Cancer in older adults living with HIV

Question

What are the aspects of the incidence, prevalence, prevention, diagnosis, and immunological profiles of cancer among older people living with HIV?

Key Take-Home Messages

- Evidence shows that cancer risk among older people living with HIV is increased for some cancers (e.g., anal, lung, liver) (1).
- Earlier initiation of antiretroviral therapy (ART) following HIV acquisition reduces non-AIDS-defining cancer risk (NADC) (2, 3).
- Due to the longer life expectancy of people living with HIV achieved with antiretroviral therapy , the burden from aging-related cancers (e.g., breast, colon, prostate cancers) can be expected to increase (4). By 2030, prostate and lung cancers are expected to emerge as the most common types of cancer among people living with HIV (5).
- Cancer prevention in older people living with HIV requires a comprehensive and multifaceted approach; prevention strategies include cancer screening (6, 7), vaccinations against oncogenic viruses, management of co-infections, sustained ART adherence, and lifestyle changes (e.g., diet, exercise, smoking cessation) (8, 9). However, uptake of preventive services (e.g., anal cancer screening) remains suboptimal (10, 11).
- Older adults living with HIV who develop NADCs exhibit a distinct immunological profile characterized by preserved immune function alongside chronic inflammation (12), immune activation (13), and accelerated aging (14). This suggests that cancer risk in this population is driven more by immune dysregulation and inflammaging rather than by immunosuppression (14, 15).

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Prepared by
Ryan LaPenna

Program Leads / Editors
David Gogolishvili

Contact
rapidresponse@ohtn.on.ca

For more information visit
www.ohtn.on.ca/rapid-response-service

The Ontario HIV Treatment Network
1300 Yonge Street, Suite 600
Toronto ON M4T 1X3
www.ohtn.on.ca

The Issue and Why it's Important

Globally, the population of people living with HIV is aging. For example, according to 2022 data from the Centers for Disease Control and Prevention, approximately 54% of people living with HIV in the U.S. were 50 years and older (16). HIV surveillance data from Ontario reported that in 2020, the median age of males (52 years) living with diagnosed HIV in Ontario was slightly higher compared to their female counterparts (46 years) (17). Notably, those aged between 55 and 64 made up the largest number (n=5,278; 26.5%) of people living with diagnosed HIV in Ontario (17).

The primary reason for this demographic shift is the improvements in the effectiveness of antiretroviral therapy (ART) in prolonging life (16). According to a model simulation study from 2015, the proportion of the HIV population over 50 years old will rise from 28% in 2010 to 73% by the year 2030 (18). Longer life expectancy from ART is itself associated with a greater burden of multimorbidities (19). One comorbidity that has received significant attention since the beginning of the HIV epidemic is cancer, a leading cause of death in people living with HIV (20). In the pre-ART era, a significant burden of cancer among people living with HIV was associated with advanced immunosuppression, caused by the natural progression of HIV infection (14). These types of cancers are called acquired immunodeficiency syndrome defining cancer (ADC). Examples of ADCs include Kaposi sarcoma, Non-Hodgkin lymphoma, and invasive cervical cancer (14). The introduction and effectiveness of ART have shifted the cancer burden in people living with HIV from ADCs to NADCs (14, 21).

A 2023 meta-analysis of 20 studies (half from the U.S.) reported a decreasing trend in the incidence of ADCs and increasing trend of NADCs among people living with HIV (21). NADCs, such as lung, liver, and anal cancers, develop through mechanisms that are not directly related to immunodeficiency (14). They may be influenced by factors such as chronic inflammation, viral co-infections, and environmental or behavioural exposures (14). While the researchers suggest that the decrease in ADCs can be attributed to improved immunity resulting from the effectiveness of ART, the reason for an increase in NADCs is not yet fully explained (21). Although getting older increases the risk of cancer because of harmful changes in cells build up over time and the weakening of the immune system in fighting abnormal cells (14, 22), the increase in the incidence of NADCs cannot be explained solely by this fact (21) . Notably, cancer risk is complex and associated with multiple factors in addition to older age, such as risk behaviors (e.g. smoking) and coinfection with viruses linked to cancer (i.e. oncogenic viruses) (21).

