



COURSE: Evidence-Based Approaches to HPV Screening implementation

Module 7. Screening in special populations

Author

Helen Kelly, PhD

Consultant epidemiologist, Department of HIV, Hepatitis and Sexually Transmitted Infections, World Health Organization. Honorary Assistant Professor, London School of Hygiene and Tropical Medicine, United Kingdom


Reviewers

Gary Clifford, PhD

Deputy Branch Head, Early Detection Prevention and Infections, International Agency for Research on Cancer (IARC/WHO).

Philippe Mayaud, MD, Prof

Professor, Department of Clinical Research, London School of Hygiene and Tropical Medicine, United Kingdom.



This module is part of the training course: ***Evidence-Based Approaches to HPV Screening implementation***, developed within the [RISCC](#) project, funded by *European Union's Horizon 2020 research and innovation programme under grant agreement No 847845*.



**Funded by the
European Union**

Views and opinions expressed in this course material are those of the authors and do not necessarily reflect the views of the European Commission. The Commission is not responsible for any use that may be made of the information contained herein.

Copyright and License

© 2025 RISCC project consortium (EU Horizon 2020 grant number 847845).

This material is part of the course "*Evidence-Based Approaches to HPV Screening Implementation*," developed collaboratively by the partners of the RISCC project. It is licensed under a Creative Commons Attribution-NonCommercial-ShareAlike 4.0 International License (CC BY-NC-SA 4.0).

CONTENTS

Contents	3
Introduction and learning objectives	4
Unit 1. HPV and cervical cancer in women living with HIV and other immunosuppressed women	5
Unit 2. Women living with HIV	6
2.1 Epidemiology of HPV and cervical cancer in WLHIV	6
2.2. Screening strategies for WLHIV	12
<i>Visual inspection using acetic acid or Lugol's iodine (VIA/VILI)</i>	12
<i>Cervical cytology</i>	13
<i>HPV DNA tests</i>	13
2.3. Considerations on when to initiate screening and follow-up of WLHIV.....	20
<i>Age to start screening</i>	20
<i>Post-treatment surveillance among WLHIV treated for cervical precancer</i>	21
2.4 Access to screening and integration in HIV care	24
2.5 HPV-associated anal cancer and precancer in WLHIV	27
Unit 3. Epidemiology of HPV & cervical cancer in immunosuppressed women not HIV-infected	30
Summary	33
Bibliography	34



INTRODUCTION AND LEARNING OBJECTIVES

Women living with HIV (WLHIV) and immunosuppressed women who are not HIV-infected, including women with solid organ transplant, hematopoietic stem cell transplant, and autoimmune diseases on immunosuppressive therapy are at increased risk of cervical cancer compared to the general population. Consequently, specific guidelines for cervical cancer screening and management of these women are required.

In this module, we will review the epidemiology of HPV and cervical cancer, and the effectiveness and diagnostic accuracy of screening strategies for immunosuppressed women with and without HIV.

At the conclusion of this course, participants will be able to:

- Understand the physio-pathological mechanisms that make immunosuppressed individuals at much higher risk of persistent HPV infection and associated cervical disease progression.
- Understand the epidemiology of HPV infection and cervical cancer among immunosuppressed WLHIV and among those immunosuppressed for other reasons.
- Understand the effectiveness and diagnostic accuracy of cervical cancer screening strategies in immunosuppressed populations.

UNIT 1. HPV AND CERVICAL CANCER IN WOMEN LIVING WITH HIV AND OTHER IMMUNOSUPPRESSED WOMEN

Women living with HIV (WLHIV) and other immunosuppressed women with solid organ transplant (SOT, such as liver, kidney or heart), hematopoietic stem cell transplant, and autoimmune diseases (eg. lupus, multiple sclerosis, or rheumatoid arthritis) on immunosuppressive therapy are at increased risk of cervical cancer compared to the general population.

More precisely, compared to women without HIV, WLHIV have a:

- 2-fold increased risk of acquiring a new high-risk (hrHPV) infection ([Looker et al., 2018](#));
- 1.4-fold higher risk of hrHPV infection persistence ([Looker et al., 2018](#));
- 5-fold increased risk of squamous intraepithelial lesion (SIL) or high-grade SIL (HSIL) incidence ([Denslow et al., 2014](#); [Hawes et al., 2006](#));
- 6-fold increased risk of invasive cervical cancer ([Stelzle et al., 2020](#)).
- 3-fold increased risk of high-grade lesion recurrence following treatment ([Debeaudrap et al., 2019](#)).

In a review of the available literature, [Moscicki et al. \(2019\)](#) concluded that immunosuppressed but HIV negative women have an increased risk of cervical cancer compared to women in the general population with highest risk among women with SOT.

Did you know?

The host response to natural HPV infection is characterised by weak antibody development or low antibody titres where there is an antibody response, that fails to prevent against re-infection ([Beachler et al., 2016](#)). The host relies on the innate or cellular immune response, which include T-lymphocyte cells, to clear new HPV infections. Therefore, the increased risk of cervical cancer in WLHIV and other immunosuppressed women is a consequence of the suboptimal cellular immunological control of HPV infection associated with HIV immunosuppression (manifested by a decrease in CD4+ T-lymphocyte cells) and by immunosuppressive medications given to transplant recipients or patients with autoimmune disease.

The present module presents the evidence on screening strategies for these high-risk populations.

UNIT 2. WOMEN LIVING WITH HIV

2.1 Epidemiology of HPV and cervical cancer in WLHIV

Cervical cancer ranks as one of the most common neoplasms among WLHIV and is considered an AIDS-defining illness (Castro et al., 1992).

WLHIV have a substantially increased risk of cervical cancer incidence compared to HIV negative women (Stelzle et al., 2020). Therefore, in regions where HIV prevalence is high, cervical cancer incidence is also high as observed in sub-Saharan Africa, the region with the highest combined HIV prevalence and cervical cancer incidence (Figure 1).

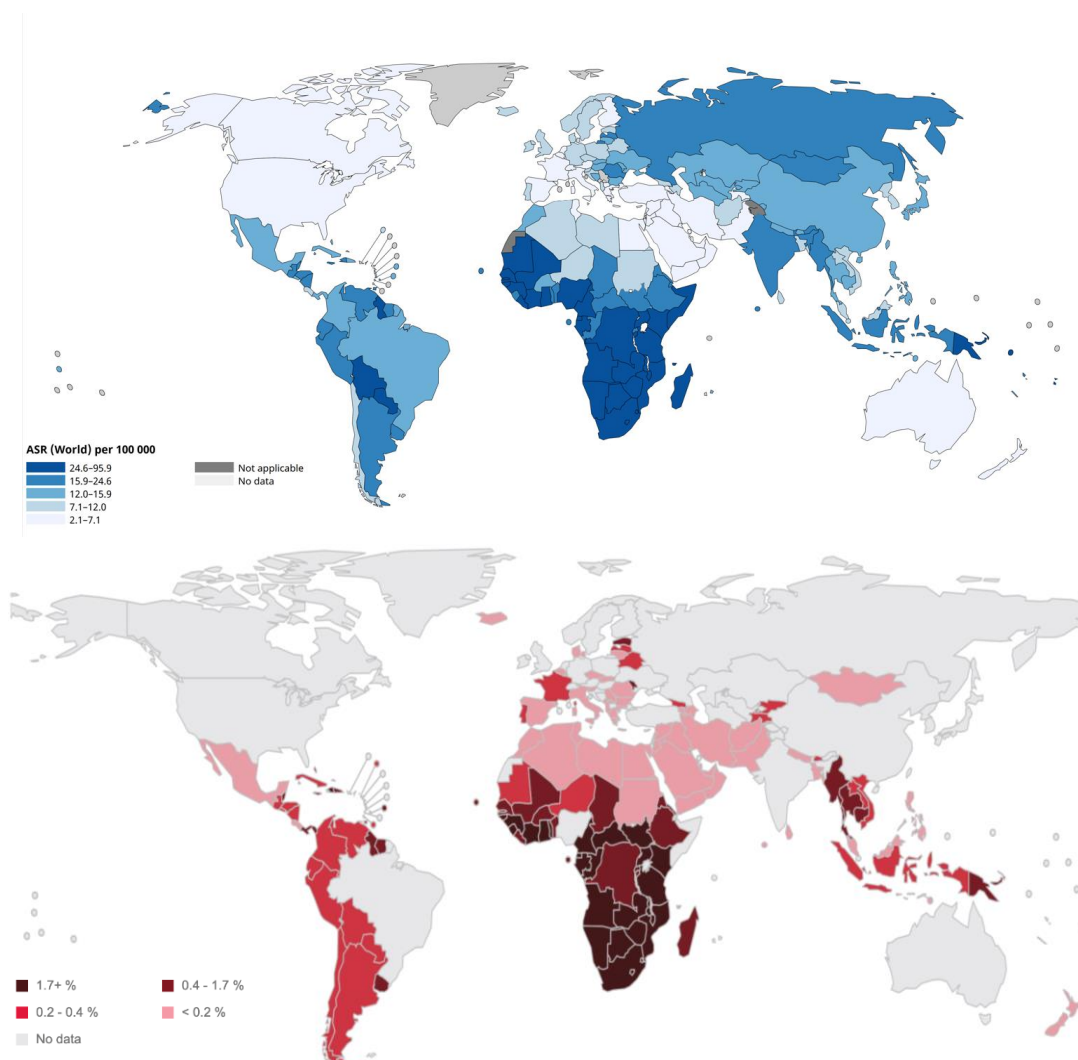



Figure 1. Age standardised incidence of cervical cancer per 100,000 women in 2022 (Ferlay et al., 2024) on top panel versus **worldwide prevalence of HIV among women aged ≥15 years in 2020** (Joint United Nations Programme on HIV/AIDS (UNAIDS), 2020) on the bottom panel



Several recent reviews reported that WLHIV with cervical cancer were significantly younger than women without HIV with cervical cancer, by approximately 10 years ([Ibrahim Khalil et al., 2022](#); [Mapanga et al., 2020](#); [Ntekim et al., 2015](#); [Shah et al., 2021](#)). Despite some heterogeneous findings between studies reporting survival following cervical cancer treatment, those studies that adjusted for prognostic factors such as cancer stage reported no difference in survival by HIV status ([Fenlon et al., 2022](#); [Shah et al., 2021](#)). Higher mortality rates have been reported among WLHIV with lower activated CD4 cell counts ([Dryden-Peterson et al., 2016](#)).

Of the estimated 570,000 cervical cancer cases reported in 2018, an estimated 33,000 (5.8%) were detected in WLHIV, with the majority (70%) in Eastern and Southern Africa ([Stelzle et al., 2020](#)). The attributable fraction of HIV in cervical cancer among WLHIV varies dramatically according to region and is highest in Eastern and Southern Africa where 30% of cervical cancer cases can be attributed to HIV.

In 2023, of the 20.5 million WLHIV globally, 12.9 million (63%) were in Eastern and Southern Africa and 3.1 million (15%) in West and Central Africa. Of the 1.3 million new HIV infections globally in 2023, the highest risk was among girls and young women aged 15–24 years (210,000 new infections), particularly in sub-Saharan Africa ([The Urgency of Now: AIDS at a Crossroads. UNAID, 2024](#)). Although HIV incidence has been declining among this group, HIV prevalence among adolescent girls and young women is more than three times higher than among males of the same age (**Figure 2**). Long-standing gender inequalities, discrimination and poverty deny many women and adolescent girls economic autonomy, deprive them of control over their sexual lives, and expose them to risk of emotional and bodily harm ([The Path That Ends AIDS, 2023](#)).

