HHS Public Access

Author manuscript

Cancer Epidemiol Biomarkers Prev. Author manuscript; available in PMC 2018 July 01.

Published in final edited form as:

Cancer Epidemiol Biomarkers Prev. 2017 July ; 26(7): 1027–1033. doi:10.1158/1055-9965.EPI-16-0964.

Excess Mortality among HIV-infected Individuals with Cancer in the United States

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Abstract

Background—HIV-infected persons are living longer in the era of effective HIV treatment, resulting in an increasing cancer burden in this population. The combined effects of HIV and cancer on mortality are incompletely understood.

Methods—We examined whether individuals with both HIV and cancer have excess mortality using data from the HIV/AIDS Cancer Match Study and the National Center for Health Statistics (1996–2010). We compared age, sex, and race-stratified mortality between people with and without HIV or one of the following cancers: lung, breast, prostate, colorectum, anus, Hodgkin lymphoma, or non-Hodgkin lymphoma. We utilized additive Poisson regression models that included terms for HIV, cancer, and an interaction for their combined effect on mortality. We report the number of excess deaths per 1,000 person-years for models with a significant interaction ($P<0.05$).

Results—For all cancers examined except prostate cancer, at least one demographic subgroup of HIV-infected cancer patients experienced significant excess mortality. Excess mortality was most pronounced at younger ages (30–49 years), with large excesses for males with lung cancer (white race:573 per 1,000 person-years; non-white:503) and non-Hodgkin lymphoma (white:236; non-white:261), and for females with Hodgkin lymphoma (white:216; non-white:136) and breast cancer (non-white:107).

Conclusion—In the era of effective HIV treatment, overall mortality in patients with both HIV and cancer was significantly higher than expected based on mortality rates for each disease separately.

Impact—These results suggest that HIV may contribute to cancer progression and highlight the importance of improved cancer prevention and care for the US HIV population.

Keywords

HIV and cancer mortality; HIV and cancer burden; non-AIDS-defining malignancies

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Introduction

HIV infection leads to progressive immunosuppression (i.e., acquired immunodeficiency syndrome [AIDS]), and HIV-infected individuals are at higher risk for developing certain cancers, particularly those caused by viruses.[1–4] The introduction of highly-active antiretroviral therapy (HAART) in 1996 has led to improvements in patient immune function, and in this era of effective treatment, HIV-infected persons experience life expectancies approaching that of the general population.[5, 6] One consequence of increased longevity is that the burden of chronic illnesses such as cancer has also increased. Despite substantial decreases in the incidence of infection-related cancers that are considered AIDS-defining (ADCs: Kaposi sarcoma, non-Hodgkin lymphoma [NHL], cervical cancer),[7–10] an ever-increasing number of HIV-infected individuals are living to ages where development of non-AIDS-defining cancers (NADCs) such as lung, colorectal, prostate, and breast cancers is more common.[11, 12]

Notably, NADCs were recently reported to be the second most common cause of death behind AIDS-related complications in 11 HIV cohorts across the US, Europe, and Australia.[13] The consequences of being diagnosed with both HIV and cancer are not yet fully understood. Both diseases can markedly increase mortality, contributing to a particularly elevated risk of death for HIV-infected people diagnosed with cancer. We and others have previously reported that HIV-infected cancer patients not only have higher overall mortality compared to their HIV-uninfected counterparts but also have higher mortality due to the cancer itself (i.e., cancer-specific mortality).[14, 15] Elevated cancer-specific mortality in HIV-infected people could be due to several factors, including poor access to cancer treatment or impaired immune control of the cancer.

One challenge in assessing patterns in mortality is that it can be difficult to determine the underlying cause of death in people with more than one serious illness. Data from death certificates regarding cause of death may have affected the results of prior studies that assessed cancer-specific mortality among HIV-infected people.[14, 16] Indeed, ambiguity in assigning a cause of death (e.g., mistakenly assigning some deaths from AIDS as due to cancer) makes it difficult to determine whether HIV impacts the progression of cancer. In the present study, we used a statistical approach to model overall mortality rates in people with and without HIV and cancer to distinguish between two possibilities: (1) overall mortality in these individuals is simply due to the added individual effects of HIV and cancer on overall mortality, or instead, (2) overall mortality is higher than expected in the presence of both conditions, reflecting additional deaths (i.e., excess mortality). An advantage of this approach is that it uses an unambiguous outcome, overall mortality, to ascertain the cause of death.