The shift in cancer burden after the introduction of ART is also reflected in cancer epidemiological data of people living with HIV in Ontario (23). In this study, the authors grouped cancers as infection-related and infection-unrelated (23). From 1997–2000 to

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2016–2020, the overall incidence of cancer among people living with HIV declined, primarily due to a considerable decrease in the incidence of ADCs (23). By comparison, there was little to no decline in the incidence of infection-related NADCs, while the incidence of infection-unrelated cancers remained stable and accounted for the greatest proportion of the overall cancer burden (23).

With the increasing number of people aging with HIV in Ontario (17), there remains knowledge gaps such as identifying the best practices surrounding the care of this population (24). Additionally, the aging of people living with HIV suggests increased future health care resource utilization (25). From a health policy perspective, this underscores the need to organize health care systems in ways that effectively address the unique needs of this population. This review aims to synthesize research evidence from the literature on the incidence, prevalence, diagnosis, types, and immunological profiles of cancer among older adults aging with HIV. It is focused on older adults (typically defined as people aged 50 and older) living with HIV with non-AIDS defining cancers in high-income countries.

What We Found

We found several systematic reviews and/or meta-analyses estimating the cancer incidence and mortality risk in the general HIV population and not specifically focused on older age groups by age, (26–29). As it is important for a general understanding of this issue, we present these findings first (26–29), followed by cancer-related evidence specifically among older adults living with HIV (1, 4, 30, 31).

NADC risk in people living with HIV

Incidence and mortality risk of NADCs for people living with HIV (non-age specific)

A 2024 systematic review and meta-analysis by Jin *et al.*, published in Lancet Oncology, focused on evaluating the cancer risk in people living with HIV and solid organ transplants (26). The researchers included 46 studies which compared cancer incidence in people living with HIV, covering the years of HIV diagnosis from 1978–2017, with cancer incidence in the general population, and subsequently calculated meta-standardised incidence ratios (SIR) (26). Due to the lack of uniformity in the time periods and age groups reported by individual studies, the researchers were unable to calculate trends in age-specific meta-SIR over time (26). Nonetheless, meta-SIRs were estimated for several types of NADCs, and compared to the general population, there was an over four-fold increase in liver cancer incidence (SIR=4.26; 95% CI 3.09–5.88) (26). People living with HIV

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had an increased risk of cancers caused by human papillomavirus (HPV), with anal cancer exhibiting the highest excess risk (SIR=37.28; 95% CI 23.65–58.75) (26). For all five cancer types classified as being possibly associated with HPV infection (lip, esophageal, laryngeal, cutaneous squamous cell, eye), risk was also significantly elevated (26). Authors found that thyroid cancer among people living with HIV was significantly lower than in the general population (SIR=0.52; 95% CI 0.44–0.62) (26). Additionally, the risk of six types of cancers (brain, breast, ovary, uterus, prostate and testicle) was not increased among people living with HIV (26). Although this review does not focus on older adults living HIV, it highlights that people living with HIV have a higher risk of several cancers, influenced by factors such as immune status, cancer-causing viruses, and other risk factors (26).