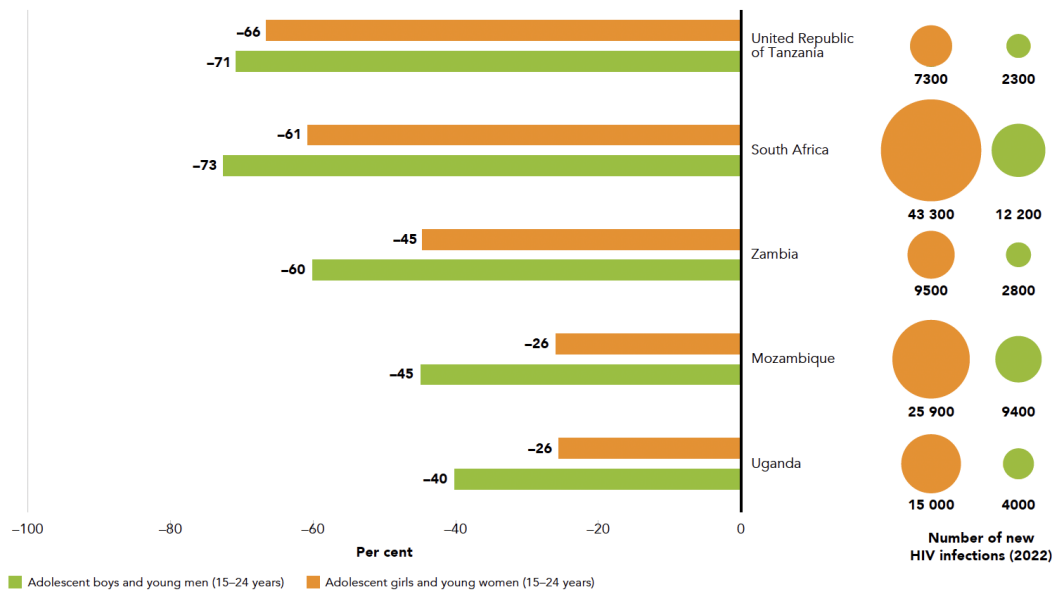


Figure 2. Percentage change in new HIV infections between 2010 and 2022 in people aged 15–24 by sex in selected African countries. Adapted from [The Path That Ends AIDS, 2023](#).


HPV and HIV share common risk factors for acquisition including:

- low use of barrier contraceptive methods,
- co-existence of other sexually transmitted infections (STI) and
- other sexual behaviour factors including early age at sexual debut and multiple sex partners

WLHIV are more likely to be infected with multiple hrHPV types with a broader range of genotypes ([Clifford et al., 2006](#)), possibly due to the reduced clearance of infection linked to HIV-associated immunosuppression and increased likelihood of acquiring new infections ([Looker et al., 2018](#)). Despite the higher prevalence of multiple hrHPV co-infection in WLHIV with normal cytology and with high-grade lesions ([Clifford et al., 2006](#)), the prevalence of multiple hrHPV infections were lower in women with invasive cervical cancer, irrespective of HIV status. The proportion of cervical cancers attributable to HPV16/18 alone were similar among women with and without HIV (62% and 67%, respectively) ([Clifford et al., 2016](#)).

The immunological response to infection in WLHIV

Persistent infection with hrHPV is common in WLHIV, as the HIV-associated immune suppression is associated with a 2-fold decreased probability of clearing infection




compared to HIV negative women ([Looker et al., 2018](#)). A low CD4+ lymphocyte cell count at the time of antiretroviral therapy (ART) initiation, indicative of the duration of immunosuppression, is one of the strongest predictors of hrHPV persistence and cervical cancer incidence ([Clifford et al., 2016](#); [Guiguet et al., 2009](#); [Kelly et al., 2018](#)).

Did you know?

hrHPV persistence is suggested to be associated with expression of HPV oncogenes E6 and E7 resulting in abnormal basal cell proliferation and progression of cell abnormalities to higher epithelial layers ([Doorbar, 2006](#)). Activation of telomerase, blockage of apoptosis, and viral integration are also thought to lead to carcinogenesis ([Woodman et al., 2007](#)). The innate immune response is the first line of recognition and defence against viral infection, although the role of the innate immune response to HPV infection is still poorly understood. Keratinocytes, the target cell for HPV, can act as Antigen Presenting Cells (APC) for presentation of antigen in association with the Major Histocompatibility Complex (MHC) class I. Keratinocytes are also able to secrete pro-inflammatory cytokines and chemokines and can activate CD4+ and CD8+ T-cells ([Black et al., 2007](#)). HPV virus capsid entry is usually an activating signal for APCs of the squamous epithelia, the Langerhans cells. Once the virus is detected, the APCs secrete cytokines to promote a T-cell response to HPV infection ([Moerman-Herzog & Nakagawa, 2015](#)), including IFN- γ which is expressed by Natural Killer (NK) cells and activated T-cells. Lymphocyte mediated protection from viral infections as well as control of tumors is thought to be mediated by Th1 cytokine (IL-2 and IFN γ) and cellular effectors such as cytotoxic T cells and natural killer (NK) cells. This immune response is impaired by Th2 cytokine and a shift to Th2 response during cervical cancer development is observed ([Wu & Kurman, 1997](#)). Natural Killer (NK) cells represent important early effector cells in innate immune defense and participate in regulation by collaborating with dendritic cells (DCs) to induce an immune response against viral infections and tumours ([Langers et al., 2014](#)).

HIV attacks and destroys CD4+ cells that trigger the immune response to infection which makes it difficult to clear infections and may favour the development of certain cancers. Reported alterations in the numbers and functions of NK cells among HIV positive patients might also negatively influence the course and severity of the disease ([Jacobs et al., 2005](#); [Kobayashi et al., 2004](#)).

While there is no effective cure for HIV nor a vaccine to protect against infection, HIV infection is now manageable as a chronic disease in persons with access to ART who achieve sustained HIV viral suppression (i.e. HIV plasma viral load <1000 copies/mL for >6 months). Most people who begin ART before onset of advanced immunodeficiency, and combined with adherence, can achieve HIV viral suppression within six months of



initiating ART. Sustained CD4+ T-cell count gains reduce the risk of HIV associated co-morbidities. Without effective ART, HIV can gradually destroy the immune system and advance to Acquired Immunodeficiency Syndrome (AIDS).

ART started soon after HIV diagnosis and with sustained HIV viral suppression has been reported to reduce the risk of cervical lesions and cancer (Kelly et al., 2018).

The **combination of at least three antiretroviral drugs (combination ART) to suppress the HIV virus and stop the progression of HIV disease** is associated with a reduction in cervical cancer incidence, especially if started at high CD4+ cell count at HIV diagnosis (Clifford et al., 2016), and with high levels of adherence (Chen et al., 2014).


ART initiation immediately after HIV diagnosis, together with rapid and sustained HIV viral suppression maintains CD4+ cell count at a higher level, leading to an earlier and possibly more functionally complete mucosal immune reconstitution (INSIGHT START Study Group et al., 2015) which should in turn lead to a more rapid clearance of cervical HPV, thus reducing the risk of cervical lesion development and ultimately cervical cancer incidence. However, ART users with low or unknown CD4+ cell count at diagnosis (also known as *nadir*) remain at significant high risk despite ART use.

Did you know?

With growing evidence that ART initiation immediately following HIV diagnosis and before significant CD4+ count depletion is associated with a reduction in risk of opportunistic infection morbidity, including infection-related cancer, especially for Kaposi's sarcoma and non-Hodgkin's lymphoma (Borges et al., 2016), the UNAIDS launched the "90-90-90" strategy in 2014 (UNAIDS, 2024), updated to "95-95-95" in 2020, with the aim of ensuring that, by 2025:

- 95% of all people living with HIV (PLHIV) know their HIV status,
- 95% of all PLHIV who know their status initiate antiretroviral therapy and
- 95% of PLHIV receiving antiretroviral therapy are virally suppressed

Achieving the 95-95-95 UNAIDS target results in a minimum of 86% of people living with HIV achieving viral suppression. At the end of 2023, 86% of people living with HIV knew their HIV status, 89% of those who knew their status were on antiretroviral



therapy, and 93% of ART users were virally suppressed. Globally, and in nearly all regions, greater percentages of women are accessing antiretroviral therapy than men. It is estimated that in 2023, 83% of adult men living with HIV in sub-Saharan Africa knew their HIV-positive status, 86% of those were accessing treatment and 94% of those were virally suppressed. Among women, the corresponding coverage levels were 91%, 91% and 94% ([The Urgency of Now: AIDS at a Crossroads. UNAIDS Global AIDS Update 2023, 2024](#)).

ACTIVITY

Read the following statements and decide if they are TRUE or FALSE.

1. HPV infections or related cancers and HIV infections are independent from each other, i.e., there is no relation between them.
2. Latin America is the world region with the highest combined incidence of cervical cancer and prevalence of HIV among women aged 15 years and older.
3. Antiretroviral therapy (ART) is associated with a decreased risk of cervical cancer in WLHIV.

The correct answers are:

1 False, 2 False (correct region: Sub-Saharan Africa), 3 True.



2.2. Screening strategies for WLHIV

Screening strategies more commonly used in settings where majority of WLHIV live include visual inspection using acetic acid or Lugol's iodine. Cytology and HPV testing are less common, although HPV-DNA testing is now being introduced and integrated within established HIV programmes ([McCormick et al., 2023](#)).


Visual inspection using acetic acid or Lugol's iodine (VIA/VILI)

Visual inspection using acetic acid (VIA) or Lugol's iodine (VILI) can be feasibly integrated into HIV services in resource-constrained settings because:

- Any level of health care worker may perform visual examination once trained
- It uses readily available materials including a vaginal speculum and acetic acid (or Lugol's iodine)
- The examination is laboratory independent and inexpensive.

However, its accuracy is highly variable among both WLHIV and HIV-negative women. In a meta-analysis of studies evaluating cervical cancer screening strategies among WLHIV ([Kelly et al., 2022](#)), the sensitivity of VIA varied from 44% to 87% for detection of CIN2+ and 54% to 100% for detection of CIN3+ and the specificity to distinguish CIN2+ from <CIN2 ranged between 47% to 97%. The diagnostic accuracy of VIA was found to be highest in studies where VIA operators were more experienced and where frequent supervision and quality control procedures are undertaken, including review of digital cervicography to ensure standardization of VIA/VILI ([Bateman et al., 2014](#); [Chibwasha et al., 2016](#); [Firnhaber et al., 2013a](#); [Huchko et al., 2015](#); [Joshi et al., 2013](#)) although this can be challenging to implement at scale ([Fokom Domgue & Valea, 2018](#)).

The variable accuracy of VIA among WLHIV could also be attributed to differences in HIV control as women with low CD4+ count and/or high HIV viral load have larger, well-demarcated and more easily identifiable acetowhite lesions ([Sahasrabuddhe et al., 2012](#)). The variable accuracy might also be explained by the higher prevalence of other cervical STIs and accompanying cervicitis and cervical inflammation among WLHIV compared to HIV negative women which could impact the visualisation of the cervix.



Chronic genital inflammation caused by the egg deposition of the *Schistosoma haematobium* parasite associated with female genital schistosomiasis may also confound the visualisation of the cervix among women in schistosoma endemic setting (Bustinduy et al., 2022).

Computer-aided approaches using automated visual evaluation (AVE) could improve accuracy and reproducibility of visual inspection methods. Data are still limited on the diagnostic accuracy of AVE methods, but validation studies are ongoing (de Sanjosé et al., 2024).

NOTE: For more information on artificial intelligence approaches, please see **MODULE 5**.

Cervical cytology

Cervical cytology (eg. Pap smear or liquid cytology) is less widely used in many low- and middle-income countries (LMIC) compared to VIA or HPV-DNA tests.

Like VIA, cytology shows variable diagnostic accuracy in WLHIV. Using a cytology threshold of HSIL or worse (HSIL+) to define the test positivity, sensitivity for CIN2+ ranged from 20% to 78% and specificity ranged from 58% to 99% (Bateman et al., 2014; Firnhaber et al., 2013a; Joshi et al., 2013; Mabeya et al., 2012). Similar estimates were observed for detection of CIN3+ (sensitivity range: 27–95%, specificity range: 57–99%).

However, cytology has shown to have high sensitivity and specificity for detection of CIN2+/CIN3+ among WLHIV in settings with established cytology programme and with external quality assessment (Firnhaber et al., 2013a; Segondy et al., 2016). In these settings, with a CIN2+ prevalence between 23–26%, cytology HSIL+ showed a sensitivity for CIN2+ between 70.1% and 78.4%, specificity between 81.6% and 96.5%, and a high PPV between 52.7% and 86.8% (Chung et al., 2013; Firnhaber et al., 2013a; Kelly et al., 2021).

HPV DNA tests

Screening approaches using HPV DNA tests can be easily adapted to resource-limited settings.

HPV-DNA detection assays targeting 13 to 15 hrHPV types show consistently high sensitivity but low specificity to rule out CIN2+/CIN3+ among WLHIV due to the high prevalence of hrHPV infection among WLHIV.

The sensitivity of different HPV-DNA tests targeting 13–14 hrHPV types for CIN2+ in WLHIV has been consistently high, ranging from 92% to 95% (Kelly et al., 2022). However, the specificity to distinguish CIN2+ from <CIN2 was low (range: 55% to 64%) across studies (Firnhaber et al., 2013a; Kelly et al., 2021).

