The Thesis Committee for Sabina Onyinye Nduaguba
Certifies that this is the approved version of the following thesis:

The Relationships between Age, Gender, and Race and Rate of Immune Recovery and Life Expectancy among Patients Living with HIV

APPROVED BY
SUPERVISING COMMITTEE:

Supervisor: _____
James P. Wilson

Co-Supervisor: _____
Kentya H. Ford

_____
Kenneth A. Lawson

The Relationships between Age, Gender, and Race and Rate of Immune Recovery and Life Expectancy among Patients Living with HIV

by

Sabina Onyinye Nduaguba, MSPharm, BPharm

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Abstract

The Relationships between Age, Gender, and Race and Rate of Immune Recovery and Life Expectancy among Patients Living with HIV

Sabina Onyinye Nduaguba, M.S.P.S.

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Supervisor: James P. Wilson

Co-Supervisor: Kentya H. Ford

Despite medical advancement transforming HIV disease from a death sentence to a chronic illness, not all patients living with HIV (PLWH) experience the best health outcomes. The purpose of this study was to identify disparities (age, gender, and ethnicity) in health outcomes among patients living with HIV who reside in Texas. HIV surveillance data from the Texas Department of State Health Services was used to identify patients diagnosed with HIV between 1996 and 2013. This cohort was divided into 4 subcohorts according to year of HIV diagnosis; 1996-1997, 1998-2006, 2007-2010, and 2011-2013.

The primary outcomes were rate of immune recovery, AIDS diagnosis, and death. Hierarchical linear models and survival analyses were used to assess the relationships between age, gender, and ethnicity and rate of immune recovery and AIDS diagnosis and death.

A total of 70,996 patients were included in the study; 7,206, 36,286, 15,628, and 11,876 in the 1996-1997, 1998-2006, 2007-2010, and 2011-2013 subcohorts respectively.

The results showed that age, gender, and ethnicity were not statistically associated with rate of immune recovery ($p>0.01$) but tended towards lower rate of immune recovery with increasing age and in males and Hispanics. Age was associated with clinical progression to AIDS and death ($p<0.01$) in all 4 subcohorts. Male gender was associated with clinical progression to AIDS in all subcohorts except the 2011-2013 subcohort but there was no relationship between gender and death in the 4 subcohorts. Compared to Hispanics, the risk of an AIDS diagnosis was lower in Blacks across all 4 subcohorts. After controlling for covariates, the relationship was lost in the 1996-1997 and 2011-2013 subcohorts. There was no clear difference in the risk of an AIDS diagnosis between Blacks and Whites. Compared to Whites and Hispanics, Blacks had higher risk of death in the 1996-1997 and 1998-2006 subcohorts. However, there was no relationship between ethnicity and death in the 2007-2010 and 2011-2013 subcohorts after controlling for covariates.

In conclusion, the results of the survival analyses suggests some clinical relevance of differential rates of immune recovery, which presents an opportunity for early intervention before long-term outcomes like AIDS diagnosis and death occur.

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Chapter 1: Literature Review

1.1 OVERVIEW

Acquired Immune Deficiency Syndrome (AIDS) is a relatively new disease, having been recognized for just over 30 years. It is caused by a virus called Human Immunodeficiency Virus (HIV), which breaks down the immune system and makes the infected individual prone to opportunistic infections. At the beginning of its history, a diagnosis of HIV infection was seen as a death sentence. But with the introduction of drug therapy followed by subsequent advancements, the prognosis of persons infected with the virus has improved. Antiretroviral therapy, which is used in the management of HIV/AIDS helps restore immune function, reduce viral load, prevent transmission and prolong life. However, there is evidence that the extent to which these outcomes are realized varies by age, gender, and race. The effects of age, gender, and race/ethnicity on rates of immune recovery and survival have not been extensively studied. The purpose of this proposed study is to determine the rate of immune recovery and life expectancy among patients living with HIV (PLWH) who have been linked to care and to quantify the effects of age, gender, and race as factors associated with differential rates of immune recovery and survival.

1.2 HIV/AIDS

It is thought that HIV/AIDS must have originated in Africa in the 1920s.[1, 2] However, awareness of the disease did not occur until the 1980s.

In March 1981, cases of an aggressive form of Kaposi's sarcoma, a benign cancer that typically affected older people, were reported among young gay men in New York.[3] At about the same time, there was also an increase in the number of cases of Pneumocystis carinii peumonia (PCP) in both California and New York.[4] It was

initially thought that this outbreak affected only the gay population,[5] but in December 1981, the first cases of PCP were reported among injecting drug users.[6] This new (at the time) disease was referred to by different names including: gay compromise syndrome,[7] gay-related immune deficiency (GRID), acquired immunodeficiency disease (AID), gay cancer, and community-acquired immune dysfunction.[8]

By 1982, cases of the disease were reported among Haitians and hemophiliacs. This led to the recognition of the "4 H's", namely heroin addicts, homosexual men, heterosexual Haitians, and hemophiliacs.[9] Descriptive names for the disease that tagged just the gay population were lost and by August 1982, the disease was being referred to as Acquired Immune Deficiency Syndrome (AIDS).[10, 11] Cases of the disease were also reported among women without risk factors related to the "4 H's"[12] and in young children. This suggested transmission by heterosexual contact and mother-to-child transmission.[13]

In 1983, the Centers for Disease Control and Prevention (CDC) acknowledged that the cause of AIDS was unknown but stated that it was most likely caused by an infectious agent transmitted by intimate sexual contact, through contaminated needles, or by percutaneous inoculation of infected blood or blood products. The same year, a new virus was isolated at the Institute Pasteur in France and it was suggested that the virus might be the cause of AIDS.[14] A sample of the virus was sent to the CDC.[15] The virus was named Lymphadenopathy-associated Virus (LAV). In 1984, it was announced that a researcher at the United States National Cancer Institute had isolated the virus which caused AIDS.[15] The virus was named HTLV-III. It was later found that LAV and HTLV-III were the same virus.[16] The virus was renamed Human Immunodeficiency Virus (HIV) in 1986.[17]

1.2.1 Incidence, Prevalence, Morbidity, and Mortality

The incidence of HIV infection in the United States dropped from roughly 130,000 cases annually in the mid-1980s and has stabilized at about 50,000 cases annually.[18] In 2014, there were 44,073 estimated cases of new HIV infection and 20,896 estimated cases of AIDS diagnosis.[19] An estimated 931,526 adults and adolescents were living with HIV infection by the end of 2013.[19] Overall, 1,210,835 people in the United States have been diagnosed with AIDS through 2014.[19] In 2013, there were 16,281 deaths of people with HIV infection.[20] Of those, 12,693 had been diagnosed with AIDS.[19] The mortality rate directly attributed to HIV/AIDS in 2011 was 2.5 per 100,000 population.[21]

In Texas, there were 4,833 estimated cases of new HIV infection and 2,263 estimated cases of AIDS diagnosis in 2014.[19] An estimated 73,959 adults and adolescents were living with HIV infection by the end of 2013.[19] Overall, 92,816 people had been diagnosed with AIDS through 2014.[19] The mortality rate directly attributable to HIV/AIDS, in 2011, was 2.7 per 100,000 population, a little higher than the national average.[21]

1.2.2 Modes of Transmission

HIV can be isolated from a wide range of body fluids and tissues. The majority of infections are transmitted through semen, breast milk, cervical secretions, and blood. The modes of transmission of HIV are broadly grouped into:[22]

- Sexual intercourse;
- Mother-to-child (perinatally, breastfeeding); and
- Contaminated blood, blood products, and needles.

1.2.3 Pathophysiology of HIV

The HIV virus typically attacks the CD4+ T lymphocytes, which are specific protective cells that form part of the immune system. Primary infection with HIV triggers an immune response involving increased production of CD8+ lymphocytes, cytokine expression, and the release of antibodies specific for a variety of HIV proteins.[23] This initial immune response results in the down-regulation of circulating viral particles. However, the HIV virus is able to escape the immune response resulting in chronic infection. Approximately 7×10^{10} viral particles are produced daily but this is balanced by clearance of the viruses at a corresponding rate so that HIV viral levels remain at a steady state.[23] AIDS pathogenesis is marked by a progressive loss of CD4+ cells.

1.2.4 Clinical Manifestation

About 60% of individuals infected with HIV experience a clinical syndrome within 5 days following primary infection.[23] This syndrome is characterized by fever, sore throat, nausea, diarrhea, skin rash, myalgia, lymphadenopathy, and rarely meningitis. Because of the non-specific nature of the syndrome, primary infection can go unnoticed. This clinical syndrome is self-limiting and usually resolves within 12 weeks of primary infection. This is followed by an asymptomatic period which lasts a few months and can extend to more than 13 years before AIDS-specific clinical symptoms develop.[24] During this period, there is a gradual decline in CD4 T cells, which die by apoptosis. The immune system progressively weakens and, eventually, the infected individual becomes prone to opportunistic infections. Based on the clinical manifestation of HIV, the Centers for Disease Control and Prevention classifies HIV infection into categories A, B, and C.[25]

1.2.4.1 Category A

This is the asymptomatic stage. There could also be persistent generalized lymphadenopathy at this stage.

1.2.4.2 Category B

This stage covers symptomatic conditions that are attributed to HIV infection or which have a clinical course or management that is complicated by HIV infection. Examples include:

- Bacillary angiomatosis;
- Oropharyngeal candidiasis (thrush);
- Vulvovaginal candidiasis, persistent or resistant;
- Pelvic inflammatory disease (PID);
- Cervical dysplasia (moderate or severe)/cervical carcinoma in situ;
- Hairy leukoplakia, oral;
- Peripheral neuropathy;
- Herpes zoster (shingles), involving two or more episodes or at least one dermatome;
- Idiopathic thrombocytopenic purpura; and

Constitutional symptoms, such as fever (>38.5ºC) or diarrhea lasting >1 month.[25]

1.2.4.3 Category C

Specific AIDS-defining illnesses manifest at this stage. The AIDS-indicator conditions include:

- Bacterial pneumonia, recurrent (two or more episodes in 12 months);
- Candidiasis of the bronchi, trachea, or lungs;
- Candidiasis, esophageal;

- Cervical carcinoma, invasive, confirmed by biopsy;
- Coccidioidomycosis, disseminated or extrapulmonary;
- Cryptococcosis, extrapulmonary;
- Cryptosporidiosis, chronic intestinal (>1 month in duration);
- Cytomegalovirus disease (other than liver, spleen, or nodes);
- Encephalopathy, HIV-related;
- Herpes simplex: chronic ulcers (>1 month in duration), or bronchitis, pneumonitis, or esophagitis;
- Histoplasmosis, disseminated or extrapulmonary;
- Isosporiasis, chronic intestinal (>1-month in duration);
- Kaposi sarcoma;
- Lymphoma (Burkitt, immunoblastic, or primary central nervous system);
- Mycobacterium avium complex (MAC) or Mycobacterium kansasii, disseminated or extrapulmonary;
- Mycobacterium tuberculosis, pulmonary or extrapulmonary;
- Mycobacterium, other species or unidentified species, disseminated or extrapulmonary;
- Pneumocystis jiroveci (formerly carinii) pneumonia (PCP);
- Progressive multifocal leukoencephalopathy (PML);
- Salmonella septicemia, recurrent (nontyphoid);
- Toxoplasmosis of brain; and
- Wasting syndrome caused by HIV (involuntary weight loss >10% of baseline body weight) associated with either chronic diarrhea (two or more loose stools per day for ≥1 month) or chronic weakness and documented fever for ≥1 month.[25]

1.2.5 Management

Management of HIV/AIDS involves HIV prevention, antiretroviral therapy (ART), treatment of dyslipidemia, reduction of perinatal HIV transmission in pregnant infected women, prevention and treatment of opportunistic infections, tuberculosis, and sexually transmitted diseases, and prophylaxis of occupational exposure.[26]

1.2.5.1 HIV Prevention

HIV prevention strategies include screening for behavioral and clinical risk factors, behavioral intervention, and partner counseling and referral services among persons not yet infected as well as those already infected.[27]

1.2.5.2 Antiretroviral Therapy

Antiretroviral therapy started off as monotherapy until clinical trials showed that combination therapy provided better survival benefits.[28-30] This led to the derivation of highly active antiretroviral therapy (HAART) consisting of three or more antiretroviral drugs from at least 2 classes. HAART is the mainstay of drug therapy for patients living with HIV and is strongly recommended for patients with a CD4 cell count at or below 500 cells/mm^3.[31-33]

1.2.5.3 Treatment of Dyslipidemia

Dyslipidemia is common among patients with advanced HIV disease and is also an observed side effect among patients who are on antiretroviral therapy.[34] Research indicates that this places affected patients at increased risk of cardiovascular morbidity, making it necessary to address dyslipidemia.[35]

1.2.5.4 Reduction of Perinatal HIV Transmission

Practices aimed at reducing perinatal HIV transmission include universal prenatal HIV counseling and testing, antiretroviral prophylaxis, scheduled Cesarean

delivery, and avoidance of breastfeeding.[36] Implementation of these practices are largely successful, resulting in reduction of perinatal transmission risk to 2% or less.[36] In fact, Cuba was officially certified by the World Health Organization as a country that has successfully eliminated mother-to-child transmission of HIV.[37] Several other countries in the Americas are close to achieving this goal.

1.2.5.5 Prevention and Treatment of Opportunistic Infections, Tuberculosis, and Sexually Transmitted Diseases

Opportunistic infections are infections that become more frequent or more severe in the presence of HIV infection.[38] They are managed alongside HIV infection through prevention efforts and treatment of active infection. Such opportunistic infections include *Mycobacterium tuberculosis* infection, *Pneumocystis* pneumonia, *Toxoplasma gondii* encephalitis, syphilis, and candidiasis to name but a few.

1.2.5.6 Prophylaxis of Occupational Exposure

Occupational exposure to HIV is managed by using post-exposure prophylaxis, accompanied by careful monitoring for side effects and signs of infection.[39]

1.3 HIV-RELATED HEALTH OUTCOMES

AIDS pathogenesis is marked by a progressive loss of CD4+ T cells. The risk for development of AIDS-related symptoms increases with declining CD4+ T cells.[40] The viral load is also an important predictor of clinical disease progression and death.[41, 42] Hence, disease progression and treatment effectiveness are monitored by periodic measurement of CD4 cell count and viral load.[31] The occurrence of an AIDS event and eventual death are also used as indicators of HIV-related health outcomes and in determining survival and life expectancy of patients living with HIV. More recently, drug therapy has also been shown to be related to non-AIDS-related

outcomes.[43] In a 2015 study by Lundgren et al. aimed at determining whether it is beneficial to initiate antiretroviral therapy in patients with a CD4+ cell count greater than 350 cells/mm^3, patients with CD4 counts greater than 500 cells/mm3 who initiated therapy immediately had lower rates of not only serious AIDS-related events (HR=0.25, p<0.001, 95% CI=0.15-0.50) but also lower rates of serious non-AIDS related events (HR=0.61, p=0.04, 95% CI=0.38-0.97). Serious non-AIDS-related events consisted of cardiovascular disease or death from cardiovascular disease, end-stage renal disease or death from renal disease, liver disease or death from liver disease, non-AIDS-defining cancer or death from cancer, and any death not attributable to AIDS.

1.3.1 Immune Recovery among Patients Living with HIV

One of the goals of treatment with HAART is to increase CD4+ cell count in patients living with HIV.[44] There is an accelerated increase in CD4+ cell count in the first few months following initiation of HAART. This is followed by a constant increase in CD4 count until a steady state is reached.[45] Increases in CD4 count are still observed in patients after 3 years.[46] Cohort studies suggest that the process of immune recovery can take up to 5 years.[47]

A few studies investigated factors that affect rate of immune recovery. Baseline CD4 count was shown to be predictive of immune recovery. In a study in which patients were followed for 24 months, a significant proportion of patients doubled their cell count every 3 months. However, patients with a high baseline CD4 count had a higher final CD4 count than those with a low baseline CD4 count.[48] In a different study in which patients were followed for 5 years, a similar trend of a higher final CD4 count with a high baseline CD4 count was observed.[49]

Another goal of HAART is sustained viral suppression. In most patients on HAART, an increase in CD4 count is accompanied by viral suppression. However, in about 12% of patients, particularly in those with advanced HIV disease, the CD4 cell count fails to increase despite viral suppression.[50, 51] This group of patients are referred to as immunological nonresponders (INRs).[44] The incidence of AIDS-defining events in INRs tends to be as high as in those who fail to respond both immunologically and virologically.[51]

1.3.2 Survival and Life Expectancy among Patients Living with HIV

Although HAART was found to provide survival benefits superior to those of dual- or monotherapy,[32, 33, 52-54] early studies showed that death rates in the HIV population were still far higher than in the general population.[54] In the ATHENA national observational cohort study, mortality was predicted to be 5.3 and 10.4 times higher in the HIV population than in the general population for 25-year-old men and women, respectively.[55] However, studies also show that outcomes are better for those who have not developed AIDS at the time of diagnosis compared with those who already have AIDS. A Taiwanese study showed that the 5-year survival rate was 58% in patients who had developed AIDS at diagnosis and 89% in those who had not.[56]

In addition, some studies have identified subgroups in the HIV population who have a life expectancy comparable to that of the general population. In the CASCADE study, which included individuals 15 years and older at seroconversion who had sexual or IDU exposure to HIV, patients were followed for a median duration of 6.3 years. Excess mortality among HIV-infected individuals was compared with that of the general uninfected population. Not suprisingly, the excess mortality rate (per 1,000 person-years) decreased from 40.8 before the introduction of HAART to 6.1 in 2004-

2006. But more importantly, by 2004-2006, no excess mortality was observed in the first 5 years following HIV seroconversion among those infected sexually.[57]

More recently, the UK collaborative HIV cohort study found that the expected age at death of 35-year-old men with a CD4+ cell count less than 200 cells/mm^3, between 200 cells/mm^3 and 349 cells/mm^3, and at least 350 cells/mm^3 was 71 years, 78 years, and 77 years, respectively, compared with 78 years for men in the general UK population. After 5 years of therapy, the expected age at death of 35-year-old men who achieved a CD4+ cell count of at least 350 cells/mm^3 and viral suppression was 80 years.[58] In northern Italy, a study was conducted in which HIV patients were classified into 3 groups: patients who started ART in the post-HAART period with a nadir CD4 count of at most 350 cells/mm^3 and who did not attain a CD4 count of at least 500 cells/mm^3 (nIR group), those who started ART with a nadir CD4 count of at most 350 cells/mm^3 and attained a CD4 count of at least 500 cells/mm^3 (IR group), and those who started with a nadir CD4 count of more than 350 cells/mm^3 and maintained this level over follow-up (IM group). As expected, life expectancy at 25 years was higher in the IR group (51 years) compared with the nIR group (34 years). It was also significantly lower than that of the northern Italian general population (56 years) ($p=0.02$). Life expectancy at 40 years was 38 years in the IR group, 23 years in the nIR group, and 41 years in the general population. There was no significant difference in life expectancy at 40 years between the IR group and the general population.[59] These studies indicate that immune recovery may also mean life years recovery.

1.4 DISPARITIES IN HIV

With advances in the treatment of HIV, the prospects of patients living with HIV have improved tremendously.[32] However, there is a lot of evidence showing that the benefits of treatment are not evenly realized among groups. Some of the disparities are related to modifiable factors such as socioeconomic status.[60, 61] There are also disparities related to seemingly non-modifiable factors including age, gender, and race. There are several studies showing specific outcomes that reflect the disparities, such as hospitalizations and mortality, as well as explanations as to why these natural factors play a role in perpetuating differential outcomes.

1.4.1 Age Disparity in HIV Outcomes

The widely accepted explanation for age disparity in outcomes for people living with HIV is biological. In humans, the thymus is part of the immune system and is the site for CD4 T cell maturation.[62-65] Thymic function declines with age.[66] In patients living with HIV, CD4 cells are depleted as the HIV virus attacks these cells.[67] However, depletion of the CD4 T cells is slowed down by replacement from the thymus. Because thymic function declines with age, CD4 restoration is less effective with increasing age.[68] Viard et al. demonstrated this in a study comparing time to CD4 increase of >200 cells/μL by age group. Older patients took longer to reach the endpoint ($p=0.0026$).[68]

1.4.2 Gender Disparity in HIV Outcomes

In the 1980s, HIV affected mainly males.[3, 5, 7] However, the proportion of new cases who are women rose from 7% in 1985 to 27% in 2007.[69] The figure has dropped since then to 20% in 2013.[70] In a report by the Centers for Disease Control and Prevention, only 45% of all women living with HIV in 2011 were engaged in care and only 32% had achieved viral suppression.[70] Studies suggest that these figures may be

higher in men.[71, 72] Several reasons have been proposed to explain poor access to care by women with HIV and suboptimal outcomes including family responsibilities,[73, 74] lack of education and poverty,[75] lack of insurance coverage, and perceived barriers to accessing HIV care. It has been shown that where there is equal access to care and treatment, outcomes are similar between men and women. In a study by Mocroft et al., women were significantly less likely to start a HAART treatment regimen (RH 0.69; 95% CI 0.49-0.98; p=0.033).[72] Among those who started therapy, there was no difference between men and women in time taken to achieve a viral load of <400 copies/ml (p=0.32) and in time taken to achieve a 50% increase in CD4 count (p=0.66). Another study showed no significant difference in time to viral suppression between men and women without IDU history, after correcting for pregnancy (AHR 0.94; 95% CI 0.85-1.04; p=0.254).[76] Similar non-significant results have been obtained in other studies.[77, 78]

1.4.3 Racial Disparity in HIV Outcomes

Independent of HIV complexities, life expectancy is generally high in Hispanics and low in Blacks, relative to Whites. When healthy life years become the focus, Whites have a longer healthy life expectancy, compared to Hispanics and Blacks.[79] In the context of HIV, statistics remain worse for Blacks. In a national survey study by Oramasionwu et al., Blacks living with HIV were 6 times more likely to be hospitalized than Whites living with HIV.[80] Another study showed that Blacks have a 40% higher risk of virological failure than Whites after controlling for measured confounders (HR 1.4; 95% CI 1.2-1.6; p<0.001). Notably, Whites reported fewer missed doses.[81]

For Blacks in Texas, the incidence of HIV in 2013 was six and a half times that in Whites and over three times that in Hispanics. HIV was the sixth leading cause of

death in Blacks in 2011, compared to its being the tenth leading cause of death in Whites and the eighth leading cause of death in Hispanics. However, the rate of death due to HIV per 100,000 PLWH was numerically higher in Hispanics (774.0) than in Blacks (771.4) or Whites (702.0).[21]

Research suggests that the disproportionate figures are due to lower rates of engagement of Blacks with the health care system, stemming from distrust of the health care system which can be traced back to the Tuskegee study.[82] There is still evidence of differential treatment in modern times [83-85] as well as racial differences in adherence behavior, [81, 86] with Blacks who are engaged in care being less adherent to medication.

Hispanics are not free from negative outcomes. In the Women's Interagency HIV Study, a larger proportion of Hispanic women experienced virologic rebound (69.1%) and immunologic failure (49.3%) compared to African American women (63.5% and 38.1%, respectively) and White women (55.3% and 31.7%, respectively).[87] Hispanic women were more likely than Black women to experience immunologic failure even after adjusting for ART use prior to HAART initiation, age at last pre-HAART visit, pre-HAART AIDS status, pre-HAART nadir CD4+ cell count, pre-HAART peak HIV-1 RNA, and self-reported baseline HIV-1 exposure category (RH=1.44, p=0.013). A later study revealed that the odds of medically eligible Hispanic women receiving HAART was 55% lower compared to medically eligible White women (OR=0.45, 95% CI=0.215-0.956, $p<0.05$).[88]

1.5 RATIONALE

The main goal of care of patients living with HIV is to delay disease progression and reduce HIV-related mortality. Clinically, the viral load and CD4 cell

count are used to determine if these goals are being met and serve as predictors of HIV outcomes. There is evidence that outcomes are poor for certain groups. For example, HIV-related mortality among Blacks in Texas is 5 times that of Hispanics or Whites.[21] Most studies assessing disparities have used viral load as the outcome measure but research indicates that immunological response remains an important predictor of disease progression, even after viral suppression with HAART.[51, 89, 90] Assessing disparities in terms of rate of immune recovery may help in identifying groups at risk of HIV-related morbidity and mortality even before immune reconstitution is complete. Also, studies show that certain groups living with HIV have life expectancies comparable to that of the general population.[57, 59] Identifying groups living with HIV with life expectancies similar to that of the general population will lend support to other similar studies that patients living with HIV can have a normal life span.

1.6 OBJECTIVES AND HYPOTHESES

The objectives and related hypotheses of the study are:

1. To describe the demographic and clinical characteristics of patients living with HIV who reside in Texas, with respect to gender, race/ethnicity, age at HIV diagnosis, risk transmission category, linkage to care, viral load, CD4 count, and age at AIDS diagnosis;
2. To determine the relationship between CD4 count and time;

   H_1: CD4 count increases with time

   H_2: Rate of increase in CD4 count declines with time
3. To determine the relationship between age, gender, and race/ethnicity and **rate of immune recovery**;

H_3: Age is negatively associated with rate of immune recovery

H_4: Male gender is associated with a lower rate of immune recovery

H_5: Black ethnicity (compared to White and Hispanic ethnicities) is associated with a lower rate of immune recovery

4. To determine the relationships between age, gender, and race/ethnicity and **rate of immune recovery** after adjusting for age, gender, race/ethnicity, risk transmission category, linkage to care, CD4 count, viral load, and AIDS diagnosis;

   H_6: Age is negatively associated with rate of immune recovery after adjusting for gender, race/ethnicity, risk transmission category, linkage to care, CD4 count, viral load, and AIDS diagnosis

   H_7: There is no significant relationship between gender and rate of immune recovery after adjusting for age, race/ethnicity, risk transmission category, linkage to care, CD4 count, viral load, and AIDS diagnosis

   H_8: Black ethnicity (compared to White and Hispanic ethnicities) is associated with a lower rate of immune recovery after adjusting for age, gender, risk transmission category, linkage to care, CD4 count, viral load, and AIDS diagnosis

5. To determine the magnitude and direction of the associations between age, gender, race/ethnicity, risk transmission category and **the risk of an AIDS diagnosis and death**;

   H_9: Age is positively associated with the risk of an AIDS diagnosis

   H_{10}: Age is positively associated with the risk of death

   H_{11}: Male gender is associated with the risk of an AIDS diagnosis

   H_{12}: Male gender is associated with the risk of death

H_{13}: Black ethnicity (compared to White and Hispanic ethnicities) is associated with the risk of an AIDS diagnosis

H_{14}: Black ethnicity (compared to White and Hispanic ethnicities) is associated with the risk of death

6. To determine the magnitude and direction of the association between risk transmission category, linkage to care, CD4 count, and viral load and **the risk of an AIDS diagnosis and death**;

   H_{15}: IDU risk exposure (compared to heterosexual risk exposure and risk exposure in MSM) is positively associated with the risk of an AIDS diagnosis

   H_{16}: IDU risk exposure (compared to heterosexual risk exposure and risk exposure in MSM) is positively associated with the risk of death

   H_{17}: Linkage to care is negatively associated with the risk of an AIDS diagnosis

   H_{18}: Linkage to care is negatively associated with the risk of death

   H_{19}: CD4 count is negatively associated with the risk of an AIDS diagnosis

   H_{20}: CD4 count is negatively associated with the risk of death

   H_{21}: Viral load is positively associated with the risk of an AIDS diagnosis

   H_{22}: Viral load is positively associated with the risk of death

7. To determine the relationships between age, gender, and race/ethnicity and **the risk of an AIDS diagnosis** after adjusting for age, gender, race/ethnicity, risk transmission category, linkage to care, CD4 count, and viral load;

   H_{23}: Age is positively associated with the risk of an AIDS diagnosis after adjusting for gender, race/ethnicity, risk transmission category, linkage to care, CD4 count, and viral load

H_{24}: Male gender is not associated with the risk of an AIDS diagnosis after adjusting for age, race/ethnicity, risk transmission category, linkage to care, CD4 count, and viral load

H_{25}: Black ethnicity (compared to White and Hispanic ethnicities) is positively associated with the risk of an AIDS diagnosis after adjusting for age, gender, risk transmission category, linkage to care, CD4 count, and viral load

8. To determine the relationships between age, gender, and race/ethnicity and **the risk of death** after adjusting for age, gender, race/ethnicity, risk transmission category, linkage to care, CD4 count, viral load, and AIDS diagnosis;

   H_{26}: Age is positively associated with the risk of death after adjusting for gender, race/ethnicity, risk transmission category, linkage to care, CD4 count, viral load, and AIDS diagnosis

   H_{27}: Male gender is not associated with the risk of death after adjusting for age, race/ethnicity, risk transmission category, linkage to care, CD4 count, viral load, and AIDS diagnosis

   H_{28}: Black ethnicity (compared to White and Hispanic ethnicities) is positively associated with the risk of death after adjusting for age, gender, risk transmission category, linkage to care, CD4 count, viral load, and AIDS diagnosis

9. To construct life tables of patients living with HIV who reside in Texas, grouped by age, gender, race, risk transmission category, linkage to care, and time period; and

10. To compare life expectancy among patients living with HIV who reside in Texas with that of the general population.

Chapter 2: Methodology

2.1 INSTITUTIONAL REVIEW BOARD APPROVAL

Approval for conducting this study was obtained from the Texas Department of State Health Services Institutional Review Board (DSHS IRB). This study has minimal risk since the data are de-identified. It was classified as exempt by the DSHS IRB. The study was also reviewed by the University of Texas at Austin Office of Research Support (UTA ORS) and determined to be non-human subjects research. For this reason, it did not require review by the University of Texas at Austin Institutional Review Board (UTA IRB).

2.2 STUDY DESIGN AND DATA SOURCE

This study is a retrospective data base analysis of data from the Texas DSHS TB/HIV/STD Epidemiology and Surveillance Branch. DSHS runs an HIV/STD program with the objective to prevent the spread of HIV and other sexually transmitted diseases while minimizing complications and costs. It provides education, prevention counseling, screening and testing, partner elicitation and notification, as well as medical and social services. It also keeps demographic and clinical records of patients clinically diagnosed with HIV within the state of Texas. Data was extracted for patients diagnosed with HIV between 1996 and 2013. A total of 77,844 patients were identified.

2.3 DESCRIPTION OF COHORTS AND SUBCOHORTS

The cohort assembled for this study consisted of patients diagnosed between 1996 and 2013, including those who died during the follow-up period. Patients entered the cohort at HIV diagnosis and left the cohort at death or AIDS diagnosis. Otherwise, they were right censored at the end of the study period (2013). Over time, there have

been changes in treatment guidelines based on clinical evidence that show improved health outcomes for patients with the newer recommendations. Between 1996 and 2013, there have been evidence-based revisions to treatment guidelines for adults infected with HIV. The International Antiviral Society made major revisions to treatment regimen recommendations in 1996 and 1997 and made recommendations on when to initiate therapy in 2006 and 2010.[91-94] In 1996, the panel recommended initiating therapy with 2 nucleoside reverse transcriptase inhibitors (NRTIs).[92] This was upgraded to a 3-drug combination regimen (2 NRTIs plus a protease inhibitor or non-nucleoside reverse transcriptase inhibitor) in 1997.[91] In 2006, the panel recommended initiating therapy at some point after the CD4 count has declined to 350 cells/mm^3 but before it reaches 200 cells/mm^3.[93] Treatment initiation was not recommended for patients with a CD4 count greater or equal to 350 cells/mm^3. The 2010 recommendation for treatment initiation was that treatment should be initiated at CD4 counts less than or equal to 500 cells/mm^3.[94] Research indicates that these changes directly affect survival.[29, 30, 32, 33, 53, 95, 96]

Studies suggest that the adoption rate of treatment guidelines is less than 1 year. In the Department of Veteran Affairs, for example, 98% of patients on ART were receiving at least 2 drugs in combination in 1997 and the proportion of patients taking at least 3 drugs in combination rose from 64% in 1997 to 88% in 1998.[97] Because differences in outcomes are expected for patients diagnosed in different time periods as a result of differences in treatment plans, the main cohort was divided into 4 subcohorts based on major revisions to treatment guidelines with 1 year allowed for adoption on the assumption that adoption rate of treatment guidelines in the Department of Veteran Affairs can be generalized to other provider organizations. Hence, the subcohorts are:

- Patients diagnosed with HIV between 1996 and 1997
- Patients diagnosed with HIV between 1998 and 2006
- Patients diagnosed with HIV between 2007 and 2010
- Patients diagnosed with HIV between 2011 and 2013

Data analyses were performed separately for each sub-cohort since differences in magnitude of effect are expected by time period

2.4 INCLUSION/EXCLUSION CRITERIA

Patients included in this study had received a diagnosis of HIV and were between the ages of 18 and 89 years at the time of diagnosis. Patients below 18 years at the time of diagnosis or above 89 years at diagnosis or death were excluded.

2.5 STUDY VARIABLES

Below is a description of the study's outcomes of interest and independent variables, followed by operational definitions.

2.5.1 Outcomes of Interest

1. Death: This was a dichotomous categorical variable with "not reported dead during study period" (coded 0) versus "reported dead during study period" (coded 1). This was determined from the variable 'death year', a continuous variable on an interval scale. The variable 'death year' was recoded so that cases with a reported death year were labelled "reported dead during study period" while cases with missing values were labelled "not reported dead during study period".
2. AIDS diagnosis: This was a dichotomous categorical variable with "not diagnosed with AIDS during study period" (coded 0) versus "diagnosed with

AIDS during study period" (coded 1). This was determined from the variable 'AIDS diagnosis year', a continuous variable on an interval scale. The variable 'AIDS diagnosis year' was recoded so that cases with a reported AIDS diagnosis year were labelled "diagnosed with AIDS within study period" while cases with missing values were labelled "not diagnosed with AIDS within study period".

