Science Journal of Public Health
2025, Vol. 13, No. 6, pp. 354–368
https://doi.org/10.11648/j.sjph.20251306.15

Research Article

Predictors of AIDS-defining and Non-AIDS-defining Cancers Among PLHIV Accessing Services in Selected Hospitals in Nairobi City County, Kenya

Peter Onyango Omollo[1], **Alloys Orago**[2, *], **Isaac Mwanzo**[1]

[1]Department of Family Medicine, Community Health and Epidemiology, Kenyatta University, Nairobi, Kenya
[2]Department of Medical Microbiology and Parasitology, Kenyatta University, Nairobi, Kenya

Abstract

Human infection with HIV compromises the immune system and reduces the body's ability to fight viral infections that may promote the development of certain types of cancers. The diagnosis of AIDS-defining cancers in PLHIV indicates the progression of an HIV infection to the AIDS stage. Non-AIDS-defining cancers occur in HIV-positive individuals without necessarily being caused or exacerbated by HIV infection. WHO estimates that 39.9 million are PLHIV, whereas 42.3 million lives have been lost to HIV. Kenya's HIV prevalence was 3.3% and in Nairobi, 4.3%. NCD mortalities in Kenya were 39%, including cancers, up from 27% and HIV remains a major risk factor. This study's main purpose was to identify the predictors of AIDS-defining and non-AIDS-defining cancers among PLHIV accessing services in selected hospitals in Nairobi City County, Kenya. An analytical cross-sectional design was used. Study sites were purposively selected, whereas a simple random method was used to select 406 adults, aged 18 years and above, HIV positive and on ART. The study was conducted in seven selected facilities in Nairobi County. Quantitative data were collected using semi-structured questionnaires, whereas qualitative data were obtained from seven key informant interviews and three focus group discussions. Descriptive statistics (percentages, graphs, and charts) and inferential statistics (chi-square and logistic regression models) were performed using SPSS v. 27. Qualitative data were transcribed, coded, and grouped into themes. AIDS-defining cancers were the most prevalent (74.6%) among PLHIV accessing services in the selected hospitals. A Pearson's Chi-square (X^2) test revealed that socio-demographic characteristics such as sex (p = 0.00), age in years (45-54 for AIDS-defining cancer and 65 and above for Non-AIDS-defining cancers) (p = 0.00), marital status (married and widowers for ADC and NADC, p = 0.02) and level of education (secondary and 'other' for ADC and NADC respectively; p = 0.005) were associated with the type of cancer development among people living with HIV. A binary logistic regression model found that age ($\chi^2(5) = 14.96$, $p = 0.011$), income level ($X^2(5) = 9.96$; $p = 0.076$), history of cigarette smoking (B = 1.53; $p = 0.001$; OR = 4.638; 95% CI: 2.28 – 9.42), alcohol consumption (B = 0.295; $p = 0.356$), family history of cancers (B = 1.04; $p = 0.001$; OR = 2.827; 95% CI: 1.61 – 4.97), were statistically associated with AIDS and non-AIDS-defining cancers. These findings will help formulate programmatic and policy interventions for ADC and NADC among PLHIV.

Keywords

AIDS-defining Cancers, Non-AIDS-defining Cancers, HIV, Predictors, Prevalence

*Corresponding author: orago.alloysss@ku.ac.ke (Alloys Orago)

Received: 8 August 2025; **Accepted:** 16 September 2025; **Published:** 29 December 2025

1. Introduction

AIDS-defining cancers are a specific type of cancer (such as Kaposi Sarcoma, aggressive B-cell non-Hodgkin's lymphoma, and invasive cervical cancer) that, if diagnosed in an HIV patient, indicate that they have progressed to the AIDS stage or advanced HIV disease (AHD). However, non-AIDS-defining cancers are malignancies (such as breast, colorectal, lung, liver, esophageal, or skin cancer, among others) that occur in HIV-positive individuals but are not primarily caused by the weakened immune system associated with HIV infection. They may, however, be exacerbated in PLHIV [1].

Globally, the WHO estimates that 39.9 million people were PLHIV as of 2023, while more than 42.3 million people have so far died from HIV-related complications. In 2023 alone, an estimated 630,000 people died from HIV-related complications, whereas 1.3 million people developed HIV infections [2]. Currently, a cure for HIV infection has not been established; however, increased availability of HIV prevention, diagnosis, treatment, and care for opportunistic infections has led to HIV infection becoming a manageable chronic illness.

The number of HIV-positive people living in Sub-Saharan Africa accounted for two-thirds (25.9 million) of those living with HIV as of the end of 2023, according to the World Health Organization, 2023.

According to the Kenya HIV Estimates (2023) [3], HIV/ART Guidelines (2022) [4], and National Syndemic Disease Control Council (2024) [5], Kenya's overall HIV prevalence was 3.3%, with an estimated 1.4 million PLHIV (71,433 children aged between 0 – 14 years and 1,378,457 adults PLHIV). The prevalence among women and men was 4.5% and 2.2%, respectively. The counties of the former Nyanza Province (Homa Bay, Kisumu, Siaya, and Migori) had a prevalence rate of 10.6%, 11.7%, 9.8%, and 10.4%, respectively, while Nairobi had a prevalence of 4.3%. The overall number of new HIV infections was 16,752, with adults 15 years and above recording 13,009, while children between 0-14 years recorded 3,743 new infections. An interesting finding was that 39% of new HIV cases were reported among adolescents and young persons between 15-24 years.

