results of hrHPV by participants characteristics were stratified according to HIV status and by VIA results. A *t* test was used to assess the statistical differences of continuous variables across different hrHPV and VIA groups, acording to HIV status. Chi-square tests assessed the association of categorical variables with hrHPV and VIA results, acording to HIV status. Variables with frequency of less than 5 values were evaluated with Fischer´s exact test. Statistically significant ($p<0.05$) variables for hrHPV and VIA results were considered for logistic regression analysis. Odds Ratios (OR) and 95% confidence intervals (95% CI) were calculated as indicators of the magnitude of association and statistical significance of hrHPV and VIA results.

3. Results

3.1. Characteristics of Participants

Characteristic of study population (N=1,248) analyzed in this study are shown in Table 2. The majority (84.3%) were recruited within the study site – DREAM Sant'Egidio health center, while smaller proportions were referred from DREAM centers, Machava (10.9%), Consolata/Criança (3.7%) and Matola-II (0.9%), and other health facilities external to the DREAM program (0.2%).

The mean age of the participants was 43.0±8.6 years (range, 18–72 years); the age group with the highest number of subjects (16.3%) was 30-45 years (with the majority being between 41-45 years). Regarding screening history, nearly three-quarters (74%) were screened for the first time, in comparison to other screening types. The mean age at sexual debut was 17.5 years, with over half (53.4%) reporting initiation at ≤17 years. Most women were multiparous: 77.2% had ≥3 pregnancies and 63.5% had ≥3 deliveries, while nulligravidity and nulliparity were relatively small (4.0% and 6.2%, respectively).

Concerning reproductive and lifestyle characteristics, 32.9% reported irregular menstrual cycles, and 29.9% used contraceptives, mainly oral pills (9.4%), implants (6.7%), and injectables (6.1%). Family history of cervical cancer was uncommon (1.2%), and smoking was virtually absent (0.1%). A small proportion reported prior STIs or vaginal discharge (7.9%). Gynecological examination showed abnormalities in 8.1% of cases, while the SCJ was visible in 92.4%. VIA testing yielded 11.1% positive results, with most lesions involving <75% of the cervix. The prevalence of hrHPV infection was 28%.

Table 2. Characteristics of study population.

Characteristic varables	Frequency	
	n	%
Health center of provenance		-
DREAM Sant'Egidio	1052	84.3
DREAM Consolata/Criança	46	3.7
DREAM Machava	136	10.9
DREAM Matola-II	11	0.9
Other – external to DREAM	3	0,2
Age (years), mean±SD	43.0±8.6	–
Age category (years)		
≤29	56	4.5
30-45	700	56.1
≥46	492	39.4
Screening type*		
First time	924	74
1 year follow-up	272	21.8

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3 year follow-up	52	4.2
Age at sexual debut (years), mean±SD	17.5±2.4	–
Age at sexual debut (years)		
≤17 (adolescent)	666	53.4
18-25 (young)	577	46.2
≥26 (adult)	5	0.4
Number of pregnancy, mean±SD	4.1±2.1	–
Number of pregnancy		
Nulligravida	52	4.2
1-2	233	18.7
≥3	963	77.1
Number of deliveries, mean±SD	3.2±1.9	–
Number of deliveries		
Nulliparous	77	6.2
1-2	379	30.4
≥3	792	63.4
Menstrual cycle, n (%)		
Normal (regular)	838	67.1
Abdnormal (irregular)	410	32.9
Use of contraceptives		
No	875	70.1
Yes**	373	29.9
Condom	31	2.5
Oral pills	117	9.4
IUD	28	2.2
Implant	84	6.7
Injectable	76	6.1
Other type	16	1.3
Not declared	21	1.7
Family history of CC		
No	1207	96.7
Yes	15	1.2
Don't know	26	2.1
Smoking (or ever smoked)		
No	1164	93.3
Yes	1	0.1
Not declared	83	6.6
Previous STI/Vaginal discharge		
No	1149	92.1
Yes	99	7.9
Gynecological findings – vaginal/uterus		
Normal	1147	91.9
Abdormal***	101	8.1
Gynecological findings – SCJ		
Totally visible	1153	92.4
Partially/Not visible	95	7.6
VIA result		
Negative	1110	88.9
Positive	138	11.1
<75%	125	10.1
≥75%	13	1.0
hrHPV result		
Negative	898	72.0

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	Positive	350	28.0

*VIA (Visual Inspection with Acetic Acid)-based screening; **Contraceptives types frequently used – ; ***Includes cervicitis, bleeding, condylomas, polyps, others; IUD – intrauterine device; CC – cervical cancer; SCJ – squamocolumnar junction; STI – Sexually transmitted infections (self-reported – last 3 months).

3.2. Distribution of hrHPV and VIA Results by Participants Characteristics and According to HIV Status

Tables 3 and 4 summarize the participants characteristics by hrHPV status and VIA results in HIV-positive [+] and HIV-negative [-] women, respectively. Women with hrHPV positivity [+] (Tables 3) were slightly younger than those who tested negative (mean age 42.0 vs. 43.3 years, p=0.013), a difference that was particularly evident among HIV [-] women (p<0.001). Stratification by age groups showed higher hrHPV prevalence among women aged 30-45 years (16.5%) and ≥46 years (9.9%), compared to those ≤29 years (1.7%). Screening history also influenced hrHPV detection, with first-time attendees more frequently hrHPV [+] than those at follow-up (p=0.038).

Reproductive history revealed significant associations. Women with hrHPV [+] were more likely to be nulligravida (p=0.038) or have had one to two deliveries (p=0.046), particularly among HIV [-] participants (p=0.013 and p=0.017, respectively). In contrast, age at sexual debut, number of pregnancies, contraceptive use, menstrual regularity, and family history of cervical cancer did not show significant associations with hrHPV. Finally, gynecological abnormalities of the vagina or uterus were more common in hrHPV [+] women (3.1% vs. 5.0%, p=0.020), while visibility of the squamocolumnar junction and prior STI history were not significantly related (Tables 3).

