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ORIGINAL PAPER

Healthy behavioral choices and cancer screening in persons living with HIV/AIDS are different by sex and years since HIV diagnosis

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Abstract

Purpose The prevalence of non-AIDS-related malignancies is on the rise among people aging with HIV population, but the evidence on healthy behaviors including cancer screening practices in this population subgroup is extremely limited. Therefore, we investigated the prevalence of healthy behaviors and sex-specific cancer screening among persons living with HIV, by sex and time since HIV diagnosis.

Methods We included 517 persons living with HIV from the Florida Cohort. Data were obtained from the baseline and follow-up questionnaires, electronic medical records, and Enhanced HIV/AIDS Reporting System. The prevalence of self-reported, age-appropriate cancer screening (anal, colorectal, prostate, breast, and cervical), and healthy behaviors (sustaining healthy body weight, refraining from smoking and alcohol and engaging in physical activity) was compared by sex and years since HIV diagnosis (≤ 13 vs. > 13 years).

Results In the analyses by sex, females were more likely to be obese than males (56.5% vs. 22.2%, $p < 0.0001$). Distribution of healthy behaviors did not differ by time since diagnosis among males and females. In the analysis of age-appropriate screening among males, 64.8% never had an anal Pap-smear, 36.2% never had a colonoscopy, and 38.9% never had prostate cancer screening. In the analysis of age-appropriate screening among females, 50.0% never had an anal Pap-smear, 46.5% never had a colonoscopy, 7.9% never had a cervical Pap-smear, and 12.7% never had a mammogram. The difference in anal Pap-smear by sex was statistically significant ($p < 0.0001$). Among males, the age-adjusted prevalence of never having a colonoscopy was higher in those who had HIV for ≤ 13 years (50.8% vs. 30.6%, $p = 0.03$).

Conclusion The prevalence of selected healthy behaviors and cancer screening differed by sex and/or years since HIV diagnosis suggesting a need for tailored cancer prevention efforts among persons living with HIV via long-term sex-specific interventions.

Keywords Cancer screening · Healthy behaviors · HIV/AIDS

Introduction

In the last two decades, advancements in anti-retroviral therapy and the implementation of population-based interventions resulted in improved survival among persons living with HIV/AIDS in the US [1–3]. HIV continues to be a major public health and economic burden in the US, accounting for more than 1.2 million persons live with the disease and nearly half of that population being aged 50 or older [4]. Older adults living with HIV/AIDS are at an increased risk for developing AIDS-defining (Kaposi sarcoma, non-Hodgkin lymphoma, and cervical cancer) and non-AIDS-defining malignancies (anal cancer, liver cancer, lung cancer, Hodgkin lymphoma) as well as other co-morbidities including metabolic syndrome and

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cardiovascular diseases [5, 6]. The evidence on the risk of colorectal, breast, and prostate cancers among individuals with HIV as compared to the general population remains very limited and inconsistent [6–10], but, individuals with HIV appear to have poorer outcomes after colon, breast, and prostate cancers as compared to the general population [11–13]. Thus, this large proportion of older individuals presents challenges for chronic disease prevention and early cancer detection.

Comparison of the cancer rates among persons living with HIV [HIV/AIDS Cancer Match (HACM) Study] and those for the general US population from Surveillance, Epidemiology, and End Results program, in 2010 showed that AIDS-defining cancers represented one–third of all incident cancers among persons living with HIV; two–thirds were represented by non-AIDS-defining cancers [14]. There was a 50% excess in total cancer incidence (both AIDS-defining and non-AIDS-defining malignancies) in people living with HIV/AIDS when compared to the general US population [14].

Several healthy lifestyle factors have been previously suggested as general guidelines for cancer prevention, including smoking cessation, compliance with recommended alcohol consumption limits ($\leq$7 drinks per week for females and $\leq$14 drinks per week for males), sustaining normal Body Mass Index (BMI), engaging in adequate physical activity, and adherence to recommended cancer screening [15, 16]. In addition, screening practices for potential co-infections such as Hepatitis C virus (HCV) and long-term adherence to recommended anti-retroviral treatment are recommended for people living with HIV/AIDS [5, 17].