According to the WHO, cancers are among the leading causes of death, accounting for more than ten million mortalities in 2020. The most common types of malignancies are breast, colon, lung, rectum, and prostate cancer. Approximately one-third of cancers are attributable to cigarette use, alcohol consumption, sedentary lifestyles, poor diet, and air pollution. HIV causes the immune system to weaken over time, thereby putting PLHIV at risk of getting HIV [6].

In Sub-Saharan Africa, cancer-causing agents, such as HPV and hepatitis, account for more than 30% of the deaths in low- and middle-income countries [7]. Physical carcinogens such as ultraviolet and ionizing radiation, chemical carcinogens such as asbestos, cigarette smoking, alcohol, genetics, aflatoxin, and arsenic, have been attributed to cancer development in SSA.

Kenya recorded more than 47,000 new cancer cases yearly and more than 32,000 deaths (8% of all NCD-related deaths nationally were attributed to cancers) [8-10]. The prevalence (5-year) was estimated at 102,152. The most common cancers included breast, cervical, prostate, esophageal, and colorectal. Women were, however, disproportionately affected. Approximately 39% of mortalities in Kenya were attributed to non-communicable (NCD) diseases, up from 27% in 2014 [11]. PLHIV were also found to suffer from cancers classified as AIDS-defining and non-AIDS-defining [12].

The National Cancer Registry, 2021/2022, showed that Nairobi recorded the highest number of cancers compared to its neighboring counties of Kiambu, Machakos, and Kajiado.

Some of the factors attributed to the rise in cancer incidence were genetics, cigarette smoking, alcohol use, infectious agents such as HPV and hepatitis, sedentary lifestyles, old age, and poor diet [13].

The human immunodeficiency virus poses a serious risk factor for developing concurrent diseases. HIV confers a considerable risk for cancer development. By its chronicity, the interplay between viral replication, the use of ARVs, the overall increase in inflammatory markers, and immune dysregulation poses significant risks for cancer development [14]. People living with HIV will likely live longer with the correct use of antiretroviral drugs; however, aging also puts them at a considerable risk for cancer. KS, cervical cancer, and NHL have all been identified as AIDS-defining cancers, whereas breast, lung, liver, skin, stomach, throat, colorectal, and gastric cancers are not associated with AIDS.

Unfortunately, these malignancies, if not controlled, may aggressively metastasize to other body parts, thereby leading to a high cost of treatment or even being fatal in some cases.

In Kenya, HIV has been known to be a predictor for the development of AIDS-related cancers as described above. HIV is a leading predictor of cervical cancer development in the presence of human papillomavirus. Breast cancer also develops early among PLHIV, while Kaposi sarcoma manifests as a late presentation of advanced HIV infection or in AIDS patients [15, 16].

Other known risk factors that have been cited to contribute to non-AIDS malignancies include cigarette smoking, hepatitis C virus, and alcohol consumption [17].

Generally, HIV doesn't seem to cause cancers directly, but over time, HIV causes the immune system to get weaker, thereby increasing the risk of cancer acquisition. Several factors are critical to cancer development. These include increased inflammation and damage to the immune system. People living with HIV tend to have other infectious agents, such as the HPV responsible for cervical cancer, hepatitis C virus, known to cause liver cancer, and the herpes virus type 8, known to cause Kaposi sarcoma, among others [16].

2. Materials and Methods

2.1. Study Design

This research employed an analytical cross-sectional design with a combination of quantitative and qualitative methods and was conducted between June and December 2024. Responses from 406 study participants in the comprehensive care clinics were used to obtain quantitative data, while 7 key informant interviews and 3 focus groups (11, 9, and 8) were used to obtain qualitative information.

2.2. Setting

This research was conducted at selected health facilities within Nairobi City County. This included Mbagathi Hospital, Mama Lucy Kibaki Hospital, Kangemi Health Centre, Langata Sub-County Hospital, The DREAM Medical Clinic, St Mary's Mission Hospital, and Texas Cancer Centre.

2.3. The Study Population

The study targeted adults 18 years and above who were HIV positive, on ART, and were active in the comprehensive care clinic at the selected facilities above.

2.4. Selection Criteria

2.4.1. Inclusion Criteria

These were adults 18 years and above, on HAART, with a known case of malignancy, and were ready to consent and volunteer information, able to understand and communicate in English, Kiswahili, or vernacular language to provide voluntary information, and must have lived in Nairobi for at least 3 months.

2.4.2. Exclusion Criteria

These were those below 18 years, unwilling to consent and volunteer information, HIV Negative or HIV positive but did not have any cancer diagnosis, and those with mental disorders or were too sick to volunteer any information.