3. Time to Death: This was a continuous variable on an interval scale and is the time (in years) from HIV diagnosis to death. It was operationalized as the difference between HIV diagnosis year and death year. Patients without a report of death had missing values for this variable.
4. Time to AIDS: This was a continuous variable on an interval scale and is the time (in years) from HIV diagnosis to AIDS diagnosis. It was operationalized as the difference between HIV diagnosis year and AIDS diagnosis year. Patients without a report of AIDS diagnosis had missing values for this variable.
5. Rate of Immune Recovery: This was a continuous variable on a ratio scale and was operationalized as the difference between successive CD4 counts divided by the time difference. This was determined only for patients diagnosed between 2011 and 2013 who had at least 2 CD4 measurements since laboratory data (CD4 count and viral load) for patients being followed by the Texas Department of State Health Services only became available in 2010. The number of values determined for patients ranged from 0 to 92 over the follow-up period. This was possible because CD4 count data was available at different time points.

2.5.2 Independent Variables

1. Age at HIV diagnosis: This was a continuous variable on an interval scale and was operationalized as the age of the patient at diagnosis with HIV. Age ranged from 18 years to 89 years.
2. Gender: This was a dichotomous categorical variable with “Male” (coded M) versus “Female” (coded F). It was operationalized as the gender of the patient at birth.
3. Race: This was a categorical variable at the nominal level of measurement with “White, not Hispanic” (coded 1), “Black, not Hispanic”” (coded 2), “Hispanic (coded 3), “Other” (coded 4), and “Unknown” (coded 9).
4. Risk Transmission Category: This was a categorical variable at the nominal level of measurement with “Men having sex with men (MSM)” (coded 1), “Injecting drug users (IDU)” (coded 2), “MSM/IDU” (coded 3), “Heterosexual” (coded 4), “Pediatric” (coded 5), and “Adult Other” (coded 6). It was operationalized as the most probable mode of exposure to HIV infection based on patient report of risk behaviors. In the extracted data, weights for each category were assigned to patients so that they sum up to 1 for each patient. The assigned weights are the probabilities of infection through a given mode of exposure. For each patient, the highest probability was chosen as the risk transmission category. For example, if a patient was assigned weights of 0.8 and 0.2 for IDU and heterosexual, respectively, the patient was placed in the IDU risk transmission category.
5. AIDS Diagnosis: This has already been described.
6. Viral Load: This was a continuous variable on an interval scale taken at various time points, ranging from 0 to 87 time points for each patient. It was

operationalized as the number of viral copies per milliliter of blood. Data on this variable was only available for the time period 2010 to 2013. For answering the research questions under objectives 3, 5, 6. And 7, only the initial viral load was used. As a result of the time this data became available, the variable was included only in the model fitted for the 2011-2013 subcohort.

7. CD4 Count: This was a continuous variable on an interval scale taken at various time points, ranging from 0 to 93 points for each patient. It was operationalized as the number of CD4 T cells per microliter of blood. Data on this variable was available for the time period 2010 to 2013. For answering research questions under objectives 2 and 3, all data points were plugged into a Repeated Measures Hierarchical Linear Model to model the change in CD4 count over time and this model was fitted for only the 2011-2013 subcohort.
8. Linkage to Care: This variable was only available for patients diagnosed between 2011 and 2013. It was a dichotomous categorical variable with “not linked to care” (coded 0) versus “linked to care” (coded 1) and derived from CD4 count and HIV viral load. Patients with laboratory data (CD4 cell count or HIV viral load) within 365 days of diagnosis were considered linked to care. Otherwise, they were considered not linked to care. An error of 180 days was allowed because data on the exact date of diagnosis was not available. That is, in the extracted data, date of diagnosis was provided as diagnosis year. All diagnoses were assumed to occur at midyear in the year of diagnosis (180 days into the year of diagnosis). Since this variable could be determined only for the patients in the 2011-2013 subcohort, it was added

as a covariate in multivariate analyses for this subcohort and excluded from multivariate analyses for other subcohorts.

9. Length of follow-up: This was determined for both AIDS diagnosis and death. For patients who did not experience the event of interest, the length of follow-up was operationalized as the time (in years) from HIV diagnosis to the right censoring (the end of 2013). For patients who experienced the event of interest, length of follow-up was operationalized as the time (in years) from HIV diagnosis to death or AIDS diagnosis. It was assumed that there was no loss to follow-up.

2.6 STATISTICAL ANALYSES

Descriptive statistics were used to summarize demographic, clinical, and vital data. Means and standard deviations were used to describe continuous variables while frequencies and percentages was used to describe categorical variables. Repeated Measures Hierarchical Linear Models were used to determine the relationships between CD4 count and time and between age, gender, and race and rate of immune recovery. Hierarchical Linear Models were used to allow for all available CD4 count data and rate of immune recovery values to be included in the models where time served as a level-1 covariate and patient-level served as the level-2 factor, with CD4 count being nested within patient level. Survival analyses using Kaplan-Meier methods were used to determine the relationships between categorical predictors (gender, race, risk transmission category, and linkage to care) and the risk of an AIDS diagnosis and death while univariate Cox-proportional hazard models were used to determine the relationships between continuous predictors (age, CD4 count, and viral load) and the risk of an AIDS diagnosis and death and to compare groups within

categorical predictors. Cox-proportional hazard models were also used to determine the relationships between age, gender, and race before and after controlling for confounders. Mortality rates were determined by age group, gender, race, risk transmission category, linkage to care, and time period and used to create life tables for the estimation of life expectancies following Chiang's method.[98] Data cleaning and preparation was conducted using SAS version 9.4 (SAS Institute Inc., Cary, North Carolina). Stata was used to perform data analyses for objectives related to rates of immune recovery and survival. Life tables were constructed using Microsoft Excel. Since sample size of the groups was large, the apriori alpha level of statistical significance was set at $p<0.01$ for all statistical analyses related to rate of immune recovery and survival in order to be conservative. For all statistical analyses related to life expectancy, the apriori alpha level of statistical significance was set at 0.05 because of the small sample sizes of the subgroups. A summary of the statistical procedures that were performed to address the objectives and hypotheses is presented in table 2.1.

Formulas Used in the Construction of Life Tables

Given:

N_x=Number of people alive in age group x=Population count

D_x=Number of people who died in age group x=Death count

n_x=Age interval of age group

Where:

X=1=first age group

X=w=last age group

Midyear population, $P_x=(N_x-D_x)n_x+(0.5)(D_x)(n_x)$

Mortality rate, $M_x = D_x/P_x$, $x=1,2,3,\ldots,w-1$

$M_w = 1/(0.5)n_w$

Proportion dying in interval, $q_x=n_xM_x/(1+(0.5)(M_x)(n_x))$, $x=1,2,3,\ldots,w-1$

l_x=Hypothetical number living in age group x

d_x=Hypothetical number dying in age group x

$l_1=100,000$

$d_1=l_1q_1$

For other age groups,

$l_{x+1}=l_x-d_x$, $x=2,3,4,\ldots,w-1$

$d_x=l_xq_x$

Number of years lived in interval, $L_x=n_x(l_x-d_x)+(0.5)n_xd_x$, $x=1,2,3,4,\ldots,w-1$

Where x=w,

$L_w=l_w/M_w$

Life expectancy, $e_x= (L_x+L_{x+1}+\ldots+L_w)/l_x$

Sample Life Table

Table 2.1 shows a sample life table constructed using the formulas described above.

Given Nx, Dx, and nx.

$P_1 = (60-3)(2) + (0.5)(3)(2) = 117$

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.

.

$P_w = P_{13} = (8-6)(5) + (0.5)(6)(5) =25$

$M_1 = 3/117 = 0.026$

.

.

.

$M_{13} = 1/(0.5)(5) = 0.4$

$q_1 = (2)(0.026)/(1+(0.5)(2)(0.026) = 0.05$

.

.

.

$q_w = q_{13} = 1$

$l_1 = 100,000$

$d_1 = (100,000)(0.05) = 5,000$

$l_2 = 100,000\text{-}5,000 = 95,000$

.

.

.

$d_{13} = (5,232)(1) = 5,232$

$L_1 = (2)(100,000\text{-}5,000)+(0.5)(2)(5,000) = 195,000$

.

.

.

$L_w = L_{13} = 5,232/0.4 = 13,079$

$T_{12} = L_{12}+L_{13} = 13,079+ 45,777 = 58,856$

$T_{11}= L_{11}+L_{12}+L_{13} = 89,655+58,856 = 148,511$

.

.

.

$e_1 = T_1/l_1 = 3,191,401/100,000 = 31.91$

.

.

.

$e_{13} = 13,079/5,232 = 2.50$

Table 2.1: Sample Life Table

x	n_x	N_x	D_x	P_x	M_x	a_x	q_x	l_x	d_x	L_x	T_x	e_x
1	18-19	60	3	117	0.026	0.5	0.050	100,000	5,000	195,000	3,191,401	31.91
2	20-24	445	11	2198	0.005	0.5	0.025	95,000	2,348	469,129	2,996,401	31.54
3	25-29	895	63	4318	0.015	0.5	0.070	92,652	6,522	446,954	2,527,272	27.28
4	30-34	1425	124	6815	0.018	0.5	0.087	86,130	7,495	411,912	2,080,318	24.15
5	35-39	1810	224	8490	0.026	0.5	0.124	78,635	9,732	368,846	1,668,406	21.22
6	40-44	1556	185	7318	0.025	0.5	0.119	68,903	8,192	324,036	1,299,560	18.86
7	45-49	957	148	4415	0.034	0.5	0.155	60,711	9,389	280,083	975,524	16.07
8	50-54	530	102	2395	0.043	0.5	0.192	51,322	9,877	231,918	695,440	13.55
9	55-59	318	81	1388	0.058	0.5	0.255	41,445	10,557	180,833	463,522	11.18
10	60-64	141	37	613	0.060	0.5	0.262	30,888	8,105	134,178	282,689	9.15
11	65-69	54	23	213	0.108	0.5	0.426	22,783	9,704	89,655	148,511	6.52
12	70-74	20	12	70	0.171	0.5	0.6	13,079	7,847	45,777	58,856	4.50
13	≥75	8	6	25	0.400	0.5	1	5,232	5,232	13,079	13,079	2.50

Table 2.2: Summary of the study hypotheses, variables, levels of measure, and statistical procedures

Objectives	Hypotheses	Dependent Variables (Level of Measure)	Independent Variables (Level of Measure)	Statistical Procedure
1. To describe the demographic and clinical characteristics of patients living with HIV who reside in Texas, with respect to gender, race, age at HIV diagnosis, risk transmission category, linkage to care, viral load, CD4 count, and age at AIDS diagnosis	*N/A*	N/A	N/A	Means Standard Deviations Frequencies Percentages
2. To determine the relationship between CD4 count and time	*H_1: CD4 count increases with time* *H_2: Rate of increase in CD4 count declines with time*	CD4 count	Time interval between CD4 counts	Hierarchical Linear Modeling
3. To determine the relationships between age, gender, and race/ethnicity and rate of immune recovery	*H_3: Age is negatively associated with rate of immune recovery* *H_4: Male gender is associated with a lower rate of immune recovery* *H_5: Black ethnicity is associated with a lower rate of immune recovery*	Rate of immune recovery (Continuous)	Age (Continuous/Interval) Gender (Categorical/ Dichotomous) Race/Ethnicity (Categorical/Nominal)	Hierarchical Linear Modeling

Table 2.2: Summary of the study hypotheses, variables, levels of measure, and statistical procedures…*(continued)*

Objectives	Hypotheses	Dependent Variables (Level of Measure)	Independent Variables (Level of Measure)	Statistical Procedure
4. To determine the relationships between age, gender, and race and rate of immune recovery after adjusting for risk transmission category, linkage to care, CD4 count, viral load, and AIDS diagnosis	*H_6: Age is negatively associated with rate of immune recovery after adjusting for gender, race/ethnicity, risk transmission category, linkage to care, CD4 count, viral load, and AIDS diagnosis* *H_7: There is no significant relationship between gender and rate of immune recovery after adjusting for age, race/ethnicity, risk transmission category, linkage to care, CD4 count, viral load, and AIDS diagnosis* *H_8: Black ethnicity is associated with a lower rate of immune recovery after adjusting for age, gender, risk transmission category, linkage to care, CD4 count, viral load, and AIDS diagnosis*	Rate of immune recovery (Continuous)	Age (Continuous/Interval) Covariates[a] Gender (Categorical/ Dichotomous) Covariates[a] Race/Ethnicity (Categorical/Nominal) Covariates[a]	Hierarchical Linear Modeling

Table 2.2: Summary of the study hypotheses, variables, levels of measure, and statistical procedures…*(continued)*

Objectives	Hypotheses	Dependent Variables (Level of Measure)	Independent Variables (Level of Measure)	Statistical Procedure
5. To determine the magnitude and direction of the association between age, gender, and race/ethnicity and the risk of an AIDS diagnosis and death	*H_9: Age is positively associated with the risk of an AIDS diagnosis* *H_{10}: Age is positively associated with the risk of death* *H_{11}: Male gender is positively associated with the risk of an AIDS diagnosis* *H_{12}: Male gender is positively associated with the risk of death* *H_{13}: Black ethnicity (compared to White and Hispanic ethnicities) is positively associated with the risk of an AIDS diagnosis* *H_{14}: Black ethnicity (compared to White and Hispanic ethnicities) is associated with the risk of death*	AIDS Diagnosis Death (Event)	Age (Continuous/Interval) Gender (Categorical/ Dichotomous) Race/Ethnicity (Categorical/Nominal)	Kaplan-Meier Analysis Log-Rank Test Cox Proportional Hazards Regression

Table 2.2: Summary of the study hypotheses, variables, levels of measure, and statistical procedures…*(continued)*

Objectives	Hypotheses	Dependent Variables (Level of Measure)	Independent Variables (Level of Measure)	Statistical Procedure
6. To determine the magnitude and direction of the association between risk transmission category, linkage to care, CD4 count, and viral load and time to AIDS and death	*H_{15}: IDU risk exposure (compared to heterosexual risk exposure and risk exposure in MSMs) is positively associated with the risk of an AIDS diagnosis* *H_{16}: IDU risk exposure (compared to heterosexual risk exposure and risk exposure in MSMs) is positively associated with the risk of death* *H_{17}: Linkage to care is negatively associated with the risk of an AIDS diagnosis* *H_{18}: Linkage to care is negatively associated with the risk of death* *H_{19}: CD4 count is negatively associated with the risk of an AIDS diagnosis* *H_{20}: CD4 count is negatively associated with the risk of death*	AIDS Diagnosis Death (Event)	Risk Transmission Category (Categorical/Nominal) Linkage to Care (Categorical/ Dichotomous) CD4 Count (Continuous/Interval)	Kaplan-Meier Analysis Log-Rank Test Cox Proportional Hazards Regression

Table 2.2: Summary of the study hypotheses, variables, levels of measure, and statistical procedures…*(continued)*

Objectives	Hypotheses	Dependent Variables (Level of Measure)	Independent Variables (Level of Measure)	Statistical Procedure
6. To determine the magnitude and direction of the association between risk transmission category, linkage to care, CD4 count, and viral load and time to AIDS and death	*H_{21}: Viral load is positively associated with the risk of an AIDS diagnosis* *H_{22}: Viral load is positively associated with the risk of death*	AIDS Diagnosis Death (Event)	Viral Load (Continuous/Interval)	Kaplan-Meier Analysis Log-Rank Test Cox Proportional Hazards Regression
7. To determine the relationships between age, gender, and race/ethnicity and time to AIDS after adjusting for age, gender, race/ethnicity, risk transmission category, linkage to care, CD4 count, and viral load	*H_{23}: Age is positively associated with the risk of an AIDS diagnosis after adjusting for gender, race/ethnicity, risk transmission category, linkage to care, CD4 count, and viral load* *H_{24}: Male gender is not associated with the risk of an AIDS diagnosis after adjusting for age, race/ethnicity, risk transmission category, linkage to care, CD4 count, and viral load*	AIDS Diagnosis	Age (Continuous/Interval) Covariates[a] Gender (Categorical/ Dichotomous) Covariates[a]	Cox Proportional Hazards Regression

Table 2.2: Summary of the study hypotheses, variables, levels of measure, and statistical procedures…*(continued)*

Objectives	Hypotheses	Dependent Variables (Level of Measure)	Independent Variables (Level of Measure)	Statistical Procedure
7. To determine the relationships between age, gender, and race/ethnicity and time to AIDS after adjusting for age, gender, race/ethnicity, risk transmission category, linkage to care, CD4 count, and viral load	*H_{25}: Black ethnicity (compared to White and Hispanic ethnicities) is positively associated with the risk of an AIDS diagnosis after adjusting for age, gender, risk transmission category, linkage to care, CD4 count, and viral load*	AIDS Diagnosis	Race/Ethnicity (Categorical/Nominal) Covariates[a]	Cox Proportional Hazards Regression
8. To determine the relationships between age, gender, and race/ethnicity and death after adjusting for risk transmission category, linkage to care, CD4 count, viral load, and AIDS diagnosis	*H_{26}: Age is positively associated with the risk of death after adjusting for gender, race/ethnicity, risk transmission category, linkage to care, CD4 count, viral load, and AIDS diagnosis* *H_{27}: Male gender is not associated with the risk of death after adjusting for age, race/ethnicity, risk transmission category, linkage to care, CD4 count, viral load, and AIDS diagnosis*	Death (Event)	Age (Continuous/Interval) Covariates[a] Gender (Categorical/ Dichotomous) Covariates[a]	Cox Proportional Hazards Regression

Table 2.2: Summary of the study hypotheses, variables, levels of measure, and statistical procedures…*(continued)*

Objectives	Hypotheses	Dependent Variables (Level of Measure)	Independent Variables (Level of Measure)	Statistical Procedure
8. To determine the relationships between age, gender, and race/ethnicity and death after adjusting for risk transmission category, linkage to care, CD4 count, viral load, and AIDS diagnosis	*H_{28}: Black ethnicity (compared to White and Hispanic ethnicities) is positively associated with the risk of death after adjusting for age, gender, risk transmission category, linkage to care, CD4 count, viral load, and AIDS diagnosis*	Death (Event)	Race/Ethnicity (Categorical/Nominal) Covariates[a]	Cox Proportional Hazards Regression
9. To construct life tables of patients living with HIV who reside in Texas, grouped by age, gender, race, risk transmission category, linkage to care, and time period	*N/A*	N/A	N/A	N/A
10. To compare life expectancy among patients living with HIV who reside in Texas with that of the general population	*N/A*	N/A	N/A	N/A

[a] Includes age, gender, race/ethnicity, risk transmission category, linkage to care, CD4 count, viral load, and AIDS diagnosis with the exception of the main variables of interest

Chapter 3: Results

3.1 CHAPTER OVERVIEW

This chapter presents the results of the study. All results are organized by study objectives and associated statistical analyses with separate results presented for each subcohort. Justification for performing separate analyses for each subcohort is presented before the results addressing study objectives.

3.2 JUSTIFICATION FOR PERFORMING SEPARATE ANALYSES FOR THE FOUR SUBCOHORTS

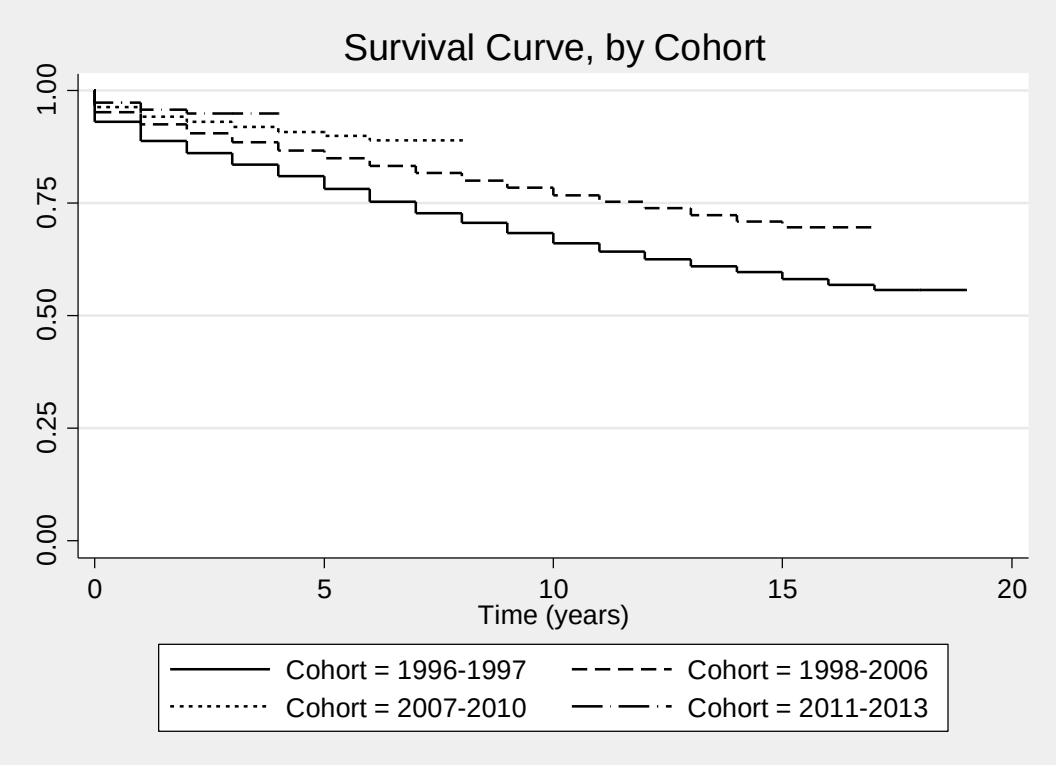
This study includes patients diagnosed with HIV in the state of Texas between 1996 and 2013, of which the diagnoses were reported to Texas Department of State Health Services Within this period, treatment guidelines were changed based on clinical evidence that showed improved health outcomes for patients with the newer recommendations. The recommendations made by the International Antiviral Society in 1996, 1997, 2006, and 2010 have been shown to affect survival directly. On the assumption that the adoption rate for treatment guidelines is 1 year, the study cohort was divided into 4 subcohorts. The subcohorts are:

- Patients diagnosed with HIV between 1996 and 1997
- Patients diagnosed with HIV between 1998 and 2006
- Patients diagnosed with HIV between 2007 and 2010
- Patients diagnosed with HIV between 2011 and 2013

Figure 3.1 shows the Kaplan-Meier curve comparing the proportion of patients who survived during the follow-up period by subcohort. The log-rank test (χ^2=999.02; df=3; p<0.001) showed a significant difference among the subcohorts. As shown in the figure, survival outcomes was better for those diagnosed in later time periods

compared to those diagnosed in an earlier time period. Hence, there was a need to perform separate analyses for each time period in order to identify trends.

Figure 3.1: Kaplan-Meier Curve Comparing the Proportion of Patients Who Survived by Subcohort



3.3 OBJECTIVE 1: Description of Demographic and Clinical Characteristics

Objective 1 was to describe the demographic and clinical characteristics of patients living with HIV who reside in Texas, with respect to gender, race, age at HIV diagnosis, risk transmission category, linkage to care, viral load, CD4 count, and age at AIDS diagnosis. Summary statistics were determined for the overall cohort and for each sub-cohort using means, standard deviations, frequencies, and percentages.

Means and standard deviations were used to describe age, initial CD4 count, initial viral load, and number of months between HIV and AIDS diagnosis while frequencies and percentages were used to describe gender, ethnicity, risk transmission category, AIDS diagnosis, death, and linkage to care. Initial CD4 count, initial viral load, and linkage to care were summarized for the 2011-2013 sub-cohort only, since laboratory data (CD4 count and viral load) became available from 2010 with the linkage to care variable being derived from laboratory data. Table 3.1 shows the summary statistics describing the overall cohort and subcohorts.

Table 3.1: Demographic and Clinical Characteristics of Study Cohort and Subcohorts (N=70,996)

Characteristic	1996-1997 Sub-cohort	1998-2006 Sub-cohort	2007-2010 Sub-cohort	2011-2013 Sub-cohort	Total
N	7,206	36,286	15,628	11,876	70,996
Number of years of follow-up	18	16	7	3	
Age, Mean (SD)	35.86 (9.59)	36.57 (10.38)	35.62 (11.67)	35.19 (12.14)	35.62 (11.67)
Gender, n (%)					
Female	1,598 (22.18)	8,744 (24.10)	3,533 (22.61)	2,336 (19.67)	16,211 (22.83)
Male	5,608 (77.82)	27,542 (75.90)	12,095 (77.39)	9,540 (80.33)	54,785 (77.17)
Race, n (%)					
White, not Hispanic	2,458 (34.11)	10,848 (29.90)	3,605 (23.07)	2,581 (21.73)	19,492 (27.46)
Black, not Hispanic	2,880 (39.97)	14,485 (39.92)	6,512 (41.67)	4,678 (39.39)	28,555 (40.22)
Hispanic	1,868 (25.92)	10,953 (30.19)	5,511 (35.26)	4,617 (38.88)	22,949 (32.32)
Risk Transmission Category, n (%)					
MSM[a]	4,132 (57.34)	20,541 (56.61)	10,128 (64.81)	8,549 (71.99)	43,350 (61.06)
IDU[b]	1,323 (18.36)	5,725 (15.78)	1,123 (7.19)	479 (4.03)	8,650 (12.18)
Heterosexual	1,751 (24.30)	10,020 (27.61)	4,377 (28.01)	2,848 (23.98)	18,996 (26.76)
AIDS Diagnosis, n (%)					
No	912 (12.66)	13,760 (37.92)	8,347 (53.41)	7,691 (64.76)	30,710 (43.26)
Yes	6,294 (87.34)	22,526 (62.08)	7,281 (46.59)	4,185 (35.24)	40,286 (56.74)
Number of Months Between HIV and AIDS Diagnosis, Mean (SD)	21.40 (43.21)	25.70 (39.67)	12.33 (20.59)	3.78 (8.27)	20.36 (36.22)
Death, n (%)					
No	3,974 (55.15)	26,952 (74.28)	14,002 (89.60)	11,263 (94.84)	56,191 (79.15)
Yes	3,232 (44.85)	9,334 (25.72)	1,626 (10.40)	613 (5.16)	14,805 (20.85)

Table 3.1: Demographic and Clinical Characteristics of Study Cohort and Subcohorts (N=70,996)…*(continued)*

Characteristic	1996-1997 Sub-cohort	1998-2006 Sub-cohort	2007-2010 Sub-cohort	2011-2013 Sub-cohort	Total
Linkage to Care, n (%)					
No	-	-	-	341 (2.87)	-
Yes	-	-	-	11,535 (97.13)	-
Initial CD4 Count, Mean (SD)	-	-	-	404.35 (950.48)[c]	-
Initial Viral Load/10,000, Mean (SD)	-	-	-	26.45 (78.86)[d]	-

[a]Males who have sex with males
[b]Injecting drug users
[c]Available and summarized for 10,058 patients
[d]Available and summarized for 9,242 patients. Value provided is average viral load divided by 10,000.

3.4 OBJECTIVE 2: Relationship between CD4 Count and Time

Objective 2 was to determine the relationship between CD4 count and time. The relationship between CD4 count and time was assessed using descriptive statistics and hierarchical linear modeling. The descriptive statistics estimated the number of patients included in the analysis as well as the means and range of time points. In the hierarchical linear model, time served as a level-1 covariate and patient level served as the level-2 factor, with CD4 count being nested within patient level. The main independent variables (age, gender, and ethnicity) were included in the model to control for them. Also controlled for were risk transmission category, linkage to care, initial CD4 count, initial viral load, and AIDS diagnosis. Since change in CD4 count was expected to follow a curvilinear growth curve, time by time interaction was included in the model along with the time variable. The time covariate reflected change in CD4 count over time while the time by time interaction reflected the rate of immune recovery. This objective was addressed using data from the 2011-2013 cohort since CD4 count data was only available from 2010. Results were significant at $p<0.01$.

H_1: CD4 count increases with time

H_2: Rate of increase in CD4 count declines with time

2011-2013 Subcohort

Of the 11,876 patients in this cohort, 7,843 were included in the model involving CD4 count while 4,033 were excluded because of invalid or missing CD4 count data, missing viral load data or missing data on the rate of immune recovery variable. For the patients included in the analysis, there was an average of 4.2 time points (Range: 1-18).

Table 3.2 shows the results of the hierarchical linear model of the relationship of CD4 count with time, after adjusting for covariates. The overall model fit was statistically significant (Wald $\chi^2(12)=10{,}170.39$; $p<0.001$). CD4 count increased over time ($\beta=0.462$; 95% CI=0.442 – 0.482; $p<0.001$) while the rate of immune recovery declined over time ($\beta=-0.0003$; 95% CI=-0.0003 - -0.0003; $p<0.001$). There was a negative relationship between CD4 count and age after controlling for covariates. CD4 count was 0.80 units lower for each additional year of age ($\beta=-0.801$; 95% CI=-1.166 - -0.436; $p<0.001$). Male gender was negatively associated with CD4 count after controlling for covariates. CD4 count was 37.74 units lower in males, compared to females ($\beta=-37.739$; 95% CI=-55.296 - -20.182; $p<0.001$). Compared to Blacks, CD4 count was 35.92 units higher for Whites ($\beta=35.921$; 95% CI=24.529 – 47.312; $p<0.001$) but there was no significant difference between Blacks and Hispanics ($p=0.067$).

H_1: CD4 count increases with time

Failed to reject

H_2: Rate of increase in CD4 count declines with time

Failed to reject

Table 3.2: Hierarchical Linear Model of the Relationship of CD4 Count with Age, Gender, and Ethnicity in the 2011-2013 Sub-cohort, Controlling for Covariates

CD4 Count	Coefficient	Standard Error	Z	p-value	95% Confidence Interval
Age	-0.8010	0.1864	-4.30	<0.001	-1.1664 - -0.4355
CD4 Count/10	1.5810	0.0844	18.72	<0.001	1.4155 – 1.7465
Viral Load/10,000	48.3448	11.0175	4.39	<0.001	26.7509 – 69.9387
Gender					
Male	-37.7389	8.9579	-4.21	<0.001	-55.2960 - -20.1818
Ethnicity					
White vs Black	35.9205	5.8122	6.18	<0.001	24.5288 – 47.3123
Hispanic vs Black	-8.9759	4.8949	-1.83	0.067	-18.5696 – 0.6178
Risk Transmission Category					
IDU vs MSM	-14.0122	11.4455	-1.22	0.221	-36.4450 – 8.4207
Heterosexual vs MSM	-6.9347	8.5698	-0.81	0.418	-23.7312 – 9.8618
Linkage to Care					
Yes	14.1561	13.9579	1.01	0.310	-13.2008 – 41.5130
AIDS Diagnosis					
Yes	-320.0116	4.5795	-69.88	<0.001	-328.9873 - -311.0358
Time (days)	0.4622	0.0102	45.33	<0.001	0.4422 – 0.4822
Time*Time	-0.0003	0.0000	-20.73	<0.001	-0.0003 - -0.0003
Intercept	455.0824	18.2829	24.89	<0.001	419.2485 – 490.9162

3.5 OBJECTIVE 3: Unadjusted Hierarchical Linear Modeling of Rate of Immune Recovery against Age, Gender, and Race/Ethnicity

Objective 3 was to determine the relationships between age, gender, and race/ethnicity and rate of immune recovery. The relationships between age, gender, and ethnicity and rate of immune recovery were assessed using descriptive statistics and hierarchical linear modeling. The descriptive statistics estimated the number of patients included in the analyses as well as the means and range of time points included in each analysis. In the hierarchical model, time served as a level-1 covariate

and patient level served as the level-2 factor, with rate of immune recovery (change in CD4 count between 2 successive points divided by the time interval) being nested within patient level. This objective was addressed using data from the 2011-2013 cohort since CD4 count data was only available from 2010. To guard against errors due to miscoding and to improve the normality characteristic of the outcome variable, rate of immune recovery, cases with CD4 count values greater than 2,000 were excluded before analysis. Results were significant at $p<0.01$.

H_3: Age is negatively associated with rate of immune recovery

2011-2013 Cohort

Of the 11,876 patients in this cohort, 7,887 were included in the model involving CD4 count while 3,989 were excluded because of invalid CD4 count data or missing data on the rate of immune recovery variable. For the patients included in the analysis, there was an average of 4.2 time points (Range: 1-18). Table 3.3 shows the results of the hierarchical linear model of the relationship of rate of immune recovery with age and time. The overall model fit was statistically significant (Wald $\chi^2(2)=136.50$; $p<0.001$). There was a negative relationship between age and rate of immune recovery, although this relationship was not significant ($p=0.521$).

H_3: Age is negatively associated with rate of immune recovery

Rejected

Table 3.3: Hierarchical Linear Model of the Relationship of Rate of Immune Recovery with Age and Time in the 2011-2013 Sub-cohort

Rate of Immune Recovery	Coefficient	Standard Error	Z	p-value	95% Confidence Interval
Age (years)	-0.0007	0.0011	-0.64	0.521	-0.0030 – 0.0015
Midtime (days)	-0.0007	0.0001	11.65	0.000	-0.0009 - -0.0006
Intercept	0.6642	0.0454	14.62	0.000	0.5752 – 0.7532

H_4: Male gender is associated with lower rate of immune recovery

2011-2013 Cohort

Of the 11,876 patients in this cohort, 7,887 were included in the model involving CD4 count while 3,989 were excluded because of invalid CD4 count data or missing data on the rate of immune recovery variable. For the patients included in the analysis, there was an average of 4.2 time points (Range: 1-18). Table 3.4 shows the results of the hierarchical linear model of the relationship of rate of immune recovery with gender and time. The overall model fit was statistically significant (Wald $\chi^2(2)=140.63$; $p<0.001$). There was a significantly negative relationship between male gender and rate of immune recovery. Rate of immune recovery was 0.07 units lower for males than for females ($\beta=-0.071$; 95% CI=-0.137 - -0.006; $p=0.033$).