The prevalence of healthy behaviors for cancer prevention among HIV/AIDS populations is poorly described. Previous studies in the general population and among cancer survivors suggest that these behaviors and adherence to cancer screening practices may differ by gender, race, education, and, among cancer survivors, also by time since diagnosis [18–22]. The evidence on these differences among persons living with HIV remains extremely limited, but a few previous studies suggest that some of these behaviors and screening practices may differ by sex and time since HIV diagnosis in HIV/AIDS populations [23–25]. To address these knowledge gaps, we examined the prevalence of selected healthy behaviors including never smoking or smoking cessation, adhering to recommended alcohol consumption limits, maintaining a healthy body weight, engaging in physical activity, and compliance with age-appropriate cancer screening practices in a cohort of persons living with HIV in Florida. We next compared distributions of these factors by sex and time since HIV diagnosis. We focus on differences by sex and time since HIV diagnosis as, in our study population, the distribution of other factors that may influence these behaviors and screening practices would not allow us to have sufficient number of individuals in certain strata thus preventing us from obtaining meaningful results.

Methods

Study population

This study was conducted using the data collected by the Florida Cohort between 2014 and 2017. Details of this cohort have been previously described in detail [26]. Briefly, the Florida Cohort recruited individuals aged 18 or older who are living with HIV/AIDS to assess demographic, behavioral, and social determinants associated with the disease outcomes and access to care. The study uses a convenience sample recruitment strategy in a collaborative network of county health departments and community clinics including sites at Lake City, Gainesville, Tampa, Orlando, Sanford, Ft. Lauderdale, and Miami in the State of Florida.

At the time of recruitment, all participants completed a baseline questionnaire on demographics, selected lifestyle factors, and medication use (available from http://sharc-research.org/projects/#Cohort). The follow-up questionnaire was administered on average 8 months after the recruitment (inter quartile range 6–11 months) to collect information on detailed demographics, socioeconomic characteristics, basic health parameters, access to health care, risk behaviors related to HIV/AIDS (including substance use and sexual behaviors), and cancer screening. Additionally, for each participant in the Florida Cohort, medical history (such as HIV viral load, CD4 T-cell count, height, and weight) was collected through electronic medical record abstraction and linkage to the Enhanced HIV/AIDS Reporting System (eHARS) database which is a real-time medical information collection application provided by the Centers for Disease Control and Prevention [27].

From 902 participants in the Florida Cohort, 57% (n=517) completed the follow-up questionnaire and were included in the current analysis. Characteristics of individuals in this analysis and all cohort participants were similar. This study was approved by the University of Florida, Florida International University, and the Florida Department of Health Institutional Review Boards (IRBs). All participants provided written informed consent.

Healthy behaviors and cancer screening

We included the following lifestyle and behavioral factors in the analysis: BMI, smoking status, alcohol use, ability to do physical activity, and age-appropriate screening for female breast (mammogram), cervical (cervical Pap-smear), colorectal (colonoscopy), prostate, and anal (anal Pap-smear) cancers.

Height and weight from the medical records were used to calculate BMI (kg/m^2). BMI was categorized as underweight (< 18.5 kg/m^2), normal weight (18.5–24.9 kg/m^2), overweight (25.0–29.9 kg/m^2), and obese (≥ 30.0 kg/m^2) [28]. Alcohol use within past six months and physical activity within the past week were self-reported on the follow-up questionnaire. Tobacco smoking status was self-reported on the baseline and follow-up questionnaire. Because the baseline questionnaire collected information on current and ever smoking but the follow-up questionnaire only asked about current smoking status, information from both questionnaires were combined to categorize the smoking status as never, former, and current smoking. Alcohol drinking was defined according to the Dietary Guidelines for Americans for 2015–2020 as follows: no alcohol consumption, current use below the recommended limit (≤ 7 drinks per week for females or ≤ 14 drinks per week for males), and current use above the recommended limit [29]. Physical activity in the Florida Cohort was assessed using the frequency of engaging in physical activity that was long enough to work up a sweat. Finally, we calculated the duration since HIV diagnosis using the date of HIV diagnosis provided by eHARS.

In the follow-up questionnaire, participants were asked to indicate the frequency of screening for each of the cancers as none, within past 3 years, and more than 3 years ago. Based on American Cancer Society (ACS) screening recommendations for the general public, sex-specific screening practices were described only for individuals who reached the recommended age for starting the screening for each screening modality (age 50 years for colon and prostate cancer, age 40 years for breast cancer, and age 21 years for cervical cancer) [30, 31]. However, there are no national guidelines for routine anal cancer screening in the general population due to its very low prevalence [32, 33].