2.5. Sampling

2.5.1. Sampling Method

The Nairobi City County and the selected facilities/hospitals were purposively picked owing to their capacity as either referral facilities or infectious disease hospitals with a considerable population of HIV-infected patients currently on HAART or those that were offering comprehensive care services to people living with HIV. The facilities above had over ten thousand patients currently on ART (MOH KHIS, 2023).

A simple random method was used to select participants for this research.

2.5.2. Sample Size Determination

For large samples, the Cochran formula (Cochran, 1977) was used.

The formula was as follows:

$n = N / (1 + N(e^2)$

Where:

n = sample size

N = population size

e = desired level of precision (margin of error)

^2 = squared

Nairobi's HIV prevalence was 4.3%, and the total population with HIV was 82,820. The desired level of precision was 5%, with a 95% confidence level.

$n = 82{,}820 / (1 + 82{,}820*0.05^2) = 399$

This study required a sample size of at least 399 participants. However, this number was adjusted based on potential non-response rates of at least 10% to 439.

Table 1. *Sample frame.*

acility	Type of Facility	PLHIV on ART	PLHIV on ART with a type of cancer	Proportion of sampled study participants (60%)
DREAM Centre Medical Clinic	Private	3346	25	15
Kangemi Health Centre	Public	2316	12	7
Langata Sub-County Hospital	Public	1275	28	17
Mama Lucy Kibaki Hospital	Public	3152	61	37
Mbagathi County Referral Hospital	Public	4659	61	37
St Mary's Mission Hospital, Langata	Faith Based	3120	16	10
Texas Cancer Centre	Private	2340	471	283
Nairobi County (Total)		20,208	674	406

2.5.3. Pretesting

The research tools were pretested at Riruta, Westlands, and STC Casino Health Centers. Some 10% (43) of the study participants, 3 key informants, and 1 FGD were carried out. This was necessary to identify any gaps with the instruments.

2.5.4. Validity

The university supervisors reviewed and approved the research instruments based on the existing body of literature. They agreed with the study concept and what it was measuring, and agreed that the tools used would accurately provide the data that was necessary. Purposive sampling for the study location and random sampling for the study participants were used to enhance the homogeneity and representativeness of the selected population.

2.5.5. Reliability

The consistency of the data collection tools was ensured through standardization, pretesting, and training of research assistants. Unclear questions were addressed by rephrasing them. Further, randomisation of the study participants was conducted to eliminate any bias during data collection and to enhance representativeness.

2.6. Data Management

2.6.1. Data Collection

Quantitative data were collected from 406 study participants using semi-structured questionnaires, whereas qualitative data were obtained from 7 key informants and 3 focus group discussions. The KII participants included 6 clinical officers and 1 nurse. Each of the FGDs had 11, 9, and 8 participants comprising PLHIV, adolescents, and young people living with HIV, mentors, peers, OVC champions, a clinician, a data officer, and a religious leader.

2.6.2. Data Analysis

Quantitative data collection, cleaning, and validation were done using Microsoft Excel.

Quantitative data were transferred into an electronic format and analyzed using SPSS V. 27. Qualitative data were transcribed, coded, and grouped into themes and analyzed thematically. Data was stored in password-protected systems after the removal of participants' identifiers.

2.7. Ethical Considerations

Kenyatta University Ethical Review Committee (KUERC) approved the research proposal issued under reference PKU/2942/I12965. The National Commission for Science, Technology, and Innovation (NACOSTI) issued the permit to undertake the research within Nairobi County.

Authorization was also obtained from the Nairobi City County Health Department. This was cascaded downward through the various Sub-County Administrators up to the facility levels. Informed consent was obtained from the study participants before recruitment. Research assistants also signed a confidential agreement and nondisclosure form to protect the respondents from any disclosure and unauthorized data sharing. To enhance privacy and confidentiality, data was collected in private settings, and all patient identifiers were removed to seal their identity. Data was computer-password protected and only available to the research team.

3. Results

3.1. The Socio-demographic and Socioeconomic Characteristics of the Study Participants

This study found that 98.5% (400) of the respondents were clients/patients, whereas 1.5% (6) were treatment supporters/caregivers. Women represented 81.6% (333) of the total respondents. A higher frequency (134) of the study participants, or 32.8%, were aged between 45 – 54 years, 60% (245) were married, 88.7% (362) were Christians, and 11.3% (46) were Muslims. 44.8% (183) had attained secondary education. 42.2% (172), 12% (49), and 1% (4) had attained tertiary, primary, and other forms of education, respectively. Concerning economic status, 47.8% (195) reported self-employment, 32.8% (134) were in formal employment, 14.5% (59) had no employment, and 4.9% (20) were retirees.