Materials and Methods

We examined mortality data from the HIV/AIDS Cancer Match (HACM) Study and the National Center for Health Statistics (NCHS). HACM is a linkage of US population-based HIV and cancer registries (http://hivmatch.cancer.gov/).[17] Our study utilized data from 6

HACM sites that provided prospective data on HIV registration and date of death (Colorado, Connecticut, Georgia, Michigan, New Jersey, and Texas).

From the cancer registries, we identified incident cases of 7 of the most common cancers that arise in HIV-infected people: cancers of the colorectum, anus, lung, breast, and prostate, as well as Hodgkin lymphoma (HL) and NHL. If an individual was diagnosed with multiple cancers, we considered only the first cancer. Individuals were included if they were diagnosed with cancer during the overlap of the following intervals: (1) the HAART era (1996–present), (2) years when HIV infection was reportable, and (3) years when cancer registries had complete case ascertainment. This resulted in the following calendar intervals by registry: Colorado (1996–2007), Connecticut (2002–2010), Georgia (2004–2008), Michigan (1996–2010), New Jersey (1996–2007), Texas (1997–2009). Persons in the cancer registries who could not be linked to the corresponding HIV registry were considered HIV-uninfected cancer patients. Individuals in the HIV registries who could not be linked to the cancer registry were considered HIV-infected without cancer. For cancer cases linked to an HIV registry, each patient was classified as HIV-infected starting at the date of HIV report or AIDS diagnosis (whichever was first), and HIV-only person-time and HIV-infected cancer person-time was partitioned according to the date of cancer diagnosis.

NCHS provides age, sex, and race stratified annual mortality data for the general US population (http://www.cdc.gov/nchs/). We obtained NCHS mortality data specific to the 6 states and years coinciding with the HACM Study to estimate mortality rates for individuals without HIV or cancer. Specifically, using data from the HACM Study and NCHS, we calculated the number of deaths from any cause and the person-time of follow-up in four distinct groups:

1. Individuals without either HIV or cancer (i.e., reference group)
2. Individuals with cancer only
3. Individuals with HIV only
4. Individuals with HIV and cancer

To accurately estimate overall mortality rates in the reference group, deaths and person-time from the HACM study for all HIV-infected people (group 3) as well as individuals diagnosed with cancer (groups 2 and 4) were subtracted from NCHS general population counts for each participating state. For groups 2 and 4, we carried out cancer-specific analyses. For example, an evaluation of lung cancer-specific mortality included only lung cancer patients in groups 2 and 4.

Statistical Analysis

Analyses were conducted separately for strata defined by sex, race (non-Hispanic whites, termed “white”; non-Hispanic blacks and Hispanics, termed “non-white”), and attained age (30–49, 50–60, 70+ years). We used mortality rates in the four groups described above to determine whether the mortality in HIV-infected people with cancer was higher than expected. To evaluate this possibility, we fit a Poison regression modeling the overall mortality rate additively as:

$$\text{Overall mortality rate} = exp(\beta 0) * (1 + \beta 1 [\text{HIV status}] + \beta 2 [\text{cancer status}] + \beta 3 [\text{HIV} * \text{cancer}]),$$

where exp(β0) estimates the mortality rate in the reference group, β1 and β2 provide a measure of the effects of an individual's HIV and cancer status on mortality, respectively, and β3 provides a measure of the interaction of HIV and cancer. If the interaction term was positive (β3>0) and statistically significant (P<0.05), we considered individuals with both HIV and cancer to have significant excess mortality, in addition to the overall mortality expected based on HIV and cancer mortality effects separately. A negative interaction (β3<0) indicated lower mortality than expected. Analyses were conducted using SAS version 9.3 (PROC NLMIXED).

We assessed model fit for all possible combinations of 24 different starting values for each β coefficient to ensure convergence of the model before predicting mortality rates. We further confirmed that the predicted mortality rates based on our final models agreed with the observed mortality rates calculated from raw data. For example, the predicted mortality rate for HIV-only individuals was computed as exp(β0)*(1+ β1); this value was compared to the simple overall mortality rate calculated from the observed data (deaths/person-years). Models that did not correctly predict the observed mortality rates within a range of 15% were considered invalid.