NOTE: The specificity of a screening test is an inverse linear function of the HPV prevalence (for more information, see **MODULES 2 and 3**). In WLHIV, where disease prevalence is high, the specificity will be lower than in women without HIV which affects the balance between sensitivity and specificity. Therefore, the positive predictive value (PPV) of a screening test can be especially relevant in WLHIV when choosing which screening test to be used.

The high prevalence of HPV and co-infection with multiple hrHPV types among WLHIV (Clifford et al., 2017), many of which may be transient infections, results in low specificity of HPV-DNA tests for CIN2+ leading to unnecessary colposcopy referral or overtreatment.

EXAMPLE

A meta-analysis of 20 studies evaluating the relationship between hrHPV prevalence and the specificity of HPV testing (using Hybrid Capture 2) for the presence of CIN2+ reported that for a 10% increase in hrHPV prevalence, specificity of the HPV test decreased by 8.4% (Giorgi-Rossi et al., 2012).

Evidence suggests that in settings with routine follow-up for both HIV care and cervical cancer screening and treatment, the risk of CIN2/3 among HPV DNA negative women is similar irrespective of HIV status.

EXAMPLE

A 5-year follow-up study in the USA with WLHIV using an effective ART regimen with suppressed HIV viral load and high CD4+ count (Strickler et al., 2020) showed similar CIN2/3 incidences after a negative HPV-DNA test:

- 1% (95%CI: 0-3) in WLHIV with high CD4+ count (>500 cells/ μ l)
- 3% (95%CI: 0-7) in WLHIV with low CD4+ count (<350 cells/ μ l), and
- 4% (95%CI: 0-7) in HIV negative women.

Similar results were obtained in another cohort from the USA (Castle et al., 2022). but there is limited data available from settings with limited resources. Yet, the negative predictive value (NPV) of HPV is better than that of cytology or VIA. In longitudinal studies the risk of CIN2+ over 18 months was lower among WLHIV with a HPV-DNA negative test compared to those with a normal VIA or cytology (Kelly et al., 2021; Firnhaber et al., 2013b; Joshi et al., 2018).


Variations in extended genotyping HPV DNA tests

Many HPV infections may be transient and not clinically relevant. Therefore, a more novel approach using extended genotyping tests, which restricts test positivity to hrHPV types known to cause the majority of cervical cancer cases (e.g. HPV16, 18, 31, 33, 35, 45, 52 and 58) (IARC, 2022) and/or increases the threshold for HPV DNA positivity, show promise in a high HPV prevalence setting.

Both modifications result in a lower proportion of women who screen positive but corresponds with a marginal decrease in sensitivity compared to a HPV-DNA test targeting 13-15 hrHPV types, but a higher specificity to detect CIN2/CIN3+.

A pooled analysis assessed the diagnostic accuracy of using modified extended genotyping approaches in WLHIV (Kelly et al., 2022):

- The sensitivity for CIN2+ was similar between a test targeting 8 hrHPV types (HPV16/18/31/33/35/45/52/58) in comparison to a HPV DNA test targeting 14 hrHPV types (8 hrHPV vs 14 hrHPV: 86.4% vs. 91.5%, Relative Sensitivity: 0.94, 95%CI: 0.88-1.00) but the specificity was significantly higher (65.7% vs. 56.3%; Relative Specificity=1.18; 95%CI: 1.10-1.23). Similar findings were observed for CIN3+ detection.

- 
- A higher positivity threshold or cut-off in the restricted 8 hrHPV types approach (higher relative light unit [RLU] or PCR cycle thresholds corresponding with higher HPV viral load) showed an even higher specificity than a 14 hrHPV test (36% increase) though with an 11% loss in sensitivity.

These modifications may result in fewer referrals to colposcopy or treatment, which may be important considerations in settings with high prevalence of HPV but limited resources for colposcopy and treatment. It is relevant to consider the impact of the lower sensitivity of a screening test among WLHIV.


For example, in a prospective follow-up study following WLHIV who were screened using the modified extended genotyping approach, 19% of WLHIV with a screen-negative result using the 8-hrHPV and a modified test cut-off had CIN2/3 detected over 12 months of follow-up ([Denny et al., 2023](#)).

Any associated loss in sensitivity with this approach may need to be balanced with the capacity to refer hrHPV positive women for colposcopy and treatment in order to prioritise the clinical management of those at highest risk of progression.

Given their high sensitivity to detect CIN2/CIN3+, revised WHO guidelines suggest use of HPV DNA detection assays in a screen, triage and treat approach among WLHIV starting at age 25 with a regular screening interval every 5 years.

The revised WHO guidelines ([WHO Guideline for Screening and Treatment of Cervical Pre-Cancer Lesions for Cervical Cancer Prevention, 2021](#)) also recommend:

- While transitioning to HPV DNA testing – which should be done as soon as feasible – existing programmes with quality assured cytology or quality assured VIA should be continued until large scale HPV DNA testing is operational.
- Where VIA or cytology are used as primary screening test, a regular screening interval of every 3 years is suggested.

- 
- Where HPV-DNA test is used as primary screening test, a regular screening interval of every 5 years is suggested.

Given the low specificity of HPV-DNA based tests, triage of HPV-positive WLHIV is recommended using partial genotyping, colposcopy, VIA or cytology to avoid over-referral to colposcopy or overtreatment ([World Health Organization, 2021](#)). Extended genotyping may soon be recommended to improve management (expected November 2025).

Studies evaluating the diagnostic accuracy of VIA following a positive HPV DNA test have shown that the sensitivity and specificity for CIN2+ detection were similarly heterogeneous as observed for VIA as primary screening test (sensitivity range: 45% to 84%; specificity: 45% to 95%). Similar findings were observed for cervical cytology following an HPV-positive test ([Kelly et al., 2022](#)).


Did you know?

Prevalence of hrHPV is lower among women controlling HIV, i.e. with prolonged ART use, sustained HIV viral suppression and stable high CD4+ count ([Kelly et al., 2018](#)). Consequently, in these women, HPV DNA tests have higher specificity to rule out CIN2+ with no loss in sensitivity. In the universal ART era when people living with HIV start ART at the point of HIV diagnosis, HPV DNA based tests will be a better option in screening as the information they provide on genotype specific results can be used for triage.

Several studies have evaluated **novel screening approaches** in WLHIV, either as screening or triage of HPV positive women, however whether they are accessible and cost-effective needs to be assessed:

DNA methylation of host genes and/or HPV virus

Aberrant DNA methylation of human tumour suppressor genes and HPV virus is a potentially good early indicator of existing cervical disease and may help distinguish non-progressive HPV infections from those that progress to cancer. Although the performance of DNA methylation of human genes has been well studied in the general population ([Kelly et al., 2019](#); [Kremer et al., 2021](#)), there are few studies evaluating these methods among WLHIV.



Among 321 screened WLHIV in South Africa, measurement of DNA methylation of *CADMI/MAL/miR124-2* (Zummeren et al., 2017) had a sensitivity of 78% and specificity of 52% for detection of CIN2+, a performance not superior to that of a HPV DNA based test (79% and 73% for sensitivity and specificity, respectively).

Used as triage test in HPV-positive women, a test measuring DNA methylation of *CADMI/MAL/miR124-2* (De Vuyst et al., 2015) and *FAM19A4/miR124-2* (Kremer et al., 2019) maintained high sensitivity (72–73%) with high specificity (70–76%).

Dual staining with p16/ki67

Among 865 WLHIV in the United States (Strickler et al., 2020), 95% of whom were taking ART, the use of p16/Ki-67 dual-stain (CINTech+) cytology had lower sensitivity to detect precancer compared to HPV DNA test (82% and 91%, respectively) but greater specificity (88% and 73%, respectively). When compared to cytology and HPV DNA tests, dual staining showed the highest PPV at 20%, although the proportion of inadequate specimens (13%) was higher compared to that for cytology (3%) and HPV DNA (2%).

Detection of HPV E6 oncoprotein.


The OncoE6 test (targeting HPV16/18 E6 oncoproteins) has been evaluated among 879 WLHIV in Zambia and Burundi (Chibwasha et al., 2016; Ndizeye et al., 2019). The specificity of the test ranged from 98–99% but the sensitivity for CIN2+ and CIN3+ detection was low (31–42% for CIN2+, 47% for CIN3+) because of the high prevalence of multiple hrHPV types other than HPV16/18 that are implicated in CIN2 and CIN3 lesion development among WLHIV.

NOTE: For more information on the use of the above strategies for triage of HPV positive results in the general population, please see **MODULE 4A**.

ACTIVITY

Read the following statements and decide if they are TRUE or FALSE.

1. VIA, cervical cytology and HPV DNA based methods are screening strategies with similar accuracy for CIN2/3, irrespective of HIV status.
2. Cytology is the most common screening test used in WLHIV due to its high specificity.

- 
3. Artificial intelligence is being explored to improve the accuracy and reproducibility of visual inspection methods such as VIA or cytology.
 4. Due to the high prevalence of hrHPV in WLHIV, the specificity of HPV tests is lower than in the general population.
 5. Extended genotyping approaches are promising as to reduce the number of referrals to colposcopy and treatment but result in low decreases in sensitivity.

The correct answers are:

1 False, 2 False, 3 True, 4 True, 5 True.

2.3. Considerations on when to initiate screening and follow-up of WLHIV

Age to start screening

Given that cervical cancer is occurring at younger age in WLHIV compared to the general population, screening guidelines suggest initiation of screening from age 25 years in WLHIV and age 30 years in general population ([World Health Organization, 2021](#)).


There is limited evidence to support starting screening at a younger age than 25 years. In South Africa ([McDonald et al., 2014](#)) a lower prevalence of CIN2/3 was observed in WLHIV younger than 25 years (6.7%) than those aged 25–65 years (9.9%) and is unclear what proportion of these CIN2/3 lesions would spontaneously regress over time, in particular among young women on effective ART. In a multicohort study which followed 64,231 WLHIV in Europe, South Africa, Latin and North America over 7 years ([Rohner et al., 2020](#)), of the 356 incident cervical cancer cases identified, 11% were in WLHIV aged 16 to 30 years.

HPV vaccination for WLHIV

HPV vaccination of girls (target age of 9–13 years) today may protect future generations of women from cervical cancer who acquire HIV later in life, but there remains a generation of unvaccinated WLHIV who could benefit from protection with HPV vaccination, including women who were outside the age eligibility for HPV vaccination and young women who have not received HPV vaccination before they became HIV infected.

Very few countries have HPV vaccination programmes which include people living with HIV but the relevance of extending vaccination to WLHIV is of public health importance given:

- WLHIV have a higher risk of preventable disease compared to women in the general population


- 
- HPV vaccination of adult women (with evidence of prior infection) can result in an additional benefit to women with high probability of HPV re-infection (Bosch et al., 2016).
 - HPV vaccines are safe and immunogenic among people living with HIV (Toft et al., 2014), but data are lacking on their effectiveness in preventing HPV infection and related cervical disease among WLHIV.
 - Although WLHIV have a higher prevalence of multiple hrHPV infections, few WLHIV are simultaneously infected by all vaccine-types and a vaccine targeting 7 hrHPV types offers the potential to prevent infection from HPV types not yet acquired. There is also limited evidence that natural immunity can protect against subsequent type specific re-infection (Beachler et al., 2016; Kelly, Faust, et al., 2018).

Current guidelines recommended 3 doses among people living with HIV (World Health Organization, 2022). While single dose HPV vaccination may prove to be a cost-effective and feasible strategy in LMIC, it remains unknown if fewer than 3 doses will be effective among PLHIV. Recent data from repeated population-based surveys in South Africa (Machalek et al., 2022) have reported a decrease in vaccine type HPV prevalence among individuals who received single dose HPV vaccine, and this decrease was observed in both girls and women with and without HIV.

Post-treatment surveillance among WLHIV treated for cervical precancer

WLHIV have a high risk of post-treatment failure, and close monitoring of these women post-treatment is important.