Regarding the VIA results, women with VIA-positive [+] results were significantly younger than VIA-negative [-] women (mean age 38.9 vs. 43.5 years, p<0.001). This trend was consistent across both HIV [+] and HIV [-] groups. The highest VIA [+] was observed among women aged 30-45 years, while those ≥46 years were more often VIA negative (p<0.001). Screening type showed no significant differences, although most VIA [+] cases were detected during first-time screening (Tables 4).

Reproductive factors showed mixed associations. VIA [+] women had slightly fewer pregnancies and deliveries on average, but only parity was marginally associated, with nulliparous women less likely to test VIA [+] (p=0.036). Age at sexual debut, family history of cervical cancer, and reported STI/vaginal discharge were not significantly related to VIA results (Table 4). Contraceptive use showed an interesting pattern: women not using contraceptives had higher VIA [+] compared to users, particularly among HIV [-] women (p=0.007). Menstrual cycle regularity, smoking history, and gynecological findings of the vagina/uterus were not significant predictors. However, visibility of the SCJ was strongly associated with VIA results, especially among HIV [+] women (p<0.001).

Table 3. Distribution of hrHPV results by participants characteristics and according to HIV status.

Varables	All			HIV-positive (+)			HIV-negative (-)		
	hrHPV (+)	**hrHPV (-)**	***P* value**	**hrHPV (+)**	**hrHPV (-)**	***P* value**	**hrHPV (+)**	**hrHPV (-)**	***P* value**
Age (years), mean±SD	42.0±8.9	43.3±8.0	**0.013**[a]	43.3±8.1	42.9±7.4	0.540	39.9±9.9	43.6±9.1	**<0.001**[a]
Age category (years), n (%)									
≤29	21 (1.7)	35 (2.8)		5 (0.9)	7 (1.2)		16 (2.4)	28 (4.2)	
30-45	206 (16.5)	494 (39.6)	0.067	132 (22.6)	228 (39.0)	0.751	74 (11.1)	266 (40.1)	**<0.001**[a]
≥46	123 (9.9)	369 (29.6)		84 (14.4)	128 (21.9)		39 (5.9)	241 (36.3)	
Screening type*, n (%)									
First time	259 (20.8)	665 (53.3)		151 (25.9)	229 (39.2)		108 (16.3)	436 (65.7)	
1 year follow-up	84 (6.7)	188 (15.1)	**0.038**[a]	70 (12.0)	133 (22.8)	0.339	14 (2.1)	55 (8.3)	0.561
3 year follow-up	7 (0.6)	45 (3.6)		0 (0.0)	1 (0.2)		7 (1.1)	44 (6.6)	
Age at sexual debut (years), mean±SD	17.5±2.7	17.6±2.3	0.512	17.3±2.7	17.4±2.2	0.626	17.7±2.7	17.7±2.4	1.00

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Age at sexual debut (years), n (%)									
≤17 (adolescent)	197 (15.8)	469 (37.6)		128 (21.9)	202 (34.6)		69 (10.4)	267 (40.2)	
18-25 (young)	150 (12.0)	427 (34.2)	0.105	91 (15.6)	160 (27.4)	0.483	59 (8.9)	267 (40.2)	0.401
≥26 (adult)	3 (0.2)	2 (0.2)		2 (0.3)	1 (0.2)		1 (0.2)	1 (0.2)	
Number of pregnancy, mean±SD	4.0±2.2	4.1±2.1	0.456	3.9±2.0	4.0±2.0	0.558	4.2±2.5	4.2±2.1	1.00
Number of pregnancy, n (%)									
Nulligravida	23 (1.8)	29 (2.2)		10 (1.7)	10 (1.7)		12 (1.8)	18 (2.7)	
1-2	65 (5.2)	168 (13.5)	**0.038**[a]	47 (8.1)	80 (13.7)	0.524	18 (2.7)	88 (13.3)	**0.013**[a]
≥3	263 (21.1)	700 (56.2)		164 (28.2)	271 (46.6)		99 (14.9)	429 (64.6)	
Number of deliveries, mean±SD	3.2±2.0	3.3±1.8	0.393	3.1±1.9	3.1±1.7	1.00	3.3±2.2	3.4±1.8	0.589
Number of deliveries, n (%)									
Nulliparous	29 (2.3)	48 (3.8)		15 (2.6)	24 (4.1)		14 (2.1)	24 (3.6)	
1-2	115 (9.2)	264 (21.2)	**0.046**[a]	78 (13.4)	115 (19.7)	0.645	37 (5.6)	149 (22.4)	**0.017**[a]
≥3	206 (16.5)	586 (47.0)		128 (21.9)	224 (38.4)		78 (11.7)	362 (54.5)	
Menstrual cycle, n (%)									
Normal (regular)	239 (19.2)	599 (48.0)	0.639	152 (26.0)	256 (43.8)	0.710	87 (13.1)	343 (51.7)	0.538
Abdnormal (irregular)	111 (8.9)	299 (24.0)		69 (11.8)	107 (18.3)		42 (6.3)	192 (28.9)	
Use of contraceptives, n (%)									
No	244 (19.5)	631 (50.6)	0.891	165 (28.3)	259 (44.3)	0.339	79 (11.9)	372 (56.1)	0.075
Yes**	106 (8.5)	267 (21.4)		56 (9.6)	104 (17.8)		50 (7.5)	163 (24.5)	
Condom	11 (0.9)	20 (1.6)		8 (1.4)	11 (1.9)		3 (0.5)	9 (1.4)	
Oral pills	32 (2.6)	85 (6.8)		12 (2.1)	27 (4.6)		20 (3.0)	58 (8.7)	
IUD	5 (0.4)	23 (1.8)		1 (0.2)	9 (1.5)		4 (0.6)	14 (2.1)	
Implant	26 (2.1)	58 (4.6)		19 (2.9)	19 (3.3)		9 (1.4)	39 (5.9)	
Injectable	23 (1.8)	53 (4.2)		10 (1.7)	26 (4.5)		13 (2.0)	27 (4.1)	
Other type	4 (0.3)	12 (1.0)		4 (0.7)	6 (1.0)		0 (0.0)	6 (0.9)	
Not declared	5 (0.4)	16 (1.3)		4 (0.7)	6 (1.0)		1 (0.2)	10 (1.5)	
Family history of CC, n (%)									
No	337 (27.0)	870 (69.7)	0.389	212 (36.3)	347 (59.4)	0.698	125 (18.8)	523 (78.8)	0.687
Yes	3 (0.2)	12 (1.0)		1 (0.2)	4 (0.7)		2 (0.3)	8 (1.2)	
Don't know	10 (0.8)	16 (1.3)		8 (1.4)	12 (2.1)		2 (0.3)	4 (0.6)	
Smoking (or ever smoked), n (%)									
No	326 (26.1)	838 (67.1)	0.276	203 (34.8)	333 (57.0)	0.428	123 (18.5)	505 (76.1)	0.829
Yes	1 (0.2)	0 (0.0)		1 (0.2)	0 (0.0)		0 (0.0)	0 (0.0)	
Not declared	23 (1.8)	60 (4.8)		17 (2.9)	30 (5.1)		6 (0.9)	30 (4.5)	
Previous STI/Vaginal discharge, n (%)									
No	318 (25.5)	831 (66.6)	0.351	199 (34.1)	331 (56.7)	0.660	119 (17.9)	500 (75.3)	0.696
Yes	32 (2.6)	67 (5.4)		22 (3.8)	32 (5.5)		10 (1.5)	35 (5.3)	
Gynecological findings – vaginal/uterus, n (%)									
Normal	311 (24.9)	836 (67.0)	**0.020**[a]	195 (33.4)	330 (56.5)	0.323	116 (17.5)	506 (76.1)	0.067
Abdormal***	39 (3.1)	62 (5.0)		26 (4.5)	33 (5.7)		13 (2.0)	29 (4.4)	