Table 2. *Respondents' socio-demographic and socio-economic characteristics.*

Variable	Category	Frequency (n=406)	Proportion (%)
Sex	Male	74	18.2
	Female	332	81.8
Age in Years	18 - 24	11	2.7
	25 - 34	46	11.3

Variable	Category	Frequency (n=406)	Proportion (%)
	35 - 44	101	24.8
	45 - 54	132	32.5
	55 - 64	64	15.7
	≥ 65	52	12.8
Marital Status	Married	243	59.8
	Single	62	15.2
	Widows	44	10.8
	Divorced	39	9.6
	Never Married	13	3.2
	Widower	5	1.2
Religion	Christians	360	88.6
	Muslims	46	11.4
Education	Primary	49	12.0
	Secondary	183	45.0
	Tertiary	170	41.8
	None	2	0.49
	Others	2	0.49
Employment Status	Employed	133	32.7
	Self-employed	194	47.7
	Retired	20	4.9
	None	54	13.3
	Others	5	1.4
Average monthly income (Kshs.)	Below 10,000	114	28.1
	10,000-49,999	186	45.8
	50,000-100,000	84	20.7
	Above 100,000	22	5.4

3.2. Prevalence of AIDS-defining and Non-AIDS-defining Cancers Among PLHIV

Overall, all the cancer typologies were summarized in the table below based on their frequency of occurrence among PLHIV in selected facilities in Nairobi City County.

Table 3. *Frequency of all cancer typologies.*

Type of Cancer	Frequency	Percentage (%)	Cancer Typology
	266	65.5	ADC
Cervical Cancer	43	10.6	NADC
Breast Cancer	24	5.9	ADC
Lymphoma	13	3.2	ADC
Kaposi Sarcoma	8	2.0	NADC

Type of Cancer	Frequency	Percentage (%)	Cancer Typology
Ovarian Cancer	7	1.7	NADC
Oesophageal Cancer	5	1.2	NADC
Prostate Cancer	3	0.7	NADC
Liver Cancer	3	0.7	NADC
Colorectal Cancer	3	0.7	NADC
Gastric Cancer	3	0.7	NADC
Nasopharyngeal Carcinoma	2	0.5	NADC
Brain Cancer	2	0.5	NADC
Abdominal Cancer	2	0.5	NADC
Kidney Cancer	2	0.5	NADC
Lung Cancer	2	0.5	NADC
Oral Cavity Cancer	2	0.5	NADC
Pancreatic Cancer	1	0.2	NADC
Cancer of the Oesophagus	1	0.2	NADC
Gall Bladder Cancer	1	0.2	NADC
Gastrointestinal Stromal Tumour (GIST)	1	0.2	NADC
Leukemia	1	0.2	NADC
Bladder Cancer	1	0.2	NADC
Multiple Myeloma	1	0.2	NADC
Retinoblastoma	1	0.2	NADC
Skin Cancer	1	0.2	NADC
Stomach Cancer	1	0.2	NADC
Bone Cancer	1	0.2	NADC
Throat Cancer	1	0.2	NADC
Cancer of the Nose	1	0.2	NADC
Colon Cancer	1	0.2	NADC
Total	406	100	

ADC: AIDS-defining cancer; NADC: Non-AIDS-defining cancers

3.3. Sex-specific Cancer

The table below shows the sex specific cancers among the study participants.

Table 4. *Sex-specific cancers.*

Type of Cancer	Sex	Frequency	Percentage (%)	Typology
Cervical Cancer	F	266	98	ADC
Prostate Cancer	M	5	2	NADC

3.4. Frequency Distribution of the Typology of Cancers

The figure below shows that AIDS-defining cancers were the most prevalent (74.6%) among people accessing services in selected hospitals within Nairobi City County.

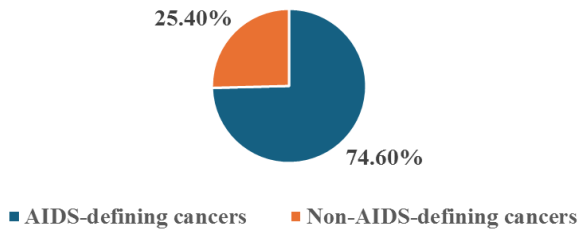

Figure 1. *Frequency distribution of the typology of cancers.*

3.5. Bivariate Analysis

3.5.1. Bivariate Analysis of Sociodemographic Factors

A Pearson's Chi-square (X^2) test revealed that socio-demographic characteristics such as sex (p = 0.00), age in years (45-54 for AIDS-defining cancer and 65 and above for Non-AIDS-defining cancers) (p = 0.00), marital status (married and widowers for ADC and NADC, p = 0.02) and level of education (secondary and 'other' for ADC and NADC respectively; p = 0.005) were associated with the type of cancer development among PLHIV. However, there was no statistically significant association between any cancer type and the type of respondents (p = 0.17) or religious affiliation (p = 0.25).