A 2022 systematic review and meta-analysis of 92 publications based on 46 independent studies by Yuan *et al.*, estimated the pooled risk of incidence and mortality of NADCs among people living with HIV compared to the general population by calculating pooled SIRs and standardised mortality ratios (SMRs) (27). The review grouped NADCs by infection-related cancers (e.g., anal cancer) and cancers remotely relevant or irrelevant to infection (e.g., lung cancer) (27). The authors found that among the 40 types of NADCs investigated, all 20 infection-related types—especially those linked to HPV—and half of the 20 non-infection-related types occurred more frequently in people living with HIV compared to the general population (27). Specifically, the review found that people living with HIV were more likely to die from the following cancers in comparison to the general population:

A) Infection-related cancers: anal cancer (SMR=124.07; 95% CI 27.31–563.72), Hodgkin lymphoma (SMR=41.03; 95% CI 2.91–577.88), liver cancer (SMR=8.36; 95% CI 3.86–18.11)

B) Non-infection-related cancers: trachea, bronchus, lung (SMR=3.95 (1.52–10.26), brain and central nervous system (SMR=3.82; 95% CI 1.01–14.49), and skin melanoma (SMR=3.95; 95% CI 1.28–12.20) (27).

Yuan *et al.*, indicate several limitations in their review, notably the inability to conduct analyses using more direct measures of HIV-related immunosuppression, such as CD4 count and viral load (27). Importantly, the authors highlight the need for more well-designed clinical cohort studies to assess the impact of HIV-related immunodeficiency and ART use on the risk and outcomes of NADCs (27). Studies comparing NADCs risk across subgroups (e.g. by age, sex, HIV key populations) with adjustment for confounders (e.g. frequency of cancer screening) are also essential (27).

In summary, these two recently published review articles estimate a two- to 37-fold increased risk of several NADCs in people living with HIV compared to the general population—especially liver cancer

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(SIR 4.3, SMR 8.4) and HPV-related cancers like anal cancer (SIR up to 37.3, SMR 124.1) (26, 27).

NADC burden among older people living with HIV

Mahale *et al.* (2018) focused specifically on cancer risk in older adults living with HIV (1, 27). Data from the HIV/AIDS Cancer Match Study (1996-2012) were used to compare cancer risks in older people living with HIV (183,542 individuals aged 50 years and older) to the general population by calculating SIRs and excess absolute risks (i.e. difference between the expected and observed cancer rates) for multiple cancer types (1). The study found significantly increased risks for NADCs, including anal (SIR 14.00), lung (SIR 1.71), liver (SIR 2.91), oral cavity/pharyngeal (SIR 1.66) cancers and Hodgkin lymphoma (SIR 7.61) (1). In contrast, risks were reduced for breast (SIR 0.61), prostate (SIR 0.47), and colon (SIR 0.63) cancers (1). While SIRs declined with age, excess absolute risks increased for anal, lung, liver, and oral cavity/pharyngeal cancers—indicating a higher cancer burden in older people living with HIV (as the raw number of cancer cases still rise due to the natural increase in cancer incidence with aging) (1). Notably, lung cancer risk declined with longer time since HIV diagnosis, highlighting an observed association between time since diagnosis and lung cancer incidence among older people living with HIV (1).

Relating to the findings of Mahale *et al.* (2018), which highlighted elevated risk of some cancers among older people living with HIV (1), a study by Haas *et al.* (2025) further demonstrates that cancer incidence—particularly for aging-related cancers like breast, colon, and prostate—increases sharply with age in this population (4). On a related note, a study using data from the Medicaid Analytic eXtract database, which included 72,508 women living with HIV, found that breast cancer prevalence was five times higher among older women (aged 45–64) compared to younger women (aged 18-44), with an adjusted prevalence ratio of 5.13 [95% CI 4.22–6.22] (30). Haas *et al.* estimated cancer incidence rates (IRs) using a population-based linkage of HIV and cancer registries of data from 12 U.S. States between 2001–2019 (4). From their cohort that included 847,107 people living with HIV (7.2 million person-years), they found that the incidence of breast, colon, and prostate cancers dramatically increased with older age; thus, the cancer burden among people with HIV can be expected to increase (4).