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Gynecological findings – SCJ, n (%)									
Totally visible	320 (25.6)	833 (66.7)	0.409	201 (34.4)	341 (58.4)	0.189	119 (17.9)	492 (74.1)	1.00
Partially/Not visible	30 (2.4)	65 (5.3)		20 (3.4)	22 (3.8)		10 (1.5)	43 (6.5)	

Pearson chi-square/Fisher exct tests for categorical variables and *t* test for continous; (a) statistically significant ($p < 0.05$); * VIA (Visual Inspection with Acetic Acid)-based screening; **Contraceptives types frequently used; ***Includes cervicitis, bleeding, condylomas, polyps, others; IUD – intrauterine device; CC – cervical cancer; SCJ – squamocolumnar junction; SD – standard deviation; STI – Sexually transmitted infections (self-reported – last 3 months).

Table 4. Distribution of VIA results by participants characteristics and according to HIV status.

Varables	All			HIV-positive (+)			HIV-negative (-)		
	VIA (+)	VIA (-)	*P* value	VIA (+)	VIA (-)	*P* value	VIA (+)	VIA (-)	*P* value
Age (years), mean±SD	38.9±7.9	43.5±8.5	**<0.001**[a]	39.6±8.1	43.6±7.5	**<0.001**[a]	38.1±7.8	43.4±9.3	**<0.001**[a]
Age category (years), n (%)									
≤29	14 (1.1)	42 (3.4)		7 (1.2)	5 (0.9)		7 (1.1)	37 (5.6)	
30-45	95 (7.6)	605 (48.5)	**<0.001**[a]	49 (8.4)	311 (53.3)	**<0.001**[a]	46 (6.9)	294 (44.3)	**<0.001**[a]
≥46	29 (2.3)	463 (37.1)		17 (2.9)	195 (33.4)		12 (1.8)	268 (40.4)	
Screening type, n (%)									
First time	112 (9.0)	812 (65.1)		54 (9.4)	326 (55.8)		58 (8.7)	486 (73.2)	
1 year follow-up	24 (1.9)	248 (19.9)	0.075	19 (3.3)	184 (31.5)	0.224	5 (0.9)	64 (9.6)	0.227
3 year follow-up	2 (0.2)	50 (4.0)		0 (0.0)	1 (0.2)		2 (0.3)	49 (7.4)	
Age at sexual debut (years), mean±SD	17.3±2.7	17.6±2.4	0.213	17.2±1.6	17.4±2.5	0.507	17.3±3.5	17.7±2.3	0.210
Age at sexual debut (years), n (%)									
≤17 (adolescent)	81 (6.5)	585 (46.9)		40 (6.8)	290 (49.7)		41 (6.2)	295 (44.4)	
18-25 (young)	56 (4.5)	521 (41.7)	0.316	33 (5.7)	218 (37.3)	0.753	23 (3.5)	303 (45.6)	**0.013**[a]
≥26 (adult)	1 (0.1)	4 (0.3)		0 (0.0)	3 (0.5)		1 (0.2)	1 (0.2)	
Number of pregnancy, mean±SD	3.8±1.8	4.1±2.1	0.070	3.7±1.7	4.0±2.0	0.223	4.0±2.0	4.2±2.2	0.483
Number of pregnancy, n (%)									
Nulligravida	4 (0.3)	46 (3.7)		2 (0.3)	18 (3.1)		2 (0.3)	28 (4.2)	
1-2	26 (2.1)	207 (16.6)	0.778	17 (2.9)	110 (18.9)	0.902	9 (1.4)	97 (14.2)	0.723
≥3	108 (8.7)	855 (68.6)		54 (9.3)	381 (65.5)		54 (8.1)	474 (71.4)	
Number of deliveries, mean±SD	3.0±1.7	3.3±1.8	0.052	2.9±1.7	3.1±1.8	0.372	3.1±1.7	3.4±1.9	0.223
Number of deliveries, n (%)									
Nulliparous	8 (0.6)	69 (5.5)		4 (0.7)	35 (6.0)		4 (0.6)	34 (5.1)	
1-2	55 (4.4)	324 (26.0)	**0.036**[a]	33 (5.7)	160 (27.4)	0.062	22 (3.3)	164 (24.7)	0.515
≥3	75 (6.0)	717 (57.5)		36 (6.2)	316 (54.1)		39 (5.9)	401 (60.4)	
Menstrual cycle, n (%)									
Normal (regular)	89 (7.1)	749 (60.0)	0.502	52 (8.9)	356 (61.0)	0.892	37 (5.6)	393 (59.2)	0.173
Abdnormal (irregular)	49 (3.9)	361 (28.9)		21 (3.6)	155 (26.5)		28 (4.2)	206 (31.0)	
Use of contraceptives, n (%)									
No	83 (6.7)	792 (63.4)	**0.008**[a]	49 (8.4)	375 (64.2)	0.264	34 (5.1)	417 (62.8)	**0.007**[a]