Table 5. *Bivariate analysis of socio-demographic characteristics and cancer type.*

Variable	ADC n1 (303)	NADC n2 (103)	Sub-total (n1+n2)	Proportion of the total (N=406) (%)	d.f.	Chi-square	p Value
Sex							
Male	55	19	74	18.2	1	74.55	0.00
Female	248	84	332	81.8			
Age in Years							
18 - 24	8	3	11	2.7	5	29.64	0.00
25 - 34	34	12	46	11.3			
35 - 44	75	26	101	24.8			
45 - 54	98	34	132	32.8			
55 - 64	48	16	64	15.7			
65 and above	39	13	54	12.7			
Marital Status							
Divorced	29	10	39	9.6	5	13.19	0.02
Married	181	62	243	60			
Never Married	10	3	13	3.2			
Single	46	16	62	15.2			
Widow	33	11	44	10.8			
Widower	4	1	5	1.2			
Religious Affiliation							
Christians	269	91	360	88.7	1	0.70	0.25
Muslims	34	12	46	11.3			
Level of Education							
Primary	37	12	49	12	4	14.69	0.04

Variable	ADC n1 (303)	NADC n2 (103)	Sub-total (n1+n2)	Proportion of the total (N=406) (%)	d.f.	Chi-square	p Value
Secondary	137	46	183	44.8			
Tertiary	127	43	170	42.2			
Others	2	0	2	0.5			
None	2	0	2	0.5			

ADC: AIDS-defining-cancers; NADC: Non-AIDS-defining cancers; d.f: degree of freedom

3.5.2. Bivariate Analysis of Socio-economic Factors

Table 6 shows the association between economic factors and various cancer typologies. A Chi-square test indicated that employment status (p=0.00) and the type of work industry (p=0.021) were statistically significant. However, the level of income and workplace exposure to hazards did not show any statistical significance.

Table 6. *Bivariate analysis of socio-economic factors.*

Variable	ADC n1 (303)	NADC n2 (103)	Sub-total (n1+n2)	Proportion of the total (N=406) (%)	d.f.	Chi-square	p Value
Employment Status							
Employed	99	34	133	32.8			
Self-employed	145	49	194	47.8	4	30.37	0.00
Retired	15	5	20	4.9			
Others	44	15	59	14.5			
Level of income							
Below 10,000	85	29	114	28.0			
10,000-49,999	139	47	186	45.8	4	9.12	0.1
50,000-100,000	63	21	84	20.6			
Above 100,000	16	6	22	5.4			
Type of Industry							
All (Manufacturing, Service, Agriculture, Military, Casuals)	303	103	406	100	102	132.93	0.021
Workplace Exposure to Hazards							
Yes	24	8	32	7.8	1	0.00	0.57
No	279	95	374	92.2			

ADC: AIDS-defining-cancers; NADC: Non-AIDS-defining cancers; d.f: degree of freedom

3.5.3. Bivariate Analysis of Lifestyle and Biological Factors

A Chi-square test of significance showed that lifestyle and biological factors such as length of time to diagnosis of cancer (p = 0.00), smoking (p = 0.00), alcohol intake (p = 0.00), family history of cancers (0.00), frequency of exercise (p=0.03), and history of other viral infections (p = 0.01) were statistically significant. However, there was no significant relationship between multiple sexual partners, sexual and gender-based violence, non-viral infections, and cancer development.

Table 7. *Bivariate analysis of lifestyle and biological factors.*

Variable	ADC n1 (303)	NADC n2 (103)	Sub-total (n1+n2)	Proportion of total (N=406) (%)	d.f.	Chi-square	p Value
Cancer diagnosis before or after knowing HIV status							
Yes, after knowing my HIV status	290	37	327	80.5	1	175.32	0.00
No, before knowing HIV status	13	66	79	19.5			
Ever smoked a cigarette before diagnosis?							
Yes	26	39	65	16	1	49.02	0.00
No	277	64	341	84			
Duration of smoking before cancer development							
< 1 year	1	0	1	0.2			
1 - 5 years	11	7	18	4.4			
5 - 10 years	4	1	5	1.2	4	64.66	0.00
More than 10 years	10	31	41	10.0			
None	277	64	341	84.0			
Duration without smoking before cancer development							
5 -10 years	1	0	1	0.2	1	0.34	0.74
None	302	103	405	99.8			
Alcohol intake before cancer development							
Yes	122	69	191	47	1	22.04	0.00
No	181	34	215	53			
Duration of alcohol consumption before cancer development							
< 1 year	4	2	6	1.4			
1 - 5	24	9	33	8.1			
5 - 10	48	12	60	14.8	4	43.46	0.00
More than 10 years	44	46	90	22.3			
None	183	34	217	53.4			
Duration without alcohol before cancer development							
1 - 5 years	1	0	1	0.2	1	0.34	0.74
None	302	103	405	99.8			
Family History of Cancer							
Yes	125	178	303	74.6	1	23.5	0.00
No	71	32	103	25.4			

Variable	ADC	NADC	Sub-total (n1+n2)	Proportion of total (N=406) (%)	d.f.	Chi-square	p Value
Multiple Sexual Partners							
Yes	204	99	303	74.6	1	1.99	0.09
No	77	26	103	25.4			
Frequency of Exercise							
Regularly	69	33	102	25.1			
Rarely	141	51	192	47.2	2	6.95	0.031
Never	93	19	112	27.5			
Sexual Violence Experience							
Yes	28	11	39	9.6	1	0.18	0.39
No	275	92	367	90.4			
Prior Other Viral Infections							
Yes	131	31	162	40	1	5.53	0.01
No	172	72	244	60			
Prior Non-Viral Infections							
Yes	211	76	287	70.6	1	0.63	0.25
No	92	27	119	29.4			

ADC: AIDS-defining-cancers; NADC: Non-AIDS-defining cancers; d.f: degree of freedom

3.5.4. Bivariate Analysis of Health System-related Factors That Affect Cancer Development

A Pearson's Chi test showed that the frequency of hospital visits P = (0.00), access to early screening (p = 0.00), screening in the same comprehensive care hospital (p = 0.00), and reasons for missing screening (p = 0.00) were statistically significant.