Statistical analysis

The study population was first described in terms of important socio-demographic characteristics (age, sex, race, education, health insurance, sexual orientation reported at baseline, marital status reported at baseline) and HIV/AIDS-related measures (CD4 cell count categories based on clinical significance of HIV continuum: < 199 cells/ml, 200–349 cells/ml and more than 350 cells/ml [34], use of HIV anti-retroviral drugs, and HCV test status at baseline). The crude and age-adjusted prevalence of selected healthy behaviors and cancer screening was then described overall as well as by sex (male or female) and years since HIV diagnosis (dichotomized based on the median in the study population, ≤ 13 vs. > 13 years). The prevalence across the strata was compared using χ^2 test or Fisher's exact test where appropriate (for crude rates) or Mantel–Haenszel test (for adjusted rates). All analyses were conducted using SAS version 9.4 (SAS Institute, Inc., Cary, NC, USA).

Results

In our study population, majority of the individuals were older than 50 years (54.5%) and males (61.1%). Overall, 36.3% of the participants were obese, 9.0% were non-compliant to recommended alcohol intake limits, 50.7% were current smokers, and 12.4% reported never engaging in physical activity that was long enough to work up a sweat. Characteristics of the 517 study participants, overall, and by sex are presented in Table 1.

The prevalence of healthy behaviors is presented in Table 2. In the analysis by sex, prevalence of obesity among females was significantly higher than that among males (56.5% vs. 22.2%, $p < 0.0001$). The prevalence of alcohol consumption above the recommended limit was similar in both males and females (8.3% vs. 8.5%), but males were more likely to consume alcohol below the recommended limit (61.0 vs. 43.2, $p < 0.001$). No differences were noted for the prevalence of current smoking and never engaging in physical activity by sex. These prevalence patterns remained similar in age-adjusted analysis (Table 3). In the analysis by the years since HIV diagnosis, the prevalence of overweight or obese BMI among males was significantly higher in those who had HIV diagnosis for more than 13 years (overweight: 41.7% vs. 28.2%; obese: 25.0% vs. 20.1%, $p = 0.02$) (Table 2). After adjustment for age, these differences in BMI were no longer significant (Table 3). We found no statistically significant differences in the prevalences of alcohol consumption, smoking, and physical activity by time since HIV diagnosis among males and females (Table 2). These findings remained unchanged after age adjustment (Table 3).

The prevalence of sex-specific, age-appropriate cancer screening practices among individuals at the screening recommended age is presented in Table 4. Among males, 64.8% never had an anal Pap-smear, 36.2% never had a colonoscopy, and 38.9% never had prostate cancer screening. Among females, 50.0% never had an anal Pap-smear (p for difference by sex < 0.0001), 46.5% never had a colonoscopy (p for difference by sex = 0.28), 7.9% never had a cervical Pap-smear, and 12.7% never had a mammogram. These results were similar after adjustment for age (Table 5). In the analysis by the years since HIV diagnosis, males who had HIV for ≤ 13 years were more likely to never have had colonoscopy as compared to those with time since diagnosis > 13 years (49.1% vs. 28.3%, $p = 0.02$). These differences in colonoscopy were still significant after age adjustment ($p = 0.03$) (Table 5). None of the other screening procedures showed statistically significant differences by time since

Table 1 Characteristics of study participants, by sex [number (%)]