H_4: Male gender is associated with lower rate of immune recovery

Rejected

Table 3.4: Hierarchical Linear Model of the Relationship of Rate of Immune Recovery with Gender and Time in the 2011-2013 Sub-cohort

Rate of Immune Recovery	Coefficient	Standard Error	Z	p-value	95% Confidence Interval
Gender					
Male	-0.0712	0.0335	-2.13	0.033	-0.1367 - -0.0056
Time (days)	-0.0007	0.0001	-11.70	<0.001	-0.0009 - -0006
Intercept	0.6942	0.0327	21.22	<0.001	0.6301 – 0.7583

H_5: Black ethnicity is associated with lower rate of immune recovery

2011-2013 Cohort

Of the 11,876 patients in this cohort, 7,887 were included in the model involving CD4 count while 3,989 were excluded because of invalid CD4 count data or missing data on the rate of immune recovery variable. For the patients included in the analysis, there was an average of 4.2 time points (Range: 1-18). Table 3.5 shows the results of the hierarchical linear model of the relationship of rate of immune recovery with ethnicity and time. The overall model fit was statistically significant (Wald $\chi^2(3)=137.49$; $p<0.001$). Rate of immune recovery was higher for Blacks, compared to Whites and Hispanics. However, these relationships were not significant ($p=0.849$ and $p=0.262$, respectively).

H_5: Black ethnicity is associated with lower rate of immune recovery

Rejected

Table 3.5: Hierarchical Linear Model of the Relationship of Rate of Immune Recovery with Ethnicity and Time in the 2011-2013 Sub-cohort

Rate of Immune Recovery	Coefficient	Standard Error	Z	p-value	95% Confidence Interval
Ethnicity					
White vs Black	-0.0069	0.0364	-0.19	0.849	-0.0783 – 0.0644
Hispanic vs Black	-0.0352	0.0314	-1.12	0.262	-0.0968 – 0.0263
Time (days)	-0.0007	0.0001	-11.64	0.000	-0.0009 - -0.0006
Intercept	0.6535	0.0264	24.72	0.000	0.6017 – 0.7054

3.6 OBJECTIVE 4: Adjusted Hierarchical Linear Modeling of Rate of Immune Recovery against Age, Gender, and Race/Ethnicity

Objective 4 was to determine the relationships between age, gender, and race and rate of immune recovery after adjusting for risk transmission category, linkage to care, CD4 count, viral load, and AIDS diagnosis. The relationships between age, gender, and ethnicity and rate of immune recovery were assessed using descriptive statistics and hierarchical linear modeling. The descriptive statistics estimated the number of patients included in the analyses as well as the means and range of time points included in each analysis. In the hierarchical linear model, time served as a level-1 covariate and patient level served as the level-2 factor, with rate of immune recovery (change in CD4 count between 2 successive points divided by time interval) being nested within patient level. Risk transmission category, linkage to care, initial CD4 count, initial viral load, and AIDS diagnosis were included in the models. This objective was addressed using data from the 2011-2013 cohort since CD4 count data was only available from 2010. Results were significant at $p<0.01$.

H_6: Age is negatively associated with rate of immune recovery after adjusting for gender, race/ethnicity, risk transmission category, linkage to care, CD4 count, viral load, and AIDS diagnosis

H_7: There is no significant relationship between gender and rate of immune recovery after adjusting for age, race/ethnicity, risk transmission category, linkage to care, CD4 count, viral load, and AIDS diagnosis

H_8: Black ethnicity is associated with a lower rate of immune recovery after adjusting for age, gender, risk transmission category, linkage to care, CD4 count, viral load, and AIDS diagnosis

2011-2013 Cohort

Of the 11,876 patients in this cohort, 7,843 were included in the model involving CD4 count while 4,033 were excluded because of invalid CD4 count data, missing viral load data or missing data on the rate of immune recovery variable. For the patients included in the analysis, there was an average of 4.2 time points (Range: 1-18). Table 3.6 shows the results of the hierarchical linear model of the relationship of rate of immune recovery with age, gender, and ethnicity, after adjusting for covariates. The overall model fit was statistically significant (Wald $\chi^2(11)=201.63$; $p<0.001$). Age was negatively associated with rate of immune recovery but this relationship was not significant ($p=0.060$). Male gender was negatively associated with rate of immune recovery but this relationship was not significant ($p=0.070$). Rate of immune recovery was higher for Whites, compared to Blacks and lower for Hispanics, compared to Blacks. However, these relationships were not significant ($p=0.474$ and $p=0.318$, respectively).

H_6: Age is negatively associated with rate of immune recovery after adjusting for gender, race/ethnicity, risk transmission category, linkage to care, CD4 count, viral load, and AIDS diagnosis

Rejected

$H0_7$: There is no significant relationship between gender and rate of immune recovery after adjusting for age, race/ethnicity, risk transmission category, linkage to care, CD4 count, viral load, and AIDS diagnosis

Failed to reject

H_8: Black ethnicity is associated with a lower rate of immune recovery after adjusting for age, gender, risk transmission category, linkage to care, CD4 count, viral load, and AIDS diagnosis

Rejected

Table 3.6: Hierarchical Linear Model of the Relationship of Rate of Immune Recovery with Age, Gender, and Ethnicity in the 2011-2013 Sub-cohort, Controlling for Covariates

Rate of Immune Recovery	Coefficient	Standard Error	Z	p-value	95% Confidence Interval
Age	-0.0023	0.0012	-1.88	0.060	-0.0047 – 0.0001
CD4 Count/10	-0.0031	0.0006	-5.56	<0.001	-0.0041 - -0.0020
Viral Load/10,000	0.0878	0.0726	1.21	0.226	-0.0545 -0.2302
Gender					
Male	-0.1059	0.0585	-1.81	0.070	-0.2205 – 0.0088
Ethnicity					
White vs Black	0.0275	0.0383	0.72	0.474	-0.0477 – 0.1026
Hispanic vs Black	-0.0324	0.0324	-1.00	0.318	-0.0960 – 0.0312
Risk Transmission Category					
IDU vs MSM	-0.1035	0.0748	-1.38	0.166	-0.2500 -0.0430
Heterosexual vs MSM	-0.0222	0.0324	-0.40	0.692	-0.1318 – 0.0875
Linkage to Care					
Yes	-0.1033	0.1160	-0.89	0.373	-0.3307 – 0.1241
AIDS Diagnosis					
Yes	0.0897	0.0297	3.02	0.003	0.0315 – 0.1480
Time (days)	-0.0007	0.0001	-11.61	<0.001	-0.0009 - -0.0006
Intercept	1.0277	0.1398	7.35	<0.001	0.7536 – 1.3017

3.7 OBJECTIVE 5: Survival Analyses by Age, Gender, and Race/Ethnicity

Objective 5 was to determine the magnitude and direction of the association between age, gender, and race/ethnicity and the risk of an AIDS diagnosis and death. The associations between age, gender, and race/ethnicity and the risk of an AIDS diagnosis and death were assessed using descriptive and survival analyses. The descriptive analysis estimated the numbers of patients who were diagnosed with AIDS and who died during the follow-up period for each cohort. Survival curves were calculated using the Kaplan-Meier method for categorical independent variables

(gender and race /ethnicity) and the statistical significance was determined using the log-rank test. Univariate Cox proportional hazards regression models were used to compare and quantify differences between groups within categorical independent variables. Univariate Cox proportional hazards regression models were also used for interval–level independent variables (age). Results were significant at $p<0.01$.

H_9: Age is positively associated with the risk of an AIDS diagnosis

1996-1997 Cohort

Of the 7,206 patients included in the analysis, 6,266 (86.96%) were diagnosed with AIDS during the 18-year follow-up period. The univariate Cox proportional hazards model was statistically significant (Likelihood ratio χ^2, LR $\chi^2=83.13$; df=1; $p<0.001$). With each additional year in age, patients were 1% more likely to receive an AIDS diagnosis (Hazard ratio, HR=1.012; 95% confidence interval, 95% CI=1.009-1.014; $p<0.001$).

$H_{9(1996\text{-}1997)}$: Age is positively assoicated with the risk of an AIDS diagnosis

Failed to reject

1998-2006 Cohort

Of the 36,286 patients included in the analysis, 22,188 (61.15%) were diagnosed with AIDS during the 16-year follow-up period. The univariate Cox proportional hazards model was statitically significant (LR $\chi^2=382.46$; df=1; $p<0.001$). With each additional year in age, patients were 1% more likely to receive an AIDS diagnosis (HR=1.012; 95% confidence interval, 95% CI=1.011-1.014; $p<0.001$).

$H_{9(1998\text{-}2006)}$: Age is positively assoicated with the risk of an AIDS diagnosis

Failed to reject

2007-2010 Cohort

Of the 15,628 patients included in the analysis, 6,933 (44.36%) were diagnosed with AIDS during the 7-year follow-up period. The univariate Cox proportional hazards model was statistically significant (LR χ^2=370.32; df=1; p<0.001). With each additional year in age, patients were 2% more likely to receive an AIDS diagnosis (HR=1.019; 95% confidence interval, 95% CI=1.017-1.021; p<0.001).

$H_{9(2007-2010)}$: Age is positively assoicated with the risk of an AIDS diagnosis

Failed to reject

2011-2013 Cohort

Of the 11,876 patients included in the analysis, 3,841 (32.34%) were diagnosed with AIDS during the 3-year follow-up period. The univariate Cox proportional hazards model was staitistically significant (LR χ^2=449.80; df=1; p<0.001). With each additional year in age, patients were 3% more likely to receive an AIDS diagnosis (HR=1.027; 95% CI=1.024-1.029; p<0.001).

$H_{9(2011-2013)}$: Age is positively assoicated with the risk of an AIDS diagnosis

Failed to reject

H_{10}: Age is positively associated with the risk of death

1996-1997 Cohort

Of the 7,206 patients included in the analysis, 3,150 (43.71%) deaths were observed during the 18-year follow-up period. The univariate Cox proportional hazards model was statistically significant (LR χ^2=369.10; df=1; p<0.001). With each additional year in age, patients were 4% more likely to die (HR=1.035; 95% CI=1.032-1.039; p<0.001).

$H_{10(1996\text{-}1997)}$: Age is positively associated with the risk of death

Failed to reject

1998-2006 Cohort

Of the 36,286 patients in this group, 2 were excluded as a result of inconsistency in coding (i.e. the entry made in the dataset for year of diagnosis fell after the entry made for year of death). Of the remaining 36,284 patients included in the analysis, 8,883 (24.48%) deaths were observed during the 16-year follow-up period. The univariate Cox proportional hazards model was statistically significant (Likelihood ratio χ^2=2,034.45; df=1; p<0.001). With each additional year in age, patients were 5% more likely to die (HR=1.046; 95% CI=1.044-1.047; p<0.001).

$H_{10(1998\text{-}2006)}$: Age is positively associated with the risk of death

Failed to reject

2007-2010 Cohort

Of the 15,628 patients included in the analysis, 1454 (9.30%) deaths were observed during the 7-year follow-up period. The univariate Cox proportional hazards model was statistically significant (Likelihood ratio χ^2=840.64; df=1; p<0.001). With each additional year in age, patients were 6% more likely to die (HR=1.062; 95% CI=1.057-1.066; p<0.001).

$H_{10(2007\text{-}2010)}$: Age is positively associated with the risk of death

Failed to reject

2011-2013 Cohort

Of the 11,876 patients included in the analysis, 471 (3.97%) deaths were observed during the 3-year follow-up period. The univariate Cox proportional hazards model was statistically significant (Likelihood ratio χ^2=394.15; df=1; p<0.001). With each additional year in age, patients were 7% more likely to die (HR=1.070; 95% CI=1.063-1.077; p<0.001).

$H_{10(2011\text{-}2013)}$: Age is positively associated with the risk of death

Failed to reject

H_{11}: Male gender is positively associated with the risk of an AIDS diagnosis

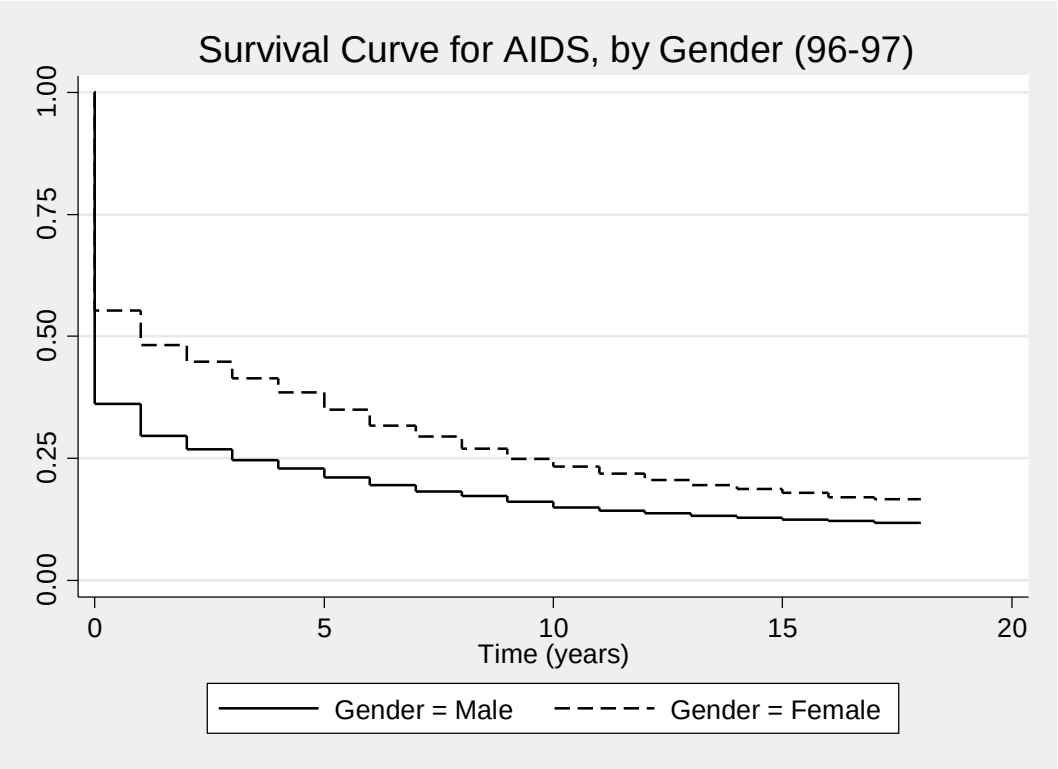
1996-1997 Cohort

Of the 7,206 patients included in the analysis, 6,266 (86.96%) were diagnosed with AIDS during the 18-year follow-up period. Of these, 4,937 (78.79%) were males and 1,329 (21.21%) were females. Figure 3.2 shows Kaplan-Meier curves comparing the percentage of patients who received an AIDS diagnosis during the 18-year follow-up period by gender. The log-rank test (χ^2=83.55; df=1; p<0.001) showed a significant difference between males and females. As shown in the figure, males had a higher rate of AIDS diagnosis than females.

$H_{11(1996\text{-}1997)}$: Males gender is positively associated with the risk of an AIDS diagnosis

Failed to reject

Fig 3.2: Kaplan-Meier Curves Comparing the Percentage of Patients by Gender in the 1996-1997 Sub-cohort Who Received an AIDS Diagnosis



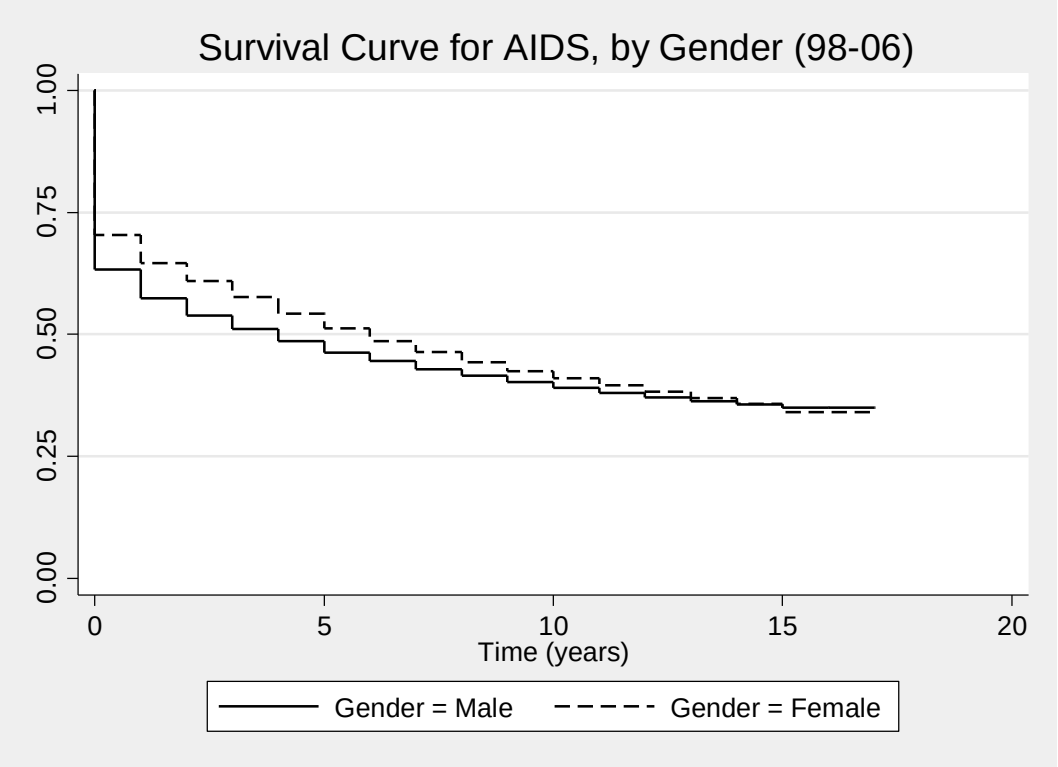
1998-2006 Cohort

Of the 36,286 patients included in the analysis, 22,188 (61.15%) were diagnosed with AIDS during the 16-year follow-up period. Of these, 16,921 (76.26%) were males and 5,267 (23.74%) were females. Figure 3.3 shows Kaplan-Meier curves comparing the percentage of patients who received an AIDS diagnosis during the 16-year follow-up period by gender. The log-rank test (χ^2=25.00; df=1; p<0.001) showed a significant difference between males and females. As shown in the figure, males had a higher rate of AIDS diagnosis than females.

$H_{11(1998\text{-}2006)}$: Males gender is positively associated with the risk of an AIDS diagnosis

Failed to reject

Fig 3.3: Kaplan-Meier Curves Comparing the Percentage of Patients by Gender in the 1998-2006 Sub-cohort Who Received an AIDS Diagnosis



2007-2010 Cohort

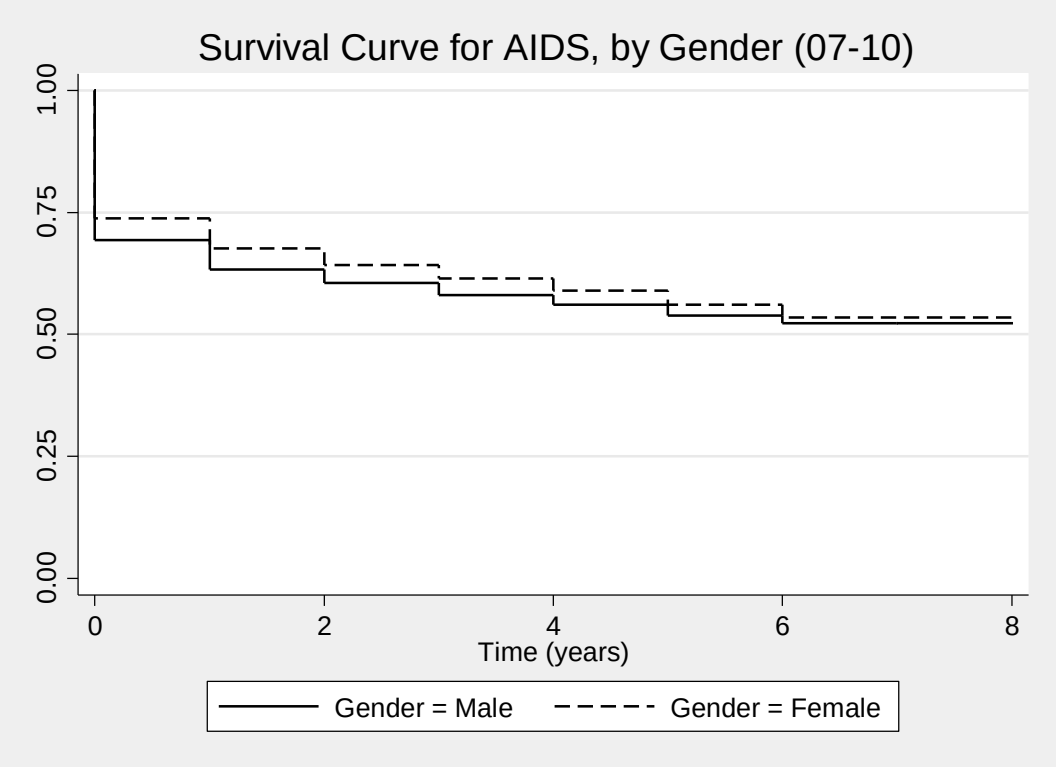
Of the 15,628 patients included in the analysis, 6,933 (44.36%) were diagnosed with AIDS during the 7-year follow-up period. Of these, 5432 (78.35%) were males and 1,501 (21.65%) were females. Figure 3.4 shows Kaplan-Meier curves comparing the percentage of patients who received an AIDS diagnosis during the 7-year follow-

up period by gender. The log-rank test (χ^2=8.90; df=1; p=0.003) showed a significant difference between males and females. As shown in the figure, males had a higher rate of AIDS diagnosis than females.

$H_{11(2007\text{-}2010)}$: Males gender is positively associated with the risk of an AIDS diagnosis

Failed to reject

Fig 3.4: Kaplan-Meier Curves Comparing the Percentage of Patients by Gender in the 2007-2010 Sub-Cohort Who Received an AIDS Diagnosis



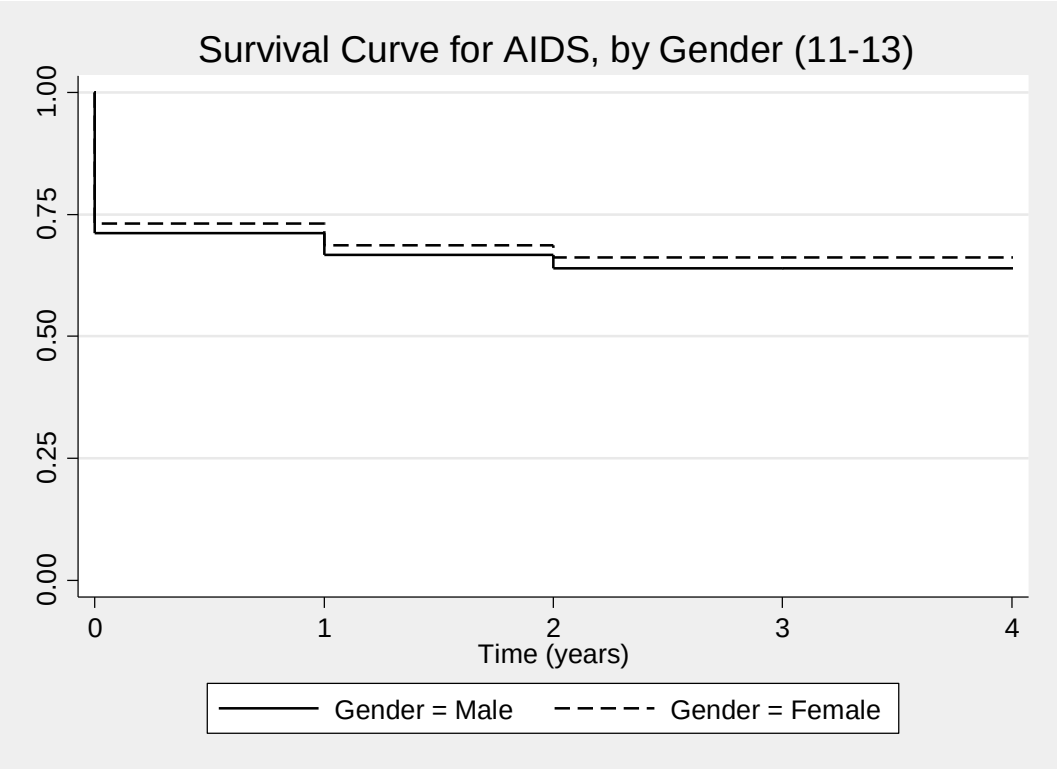
2011-2013 Cohort

Of the 11,876 patients included in the analysis, 3,841 (32.34%) were diagnosed with AIDS during the 3-year follow-up period. Of these, 3,120 (81.23%) were males and 721 (18.77%) females. Figure 3.5 shows Kaplan-Meier curves comparing the percentage of patients who survived during the 3-year follow-up period by gender. The log-rank test (χ^2=3.51; df=1; p=0.061) showed an insignificant difference between males and females.

$H_{11(2011\text{-}2013)}$: Males gender is positively associated with the risk of an AIDS diagnosis

Rejected

Fig 3.5: Kaplan-Meier Curves Comparing the Percentage of Patients by Gender in the 2011-2013 Sub-Cohort Who Received an AIDS Diagnosis



H_{12}: Male gender is positively associated with the risk of death

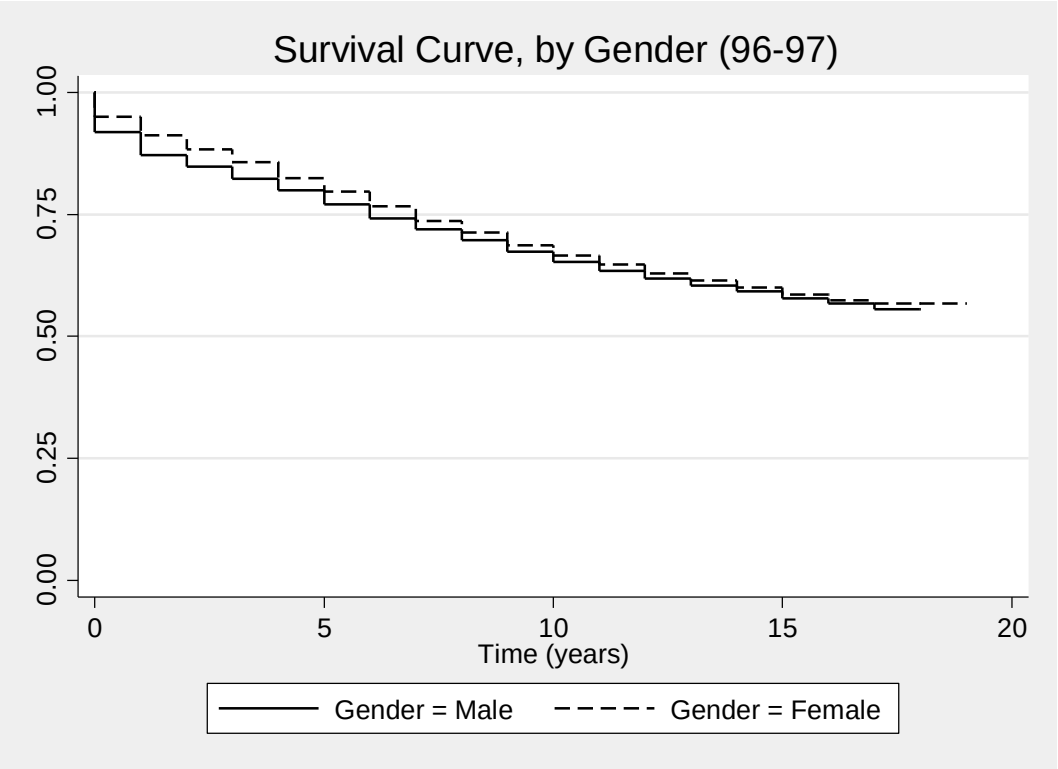
1996-1997 Cohort

Of the 7,206 patients included in the analysis, 3,150 (43.71%) deaths were observed during the 18-year follow-up period. Of these, 2,463 (78.19%) were males and 687 (21.81%) were females. Figure 3.6 shows Kaplan-Meier curves comparing the percentage of patients who survived during the 18-year follow-up period by gender. The log-rank test (χ^2=1.16; df=1; p=0.282) showed an insignificant difference between males and females.

$H_{12(1996\text{-}1997)}$: Male gender is positively associated with the risk of death

Rejected

Fig 3.6: Kaplan-Meier Curves Comparing the Percentage of Patients by Gender in the 1996-1997 Sub-Cohort Who Survived



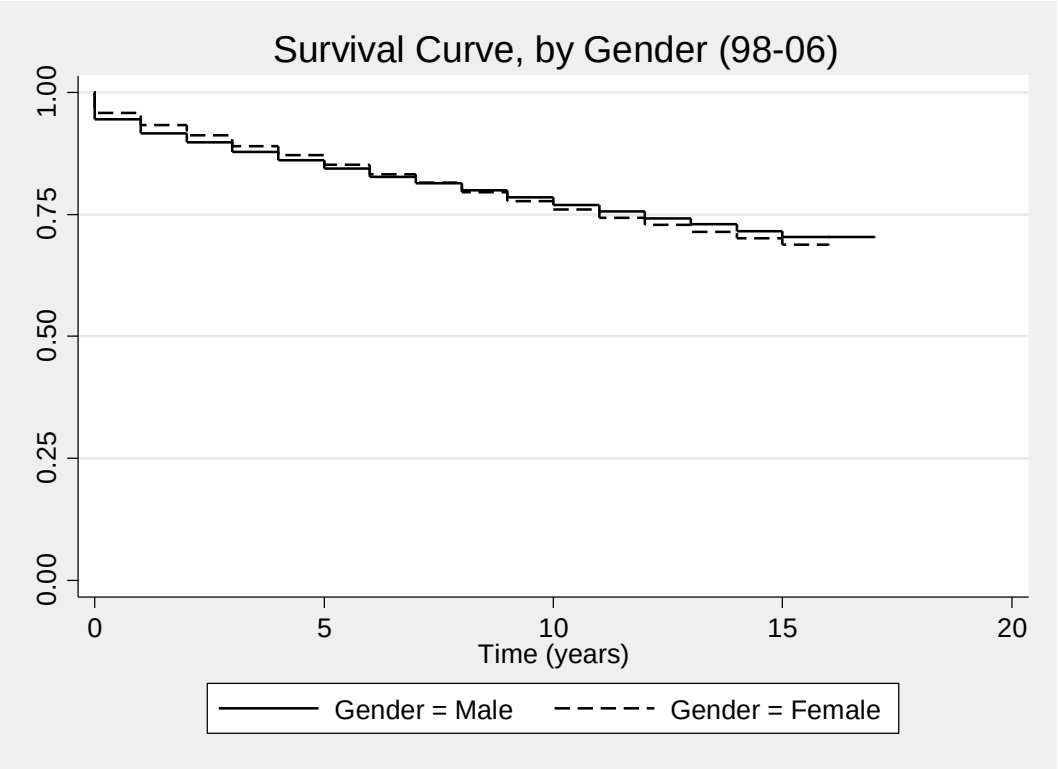
1998-2006 Cohort

Of the 36,284 patients included in the analysis, 8,883 (24.48%) deaths were observed during the 16-year follow-up period. Of these, 6,661 (74.99%) were males and 2,222 (25.01%) were females. Figure 3.7 shows Kaplan-Meier curves comparing the percentage of patients who survived during the 16-year follow-up period by gender. The log-rank test (χ^2=2.09; df=1; p=0.149) showed an insignificant difference between males and females.

$H_{12(1998\text{-}2006)}$: Male gender is positively associated with the risk of death

Rejected

Fig 3.7: Kaplan-Meier Curves Comparing the Percentage of Patients by Gender in the 1998-2006 Sub-Cohort Who Survived



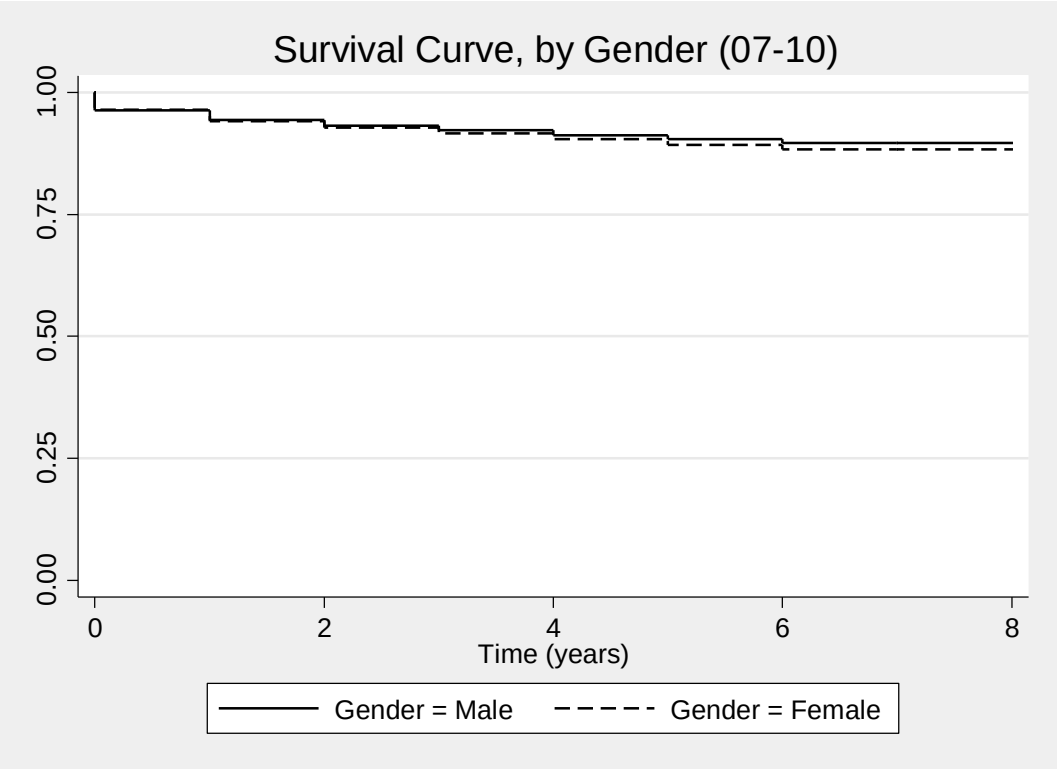
2007-2010 Cohort

Of the 15,628 patients included in the analysis, 1,454 (9.30%) deaths were observed during the 7-year follow-up period. Of these, 1,097 (75.45%) were males and (24.55%) were females. Figure 3.8 shows Kaplan-Meier curves comparing the percentage of patients who survived during the 7-year follow-up period by gender. The log-rank test (χ^2=3.14; df=1; p=0.076) showed an insignificant difference between males and females.