In two meta-analyses that evaluated the likelihood of treatment failure (defined as residual and/or recurrent cytology-verified HSIL+ or histology-verified CIN2+) in WLHIV at least 6-months post-treatment (Atemnkeng et al., 2020; Debeaudrap et al., 2019), the risk of treatment failure was:

- 
- 3-fold higher in WLHIV compared to HIV negative women (23% vs. 10%),
 - 1.7-fold higher in WLHIV undergoing cryotherapy (22%) compared to excisional large loop electrosurgical excision procedure (LEEP) (13%). There is limited data available on the risk of treatment failure in WLHIV treated with thermal ablation; a randomised controlled trial reported similar efficacy for hrHPV clearance between thermal ablation and cryotherapy (44% and 46%, respectively) although lower than that achieved with LEEP (55%).
 - 3-fold higher among WLHIV with positive margins compared to WLHIV with negative margins among women undergoing excisional management (50% vs. 16%),
 - 2-fold lower among ART users with suppressed viral load and with early initiation

A test of cure that combines high sensitivity with a high negative predictive value would be useful to monitor the risk of treatment failure and can provide women with reassurance against future risk of precancer recurrence. In studies among WLHIV followed after treatment for cervical precancer, HPV DNA tests had high sensitivity (85–94%) and high NPV (94–96%) for re-detection of CIN2+ 6 months after cryotherapy, but low specificity (36–54%) (De Vuyst et al., 2014; Omenge Orang'o et al., 2017). The low specificity of an HPV DNA test targeting 13–14 hrHPV types is a consequence of the greater probability of type-specific persistent HPV infection, especially after ablative methods.

Current recommendations suggest that WLHIV who have been treated for histologically confirmed CIN2/3 or adenocarcinoma in situ (AIS), or treated as a result of a positive screening test are retested at 12 months with HPV DNA testing when available, and, if negative, are retested again at 12 months and, if negative again, move to the recommended regular screening Interval (World Health Organization, 2021).

Type-specific hrHPV persistence is an important predictor of treatment failure (Chung et al., 2021). HPV DNA tests that allow for genotype-level data may be useful as *test of cure* to identify women with type-specific persistence who are at highest risk of lesion



recurrence. However, further evidence is needed on the accuracy of a test targeting hrHPV type persistence as a test of cure following cervical precancer treatment.

ACTIVITY

Read the following statements and decide if they are TRUE or FALSE.

1. Current recommendations suggest that WLHIV initiate cervical cancer screening at the same age as women without HIV.
2. WLHIV have a high risk of post-treatment failure, and they should be monitored at frequent intervals following treatment.
3. The risk of treatment failure in WLHIV is independent from the treatment used.

The correct answers are:

1 False, 2 True, 3 False.

2.4 Access to screening and integration in HIV care

Cervical cancer screening coverage, and linkage to care, is low in LMICs, where infrastructure and personnel requirements for cervical screening and management put high demands on the health systems.

A systematic review reporting on cervical cancer screening coverage from 127 countries worldwide using data from published literature and official websites indicated 38% of women aged 30–49 years worldwide have been screened at least once in their lifetime (Bruni et al., 2022). However, when countries are stratified by income level, coverage is of 84% in high-income countries compared to only 9% in lower-middle income countries and 11% in low-income countries (Figure 3), which is far from the WHO elimination target of 70% screening coverage, in particular in the regions with the highest combined incidence of cervical cancer and prevalence of HIV.

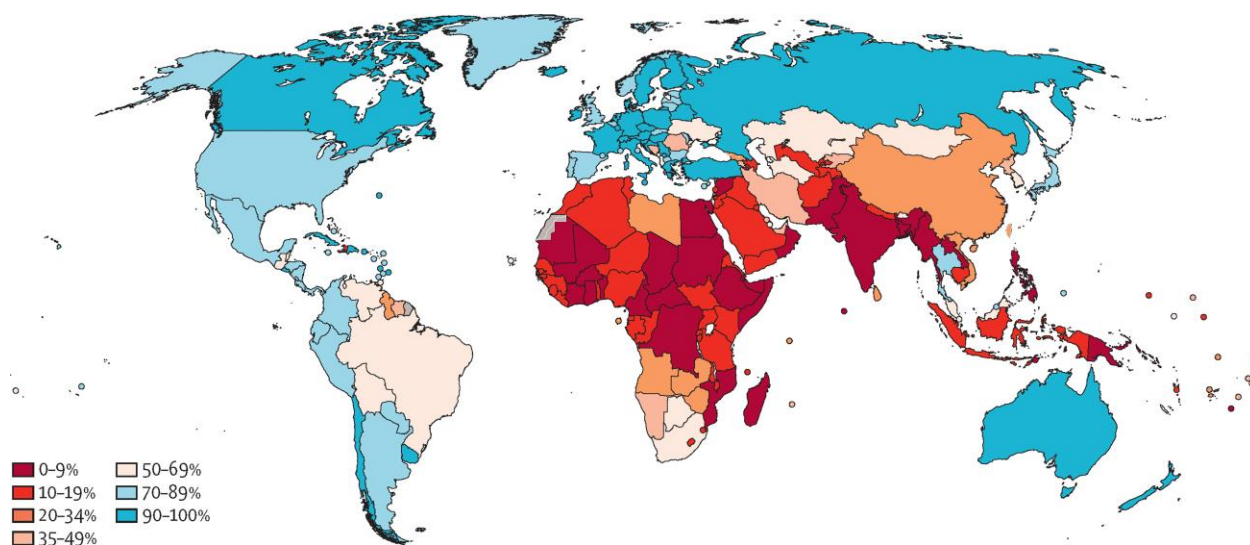


Figure 3. Estimated cervical cancer screening coverage in 2019, women aged 30–49 years
(*National Cervical Cancer Screening Programs and Coverage Worldwide., 2020*)

While HPV DNA testing and/or cytology were the most commonly used screening strategies in high-income settings, VIA was the most used strategy in Sub-Saharan Africa because how easily can be implemented in resource-constrained settings.

Additionally, because the results of the examination are immediately available, immediate treatment is possible if examination indicates cervical abnormality, thereby facilitating a *screen and treat* protocol.



Did you know?

Limiting screening to 1-2 lifetime events as proposed in the WHO *Global Strategy to Accelerate the Elimination of Cervical Cancer* may not be sufficient to reduce the risk of cervical cancer in WLHIV because:


- WLHIV have a high risk of hrHPV acquisition and persistence,
- Standard screening and triage approaches have limited accuracy to detect precancer
- WLHIV present faster progression to high-grade lesions.

The lack of large-scale cancer screening programmes in LMICs means that women may be screened late with advanced cervical cancer stages and in some cases, treatment may not be available in the country due to high cost, infrastructure requirements, and the scarcity of pathologists, medical oncologists, radiation oncologists, and other specialised health-care workers including palliative care and nursing personnel needed for cancer care (Jemal et al., 2012).

Inequities in access to effective cervical cancer screening and timely treatment of precancer lesions, combined with early access to ART, leads to regional variation in cervical cancer among WLHIV (Clifford et al., 2017; Rohner et al., 2020).

Although cervical cancer screening is less widely implemented in LMICs compared to high income countries, integration of cervical cancer screening services within HIV treatment services would ensure that WLHIV at high risk of developing cervical cancer precursor lesions are screened with frequent follow-up and monitoring, and lead to continuity in primary prevention, favouring early detection and management of HPV-related cervical lesions with minimal loss to follow-up (Sigfrid et al., 2017). However, to achieve desired cervical cancer prevention among WLHIV, adequate treatment facilities offering ablative (cryotherapy, thermal ablation) and excisional (LEEP) treatment methods should be readily available within screening facilities, and referral structures established.

In recent years, cervical cancer screening and treatment programmes have been introduced and integrated in HIV control programmes in high HIV prevalence settings



in sub-Saharan African (McCormick et al., 2023). In a meta-analysis of cervical cancer screening coverage in sub-Saharan Africa, limited available evidence suggests that WLHIV in countries outside of Southern Africa have a 2-fold increased likelihood of ever having a screening event in their lifetime compared to women in the general population while women in southern Africa had an equal odds of being screened as women in general population (Yang et al., 2023), highlighting the success of integrated programmes, but also the inequities in access to cervical cancer screening in regions with the highest incidence of cervical cancer.

ACTIVITY

Read the following statements and decide if they are TRUE or FALSE.

1. Women living in regions with high burden of HIV and cervical cancer have the same likelihood of being screened in their lifetime as women in high income settings.
2. Recent evidence from sub-Saharan Africa demonstrates the feasibility of integrating cervical cancer screening in routine HIV care.

The correct answers are:

1 False, 2 True.

2.5 HPV-associated anal cancer and precancer in WLHIV

Anal cancer is rare in the general population; the age standardised incidence ratio (ASIR) among women and men in the general population is 0.58 and 0.49 per 100,000 persons, respectively (Ferlay et al., 2024). People living with HIV are at increased risk of anal cancer compared to the general population (Grulich et al., 2007; Machalek et al., 2012). This risk varies by age, sex and sexual identity.

EXAMPLE

A recent meta-analysis (Clifford et al., 2021) estimated that the anal cancer incidence rates for anal cancer among men who have sex with men living with HIV, non-MSM males living with HIV, women living with HIV and men who have sex with men without HIV are 85, 32, 22 and 19 cases per 100,000 person-year, respectively (Figure 4). These risks increase with increasing age in all groups, with the highest incidence observed among older MSM living with HIV (108 per 100,000 person years among those ≥60 years).

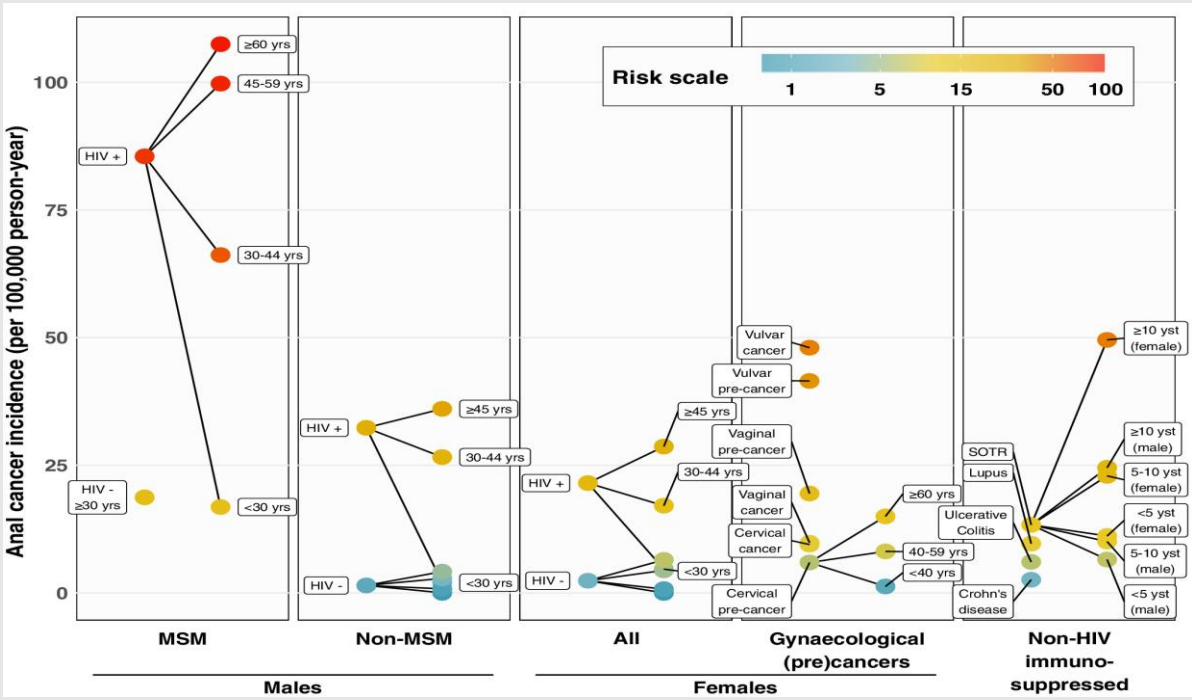



Figure 4. Anal cancer risk scale, according to risk group and age. Adapted from Clifford et al., 2021.

Cytology and high resolution anoscopy (HRA) are frequently used to detect anal lesions but often underestimate the severity of lesions determined by histology (Darragh & Winkler, 2011; Stewart et al., 2018). HRA is similar to cervical colposcopy and requires extensive training and observer experience (Neukam et al., 2019).



NOTE: For more information on formal guidelines for anal cancer screening for high-risk groups including PLHIV, please see those from experts panels from Spain ([Blanco et al., 2017](#)) and France ([Delfraissy & Expert group, 2002](#)), the European AIDS Clinical Society ([European AIDS Clinical Society Guidelines 2019, Versión 10.0, n.d.](#)) and the New York State ([New York State Health Department of Health AIDS Institute, 2020](#)).

Irrespective of their HIV status, women with cervical HPV16 infection or cervical cancer are at high risk of anal HPV16 infection, HPV16-positive anal HSIL, or any anal HSIL ([Lin et al., 2019](#)).