Table 8. *Bivariate analysis of health system factors.*

Variable	ADC n1 (303)	NADC n2 (103)	Sub-total (n1+n2)	Proportion of total (N=406) (%)	d.f	Chi-square	p Value
Facility utilization and access: Frequency of facility visits before diagnosis:							
Annually	80	50	130	32	3	20.86	0.00
Quarterly	199	42	241	59.4			
Bi-annually	23	10	33	8.1			
Never	1	1	2	0.5			
Accessibility of health facilities							
Yes accessible	284	95	379	93.3	1	0.27	0.37
Not accessible	19	8	27	6.7			
Prior screening before diagnosis							
Yes	182	21	203	50	1	48.40	0.00
No	121	82	203	50			
Screening offered in the same hospital							

Variable	ADC n1 (303)	NADC n2 (103)	Sub-total (n1+n2)	Proportion of total (N=406) (%)	d.f	Chi-square	p Value
Yes	156	15	171	42.1			
No	27	12	39	9.6	2	44.0	0.00
NA	120	76	196	48.3			
Reasons for not being screened							
Screening services not available	79	68	14	36.2			
User fee needed	15	11	26	6.4			
Declined	14	2	16	3.9			
No trained HCW	26	4	30	7.4	5	67.59	0.00
Unaware	9	3	12	3.0			
NA	160	15	175	43.1			
Access to treatment within the facility							
Yes	45	5	50	12			
No	257	99	356	88	2	9.12	0.01
Immediate treatment initiation							
Yes	28	4	32	7.5			
No	60	11	71	17.5	3	10.59	0.01
NA	214	89	303	75			
Accessing treatment challenges							
Lack of commodities and trained personnel	62	47	109	26.9			
Lack of treatment commodities	156	49	205	50.5			
Lack of trained HCW's	53	4	57	14.0	5	37.97	0.00
Declined	4	0	4	1.0			
NA	28	3	31	7.6			
Referral for treatment							
Yes, to a higher facility	60	8	68	16.7			
Yes, to an Oncology specialist	217	94	311	76.6			
Not referred	16	1	17	4.2	5	17.48	0.04
Declined	2	0	2	0.5			
NA	8	0	8	2			

ADC: AIDS-defining-cancers; NADC: Non-AIDS-defining cancers; NA: not applicable; d.f: degree of freedom

3.6. Multivariate Analysis (Logistic Regression Model)

A binary logistic regression model was conducted to predict the factors associated with AIDS-defining and non-AIDS-defining cancers among people living with HIV attending selected hospitals in Nairobi County. The following null hypotheses were tested:

1) H_{01} There was no significant relationship between socio-demographic factors and AIDS-defining and non-AIDS-defining cancers among people living with HIV.
2) H_{02} There was no significant relationship between so-

cioeconomic factors and AIDS-defining and non-AIDS-defining cancers among people living with HIV in the selected health facilities.

3) H_{03} There was no significant relationship between life-style and biological factors associated with AIDS-defining and non-AIDS-defining cancers among people living with HIV in the selected facilities.
4) H_{05} The relationship between health system-related factors and the development of AIDS-defining and non-AIDS-defining cancers among people living with HIV at the selected sites was not significant.

Results from Pearson's Chi-square tests showed that sex, age, marital status, level of education, employment status, type of industry, time of diagnosis (before or after HIV infection), cigarette smoking, alcohol consumption, family history, lack of exercise, prior infection with others viruses, frequency of hospital visits, screening, access to treatment and referral pathways were statistically significant and associated with AIDS and Non-AIDS defining cancers among PLHIV.

However, when subjected to a binary logistic regression model, only age, income level, history of cigarette smoking, alcohol consumption, family history of cancers, and multiple sexual partners were independently associated with AIDS and non-AIDS-defining cancers.

The model was statistically significant (X^2 = 86.72, d.f. = 14, p = 0.001), reliably distinguishing the predictors of AIDS-defining and non-AIDS-defining cancers.

The table below indicates that age was a significant overall predictor ($\chi^2(5) = 14.96$, $p = 0.011$). Relative to the reference category (those aged 65 years and above), those in the 25 to 34 age group had significantly lower odds of having AIDS-defining cancers (B = - 1.54; $p = 0.012$; OR = 0.214; 95% CI: 0.07 – 0.69). Similarly, those aged between 35 – 44 years had reduced odd of AIDS-defining cancers (B = - 1.84; $p = 0.001$; OR = 0.0160; 95% CI: 0.06 – 0.43) and those aged between 45- 54 years also exhibited significantly lower odds (B = - 1.23; $p = 0.008$; OR = 0.291; 95% CI: 0.11 – 0.73). The age group 55 – 64 years showed a marginal association (B = -0.82; $p = 0.087$). These results suggest that those in the middle age brackets were less likely to be diagnosed with AIDS-defining cancers compared to those in the oldest group.