$H_{12(2007\text{-}2010)}$: Male gender is positively associated with the risk of death

Rejected

Fig 3.8: Kaplan-Meier Curves Comparing the Percentage of Patients by Gender in the 2007-2010 Sub-Cohort Who Survived



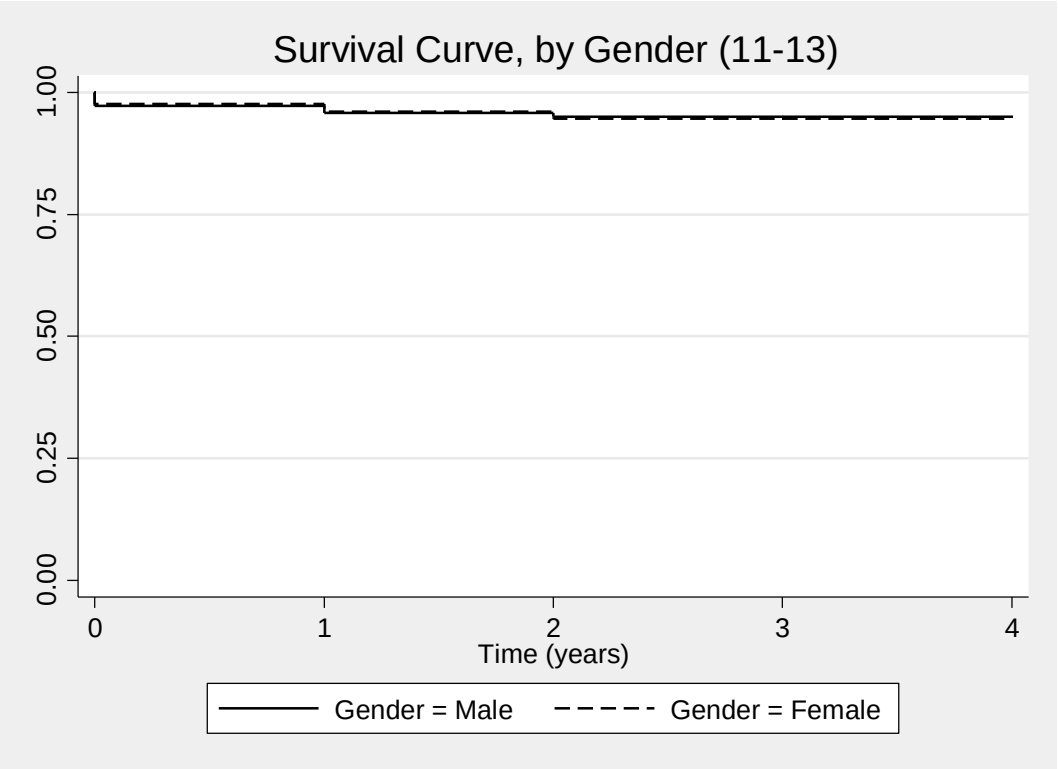
2011-2013 Cohort

Of the 11,876 patients included in the analysis, 471 (3.97%) deaths were observed during the 3-year follow-up period. Of these 379 (80.47%) were males and 92 (19.53%) were females. Figure 3.9 shows Kaplan-Meier curves comparing the percentage of patients who survived by gender. The log-rank test (χ^2=0.04; df=1; p=0.842) showed an insignificant difference between males and females.

$H_{12(2011-2013)}$: Male gender is positively associated with the risk of death

Rejected

Fig 3.9: Kaplan-Meier Curves Comparing the Percentage of Patients by Gender in the 2011-2013 Sub-Cohort Who Survived



H_{13a}: Black ethnicity (compared to White ethnicity) is positively associated with the risk of an AIDS diagnosis

H_{13b}: Black ethnicity (compared to Hispanic ethnicity) is positively associated with the risk of an AIDS diagnosis

1996-1997 Cohort

Of the 7,206 patients included in the analysis, 6,266 (86.96%) were diagnosed with AIDS during the 18-year follow-up period. Of these, 2,096 (33.45%) were White, 2,507 (40.01%) Black, and 1,663 (26.54%) Hispanic. Figure 3.10 shows Kaplan-Meier curves comparing the percentage of patients who received an AIDS diagnosis during

the 18-year follow-up period by race/ethnicity. The log-rank test (χ^2=17.31; df=2; p<0.001) showed a significant difference among ethnicities. As shown in the figure, Blacks had a lower rate of AIDS diagnosis compared to Whites and Hispanics. A univariate Cox proportional hazards model test showed that the difference was statistically significant between Blacks and Hispanics (HR=1.102; 95% CI=1.036-1.172; p=0.002) but not between Blacks and Whites (HR=1.026; 95% CI=0.969-1.088; p=0.379).

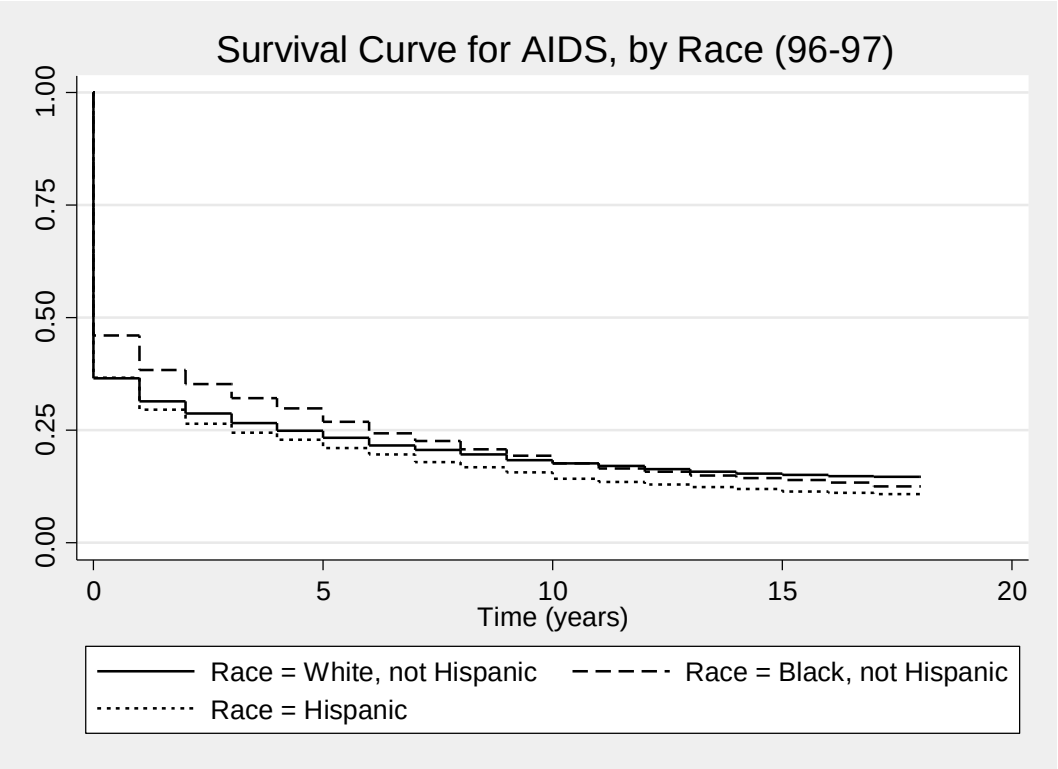
$H_{13a(1996\text{-}1997)}$: Black ethnicity (compared to White ethnicity) is positively associated with the risk of an AIDS diagnosis

Rejected

$H_{13b(1996\text{-}1997)}$: Black ethnicity (compared to Hispanic ethnicity) is positively associated with the risk of an AIDS diagnosis

Rejected

Fig 3.10: Kaplan-Meier Curves Comparing the Percentage of Patients by Ethnicity in the 1996-1997 Sub-Cohort Who Received an AIDS Diagnosis



1998-2006 Cohort

Of the 36,286 patients included in the analysis, 22,188 (61.15%) were diagnosed with AIDS during the 16-year follow-up period. Of these, 5,909 (26.63%) were White, 8,996 (40.54%) Black, and 7,283 (32.82%) Hispanic. Figure 3.11 shows Kaplan-Meier curves comparing the percentage of patients who received an AIDS diagnosis during the 16-year follow-up period by race/ethnicity. The log-rank test (χ^2=374.59; df=2; p<0.001) showed a significant difference among ethnicities. As shown in the figure, Blacks had a higher rate of AIDS diagnosis compared to Whites but a lower rate of AIDS diagnosis compared to Hispanics. A univariate Cox

proportional hazards model test showed this differences to be statistically significant (HR=0.853; 95% CI=0.825-0.882; p<0001 and HR=1.149; 95% CI=1.114-1.185; p<0.001, respectively).

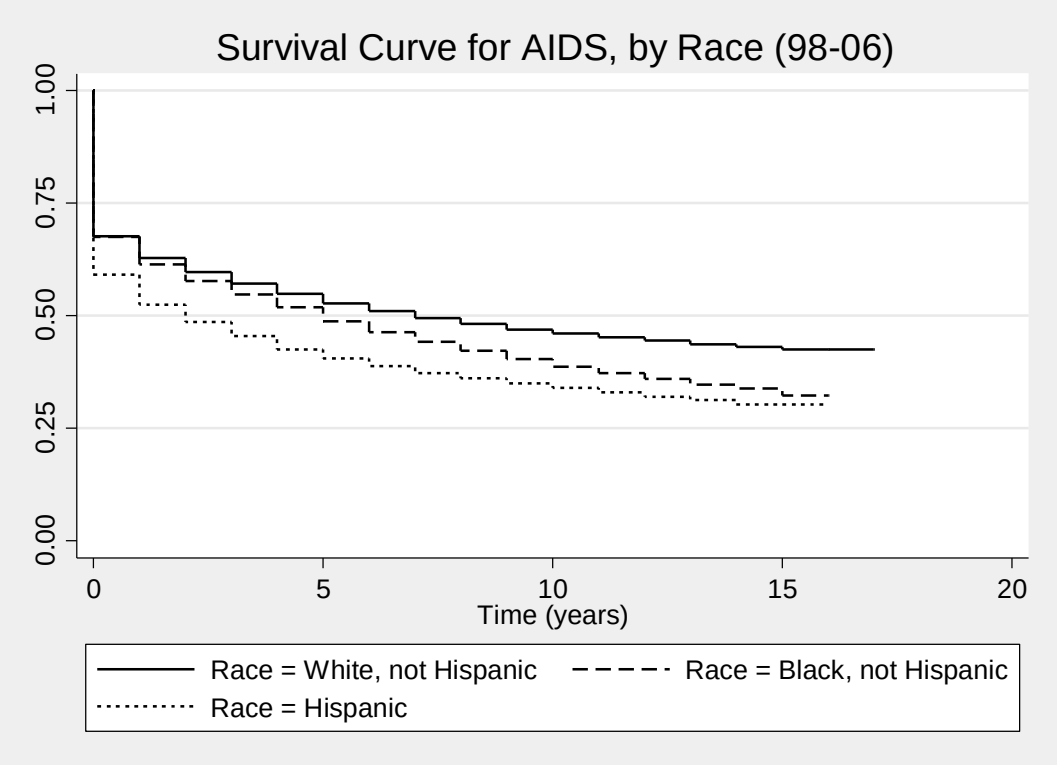
$H_{13a(1998-2006)}$: Black ethnicity (compared to White ethnicity) is positively associated with the risk of an AIDS diagnosis

Failed to reject

$H_{13b(1998-2006)}$: Black ethnicity (compared to Hispanic ethnicity) is positively associated with the risk of an AIDS diagnosis

Rejected

Fig 3.11: Kaplan-Meier Curves Comparing the Percentage of Patients by Ethnicity in the 1998-2006 Sub-Cohort Who Received an AIDS Diagnosis



2007-2010 Cohort

Of the 15,628 patients included in the analysis, 6,933 (44.36%) were diagnosed with AIDS during the 7-year follow-up period. Of these, 1,425 (20.55%) were White, 2,716 Black (39.17%), and 2,792 (40.27%) Hispanic. Figure 3.12 shows Kaplan-Meier curves comparing the percentage of patients who received an AIDS diagnosis during the 7-year follow-up period by race/ethnicity. The log-rank test (χ^2=158.96; df=2; p<0.001) showed a significant difference among ethnicities. As shown in the figure, there was no clear distinction between Blacks and Whites but Blacks had a lower rate of AIDS diagnosis than Hispanics. A univariate Cox proportional hazards model test confirmed these relationships (HR=0.951; 95% CI=0.892-1.014; p=0.123 and HR=1.286; 95% CI=1.220-1.356; p<0.001, respectively).

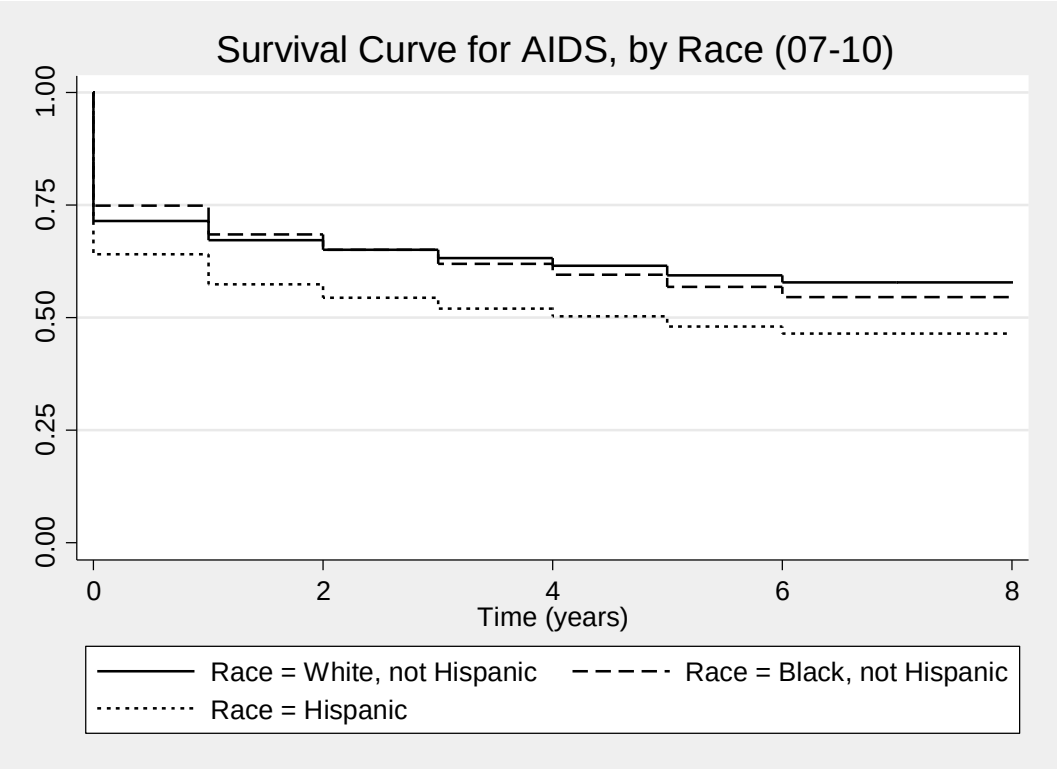
$H_{13a(2007\text{-}2010)}$: Black ethnicity (compared to White ethnicity) is positively associated with the risk of an AIDS diagnosis

Rejected

$H_{13b(2007\text{-}2010)}$: Black ethnicity (compared to Hispanic ethnicity) is positively associated with the risk of an AIDS diagnosis

Rejected

Fig 3.12: Kaplan-Meier Curves Comparing the Percentage of Patients by Ethnicity in the 2007-2010 Sub-Cohort Who Received an AIDS Diagnosis



2011-2013 Cohort

Of the 11,876 patients included in the analysis, 3,841 (32.34%) were diagnosed with AIDS during the 3-year follow-up period. Of these, 786 (20.46%) were White, 1,322 Black (34.42%), and 1,733 (45.12%) Hispanic. Figure 3.13 shows Kaplan-Meier curves comparing the percentage of patients who received an AIDS diagnosis during the 3-year follow-up period by race/ethnicity. The log-rank test (χ^2=97.32; df=2; p<0.001) showed a significant difference among ethnicities. As shown in the figure, Blacks had a lower rate of AIDS diagnosis compared to Whites or Hispanics. A univariate Cox proportional hazards model test showed the difference to be

statistically significant between Blacks and Hispanics but not between Blacks and Whites (HR=1.349; 95% CI=1.256-1.449; p<0.001 and HR=1.086; 95% CI=0.995-1.187; p=0.066, respectively).

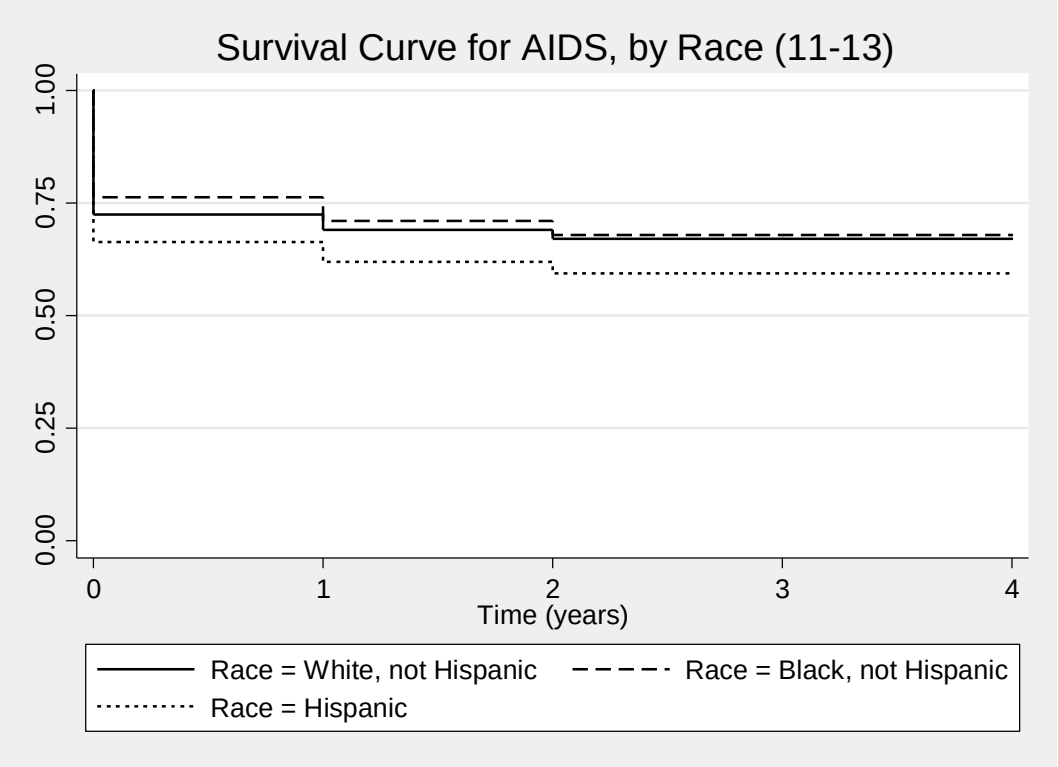
H_{13a}: Black ethnicity (compared to White ethnicity) is positively associated with the risk of an AIDS diagnosis

Rejected

H_{13b}: Black ethnicity (compared to Hispanic ethnicity) is positively associated with the risk of an AIDS diagnosis

Rejected

Fig 3.13: Kaplan-Meier Curves Comparing the Percentage of Patients by Ethnicity in the 2011-2013 Sub-Cohort Who Received an AIDS Diagnosis



H_{14a}: Black ethnicity (compared to White ethnicity) is positively associated with the risk of death

H_{14b}: Black ethnicity (compared to Hispanic ethnicity) is positvely associated with the risk of death

1996-1997 Cohort

Of the 7,206 patients included in the analysis, 3,150 (43.71%) deaths were observed during the 18-year follow-up period. Of these, 1,026 (32.57%) were White, 1,418 (45.02) were Black, and 706 (22.41%) were Hispanic. Figure 3.14 shows Kaplan-Meier curves comparing the percentage of patients who survived during the 18-year follow-up period by race/ethnicity. The log-rank test (χ^2=61.04; df=2; p<0.001) showed a significant difference among ethnicities. As shown in the figure, Blacks had a lower survival rate compared to Whites or Hispanics. A univariate Cox proportional hazards model test showed these relationships to be statistically significant (HR=0.805; 95% CI=0.743-0.872; p<0.001 and HR=0.722; 95% CI=0.659-0.790; p<0.001, respectively).

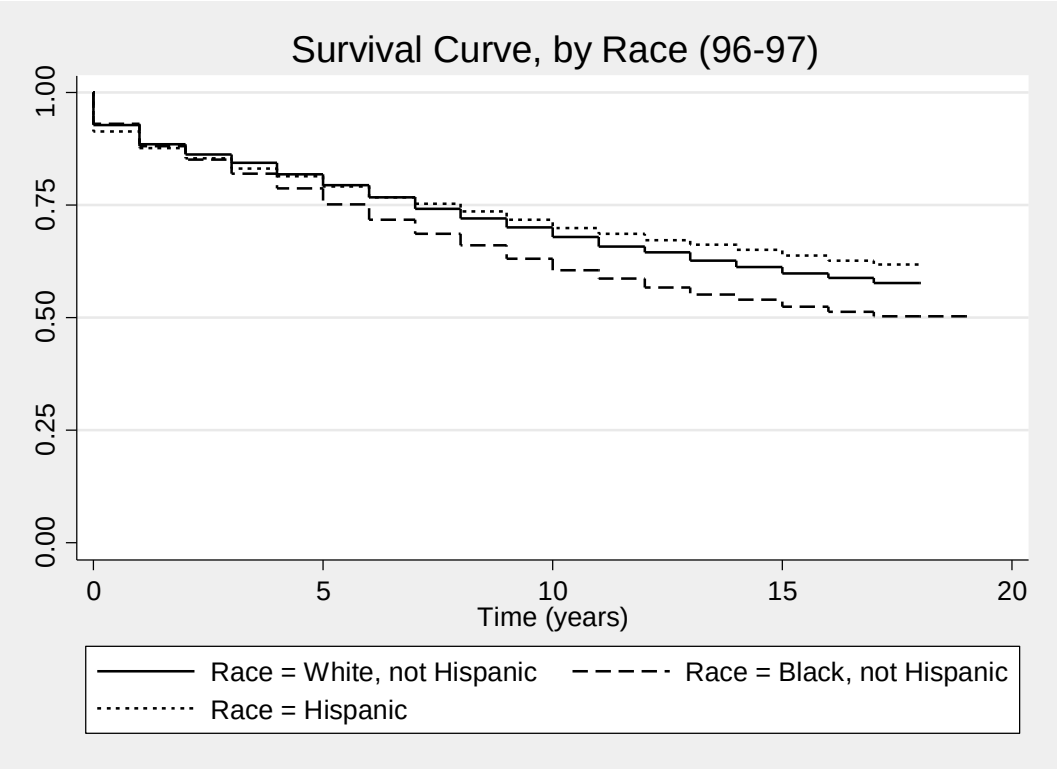
$H_{14a(1996\text{-}1997)}$: Black ethnicity (compared to White ethnicity) is positively associated with the risk of death

Failed to reject

$H_{14b(1996\text{-}1997)}$: Black ethnicity (compared to Hispanic ethnicity) is positvely associated with the risk of death

Failed to reject

Fig 3.14: Kaplan-Meier Curves Comparing the Percentage of Patients by Ethnicity in the 1996-1997 Sub-Cohort Who Survived



1998-2006 Cohort

Of the 36,284 patients included in the analysis, 8,883 (24.48%) deaths were observed during the 16-year follow-up period. Of these, 2,532 (28.50%) were White, 3,989 (44.91%) were Black, and 2,362 (26.59%) were Hispanic. Figure 3.15 shows Kaplan-Meier curves comparing the percentage of patients who survived during the 16-year follow-up period by race/ethnicity. The log-rank test (χ^2=118.59; df=2; p<0.001) showed a significant difference among ethnicities. As shown in the figure, Blacks had a lower survival rate compared to Whites or Hispanics. A univariate Cox proportional hazards model test showed these relationships to be statistically

significant (HR=0.824; 95% CI=0.784-0.867; p<0.001 and HR=0.774; 95% CI=0.735-0.814; p<0.001, respectively).

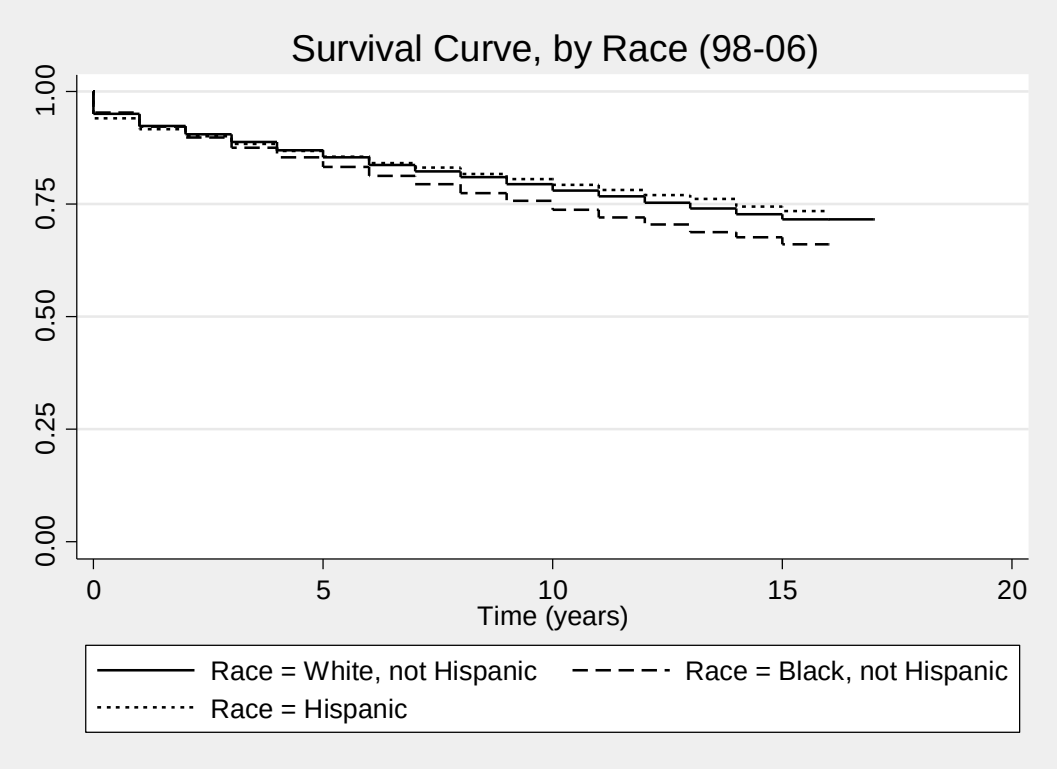
$H_{14a(1998-2006)}$: Black ethnicity (compared to White ethnicity) is positively associated with the risk of death

Failed to reject

$H_{14b(1998-2006)}$: Black ethnicity (compared to Hispanic ethnicity) is positvely associated with the risk of death

Failed to reject

Fig 3.15: Kaplan-Meier Curves Comparing the Percentage of Patients by Ethnicity in the 1998-2006 Sub-Cohort Who Survived



2007-2010 Cohort

Of the 15,628 patients included in the analysis, 1,454 (9.3%) deaths were observed during the 7-year follow-up period. Of these, 351 (24.14%) were White, 593 (40.78%) were Black, and 510 (35.08%) were Hispanic. Figure 3.16 shows Kaplan-Meier curves comparing the percentage of patients who survived during the 7-year follow-up period by race/ethnicity. The log-rank test (χ^2=0.97; df=2; p=0.614) showed an insignificant difference among ethnicities.

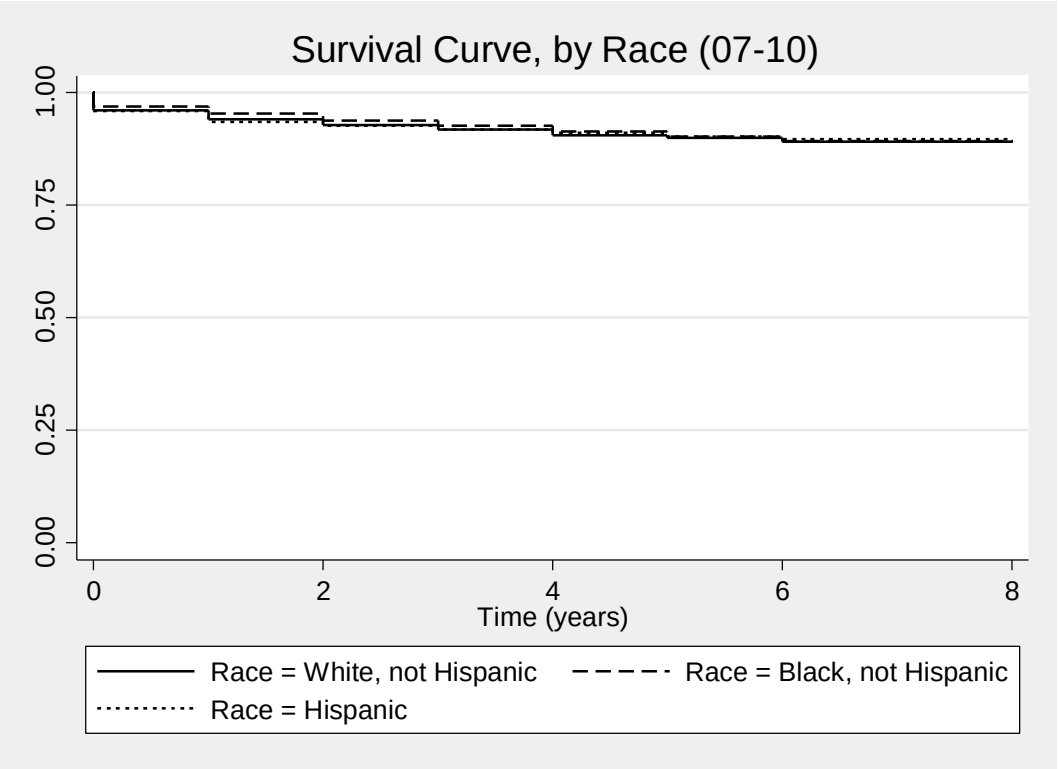
$H_{14a(2007\text{-}2010)}$: Black ethnicity (compared to White ethnicity) is positively associated with the risk of death

Rejected

$H_{14b(2007\text{-}2010)}$: Black ethnicity (compared to Hispanic ethnicity) is positvely associated with the risk of death

Rejected

Fig 3.16: Kaplan-Meier Curves Comparing the Percentage of Patients by Ethnicity in the 2007-2010 Sub-Cohort Who Survived



2011-2013 Cohort

Of the 11,876 patients included in the analysis, 471 (3.97%) deaths were observed during the 3-year follow-up period. Of these, 121 (25.69%) were White, 133 (28.24%) were Black, and 217 (46.07%) were Hispanic. Figure 3.17 shows Kaplan-Meier curves comparing the percentage of patients who survived during the 3-year follow-up period by race/ethnicity. The log-rank test (χ^2=25.61; df=2; p<0.001) showed a significant difference among ethnicities. From the figure, Blacks appeared to have a higher survival rate compared to Whites or Hispanics, although the differences were not very distinct. A univariate Cox proportional hazards model test showed that

these differences were significant. Blacks had a significantly higher survival rate compared to Whites or Hispanics (HR=1.661; 95% CI=1.298-2.124; p<0.001 and HR=1.660; 95% CI=1.337-2.059; p<0.001, respectively).