For each cancer and sex, race, and age stratum, we report the excess mortality per 1,000 person-years in HIV-infected individuals with cancer (i.e., calculated using the interaction term in our regression model as exp(β0)* β3). Confidence intervals around excess mortality estimates were obtained using the delta method applied to the model estimates (β's). For cancers with significant excess mortality, we further report relative excess mortality, defined as the proportion of total mortality in HIV-infected people with cancer comprised of excess deaths (i.e., ratio of excess mortality to overall mortality). Finally, we report results specific to non-advanced stage (local, regional) at diagnosis for the solid tumors (lung, anal, colorectal, breast, and prostate cancers) and specific to relevant histological categories for the most common NADC (non-small-cell lung cancer [NSCLC]) and ADC (diffuse large B-cell lymphoma [DLBCL]).

Results

In the 6 participating states during the calendar years under observation, there were 3,276,419 deaths and 350,173,517 person-years of follow-up in individuals without HIV or cancer, 42,840 deaths during 1,103,901 person-years in HIV-infected individuals without cancer, and 587,613 deaths in 6,119,244 person-years in HIV-uninfected individuals with one of the cancers of interest. For patients with both diseases, we observed 3,947 deaths during 14,903 person-years of follow-up. Mortality rates varied greatly by cancer type. For example, among HIV-uninfected individuals, overall mortality rates ranged from 39 per 1,000 person-years for those with prostate cancer to 432 per 1,000 person-years for those with NSCLC (Table 1; Supplemental Table 1).

Overall mortality among HIV-infected individuals with cancer was nearly 30-fold higher than the mortality rates in the reference population, with rates reaching 263 and 274 per 1,000 person-years among HIV-infected men and women, respectively. Overall mortality rates increased with age across all four comparison groups and declined over time for both HIV-infected persons and cancer patients, including 3-fold lower mortality in HIV-infected individuals with cancer in more recent years (181 vs. 590 per 1,000 person-years in 2006–2010 vs. 1996–2000, respectively).

Selected examples of excess mortality are illustrated in Figure 1; expected mortality in individuals with both HIV and cancer is represented by a bar with the following segments from bottom to top: (1) baseline mortality in the reference group without HIV or cancer, (2) added mortality in HIV-infected individuals (difference between overall mortality rate in HIV-infected persons and the reference population), and (3) added mortality in cancer patients (difference between overall mortality rate in cancer patients and the reference population). Combining these three segments sums to the total expected mortality for HIV-infected individuals with cancer, assuming no interaction. The adjacent bar depicts the actual, observed mortality for HIV-infected individuals with cancer. Differences between the heights of the two bars illustrates the magnitude of excess mortality in patients with both diseases. For example, HIV-infected lung cancer patients experienced substantial excess mortality, so the observed bar is higher relative to the expected bar. In contrast, for prostate cancer the similar height of the two bars signifies a finding of no excess mortality beyond what would be expected.

For each cancer type, Table 2 quantifies the excess mortality in individuals with both HIV and cancer according to sex, race, and age. Bolded text denotes statistically significant excess mortality according to our Poisson model. Some results are not provided because the models did not converge (see Methods). We observed significant excess mortality among HIV-infected individuals diagnosed with cancer at young ages (30–49 years), but the magnitude of excess varied by cancer type. Specifically, for young males, as well as young non-white females, excess mortality rates exceeded 500 and 200 per 1,000 person-years for lung cancer and NHL, respectively. Sparse data for HIV-infected white females precluded valid model estimation for many cancers, but this group did experience significant excess mortality for NHL (257 per 1000 person-years). We further observed excess mortality for HIV-infected individuals diagnosed with HL at young ages, regardless of sex or race. For breast cancer, significantly excess mortality was restricted to non-white females below 70 years of age (age 30–49: 107 per 1,000 person-years; 50–69: 89 per 1,000 person-years).