A 2021 review by Chiao *et al.* in Lancet Oncology touches upon the evolving cancer risk and burden in the aging HIV population (28). The authors note that the magnitude and direction of the association between rates of HIV and NADCs vary by tumour type and do not directly reflect overall cancer burden (28). For instance, in cancers that are less common among people living with HIV than in the general population—such as prostate cancer, which showed an SIR ≤1 in two of three studies—the longer life expectancy achieved

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with ART has led to a higher absolute number of older adults living with HIV (28). As a result, more individuals living with HIV are now reaching ages at which these cancers typically occur (28).

These nuances in cancer epidemiology are important for improving our understanding as the cancer burden among people with HIV is projected to shift in the coming years (5). A modelling study projected that by 2030, prostate and lung cancers are expected to emerge as the most common types of cancer among people living with HIV (5). Similarly, a simulation study estimated that as the population of people living with HIV on ART continues to grow, the prevalence of most comorbidities will surge by 2030, while the prevalence of cancer is expected to remain relatively stable at around 11% (32).

Chiao *et al.* identified one study reporting cancer outcomes among older adults living with HIV in the U.S. (28). Using Medicare data among adults aged 65 and older, there was a significantly higher overall mortality for colorectal (hazard ratio [HR]: 1.73; 95% CI 1.11–2.68), prostate (HR=1.58; 95% CI 1.23-2.03), and breast (HR=1.50; 95% CI 1.01–2.24) cancers amongst people living with HIV, compared to those not living with HIV (28, 31). Additionally, older adults living with HIV with breast cancer (HR=1.63; 95% CI 1.09–2.43) or prostate cancer (HR=1.32; 95% CI 1.03–1.71) had higher rates of cancer-related death and relapse after initial treatment compared with the broader Medicare oncology population (31). These findings suggest that the consistently poor cancer outcomes observed in people living with HIV are likely driven by multiple factors—including disparities between cancer treatment, the effects of HIV-related immune dysfunction on how cancer develops and progresses, and a higher comorbidity burden—rather than being limited to cancers linked to viral co-infections (28).

Thrift *et al.* (2018) reviewed the epidemiology of NADCs in people living with HIV, with attention given to the shifting cancer burden as the HIV population ages (29). This review found that the burden of NADCs is likely to increase as people living with HIV live longer and the incidence of specific NADCs changes at different rates (29). In general, compared with the general population, the authors found strong evidence that people living with HIV are at increased risk for lung, cancer, head and neck cancers, anal cancer, hepatocellular carcinoma, and Hodgkin lymphoma (29). While most NADCs do not generally occur at younger ages, people living with HIV are diagnosed with lung, head and neck, and anal cancers at younger ages compared with the general population (29). This review analyzes the epidemiology of cancer burden by cancer type (29):

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Colorectal cancer

Despite the growing numbers of people living with HIV being diagnosed with colorectal cancer annually, evidence shows no increased risk compared to the general population (29). A meta-analysis also reported no association (SIR 1.1; 95% CI 0.69–1.7) (33), and the HIV/AIDS Cancer Match Study found a decreased risk (colon cancer SIR=0.61; 95% CI 0.56–0.67; rectal cancer SIR=0.69; 95% CI 0.61–0.77) (34). Colorectal cancer incidence increases with age in both people living with HIV and the general population, and therefore standard screening guidelines remain applicable to people living with HIV (29). Additionally, there was no evidence of earlier onset of colorectal cancer among people living with HIV, as mean age at diagnosis does not differ significantly by HIV status (29, 35).

Lung cancer

HIV infection is independently associated with an increased risk of lung cancer, above and beyond higher tobacco use among people living with HIV, with SIR of 1.97 (95% CI: 1.89–2.05) (34). Lung cancer was found to be typically diagnosed 3–4 years earlier in people living with HIV compared to the general population (35). However, the magnitude of the association between HIV infection and lung cancer risk is modest, and variability across studies likely reflects differences in how well tobacco exposure is controlled in a study (29).