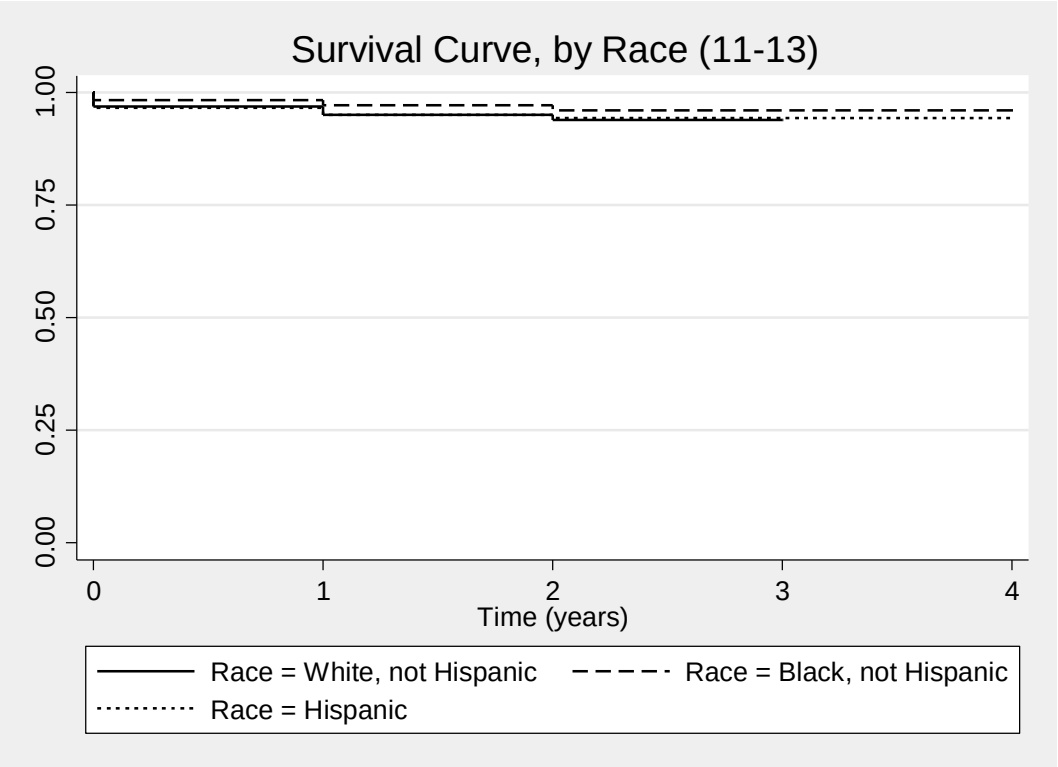
$H_{14a(2011-2013)}$: Black ethnicity (compared to White ethnicity) is positively associated with the risk of death

Rejected

$H_{14b(2011-2013)}$: Black ethnicity (compared to Hispanic ethnicity) is positively associated with the risk of death

Rejected

Fig 3.17: Kaplan-Meier Curves Comparing the Percentage of Patients by Ethnicity in the 2011-2013 Sub-Cohort Who Survived



3.8 OBJECTIVE 6: Survival Analyses for Potential Confounding Variables

Objective 6 was to determine the magnitude and direction of the association between risk transmission category, linkage to care, CD4 count, and viral load and time to AIDS and death. The associations between potential confounders of the associations between age, gender, and race/ethnicity and time to AIDS and death were assessed using descriptive and survival analyses. These potential confounders included risk transmission category, linkage to care, baseline CD4 count, and baseline viral load. The descriptive analysis used estimated the numbers of patients who were diagnosed with AIDS and who died during the follow-up period for each cohort. Survival curves were calculated using the Kaplan-Meier method for categorical independent variables (risk transmission category and linkage to care) and the statistical significance was determined using the log-rank test. Univariate Cox proportional hazards regression models were used to compare and quantify differences between groups within categorical independent variables. Univariate Cox proportional hazards regression models were also used for interval–level independent variables (baseline CD4 count and baseline viral load). Results were significant at $p<0.01$.

H_{15a}: IDU risk exposure (compared to heterosexual risk exposure) is positively associated with the risk of an AIDS diagnosis

H_{15b}: IDU risk exposure (compared to risk exposure in MSMs) is positvely associated with the risk of an AIDS diagnosis

1996-1997 Cohort

Of the 7,206 patients included in the analysis, 6,266 (86.96%) deaths were observed during the 18-year follow-up period. Of these, 1,467 (23.41%) were infected through heterosexual exposure, 1,209 (19.29%) were injecting drug users, and 3,590 (57.29%) were MSMs. Figure 3.18 shows Kaplan-Meier curves comparing the percentage of patients who received an AIDS dignosis during the 18-year follow-up period by risk transmission category. The log-rank test (χ^2=73.82; df=2; p<0.001) showed a significant difference among the risk transmission categories. As shown in the figure, IDUs had a higher rate of AIDS diagnosis compared to those infected through heterosexual exposure or MSMs. A univariate Cox proportional hazards model test showed the difference was statistically significant between those infected through IDU exposure and heterosexual exposure but not between those infected through IDU exposure and MSM (HR=0.786; 95% CI=0.728-0.848; p<0.001 and HR=0.923; 95% CI=0.865-0.985; p=0.016, respectively).

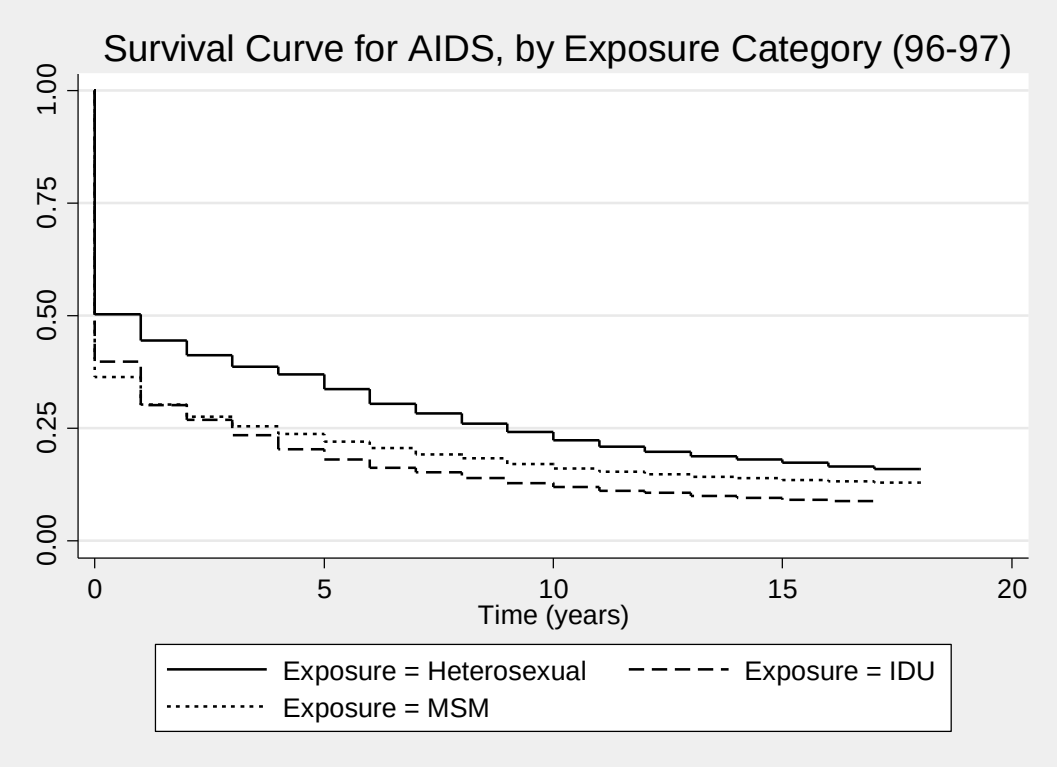
$H_{15a(1996\text{-}1997)}$: IDU risk exposure (compared to heterosexual risk exposure) is positively associated with the risk of an AIDS diagnosis

Failed to reject

$H_{15b(1996\text{-}1997)}$: IDU risk exposure (compared to risk exposure in MSMs) is positvely associated with the risk of an AIDS diagnosis

Rejected

Fig 3.18: Kaplan-Meier Curves Comparing the Percentage of Patients by Route Transmission Category in the 1996-1997 Sub-Cohort Who Received an AIDS Diagnosis



1998-2006 Cohort

Of the 36,286 patients included in the analysis, 22,188 (61.15%%) were diagnosed with AIDS during the 16-year follow-up period. Of these, 6,278 (28.29%) were infected through heterosexual exposure, 3,679 (16.58%) were injecting drug users, and 12,231 (55.12%) were MSMs. Figure 3.19 shows Kaplan-Meier curves comparing the percentage of patients who received an AIDS diagnosis during the 16-year follow-up period by risk transmission category. The log-rank test (χ^2=24.08; df=2; p<0.001) showed a significant difference among the risk transmission categories. As shown in the figure, MSMs had a lower rate of AIDS diagnosis compared to those infected through heterosexual exposure or injecting drug use. There was no clear distinction between those infected through heterosexual exposure and those infected by injecting drug use. A univariate Cox proportional hazards model test confirmed these relationships (HR=0.930; 95% CI=0.897-0.965; p<0.001 and HR=0.975; 95% CI=0.936-1.015; p=0.218, respectively).

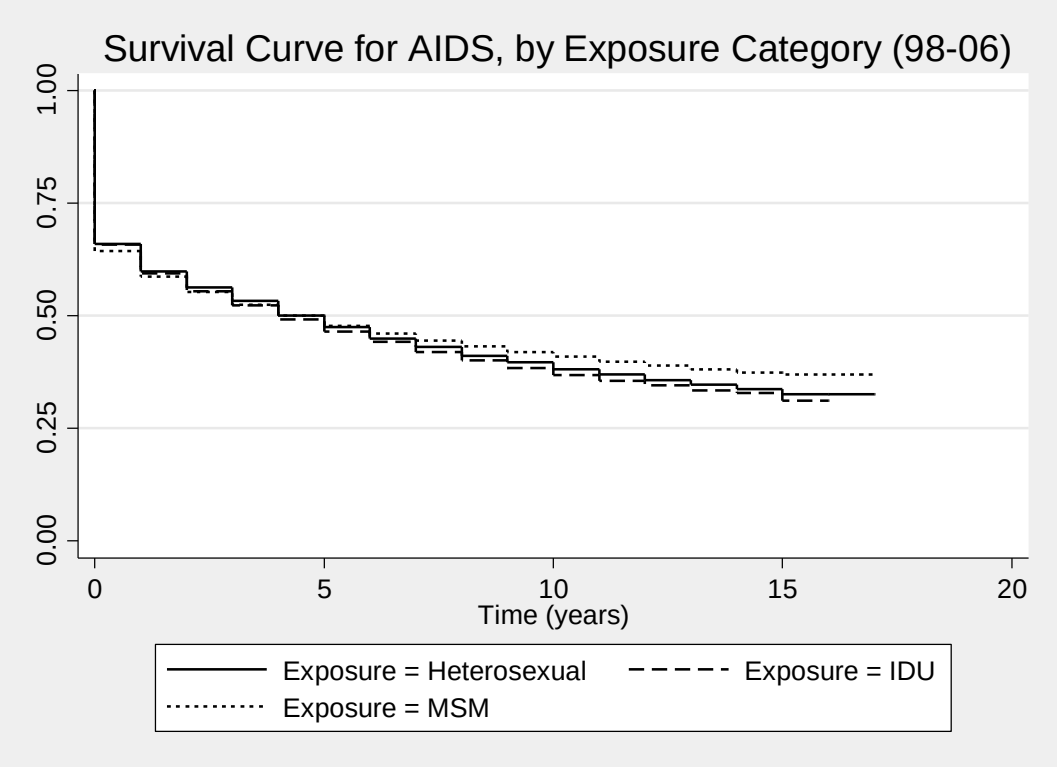
$H_{15a(1998-2006)}$: IDU risk exposure (compared to heterosexual risk exposure) is positively associated with the risk of an AIDS diagnosis

Rejected

$H_{15b(1998-2006)}$: IDU risk exposure (compared to risk exposure in MSMs) is positvely associated with the risk of an AIDS diagnosis

Failed to reject

Fig 3.19: Kaplan-Meier Curves Comparing the Percentage of Patients by Route Transmission Category in the 1998-2006 Sub-Cohort Who Received an AIDS Diagnosis



2007-2010 Cohort

Of the 15,628 patients included in the analysis, 6,933 (44.36%) deaths were observed during the 7-year follow-up period. Of these, 2,037 (29.38%) were infected through heterosexual exposure, 519 (7.49%) were injecting drug users, and 4,377 (63.13%) were MSMs. Figure 3.20 shows Kaplan-Meier curves comparing the percentage of patients who received an AIDS dignosis during the 7-year follow-up period by risk transmission category. The log-rank test (χ^2=11.51; df=2; p=0.003) showed a significant difference among the risk transmission categories. As shown in the figure, those infected through heterosexual exposure had a higher rate of AIDS diagnosis compared to those infected through injecting drug use. There was no clear distinction between MSMs and those infected through injecting drug use. A univariate Cox proportional hazards model test showed there was no difference in AIDS diagnosis between those infected through IDU exposure and those infected through heterosexual exposure or MSMs (HR=1.030; 95% CI=0.935-1.134; p=0.549 and HR=0.952; 95% CI=0.869-1.042; p=0.285, respectively).

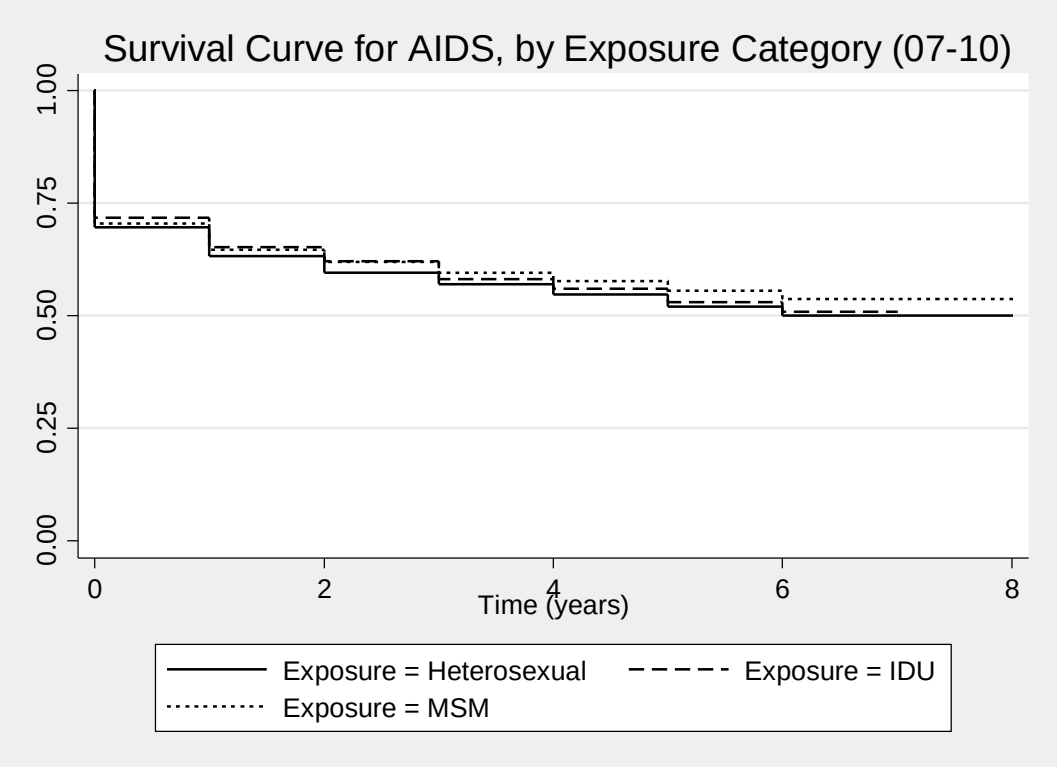
$H_{15a(2007-2010)}$: IDU risk exposure (compared to heterosexual risk exposure) is positively associated with the risk of an AIDS diagnosis

Rejected

$H_{15b(2007-2010)}$: IDU risk exposure (compared to risk exposure in MSMs) is positvely associated with the risk of an AIDS diagnosis

Rejected

Fig 3.20: Kaplan-Meier Curves Comparing the Percentage of Patients by Route Transmission Category in the 2007-2010 Sub-Cohort Who Received an AIDS Diagnosis



2011-2013 Cohort

Of the 11,876 patients included in the analysis, 3,841 (32.34%) were diagnosed with AIDS during the 3-year follow-up period. Of these, 984 (26.62%) were infected through heterosexual exposure, 181 (4.71%) were injecting drug users, and 2,676 (69.67%) were MSMs. Figure 3.21 shows Kaplan-Meier curves comparing the percentage of patients who received an AIDS diagnosis during the 3-year follow-up period by risk transmission category. The log-rank test (χ^2=15.01; df=2; p<0.001) showed a significant difference among the risk transmission categories. As shown in the figure, those infected through injecting drug use had a higher rate of AIDS diagnosis compared to those infected through heterosexual exposure or MSMs. A univariate Cox proportional hazards model test showed that these relationships were not significant (HR=0.917; 95% CI=0.783-1.075; p=0.286 and HR=0.832; 95% CI=0.716-0.967; p=0.017, respectively).

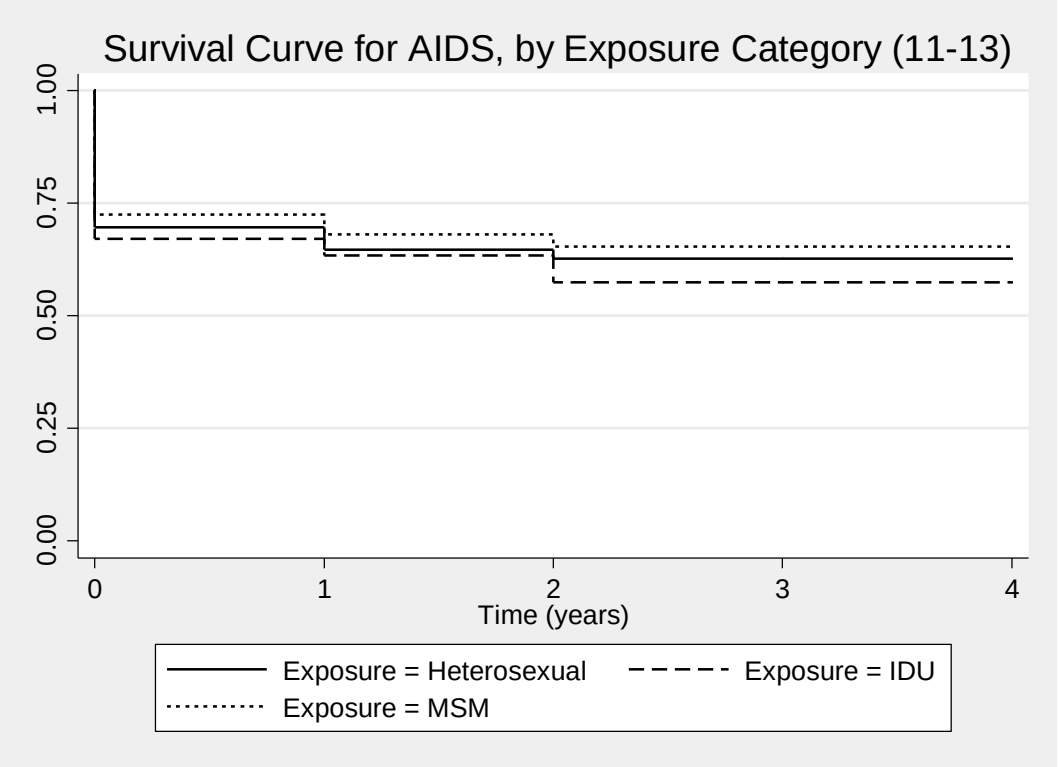
H_{15a}: IDU risk exposure (compared to heterosexual risk exposure) is positively associated with the risk of an AIDS diagnosis

Rejected

H_{15b}: IDU risk exposure (compared to risk exposure in MSMs) is positvely associated with the risk of an AIDS diagnosis

Rejected

Fig 3.21: Kaplan-Meier Curves Comparing the Percentage of Patients by Route Transmission Category in the 2011-2013 Sub-Cohort Who Received an AIDS Diagnosis



H_{16a}: IDU risk exposure (compared to heterosexual risk exposure) is positively associated with the risk of death

H_{16b}: IDU risk exposure (compared to risk exposure exposure in MSMs) is positively associated with the risk of death

1996-1997 Cohort

Of the 7,206 patients included in the analysis, 3,150 (43.71%) deaths were observed during the 18-year follow-up period. Of these, 733 (23.27%) were infected through heterosexual exposure, 776 (24.63%) were injecting drug users and 1,641 (53.10%) were MSMs. Figure 3.22 shows Kaplan-Meier curves comparing the percentage of patients who survived during the 18-year follow-up period by risk transmission category. The log-rank test (χ^2=167.05; df=2; p<0.001) showed a significant difference among the risk transmission categories. As shown in the figure, those infected through injecting drug use had a lower survival rate compared to those infected through heterosexual exposure or MSMs. A univariate Cox proportional hazards model test showed these relationships to be statistically significant (HR=0.619; 95% CI=0.559-0.685; p<0.001 and HR=0.587; 95% CI=0.539-0.640; p<0.001, respectively).

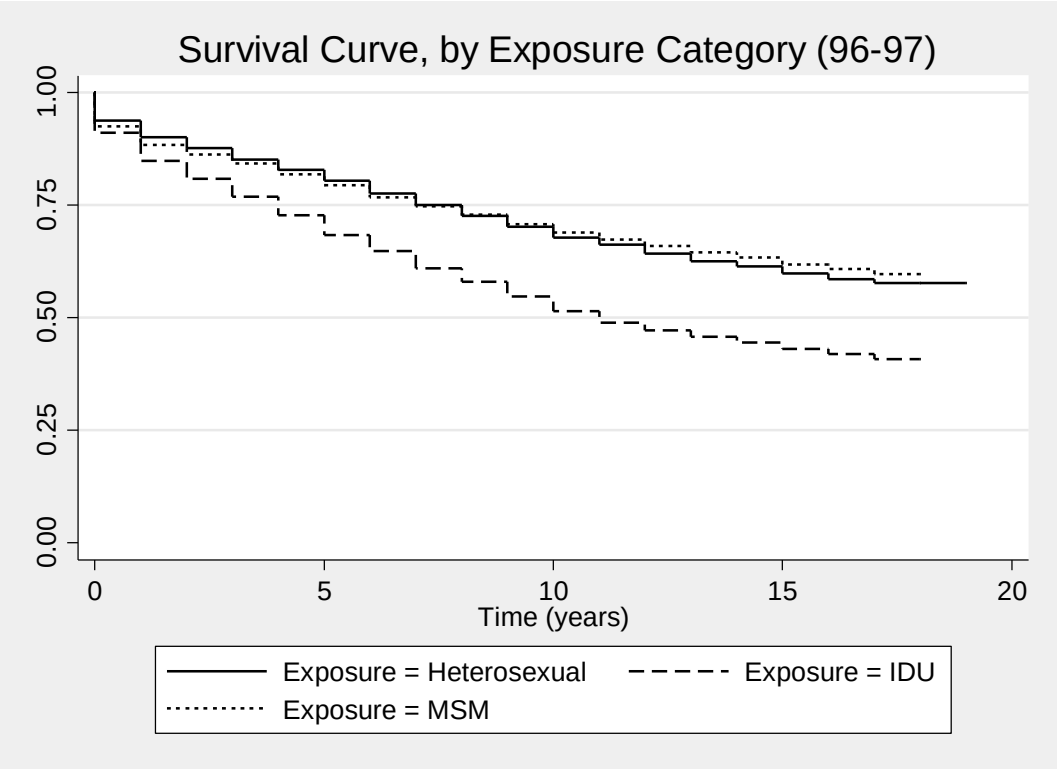
$H_{16a(1996\text{-}1997)}$: IDU risk exposure (compared to heterosexual risk exposure) is positively associated with the risk of death

Failed to reject

$H_{16b(1996\text{-}1997)}$: IDU risk exposure (compared to risk exposure exposure in MSMs) is positively associated with the risk of death

Failed to reject

Fig 3.22: Kaplan-Meier Curves Comparing the Percentage of Patients by Route Transmission Category in the 1996-1997 Sub-Cohort Who Survived



1998-2006 Cohort

Of the 36,284 patients included in the analysis, 8,883 (24.48%) deaths were observed during the 16-year follow-up period. Of these, 2,476 (27.87%) were infected through heterosexual exposure, 2,058 (23.17%) were injecting drug users and 4,349 (48.96%) were MSMs. Figure 3.23 shows Kaplan-Meier curves comparing the percentage of patients who survived during the 16-year follow-up period by risk transmission category. The log-rank test (χ^2=464.31; df=2; p<0.001) showed a significant difference among the risk transmission categories. As shown in the figure, those infected through injecting drug use had a lower survival rate compared to those infected through heterosexual exposure or MSMs. A univariate Cox proportional hazards model test showed these relationships to be statistically significant (HR=0.672; 95% CI=0.634-0.713; p<0.001 and HR=0.570; 95% CI=0.541-0.601; p<0.001, respectively).

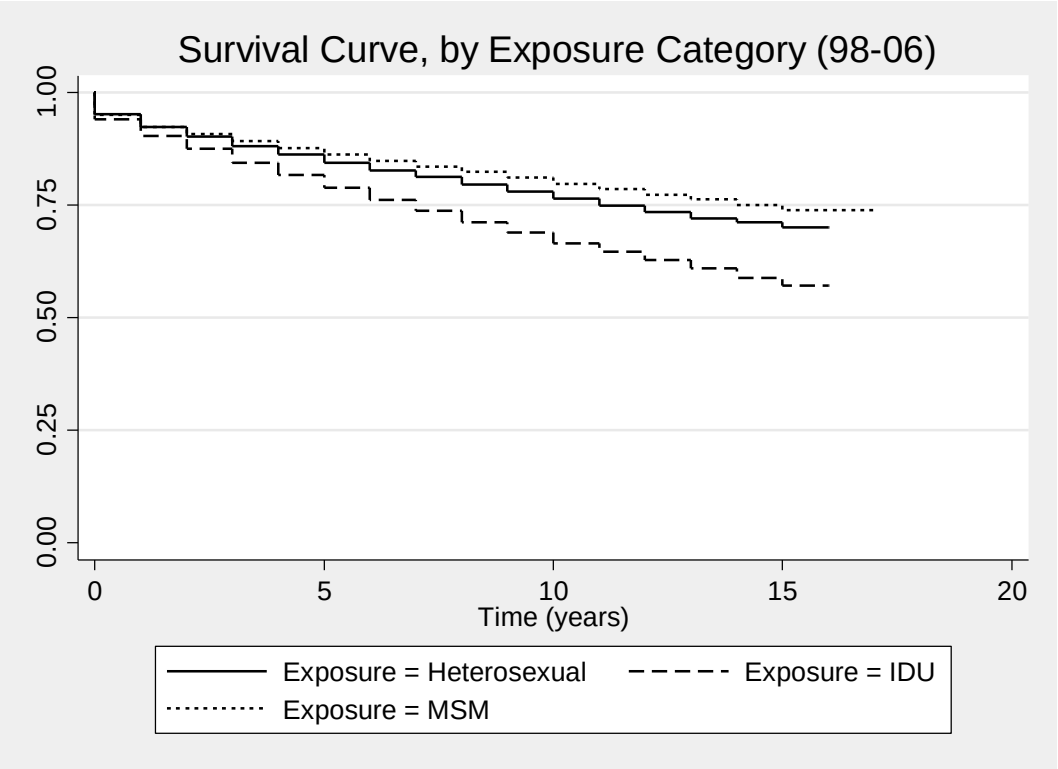
$H_{16a(1998-2006)}$: IDU risk exposure (compared to heterosexual risk exposure) is positively associated with the risk of death

Failed to reject

$H_{16b(1998-2006)}$: IDU risk exposure (compared to risk exposure exposure in MSMs) is positively associated with the risk of death

Failed to reject

Fig 3.23: Kaplan-Meier Curves Comparing the Percentage of Patients by Route Transmission Category in the 1998-2006 Sub-Cohort Who Survived



2007-2010 Cohort

Of the 15,628 patients included in the analysis, 1, 454 (9.30%) deaths were observed during the 7-year follow-up period. Of these, 476 (32.74%) were infected through heterosexual exposure, 190 (13.07%) were injecting drug users and 788 (54.20%) were MSMs. Figure 3.24 shows Kaplan-Meier curves comparing the percentage of patients who survived during the 7-year follow-up period by risk transmission category. The log-rank test (χ^2=109.13; df=2; p<0.001) showed a significant difference among the risk transmission categories. As shown in the figure, those infected through injecting drug use had a lower survival rate compared to those infected through heterosexual exposure or MSMs. A univariate Cox proportional hazards model test showed these relationships to be statistically significant (HR=0.643; 95% CI=0.544-0.761; p<0.001 and HR=0.460; 95% CI=0.393-0.539; p<0.001, respectively).

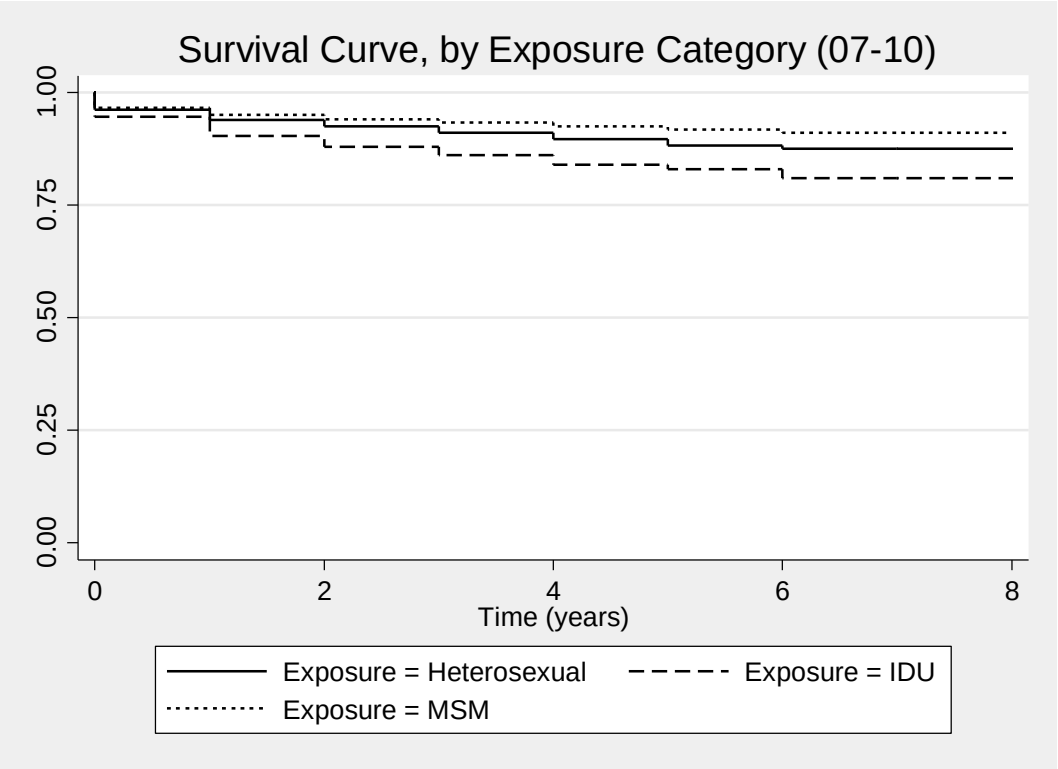
$H_{16a(2007-2010)}$: IDU risk exposure (compared to heterosexual risk exposure) is positively associated with the risk of death

Failed to reject

$H_{16b(2007-2010)}$: IDU risk exposure (compared to risk exposure exposure in MSMs) is positively associated with the risk of death

Failed to reject

Fig 3.24: Kaplan-Meier Curves Comparing the Percentage of Patients by Route Transmission Category in the 2007-2010 Sub-Cohort Who Survived



2011-2013 Cohort

Of the 11,876 patients included in the analysis, 471 (3.97%) deaths were observed during the 3-year follow-up period. Of these, 108 (22.93%) were infected through heterosexual exposure, 37 (7.86%) were injecting drug users and 326 (69.21%) were MSMs. Figure 3.25 shows Kaplan-Meier curves comparing the percentage of patients who survived during the 3-year follow-up period by risk transmission category. The log-rank test (χ^2=16.63; df=2; p<0.001) showed a significant difference among the risk transmission categories. As shown in the figure, those infected by injecting drug use had a lower survival rate compared to those infected through heterosexual exposure or MSMs. A univariate Cox proportional hazards model test showed these relationships to be statistically significant (HR=0.501; 95% CI=0.345-0.728; p<0.001 and HR=0.510; 95% CI=0.363-0.717; p<0.001, respectively).