Colorectal cancer showed differences in excess mortality by age. We observed significant excess mortality in non-white males diagnosed between 30–49 years of age (97 per 1,000 person-years), but a deficit in mortality among those diagnosed older than age 69 (−130 per 1,000 person-years). We observed no excess mortality for HIV-infected males diagnosed with prostate cancer. We also observed no excess mortality in HIV-infected individuals diagnosed with any of the selected cancers at age 69 or older, regardless of sex or race. When we restricted investigation to non-advanced stage or specific histologic subtypes of cancer, the patterns paralleled those for cancers overall (Table 3). For example, pronounced

excess mortality was observed in young, HIV-infected white males for non-advanced NSCLC and DLBCL (452 and 212 per 1000 person-years, respectively).

Limited numbers prohibited a comprehensive evaluation of excess mortality within patient subgroups defined according to immunodeficiency or receipt of stage-appropriate cancer treatment. However, we were able to examine excess mortality in select strata. Among young non-white males diagnosed with the most common NADC (lung cancer), excess mortality was similar between those with (468 per 1000 person-years; $p<0.001$) or without (467 per 1000 person-years; $p=0.01$) a prior AIDS diagnosis. However, among non-white men ages 50–69 years diagnosed with lung cancer, only those with a prior AIDS diagnosis experienced significant excess mortality (AIDS: 364 per 1000 person-years; $p<0.001$ vs. HIV-only: 137 per 1000 person-years; $p=0.19$). Interestingly, we still observed excess mortality when restricting to young males diagnosed with early-stage DLBCL who received stage-appropriate treatment (white race: 102 per 1000 person-years; $p<0.01$ and non-white: 93 per 1000 person-years; $p=0.04$).

Finally, for those cancers with significant excess mortality noted in Table 2, we expressed this excess as a proportion of the overall mortality in HIV-infected individuals with cancer (Table 4). Among the 24 strata with significant excess mortality (13 male strata; 11 female strata), relative excess mortality ranged from 35% for lung cancer in 50–69 year-old non-white males to 76% for NHL in 30–49 year-old white males. For females, relative excess mortality was equally high, reaching 79% for NHL and 83% for HL in 30–49 year-old white females.

Discussion

HIV-infected individuals diagnosed with common malignancies in the US during the HAART era experienced significant excess mortality, beyond that expected based on the separate overall mortality effects of HIV and cancer alone. Specifically, we observed excess mortality in at least one demographic group for lung cancer, NHL, HL, colorectal cancer, anal cancer and breast cancer, including among HIV-infected individuals diagnosed with either non-advanced stage cancers of the breast or colorectum as well as NSCLC and DLBCL.

Excess mortality was most pronounced for HIV-infected individuals diagnosed with cancer below the age of 50. Relative excess mortality was also high in this group. Depending on individuals' race and cancer type, 44–76% of all deaths in young HIV-infected males diagnosed with cancer were excess deaths attributable to the combination of both diseases. In contrast, while overall mortality was quite high among older HIV-infected individuals with cancer (70+years at diagnosis), these rates reflected what would be expected from the reference group mortality at this age combined with the separate mortality effects of an individual's HIV and cancer status, rather than a unique excess due to the presence of both HIV and cancer.

The increasing effectiveness of HAART and improvements in cancer patient care over time were manifested in encouraging declines in overall mortality in more recent years among

individuals with HIV and cancer illustrated in Table 1. However, the excess mortality observed in HIV-infected individuals with cancer, especially those 30–69 years old, suggests that more needs to be done. This need is particularly acute in light of the fact that the HIV population in the US is aging over time, increasing the likelihood that HIV-infected persons will live into their 50's and 60's and be more susceptible to a cancer diagnosis. The oldest group of individuals (70+ years of age at cancer diagnosis), for whom there was no demonstrable excess mortality, still experienced substantial overall death rates, highlighting an important disease burden that will also grow as the HIV population ages.