Therefore, the results from cervical cancer screening programmes could help to stratify the anal cancer risk of screened women and can guide the anal screening recommendations as described in the examples below:

- In WLHIV with cervical precancerous lesions, the European AIDS Clinical Society advises digital rectal examination, high resolution anoscopy or anal cytology every 1–3 years
- The New York State (USA) recommends annual digital rectal examination and anal for all WLHIV aged 35 or older ([New York State Health Department of Health AIDS Institute, 2020](#))

Did you know?

A randomised controlled trial among people living with HIV (80% male) with biopsy-proven anal HSIL show that the treatment of such lesions with office-based ablative procedures, ablation or excision under anaesthesia, or the administration of topical fluorouracil or imiquimod reduces the rate of progression to anal cancer in the following 26 months by 57% (95%CI: 6–80) when compared to active monitoring without treatment ([Palefsky et al., 2022](#)).



ACTIVITY

Read the following statements and decide if they are TRUE or FALSE.

1. Anal cancer incidence is higher in people living with HIV.
2. Anal cancer incidence does not vary by age.
3. Women with cervical disease, irrespective of their HIV status, are at higher risk of anal cancer.

The correct answers are:

1 True, 2 False, 3 True.

UNIT 3. EPIDEMIOLOGY OF HPV & CERVICAL CANCER IN IMMUNOSUPPRESSED WOMEN NOT HIV-INFECTED

HPV-related cancers are more frequent among post-transplant populations compared to those in the general population. In a meta-analysis that examined the risk of multiple cancer types in over 27,000 SOT patients (97% kidney transplant recipients) from 5 different studies, the standardised incidence for cervical cancer in transplant patients was 2.1 times higher compared to the general population, while that among WLHIV was 5.8 times higher ([Grulich et al., 2007](#)).

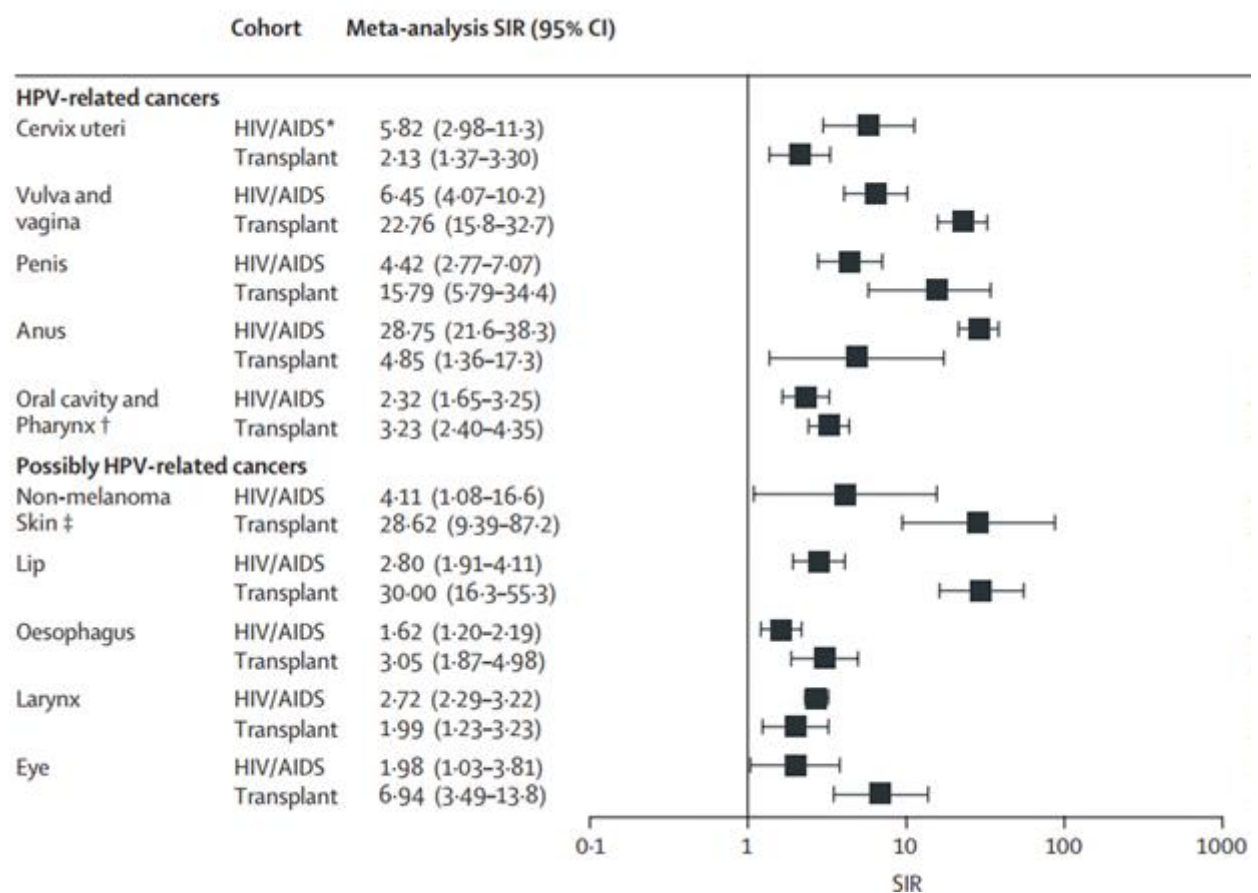



Figure 5. Incidence cancer ratios in people living with HIV and transplants recipients in comparison to the general population. Adapted from [Grulich et al., 2007](#).

The increased risk of cancer in both transplant patients and people living with HIV suggests that immune suppression may be the strongest predictor for cancer risk in these populations, as other risk factors for cancer including tobacco smoking have shown to be substantially different between the two populations ([Grulich et al., 2007](#)).



This increased risk of a spectrum of malignancies, including those HPV-related, is mainly attributed to ongoing and long-term use of immunosuppressive medication, graft versus host disease (GvHD), and infections with oncogenic viruses.

Because HPV-related cancers result from persistent infection with hrHPV, it is hypothesized that medications including maintenance immunosuppression to prevent graft rejection may contribute to persistence of infection and/or reactivation of latent HPV infections, including hrHPV types that may become persistent and develop into high-grade lesions and cancer ([Liao et al., 2019](#); [Schiffman et al., 2016](#)).

Therefore, women in the following categories have a higher risk of cervical cancer than the general population:

- Solid Organ Transplant recipients;
- Hematopoietic Stem Cell Transplant recipients, especially those with a diagnosis of genital or chronic graft versus host disease (GvHD)
- Women with inflammatory bowel disease being treated with immunosuppressive drugs;
- Women with systemic lupus erythematosus, whether on immunosuppressant therapy or not;
- Women with rheumatoid arthritis on immunosuppressant drugs

The American College of Obstetrics and Gynaecology guidelines note that the above list of immunocompromised women “may require more frequent cervical cancer screening than is recommended in the routine screening guidelines” and due to the similarity in cervical cancer risk, screening and surveillance guidelines recommended for WLHIV have been similarly proposed for immunosuppressed non-HIV infected women ([Moscicki et al., 2019](#)).

Weak evidence suggests that women with inflammatory bowel disease or rheumatoid arthritis not on immunosuppressive therapy as well as women with Type 1 diabetes mellitus are not at an increased risk and should follow screening guidelines for the general population.



ACTIVITY

Read the following statements and decide if they are TRUE or FALSE.

1. Immunosuppressed women who are not HIV infected are at increased risk of cervical cancer compared to the general population.
2. Immunosuppressed women who are not HIV infected may require less frequent cervical cancer screening than is recommended in the routine screening guidelines.
3. Immunosuppressive medications may contribute to the persistence of HPV infection and/or reactivation of latent HPV infections.

The correct answers are:

1 True, 2 False, 3 True.




SUMMARY

- The regions with the highest incidence of cervical cancer are also the regions with the highest prevalence of HIV among women.
- Compared to women without HIV, women living with HIV have an increased risk of acquiring hrHPV infection, a decreased risk of clearing infection and an increased risk of developing cervical cancer.
- Antiretroviral therapy (ART), when initiated early after HIV acquisition and with HIV viral load suppression, decreases the risk of cervical cancer
- Cervical cancer screening among WLHIV is effective in reducing risk of cervical precancer and cancer, especially where HPV-DNA are used in screening.
- Due to the low specificity of HPV tests in WLHIV, triage of HPV-positive WLHIV is recommended, although current triage methods have low or variable sensitivity and specificity
- Type-specific genotype approaches show promise in prioritising women at highest risk of cervical precancer and cancer.
- WLHIV show more treatment failure following ablation or excisional methods than women without HIV and therefore should be monitored more intensively following treatment for cervical precancer.
- Cervical cancer screening and treatment programmes can be feasibly integrated into HIV care
- Women with cervical HPV16 infection or cervical cancer are at high risk of anal HPV16 infection, HPV16-positive anal HSIL, or any anal HSIL
- HPV-related cancers are more frequent among post-transplant populations compared to those in the general population. These women may benefit from more frequent cervical cancer screening than is recommended in the routine screening guidelines

BIBLIOGRAPHY

- Atemnkeng, N., Aji, A. D., de Sanjose, S., Mayaud, P., & Kelly, H. (2020). Antiretroviral therapy and detection of high-grade cervical intraepithelial neoplasia (CIN2+) at post-CIN management follow-up among women living with HIV: A systematic review and meta-analysis. *Clinical Infectious Diseases: An Official Publication of the Infectious Diseases Society of America*. <https://doi.org/10.1093/cid/ciaa238>
- Bateman, A. C., Parham, G. P., Sahasrabuddhe, V. V., Mwanahamuntu, M. H., Kapambwe, S., Katundu, K., Nkole, T., Mulundika, J., Pfaendler, K. S., Hicks, M. L., Shibemba, A., Vermund, S. H., Stringer, J. S. A., & Chibwesa, C. J. (2014). Clinical Performance of Digital Cervicography and Cytology for Cervical Cancer Screening in HIV-infected Women in Lusaka, Zambia. *Journal of Acquired Immune Deficiency Syndromes* (1999), 67(2), 212–215. <https://doi.org/10.1097/QAI.0000000000000270>
- Beachler, D. C., Jenkins, G., Safaeian, M., Kreimer, A. R., & Wentzensen, N. (2016). Natural Acquired Immunity Against Subsequent Genital Human Papillomavirus Infection: A Systematic Review and Meta-analysis. *The Journal of Infectious Diseases*, 213(9), 1444–1454. <https://doi.org/10.1093/infdis/jiv753>
- Black, A. P. B., Ardern-Jones, M. R., Kasprowicz, V., Bowness, P., Jones, L., Bailey, A. S., & Ogg, G. S. (2007). Human keratinocyte induction of rapid effector function in antigen-specific memory CD4+ and CD8+ T cells. *European Journal of Immunology*, 37(6), 1485–1493. <https://doi.org/10.1002/eji.200636915>
- Blanco, J. L., Blanco, J. R., Camino, X., Curran, A., Merchante, A., Díaz, A., Fernández, C., Gil, L., Hidalgo, C., López de Munain, J., Margall, N., Otero, L., Prieto, L., Muñoz, E., Puerta, T., Pueyo, I., Vázquez, F., & Viñuela, M. C. (2017). *Documento de consenso sobre diagnóstico y tratamiento de las infecciones de transmisión sexual en adultos, niños y adolescentes*. Panel de expertos del Grupo de Estudio de Sida (GESIDA). <http://gesida-seimc.org/category/guias-clinicas/otras-guidas-vigentes/page/2/>
- Borges, Á. H., Neuhaus, J., Babiker, A. G., Henry, K., Jain, M. K., Palfreeman, A., Mugenyi, P., Domingo, P., Hoffmann, C., Read, T. R. H., Pujari, S., Meulbroek, M., Johnson, M., Wilkin, T., & Mitsuyasu, R. (2016). Immediate Antiretroviral Therapy Reduces Risk of Infection-Related Cancer During Early HIV Infection. *Clinical Infectious*



Diseases: An Official Publication of the Infectious Diseases Society of America, 63(12), 1668–1676. <https://doi.org/10.1093/cid/ciw621>

Bosch, F. X., Robles, C., Díaz, M., Arbyn, M., Baussano, I., Clavel, C., Ronco, G., Dillner, J., Lehtinen, M., Petry, K.-U., Poljak, M., Kjaer, S. K., Meijer, C. J. L. M., Garland, S. M., Salmerón, J., Castellsagué, X., Bruni, L., de Sanjosé, S., & Cuzick, J. (2016). HPV-FASTER: Broadening the scope for prevention of HPV-related cancer. *Nature Reviews Clinical Oncology*, 13(2), 119–132. <https://doi.org/10.1038/nrclinonc.2015.146>