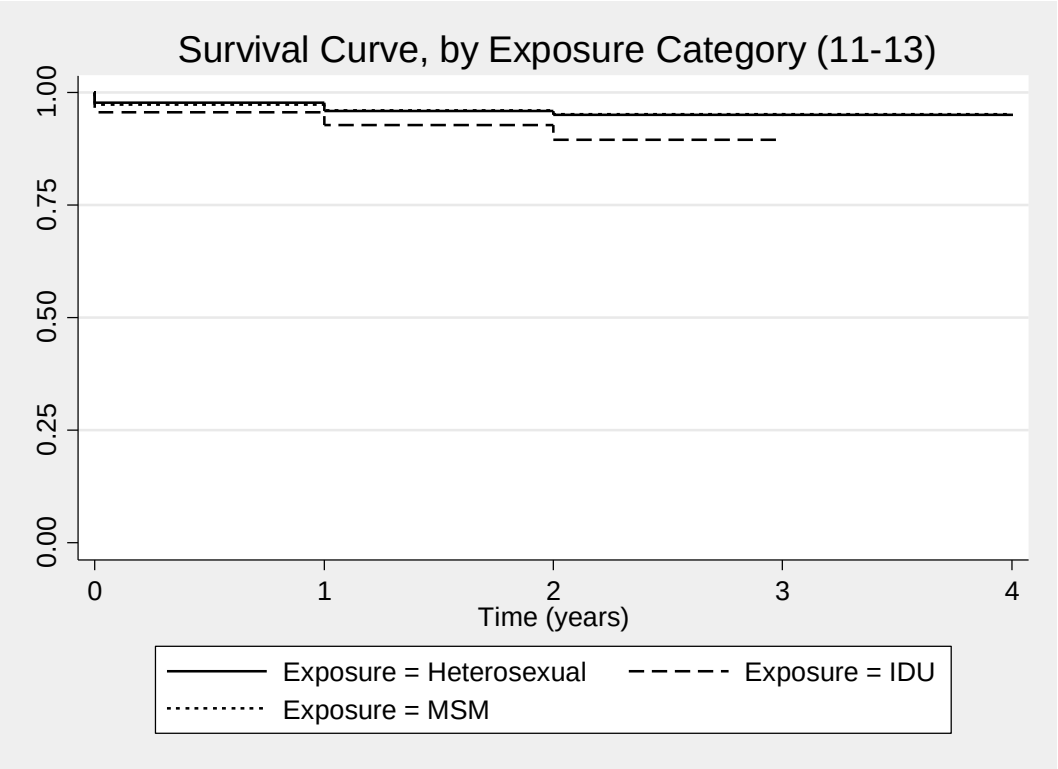
$H_{16a(2011\text{-}2013)}$: IDU risk exposure (compared to heterosexual risk exposure) is positively associated with the risk of death

Failed to reject

$H_{16b(2011\text{-}2013)}$: IDU risk exposure (compared to risk exposure exposure in MSMs) is positively associated with the risk of death

Failed to reject

Fig 3.25: Kaplan-Meier Curves Comparing the Percentage of Patients by Route Transmission Category in the 2011-2013 Sub-Cohort Who Survived



H_{17}: Linkage to care is negatively associated with the risk of an AIDS diagnosis

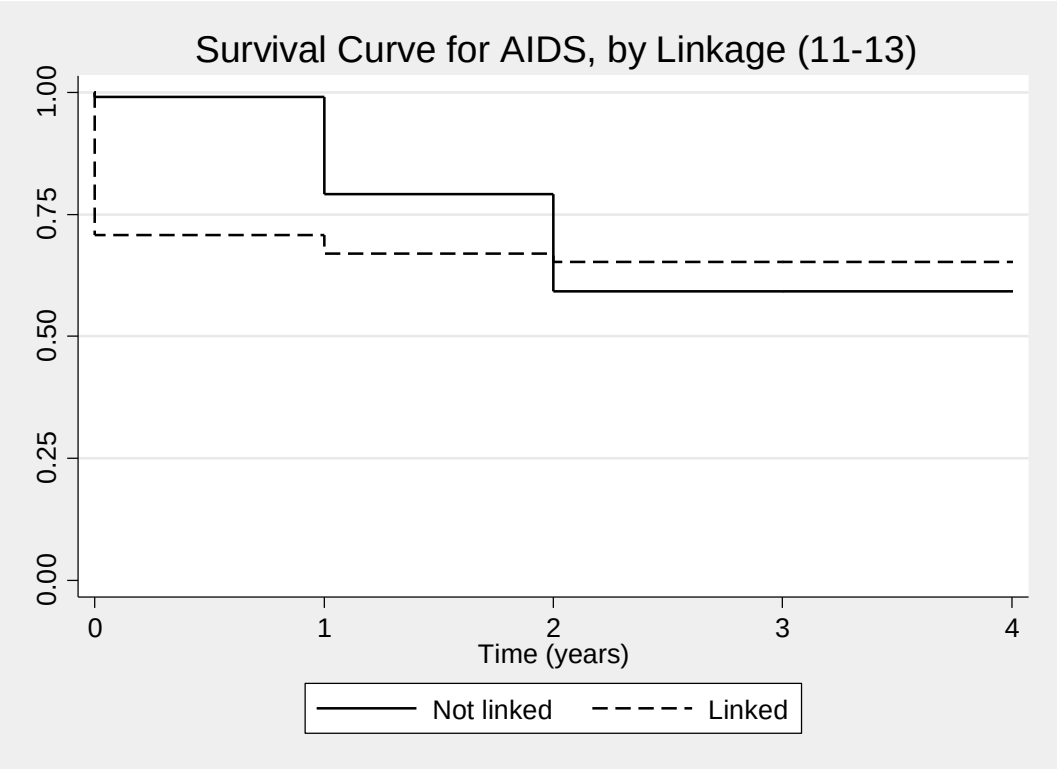
2011-2013 Cohort

Of the 11,876 patients included in the analysis, 3,841 (32.34%) were diagnosed with AIDS during the 3-year follow-up period. Of these, 3,726 (97.00%) had been linked to care within 1 year while 115 (2.99%) had not. Figure 3.26 shows Kaplan-Meier curves comparing the percentage of patients who received an AIDS diagnosis during the 3-year follow-up period by linkage to care. The log-rank test (χ^2=1.11; df=1; p=0.292) showed an insignificant difference between those linked to care and those not linked to care.

$H_{17(2011\text{-}2013)}$: Linkage to care is negatively associated with the risk of an AIDS diagnosis

Rejected

Fig 3.26: Kaplan-Meier Curves Comparing the Percentage of Patients by Linkage to Care in the 2011-2013 Sub-Cohort Who Received an AIDS Diagnosis



H_{18}: Linkage to care is negatively associated with the risk of death

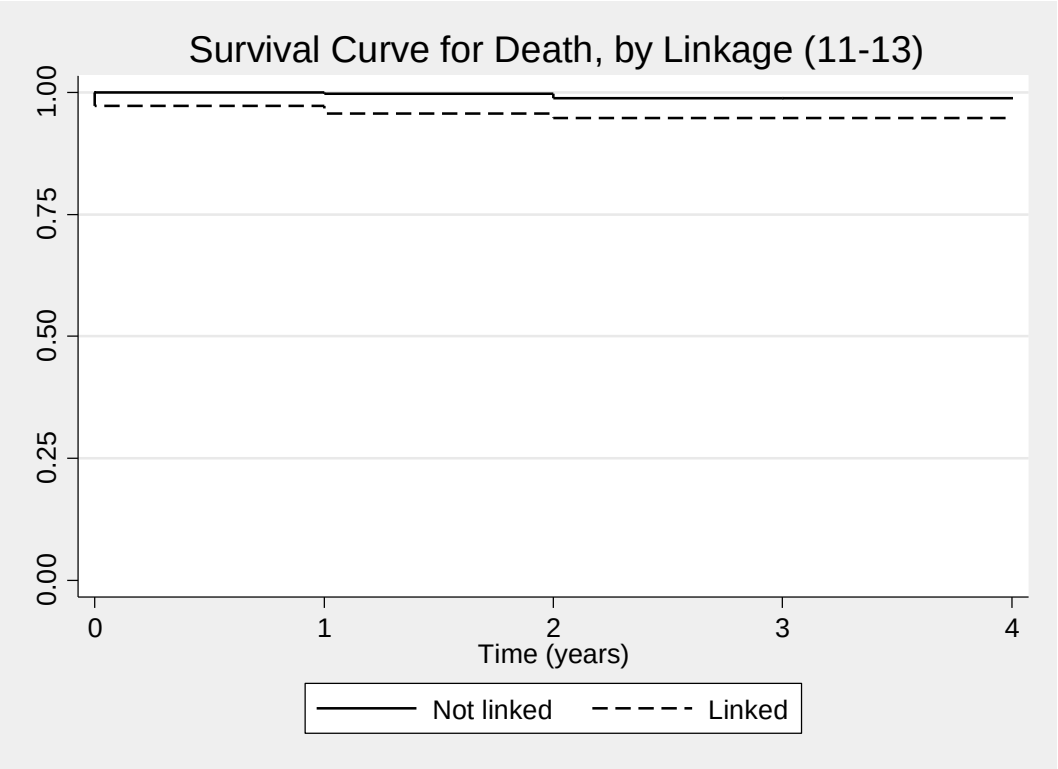
2011-2013 Cohort

Of the 11,876 patients included in the analysis, 471 (3.97%) deaths were observed during the 3-year follow-up period. Of these, 468 (99.36%) had been linked to care within 1 year while 3 (0.64%) had not. Figure 3.27 shows Kaplan-Meier curves comparing the percentage of patients who survived during the 3-year follow-up period by linkage to care. The log-rank test (χ^2=11.57; df=1; p<0.001) showed a significant difference between those linked to care and those not linked to care. As shown in the figure, those linked to care had a lower survival rate compared to those not linked to care.

$H_{18(2011\text{-}2013)}$: Linkage to care is negatively associated with the risk of death

Rejected

Fig 3.27: Kaplan-Meier Curves Comparing the Percentage of Patients by Linkage to Care in the 2011-2013 Sub-Cohort Who Survived



H_{19}: CD4 count is negatively associated with the risk of an AIDS diagnosis

2011-2013 Cohort

Of the 11,876 patients included in the cohort, 1,818 were excluded from the analysis due to missing data. Of the 10,058 included in the analysis, 3,781 (37.59%) were diagnosed with AIDS during the 3-year follow-up period. The univariate Cox proportional hazards model was statistically signifcant (LR χ^2=3,769.21; df=1; p<0.001). With every 10 cells /mm3 increase in initial CD4 count, patients were 5% less likely to receive an AIDS diagnosis (HR=0.950; 95% CI=0.948-0.952; p<0.001).

$H_{19(2011\text{-}2013)}$: CD4 count is negatively associated with the risk of an AIDS diagnosis

Failed to reject

H_{20}: CD4 count is negatively associated with the risk of death

2011-2013 Cohort

Of the 11,876 patients included in the cohort, 1,818 were excluded from the analysis due to missing data. Of the 10,058 included in the analysis, 402 (4%) deaths were observed during the 3-year follow-up period. The univariate Cox proportional hazards model was statistically significant (LR χ^2=40.31; df=1; p<0.001). With every 10 cells/mm3 increase in initial CD4 count, patients were 1% less likely to die (HR=0.988; 95% CI=0.984-0.992; p<0.001).

$H_{20(2011\text{-}2013)}$: CD4 count is negatively associated with the risk of death

Failed to reject

H_{21}: Viral load is positively associated with the risk of an AIDS diagnosis

2011-2013 Cohort

Of the 11,876 patients included in the cohort, 2,634 were excluded from the analysis due to missing data. Of the 9,242 included in the analysis, 3,428 (37.09%) were diagnosed with AIDS during the 3-year follow-up period. The univariate Cox proportional hazards model was statistically significant (LR χ^2=222.86; df=1; p<0.001). With every 10,000 copies/ml increase in initial CD4 count, the risk of an AIDS diagnosis increased by 0.2% (HR=1.002; 95% Cl=1.002-1.002; p<0.001).

$H_{21(2011\text{-}2013)}$: Viral load is positively associated with the risk of an AIDS diagnosis

Failed to reject

H_{22}: Viral load is positively associated with the risk of death

2011-2013 Cohort

Of the 11,876 patients included in the cohort, 2,634 were excluded from the analysis due to missing data. Of the 9,242 included in the analysis, 334 (3.61%) deaths were observed during the 3-year follow-up period. The univariate Cox proportional hazards model was statistically significant (LR χ^2=44.71; df=1; p<0.001). With every 10,000 copies/ml increase in initial viral load, the risk of death increased by 0.3% (HR=1.003; 95% CI=1.002-1.003; p<0.001).

$H_{22(2011\text{-}2013)}$: Viral load is positively associated with the risk of death

Failed to reject

3.9 OBJECTIVE 7: Adjusted Hazard of AIDS Diagnosis by Age, Gender and Race/Ethnicity

Objective 7 was to determine the relationships between age, gender, and race/ethnicity and time to AIDS after adjusting for age, gender, race/ethnicity, risk transmission category, linkage to care, CD4 count, and viral load. Cox regression models were used to determine if age, gender, and race/ethnicity were associated with time to AIDS after controlling for covariates. For the 1996-1997, 1998-2006, and 2007-2010 cohorts, only age, gender, ethnicity and mode of exposure were included in the models. Initial viral load and CD4 count were excluded from the models because these data only became available in 2010. Linkage to care was also excluded since deriving the variable was dependent on the availability of viral load and CD4 count data. For the 2011-2013 cohort, age, gender, race, mode of exposure, linkage to care, initial viral load, and initial CD4 count were included in the model. Results were significant at $p<0.01$.

H_{23}: Age is positively associated with the risk of an AIDS diagnosis after adjusting for gender, race/ethnicity, and risk transmission category

$H0_{24}$: Male gender is not associated with the risk of an AIDS diagnosis after adjusting for age, race/ethnicity, and risk transmission category

H_{25a}: Black ethnicity (compared to White ethnicity) is positively associated with the risk of an AIDS diagnosis after adjusting for age, gender, and risk transmission category

H_{25b}: Black ethnicity (compared to Hispanic ethnicity) is positively associated with the risk of an AIDS diagnosis after adjusting for age, gender, and risk transmission category

1996-1997 Cohort

Table 3.7 shows the results of the Cox proportional hazards regression model of the relationships between AIDS diagnosis and age, gender, and race while controlling for mode of exposure. The overall model was statistically significant (LR $\chi^2(6)=146.47$; $p<0.001$). This model indicated that age, gender, and race were significantly related to AIDS diagnosis. Each year increase in age was associated with a 1% increase in the risk of an AIDS diagnosis (HR=1.011; 95% CI=1.008-1.013; p<0.001). Compared to males, females were 16% less likely to receive an AIDS diagnosis (HR=0.840; 95% CI=0.775-0.911; p<0.001). There was no difference in time to AIDS diagnosis between Blacks and Whites (HR=0.966; 95% CI=0.908-1.028; p=0.280) or Hispanics (HR=1.080; 95% CI=1.013-1.151; p=0.018).

Mode of exposure was also a significant predictor of AIDS diagnosis. Compared to those infected through IDU exposure, those infected through heterosexual exposure were 15% less likely to receive an AIDS diagnosis (HR=0.849; 95% CI=0.784-0.920; p<0.001) while MSMs were 12% less likely to receive an AIDS diagnosis (HR=0.884; 95% CI=0.822-0.951; p=0.001).

$H_{23(1996\text{-}1997)}$: Age is positively associated with the risk of an AIDS diagnosis after adjusting for gender, race/ethnicity, and risk transmission category

Failed to reject

$H0_{24(1996\text{-}1997)}$: Male gender is not associated with the risk of an AIDS diagnosis after adjusting for age, race/ethnicity, and risk transmission category

Rejected

$H_{25a(1996-1997)}$: Black ethnicity (compared to White ethnicity) is positively associated with the risk of an AIDS diagnosis after adjusting for age, gender, and risk transmission category

Rejected

$H_{25b(1996-1997)}$: Black ethnicity (compared to Hispanic ethnicity) is positively associated with the risk of an AIDS diagnosis after adjusting for age, gender, and risk transmission category

Rejected

Table 3.7: Cox Proportional Hazards Regression Model for the 1996-1997 Subcohort of the Relationships between AIDS Diagnosis and Age, Gender, and Race while Controlling for Mode of Exposure

Variable	Hazard Ratio	Standard Error	Z	p-value	95% Hazard Ratio Confidence Limits
Age	1.0107	0.0013	8.00	<0.001	1.0081-1.0133
Gender					
Female	0.8399	0.0346	-4.23	<0.001	0.7747-0.9105
Race/Ethnicity					
White	0.9665	0.3052	-1.08	0.280	0.9085-1.0282
Hispanic	1.0801	0.0351	2.37	0.018	1.0134-1.1512
Exposure					
Heterosexual	0.8493	0.0347	-4.00	<0.001	0.7839-0.9201
MSM	0.8842	0.0330	-3.30	0.001	0.8219-0.9512

1998-2006 Cohort

Table 3.8 shows the results of the Cox proportional hazards regression model of the relationships between AIDS diagnosis and age, gender, and race while controlling for mode of exposure. The overall model was statistically significant (LR $\chi^2(6)=801.75$; $p<0.001$). This model indicated that age, gender, and race were

significantly related to AIDS diagnosis. Each year increase in age was associated with a 1.3% increase in the risk of an AIDS diagnosis (HR=1.013; 95% CI=1.012-1.015; p<0.001). Compared to males, females were 12% less likely to receive an AIDS diagnosis (HR=0.880; 95% CI=0.843-0.918; p<0.001). Compared to Blacks, Whites were 17% less likely to receive an AIDS diagnosis (HR=0.831; 95% CI=0.803-0.861; p<0.001) while Hispanics were 16% more likely to receive an AIDS diagnosis (HR=1.161; 95% CI=1.125-1.199; p<0.001).

Mode of exposure was also a significant predictor of AIDS diagnosis. Compared to patients infected through injecting drug use, MSMs were 8% less likely to receive an AIDS diagnosis (HR=0.925; 95% CI=0.972-1.061; p<0.001). There was no difference in time to AIDS diagnosis between those infected through heterosexual exposure and those infected by injecting drug use (HR=1.016; 95% CI=0.972-1.061; p=0.484).

$H_{23(1998\text{-}2006)}$: Age is positively associated with the risk of an AIDS diagnosis after adjusting for gender, race/ethnicity, and risk transmission category

Failed to reject

$H0_{24(1998\text{-}2006)}$: Male gender is not associated with the risk of an AIDS diagnosis after adjusting for age, race/ethnicity, and risk transmission category

Rejected

$H_{25a(1998\text{-}2006)}$: Black ethnicity (compared to White ethnicity) is positively associated with the risk of an AIDS diagnosis after adjusting for age, gender, and risk transmission category

Failed to reject

$H_{25b(1998-2006)}$: Black ethnicity (compared to Hispanic ethnicity) is positively associated with the risk of an AIDS diagnosis after adjusting for age, gender, and risk transmission category

Rejected

Table 3.8: Cox Proportional Hazards Regression Model for the 1998-2006 Subcohort of the Relationships between AIDS Diagnosis and Age, Gender, and Race while Controlling for Mode of Exposure

Variable	Hazard Ratio	Standard Error	Z	p-value	95% Hazard Ratio Confidence Limits
Age	1.0134	0.0006	20.93	<0.001	1.0122-1.0147
Gender					
Female	0.8798	0.0191	-5.90	<0.001	0.8431-0.9180
Race/Ethnicity					
White	0.8312	0.0148	-10.36	<0.001	0.8026-0.8608
Hispanic	1.1614	0.0189	9.22	<0.001	1.1251-1.1990
Exposure					
Heterosexual	1.0157	0.0227	0.70	0.484	0.9723-1.0611
MSM	0.9253	0.0189	-3.81	<0.001	0.8891-0.9630

2007-2010 Cohort

Table 3.9 shows the results of the Cox proportional hazards regression model of the relationships between AIDS diagnosis and age, gender, and race while controlling for mode of exposure. The overall model was statistically significant (LR $\chi^2(6)=567.52$; $p<0.001$). This model indicated that age, gender, and race were significantly related to AIDS diagnosis. Each year increase in age was associated with a 2% increase in the risk of an AIDS diagnosis (HR=1.020; 95% CI=1.018-1.022; $p<0.001$). Compared to males, females were 19% less likely to receive an AIDS diagnosis (HR=0.808; 95% CI=0.744-0.878; $p<0.001$). Compared to Blacks, Whites

were 12% less likely to receive an AIDS diagnosis (HR=0.881; 95% CI=0.824-0.941; p<0.001) while Hispanics were 30% more likely to receive an AIDS diagnosis (HR=1.296; 95% CI=1.228-1.368; p<0.001). There was no significant difference in time to AIDS diagnosis between those infected through IDU exposure and those infected through heterosexual exposure or MSMs.

$H_{23(2007\text{-}2010)}$: Age is positively associated with the risk of an AIDS diagnosis after adjusting for gender, race/ethnicity, and risk transmission category

Failed to reject

$H0_{24(2007\text{-}2010)}$: Male gender is not associated with the risk of an AIDS diagnosis after adjusting for age, race/ethnicity, and risk transmission category

Rejected

$H_{25a(2007\text{-}2010)}$: Black ethnicity (compared to White ethnicity) is positively associated with the risk of an AIDS diagnosis after adjusting for age, gender, and risk transmission category

Failed to reject

$H_{25b(2007\text{-}2010)}$: Black ethnicity (compared to Hispanic ethnicity) is positively associated with the risk of an AIDS diagnosis after adjusting for age, gender, and risk transmission category

Rejected

Table 3.9: Cox Proportional Hazards Regression Model for the 2007-2010 Subcohort of the Relationships between AIDS Diagnosis and Age, Gender, and Race while Controlling for Mode of Exposure

Variable	Hazard Ratio	Standard Error	Z	p-value	95% Hazard Ratio Confidence Limits
Age	1.0204	0.0010	19.91	<0.001	1.0183-1.0224
Gender					
Female	0.8081	0.0341	-5.06	<0.001	0.7440-0.8777
Race/Ethnicity					
White	0.8805	0.0301	-3.73	<0.001	0.8235-0.9415
Hispanic	1.2962	0.0358	9.38	<0.001	1.2278-1.3684
Exposure					
Heterosexual	1.1291	0.0581	2.36	0.018	1.0207-1.2489
MSM	0.9549	0.0467	-0.94	0.346	0.8675-1.0510

2011-2013 Cohort

Table 3.10 shows the results of the Cox proportional hazards regression model of the relationships between AIDS diagnosis and age, gender, and race while controlling for mode of exposure, initial CD4 count, initial viral load, and linkage to care. The overall model was statistically significant (LR $\chi^2(9)=3{,}365.26$; $p<0.001$). This model indicated that age was statistically significantly related to AIDS diagnosis. Each year increase in age was associated with a 0.7% increase in the risk of an AIDS diagnosis (HR=1.007; 95% CI=1.005-1.010; $p<0.001$). There was no significant difference in AIDS diagnosis between males and females. There was also no significant difference in AIDS diagnosis between Blacks and Whites or Hispanics. Linkage to care, initial CD4 count, and initial viral load were also significant predictors of AIDS diagnosis.

$H_{23(2011\text{-}2013)}$: Age is positively associated with the risk of an AIDS diagnosis after adjusting for gender, race/ethnicity, risk transmission category, linkage to care, CD4 count, and viral load

Failed to reject

$H0_{24(2011\text{-}2013)}$: Male gender is not associated with the risk of an AIDS diagnosis after adjusting for age, race/ethnicity, risk transmission category, linkage to care, CD4 count, and viral load

Failed to reject

$H_{25a(2011\text{-}2013)}$: Black ethnicity (compared to White ethnicity) is positively associated with the risk of an AIDS diagnosis after adjusting for age, gender, risk transmission category, linkage to care, CD4 count, and viral load

Rejected

$H_{25b(2011\text{-}2013)}$: Black ethnicity (compared to Hispanic ethnicity) is positively associated with the risk of an AIDS diagnosis after adjusting for age, gender, risk transmission category, linkage to care, CD4 count, and viral load

Rejected

Table 3.10: Cox Proportional Hazards Regression Model for the 2011-2013 Subcohort of the Relationships between AIDS Diagnosis and Age, Gender, and Race while Controlling for Mode of Exposure, Initial CD4 Count, Initial Viral Load, and Linkage to Care

Variable	Hazard Ratio	Standard Error	Z	p-value	95% Hazard Ratio Confidence Limits
Age	1.0074	0.0015	4.99	<0.001	1.0045-1.0104
CD4 count/10	0.9522	0.0011	-43.46	<0.001	0.9501-0.9543
Viral Load/10,000	1.0007	0.0002	4.62	<0.001	1.0004-1.0010
Gender					
Female	0.9550	0.0651	-0.68	0.499	0.8357-1.0914
Race					
White	0.9521	0.0986	-0.97	0.330	0.8626-1.0509
Hispanic	1.0430	0.0944	1.05	0.293	0.9643-1.1281
Exposure					
Heterosexual	1.0471	0.0986	0.49	0.625	0.8707-1.2592
MSM	1.0460	0.0944	0.50	0.618	0.8764-1.2484
Linkage to Care					
Yes	1.5080	0.1498	4.14	<0.001	1.241-1.8322

3.10 OBJECTIVE 8: Adjusted Hazard of Death by Age, Gender and Race/Ethnicity

Objective 8 was to determine the relationships between age, gender, and ethnicity and death after adjusting for risk transmission category, linkage to care, CD4 count, viral load, and AIDS diagnosis. Cox regression models were used to determine if age, gender, and race/ethnicity were associated with death after controlling for covariates. For the 1996-1997, 1998-2006, and 2007-2010 cohorts, only age, gender, race/ethnicity and mode of exposure were included in the models. Initial viral load and CD4 count were excluded from the models because these data only became available in 2010. Linkage to care was also excluded since deriving the variable was dependent

on the availability of viral load and CD4 count data. For the 2010 cohort, age, gender, ethnicity, mode of exposure, linkage to care, initial viral load, initial CD4 count and AIDS diagnosis were included in the models. Results were significant at $p<0.01$.

H_{26}: Age is positively associated with the risk of death after adjusting for gender, race/ethnicity, and risk transmission category

$H0_{27}$: Male gender is not associated with the risk of death after adjusting for age, race/ethnicity, and risk transmission category

H_{28a}: Black ethnicity (compared to White ethnicity) is positively associated with the risk of death after adjusting for age, gender, and risk transmission category

H_{28b}: Black ethnicity (compared to Hispanic ethnicity) is positively associated with the risk of death after adjusting for age, gender, and risk transmission category

1996-1997 Cohort

Table 3.11 shows the results of the Cox proportional hazards regression model of the relationships between death and age, gender, and race while controlling for mode of exposure. The overall model was statistically significant (LR $\chi^2(6)=525.23$ $p<0.001$). This model indicated that age and race were significantly related to death. Each year increase in age was associated with a 3.4% increase in the risk of death (HR=1.034; 95% CI=1.030-1.038; $p<0.001$). There was no significant difference in time to death between males and females ($p=0.071$). Compared to Blacks, the risk of death was 21% lower for Whites (HR=0.789; 95% CI=0.724-0.860; $p<0.001$) and 24% lower for Hispanics (HR=0.757; 95% CI=0.690-0.831; $p<0.001$). Mode of exposure was also a significant predictor of death. Compared to patients infected

through injecting drug use, those infected through heterosexual exposure had a 30% lower risk of death (HR=0.699; 95% CI=0.629-0.776; p<0.001) while MSMs had a 34% lower risk of death (HR=0.658; 95% CI=0.598-0.725; p<0.001).

$H_{26(1996-1997)}$: Age is positively associated with the risk of death after adjusting for gender, race/ethnicity, and risk transmission category

Failed to reject

$H0_{27(1996-1997)}$: Male gender is not associated with the risk of death after adjusting for age, race/ethnicity, and risk transmission category

Failed to reject

$H_{28a(1996-1997)}$: Black ethnicity (compared to White ethnicity) is positively associated with the risk of death after adjusting for age, gender, and risk transmission category

Failed to reject

$H_{28b(1996-1997)}$: Black ethnicity (compared to Hispanic ethnicity) is positively associated with the risk of death after adjusting for age, gender, and risk transmission category

Failed to reject

Table 3.11: Cox Proportional Hazards Regression Model for the 1996-1997 of the Relationships between Death and Age, Gender, and Race while Controlling for Mode of Exposure

Variable	Hazard Ratio	Standard Error	Z	p-value	95% Hazard Ratio Confidence Limits
Age	1.0341	0.0018	18.74	<0.001	1.0304-1.0377
Gender					
Female	0.9061	0.0496	-1.80	0.071	0.8140-1.0087
Race/Ethnicity					
White	0.7887	0.0347	-5.40	<0.001	0.7236-0.8597
Hispanic	0.7574	0.0358	-5.87	<0.001	0.6904-0.8310
Exposure					
Heterosexual	0.6988	0.0375	-6.68	<0.001	0.6291-0.7763
MSM	0.6582	0.0325	-8.47	<0.001	0.5975-0.7251

1998-2006 Cohort

Table 3.12 shows the results of the Cox proportional hazards regression model of the relationships between death and age, gender, and race while controlling for mode of exposure. The overall model was statistically significant (LR $\chi^2(6)$=2,447.09; p<0.001). This model indicated that age and race were significantly related to death. Each year increase in age was associated with a 4.5% increase in the risk of death (HR=1.045; 95% CI=1.043-1.047; p<0.001). There was no difference in risk of death between males and females (p=0.260). Compared to Blacks, the risk of death was 19% lower for Whites (HR=0.806; 95% CI=0.764-0.850; p<0.001) and 16% lower for Hispanics (HR=0.845; 95% CI=0.802-0.890; p<0.001). Mode of exposure was also a significant predictor of death. Compared to patients infected through injecting drug use, the risk of death was 30% lower for those infected through heterosexual exposure (HR=0.698; 95% CI=0.655-0.743; p<0.001) and 37% lower for MSMs (HR=0.633; 95% CI=0.597-0.670; p<0.001).

$H_{26(1998-2006)}$: Age is positively associated with the risk of death after adjusting for gender, race/ethnicity, and risk transmission category

Failed to reject

$H0_{27(1998-2006)}$: Male gender is not associated with the risk of death after adjusting for age, race/ethnicity, and risk transmission category

Failed to reject

$H_{28a(1998-2006)}$: Black ethnicity (compared to White ethnicity) is positively associated with the risk of death after adjusting for age, gender, and risk transmission category

Failed to reject

$H_{28b(1998-2006)}$: Black ethnicity (compared to Hispanic ethnicity) is positively associated with the risk of death after adjusting for age, gender, and risk transmission category

Failed to reject

Table 3.12: Cox Proportional Hazards Regression Model for the 1998-2006 of the Relationships between Death and Age, Gender, and Race while Controlling for Mode of Exposure

Variable	Hazard Ratio	Standard Error	Z	p-value	95% Hazard Ratio Confidence Limits
Age	1.0451	0.0010	45.87	<0.001	1.0431-1.0471
Gender					
Female	0.9648	0.0307	-1.13	0.260	0.9065-1.0269
Race/Ethnicity					
White	0.8057	0.0220	-7.91	<0.001	0.7637-0.8500
Hispanic	0.8450	0.0225	-6.31	<0.001	0.8020-0.8904
Exposure					
Heterosexual	0.6977	0.0222	-11.30	<0.001	0.6555-0.7426
MSM	0.6325	0.0187	-15.50	<0.001	0.5969-0.6702

2007-2010 Cohort

Table 3.13 shows the results of the Cox proportional hazards regression model of the relationships between death and age, gender, and race while controlling for mode of exposure. The overall model was statistically significant (LR $\chi^2(6)=886.76$; $p<0.001$). This model indicated that age was significantly related to death. Each year increase in age was associated with a 6.1% increase in the risk of death (HR=1.061; 95% CI=1.056-1.065; $p<0.001$). There was no difference in risk of death between males and females ($p=0.111$). There was also no difference in risk of death between Blacks and Whites ($p=0.150$) or Hispanics ($p=0.049$). Mode of exposure was a significant predictor of death. Compared to patients infected through injecting drug use, the risk of death was 30% lower for those infected through heterosexual exposure (HR=0.696; 95% CI=0.583-0.30; $p<0.001$) and 42% lower for MSMs (HR=0.583; 95% CI=0.492-0.691; $p<0.001$).

$H_{26(2007\text{-}2010)}$: Age is positively associated with the risk of death after adjusting for gender, race/ethnicity, and risk transmission category

Failed to reject

$H0_{27(2007\text{-}2010)}$: Male gender is not associated with the risk of death after adjusting for age, race/ethnicity, and risk transmission category

Failed to reject

$H_{28a(2007\text{-}2010)}$: Black ethnicity (compared to White ethnicity) is positively associated with the risk of death after adjusting for age, gender, and risk transmission category

Rejected

$H_{28b(2007-2010)}$: Black ethnicity (compared to Hispanic ethnicity) is positively associated with the risk of death after adjusting for age, gender, and risk transmission category

Rejected

Table 3.13: Cox Proportional Hazards Regression Model for the 2007-2010 of the Relationships between Death and Age, Gender, and Race while Controlling for Mode of Exposure

Variable	Hazard Ratio	Standard Error	Z	p-value	95% Hazard Ratio Confidence Limits
Age	1.0607	0.0022	28.76	<0.001	1.0565-1.0650
Gender					
Female	0.8781	0.0716	-1.59	0.111	0.7484-1.0302
Race/Ethnicity					
White	0.9030	0.0640	-1.44	0.150	0.786-1.038
Hispanic	1.1305	0.0703	1.97	0.049	1.0007-1.2771
Exposure					
Heterosexual	0.6959	0.0627	-4.02	<0.001	0.5833-0.8304
MSM	0.5829	0.0506	-6.22	<0.001	0.4917-0.6910

2011-2013 Cohort

Table 3.14 shows the results of the Cox proportional hazards regression model of the relationships between death and age, gender, and race while controlling for mode of exposure, initial CD4 count, initial viral load, linkage to care and AIDS diagnosis. The overall model was statistically significant (LR $\chi^2(10)=524.77$; $p<0.001$). This model indicated that age was statistically significantly related to death. Each year increase in age was associated with a 5.7% increase in the risk of death (HR=1.057; 95% CI=1.048-1.067; $p<0.001$). There was no difference in risk of death between males and females ($p=0.424$). Likewise, there was no difference in risk of

death between Blacks and Whites (p=0.310) or Hispanics (p=0.51). Linkage to care and AIDS diagnosis were the strongest predictors of death, increasing the risk of death by 5 and 8 times respectively. Initial CD4 count and initial viral load were also significant predictors of death.