This study is the first to model excess mortality in HIV-infected individuals with cancer based on overall mortality rates. These results complement the findings of prior studies that used information on causes of death to assess cancer-specific mortality among HIV-infected and HIV-uninfected individuals with cancer. Using HACM data, we previously reported increased cancer-specific mortality for HIV-infected people with cancers of the colorectum, lung, breast, or prostate.[14, 15] A study of the insured Kaiser Permanente population demonstrated poorer NHL-specific outcomes in the presence of HIV infection. [18] Although we did not observe excess mortality in the oldest HIV-infected cancer patients in this analysis, prior research utilizing SEER-Medicare data reported that elderly HIV-infected lung cancer patients had higher cancer-specific mortality than HIV-uninfected lung cancer patients.[19]

The explanation for the excess mortality that we observed in HIV-infected cancer patients is uncertain. The excess may reflect underlying biology, pointing to a role for immunosuppression in increasing cancer aggressiveness or decreasing treatment effectiveness, or instead, pointing to cancer and its treatment precipitating advanced HIV disease. We were not able to examine excess mortality for every stratum according to the level of immunosuppression (e.g., as indicated by a prior AIDS diagnosis), but the data for non-white males diagnosed with lung cancer did not reveal a consistent pattern. Alternatively, excess mortality may be attributable in part to differences in clinical stage at presentation or inadequate treatment for HIV-infected cancer patients [20–22] due to difficulties that patients have in gaining access to medical care or clinicians' lack of experience in treating the conditions simultaneously.[23] Along these lines, we observed that HIV-infected white females with non-advanced breast cancer had mortality rates comparable to expected values, whereas non-white females experienced significant excess mortality (70 and 58 per 1,000 person-years for 30–49 and 50–69 years of age, respectively). Although these differences could be due to variation in tumor biology (e.g., hormone receptor status of breast cancers), they may also reflect racial disparities in clinical care. Notably, we still observed significant excess mortality in young males diagnosed with early-stage DLBCL, even after restricting to patients who received stage-appropriate cancer treatment, suggesting that treatment differences do no account for all of the excess mortality in patients diagnosed with both HIV and cancer.

Strengths of our study include the availability of population-based data from 6 US states, as well as our assessment of excess mortality across specific demographic strata for multiple tumor types. However, we lacked detailed information on HIV-related factors such as CD4 T-cell count and HAART use, which could have shed light on the reasons for the observed

excess mortality. Although our focus on modeling overall mortality rather than examining cause of death did not allow us to evaluate the underlying reasons that clinicians would attribute to the excess deaths, this outcome is not subject to misclassification that can affect studies of cancer-specific mortality. We cannot rule out some degree of unmeasured confounding, although differences in demonstrated risk factors for death would not be expected to substantially impact our results since we compared HIV-infected individuals with cancer to groups with HIV or cancer alone, and these risk factors for death would be present across all such groups.

Our Poisson model assessed mortality effects of an individual's HIV and cancer status, and their combination, on an additive scale.[24] We chose the additive scale to assess this interaction to provide estimates of excess mortality among patients in absolute terms, facilitating better public health interpretability of the results. Of note, certain mortality rates that we observed would yielded a negative interaction on the multiplicative scale, implausibly suggesting that the presence of both HIV and cancer would reduce mortality in patients. We also note that the HIV-infected and HIV-uninfected groups for each specified cancer type were compared to a reference population without any type of cancer diagnosis, which could have led to modest over-estimates of the effect of a specific cancer type on mortality but would not have likely affected the estimate of interaction between that cancer and HIV.

Our data indicate that clinical attention should be devoted to the high mortality rates experienced by HIV-infected individuals with cancer in the US. We report here that for a number of common cancers in the HAART era, mortality in the context of both HIV and cancer is significantly higher than expected based on observed HIV and cancer mortality effects separately. The excess deaths resulting from this interaction comprise a large fraction of the total observed mortality in HIV-infected people with cancer. The marked mortality burden in these individuals suggest cancer prevention in the HIV population is critical, and future work should focus on eliminating disparities in access to healthcare and elucidating other reasons underlying this large excess mortality.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Acknowledgments

The authors gratefully acknowledge the support and assistance provided by individuals at the following state HIV/AIDS and cancer registries: Colorado, Connecticut, Georgia, Michigan, New Jersey, and Texas. We also thank Timothy McNeel at Information Management Services for programming support. This research was supported in part by the Intramural Research Program of the National Cancer Institute. The views expressed in this paper are those of the authors and should not be interpreted to reflect the views or policies of the National Cancer Institute, HIV/AIDS or cancer registries, or their contractors.