Bruni, L., Serrano, B., Roura, E., Alemany, L., Cowan, M., Herrero, R., Poljak, M., Murillo, R., Broutet, N., Riley, L. M., & De Sanjose, S. (2022). Cervical cancer screening programmes and age-specific coverage estimates for 202 countries and territories worldwide: A review and synthetic analysis. *The Lancet Global Health*, 10(8), e1115–e1127. [https://doi.org/10.1016/S2214-109X\(22\)00241-8](https://doi.org/10.1016/S2214-109X(22)00241-8)


Bustinduy, A. L., Randriansolo, B., Sturt, A. S., Kayuni, S. A., Leutscher, P. D. C., Webster, B. L., Van Lieshout, L., Stothard, J. R., Feldmeier, H., & Gyapong, M. (2022). Chapter One - An update on female and male genital schistosomiasis and a call to integrate efforts to escalate diagnosis, treatment and awareness in endemic and non-endemic settings: The time is now. In D. Rollinson & R. Stothard (Eds), *Advances in Parasitology* (Vol. 115, pp. 1–44). Academic Press. <https://doi.org/10.1016/bs.apar.2021.12.003>


Castle, P. E., Befano, B., Schiffman, M., Wentzensen, N., Lorey, T., Poitras, N., Hyer, M., & Cheung, L. C. (2022). A comparison of high-grade cervical abnormality risks in women living with and without human immunodeficiency virus undergoing routine cervical-cancer screening. *Preventive Medicine*, 162, 107157. <https://doi.org/10.1016/j.ypmed.2022.107157>


Castro, K. G., Ward, J. W., Slutsker, L., Buehler, J. W., Jaffe, H. W., Berkelman, R. L., & Curran, J. W. (1992). 1993 revised classification system for HIV infection and expanded surveillance case definition for AIDS among adolescents and adults. *MMWR. Recommendations and Reports: Morbidity and Mortality Weekly Report. Recommendations and Reports*, 41(RR-17), 1–19.


Chen, Y.-C., Li, C.-Y., Liu, H.-Y., Lee, N.-Y., Ko, W.-C., & Ko, N.-Y. (2014). Effect of antiretroviral therapy on the incidence of cervical neoplasia among HIV-infected women: A population-based cohort study in Taiwan. *AIDS (London, England)*, 28(5), 709–715. <https://doi.org/10.1097/QAD.000000000000132>

- 
- Chibwasha, C. J., Frett, B., Katundu, K., Bateman, A. C., Shibemba, A., Kapambwe, S., Mwanahamuntu, M. H., Banda, S., Hamusimbi, C., Polepole, P., & Parham, G. P. (2016). Clinical Performance Validation of 4 Point-of-Care Cervical Cancer Screening Tests in HIV-Infected Women in Zambia. *Journal of Lower Genital Tract Disease*. <https://doi.org/10.1097/LGT.0000000000000206>
- Chung, M. H., De Vuyst, H., Greene, S. A., Mugo, N. R., Querec, T. D., Nyongesa-Malava, E., Cagle, A., Sakr, S. R., Luchters, S., Temmerman, M., Unger, E. R., & McGrath, C. J. (2021). Human Papillomavirus Persistence and Association With Recurrent Cervical Intraepithelial Neoplasia After Cryotherapy vs Loop Electrosurgical Excision Procedure Among HIV-Positive Women: A Secondary Analysis of a Randomized Clinical Trial. *JAMA Oncology*, 7(10), 1514–1520. <https://doi.org/10.1001/jamaoncol.2021.2683>
- Chung, M. H., McKenzie, K. P., De Vuyst, H., Richardson, B. A., Rana, F., Pamnani, R., Njoroge, J. W., Nyongesa-Malava, E., Sakr, S. R., John-Stewart, G. C., & Mugo, N. R. (2013). Comparing Papanicolaou smear, visual inspection with acetic acid and human papillomavirus cervical cancer screening methods among HIV-positive women by immune status and antiretroviral therapy. *AIDS (London, England)*, 27(18), 2909–2919. <https://doi.org/10.1097/01.aids.0000432472.92120.1b>
- Clifford, G., Franceschi, S., Keiser, O., Schöni-Affolter, F., Lise, M., Dehler, S., Levi, F., Mousavi, M., Bouchardy, C., Wolfensberger, A., Darling, K. E., Staehelin, C., Bertisch, B., Kuenzli, E., Bernasconi, E., Pawlita, M., Egger, M., & Swiss HIV Cohort Study. (2016). Immunodeficiency and the risk of cervical intraepithelial neoplasia 2/3 and cervical cancer: A nested case-control study in the Swiss HIV cohort study. *International Journal of Cancer*, 138(7), 1732–1740. <https://doi.org/10.1002/ijc.29913>
- Clifford, G. M., de Vuyst, H., Tenet, V., Plummer, M., Tully, S., & Franceschi, S. (2016). Effect of HIV Infection on Human Papillomavirus Types Causing Invasive Cervical Cancer in Africa. *Journal of Acquired Immune Deficiency Syndromes (1999)*, 73(3), 332–339. <https://doi.org/10.1097/QAI.0000000000001113>
- Clifford, G. M., Georges, D., Shiels, M. S., Engels, E. A., Albuquerque, A., Poynten, I. M., de Pokomandy, A., Eason, A. M., & Stier, E. A. (2021). A meta-analysis of anal cancer incidence by risk group: Toward a unified anal cancer risk scale. *International Journal of Cancer*, 148(1), 38–47. <https://doi.org/10.1002/ijc.33185>

- 
- Clifford, G. M., Gonçalves, M. A. G., Franceschi, S., & HPV and HIV Study Group. (2006). Human papillomavirus types among women infected with HIV: A meta-analysis. *AIDS (London, England)*, 20(18), 2337–2344. <https://doi.org/10.1097/01.aids.0000253361.63578.14>
- Clifford, G. M., Tully, S., & Franceschi, S. (2017). Carcinogenicity of Human Papillomavirus (HPV) Types in HIV-Positive Women: A Meta-Analysis From HPV Infection to Cervical Cancer. *Clinical Infectious Diseases: An Official Publication of the Infectious Diseases Society of America*, 64(9), 1228–1235. <https://doi.org/10.1093/cid/cix135>
- Darragh, T. M., & Winkler, B. (2011). Anal cancer and cervical cancer screening: Key differences. *Cancer Cytopathology*, 119(1), 5–19. <https://doi.org/10.1002/cncy.20126>
- de Sanjosé, S., Perkins, R. B., Campos, N., Inturrisi, F., Egemen, D., Befano, B., Rodriguez, A. C., Jerónimo, J., Cheung, L. C., Desai, K., Han, P., Novetsky, A. P., Ukwuani, A., Marcus, J., Ahmed, S. R., Wentzensen, N., Kalpathy-Cramer, J., Schiffman, M., & PAVE Study Group. (2024). Design of the HPV-automated visual evaluation (PAVE) study: Validating a novel cervical screening strategy. *eLife*, 12, RP91469. <https://doi.org/10.7554/eLife.91469>
- De Vuyst, H., Franceschi, S., Plummer, M., Mugo, N. R., Sakr, S. R., Meijer, C. J. L. M., Heideman, D. A. M., Tenet, V., Snijders, P. J. F., Hesselink, A. T., & Chung, M. H. (2015). Methylation Levels of CADM1, MAL, and MIR124-2 in Cervical Scrapes for Triage of HIV-Infected, High-Risk HPV-Positive Women in Kenya. *Journal of Acquired Immune Deficiency Syndromes (1999)*, 70(3), 311–318. <https://doi.org/10.1097/QAI.0000000000000744>
- De Vuyst, H., Mugo, N. R., Franceschi, S., McKenzie, K., Tenet, V., Njoroge, J., Rana, F. S., Sakr, S. R., Snijders, P. J. F., & Chung, M. H. (2014). Residual Disease and HPV Persistence after Cryotherapy for Cervical Intraepithelial Neoplasia Grade 2/3 in HIV-Positive Women in Kenya. *PLoS ONE*, 9(10). <https://doi.org/10.1371/journal.pone.0111037>
- Debeaudrap, P., Sobngwi, J., Tebeu, P.-M., & Clifford, G. M. (2019). Residual or Recurrent Precancerous Lesions After Treatment of Cervical Lesions in Human Immunodeficiency Virus-infected Women: A Systematic Review and Meta-analysis of Treatment Failure. *Clinical Infectious Diseases: An Official Publication*

- 
- of the Infectious Diseases Society of America, 69(9), 1555–1565.
<https://doi.org/10.1093/cid/ciy1123>
- Delfraissy, J.-F. & Expert group. (2002). Management of patients infected by the human immunodeficiency virus (HIV). Report of an expert group. *Revue De Pneumologie Clinique*, 58(6 Pt 1), 312–340.
- Denny, L., Saidu, R., Boa, R., Mbatani, N., Castor, D., Moodley, J., & Kuhn, L. (2023). Point-of-care testing with Xpert HPV for single-visit, screen-and-treat for cervical cancer prevention: A demonstration study in South Africa. *Scientific Reports*, 13(1), 16182. <https://doi.org/10.1038/s41598-023-43467-2>
- Denslow, S. A., Rositch, A. F., Firnhaber, C., Ting, J., & Smith, J. S. (2014). Incidence and progression of cervical lesions in women with HIV: A systematic global review. *International Journal of STD & AIDS*, 25(3), 163–177. <https://doi.org/10.1177/0956462413491735>
- Doorbar, J. (2006). Molecular biology of human papillomavirus infection and cervical cancer. *Clinical Science (London, England: 1979)*, 110(5), 525–541. <https://doi.org/10.1042/CS20050369>
- Dryden-Peterson, S., Bvochora-Nsingo, M., Suneja, G., Efstathiou, J. A., Grover, S., Chiyapo, S., Ramogola-Masire, D., Kebabonye-Pusoentsi, M., Clayman, R., Mapes, A. C., Tapela, N., Asmelash, A., Medhin, H., Viswanathan, A. N., Russell, A. H., Lin, L. L., Kayembe, M. K. A., Mmalane, M., Randall, T. C., ... Lockman, S. (2016). HIV Infection and Survival Among Women With Cervical Cancer. *Journal of Clinical Oncology: Official Journal of the American Society of Clinical Oncology*, 34(31), 3749–3757. <https://doi.org/10.1200/JCO.2016.67.9613>
- European AIDS Clinical Society Guidelines 2019, versión 10.0.* (n.d.). 2019_guidelines-10.0_final.pdf (eacsociety.org)
- Fenlon, J. B., Rositch, A. F., Dickey, B. L., Kimani, S., & Suneja, G. (2022). Gynecological radiotherapy in people living with human immunodeficiency virus: A semi-systematic literature review. *International Journal of Gynecological Cancer: Official Journal of the International Gynecological Cancer Society*, 32(3), 429–435. <https://doi.org/10.1136/ijgc-2021-002533>
- Ferlay, J., Ervik, M., Lam, F., Laversanne, M., Colombet, M., Mery, L., Piñeros, M., Znaor, A., Soerjomataram, I., & Bray, F. (2024). *Global Cancer Observatory: Cancer Today 2022 (version 1.1)*. <http://gco.iarc.fr/today>