Characteristic	Total ($n=517$)	Male ($n=313$)	Female ($n=199$)	p[a]
Age (years)				
<50	235 (45.5%)	144 (46.2%)	87 (43.7%)	0.59
≥50	281 (54.5%)	168 (53.9%)	112 (56.3%)	
Race				
Hispanic	86 (16.8%)	65 (20.8%)	21 (10.6%)	0.01
Non-hispanic, white	98 (19.1%)	64 (20.5%)	34 (17.1%)	
Non-hispanic, black	308 (60.2%)	172 (55.0%)	136 (68.3%)	
Non-hispanic, other	20 (3.9%)	12 (3.8%)	8 (4.0%)	
Education				
Less than high-school	170 (33.3%)	85 (27.2%)	85 (42.9%)	<0.0001
High-school or equivalent	164 (32.1%)	99 (31.6%)	65 (32.8%)	
More than high-school	177 (34.6%)	129 (41.2%)	48 (24.2%)	
Employment status				
Unemployed	130 (26.2%)	87 (28.5%)	43 (22.4%)	0.03
Unable to work/disabled	252 (50.7%)	140 (45.9%)	112 (58.3%)	
Employed	115 (23.1%)	78 (25.6%)	37 (19.3%)	
Marital status				
Married/long term partner	99 (19.4%)	55 (17.6%)	44 (22.2%)	0.2
Not married/other	412 (80.6%)	258 (82.4%)	154 (77.8%)	
Health insurance				
Insured	503 (99.2%)	304 (98.7%)	194 (100.0%)	0.14
Un-insured	4 (0.8%)	4 (1.3%)	0 (0.0%)	
Sexual orientation				
Heterosexual	285 (57.8%)	111 (36.4%)	174 (92.6%)	<0.0001
Homosexual	157 (31.9%)	152 (49.8%)	5 (2.7%)	
Other	51 (10.3%)	42 (13.8%)	9 (4.7%)	
CD4 T-cell categories (cells/ml)				
0–199	41 (8.2%)	28 (9.3%)	13 (6.7%)	0.01
200–349	83 (16.7%)	60 (20.0%)	21 (10.9%)	
350+	374 (75.1%)	212 (70.7%)	159 (82.4%)	
Anti-retroviral medication use				
Not using	18 (3.6%)	9 (3.0%)	9 (4.7%)	0.31
Using	483 (96.4%)	296 (97.1%)	182 (95.3%)	
Hepatitis *C* test status				
Not done/do not know	126 (25.2%)	71 (23.3%)	55 (28.21%)	0.29
Done/positive result	110 (22.0%)	73 (23.9%)	37 (19.0%)	
Done/negative result	264 (52.8%)	161 (52.8%)	103 (52.8%)	

Percentages are calculated from non-missing data

[a]p-value for χ^2 test or Fisher's exact test

HIV diagnosis among males and females (Table 4) and these findings remained similar after adjustment for age (Table 5).

Discussion

This study describes disparities in healthy behaviors and cancer screening practices by sex and years since HIV diagnosis among persons living with HIV in Florida. Our findings suggest that the prevalence of obesity and selected cancer screening practices differ by sex and years since HIV diagnosis suggesting a need for tailored cancer prevention efforts via long-term sex-specific interventions among persons living with HIV.

Health compromising behaviors such as not maintaining a normal body weight, physical inactivity, smoking, heavy drinking, and not adhering to recommended cancer screening practices can increase the risk of chronic diseases including cancer [15, 35, 36]. Previous studies have also shown that individuals with health compromising

Table 2 Prevalence of healthy behaviors in the study population, by sex and years since HIV diagnosis [number (%)]

Behavior categories	Male ($n=313$) Years since HIV diagnosis				Female ($n=199$) Years since HIV diagnosis				p[a] for comparison by sex
	Total	≤ 13 years ($n=167$)	> 13 years $n=141$)	p[a]	Total	≤ 13 years ($n=105$)	> 13 years ($n=93$)	p[a]	
BMI[b]									
Underweight	5 (1.9%)	3 (2.0%)	2 (1.9%)	0.02	8 (4.5%)	5 (5.1%)	3 (3.8%)	0.74	< 0.0001
Normal weight	109 (41.8%)	74 (49.7%)	34 (31.5%)		30 (17.0%)	14 (14.3%)	16 (20.3%)		
Overweight	89 (34.1%)	42 (28.2%)	45 (41.7%)		39 (22.0%)	23 (23.5%)	16 (20.3%)		
Obese	58 (22.2%)	30 (20.1%)	27 (25.0%)		100 (56.5%)	56 (57.1%)	44 (55.7%)		
Alcohol consumption[c]									
No consumption	96 (30.7%)	44 (26.4%)	50 (35.5%)	0.20	96 (48.2%)	43 (41.0%)	52 (55.9%)	0.07	< 0.001
Below the recommended limit	191 (61.0%)	107 (64.1%)	81 (57.5%)		86 (43.2%)	50 (47.6%)	36 (38.7%)		
Above recommended limit	26 (8.3%)	16 (9.6%)	10 (7.1%)		17 (8.5%)	12 (11.4%)	5 (5.4%)		
Smoking									
Never smoker	83 (27.2%)	45 (27.8%)	35 (25.4%)	0.89	57 (30.7%)	30 (30.3%)	27 (31.4%)	0.94	0.40
Former smoker	69 (22.6%)	37 (22.8%)	32 (23.2%)		33 (17.7%)	17 (17.2%)	16 (18.6%)		
Current smoker	153 (50.2%)	80 (49.4%)	71 (51.5%)		96 (51.6%)	52 (52.5%)	43 (50.0%)		
Frequency of physical activity									
Never	33 (10.7%)	17 (10.4%)	16 (11.5%)	0.64	29 (14.7%)	16 (15.2%)	13 (14.3%)	0.69	0.53
Rarely	91 (29.6%)	46 (28.1%)	42 (30.2%)		60 (30.5%)	35 (33.3%)	25 (27.5%)		
Sometimes	126 (40.9%)	73 (44.5%)	52 (37.4%)		73 (37.1%)	38 (36.2%)	34 (37.4%)		
Often	58 (18.8%)	28 (17.1%)	29 (20.9%)		35 (17.8%)	16 (15.2%)	19 (20.9%)		