Prostate cancer

Most studies support the evidence that there is a lower risk of prostate cancer associated with HIV infection (29, 36). However, significant heterogeneity exists among these studies and further prospective studies with better designs are needed to elucidate the association between HIV infection and prostate cancer (36), provided that the incidence of prostate cancer is expected to rise further as people living with HIV continues to age (29).

Hepatocellular carcinoma

Hepatocellular carcinoma (HCC), the most common type of primary liver cancer, is associated with hepatitis B virus (HBV) and hepatitis C virus (HCV) infections in over 70% of cases—viruses that are more prevalent among people living with HIV (29, 37). In general, evidence shows an increased risk for liver cancer among people living with HIV, as reported by a meta-analysis (SIR=5.6; 95% CI 4.0–7.7) (33) and from HIV/AIDS Cancer Match Study data (SIR=3.21; 95% CI 3.02–3.41) (34). However, the authors note that many studies face limitations in accounting for confounders like alcohol use and hepatitis C infection, and clinical guidelines recommend liver cancer

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screening for those with HIV and viral hepatitis co-infection (29).

Head and neck cancers

People with HIV are at increased risk for head and neck cancers, particularly those associated with HPV-16, with studies reporting approximately a twofold higher risk compared to the general population (SIR=1.64; 95% CI 1.46–1.84) (34). Additionally, people living with HIV were typically diagnosed with oral cavity and pharyngeal cancers about two years earlier than the general population (35).

Anal cancer

The review found that people living with HIV are at significantly increased risk for anal cancer, largely due to HPV infection (29) (REF). This risk is strongly influenced by immune status: those with CD4 counts ≤200 having a 91.5-fold increased risk and those with CD4 ≥500 still facing a 33.8-fold higher risk compared to the general population (38). People living with HIV are typically diagnosed with anal cancer about four years earlier compared to the general population (35). Declining SIRs over time and associations between lower HIV viral load and reduced anal cancer risk highlight the importance of immune function and ART in mitigating HPV-related cancer risk (29).

Hodgkin lymphoma

People living with HIV have an almost eightfold increased risk of Hodgkin lymphoma, likely due to Epstein-Barr virus, with a reported SIR of 7.7 from data analyzed from the U.S. HIV/AIDS Cancer Match study (34).

Skin cancer

We found one systematic review on skin cancer risk in people living with HIV aged 50 years and older (39). Limited data from three of the four included studies found no statistically significant associations between HIV infection and overall skin cancer risk compared to age-matched HIV-negative persons (39). However, people living with HIV with a history of basal or squamous cell carcinoma did have a higher risk of developing subsequent squamous cell carcinoma (39).

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Cancer prevention among older adults aging with HIV

Incidence for certain NADCs (especially for infection-related NADCs) may continue to change over the next several decades, with NADCs that have increased incidence among the elderly (lung cancer, prostate cancer, and colorectal cancer) causing an increasing proportion of cancer morbidity and mortality among people living with HIV (29). This highlights the need for timely and ongoing screening and prevention efforts for NADCs throughout the course of HIV care (29).

A 2023 review focused on clinical interventions that mitigate frailty and aging among people living with HIV, and areas of investigation towards achieving these interventions (9). The authors recommended a continued reinforcement of the proven strategy of ART as well as treatment of co-infections and age-appropriate health and cancer screening in people aging with HIV (9). At present, the most effective strategy to curtail persistent immune activation and inflammation as a prevention tool against developing non-AIDS defining, age-related comorbidities like NADCs, appears to be early ART initiation (40). When given special attention to cancer prevention strategies, the review authors emphasized the importance of implementing age-appropriate cancer screening with systems and reminders in place particularly for patients who are not compliant with office visits (9).