- 
- Firnhaber, C., Mayisela, N., Mao, L., Williams, S., Swarts, A., Faesen, M., Levin, S., Michelow, P., Omar, T., Hudgens, M. G., Williamson, A.-L., Allan, B., Lewis, D. A., & Smith, J. S. (2013a). Validation of Cervical Cancer Screening Methods in HIV Positive Women from Johannesburg South Africa. *PLOS ONE*, *8*(1), e53494. <https://doi.org/10.1371/journal.pone.0053494>
- Firnhaber, C., Mayisela, N., Mao, L., Williams, S., Swarts, A., Faesen, M., Levin, S., Michelow, P., Omar, T., Hudgens, M. G., Williamson, A.-L., Allan, B., Lewis, D. A., & Smith, J. S. (2013b). Validation of Cervical Cancer Screening Methods in HIV Positive Women from Johannesburg South Africa. *PLOS ONE*, *8*(1), e53494. <https://doi.org/10.1371/journal.pone.0053494>
- Fokom Domgue, J., & Valea, F. A. (2018). Is It Relevant to Keep Advocating Visual Inspection of the Cervix With Acetic Acid for Primary Cervical Cancer Screening in Limited-Resource Settings? *Journal of Global Oncology*, *4*, 1–5. <https://doi.org/10.1200/JGO.17.00048>
- Giorgi-Rossi, P., Franceschi, S., & Ronco, G. (2012). HPV prevalence and accuracy of HPV testing to detect high-grade cervical intraepithelial neoplasia. *International Journal of Cancer*, *130*(6), 1387–1394. <https://doi.org/10.1002/ijc.26147>
- Grulich, A. E., van Leeuwen, M. T., Falster, M. O., & Vajdic, C. M. (2007). Incidence of cancers in people with HIV/AIDS compared with immunosuppressed transplant recipients: A meta-analysis. *Lancet (London, England)*, *370*(9581), 59–67. [https://doi.org/10.1016/S0140-6736\(07\)61050-2](https://doi.org/10.1016/S0140-6736(07)61050-2)
- Guiguet, M., Boué, F., Cadranel, J., Lang, J.-M., Rosenthal, E., Costagliola, D., & Clinical Epidemiology Group of the FHDH-ANRS CO4 cohort. (2009). Effect of immunodeficiency, HIV viral load, and antiretroviral therapy on the risk of individual malignancies (FHDH-ANRS CO4): A prospective cohort study. *The Lancet. Oncology*, *10*(12), 1152–1159. [https://doi.org/10.1016/S1470-2045\(09\)70282-7](https://doi.org/10.1016/S1470-2045(09)70282-7)
- Hawes, S. E., Critchlow, C. W., Sow, P. S., Touré, P., N'Doye, I., Diop, A., Kuypers, J. M., Kasse, A. A., & Kiviat, N. B. (2006). Incident High-Grade Squamous Intraepithelial Lesions in Senegalese Women With and Without Human Immunodeficiency Virus Type 1 (HIV-1) and HIV-2. *JNCI: Journal of the National Cancer Institute*, *98*(2), 100–109. <https://doi.org/10.1093/jnci/djj010>
- Huchko, M. J., Sneden, J., Sawaya, G., Smith-McCune, K., Maloba, M., Abdulrahim, N., Bukusi, E. A., & Cohen, C. R. (2015). Accuracy of Visual Inspection with Acetic Acid

- 
- to detect Cervical Cancer Precursors Among HIV-infected Women in Kenya. *International Journal of Cancer. Journal International Du Cancer*, 136(2), 392–398. <https://doi.org/10.1002/ijc.28996>
- IARC. (2022). *Cervical Cancer Screening* (Vol. 18). IARC Press. <http://www.iarc.fr/en/publications/pdfs-online/prev/handbook10/>
- Ibrahim Khalil, A., Mpunga, T., Wei, F., Baussano, I., de Martel, C., Bray, F., Stelzle, D., Dryden-Peterson, S., Jaquet, A., Horner, M.-J., Awolude, O. A., Trejo, M. J., Mudini, W., Soliman, A. S., Sengayi-Muchengeti, M., Coghill, A. E., van Aardt, M. C., De Vuyst, H., Hawes, S. E., ... Clifford, G. M. (2022). Age-specific burden of cervical cancer associated with HIV: A global analysis with a focus on sub-Saharan Africa. *International Journal of Cancer*, 150(5), 761–772. <https://doi.org/10.1002/ijc.33841>
- INSIGHT START Study Group, Lundgren, J. D., Babiker, A. G., Gordin, F., Emery, S., Grund, B., Sharma, S., Avihingsanon, A., Cooper, D. A., Fätkenheuer, G., Llibre, J. M., Molina, J.-M., Munderi, P., Schechter, M., Wood, R., Klingman, K. L., Collins, S., Lane, H. C., Phillips, A. N., & Neaton, J. D. (2015). Initiation of Antiretroviral Therapy in Early Asymptomatic HIV Infection. *The New England Journal of Medicine*, 373(9), 795–807. <https://doi.org/10.1056/NEJMoa1506816>
- Jacobs, R., Heiken, H., & Schmidt, R. E. (2005). Mutual interference of HIV and natural killer cell-mediated immune response. *Molecular Immunology*, 42(2), 239–249. <https://doi.org/10.1016/j.molimm.2004.06.021>
- Jemal, A., Bray, F., Forman, D., O'Brien, M., Ferlay, J., Center, M., & Parkin, D. M. (2012). Cancer burden in Africa and opportunities for prevention. *Cancer*, 118(18), 4372–4384. <https://doi.org/10.1002/cncr.27410>
- Joint United Nations Programme on HIV/AIDS (UNAIDS). (2020). *AIDSinfo | UNAIDS*. <https://aidsinfo.unaids.org/>
- Joshi, S., Muwonge, R., Kulkarni, V., Deodhar, K., Mandolkar, M., Lucas, E., & Sankaranarayanan, R. (2018). Incidence of cervical intraepithelial neoplasia in women infected with human immunodeficiency virus (HIV) with no evidence of disease at baseline: Results of a prospective cohort study with up to 6.4 years of follow-up from India. *International Journal of Cancer*. <https://doi.org/10.1002/ijc.31826>
- Joshi, S., Sankaranarayanan, R., Muwonge, R., Kulkarni, V., Somanathan, T., & Divate, U. (2013). Screening of cervical neoplasia in HIV-infected women in India. *AIDS*

(London, England), 27(4), 607–615.
<https://doi.org/10.1097/QAD.0b013e32835b1041>

- Kelly, H., Benavente, Y., Pavon, M. A., De Sanjose, S., Mayaud, P., & Lorincz, A. T. (2019). Performance of DNA methylation assays for detection of high-grade cervical intraepithelial neoplasia (CIN2+): A systematic review and meta-analysis. *British Journal of Cancer*, 121(11), 954–965. <https://doi.org/10.1038/s41416-019-0593-4>
- Kelly, H., Chikandiwa, A., Sawadogo, B., Gilham, C., Michelow, P., Lompo, O. G., Omar, T., Zan, S., Magooa, P., Segondy, M., Nagot, N., Meda, N., Delany-Moretlwe, S., & Mayaud, P. (2021). Diagnostic accuracy of cervical cancer screening and screening–triage strategies among women living with HIV-1 in Burkina Faso and South Africa: A cohort study. *PLoS Medicine*, 18(3), e1003528. <https://doi.org/10.1371/journal.pmed.1003528>
- Kelly, H., Faust, H., Chikandiwa, A., Ngou, J., Weiss, H. A., Segondy, M., Dillner, J., Delany-Moretlwe, S., & Mayaud, P. (2018). Human Papillomavirus Serology Among Women Living With HIV: Type-Specific Seroprevalence, Seroconversion, and Risk of Cervical Reinfection. *The Journal of Infectious Diseases*. <https://doi.org/10.1093/infdis/jiy252>
- Kelly, H., Jaafar, I., Chung, M., Michelow, P., Greene, S., Strickler, H., Xie, X., Schiffman, M., Broutet, N., Mayaud, P., Dalal, S., Arbyn, M., & De Sanjosé, S. (2022). Diagnostic accuracy of cervical cancer screening strategies for high-grade cervical intraepithelial neoplasia (CIN2+/CIN3+) among women living with HIV: A systematic review and meta-analysis. *eClinicalMedicine*, 53, 101645. <https://doi.org/10.1016/j.eclinm.2022.101645>
- Kelly, H., Weiss, H. A., Benavente, Y., de Sanjose, S., Mayaud, P., & ART and HPV Review Group. (2018). Association of antiretroviral therapy with high-risk human papillomavirus, cervical intraepithelial neoplasia, and invasive cervical cancer in women living with HIV: A systematic review and meta-analysis. *The Lancet. HIV*, 5(1), e45–e58. [https://doi.org/10.1016/S2352-3018\(17\)30149-2](https://doi.org/10.1016/S2352-3018(17)30149-2)
- Kobayashi, A., Greenblatt, R. M., Anastos, K., Minkoff, H., Massad, L. S., Young, M., Levine, A. M., Darragh, T. M., Weinberg, V., & Smith-McCune, K. K. (2004). Functional attributes of mucosal immunity in cervical intraepithelial neoplasia and effects of HIV infection. *Cancer Research*, 64(18), 6766–6774. <https://doi.org/10.1158/0008-5472.CAN-04-1091>

- 
- Kremer, W. W., Steenbergen, R. D. M., Heideman, D. a. M., Kenter, G. G., & Meijer, C. (2021). The use of host cell DNA methylation analysis in the detection and management of women with advanced cervical intraepithelial neoplasia: A review. *BJOG: An International Journal of Obstetrics & Gynaecology*, *128*(3), 504–514. <https://doi.org/10.1111/1471-0528.16395>
- Kremer, W. W., Van Zummeren, M., Breytenbach, E., Richter, K. L., Steenbergen, R. D. M., Meijer, C. J. L. M., & Dreyer, G. (2019). The use of molecular markers for cervical screening of women living with hiv in South Africa. *AIDS (London, England)*. <https://doi.org/10.1097/QAD.0000000000002325>
- Langers, I., Renoux, V., Reschner, A., Touzé, A., Coursaget, P., Boniver, J., Koch, J., Delvenne, P., & Jacobs, N. (2014). Natural killer and dendritic cells collaborate in the immune response induced by the vaccine against uterine cervical cancer. *European Journal of Immunology*, *44*(12), 3585–3595. <https://doi.org/10.1002/eji.201444594>
- Liao, J. B., Fisher, C. E., & Madeleine, M. M. (2019). Gynecologic cancers and solid organ transplantation. *American Journal of Transplantation: Official Journal of the American Society of Transplantation and the American Society of Transplant Surgeons*, *19*(5), 1266–1277. <https://doi.org/10.1111/ajt.15292>
- Lin, C., Slama, J., Gonzalez, P., Goodman, M. T., Xia, N., Kreimer, A. R., Wu, T., Hessol, N. A., Shvetsov, Y., Ortiz, A. P., Grinsztejn, B., Moscicki, A.-B., Heard, I., Del Refugio González Losa, M., Kojic, E. M., Schim van der Loeff, M. F., Wei, F., Longatto-Filho, A., Mbulawa, Z. A., ... Clifford, G. M. (2019). Cervical determinants of anal HPV infection and high-grade anal lesions in women: A collaborative pooled analysis. *The Lancet. Infectious Diseases*, *19*(8), 880–891. [https://doi.org/10.1016/S1473-3099\(19\)30164-1](https://doi.org/10.1016/S1473-3099(19)30164-1)
- Looker, K. J., Rönn, M. M., Brock, P. M., Brisson, M., Drolet, M., Mayaud, P., & Boily, M.-C. (2018). Evidence of synergistic relationships between HIV and Human Papillomavirus (HPV): Systematic reviews and meta-analyses of longitudinal studies of HPV acquisition and clearance by HIV status, and of HIV acquisition by HPV status. *Journal of the International AIDS Society*, *21*(6), e25110. <https://doi.org/10.1002/jia2.25110>
- Mabeya, H., Khozaim, K., Liu, T., Orango, O., Chumba, D., Pisharodi, L., Carter, J., & Cu-Uvin, S. (2012). Comparison of Conventional Cervical Cytology versus Visual Inspection with Acetic Acid (VIA) among HIV-Infected Women in Western Kenya.