$H_{26(2011\text{-}2013)}$: Age is positively associated with the risk of death after adjusting for gender, race/ethnicity, risk transmission category, linkage to care, CD4 count, and viral load

Failed to reject

$H0_{27(2011\text{-}2013)}$: Male gender is not associated with the risk of death after adjusting for age, race/ethnicity, risk transmission category, linkage to care, CD4 count, and viral load

Failed to reject

$H_{28a(2011\text{-}2013)}$: Black ethnicity (compared to White ethnicity) is positively associated with the risk of death after adjusting for age, gender, risk transmission category, linkage to care, CD4 count, and viral load

Rejected

$H_{28b(2011\text{-}2013)}$: Black ethnicity (compared to Hispanic ethnicity) is positively associated with the risk of death after adjusting for age, gender, risk transmission category, linkage to care, CD4 count, and viral load

Rejected

Table 3.14: Cox Proportional Hazards Regression Model for the 2011-2013 Subcohort of the Relationships between Death and Age, Gender, and Race while Controlling for Mode of Exposure, Initial CD4 Count, Initial Viral Load, and Linkage to Care

Variable	Hazard Ratio	Standard Error	Z	p-value	95% Hazard Ratio Confidence Limits
Age	1.0572	0.0048	12.14	<0.001	1.0478-1.0667
CD4 Count/10	1.0005	0.0002	2.72	0.007	1.0001-1.0009
Viral Load/10,000	1.0013	0.0004	3.30	0.001	1.0005-1.0022
Gender					
Female	1.1856	0.2526	0.80	0.424	0.7809-1.7999
Race					
White	1.1754	0.1872	1.01	0.310	0.8602-1.6060
Hispanic	1.3118	0.1821	1.95	0.051	0.9993-1.7220
Exposure					
Heterosexual	0.7690	0.1940	-1.04	0.298	0.4690-1.2610
MSM	1.0618	0.2676	0.24	0.812	0.6479-1.7400
Linkage to Care					
Yes	4.7381	3.3660	2.19	0.029	1.1773-19.0685
AIDS Diagnosis	8.4757	1.5369	11.79	<0.001	5.9405-12.0927

3.11 Objective 9: Life Expectancy Tables

Objective 9 was to construct life tables of patients living with HIV who reside in Texas, grouped by age, gender, race, risk transmission category, linkage to care, and time period. Abridged cohort life tables were created using Chiang's method.[98] Subgroups were formed from the cohort based on gender, race, and time period in which diagnosis was made and. Then population counts and death counts were obtained for age groups within each subgroup. It was based on the population and death counts that life expectancies were determined. Tables 3.15 to 3.39 show the

population and death counts for age groups with the subgroups formed by gender, ethnicity, and time period of diagnosis. For those diagnosed between 2011 and 2013, two sets of life tables were constructed. One set included those linked to care within 1 year of diagnosis, the second set included all patients. Ideally, the second set was to include those not linked to care within one year of diagnosis but because of the small size of this group, all patients in the 2011-2013 subcohort were included in the second set. It was expected that if linkage to care was a strong determinant of life expectancy, life expectancy in the second set of life tables (which included all patients) would be lower than that in the first set (which included only patients linked to care within 1 year). The age interval for the age groups was 5 except for the first and last age groups (18-19 years and ≥75 years, respectively). Where there no patients in an age group (i.e. number of people in interval equals 0), the age group with no patients was merged with the preceding age group. Similarly, where there were no deaths in an age group located at the upper extreme (e.g. ≥75 years), the age group was merged with the preceding age group. This was done to ensure that extreme upper intervals has a death rate greater than 0. For the proportion dying in interval column, all values greater than 1 were approximated to 1 and the first row with a value of 1 was used as the final age interval. Tables 3.40 to 3.49 show the life expectancies of patients in our cohort, grouped by age, gender, ethnicity, risk transmission category, and time period of diagnosis.

Table 3.15: Population and Death Counts for Males Who Have Sex With Males in the 1996-1997 Subcohort

Age Group	White		Black		Hispanic	
	Population Count	Death Count	Population Count	Death Count	Population Count	Death Count
18-19	6	0	18	0	12	1
20-24	64	6	95	3	81	5
25-29	241	11	225	17	229	19
30-34	470	31	271	21	336	30
35-39	428	41	228	22	250	26
40-44	306	41	120	15	146	22
45-49	177	16	62	12	71	11
50-54	97	18	32	2	35	4
55-59	37	5	13	2	17	6
60-64	21	4	4	3	10	1
65-69	6	3	5	2	6	3
70-74	3	1	2	0	1	0
≥75	5	1	2	1	0	0

Table 3.16: Population and Death Counts for Females in the Injecting Drug Use Route Transmission Category of the 1996-1997 Subcohort

Age Group	White		Black		Hispanic	
	Population Count	Death Count	Population Count	Death Count	Population Count	Death Count
18-19	4	0	7	0	2	0
20-24	13	1	26	1	5	0
25-29	20	0	39	1	8	1
30-34	27	2	77	5	8	1
35-39	27	3	62	4	9	1
40-44	18	1	44	10	11	1
45-49	12	2	23	4	1	0
50-54	6	2	10	1	2	1
55-59	1	0	6	2	1	0
60-64	2	0	6	0	0	0
65-69	0	0	0	0	0	0
70-74	0	0	0	0	0	0
≥75	0	0	0	0	0	0

Table 3.17: Population and Death Counts for Males in the Injecting Drug Use Route Transmission Category in the 1996-1997 Subcohort

Age Group	White		Black		Hispanic	
	Population Count	Death Count	Population Count	Death Count	Population Count	Death Count
18-19	0	0	3	0	1	0
20-24	7	0	19	1	11	1
25-29	22	1	33	2	20	2
30-34	43	6	75	10	44	6
35-39	53	6	107	19	39	5
40-44	35	5	87	8	23	3
45-49	18	4	71	18	26	2
50-54	10	2	30	7	11	0
55-59	7	0	15	5	5	1
60-64	2	2	9	1	7	2
65-69	2	1	5	3	3	2
70-74	1	0	1	0	1	1
≥75	0	0	0	0	0	0

Table 3.18: Population and Death Counts for Females in the Heterosexual Exposure Route Transmission Category of the 1996-1997 Subcohort

Age Group	White		Black		Hispanic	
	Population Count	Death Count	Population Count	Death Count	Population Count	Death Count
18-19	8	0	48	1	10	1
20-24	16	0	155	4	57	3
25-29	21	0	153	4	40	1
30-34	35	0	125	10	49	3
35-39	28	2	90	9	35	1
40-44	25	1	60	7	23	0
45-49	17	3	27	2	20	3
50-54	6	2	18	2	12	1
55-59	5	1	8	2	9	2
60-64	2	2	6	1	1	1
65-69	1	1	2	0	2	1
70-74	2	0	4	0	0	0
≥75	0	0	1	0	0	0

Table 3.19: Population and Death Counts for Males in the Heterosexual Exposure Route Transmission Category of the 1996-1997 Subcohort

Age Group	White		Black		Hispanic	
	Population Count	Death Count	Population Count	Death Count	Population Count	Death Count
18-19	0	0	5	0	3	0
20-24	2	0	23	0	16	1
25-29	14	1	47	2	29	4
30-34	12	2	68	3	37	7
35-39	20	1	58	7	39	3
40-44	13	3	49	8	23	5
45-49	13	0	42	4	13	4
50-54	14	2	26	2	9	2
55-59	6	1	13	2	4	0
60-64	4	2	8	1	2	2
65-69	1	0	7	3	1	0
70-74	2	0	3	2	2	2
≥75	0	0	2	0	0	0

Table 3.20: Population and Death Counts for Males Who Have Sex With Males in the 1998-2006 Subcohort

Age Group	White		Black		Hispanic	
	Population Count	Death Count	Population Count	Death Count	Population Count	Death Count
18-19	60	3	217	8	124	3
20-24	445	11	733	51	764	42
25-29	895	63	909	95	1273	93
30-34	1425	124	964	137	1400	138
35-39	1810	224	1024	147	1477	194
40-44	1556	185	750	121	925	139
45-49	957	148	418	90	463	81
50-54	530	102	230	58	243	65
55-59	318	81	83	31	144	34
60-64	141	37	38	21	64	17
65-69	54	23	19	7	28	10
70-74	20	12	9	5	12	8
≥75	8	6	6	4	5	4

Table 3.21: Population and Death Counts for Females in the Injecting Drug Use Route Transmission Category of the 1998-2006 Subcohort

Age Group	White		Black		Hispanic	
	Population Count	Death Count	Population Count	Death Count	Population Count	Death Count
18-19	18	0	31	3	8	1
20-24	56	3	94	3	38	4
25-29	78	10	106	13	38	2
30-34	95	13	159	29	68	13
35-39	143	28	187	32	57	13
40-44	110	24	174	39	44	13
45-49	74	18	111	20	28	9
50-54	27	6	65	21	7	5
55-59	15	5	24	9	5	2
60-64	4	1	6	2	0	0
65-69	3	0	5	2	0	0
70-74	1	1	4	4	0	0
≥75	3	2	0	0	0	0

Table 3.22: Population and Death Counts for Males in the Injecting Drug Use Route Transmission Category of the 1998-2006 Subcohort

Age Group	White		Black		Hispanic	
	Population Count	Death Count	Population Count	Death Count	Population Count	Death Count
18-19	3	1	23	2	6	0
20-24	51	2	144	7	79	9
25-29	91	12	181	19	133	18
30-34	144	27	256	31	183	22
35-39	179	38	370	70	242	53
40-44	152	35	415	81	173	47
45-49	111	36	317	91	108	27
50-54	56	24	160	46	56	18
55-59	22	13	67	26	13	5
60-64	9	3	32	16	9	4
65-69	3	2	23	13	5	2
70-74	0	0	11	8	4	2
≥75	1	1	5	3	2	1

Table 3.23: Population and Death Counts for Females in the Heterosexual Exposure Route Transmission Category of the 1998-2006 Subcohort

Age Group	White		Black		Hispanic	
	Population Count	Death Count	Population Count	Death Count	Population Count	Death Count
18-19	36	1	192	8	64	2
20-24	112	7	668	56	248	11
25-29	116	6	872	74	298	23
30-34	127	9	748	68	316	22
35-39	139	26	629	100	246	16
40-44	111	18	476	74	188	21
45-49	108	20	310	55	113	16
50-54	69	14	214	54	84	17
55-59	29	7	94	24	49	11
60-64	11	4	55	15	38	15
65-69	4	2	32	8	27	9
70-74	2	0	11	5	10	5
≥75	1	1	7	4	4	2

Table 3.24: Population and Death Counts for Males in the Heterosexual Exposure Route Transmission Category of the 1998-2006 Subcohort

Age Group	White		Black		Hispanic	
	Population Count	Death Count	Population Count	Death Count	Population Count	Death Count
18-19	1	0	19	1	9	0
20-24	18	2	130	12	82	8
25-29	34	4	181	19	154	14
30-34	50	6	267	21	173	16
35-39	53	7	330	46	167	13
40-44	61	12	294	49	155	27
45-49	30	3	220	53	113	22
50-54	35	5	144	37	76	21
55-59	15	3	88	29	46	14
60-64	12	4	71	27	29	16
65-69	2	2	31	14	15	3
70-74	3	2	11	6	14	10
≥75	1	1	21	15	7	4

Table 3.25: Population and Death Counts for Males Who Have Sex With Males in the 2007-2010 Subcohort

Age Group	White		Black		Hispanic	
	Population Count	Death Count	Population Count	Death Count	Population Count	Death Count
18-19	44	0	283	5	148	0
20-24	263	2	920	10	719	15
25-29	388	9	595	19	772	23
30-34	344	11	383	12	725	28
35-39	433	21	337	15	589	31
40-44	416	16	352	23	469	43
45-49	388	21	220	16	303	30
50-54	250	30	106	21	143	29
55-59	133	14	73	12	83	14
60-64	79	16	37	6	43	9
65-69	27	10	12	4	24	6
70-74	8	3	3	2	7	1
≥75	3	2	2	1	4	2

Table 3.26: Population and Death Counts for Females in the Injecting Drug Use Route Transmission Category of the 2007-2010 Subcohort

Age Group	White		Black		Hispanic	
	Population Count	Death Count	Population Count	Death Count	Population Count	Death Count
18-19	4	0	4	0	1	0
20-24	14	0	11	0	12	1
25-29	21	0	22	0	16	0
30-34	16	1	20	2	10	0
35-39	22	2	25	3	13	1
40-44	28	3	17	1	13	1
45-49	22	2	27	4	8	2
50-54	22	1	23	3	9	3
55-59	5	0	15	6	2	0
60-64	2	0	5	2	0	0
65-69	0	0	2	1	1	0
70-74	0	0	0	0	0	0
≥75	1	0	0	0	0	0

Table 3.27: Population and Death Counts for Males in the Injecting Drug Use Route Transmission Category of the 2007-2010 Subcohort

Age Group	White		Black		Hispanic	
	Population Count	Death Count	Population Count	Death Count	Population Count	Death Count
18-19	3	0	3	0	1	0
20-24	9	0	13	0	13	0
25-29	13	0	31	0	33	5
30-34	22	1	43	1	34	0
35-39	25	2	40	1	38	2
40-44	29	4	55	6	31	5
45-49	35	8	65	6	32	7
50-54	17	6	54	6	12	5
55-59	12	3	20	3	2	0
60-64	2	0	12	3	1	1
65-69	0	0	5	2	2	0
70-74	0	0	1	0	1	0
≥75	0	0	1	0	0	0

Table 3.28: Population and Death Counts for Females in the Heterosexual Exposure Route Transmission Category of the 2007-2010 Subcohort

Age Group	White		Black		Hispanic	
	Population Count	Death Count	Population Count	Death Count	Population Count	Death Count
18-19	12	0	91	1	29	1
20-24	52	1	307	7	116	2
25-29	40	1	316	10	115	3
30-34	50	0	295	9	140	6
35-39	35	4	287	17	114	12
40-44	38	1	205	14	81	5
45-49	47	5	183	17	63	5
50-54	49	4	144	13	50	5
55-59	29	4	82	7	40	6
60-64	7	2	41	5	23	5
65-69	2	0	8	2	10	3
70-74	3	1	3	1	4	2
≥75	1	1	2	0	6	3

Table 3.29: Population and Death Counts for Males in the Heterosexual Exposure Route Transmission Category of the 2007-2010 Subcohort

Age Group	White		Black		Hispanic	
	Population Count	Death Count	Population Count	Death Count	Population Count	Death Count
18-19	3	0	8	0	3	0
20-24	9	1	54	0	35	1
25-29	14	0	76	1	66	3
30-34	11	1	89	4	64	2
35-39	21	1	87	6	63	6
40-44	27	3	128	3	51	5
45-49	19	0	89	6	45	7
50-54	16	1	72	8	37	6
55-59	5	0	50	13	17	2
60-64	7	2	28	8	12	3
65-69	4	0	15	3	5	4
70-74	3	0	8	3	3	1
≥75	1	0	7	2	5	2

Table 3.30: Population and Death Counts for Males Who Have Sex with Males in the 2011-2013 Subcohort

Age Group	White		Black		Hispanic	
	Population Count	Death Count	Population Count	Death Count	Population Count	Death Count
18-19	30	0	205	2	151	2
20-24	266	2	877	5	737	6
25-29	322	1	569	12	751	13
30-34	266	4	310	4	623	19
35-39	231	5	223	11	420	22
40-44	280	10	209	7	371	28
45-49	276	13	162	10	270	24
50-54	198	19	130	11	165	18
55-59	135	16	64	9	91	9
60-64	65	9	32	3	40	9
65-69	24	5	8	3	15	6
70-74	11	2	4	1	6	2
≥75	7	3	1	0	4	1

Table 3.31: Population and Death Counts for Females in the Injecting Drug Use Route Transmission Category of the 2011-2013 Subcohort

Age Group	White		Black		Hispanic	
	Population Count	Death Count	Population Count	Death Count	Population Count	Death Count
18-19	1	0	0	0	1	0
20-24	7	0	1	0	6	0
25-29	11	1	6	0	7	0
30-34	7	1	5	1	12	2
35-39	10	0	7	0	4	0
40-44	9	1	6	0	5	0
45-49	6	0	9	1	9	1
50-54	13	4	11	0	7	3
55-59	8	2	6	2	0	0
60-64	3	1	4	0	1	0
65-69	1	1	0	0	0	0
70-74	0	0	0	0	0	0
≥75	0	0	0	0	0	0

Table 3.32: Population and Death Counts for Males in the Injecting Drug Use Route Transmission Category of the 2011-2013 Subcohort

Age Group	White		Black		Hispanic	
	Population Count	Death Count	Population Count	Death Count	Population Count	Death Count
18-19	1	0	1	0	2	0
20-24	7	0	7	0	9	0
25-29	6	0	5	0	8	0
30-34	8	0	12	0	20	1
35-39	13	0	11	0	18	0
40-44	18	3	10	0	12	0
45-49	8	1	17	1	14	0
50-54	9	1	15	1	13	2
55-59	8	2	18	0	7	2
60-64	2	1	6	0	3	0
65-69	0	0	2	0	1	0
70-74	0	0	1	0	2	0
≥75	1	0	0	0	1	1

Table 3.33: Population and Death Counts for Females in the Heterosexual Exposure Route Transmission Category of the 2011-2013 Subcohort

Age Group	White		Black		Hispanic	
	Population Count	Death Count	Population Count	Death Count	Population Count	Death Count
18-19	6	0	65	0	18	0
20-24	37	0	207	1	62	1
25-29	30	0	231	3	74	0
30-34	43	0	209	2	76	3
35-39	27	0	171	4	60	4
40-44	24	1	131	3	65	3
45-49	37	2	138	6	62	3
50-54	20	2	95	2	51	3
55-59	19	3	65	3	36	4
60-64	6	2	33	3	20	4
65-69	3	0	10	4	14	4
70-74	0	0	3	0	1	0
≥75	1	0	2	1	1	0

Table 3.34: Population and Death Counts for Males in the Heterosexual Exposure Route Transmission Category of the 2011-2013 Subcohort

Age Group	White		Black		Hispanic	
	Population Count	Death Count	Population Count	Death Count	Population Count	Death Count
18-19	0	0	1	0	3	0
20-24	3	0	17	0	13	0
25-29	4	0	34	1	37	1
30-34	4	0	49	0	41	0
35-39	5	0	46	0	36	1
40-44	9	1	49	2	35	1
45-49	12	1	52	1	32	3
50-54	11	0	34	3	28	3
55-59	7	0	40	2	15	1
60-64	2	0	19	3	17	3
65-69	2	1	13	2	7	2
70-74	1	0	8	2	5	0
≥75	0	0	2	1	2	2

Table 3.35: Population and Death Counts for Males Linked to Care Who Have Sex With Males in the 2011-2013 Subcohort

Age Group	White		Black		Hispanic	
	Population Count	Death Count	Population Count	Death Count	Population Count	Death Count
18-19	30	0	191	2	146	2
20-24	260	2	832	4	716	6
25-29	314	1	541	12	731	13
30-34	261	4	298	4	615	19
35-39	225	5	218	11	407	21
40-44	274	10	202	6	362	28
45-49	274	13	157	10	264	24
50-54	196	19	127	11	165	18
55-59	133	16	62	9	91	9
60-64	65	9	30	3	39	9
65-69	23	5	7	3	15	6
70-74	11	2	4	1	6	2
≥75	7	3	1	0	4	1

Table 3.36: Population and Death Counts for Females Linked to Care in the Injecting Drug Use Route Transmission Category of the 2011-2013 Subcohort

Age Group	White		Black		Hispanic	
	Population Count	Death Count	Population Count	Death Count	Population Count	Death Count
18-19	1	0	0	0	1	0
20-24	7	0	1	0	5	0
25-29	9	1	6	0	7	0
30-34	7	1	5	1	10	2
35-39	10	0	7	0	4	0
40-44	8	1	6	0	4	0
45-49	5	0	9	1	9	1
50-54	13	4	11	0	7	3
55-59	7	2	6	2	0	0
60-64	3	1	4	0	1	0
65-69	1	1	0	0	0	0
70-74	0	0	0	0	0	0
≥75	0	0	0	0	0	0

Table 3.37: Population and Death Counts for Males Linked to Care in the Injecting Drug Use Route Transmission Category of the 2011-2013 Subcohort

Age Group	White		Black		Hispanic	
	Population Count	Death Count	Population Count	Death Count	Population Count	Death Count
18-19	0	0	1	0	2	0
20-24	7	0	7	0	9	0
25-29	6	0	4	0	7	0
30-34	8	0	12	0	20	1
35-39	13	0	11	0	18	0
40-44	17	3	9	0	9	0
45-49	8	1	15	1	14	0
50-54	9	1	14	1	13	2
55-59	7	2	18	0	7	2
60-64	2	1	6	0	3	0
65-69	0	0	2	0	1	0
70-74	0	0	1	0	2	0
≥75	1	0	0	0	1	1

Table 3.38: Population and Death Counts for Females Linked to Care in the Heterosexual Exposure Route Transmission Category of the 2011-2013 Subcohort

Age Group	White		Black		Hispanic	
	Population Count	Death Count	Population Count	Death Count	Population Count	Death Count
18-19	6	0	64	0	17	0
20-24	37	0	201	1	59	1
25-29	29	0	225	3	74	0
30-34	42	0	204	2	74	3
35-39	27	0	168	4	59	4
40-44	22	1	129	3	65	3
45-49	35	2	131	6	62	3
50-54	20	2	91	2	51	3
55-59	19	3	65	3	35	4
60-64	6	2	32	3	20	4
65-69	3	0	10	4	14	4
70-74	0	0	3	0	1	0
≥75	1	0	2	1	1	0

Table 3.39: Population and Death Counts for Males Linked to Care in the Heterosexual Exposure Route Transmission Category of the 2011-2013 Subcohort

Age Group	White		Black		Hispanic	
	Population Count	Death Count	Population Count	Death Count	Population Count	Death Count
18-19	0	0	1	0	2	0
20-24	3	0	17	0	12	0
25-29	4	0	32	1	37	1
30-34	4	0	45	0	41	0
35-39	5	0	42	0	35	1
40-44	9	1	48	2	34	1
45-49	12	1	49	1	31	3
50-54	10	0	33	3	28	3
55-59	6	0	38	2	15	1
60-64	2	0	18	3	16	3
65-69	2	1	13	2	7	2
70-74	1	0	8	2	5	0
≥75	0	0	2	1	2	2

Table 3.40: Life Expectancy among Males in the 1996-1997 Subcohort by Race and Risk Transmission Category

Age Group	White			Black			Hispanic		
	MSM	IDU	Hetero	MSM	IDU	Hetero	MSM	IDU	Hetero
18-19	35.69	-	-	33.28	30.05	38.36	29.76	31.47	26.08
20-24	33.69	26.46	32.31	31.28	28.05	36.36	30.37	29.47	24.08
25-29	31.92	24.46	27.31	27.22	24.47	31.36	27.21	27.17	20.52
30-34	28.33	20.50	24.22	24.24	20.89	27.64	24.44	24.91	18.41
35-39	25.15	18.42	23.56	21.07	18.72	23.80	21.59	23.45	17.12
40-44	22.55	15.45	19.67	18.05	17.22	21.72	18.81	21.53	13.34
45-49	20.65	12.61	19.82	15.27	13.71	20.47	16.70	19.38	11.35
50-54	17.46	10.50	14.82	13.34	12.52	17.37	14.31	15.79	10.28
55-59	15.87	7.50	11.88	9.06	10.57	13.61	10.83	10.79	7.50
60-64	12.96	2.50[a]	8.75	5.25	9.61	10.63	10.38	7.86	2.50[a]
65-69	10.42		10.00	8.50	5.50	6.79	6.25	5.00	
70-74	5.83		5.00[b]	7.50	5.00[b]	5.00[b]	5.00[b]	5.00[b]	
≥75	2.50			2.50					

[a]Age group= ≥60 years
[b]Age group= ≥70 years

Table 3.41: Life Expectancy among Females in the 1996-1997 Subcohort by Race and Risk Transmission Category

Age Group	White		Black		Hispanic	
	IDU	Hetero	IDU	Hetero	IDU	Hetero
18-19	35.36	36.68	34.53	38.64	31.93	32.53
20-24	33.36	34.68	32.53	37.44	29.93	34.03
25-29	30.93	29.68	28.73	33.37	24.93	30.78
30-34	25.93	24.68	24.42	29.19	23.14	26.51
35-39	22.80	19.68	20.94	26.52	21.09	23.07
40-44	20.34	16.00	17.22	24.18	18.41	18.68
45-49	16.39	11.56	16.54	22.05	15.00	13.68
50-54	14.17	8.50	14.50	18.61	10.00	10.65
55-59	15.00	6.50	10.83	15.63	12.50[b]	6.39
60-64	10.00[a]	2.50[a]	10.00[a]	15.00		2.50[a]
65-69				12.50		
70-74				7.50		
≥75				2.50		

[a]Age group= ≥60 years
[b]Age group= ≥55 years

Table 3.42: Life Expectancy among Males in the 1998-2006 Subcohort by Race and Risk Transmission Category

Age Group	White			Black			Hispanic		
	MSM	IDU	Hetero	MSM	IDU	Hetero	MSM	IDU	Hetero
18-19	31.91	16.69	28.21	26.80	24.80	27.00	30.51	24.33	29.23
20-24	31.54	22.53	26.21	25.79	25.06	26.45	29.24	22.33	27.23
25-29	27.28	18.35	24.18	22.53	21.22	23.88	25.80	19.88	24.91
30-34	24.15	15.76	22.07	19.87	18.41	21.39	22.64	17.60	22.15
35-39	21.22	13.82	19.14	17.75	15.60	18.00	19.84	14.66	19.15
40-44	18.86	11.87	17.36	15.30	13.66	15.51	17.46	13.07	15.56
45-49	16.07	9.67	16.00	12.77	11.37	13.11	15.10	12.01	13.31
50-54	13.55	8.11	12.50	10.59	9.94	11.48	12.78	10.18	10.92
55-59	11.18	7.33	9.17	8.31	7.94	9.59	11.53	8.82	9.14
60-64	9.15	9.29	5.83	6.78	6.38	8.07	9.32	7.78	7.05
65-69	6.52	7.69[a]	2.50[a]	7.06	5.27	6.49	6.79	7.00	7.64
70-74	4.50			4.72	3.86	4.77	4.17	5.00	3.93
≥75	2.50			2.50	2.50	2.50	2.50	2.50	2.50

[a]Age group= ≥65 years

Table 3.43: Life Expectancy among Females in the 1998-2006 Subcohort by Race and Risk Transmission Category

Age Group	White		Black		Hispanic	
	IDU	Hetero	IDU	Hetero	IDU	Hetero
18-19	27.23	30.36	24.48	28.86	20.69	33.25
20-24	25.23	29.20	25.00	28.07	21.50	32.29
25-29	21.52	25.98	20.74	25.41	18.74	28.67
30-34	19.31	22.26	18.29	22.54	14.64	25.86
35-39	16.98	18.77	16.81	19.54	12.51	22.61
40-44	15.50	17.51	14.76	17.76	10.46	19.01
45-49	14.13	15.42	13.30	15.57	8.80	16.08
50-54	12.87	13.36	10.68	13.39	6.79	13.32
55-59	10.83	11.12	9.58	12.07	12.50[b]	11.07
60-64	10.00	8.86	8.83	10.35		8.55
65-69	7.50	7.50	7.00	8.30		7.50
70-74	2.50[a]	7.50	5.00[a]	5.23		5.00
≥75		2.50		2.50		2.50

[a]Age group= ≥70 years
[b]Age group= ≥55 years

Table 3.44: Life Expectancy among Males in the 2007-2010 Subcohort by Race and Risk Transmission Category

Age Group	White			Black			Hispanic		
	MSM	IDU	Hetero	MSM	IDU	Hetero	MSM	IDU	Hetero
18-19	43.75	35.80	41.40	40.30	43.37	42.31	40.12	31.08	36.48
20-24	41.75	33.80	39.40	39.01	41.37	40.31	38.12	29.08	34.48
25-29	37.05	28.80	39.02	34.41	36.37	35.31	33.87	24.08	30.42
30-34	32.87	23.80	34.02	30.46	31.37	30.75	29.84	22.93	26.75
35-39	28.87	19.82	32.17	26.37	27.06	27.08	25.94	17.93	22.53
40-44	25.21	16.32	28.65	22.48	22.69	23.90	22.24	13.79	19.64
45-49	21.12	13.53	26.92	18.88	20.16	19.41	19.23	10.96	16.50
50-54	17.19	11.80	21.92	15.16	16.96	15.64	16.07	8.33	14.08
55-59	14.19	11.88	18.21	13.29	13.76	12.28	14.52	7.50	11.32
60-64	10.57	10.00[a]	13.21	10.41	10.75	10.71	11.96	2.50[a]	7.50
65-69	7.62		12.50	6.94	8.50	9.00	9.46		4.17
70-74	5.63		7.50	4.17	7.50	5.63	6.79		5.83
≥75	2.50		2.50	2.50	2.50	2.50	2.50		2.50

[a]Age group= ≥60 years

Table 3.45: Life Expectancy among Females in the 2007-2010 Subcohort by Race and Risk Transmission Category

Age Group	White		Black		Hispanic	
	IDU	Hetero	IDU	Hetero	IDU	Hetero
18-19	42.27	42.87	36.76	42.57	40.05	39.14
20-24	40.27	40.87	34.76	41.04	38.05	38.50
25-29	35.27	36.62	29.76	36.93	36.29	34.13
30-34	30.27	32.49	24.76	33.06	31.29	29.98
35-39	27.12	27.49	22.24	29.02	26.29	26.21
40-44	24.58	25.72	19.93	25.69	23.27	24.00
45-49	22.23	21.35	16.02	22.39	20.00	20.42
50-54	19.20	18.59	13.37	19.43	20.83	16.96
55-59	15.00	15.02	10.00	16.11	12.50[c]	13.57
60-64	10.00[a]	12.02	10.00	12.38		10.52
65-69		10.83	10.00[b]	8.75		7.75
70-74		5.83		5.83		5.00
≥75		2.50		2.50		2.50

[a]Age group= ≥60 years
[b]Age group= ≥65 years
[c]Age group= ≥55 years

Table 3.46: Life Expectancy among Males in the 2011-2013 Subcohort by Race and Risk Transmisson Category

Age Group	White			Black			Hispanic		
	MSM	IDU	Hetero	MSM	IDU	Hetero	MSM	IDU	Hetero
18-19	47.81	33.55	-	44.42	53.97	49.66	41.16	49.00	46.85
20-24	45.81	31.55	46.30	43.50	51.97	47.66	40.53	47.00	44.85
25-29	41.14	26.55	41.30	38.73	46.97	42.66	35.84	42.00	39.85
30-34	36.26	21.55	36.30	34.51	41.97	38.87	31.43	37.00	35.88
35-39	31.78	16.55	31.30	29.93	36.97	33.87	27.34	33.82	30.88
40-44	27.42	11.55	26.30	26.35	31.97	28.87	23.71	28.82	26.69
45-49	23.35	11.87	24.27	22.18	26.97	25.00	20.44	23.82	22.41
50-54	19.38	10.62	21.25	18.47	23.50	20.44	17.19	18.82	19.46
55-59	16.17	8.42	16.25	14.95	20.00	17.17	13.99	16.79	16.50
60-64	13.01	10.00[a]	11.25	11.99	15.00	12.95	10.25	17.50	12.50
65-69	9.70		6.25	7.97	10.00	9.90	7.50	12.50	9.64
70-74	6.59		5.00[b]	6.25	5.00[b]	6.25	5.83	7.50	7.50
≥75	2.50			2.50		2.50	2.50	2.50	2.50

[a]Age group= ≥60 years
[b]Age group= ≥70 years

Table 3.47: Life Expectancy among Females in the 2011-2013 Subcohort by Race and Risk Transmisson Category

Age Group	White		Black		Hispanic	
	IDU	Hetero	IDU	Hetero	IDU	Hetero
18-19	35.40	46.01	-	49.87	41.20	45.31
20-24	33.40	44.01	37.54	47.87	39.20	43.31
25-29	28.40	39.01	32.54	43.09	34.20	38.98
30-34	25.99	34.01	27.54	36.62	29.20	33.98
35-39	24.91	29.01	28.80	33.97	29.54	30.27
40-44	19.91	24.01	23.80	29.72	24.54	27.25
45-49	17.09	19.94	18.80	25.36	19.54	23.45
50-54	12.09	15.94	15.83	21.40	16.67[c]	19.52
55-59	11.35	12.43	10.83	16.81		15.58
60-64	9.29	9.29	10.00[b]	12.50		12.21
65-69	7.69[a]	7.69[a]		8.50		9.64
70-74				7.50		7.50
≥75				2.50		2.50

[a]Age group= ≥65 years
[b]Age group= ≥60 years
[c]Age group= ≥50 years

Table 3.48: Life Expectancy among Males Linked to Care in the 2011-2013 Sub-Cohort by Race and Risk Transmission Category

Age Group	White			Black			Hispanic		
	MSM	IDU	Hetero	MSM	IDU	Hetero	MSM	IDU	Hetero
18-19	47.66	-	-	44.64	53.67	49.37	41.84	49.00	46.65
20-24	45.66	39.14	46.30	43.10	51.67	47.37	40.40	47.00	44.65
25-29	41.00	34.14	41.30	38.30	46.67	42.37	35.72	42.00	39.65
30-34	36.12	29.14	36.30	34.11	41.67	38.65	31.32	37.00	35.68
35-39	31.64	24.14	31.30	29.54	36.67	33.65	27.24	33.82	30.68
40-44	27.31	19.14	26.30	25.97	31.67	28.65	23.59	28.82	26.51
45-49	23.25	17.71	24.27	21.69	26.67	24.79	20.36	23.82	22.24
50-54	19.28	14.88	21.25	18.00	23.39	20.25	17.14	18.82	19.35
55-59	16.08	11.43	16.25	14.47	20.00	17.03	13.94	16.79	16.38
60-64	12.94	10.00[a]	11.25	11.50	15.00	12.84	10.19	17.50	12.37
65-69	9.61		6.25	7.50	10.00	9.90	7.50	12.50	9.64
70-74	6.59		5.00[b]	6.25	5.00[b]	6.25	5.83	7.50	7.50
≥75	2.50			2.50		2.50	2.50	2.50	2.50

[a]Age group= ≥60 years
[b]Age group= ≥70 years

Table 3.49: Life Expectancy among Females Linked to Care in the 2011-2013 Sub-Cohort by Race and Risk Transmission Category

Age Group (years)	White		Black		Hispanic	
	IDU	Hetero	IDU	Hetero	IDU	Hetero
18-19	34.43	45.87	-	49.72	40.13	45.58
20-24	32.43	43.87	37.54	47.72	38.13	43.58
25-29	27.43	38.87	32.54	42.95	33.13	39.28
30-34	25.54	33.87	27.54	38.49	28.13	34.28
35-39	24.38	28.87	28.80	33.85	29.54	30.63
40-44	19.38	23.87	23.80	29.62	24.54	27.67
45-49	16.79	19.89	18.80	25.26	19.54	23.89
50-54	11.79	15.94	15.83	21.35	16.67[c]	19.98
55-59	10.92	12.43	10.83	16.78		16.07
60-64	9.29	9.29	10.00[b]	12.47		12.82
65-69	7.69[a]	7.69[a]		8.50		9.64
70-74				7.50		7.50
≥75				2.50		2.50

[a]Age group= ≥65 years
[b]Age group= ≥60 years
[c]Age group= ≥50 years

3.12 Objective 10: Comparing Life Expectancy in the HIV Population to Life Expectancy in the General Population

Objective 10 was to compare life expectancy among patients living with HIV who reside in Texas with that of the general population. Standard errors were calculated for the life expectancies obtained for the 2011- 2013 sub-cohort. This was used to determine 95% confidence intervals which were then compared to life expectancies in the general Texas population in 2013.