The following cancer registries were supported by the SEER Program of the National Cancer Institute: Connecticut (HHSN261201000024C) and New Jersey (HHSN261201300021I, N01-PC-2013-00021). The following cancer registries were supported by the National Program of Cancer Registries of the Centers for Disease Control and Prevention: Colorado (U58DP000848-04), Georgia (5U58DP003875-01), Michigan (5U58DP000812-03), New Jersey (5U58/DP003931-02), and Texas (5U58DP000824-04). The New Jersey State Cancer Registry was also supported by the state of New Jersey. The following HIV registries were supported by HIV Incidence and Case

Surveillance Branch of the Centers for Disease Control and Prevention, National HIV Surveillance Systems: Colorado, Connecticut (5U62PS001005-05), Michigan (U62PS004011-02), and New Jersey (U62PS004001-2).

Funding. This research was supported by the Intramural Research Program of the National Cancer Institute at the National Institutes of Health.

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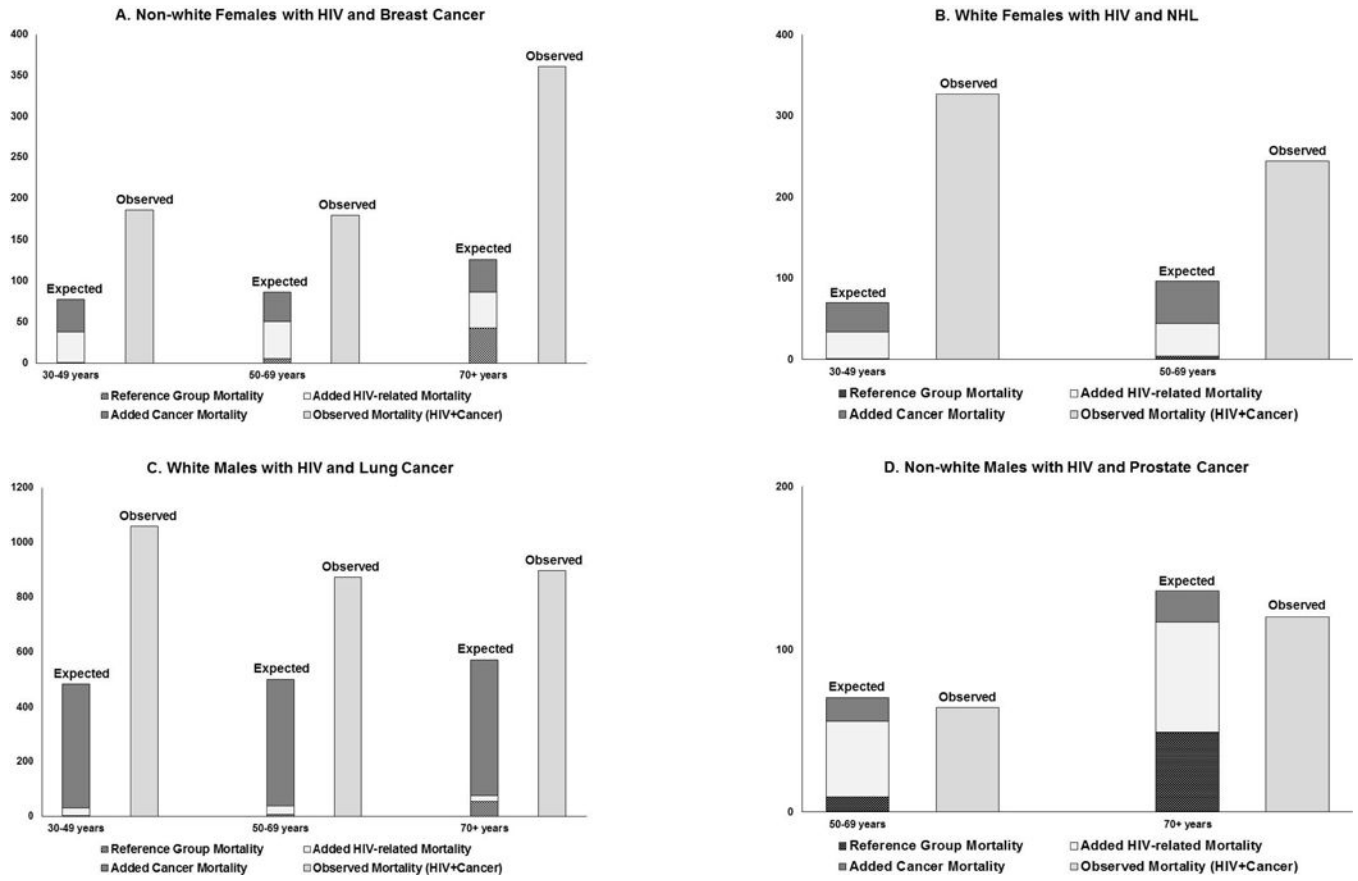

Figure 1.