Percentages are calculated from non-missing data

BMI body mass index

[a]p-value for χ^2 test or Fisher's exact test

[b]BMI was categorized as underweight (< 18.5 kg/m^2), normal weight (18.5–24.9 kg/m^2), overweight (25.0–29.9 kg/m^2), and obese (≥ 30.0 kg/m^2) [28]

[c]Alcohol consumption during the past 6 months defined as no alcohol consumption, alcohol consumption below the recommended limit of ≤ 14 drinks per week if male or ≤ 7 drinks per week if female and above the recommended limit [29]

behaviors such as smoking and heavy drinking were further more likely to underutilize recommended cancer screening [37–39]. However, the evidence on healthy behaviors and screening practices among persons living with HIV remains extremely limited. A study by Mdodo et al. has shown that people with HIV have a greater prevalence of health compromising behaviors as compared to the general population [40], which may explain the increased prevalence of chronic diseases and non-AIDS-defining cancers in persons living with HIV [6, 14, 33, 41, 42]. Therefore, tailored preventive approaches are needed in this population subgroup to alter unhealthy behaviors and improve long-term health outcomes [43]. Our study adds to the very limited evidence on the prevalence of these risk factors and adherence to cancer screening among persons living with HIV thus providing further insights into potential behavioral disparities between persons living with HIV and general population.

Our study population had similar prevalence of obesity and overweight BMI as compared to the general population (65.5% vs. 62.2%, respectively) [44]. However, in our study we found that the prevalence of obesity and overweight BMI was higher among females as compared to males in contrast to the findings in the general population where males appear to have higher prevalence (69.0% vs. 55.4%) [44]. Additionally, among males in the study population, the prevalence of obesity and overweight BMI was higher in those who had HIV diagnosis for > 13 years. Nunez-Rocha et al. reported time since HIV diagnosis as a positive and independent predictor of obesity and overweight BMI among persons living with HIV [23]. Although further studies are needed to confirm our findings, the results suggest that the prevalence

Table 3 Age-adjusted prevalence of healthy behaviors in the study population, by sex and years since HIV diagnosis [number (%)]

Behavior categories	Male ($n=307$) Years since HIV diagnosis				Female ($n=198$) Years since HIV diagnosis				p[a] for comparison by sex
	Total	≤13 years ($n=166$)	>13 years ($n=141$)	p[a]	Total	≤13 years ($n=105$)	>13 years ($n=93$)	p[a]	
BMI[b]									
Underweight	5 (1.8%)	3 (1.7%)	2 (1.6%)	0.53	8 (4.3%)	5 (4.9%)	3 (1.6%)	0.56	<0.0001
Normal weight	107 (40.8%)	73 (44.9%)	34 (27.7%)		29 (17.2%)	13 (13.7%)	16 (27.7%)		
Overweight	83 (34.0%)	40 (30.1%)	43 (36.2%)		36 (21.0%)	22 (23.8%)	14 (36.2%)		
Obese	56 (23.4%)	29 (23.3%)	27 (34.5%)		99 (57.5%)	55 (57.5%)	44 (34.5%)		
Alcohol consumption[c]									
No consumption	94 (30.8%)	44 (29.5%)	50 (35.9%)	0.91	95 (48.2%)	43 (40.1%)	52 (57.4%)	0.05	<0.001
Below the recommended limit	188 (61.2%)	107 (62.0%)	81 (57.7%)		86 (43.6%)	50 (48.0%)	36 (36.7%)		
Above recommended limit	25 (8.0%)	15 (8.5%)	10 (6.4%)		17 (8.2%)	12 (11.9%)	5 (5.9%)		
Smoking categories									
Never smoker	80 (26.9%)	45 (27.6%)	35 (29.1%)	0.57	57 (32.6%)	30 (31.8%)	27 (33.2%)	0.81	0.40
Former smoker	69 (22.3%)	37 (23.4%)	32 (18.2%)		33 (18.3%)	17 (16.7%)	16 (9.1%)		
Current smoker	150 (50.8%)	79 (49.0%)	71 (52.7%)		95 (49.1%)	52 (51.5%)	43 (57.7%)		
Frequency of physical activity									
Never	32 (10.8%)	16 (10.4%)	16 (9.9%)	0.85	29 (14.8%)	16 (14.5%)	13 (14.0%)	0.69	0.46
Rarely	86 (28.9%)	45 (28.7%)	41 (32.7%)		58 (31.0%)	34 (34.9%)	25 (27.2%)		
Sometimes	124 (42.0%)	72 (44.4%)	52 (39.6%)		71 (36.9%)	37 (35.0%)	34 (32.2%)		
Often	55 (18.4%)	27 (16.5%)	28 (17.7%)		33 (17.3%)	156 (15.6%)	19 (26.6%)		