Income level was a borderline significant predictor ($X^2(5) = 9.96$; $p = 0.076$). Those earning between 50,000 – 100,000 per month had significantly greater odds of AIDS-defining cancers (B = 1.15; $p = 0.005$; OR = 4.543; 95% CI: 1.59 – 13.00) when compared to other reference groups. Other income levels were not statistically significant but showed elevated odds ratios.

Cigarette smoking strongly predicted cancer typologies. Those who had a prior history of smoking before the diagnosis of cancer were over four times likely to have AIDS and non-AIDS-defining cancers compared to non-smokers (B = 1.53; $p = 0.001$; OR = 4.638; 95% CI: 2.28 – 9.42). Family history of cancer also significantly increased the odds of AIDS and non-AIDS-defining cancers (B = 1.04; $p = 0.001$; OR = 2.827; 95% CI: 1.61 – 4.97).

In contrast, alcohol consumption was not a statistically significant predictor in this model (B = 0.295; $p = 0.356$), suggesting that in this population, alcohol use alone did not distinguish between AIDS-defining and non-AIDS-defining cancer typologies (B = -0.437; $p = 0.190$), although the direction of the association suggested lower odds of AIDS-defining cancers among those with multiple partners.

In summary, the logistic regression model revealed that age, smoking history, family history of cancer, and, to a lesser extent, monthly income were the most significant factors among PLHIV. Middle-aged adults had lower odds of AIDS and non-AIDS-defining cancers compared to the elderly. Those who smoked or had a genetic predisposition to cancer were more likely to develop AIDS and non-AIDS-defining cancers.

Table 9. *Multivariate binary logistic regression of socio-demographic, socio-economic, lifestyle, and biological factors relating to AIDS-defining and non-AIDS-defining cancers among PLHIV.*

Variable	χ^2	B	SE	Wald	P value	OR	95% CI Lower	95% CI Upper
Overall	86.72				0.001			
Age (Overall)	14.96				0.011			
Age 18-24 (ref)		0.297	0.790	0.141	0.707	1.345	0.29	6.21
Age 25-34		-1.542	0.617	6.244	0.012	0.214	0.07	0.69
Age 35-44		-1.836	0.520	12.446	0.000	0.160	0.06	0.43
Age 45-54		-1.234	0.466	7.020	0.008	0.291	0.11	0.73
Age 55-64		-0.822	0.480	2.925	0.087	0.440	0.17	1.12
Income (Overall)	9.96				0.076			
Income (Ref: Lowest Bracket)		0.839	0.601	1.953	0.162	2.315	0.74	7.19

Variable	χ^2	B	SE	Wald	P value	OR	95% CI Lower	95% CI Upper
Income (Ksh. 50,000-100,000)		0.579	0.491	1.393	0.238	1.785	0.69	4.59
Income (Ksh. 100,000-200,000)		0.900	0.547	2.705	0.100	2.460	0.83	7.34
Income (Ksh. 200,000-500,000)		1.514	0.539	7.888	0.005	4.543	1.59	13.00
Income (Above Ksh. 500,000)		0.603	0.692	0.761	0.383	1.828	0.46	7.22
Smoking History (Ever Smoked)	18.17	1.534	0.360	18.17	0.000	4.638	2.28	9.42
Alcohol Use (Ever Taken Alcohol)		0.295	0.320	0.852	0.356	1.343	0.72	2.52
Family History of Cancer	12.84	1.039	0.290	12.842	0.000	2.827	1.61	4.97
Multiple Sexual Partners (Ever Engaged)		-0.437	0.326	1.798	0.180	0.646	0.34	1.22

χ^2-chi-square; B-unstandardized OR; SE-standard error; Wald-hypothesis testing; OR-odds ratio; CI-confidence interval

Therefore, from the hypothesis testing, $H_{01,}$ $H_{02,}$ $H_{03,}$ and H_{04} were all rejected.

4. Discussions

According to the findings of this study, women comprised 81.6% (333) of the total respondents. 32.8% (134) were aged between 45 – 54 years, 60% (245) were married, 88.7% (362) were Christians, and 11.3% (46) were Muslims. 44.8% (183) had attained secondary education. 42.2% (172), 12% (49), and 1% (4) had attained tertiary, primary, and other forms of education, respectively. Concerning economic status, 47.8% (195) reported self-employment, 32.8% (134) were in formal employment, 14.5% (59) had no employment, and 4.9% (20) were retirees.

AIDS-defining cancers (KS, NHL, and invasive cervical cancer) were the most prevalent (74.6%) among people accessing services in selected hospitals within Nairobi City County. NADC (25.4%), such as breast, liver, prostate, and colorectal cancer, were the most common.