Journal of Lower Genital Tract Disease, 16(2), 92–97.
<https://doi.org/10.1097/LGT.0b013e3182320f0c>

Machalek, D., Poynten, M., Jin, F., Fairley, C. K., Farnsworth, A., Garland, S. M., Hillman, R. J., Petoumenos, K., Roberts, J., Tabrizi, S. N., Templeton, D. J., & Grulich, A. E. (2012). Anal human papillomavirus infection and associated neoplastic lesions in men who have sex with men: A systematic review and meta-analysis. *The Lancet. Oncology*, 13(5), 487–500. [https://doi.org/10.1016/S1470-2045\(12\)70080-3](https://doi.org/10.1016/S1470-2045(12)70080-3)

Machalek, D., Rees, H., Chikandiwa, A., Munthali, R., Travill, D., Mbulawa, Z., Petoumenos, K., Delany-Moretlwe, S., Kaldor, J., & HOPE Study team. (2022). Impact of one and two human papillomavirus (HPV) vaccine doses on community-level HPV prevalence in South African adolescent girls: Study protocol and rationale for a pragmatic before-after design. *BMJ Open*, 12(2), e059968. <https://doi.org/10.1136/bmjopen-2021-059968>


Mapanga, W., Singh, E., Feresu, S. A., & Girdler-Brown, B. (2020). Treatment of pre- and confirmed cervical cancer in HIV-seropositive women from developing countries: A systematic review. *Systematic Reviews*, 9(1), 79. <https://doi.org/10.1186/s13643-020-01345-2>


McCormick, L. J., Gutreuter, S., Adeoye, O., Alger, S. X., Amado, C., Bay, Z., Chirwa, C. M., Chituwo, O., Correia, D., Deus, M., Dirlikov, E., Efuntoye, T., Gunde, L., Kabaghe, A., Kalamya, J. N., Lorenzoni, C., Magesa, D., Mate, C., Mulokoshi, T., ... Montandon, M. (2023). Cervical Cancer Screening Positivity Among Women Living With HIV in CDC-PEPFAR Programs 2018–2022. *Journal of Acquired Immune Deficiency Syndromes* (1999), 94(4), 301–307. <https://doi.org/10.1097/QAI.0000000000003286>

McDonald, A. C., Tergas, A. I., Kuhn, L., Denny, L., & Wright, T. C. (2014). Distribution of Human Papillomavirus Genotypes among HIV-Positive and HIV-Negative Women in Cape Town, South Africa. *Frontiers in Oncology*, 4, 48. <https://doi.org/10.3389/fonc.2014.00048>


Moerman-Herzog, A., & Nakagawa, M. (2015). Early Defensive Mechanisms against Human Papillomavirus Infection. *Clinical and Vaccine Immunology: CVI*, 22(8), 850–857. <https://doi.org/10.1128/CVI.00223-15>

Moscicki, A.-B., Flowers, L., Huchko, M. J., Long, M. E., MacLaughlin, K. L., Murphy, J., Spiryda, L. B., & Gold, M. A. (2019). Guidelines for Cervical Cancer Screening in

- 
- Immunosuppressed Women Without HIV Infection. *Journal of Lower Genital Tract Disease*, 23(2), 87–101. <https://doi.org/10.1097/LGT.0000000000000468>
- National cervical cancer screening programs and coverage worldwide. (2020, July). 33rd International Papillomavirus Conference Barcelona, Barcelona (online). https://ipvconference.org/wp-content/uploads/sites/40/2020/09/IPVC20_-_Abstracts-final.pdf
- Ndizeye, Z., Menon, S., Van Geertruyden, J.-P., Sauvaget, C., Jacquemyn, Y., Bogers, J.-P., Benoy, I., & Vanden Broeck, D. (2019). Performance of OncoE6™ Cervical Test in detecting cervical precancer lesions in HIV-positive women attending an HIV clinic in Bujumbura, Burundi: A cross-sectional study. *BMJ Open*, 9(9), e029088. <https://doi.org/10.1136/bmjopen-2019-029088>
- Neukam, K., Milanés Guisado, Y., Fontillón, M., Merino, L., Sotomayor, C., Espinosa, N., López-Cortés, L. F., Vicianá, P., & SeVIHanal Study Group. (2019). High-resolution anoscopy in HIV-infected men: Assessment of the learning curve and factors that improve the performance. *Papillomavirus Research (Amsterdam, Netherlands)*, 7, 62–66. <https://doi.org/10.1016/j.pvr.2019.01.003>
- New York State Department of Health AIDS Institute. (2020). *Screening for Anal Dysplasia and Cancer in Patients with HIV*. <https://www.hivguidelines.org/hiv-care/anal-dysplasia-cancer/>
- Ntekim, A., Campbell, O., & Rothenbacher, D. (2015). Optimal management of cervical cancer in HIV-positive patients: A systematic review. *Cancer Medicine*, 4(9), 1381–1393. <https://doi.org/10.1002/cam4.485>
- Omenge Orang’o, E., Liu, T., Christoffersen-Deb, A., Itsura, P., Oguda, J., Washington, S., Chumba, D., Pisharodi, L., Cu-Uvin, S., & Rositch, A. F. (2017). Use of visual inspection with acetic acid, Pap smear, or high-risk human papillomavirus testing in women living with HIV/AIDS for posttreatment cervical cancer screening: Same tests, different priorities. *AIDS (London, England)*, 31(2), 233–240. <https://doi.org/10.1097/QAD.0000000000001327>
- Palefsky, J. M., Lee, J. Y., Jay, N., Goldstone, S. E., Darragh, T. M., Dunlevy, H. A., Rosa-Cunha, I., Arons, A., Pugliese, J. C., Vena, D., Sparano, J. A., Wilkin, T. J., Bucher, G., Stier, E. A., Tirado Gomez, M., Flowers, L., Barroso, L. F., Mitsuyasu, R. T., Lensing, S. Y., ... ANCHOR Investigators Group. (2022). Treatment of Anal High-Grade Squamous Intraepithelial Lesions to Prevent Anal Cancer. *The New England Journal of Medicine*, 386(24), 2273–2282. <https://doi.org/10.1056/NEJMoa2201048>

- 
- Rohner, E., Bütikofer, L., Schmidlin, K., Sengayi, M., Maskew, M., Giddy, J., Taghavi, K., Moore, R. D., Goedert, J. J., Gill, M. J., Silverberg, M. J., D'Souza, G., Patel, P., Castilho, J. L., Ross, J., Sohn, A., Bani-Sadr, F., Taylor, N., Papanizos, V., ... Bohlius, J. (2020). Cervical cancer risk in women living with HIV across four continents: A multicohort study. *International Journal of Cancer*, *146*(3), 601–609. <https://doi.org/10.1002/ijc.32260>
- Sahasrabuddhe, V. V., Bhosale, R. A., Kavatkar, A. N., Nagwanshi, C. A., Joshi, S. N., Jenkins, C. A., Shepherd, B. E., Kelkar, R. S., Sahay, S., Risbud, A. R., Vermund, S. H., & Mehendale, S. M. (2012). Comparison of visual inspection with acetic acid and cervical cytology to detect high-grade cervical neoplasia among HIV-infected women in India. *International Journal of Cancer. Journal International Du Cancer*, *130*(1), 234–240. <https://doi.org/10.1002/ijc.25971>
- Schiffman, M., Doorbar, J., Wentzensen, N., de Sanjosé, S., Fakhry, C., Monk, B. J., Stanley, M. A., & Franceschi, S. (2016). Carcinogenic human papillomavirus infection. *Nature Reviews Disease Primers*, *2*(1), Article 1. <https://doi.org/10.1038/nrdp.2016.86>
- Segondy, M., Kelly, H., Magooa, M. P., Djigma, F., Ngou, J., Gilham, C., Omar, T., Goumbri-Lompo, O., Michelow, P., Doutre, S., Clavero, O., Chikandiwa, A., Sawadogo, B., Didelot, M.-N., Costes, V., Méda, N., Delany-Moretlwe, S., & Mayaud, P. (2016). Performance of careHPV for detecting high-grade cervical intraepithelial neoplasia among women living with HIV-1 in Burkina Faso and South Africa: HARP study. *British Journal of Cancer*, *115*(4), 425–430. <https://doi.org/10.1038/bjc.2016.207>
- Shah, S., Xu, M., Mehta, P., Zetola, N. M., & Grover, S. (2021). Differences in Outcomes of Chemoradiation in Women With Invasive Cervical Cancer by Human Immunodeficiency Virus Status: A Systematic Review. *Practical Radiation Oncology*, *11*(1), 53–65. <https://doi.org/10.1016/j.prro.2020.04.007>
- Sigrid, L., Murphy, G., Haldane, V., Chuah, F. L. H., Ong, S. E., Cervero-Liceras, F., Watt, N., Alvaro, A., Otero-Garcia, L., Balabanova, D., Hogarth, S., Maimaris, W., Buse, K., Mckee, M., Piot, P., Perel, P., & Legido-Quigley, H. (2017). Integrating cervical cancer with HIV healthcare services: A systematic review. *PloS One*, *12*(7), e0181156. <https://doi.org/10.1371/journal.pone.0181156>
- Stelzle, D., Tanaka, L. F., Lee, K. K., Khalil, A. I., Baussano, I., Shah, A. S. V., McAllister, D. A., Gottlieb, S. L., Klug, S. J., Winkler, A. S., Bray, F., Baggaley, R., Clifford, G. M., Broutet,

- N., & Dalal, S. (2020). Estimates of the global burden of cervical cancer associated with HIV. *The Lancet Global Health*, 0(0). [https://doi.org/10.1016/S2214-109X\(20\)30459-9](https://doi.org/10.1016/S2214-109X(20)30459-9)
- Stewart, D. B., Gaertner, W. B., Glasgow, S. C., Herzig, D. O., Feingold, D., Steele, S. R., & Prepared on Behalf of the Clinical Practice Guidelines Committee of the American Society of Colon and Rectal Surgeons. (2018). The American Society of Colon and Rectal Surgeons Clinical Practice Guidelines for Anal Squamous Cell Cancers (Revised 2018). *Diseases of the Colon and Rectum*, 61(7), 755–774. <https://doi.org/10.1097/DCR.0000000000001114>
- Strickler, H. D., Keller, M. J., Hessel, N. A., Eltoun, I.-E., Einstein, M. H., Castle, P. E., Massad, L. S., Flowers, L., Rahangdale, L., Atrio, J. M., Ramirez, C., Minkoff, H., Adimora, A. A., Ofotokun, I., Colie, C., Huchko, M. J., Fischl, M., Wright, R., D'Souza, G., ... Burk, R. D. (2020). Primary HPV and Molecular Cervical Cancer Screening in US Women Living with HIV. *Clinical Infectious Diseases: An Official Publication of the Infectious Diseases Society of America*. <https://doi.org/10.1093/cid/ciaa1317>
- The path that ends AIDS: UNAIDS Global AIDS Update 2023*. (2023). Joint United Nations Programme on HIV/AIDS. <https://www.unaids.org/en/resources/documents/2023/global-aids-update-2023>
- The urgency of now: AIDS at a crossroads. UNAIDS Global AIDS Update 2023*. (2024). Joint United Nations Programme on HIV/AIDS. https://www.unaids.org/sites/default/files/media_asset/2024-unaids-global-aids-update_en.pdf
- Toft, L., Tolstrup, M., Storgaard, M., Ostergaard, L., & Sogaard, O. S. (2014). Vaccination against oncogenic human papillomavirus infection in HIV-infected populations: Review of current status and future perspectives. *Sexual Health*, 11(6), 511–523. <https://doi.org/10.1071/SH14015>
- UNAIDS. (2024, April 9). *2025 AIDS TARGETS* [2025 AIDS Targets]. 2025 AIDS Targets. <https://aidstargets2025.unaids.org/>
- WHO guideline for screening and treatment of cervical pre-cancer lesions for cervical cancer prevention* (Second edition). (2021). World Health Organization.

- 
- Woodman, C. B. J., Collins, S. I., & Young, L. S. (2007). The natural history of cervical HPV infection: Unresolved issues. *Nature Reviews. Cancer*, 7(1), 11–22. <https://doi.org/10.1038/nrc2050>
- World Health Organization. (2021). *WHO guidelines for screening and treatment of precancerous lesions for cervical cancer prevention* (2nd edn). WHO Press, World Health Organization. <https://www.who.int/publications/i/item/9789240030824>
- World Health Organization. (2022). Human papillomavirus vaccines: WHO position paper (2022 update). *Weekly Epidemiological Record*, 97(50), 642–672.
- Wu, T. C., & Kurman, R. J. (1997). Analysis of cytokine profiles in patients with human papillomavirus-associated neoplasms. *Journal of the National Cancer Institute*, 89(3), 185–187. <https://doi.org/10.1093/jnci/89.3.185>
- Yang, L., Boily, M.-C., Rönn, M. M., Obiri-Yeboah, D., Morhason-Bello, I., Meda, N., Lompo, O., Mayaud, P., Pickles, M., Brisson, M., Hodgins, C., Delany-Moretlwe, S., & Maheu-Giroux, M. (2023). Regional and country-level trends in cervical cancer screening coverage in sub-Saharan Africa: A systematic analysis of population-based surveys (2000–2020). *PLoS Medicine*, 20(1), e1004143. <https://doi.org/10.1371/journal.pmed.1004143>
- Zummeren, M. V., Kremer, W. W., Aardt, M. C. V., Breytenbach, E., Richter, K. L., Rozendaal, L., Witte, B. I., Strooper, L. M. A. D., Hesselink, A. T., Heideman, D. A. M., Snijders, P. J. F., Steenbergen, R. D. M., Dreyer, G., & Meijer, C. J. L. M. (2017). Selection of women at risk for cervical cancer in an HIV-infected South African population. *AIDS*, 31(14), 1945–1953. <https://doi.org/10.1097/QAD.0000000000001583>