Percentages are calculated from non-missing data

[a]p-value for Mantel–Haenszel test

[b]BMI was categorized as underweight (<18.5 kg/m^2), normal weight (18.5–24.9 kg/m^2), overweight (25.0–29.9 kg/m^2), and obese (≥30.0 kg/m^2) [28]

[c]Alcohol consumption during the past six months defined as no alcohol consumption, alcohol consumption below the recommended limit of ≤14 drinks per week if male or ≤7 drinks per week if female and above the recommended limit [29]

of obesity and overweight BMI may differ by sex and time since HIV diagnosis.

Persons living with HIV appeared to have a higher prevalence of non-compliance to the recommended limits of alcohol intake when compared to the general population (8.2% vs. 5.4%, respectively) [44]. Our findings on differences in alcohol consumption by sex were similar to those from the general population (non-compliance to drinking limits: 6.1% for males vs. 4.8% for females) [44]. The prevalence of current smoking was similar among males and females in our study population, while in the general population, prevalence of current smoking was found to be slightly higher among males as compared to females (22.4% vs. 18.0%, respectively) [44].

We found a higher prevalence of never having physical activity among females as compared to males. Although we cannot directly compare physical activity status of the general population to the study population due to the different format of the physical activity-related items of our questionnaire and existing HIV-related disabilities, prevalence of inactivity by sex in our study population (14.5% for females vs. 10.8% for males) had a similar trend as that in the general population (36.1% for females vs. 31.4% for males) [44].

In our study, we used cancer screening guidelines of the ACS to investigate differences in cancer screening practices [16, 36]. Applicability of ACS screening guidelines to persons living with HIV has been confirmed in previous studies [33, 45]. However, there are no national recommendations for routine anal cancer screening in the general population due to its very low prevalence [32, 33]. Previous studies also do not report on anal cancer screening in the general population [41]. According to the U.S. Department of Health and Human Services, some experts recommend regular digital rectal exams and anal cytology for men and women who live

Table 4 Prevalence of cancer screening practices in the study population, by sex and years since HIV diagnosis [number (%)]

Cancer screening	Male Years since HIV diagnosis				Female Years since HIV diagnosis				p^a for comparison by sex
	Total	≤ 13 years	> 13 years	p^a	Total	≤ 13 years	> 13 years	p^a	
Anal Pap-smear									
Never	173 (64.8%)	101 (68.2%)	72 (60.5%)	0.41	90 (50.0%)	48 (49.5%)	42 (50.60%)	0.96	< 0.0001
Within past 3 years	71 (26.6%)	36 (24.3%)	35 (29.4%)		84 (46.7%)	46 (47.4%)	38 (45.78%)		
More than 3 years	23 (8.6%)	11 (7.4%)	12 (10.1%)		6 (3.3%)	3 (3.1%)	3 (3.61%)		
Colonoscopy									
Never	54 (36.2%)	28 (49.1%)	26 (28.3%)	0.02	46 (46.5%)	22 (46.8%)	24 (46.2%)	0.97	0.28
Within past 3 years	66 (44.3%)	18 (31.6%)	48 (52.2%)		39 (39.4%)	18 (38.3%)	21 (40.4%)		
More than 3 years	29 (19.5%)	11 (19.3%)	18 (19.6%)		14 (14.1%)	7 (14.9%)	7 (13.5%)		
Prostate									
Never	58 (38.9%)	26 (46.4%)	32 (34.4%)	0.30	–	–	–		NA
Within past 3 years	73 (49.0%)	25 (44.6%)	48 (51.6%)		–	–	–		
More than 3 years	18 (12.1%)	5 (8.9%)	13 (14.0%)		–	–	–		
Cervical Pap-smear									
Never	–	–	–		15 (7.9%)	7 (7.0%)	8 (8.9%)	0.50	NA
Within past 3 years	–	–	–		160 (84.2%)	87 (87.0%)	73 (81.1%)		
More than 3 years	–	–	–		15 (7.9%)	6 (6.0%)	9 (10.0%)		
Mammogram									
Never	–	–	–		20 (12.7%)	6 (7.7%)	14 (17.5%)	0.11	NA
Within past 3 years	–	–	–		119 (75.3%)	64 (82.1%)	55 (68.8%)		
More than 3 years	–	–	–		19 (12.0%)	8 (10.3%)	11 (13.8%)		