Yes*	55 (4.4)	318 (25.5)		24 (4.1)	136 (23.3)		31 (4.7)	182 (27.4)	
Condom	2 (0.2)	29 (2.3)		0 (0.0)	19 (3.3)		2 (0.3)	10 (1.5)	
Oral pills	18 (1.4)	99 (7.9)		6 (1.0)	33 (5.7)		12 (1.8)	66 (9.9)	
IUD	5 (0.4)	23 (1.8)		1 (0.2)	9 (1.5)		4 (0.6)	14 (2.1)	
Implant	14 (1.1)	70 (5.6)		5 (0.9)	31 (5.3)		9 (1.4)	39 (5.9)	
Injectable	11 (0.9)	65 (5.2)		7 (1.2)	29 (5.0)		4 (0.6)	36 (5.4)	
Other type	2 (0.2)	14 (1.1)		2 (0.3)	8 (1.4)		0 (0.0)	6 (0.9)	
Not declared	3 (0.2)	18 (1.4)		3 (0.5)	7 (1.2)		0 (0.0)	11 (1.7)	
Family history of CC, n (%)									
No	134 (10.7)	1073 (86.0)	0.307	70 (12.0)	489 (83.7)	0.661	64 (9.6)	584 (88.0)	0.494
Yes	0 (0.0)	15 (1.2)		0 (0.0)	5 (0.9)		0 (0.0)	10 (1.5)	
Don't know	4 (0.3)	22 (1.8)		3 (0.5)	17 (2.9)		1 (0.2)	5 (0.8)	
Smoking (or ever smoked), n (%)									
No	129 (10.3)	1035 (82.9)	0.216	68 (11.6)	468 (80.1)	0.857	61 (9.2)	567 (85.4)	0.772
Yes	1 (0.1)	1 (0.2)		0 (0.0)	1 (0.2)		0 (0.0)	0 (0.0)	
Not declared	9 (0.7)	74 (5.9)		5 (0.9)	42 (7.2)		4 (0.6)	32 (4.8)	

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Previous STI/Vaginal discharge, n (%)									
No	124 (9.9)	1025 (82.1)	0.190	66 (11.3)	464 (79.5)	0.831	58 (8.7)	561 (84.5)	0.315
Yes	14 (1.1)	85 (6.4)		7 (1.2)	47 (8.0)		7 (1.1)	38 (5.7)	
Gynecological findings – vaginal/uterus, n (%)									
Normal	123 (9.9)	1024 (82.0)	0.244	64 (11.0)	461 (78.9)	0.532	59 (8.9)	563 (84.8)	0.287
Abdormal**	15 (1.2)	86 (6.9)		9 (1.5)	50 (8.6)		6 (0.9)	36 (5.4)	
Gynecological findings – SCJ, n (%)									
Totally visible	115 (9.2)	1038 (83.2)	**<0.001**[a]	58 (9.9)	484 (82.9)	**<0.001**[a]	57 (8.6)	554 (83.4)	0.223
Partially/Not visible	13 (1.8)	72 (5.8)		15 (2.6)	27 (4.6)		8 (1.2)	45 (6.8)	

Pearson chi-square/Fisher exct tests for categorical variables and *t* test for continous; (a) statistically significant ($p < 0.05$); *Contraceptives types frequently used; **Includes cervicitis, bleeding, condylomas, polyps, others; VIA – Visual Inspection with Acetic Acid; IUD – intrauterine device; CC – cervical cancer; SCJ – squamocolumnar junction; SD – standard deviation; STI – Sexually transmitted infections (self-reported – last 3 months).

3.3. Overall Prevalence of hrHPV Types According to HIV Status and Its Age-Specific Distribution

Figures 3 and 4 shows the distribution of hrHPV types (HPV-16, HPV-18, and non-16/18 types) in single and multiple infections according to HIV status and age groups, respectively. Among HIV [-] women, hrHPV types other than HPV-16/18 were most common (17.0%), mainly as single infections (14.2%) and less as multiple (2.8%). HPV-16 and HPV-18 were less frequent, up to 3.6% and 2.0%, respectively. In HIV [+] women, hrHPV prevalence was higher, especially non-16/18 types (31.8%), with 23.8% single and 8.0% multiple infections. HPV-16 (9.4%) and HPV-18 (5.6%) were also more frequent than in HIV [-]. Overall, hrHPV detection was greater among HIV [+] women, but the difference compared to HIV [-] did not reach statistical significance (p=0.082) (Figure 3).