A Pearson's Chi-square (X^2) test revealed that socio-demographic characteristics such as sex (p = 0.00), age in years (45-54 for AIDS-defining cancer and 65 and above for Non-AIDS-defining cancers) (p = 0.00), marital status (married and widowers for ADC and NADC, p = 0.02) and level of education (secondary and 'other' for ADC and NADC respectively; p = 0.005) were associated with the type of cancer development among people living with HIV.

Socio-economically, employment status (p=0.00) and the type of work industry (p=0.021) were statistically significant.

Lifestyle and biological factors such as length of time to diagnosis of cancer (p = 0.00), smoking (p = 0.00), alcohol consumption (p = 0.00), family history of cancers (0.00), frequency of exercise (p=0.03), and history of other viral infections (p = 0.01) were statistically significant.

Health system factors such as frequency of hospital visits {P = (0.00)}, access to early screening (p = 0.00), screening in the same comprehensive care hospital (p = 0.00), and reasons for missing screening (p = 0.00) were statistically significant.

A binary logistic regression model found that age ($\chi^2(5)$ = 14.96, p = 0.011), income level (X^2 (5) = 9.96; p = 0.076), history of cigarette smoking (B = 1.53; p = 0.001; OR = 4.638; 95% CI: 2.28 – 9.42), alcohol consumption (B = 0.295; p = 0.356), family history of cancers (B = 1.04; p = 0.001; OR = 2.827; 95% CI: 1.61 – 4.97), were statistically associated with AIDS and non-AIDS-defining cancers.

5. Conclusions

Being the first study on the prevalence of ADC and NADC among PLHIV, ADC was found to be the most prevalent. NADC was, however, still significant, suggesting that it should not be overlooked during screening.

The most prevalent ADC was cervical cancer, whereas the common NADC was breast cancer. These findings therefore offer an opportunity for enhanced screening for both cervical cancer and breast cancer among other common cancers in PLHIV.

6. Recommendations

To ensure consistency, adherence, and strict observance, the Ministry of Health and the County Departments of Health should develop policy guidelines to ensure that all HIV positive clients are offered routine screening for cancers. They should also ensure continuous capacity building of healthcare workers, equipping health facilities with diagnostic equipment that are accessible and affordable, and health education to the PLHIV on the importance of early screening for cancers.

Abbreviations

HIV	Human Immunodeficiency Virus
PLHIV	People Living With HIV
AIDS	Acquired Immunodeficiency Syndrome

NCD	Non-Communicable Disease
ART	Antiretroviral Therapy
ADC	AIDS-Defining Cancers
NADC	Non-AIDS-Defining Cancers
AHD	Advanced HIV Disease
WHO	World Health Organization
SSA	Sub-Saharan Africa
GLOBOCAN	Global Cancer Observatory
ARV	Antiretrovirals
KS	Kaposi Sarcoma
HAART	Highly Active Antiretroviral Therapy
MOH	Ministry of Health
KHIS	Kenya Health Information System
STC	Special Treatment Clinic
FGD	Focus Group Discussion
KII	Key Informant Interview
KUERC	Kenyatta University Ethical Review Committee
NHL	Non-Hodgkin's Lymphoma

Acknowledgments

I sincerely thank our Almighty God for His sufficient grace during my study. My heartfelt gratitude also goes to my supervisors, Professor Alloys S. S. Orago and Professor Isaac Mwanzo, for guiding me during my studies. I'm also grateful to the entire Kenyatta University fraternity, particularly the Department of Family Medicine, Community Health and Epidemiology. My gratitude to the Nairobi City County Government, the various Sub-County Heads, the administration, and the comprehensive care clinic staff of Mbagathi Hospital, Mama Lucy Kibaki Hospital, Langata Sub-County Hospital, Kangemi Health Centre, St Mary's Mission Hospital Langata, The DREAMS Medical Clinic, Karen, and Texas Cancer Centre Nairobi for enabling me to obtain data from their facilities. I must mention my research assistants (Cecilia Mahugu – Mama Lucy hospital; Maurice Magudha and Catherine Malala – Mbagathi hospital; Joan Kamau- St Mary's hospital; Hemstone Otieno – Kangemi health center; Steve Wamalwa and Saulo Kogeluk - DREAM Medical Clinic; Jane Gitau – Langata Sub-County hospital, and Beatrice Mithika – Texas Cancer Centre) for the enduring work they did during my data collection in these facilities. My friends and colleagues feel much appreciated for your support. I sincerely thank my family for their cheering support throughout my studies. Lastly, I would like to thank the Royal Society of Tropical Medicine and Hygiene (RSTMH), which supported my thesis through their small grants program.

Author Contributions

Peter Onyango Omollo: Conceptualization, Methodology, Data collection, Formal analysis, Investigation, Writing – review & editing

Alloys Orago: Supervision, Methodology, Data curation, Funding acquisition, Validation, Writing – original draft

Isaac Mwanzo: Supervision, Methodology, Data curation, Funding acquisition, Validation, writing – original draft

Funding

This research was funded by the UK's Royal Society of Tropical Medicine and Hygiene (RSTMH) small grants program.

Data Availability Statement

Data available upon writing to the corresponding author.

Conflicts of Interest

The authors declare no conflicts of interest.

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