A 2019 review by McMillan *et al.* described the comorbidity burden and challenges in the care management in older adults living with HIV older than 50 years (24). The authors noted that there are distinct differences between people who are aging with HIV and people who seroconvert at an older age, and each group has their own unique needs (24). People who have aged with HIV have higher rates of comorbid illness at younger ages than people not living with HIV (24). As people living with HIV age and benefit from ART, non-HIV related cancers—particularly those linked to aging and lifestyle factors like smoking—are becoming more common, highlighting the need for appropriate cancer screening (24). The authors note that while national guidelines exist for the general population, such as the Canadian Task Force guidelines for breast, colon, lung, prostate, and hepatocellular cancers, specific cancer recommendations tailored to people living with HIV are still lacking (24). Availability of resources may play an important role as well. For example, for anal cancer, the appropriate investigation for an abnormal result on anal Pap test is high-resolution anoscopy, but access to high-resolution anoscopy in Canada is extremely limited, with only a few clinicians in major urban centres providing this service (41).

A 2021 review by Webel *et al.* discussed current evidence on the prevention strategies and screening options for people living with HIV (8). For lung cancer, prevention strategies include using the smoking cessation model, increasing physical activity and having

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a balanced, healthy diet (8). Structural changes such as tobacco taxes and tobacco-free zones may be considered for a population-based policy approach (8). For liver cancer prevention, key strategies include improving injection hygiene among people who use drugs, reducing alcohol and tobacco consumption, promoting safer sexual practices, and recommending vaccination against hepatitis B (8). Routine substance use screening and access to a collaborative care model may help mitigate barriers to promoting these lifestyle changes (8). Lastly, for anal cancer, the review suggests HPV vaccination, reduction of HPV exposure via condom use, treating anal lesions, and smoking cessation as prevention strategies (8).

In addition, a 2021 review Johnson *et al.* examined strategies that HIV care clinicians can implement for cancer screening for their older clients (7). For example, prevention strategies include tobacco counselling and low dose chest CT scan for lung cancer prevention, and rectal exam, prostate-specific antigen testing for prostate cancer prevention (7). Importantly, the authors highlight that immunizations are an important part of primary care for older adults with HIV, with the HBV vaccine as a preventative tool to prevent liver cancer (7).

Cancer prevention strategies to include in an HIV program, adapted from the aforementioned reviews, are presented in **Table 1**.

A 2025 study examining the impact of cancer screening for breast and colorectal cancer survival among U.S. Medicare enrollees aged 50 and older living with HIV highlighted the importance of cancer screening in this group (6). Among women with HIV, breast cancer mortality was 0.28% in those aged 50–64 and 0.40% in those aged 65 and older, with both age groups showing significant benefits from screening (6). Screening was associated with a 47% reduction in breast cancer mortality among women aged 50–64 (HR 0.53, 95% CI 0.32–0.87) and a 53% reduction among women aged 65+ (HR 0.47; 95% CI: 0.29–0.76) (6). In addition, colonoscopy screening showed significant survival benefit in older adults aged 50-64 (HR 0.41, 95% 0.20–0.88) (6).

Several studies highlight suboptimal cancer screening rates among older people living with HIV, despite elevated risk for many cancers (10, 11, 42). For example, only 30% of African American men with HIV aged 45–88 reported recent colorectal cancer screening (11), and a study from Ontario found that less than half of HIV-positive men aged 50–65 had received any colorectal cancer screening over five years, despite universal access to colorectal cancer screening (10). Among women, those with HIV aged 65+ had largely negative cervical cancer screening results, raising questions about the utility of continued Pap testing in this age group (43), while another study showed that HIV-positive women are significantly less likely to receive breast cancer screening compared to their HIV-negative peers (42).

Immunological profile of NADCs in older adults living with HIV

The development of NADCs among older adults living with HIV is influenced by a complex interplay of multiple factors, including chronic inflammation, immune aging (immunosenescence), persistent viral co-infections (44–46), and lifestyle factors (13). Aging is independently a major risk factor for cancer due to accumulated genetic and epigenetic (i.e. changes that affect how genes are turned on/off without altering the DNA sequence) damage, environmental exposures, and declining immune surveillance (44). Epigenetic studies revealed signs of accelerated biological aging in people living with HIV, including shortened telomeres and elevated DNA methylation age (47, 48). While higher epigenetic age has been observed in people living with HIV with NADCs compared to people without HIV (48), other findings suggest that a cancer diagnosis itself is not independently associated with accelerated aging, and that ART may help mitigate some of the aging-related changes (49). Although there appears to be a link between HIV infection and accelerated aging, the association with cellular senescence and the mechanisms contributing to it are not fully understood (50).