The distribution of hrHPV types across different age groups, shows the non-16/18 types being more consistently frequent across age categories compared with HPV-16 and HPV-18. Younger women (≤24 and 25-29 years) showed higher proportions of multiple infections, especially with non-16/18 hrHPV types. In older age groups (≥46 years), single infections predominate, particularly for hrHPV non-16/18 types. HPV-16 and HPV-18 remained relatively infrequent across all ages. No statistically significant age-related differences were observed (p=0.106) (Figure 4).

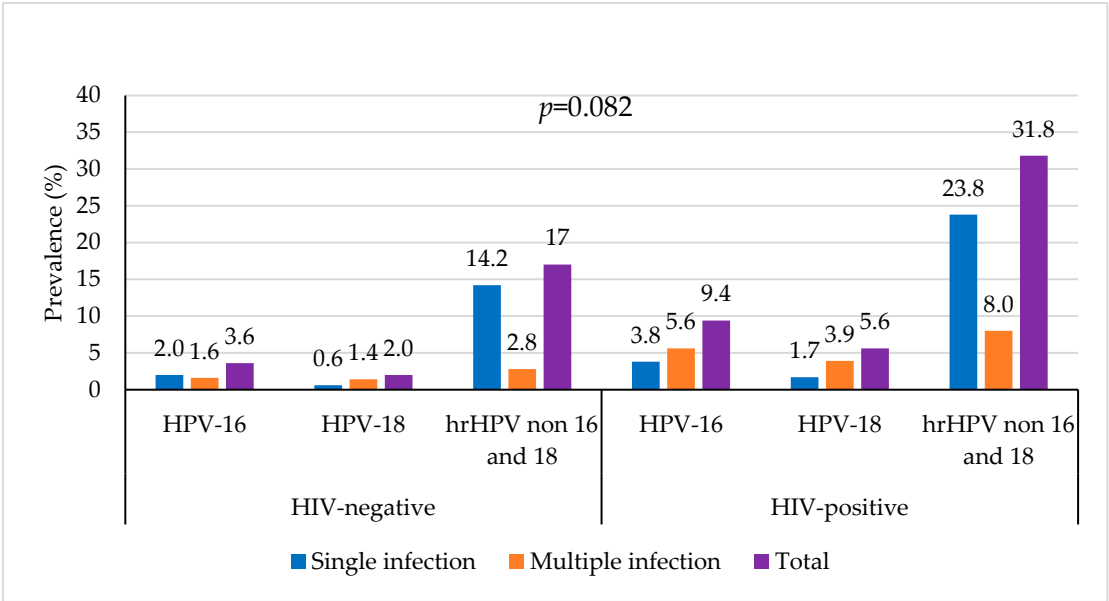

Figure 3. Distribution of high-risk HPV detection in single and multiple infection, according to HIV status. *Bar graph colors:* single (blue), multiple (orange), total (purple/violet).

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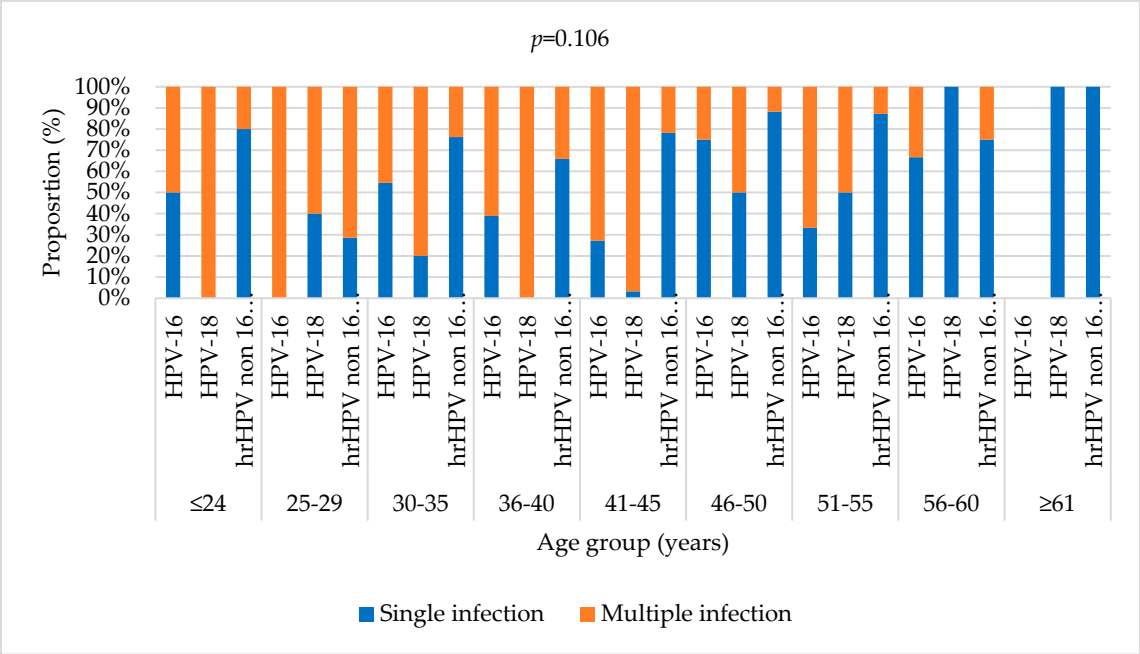

Figure 4. Age-specific distribution of high-risk HPV detection in single and multiple infection. Múltiple infection is defined as co-infection by two or tree possible detected genotypes (ether HPV-16, HPV-18 and Other hrHPV). *Bar graph colors:* single (blue), multiple (orange).