Percentages are calculated from non-missing data and cancer screenings groups are restricted to specified age ranges according to ACS guidelines, 2015 [25]: anal cancer (anal Pap-smear): no age restriction; colon cancer (colonoscopy) and prostate cancer screening: 50 years and older; breast cancer (mammogram): 40 years and older and cervical cancer (cervical Pap-smear): 21 years and above

NA not applicable

[a]p-value for χ^2 test or Fisher's exact test

with HIV [46]. The New York State AIDS Institute recommends baseline and annual screening with anal cytology for men living with HIV who have sex with men, women with a history of cervical or vulvar dysplasia, and persons with a history of anal condylomas, and the annual digital anorectal examination (DARE) for all persons with HIV [27] due to the strong association between HIV and the risk of anal cancer [33, 47]. A recent review by Goedert et al. recommends anal pap cytology testing or DARE only for HIV infected men who have sex with men [32]. Finally, the U.S. Department of Veterans Affairs recommends all men and women living with HIV to be screened at baseline and annually using anal Pap-smear or digital rectal examination [48].

We found that males appeared to be more likely to adhere to colorectal cancer screening recommendations as compared to females, but these differences were not statistically significant. These patterns were consistent with the previously reported results for the general population (32.2% for males and 29.8% for females) [49, 50]. In addition, among male participants at the screening recommended age for colorectal cancer, those with ≤ 13 years since HIV diagnosis were more likely to report never having a colonoscopy as compared to those with > 13 years since HIV diagnosis.

In our study, females were more likely to undergo anal cancer screening as compared to males. Overall, the evidence on anal cancer screening in persons living with HIV by sex is extremely limited. However, due to the absence of established national anal cancer screening guidelines, inconsistencies in expert recommendations, and absence of estimates from the general population, the prevalence rates of anal cancer screening in our study must be interpreted with caution. Although Wells et al. reported that women are less likely to be screened for anal cancer compared to men (OR = 0.2; $p = 0.007$, adjusted for age and heterosexual/men who have sex with men status), we cannot directly compare these findings to our results because of the differences in statistical approaches [41]. Further, no data are available on agreement between self-reported and confirmed history of anal Pap-smear and thus potential misclassification cannot be assessed. Finally, it is also possible that providers implementing cervical Pap-smear simultaneously obtain a sample for anal Pap-smear

Table 5 Age-adjusted prevalence of cancer screening practices in the study population, by sex and years since HIV diagnosis [number (%)]