Expected compared to Observed Mortality per 1,000 person-years in HIV-infected Individuals with Cancer

Table 1

Mortality per 1,000 person-years in 6 US states, according to HIV and cancer status

	Reference group		Individuals with cancer only		Individuals with HIV only		Individuals with HIV and cancer	
	Deaths	**Mortality rate**	**Deaths**	**Mortality rate**	**Deaths**	**Mortality rate**	**Deaths**	**Mortality rate**
Sex								
Females	1746158	9.6	275180	92.6	10587	38.4	795	274
Males	1530261	9.1	312433	99.2	32253	40.1	3152	263
Age in Years								
30–39	99505	1.1	5801	47.9	12057	32.5	907	320
40–49	198605	2.1	25742	57.0	17713	37.5	1564	270
50–59	297836	4.1	68185	62.8	9303	45.3	960	248
60–69	400172	9.1	124895	76.2	2845	61.9	393	215
70–79	707829	24.8	183244	104	805	94.7	107	208
80+	1572472	95.1	179746	171	117	105	16	257
Race/Ethnicity								
White, non-Hispanic	2596777	10.4	470891	94.7	13335	33.1	1467	235
Non-white	679642	6.8	116722	102	29505	42.1	2480	287
Calendar Year								
1996–2000	979249	9.7	131368	162	14943	64.2	1092	590
2001–2005	1235061	9.2	248156	103	16706	38.2	1523	267
2006–2010	1062109	9.3	208089	72.0	11191	25.8	1332	181
Cancer Mortality, by Diagnosis								
Lung Cancer			250668	463			895	898
NSCLC			207703	432			816	871
Non-Hodgkin lymphoma			54991	113			2130	320
DLBCL			15902	147			1085	316
Hodgkin lymphoma			2902	48.1			246	148
Colorectal Cancer			116380	118			178	179
Anal Cancer			2559	89.0			258	125
Breast Cancer			80113	41.4			141	156
Prostate Cancer			80000	38.5			99	60.3

CI: confidence interval; NSCLC: non-small cell lung cancer; DLBCL: diffuse large B-cell lymphoma

Table 2

Excess Mortality per 1,000 person-years (95% CI) among HIV-infected People with Cancer

Stratum Defined by Sex, Race, and Age	Lung Cancer	NHL	Hodgkin lymphoma	Colorectal Cancer	Anal Cancer	Breast Cancer	Prostate Cancer
Non-white Males							
30–49 years	**503 (340,666)**	**261 (234,289)**	**86 (57,115)**	**97 (31,163)**	7 (−26,41)	NA	Model not valid
50–69 years	**315 (206,424)**	**132 (94,170)**	47 (−3,98)	25 (−30,81)	−31 (−76,14)	NA	−6 (−24,12)
70+ years	−142 (−372,87)	−10 (−184,165)	20 (−328,368)	**−130 (−243,−18)**	−147 (−351,57)	NA	−16 (−65,33)
White Males							
30–49 years	**573 (354,791)**	**236 (211,262)**	**57 (27,87)**	**137 (52,222)**	14 (−9,36)	NA	No cancer cases
50–69 years	**365 (215,515)**	**168 (130,206)**	**57 (1,115)**	0 (−48,48)	4 (−30,38)	NA	−4 (−23,15)
70+ years	322 (−298,942)	−31 (−158,96)	Model not valid	161 (−128,450)	104 (−178,387)	NA	−16 (−61,28)
Non-white Females							
30–49 years	**537 (322,752)**	**206 (164,247)**	**136 (38,235)**	54 (−45,153)	79 (−31,190)	**107 (63,152)**	NA
50–69 years	**258 (109,406)**	**55 (19–406)**	164 (−18,347)	**−59,(−113,−5)**	**191 (18,363)**	**89 (39,139)**	NA
70+ years	728 (−514,1969)	129 (−186,443)	No cancer cases	42 (−301,385)	No cancer cases	214 (−119,546)	NA
White Females							
30–49 years	Model not valid	**257 (181,332)**	**216 (46–386)**	46 (−154,146)	146 (−113,405)	25 (−30,81)	NA
50–69 years	205 (−36,445)	**147 (15,280)**	Model not valid	106 (−108,321)	Model not valid	−7 (−46,32)	NA
70+ years	Model not valid	Model not valid	No cancer cases	152 (−497,801)	No cancer cases	355 (−10,720)	NA