3.4. Overall Prevalence of Cervical Lesions According to HIV Status and Its Age-Specific Distribution

Figures 5 shows the distribution of cervical lesions across age groups, stratified by HIV status. A statistically significant association between HIV status, VIA positivity [+] type, and age group (p<0.014) was observed. Among HIV [-] women, VIA [+] <75% was observed in 59 cases (8.9% of the total), with the highest frequencies in the 30-40-year age range. VIA [+] ≥75% cases was rare (6 cases, 0.9%). In HIV-positive women, VIA [+] <75% was slightly higher (66 cases, 11.3%), particularly among women aged 36-40 years. VIA [+] ≥75% cases was also more frequent in HIV [+] women (7 cases, 1.2%) compared to HIV [-] women. Overall, VIA [+] was concentrated in younger and middle-aged groups, especially 30-45 years.

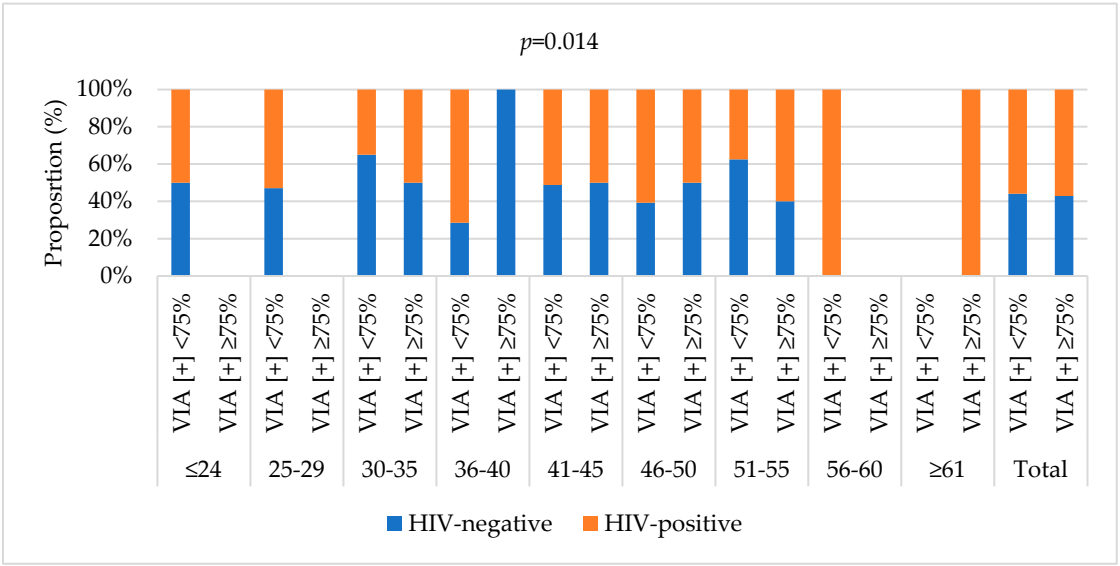

Figure 5. Age-specific distribution of cervical lesions, according to HIV satus. *Bar graph colors:* HIV-negative (blue), HIV-positive (orange).

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3.5. Factors Associated with hrHPV Prevalence and Cervical Lesions

A logistic regression analysis of assessed predictors of hrHPV infection stratified by HIV status showed an association between an increasing age with reduced hrHPV risk (OR=0.98, p=0.017), particularly among HIV [-] women (OR=0.96, p<0.001), but not in HIV [+] women. Compared with women ≤29 years, those ≥46 years had significantly lower hrHPV prevalence overall (OR=0.56, p=0.046) and among HIV [-] women (OR=0.28, p<0.001). A similar protective effect was observed for higher parity: women with ≥3 pregnancies (OR=0.48, p=0.012) or ≥3 deliveries (OR=0.58, p=0.029) had lower odds of hrHPV, especially HIV [-] women. No significant associations were found in HIV [+] women (Table 5).

Regarding the predictors for cervical lesions stratified by HIV status, the logistic regression analysis (Table 6) showed identified age as a strong predictor of VIA [+] result (presence of cervical lesions), with older age associated with lower odds across all groups (OR=0.94, p<0.001). Compared with women ≤29 years, those 30–45 and ≥46 years had reduced VIA positivity, especially in HIV-positive women (OR=0.11 and 0.06, both p<0.001). Number of deliveries showed no significant effect. Contraceptive use was associated with increased VIA [+] result overall (OR=1.65, p=0.007) and particularly among HIV [-] women (OR=2.09, p=0.005). In addition, partially or non-visible SCJ were linked with higher VIA [+] result, notably in HIV [+] women (OR=4.64, p<0.001) (Table 6).

Table 5. Logistic regression analysis for the association between hrHPV results with predictor variables, according to HIV status.