Cancer screening	Male Years since HIV diagnosis				Female Years since HIV diagnosis				p^a for comparison by sex
	Total	≤ 13 years	> 13 years	p^a	Total	≤ 13 years	> 13 years	p^a	
Anal Pap-smear									
Never	169 (64.9%)	98 (68.5%)	71 (53.6%)	0.55	89 (50.4%)	48 (48.5%)	41 (49.5%)	0.92	< 0.0001
Within past 3 years	70 (26.7%)	35 (23.7%)	35 (38.5%)		84 (46.1%)	46 (48.5%)	38 (46.9%)		
More than 3 years	22 (8.4%)	11 (7.8%)	11 (7.9%)		6 (3.4%)	3 (3.1%)	3 (3.6%)		
Colonoscopy									
Never	54 (37.6%)	28 (50.8%)	26 (30.6%)	0.03	46 (44.6%)	22 (46.1%)	24 (43.6%)	0.97	0.53
Within past 3 years	66 (44.6%)	18 (31.5%)	48 (70.5%)		39 (40.0%)	18 (37.6%)	21 (40.2%)		
More than 3 years	28 (17.8%)	11 (17.7%)	17 (18.7%)		14 (15.3%)	7 (16.2%)	7 (13.6%)		
Prostate									
Never	58 (39.5%)	26 (47.7%)	32 (36.2%)	0.37	–	–	–		NA
Within past 3 years	73 (48.9%)	25 (43.2%)	48 (70.0%)		–	–	–		
More than 3 years	17 (11.5%)	5 (9.1%)	12 (13.5%)		–	–	–		
Cervical Pap-smear									
Never	–	–	–		14 (7.3%)	7 (6.3%)	7 (7.3%)	0.79	NA
Within past 3 years	–	–	–		160 (84.3%)	87 (87.0%)	73 (82.4%)		
More than 3 years	–	–	–		15 (8.4%)	6 (6.8%)	9 (10.3%)		
Mammogram									
Never	–	–	–		20 (12.4%)	6 (7.1%)	14 (17.6%)	0.12	NA
Within past 3 years	–	–	–		119 (75.5%)	64 (82.9%)	55 (68.8%)		
More than 3 years	–	–	–		19 (12.1%)	8 (10.9%)	11 (13.6%)		

Percentages are calculated from non-missing data and cancer screenings groups are restricted to specified age ranges according to ACS guidelines, 2015 [25]: anal cancer (anal Pap-smear): no age restriction; colon cancer (colonoscopy) and prostate cancer screening: 50 years and older; breast cancer (mammogram): 40 years and older and cervical cancer (cervical pap-smear): 21 years and above

NA not applicable

[a]*p*-value for Mantel–Haenszel test

in this high-risk population of women, but it is impossible to know for sure if this is the reason for the observed patterns.

Prevalence of ever having prostate cancer screening among our male participants was greater than the prevalence of prostate-specific antigen testing among men in the general population (60.4% vs. 44.1%, respectively) [36]. These findings are consistent with the previously reported prevalence of prostate cancer screening among persons living with HIV [51].

In our study, the prevalence of ever having a mammogram among women was greater than that in the general population (87.6% vs. 64.0%, respectively) [52]. Similarly, the prevalence of cervical Pap-smear screening in the study population appeared to be greater than that in the general population (92.7% vs. 70.2%, respectively) [52]. From this study, we cannot determine the reasons for higher utilization of cervical Pap-smear screening and the adherence to the recommended screening intervals among women living with HIV as compared to the general population. Our findings may be in part explained by the larger number of encounters with primary care physicians in women diagnosed with HIV as compared to the general population [53, 54].

Our study adds to the very limited evidence on the prevalence of healthy behaviors and cancer screening practices in persons living with HIV using an established cohort with comprehensive data collection and prospective follow-up. Our findings further strengthen the understanding of sex-related disparities in healthy behaviors and cancer screening practices, and add to the very limited evidence on these differences by years since HIV diagnosis. All HIV diagnoses in Florida Cohort have been confirmed with medical records. Similarly, BMI data were also available from the medical records. However, our study has a few limitations. The format of the questions on cancer screening in Florida Cohort (available from http://sharc-research.org/projects/#Cohort) differed from the questions used to assess cancer screening in the general population thus limiting to some degree the direct comparison between our findings and those from the general population. Second, the potential for misclassification of self-reported screening practices and healthy behaviors cannot be ruled

out. However, previous studies suggest good agreement between self-reported vs. medical record-confirmed screening practices that differ by cancer type (overall agreement: 83% for colorectal cancer screening; 61% for prostate cancer screening; 62% for mammography; and 61% for cervical Pap-smear) and some healthy behaviors (95% for smoking status and 86% for alcohol intake) [55, 56]. The correlation coefficient for self-reported and objectively measured physical activity was reported to be moderate (Spearman correlation coefficient = 0.56) [57].

In conclusion, we examined the prevalence of healthy behaviors and cancer screening among persons living with HIV. Although future studies are needed to further confirm our findings by sex and years since HIV diagnosis, the results suggest that specific subgroups of persons living with HIV may benefit from long-term, tailored public health interventions aimed at improved lifestyle and cancer screening in this population segment.

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Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

Research involving human participants and/or animals All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Informed consent This study was approved by the University of Florida, Florida International University, and the Florida Department of Health Institutional Review Boards (IRBs). All participants provided written informed consent.

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