People living with HIV are predisposed to chronic inflammatory conditions that contribute to age-associated diseases, including NADCs. HIV is thought to accelerate the aging process through a process known as "inflammaging"—a chronic, low-

grade inflammation driven by persistent immune activation (12). Inflammaging could be a key driver of cancer (15). Multiple processes are envisaged as a contributor to inflammation, including chronic immune inflammation, microbial translocation, co-infections such as cytomegalovirus CMV, HBV, and HCV (13, 15).

In a retrospective observational study at clinics in Italy, Segala *et al.* (2025) reported that 87.2% of cancer cases among 70 people living with HIV occurred in those aged 50 years and above, with NADCs being more common than ADCs (14). Importantly, most NADCs occurred in individuals with well controlled HIV (i.e. suppressed viral load and CD4 counts >500/μL), with serology revealing a higher prevalence of co-infections compared with ADCs (14). The immunological profile of older adults aging with HIV on ART with cancer often reflects a paradoxical state, characterized by preserved immune function, coexisting with persistent immune activation, chronic inflammation, immune aging, and frequent co-infections (14). Thus, cancer development in this population appears to be driven less by traditional markers of immunosuppression and more by a chronically dysregulated and aging immune environment (14). These findings highlight the crucial need for tailored cancer prevention and screening strategies that account for the unique immunological and aging-related dynamics among older adults aging with HIV (14).

Factors That May Impact Local Applicability

Most of the research evidence presented in this rapid response was extracted from studies conducted in the U.S.; this may limit the applicability of the findings to Canadian jurisdictions due to differences in demographics, healthcare access and coverage, and available screening programs.

What We Did

We searched Medline (including Ovid MEDLINE® and Epub Ahead of Print, In-Process, In-Data-Review & Other Non-Indexed Citations) using text term HIV AND terms (aging or ageing or older or aged) in titles or abstracts AND term cancer* in titles or abstracts. Searches were conducted on September 30, 2025 and results limited to articles published in English since 2015. Literature search was restricted to research conducted in high-income settings. Reference lists of identified articles were also searched. The searches yielded 627 references from which 50 were included.

Table 1. Cancer prevention strategies to include in an HIV program. Cancer prevention and screening strategies adapted from Johnson *et al.*, 2021 and Webel *et al.*, 2021. SIRs for lung, anal, prostate, colorectal, and liver cancers retrieved from Thrift *et al.*, 2018.

Cancer	Risk (magnitude and direction of association) (29)	Prevention and/or screening strategies (7, 8)
Lung	+	Tobacco counselling, healthy lifestyle promotion (physical activity, healthy diet), low-dose chest CT scanning
Oral	Not available	Oral exam
Anal	+++	HPV vaccine, counselling on tobacco use and safer sex practices, rectal exam, anal cytology, treat anal lesions
Prostate	–	Rectal exam, PSA testing discussion
Cervical	Not available	Pelvic exam, cervical cytology, HPV testing
Colorectal	None	Rectal exam, fecal occult blood testing, colonoscopy
Melanoma	Not available	Periodic skin exams, sun exposure counselling
Liver	+	HBV vaccine, hepatitis B and C treatment (if applicable), injection drug use treatment (if applicable), alcohol and tobacco counselling, abdominal ultra-sound, CT scan for surveillance

+ indicates a standardized incidence ratio (SIR) < 5; + + indicates an SIR of 5–10; and + + + indicates an SIR > 10

CT: computed tomography; PSA: prostate-specific antigen