Predictor variables	All		HIV-positive (+)		HIV-negative (-)	
	OR (95%CI)	*P* value	OR (95%CI)	*P* value	OR (95%CI)	*P* value
Age (years)	0.98 (0.97 – 1.00)	**0.017**	1.01 (0.98 – 1.03)	0.662	0.96 (0.94 – 0.98)	**<0.001**
Age category (years)						
≤29			*Reference*			
30-45	0.70 (0.40 – 1.22)	0.207	0.81 (0.25 – 2.60)	0.724	0.49 (0.25 – 0.95)	**0.034**
≥46	0.56 (0.31 – 0.99)	**0.046**	0.92 (0.22 – 2.25)	0.888	0.28 (0.14 – 0.57)	**<0.001**
Screening type						
First time			*Reference*			
1 year follow-up	1.15 (0.85 – 1.54)	0.361	0.80 (0.56 – 1.14)	0.213	1.03 (0.55 – 1.92)	0.932
3 year follow-up	0.40 (0.18 – 0.90)	**0.026**	n/a	n/a	0.64 (0.28 – 1.46)	0.293
Number of pregnancy						
Nulligravida			*Reference*			
1-2	0.49 (0.26 – 0.92)	**0.027**	0.58 (0.23 – 1.52)	0.271	0.31 (0.13 – 0.75)	**0.009**
≥3	0.48 (0.27 – 0.85)	**0.012**	0.61 (0.25 – 1.49)	0.273	0.35 (0.16 – 0.74)	**0.006**
Number of deliveries						
Nulliparous			*Reference*			
1-2	0.72 (0.43 – 1.20)	0.209	1.09 (0.54 – 2.20)	0.820	0.43 (0.20 – 0.90)	**0.026**
≥3	0.58 (0.36 – 0.94)	**0.029**	0.91 (0.46 – 1.81)	0.796	0.37 (0.18 – 0.75)	**0.005**

hrHPV-negative as reference; OR - Odds ratio; CI - Confidence Interval; n/a – not applicable (not possible to estimate).

Table 6. Logistic regression analysis for the association between VIA results with predictor variables, according to HIV status.

Predictor variables	All		HIV-positive (+)		HIV-negative (-)	
	OR (95%CI)	*P* value	OR (95%CI)	*P* value	OR (95%CI)	*P* value
Age (years)	0.94 (0.92 – 0.96)	**<0.001**	0.93 (0.90 – 0.96)	**<0.001**	0.94 (0.91 – 0.97)	**<0.001**
Age category (years)						
≤29			*Reference*			
30-45	0.47 (0.25 – 0.90)	**0.022**	0.11 (0.03 – 0.37)	**<0.001**	0.83 (0.35 – 1.97)	0.667
≥46	0.19 (0.09 – 0.38)	**<0.001**	0.06 (0.02 – 0.22)	**<0.001**	0.24 (0.09 – 0.64)	**0.004**

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Number of deliveries						
Nulliparous	*Reference*					
1-2 1.46 (0.67 – 3.21)	0.342	1.80 (0.60 – 5.42)	0.293	1.14 (0.37 – 3.52)	0.820
≥3 0.90 (0.42 – 1.95)	0.793	1.00 (0.34 – 2.97)	0.995	0.83 (0.28 – 2.45)	0.731
Use of contraceptives						
No	*Reference*					
Yes 1.65 (1.15 – 2.38)	**0.007**	1.35 (0.80 – 2.29)	0.263	2.09 (1.25 – 3.50)	**0.005**
Gynecological findings – SCJ						
Totally visible	*Reference*					
Partially/Not visible 2.88 (1.74 – 4.79)	**<0.001**	4.64 (2.33 – 9.22)	**<0.001**	1.73 (0.78 – 3.85)	0.180

hrHPV-negative as reference; OR - Odds ratio; CI - Confidence Interval; n/a – not applicable (not possible to estimate); SCJ – squamocolumnar junction.

4. Discussion

Cervical cancer (CC) ranks as the most frequent cancer in Mozambique among women of all ages in 2022, accounting for about 20.5% of female cancer cases, according to GLOBOCAN estimates [44,45]. It also remains the leading cause of cancer mortality among Mozambican women [20,45]. High-risk (hr) HPV (persistent) infection is well known as prerequisite factor for the modification of the squamous epithelium and progression to premalignant lesions and cervical cancer (CC) over time [5,7,8].

This study provides important insights into the epidemiology of hrHPV infection and cervical premalignant lesions among women in Mozambique, with particular focus on its age-specific distribution and the associated risk factors, by HIV status. Our findings highlight critical epidemiological patterns that can inform prevention strategies, including screening, integration with HIV services and vaccination.

The mean age of participants (43 years) reflects the typical profile of women attending screening in Mozambique and other sub-Saharan African and worldwide countries, where uptake peaks in mid-adult life [35,46–48]. Nearly three-quarters of women were undergoing screening for the first time, pointing to major gaps in awareness and access. This is consistent with earlier studies in Maputo and Nampula, where first-time screening rates exceeded 60% [22,23]. Such low coverage continues to undermine timely prevention [46,47]

The overall hrHPV prevalence of 28% aligns with prior studies from Mozambique, which reported values between 20% to 75.9% depending on HIV status and age [21–25,49]. Comparable prevalence has been described in sub-Saharan African countries [13], including Nigeria, Rwanda, and Burkina Faso [50–52]. Unlike high-income settings, where hrHPV prevalence declines after age 30 [53,54], our data show higher positivity in older ages, particularly 30-45 and ≥46 years. This supports evidence that HPV is more frequent in African women, influenced by HIV, reproductive history, and limited access to continuous screening [54–56].

HIV was strongly associated with hrHPV infection. HIV-positive women had higher hrHPV prevalence (31.8%) and more frequent multiple infections than HIV-negative counterparts. This agrees with findings from two Systematic Reviews in Sub-Saharan Africa that reported an overall pooled higer prevalence of any HPV or hrHPV/multiple in HIV-positive, compared to HIV-negatives; OR=4.68 (0.71–30.76)] [13] and, OR=3.22 (3.00–3.42) and OR=3.71 (2.39–5.75), p<0.001, respectively [12]. Other studies from Mozambique, Zimbabwe and Kenya, also reported that HIV coinfection was linked to broader hrHPV type distribution and reduced viral clearance [56–58].