Bold text indicates statistical significance (P<0.05).

CI: confidence interval; NA: not applicable; NHL: Non-Hodgkin lymphoma

Table 3

Excess Mortality per 1,000 person-years (95% CI) among HIV-infected People with Cancer, by stage and histology

Stratum Defined by Sex, Race, and Age	NSCLC, Non-advanced	DLBCL	Colorectal cancer, Non-advanced	Anal cancer, Non-advanced	Breast cancer, Non-advanced	Prostate cancer, Non-advanced
Non-white Males						
30–49 years	**415 (223,607)**	**226 (190,262)**	**87 (15,160)**	19 (−14,51)	NA	Model not valid
50–69 years	**185 (70,301)**	**158 (90,217)**	7 (−42,56)	−7 (−54,40)	NA	**−18 (−33,−2)**
70+ years	−55 (−307,197)	−122 (−433,188)	−102 (−213,10)	−135 (−339,69)	NA	−19 (−68,31)
White Males						
30–49 years	**452 (215,690)**	**212 (179,245)**	**116 (30,202)**	17 (−7,41)	NA	No cancer cases
50–69 years	**293 (140,447)**	**100 (54,148)**	14 (−34,62)	17 (−24,57)	NA	−8 (−27,11)
70+ years	Model not valid	−108 (−272,56)	113 (−130,357)	−41 (−272,190)	NA	−14 (−56,28)
Non-white Females						
30–49 years	**233 (66,399)**	**219 (156,282)**	27 (−54,109)	80 (−54,213)	**70 (30,109)**	NA
50–69 years	**258 (75,440)**	49 (−32,130)	**−49 (−92,−4)**	171 (−6,348)	**58 (12,104)**	NA
70+ years	685 (−456,1826)	58 (−404,520)	−35 (−280,210)	No cancer cases	214 (−105,533)	NA
White Females						
30–49 years	Model not valid	**352 (227,478)**	122 (−132,175)	5 (−149,158)	1 (−49,51)	NA
50–69 years	192 (−79,464)	192 (−122,507)	0 (−156,156)	Model not valid	0 (−43,43)	NA
70+ years	Model not valid	1014 (−1480,3508)	203 (−476,881)	No cancer cases	253 (−86,592)	NA

Bold text indicates statistical significance (P<0.05).

CI: confidence interval; NA: not applicable; NSCLC: non-small cell lung cancer; DLBCL: diffuse large B-cell lymphoma

Cancer Epidemiol Biomarkers Prev. Author manuscript; available in PMC 2018 July 01.

Table 4

Excess mortality as a proportion of overall mortality in HIV-infected people with cancer, among strata with significant excess mortality

Stratum Defined by Sex, Race, and Age	Lung Cancer	NHL	Hodgkin lymphoma	Colorectal Cancer	Anal Cancer	Breast Cancer
Non-white Males						
30–49 years	47.4%	68.0%	58.2%	44.1%		NA
50–69 years	34.8%	46.2%				NA
White Males						
30–49 years	54.2%	75.9%	55.9%	56.6%		NA
50–69 years	42.5%	62.4%	41.9%			NA
Non-white Females						
30–49 years	57.6%	67.4%	70.2%			58.3%
50–69 years	37.0%	30.2%			65.8%	51.9%
White Females						
30–49 years		78.7%	82.9%			
50–69 years		60.6%				

NA: not applicable; NHL: Non-Hodgkin lymphoma