Although HPV-16 and 18 remain oncogenically important, non-16/18 hrHPV types predominated in both groups, especially among HIV-positive women. This echoes results from African cohorts [13], including Maputo - Mozambique [14,21,23,58] and Burkina Faso [52], raising implications for vaccination: current vaccines targeting HPV-16/18 may only partially prevent

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cervical cancer in this population. The nonavalent vaccine would offer broader protection, but access remains limited. Interestingly, although HIV-positive women had higher hrHPV prevalence, the difference from HIV-negative women did not reach statistical significance (p=0.082). This borderline finding may reflect sample size limitations, but also suggests that cofactors beyond HIV – such as reproductive history, genital tract inflammation, and sexual behavior – play substantial roles.

Among the factors assessed, age influenced the risk of hrHPV. Logistic regression showed that each additional year of age slightly reduced hrHPV odds, with the protective effect stronger in HIV-negative women. This agrees with evidence from several sub-Saharan African countries [13], including South Africa and Nigeria [50,59], where hrHPV declined after midlife, likely reflecting cumulative immune clearance. Conversely, HIV-positive women may sustain hrHPV well into older ages due to immunosuppression and coinfections, underlining the need for differentiated screening strategies.

Reproductive history also shaped infection risk. Nulligravida and women with 1-2 deliveries showed higher hrHPV positivity, whereas those with three or more deliveries had lower odds. This partly contrasts with global data linking high parity to cervical cancer risk [60]. Similar paradoxical findings in Rwanda [51] and Brazil [61] suggest that immune adaptations during multiple pregnancies may facilitate viral clearance. Clarifying these mechanisms will require more nuanced, longitudinal analyses.

VIA results add further perspective. Overall, 11.1% of women were VIA positive, with slightly higher prevalence among HIV-positive women (11.3% vs 8.9%). Larger lesions (≥75% of cervix) were also more frequent in HIV-positive women. These results are consistent with reports from other African countries, where HIV infection is considered as the most important factor for VIA positivity [56] and CC, with an attributable fraction of 20.4% (vs 1.3% and 1.1%, respectively, in the rest of the world) [60]. Yet, logistic regression revealed that contraceptive use was associated with higher VIA positivity, especially among HIV-negative women, while parity and prior STI history were not significant predictors. This finding contrasts with results from Nigerian and Burkinabé studies, where contraceptive use was not a significant predictor of hrHPV infection [52,55], and with an Ethiopian study that instead identified high parity and a history of STIs as determinants of VIA positivity (AOR = 2.1, 95% CI: 1.3–4.0; AOR = 1.9, 95% CI: 1.1–3.5, respectively) [62]. Possible explanations include hormonal influences on cervical epithelium or confounding by sexual behavior in our sample. Importantly, VIA positivity was strongly associated with poor SCJ visibility, particularly in HIV-positive women, confirming that VIA performance declines when the transformation zone is obscured [14,63]. This reinforces WHO recommendations to prioritize HPV DNA testing, with VIA limited to triage where feasible.

Our results on HPV type distribution underscore a regional pattern. HPV-16 and 18 were present in 9.4% and 5.6% of HIV-positive women, respectively, compared with 3.6% and 2.0% in HIV-negative women. Although modest, these rates are clinically significant, as HPV-16 and 18 account for most cervical cancers globally [14]. However, the predominance of other hrHPV types suggests that current vaccines alone will not eliminate cervical cancer in Mozambique. Expanded use of the nonavalent vaccine would further enhance protection against the circulating type spectrum.

Beyond biological factors, behavioral characteristics also shape risk. The mean sexual debut age (17.5 years) and high multiparity reflects sociocultural patterns consistent with studies in African countries and Mozambique [13,21,22,50]. Early sexual debut increases lifetime HPV exposure [1], while genital tract abnormalities were more frequent in hrHPV-positive women, suggesting that inflammation and STIs facilitate persistence [41,64]. Notably, smoking – a key risk factor in other regions [48,65] – was virtually absent, limiting its role in our cohort. This underlines the context-specific nature of HPV epidemiology in Africa.

This study contributes to understanding the interplay of HIV, hrHPV, and cervical lesions in a high-burden context. While our cross-sectional design limits causal inference, the findings reinforce that HIV-positive women are disproportionately affected by hrHPV and cervical abnormalities, especially from non-16/18 types. VIA alone may be inadequate for this group, given anatomical and

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immunological challenges. Broader vaccine coverage, HPV testing, and integrated HIV–HPV strategies are urgently needed. If scaled up effectively, these interventions could accelerate progress toward WHO's cervical cancer elimination targets in Mozambique and similar settings.

5. Conclusions

This study revealed a 28% prevalence of high-risk HPV (hrHPV) among women in Maputo, with higher rates and multiple infections in HIV-positive participants. Non-16/18 hrHPV types predominated across all ages, particularly among women aged 30–45 years. Younger age, lower parity, and HIV infection were key factors associated with hrHPV positivity, while older age and higher parity showed protective effects. VIA-positive lesions were more frequent in younger and HIV-positive women.

Authors' contributions: AS and CN conceived the idea and had a full role in the conceptualization and design of the study, formal analysis, draft writing, and revision of the manuscript. NC, CM and JS participated in the selection of study population, collection of clinical materials, gynecological examination, and patient care. JSe and ZS carried out HPV genotyping analyses. SC, FC, JSa and MCB participated in the draft writing, analysis of the results, and revision of the manuscript. All authors have read and agreed to the published version of the manuscript.

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Institutional Review Board Statement: The study was conducted in accordance with the Declaration of Helsinki and was approved by the Mozambican National ethical committee (ref. 688/CNBS/20, on December 02, 2020) and from the Institutional Health Bioethics Committee of the Faculty of Medicine, Eduardo Mondlane University, and Maputo Central Hospital (ref. CIBS FM&HCM/019/2023, on March 26, 2024).

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Data Availability Statement: The data that support the findings made in this study can be made available from the corresponding author, A.S., on request.

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