Table 3.50: Life Expectancy among White Males Having Sex with Males with HIV, White Male Injecting Drug Users with HIV, White Heterosexual Males with HIV, and White Males in the General Population

Age Group	MSM			IDU			Heterosexual			LE in General Population[a]
	LE	95% Confidence Interval		LE	95% Confidence Interval		LE	95% Confidence Interval		
		LL	UL		LL	UL		LL	UL	
18-19	47.81	45.62	50.00	33.55	27.50	39.60	-	-	-	61.46
20-24	45.81	43.62	48.00	31.55	25.50	37.60	46.30	38.77	53.82	56.65
25-29	41.14	38.99	43.30	26.55	20.50	32.60	41.30	33.77	48.82	52.02
30-34	36.26	34.12	38.41	21.55	15.50	27.60	36.30	28.77	43.82	47.37
35-39	31.78	29.67	33.89	16.55	10.50	22.60	31.30	23.77	38.82	42.68
40-44	27.42	25.36	29.49	11.55	5.50	17.60	26.30	18.77	33.82	38.02
45-49	23.35	21.30	25.39	11.87	4.68	19.07	24.27	18.49	30.05	33.45
50-54	19.38	17.32	21.43	10.62	4.76	16.48	21.25	16.57	25.93	29.05
55-59	16.17	14.08	18.26	8.42	3.94	12.90	16.25	11.57	20.93	24.89
60-64	13.01	10.88	15.14	10.00			11.25	6.57	15.93	21.00
65-69	9.70	7.60	11.79				6.25	1.57	10.93	17.23
70-74	6.59	4.97	8.21				5.00			13.64
≥75	2.50									10.30

[a]https://www.dshs.state.tx.us/chs/vstat/vs13/t24.aspx

Table 3.51: Life Expectancy among White Female Injecting Drug Users with HIV, White Heterosexual Females with HIV, and White Females in the General Population

Age Group	IDU			Heterosexual			LE in the General Population[a]
	LE	95% Confidence Interval		LE	95% Confidence Interval		
		LL	UL		LL	UL	
18-19	35.40	26.19	44.62	46.01	41.63	50.38	66.04
20-24	33.40	24.19	42.62	44.01	39.63	48.38	61.15
25-29	28.40	19.19	37.62	39.01	34.63	43.38	56.30
30-34	25.99	17.41	34.58	34.01	29.63	38.38	51.46
35-39	24.91	18.91	30.91	29.01	24.63	33.38	46.66
40-44	19.91	13.91	25.91	24.01	19.63	28.38	41.90
45-49	17.09	12.25	21.92	19.94	15.86	24.03	37.21
50-54	12.09	7.25	16.92	15.94	11.92	19.96	32.66
55-59	11.35	6.06	16.64	12.43	8.67	16.20	28.26
60-64	9.29	4.07	14.52	9.29	5.60	12.99	23.97
65-69	7.69			7.69			19.85
70-74							15.93
≥75							12.30

[a]https://www.dshs.state.tx.us/chs/vstat/vs13/t24.aspx

Table 3.52: Life Expectancy among Black Males Having Sex with Males with HIV, Black Male Injecting Drug Users with HIV, Black Heterosexual Males with HIV and Black Males in the General Population

Age Group	MSM			IDU			Heterosexual			LE in General Population[a]
	LE	95% Confidence Interval		LE	95% Confidence Interval		LE	95% Confidence Interval		
		LL	UL		LL	UL		LL	UL	
18-19	44.42	41.56	47.28	53.97	49.78	58.16	49.66	45.21	54.11	58.05
20-24	43.50	40.63	46.36	51.97	47.78	56.16	47.66	43.21	52.11	53.28
25-29	38.73	35.86	41.60	46.97	42.78	51.16	42.66	38.21	47.11	48.67
30-34	34.51	31.61	37.41	41.97	37.78	46.16	38.87	35.05	42.70	44.18
35-39	29.93	27.03	32.83	36.97	32.78	41.16	33.87	30.05	37.70	39.71
40-44	26.35	23.44	29.26	31.97	27.78	36.16	28.87	25.05	32.70	35.24
45-49	22.18	19.24	25.12	26.97	22.78	31.16	25.00	21.39	28.60	30.79
50-54	18.47	15.48	21.47	23.50	20.47	26.53	`20.44	16.89	23.99	26.54
55-59	14.95	11.83	18.07	20.00	20.00	20.00	17.17	13.96	20.39	22.48
60-64	11.99	8.69	15.28	15.00	15.00	15.00	12.95	9.80	16.09	18.80
65-69	7.97	4.61	11.33	10.00	10.00	10.00	9.90	7.24	12.57	15.48
70-74	6.25	3.39	9.11	5.00			6.25	4.22	8.28	12.33
≥75	2.50						2.50			9.50

[a]https://www.dshs.state.tx.us/chs/vstat/vs13/t24.aspx

Table 3.53: Life Expectancy among Black Female Injecting Drug Users with HIV, Black Heterosexual Females with HIV, and Black Females in the General Population

Age Group	IDU			Heterosexual			LE in the General Population[a]
	LE	95% Confidence Interval		LE	95% Confidence Interval		
		LL	UL		LL	UL	
18-19	-	-	-	49.87	46.88	52.85	63.32
20-24	37.54	26.77	48.30	47.87	44.88	50.85	58.41
25-29	32.54	21.77	43.30	43.09	40.12	46.05	53.57
30-34	27.54	16.77	38.30	38.62	35.69	41.56	48.81
35-39	28.80	23.31	34.29	33.97	31.05	36.89	44.11
40-44	23.80	18.31	29.29	29.72	26.85	32.60	37.43
45-49	18.80	13.31	24.29	25.36	22.53	28.20	34.87
50-54	15.83	11.56	20.11	21.40	18.58	24.22	30.45
55-59	10.83	6.56	15.11	16.81	14.00	19.61	26.27
60-64	10.00			12.50	9.71	15.29	22.28
65-69				8.50	5.77	11.23	18.54
70-74				7.50	7.50	7.50	14.97
≥75				2.50			11.70

[a]https://www.dshs.state.tx.us/chs/vstat/vs13/t24.aspx

Table 3.54: Life Expectancy among Hispanic Males Having Sex with Males with HIV, Hispanic Male Injecting Drug Users with HIV, Hispanic Heterosexual Males with HIV, and Hispanic Males in the General Population

Age Group	MSM			IDU			Heterosexual			LE in General Population[a]
	LE	95% Confidence Interval		LE	95% Confidence Interval		LE	95% Confidence Interval		
		LL	UL		LL	UL		LL	UL	
18-19	41.16	39.05	43.28	49.00	42.12	55.89	46.85	41.72	51.97	62.58
20-24	40.53	38.49	42.56	47.00	40.12	53.89	44.85	39.72	49.97	57.74
25-29	35.84	33.80	37.87	42.00	35.12	48.89	39.85	34.72	44.97	53.00
30-34	31.43	29.38	33.47	37.00	30.12	43.89	35.88	31.08	40.68	48.26
35-39	27.34	25.28	29.40	33.82	27.63	40.01	30.88	26.08	35.68	43.52
40-44	23.71	21.63	25.79	28.82	22.63	35.01	26.69	22.07	31.32	38.80
45-49	20.44	18.30	22.58	23.82	17.63	30.01	22.41	17.90	26.91	34.16
50-54	17.19	14.98	19.40	18.82	12.63	25.01	19.46	15.20	23.73	29.67
55-59	13.99	11.69	16.29	16.79	11.00	22.57	16.50	12.47	20.53	25.43
60-64	10.25	7.90	12.60	17.50	17.50	17.50	12.50	8.84	16.16	21.33
65-69	7.50	5.05	9.95	12.50	12.50	12.50	9.64	6.25	13.04	17.46
70-74	5.83	3.44	8.22	7.50	7.50	7.50	7.50	7.50	7.50	13.78
≥75	2.50			2.50			2.50			10.30

[a]https://www.dshs.state.tx.us/chs/vstat/vs13/t24.aspx

Table 3.55: Life Expectancy among Hispanic Female Injecting Drug Users with HIV, Hispanic Heterosexual Females with HIV, and Hispanic Females in the General Population

Age Group	IDU			Heterosexual			LE in the General Population[a]
	LE	95% Confidence Interval		LE	95% Confidence Interval		
		LL	UL		LL	UL	
18-19	41.20	34.06	48.34	45.31	41.22	49.39	67.41
20-24	39.20	32.06	46.34	43.31	39.22	47.39	62.50
25-29	34.20	27.06	41.34	38.98	35.07	42.88	57.60
30-34	29.20	22.06	36.34	33.98	30.07	37.88	52.71
35-39	29.54	25.42	33.65	30.27	26.52	34.02	47.84
40-44	24.54	20.42	28.65	27.25	23.81	30.70	43.00
45-49	19.54	15.42	23.65	23.45	20.16	26.74	38.23
50-54	16.67			19.52	16.33	22.70	33.57
55-59				15.58	12.49	18.67	28.99
60-64				12.21	9.27	15.16	24.58
65-69				9.64	7.24	12.04	20.32
70-74				7.50	7.50	7.50	16.24
≥75				2.50			12.30

[a]https://www.dshs.state.tx.us/chs/vstat/vs13/t24.aspx

A summary of all hypotheses tests results and associated statistical decisions are presented in Table 3.56.

Table 3.56: Results and Statistical Decisions of Hypotheses Testing

Objectives/Hypotheses	Statistical Test	Result (+,0,-)[a]	Statistical Decision
Objective 1: To describe the demographic and clinical characteristics of patients living with HIV who reside in Texas, with respect to gender, race, age at HIV diagnosis, risk transmission category, linkage to care, viral load, CD4 count, and age at AIDS diagnosis	Descriptive Statistics	N/A	N/A
Objective 2: To determine the relationship between CD4 count and time			
H_1: CD4 count increases with time	Hierarchical Linear Modeling	2011-2013: +	Failed to reject
H_2: Rate of increase in CD4 count declines with time	Hierarchical Linear Modeling	-	Failed to reject
Objective 3: To determine the relationships between age, gender, and race/ethnicity and rate of immune recovery			
H_3: Age is negatively associated with rate of immune recovery	Hierarchical Linear Modeling	2011-2013: **0**	Rejected
H_4: Male gender is associated with a lower rate of immune recovery	Hierarchical Linear Modeling	2011-2013: **0**	Rejected
H_5: Black ethnicity is associated with a lower rate of immune recovery	Hierarchical Linear Modeling	2011-2013: **0**	Rejected

Table 3.56: Results and Statistical Decisions of Hypotheses Testing…*(continued)*

Objectives/Hypotheses	Statistical Test	Result (+,0,-)[a]	Statistical Decision
Objective 4: To determine the relationships between age, gender, and race on rate of immune recovery after adjusting for risk transmission category, linkage to care, CD4 count, viral load, and AIDS diagnosis			
H_6: Age is negatively associated with rate of immune recovery after adjusting for gender, race/ethnicity, risk transmission category, linkage to care, CD4 count, viral load, and AIDS diagnosis	Hierarchical Linear Modeling	2011-2013: **0**	Rejected
$H0_7$: There is no significant relationship between gender and rate of immune recovery after adjusting for age, race/ethnicity, risk transmission category, linkage to care, CD4 count, viral load, and AIDS diagnosis	Hierarchical Linear Modeling	2011-2013: **0**	Failed to reject
H_8: Black ethnicity is associated with a lower rate of immune recovery after adjusting for age, gender, risk transmission category, linkage to care, CD4 count, viral load, and AIDS diagnosis	Hierarchical Linear Modeling	2011-2013: **0**	Rejected
Objective 5: To determine the magnitude and direction of the association between age, gender, and race/ethnicity and the risk of an AIDS diagnosis and death			
H_9: Age is positively associated with the risk of an AIDS diagnosis	Univariate Cox proportional hazards regression	1996-1997: + 1998-2006: + 2007-2010: + 2011-2013: +	Failed to reject Failed to reject Failed to reject Failed to reject

Table 3.56: Results and Statistical Decisions of Hypotheses Testing…*(continued)*

Objectives/Hypotheses	Statistical Test	Result (+,0,-)[a]	Statistical Decision
Objective 5: To determine the magnitude and direction of the association between age, gender, and race/ethnicity and the risk of an AIDS diagnosis and death			
H_{10}: Age is positively associated with the risk of death	Univariate Cox proportional hazards regression	1996-1997: **+** 1998-2006: **+** 2007-2010: **+** 2011-2013: **+**	Failed to reject Failed to reject Failed to reject Failed to reject
H_{11}: Male gender is positively associated with the risk of an AIDS diagnosis	Kaplan-Meier Analysis Log-Rank Test	1996-1997: **+** 1998-2006: **+** 2007-2010: **+** 2011-2013: **0**	Failed to reject Failed to reject Failed to reject Rejected
H_{12}: Male gender is positively associated with the risk of death	Kaplan-Meier Analysis Log-Rank Test	1996-1997: **0** 1998-2006: **0** 2007-2010: **0** 2011-2013: **0**	Rejected Rejected Rejected Rejected
H_{13a}: Black ethnicity (compared to White ethnicity) is positively associated with the risk of an AIDS diagnosis	Kaplan-Meier Analysis Log-Rank Test Univariate Cox Proportional Hazards Regression	1996-1997: **0** 1998-2006: **+** 2007-2010: **0** 2011-2013: **-**	Rejected Failed to reject Rejected Rejected

Table 3.56: Results and Statistical Decisions of Hypotheses Testing…*(continued)*

Objectives/Hypotheses	Statistical Test	Result (+,0,-)[a]	Statistical Decision
Objective 5: To determine the magnitude and direction of the association between age, gender, and race/ethnicity and the risk of an AIDS diagnosis and death			
H_{13b}: Black ethnicity (compared to Hispanic ethnicity) is positively associated with the risk of an AIDS diagnosis	Kaplan-Meier Analysis Log-Rank Test Univariate Cox Proportional Hazards Regression	1996-1997: **-** 1998-2006: **-** 2007-2010: **-** 2011-2013: **-**	Rejected Rejected Rejected Rejected
H_{14a}: Black ethnicity (compared to White ethnicity) is positively associated with the risk of death	Kaplan-Meier Analysis Log-Rank Test Univariate Cox Proportional Hazards Regression	1996-1997: **+** 1998-2006: **+** 2007-2010: **0** 2011-2013: **-**	Failed to reject Failed to reject Rejected Rejected
H_{14b}: Black ethnicity (compared to Hispanic ethnicity) is positively associated with the risk of death	Kaplan-Meier Analysis Log-Rank Test Univariate Cox Proportional Hazards Regression	1996-1997: **+** 1998-2006: **+** 2007-2010: **0** 2011-2013: **-**	Failed to reject Failed to reject Rejected Rejected

Table 3.56: Results and Statistical Decisions of Hypotheses Testing…*(continued)*

Objectives/Hypotheses	Statistical Test	Result (+,0,-)[a]	Statistical Decision
Objective 6: To determine the magnitude and direction of the association between risk transmission category, linkage to care, CD4 count, and viral load and time to AIDS and death			
H_{15a}: IDU risk exposure (compared to heterosexual risk exposure) is positively associated with the risk of an AIDS diagnosis	Kaplan-Meier Analysis Log-Rank Test Univariate Cox Proportional Hazards Regression	1996-1997: **+** 1998-2006: **0** 2007-2010: **0** 2011-2013: **0**	Failed to reject Rejected Rejected Rejected
H_{15b}: IDU risk exposure (compared to risk exposure in MSMs) is positively associated with the risk of an AIDS diagnosis	Kaplan-Meier Analysis Log-Rank Test Univariate Cox Proportional Hazards Regression	1996-1997: **0** 1998-2006: **+** 2007-2010: **0** 2011-2013: **0**	Rejected Failed to reject Rejected Rejected
H_{16a}: IDU risk exposure (compared to heterosexual risk exposure) is positively associated with the risk of death	Kaplan-Meier Analysis Log-Rank Test Univariate Cox Proportional Hazards Regression	1996-1997: **+** 1998-2006: **+** 2007-2010: **+** 2011-2013: **+**	Failed to reject Failed to reject Failed to reject Failed to reject

Table 3.56: Results and Statistical Decisions of Hypotheses Testing…*(continued)*

Objectives/Hypotheses	Statistical Test	Result (+,0,-)[a]	Statistical Decision
Objective 6: To determine the magnitude and direction of the association between risk transmission category, linkage to care, CD4 count, and viral load and time to AIDS and death			
H_{16b}: IDU risk exposure (compared to risk exposure in MSMs) is positively associated with the risk of death	Kaplan-Meier Analysis Log-Rank Test Univariate Cox Proportional Hazards Regression	1996-1997: + 1998-2006: + 2007-2010: + 2011-2013: +	Failed to reject Failed to reject Failed to reject Failed to reject
H_{17}: Linkage to care is negatively associated with the risk of an AIDS diagnosis	Kaplan-Meier Analysis Log-Rank Test	2011-2013: **0**	Rejected
H_{18}: Linkage to care is negatively associated with the risk of death	Kaplan-Meier Analysis Log-Rank Test	2011-2013: +	Rejected
H_{19}: CD4 count is negatively associated with the risk of an AIDS diagnosis	Univariate Cox Proportional Hazards Regression	2011-2013: -	Failed to reject
H_{20}: CD4 count is negatively associated with the risk of death	Univariate Cox Proportional Hazards Regression	2011-2013: -	Failed to reject
H_{21}: Viral load is positively associated with the risk of an AIDS diagnosis	Univariate Cox Proportional Hazards Regression	2011-2013: +	Failed to reject
H_{22}: Viral load is positively associated with the risk of death	Univariate Cox Proportional Hazards Regression	2011-2013: +	Failed to reject

Table 3.56: Results and Statistical Decisions of Hypotheses Testing…*(continued)*

Objectives/Hypotheses	Statistical Test	Result (+,0,-)[a]	Statistical Decision
Objective 7: To determine the relationships between age, gender, and race/ethnicity and time to AIDS after adjusting for age, gender, race/ethnicity, risk transmission category, linkage to care, CD4 count, and viral load			
H_{23}: Age is positively associated with the risk of an AIDS diagnosis after adjusting for gender, race/ethnicity, risk transmission category, linkage to care, CD4 count, and viral load	Multivariate Cox Proportional Hazards Regression	1996-1997: **+** 1998-2006: **+** 2007-2010: **+** 2011-2013: **+**	Failed to reject Failed to reject Failed to reject Failed to reject
$H0_{24}$: Male gender is not associated with the risk of an AIDS diagnosis after adjusting for age, race/ethnicity, risk transmission category, linkage to care, CD4 count, and viral load	Multivariate Cox Proportional Hazards Regression	1996-1997: **+** 1998-2006: **+** 2007-2010: **+** 2011-2013: **0**	Rejected Rejected Rejected Failed to reject
H_{25a}: Black ethnicity (compared to White ethnicity) is positively associated with the risk of an AIDS diagnosis after adjusting for age, gender, risk transmission category, linkage to care, CD4 count, and viral load	Multivariate Cox Proportional Hazards Regression	1996-1997: **0** 1998-2006: **+** 2007-2010: **+** 2011-2013: **0**	Rejected Failed to reject Failed to reject Rejected
H_{25b}: Black ethnicity (compared to Hispanic ethnicity) is positively associated with the risk of an AIDS diagnosis after adjusting for age, gender, risk transmission category, linkage to care, CD4 count, and viral load	Multivariate Cox Proportional Hazards Regression	1996-1997: **0** 1998-2006: **-** 2007-2010: **-** 2011-2013: **0**	Rejected Rejected Rejected Rejected

Table 3.56: Results and Statistical Decisions of Hypotheses Testing…*(continued)*

Objectives/Hypotheses	Statistical Test	Result (+,0,-)[a]	Statistical Decision
Objective 8: To determine the relationships between age, gender, and race/ethnicity and death after adjusting for risk transmission category, linkage to care, CD4 count, viral load, and AIDS diagnosis			
H_{26}: Age is positively associated with the risk of death after adjusting for gender, race/ethnicity, risk transmission category, linkage to care, CD4 count, viral load, and AIDS diagnosis	Multivariate Cox Proportional Hazards Regression	1996-1997: + 1998-2006: + 2007-2010: + 2011-2013: +	Failed to reject Failed to reject Failed to reject Failed to reject
$H0_{27}$: Male gender is not associated with the risk of death after adjusting for age, race/ethnicity, risk transmission category, linkage to care, CD4 count, viral load, and AIDS diagnosis	Multivariate Cox Proportional Hazards Regression	1996-1997: 0 1998-2006: 0 2007-2010: 0 2011-2013: 0	Failed to reject Failed to reject Failed to reject Failed to reject
H_{28a}: Black ethnicity (compared to White ethnicity) is positively associated with the risk of death after adjusting for age, gender, risk transmission category, linkage to care, CD4 count, viral load, and AIDS diagnosis	Multivariate Cox Proportional Hazards Regression	1996-1997: + 1998-2006: + 2007-2010: 0 2011-2013: 0	Failed to reject Failed to reject Rejected Rejected
H_{28b}: Black ethnicity (compared to Hispanic ethnicity) is positively associated with the risk of death after adjusting for age, gender, risk transmission category, linkage to care, CD4 count, viral load, and AIDS diagnosis	Multivariate Cox Proportional Hazards Regression	1996-1997: + 1998-2006: + 2007-2010: 0 2011-2013: 0	Failed to reject Failed to reject Rejected Rejected

Table 3.56: Results and Statistical Decisions of Hypotheses Testing…*(continued)*

Objectives/Hypotheses	Statistical Test	Result (+,0,-)[a]	Statistical Decision
Objective 9: To construct life tables of patients living with HIV who reside in Texas, grouped by age, gender, race, risk transmission category, linkage to care, and time period	Life Tables	N/A	N/A
Objective 10: To compare life expectancy among patients living with HIV who reside in Texas with that of the general population	95% Confidence Interval	--	--

[a]Symbols: + = positive association, - = negative association, 0 = no significant association

Chapter 4: Discussion

4.1 Rate of Immune Recovery

Overall, the results show improvement in CD4 count over time which indicates that the process of immune recovery is in effect. However, rate of immune recovery declined over time as indicated by the negative estimate of the time interaction in the model for CD4 count. There was no relationship between rate of immune recovery and age, gender, ethnicity. However, there were significant relationships CD4 count and age, gender, and ethnicity. Older patients had lower CD4 counts than younger patients but rate of immune recovery was similar for all ages. This result is comparable to the findings, by Smith et al., that age was not associated with CD4 cell count increase.[99] However, younger patients may still be at an advantage since, under similar conditions, a younger patient would have higher CD4 count and is, therefore, more likely to reach normal CD4 levels within a shorter time.

After adjusting for covariates, CD4 count was 38 units lower for males compared to females but gender was not associated with rate of immune recovery. In a similar study conducted in the United Kingdom, no association was found between gender and CD4 cell count increase.[99] Several studies conducted in Africa or Asia report results favoring immune recovery in women compared with men.[49, 100-102] An exception is a study conducted in a commercial city in Tanzania which found that women had higher CD4 count at baseline but lost their immunological advantage over time such that there was no difference in average CD4 count between males and females after 1 year of follow-up.[103] It is likely that the demographics of the patients in the commercial city was more similar to those of advanced countries than to the

resource-limited settings that is typical of Africa and Asia. The lack of a significant relationship between gender and rate of immune recovery in our study suggests that we can expect similar rates of clinical progression to AIDS and survival between males and females, under similar conditions. But since males are likely to have lower CD4 count, they may be at a disadvantage.

Blacks had significantly lower CD4 count than Whites after adjusting for covariates but were not significantly different from Hispanics. However, there were no significant differences in the rate of immune recovery among the ethnicities. In a study by Smith et al., White ethnicity was associated with greater increases in CD4 cell count in the first 3 months after initiating HAART but from 3 months onwards, there was no difference by ethnicity.[99] This agrees with the results of the current study since patients were followed for up to 3 years. However, Whites might have an advantage over other races since they are more likely to have higher CD4 counts under similar conditions and may reach normal CD4 count levels sooner.

4.2 Survival

In this study, age was associated with time to AIDS with younger age favoring slower clinical progression to AIDS. The association was consistent across subcohorts. The association remained significant after controlling for covariates. Likewise, age was consistently associated with death, even after controlling for covariates. This result may be explained by the relatively slow rate of immune recovery that has been observed in older patients.[68, 104] Poor immune recovery has been shown to be associated with higher risk of AIDS, non-AIDS diseases (non-AIDS cancers and cardiovascular, end-stage renal, and liver diseases), and death.[104] In a similar study in

which patients were followed up to 2001, older age was found to be consistently associated with increased risk of death while the relationship between age and AIDS diagnosis was inconsistent.[53] However, the cohort was very different from our study's cohort in that it included patients who had seroconverted before HAART became available. This may explain the inconsistency in the relationship between age and AIDS diagnosis. It is also likely that aging may be playing a stronger role in the relationship between age and death while treatment effectiveness may be playing a stronger role in the relationship between age and clinical progression to AIDS.

Males had significantly worse outcomes in AIDS diagnosis in the first 3 subcohorts (diagnosed with HIV between 1996 and 2010) but there was no difference between males and females in AIDS diagnosis in the fourth subcohort (diagnosed with HIV between 2011 and 2013). There was no difference between males and females in time to death across all subcohorts. Similar studies assessing the relationship between gender and clinical progression to AIDS have shown that males have significantly worse outcomes.[77, 105, 106] Recent studies conducted in Canada have found no difference in survival between men and women.[76] Also, in the study by Mosha et al., no difference in survival outcomes was found between men and women.[103] In other studies conducted across Africa and in Lao, women were shown to have significantly better survival outcomes than men.[101, 102, 105, 107] The differences in results can potentially be explained by setting and type of patients included in the study.

In the first subcohort, there was no significant difference in clinical progression to AIDS by ethnicity after adjustment for covariates. On the other hand, Blacks had significantly worse outcomes than Whites but better outcomes than

Hispanics in the second and third subcohort. This variation across ethnicities was again lost in the fourth subcohort. In one study by Silverberg et al., no difference was found in risk of AIDS diagnosis by ethncity.[108] This study was different from our study in that it included only patients that had been placed on antiretroviral therapy. There is evidence to suggest that in Hispanics generally have higher rates of morbidity than other ethnicities.[79] Our study controlled for initial CD4 count (potential proxy for HIV morbidity) in only the fourth cohort. Hispanics in the fourth cohort had relatively low CD4 counts. Hence, it is likely that the differences in clinical progression to AIDS observed in the second and third subcohorts of our study populations were confounded by CD4 count level.

Blacks had higher risk of death in the first and second subcohorts compared to Whites and Hispanics. This variation was absent in the third and fourth subcohorts, coinciding with the period after 2006. In the study by Silverberg et al., no difference was found in risk of death by ethnicity.[108] In a different study by Lemly et al., Blacks were at higher risk of death compared to Whites and Hispanics but this variation was lost after controlling for duration on HAART.[109] For our study, data on drug utilization was unavalilable. It would have been interesting to investigate how duration on HAART therapy affects the relationship between ethnicity and death in patients living with HIV.

Other variables found to be statistically significant predictors of clinical progression to AIDS and of death were initial viral load and initial CD4 count. Contrary to expectation, linkage to care appeared to predict worse outcomes. This may be as a result of late diagnosis of HIV as a posthoc analysis showed that a significant

proportion of patients were diagnosed with AIDS within 12 months of HIV diagnosis even in the fourth subcohort. Patients in the injecting drug use risk group were consistently at higher risk of AIDS diagnosis or death in the unadjusted analyses, although this became inconsistent after adjusting for other covariates. Finally, AIDS diagnosis was a strong predictor of death.

4.3 Life Expectancy

Life expectancy was relatively lower in the 1998-2006 subcohort (26.08-38.64) compared to the 1996-1997 subcohort (16.69-33.25). It then increased in the 2007-2010 subcohort (31.08-43.75) and the 2011-2013 subcohort (33.55-53.97). This finding does not corroborate our finding of progressively increasing mortality rate with later year of diagnosis in the Kaplan-Meier analysis that justified the conduction of separate survival analysis for each subcohort. It is possible that because the life tables of the 1998-2006 subcohort were based on mortality rate over 9 years, changes in mortality rates with time had contributed to the lower life expectancy. Patients living with HIV typically progress to AIDS and studies show that AIDS diagnosis is associated with death. Hence, the relatively lower life expectancy in the 1998-2006 subcohort may reflect maturity in the course of disease for this subcohort that are not present in the life tables of the other 3 subcohorts which considered mortality rates over 2 to 4 years following HIV diagnosis.

Ignoring the dip in life expectancy in the 1998-2006 subcohort, the trend of increasing life expectancy with period of diagnosis is consistent with the findings of another study.[110] This study identified patients diagnosed each year from 1996 to 2005. Life expectancy rose over the period. In this thesis project, patients diagnosed

from 1998 to 2006 were placed in the same subcohort. This may have precluded observing differences that may exist between patients diagnosed in the mid-2000s and those diagnosed in the late 1990s. Also, there did not appear to be a lot of difference in life expectancy between those linked to care within the 2011-2013 subcohort and the subcohort as a whole. This may be due to the small number of those who were not linked to care having little effect on the figures.

When life expectancy in the 2011-2013 subcohort was compared to that of the general population, it was consistently lower by ethnicity and risk transmission category compared to the general population with one exception; Black male injecting drug users with HIV. However, it must be noted that the 95% confidence interval in this group with the exception was very wide and the true life expectancy values may well lie in the lower spectrum. This finding of low life expectancy in the HIV population compared to the general population may be attributed to late HIV diagnosis among the study population. Even as recently as 2013, over one-third of patients diagnosed with HIV were also diagnosed with AIDS within 3 years of follow-up. A study conducted in the Netherlands showed that, compared to the general population, less than 1 year of life is lost among 25 year olds diagnosed with HIV if the diagnosis is made early. However, at least 3 studies have gone further to show that life expectancy in sucessfully treated patients living with HIV approaches that of the general population.[57-59] These findings suggest that all is not lost for the Texas HIV population. Life expectancy outcomes may improve if efforts are directed towards HIV testing, to identify infected persons early, and early commencement of antiretroviral therapy, to prevent delay in the process of immune recovery. It has been

shown in this thesis project that patients are not being diagnosed early. Further studies is needed to determine how soon antiretroviral therapy is initiated in patients following HIV diagnosis.

4.4 What This Adds to the Literature

This study found no relationship between rate of immune recovery and age, gender, and risk transmission category but there were differential outcomes in clinical progression to AIDS and survival. Few studies simultaneously evaluate disparities in rate of immune recovery, clinical progression to AIDS and survival. It must be noted that although associations of rate of immune recovery and age, gender, and risk transmission category were not significant, they were in the direction supported by the survival analyses. This may imply a clinical significance of the results. It also suggests that differential rates of CD4 count increase between two individuals on therapy should be a cause for concern even if both show increased CD4 count with time. In this era of immune recovery, more elaborate studies may be needed to determine how rate of immune recovery impacts clinical progression to AIDS and survival.

This study showed that life expectancy in the Texas HIV population was not similar to that of the general population. It also showed that many patients were being diagnosed with AIDS soon after HIV diagnosis, implying late HIV diagnosis. Since this study was state-specific, it is unclear if this is the pattern in other parts of the United States. For the state of Texas, this study identifies an area of need for the Texas HIV population and a potential point for intervention that would have high impact, HIV testing and early HIV diagnosis.

4.5 Limitations

The following potential limitations should be considered while interpreting the results of this study:

First, only specific ethnic (White, Black, and Hispanic) and risk transmission (MSM, IDU, and heterosexual) groups were included in this study thereby limiting the generalizability of the study. However, the included patients made up over 91% of patients who were diagnosed with HIV between 1996 and 2013. Hence, most of the patients were accounted for in our analyses. We also assumed that patients were not previously diagnosed outside of Texas. Between 2000 and 2014, there was a 25% turnover rate of US born Texas residents.[111] It is therefore possible that some patients may not have been originally diagnosed in their reported year of diagnosis. Since 3 to 8 year subcohorts were used for analyses in this study, it is expected that the worst case mislabelling scenario would be much less that 25%.

We also assumed that the adoption rate of treatment guidelines was one year. This assumption was guided by studies from the Department of Veteran Affairs and supported by the survival analyses we performed for the subcohorts. In addition, we used linkage to care as a proxy variable for initiation to therapy on the assumption that all patients commenced antiretroviral therapy upon being to care. This was necessary because medication data for our study population was not available. The increase in CD4 count with time observed in our hierarchical linear model suggests that patients may have actually started drug therapy as they were linked to care.

In addition, the outcome variable, rate of immune recovery, did not fully satisfy the normality assumption for the hierarchical linear models (skewness=1.05, kurtosis=41.34). However, the results obtained are believed to be valid because

hierarchical linear models have been shown to be robust against non-normality.[112] For the survival analyses, we assumed that no patient was lost to follow-up and that if a death was not reported, the patient was still alive. This may have resulted in over-estimation of the survival curve. However, if the actual rate of loss to follow-up is comparable across sub-groups, then the effect of this assumption may have balanced out. For the life tables, many of the age groups within the subgroups were small in size which potentially made the results unstable. However, the use confidence intervals adjusts for errors in measurement.

Finally, our test results were susceptible to type 1 error rate inflation because multiple comparisons were simultaneously considered.

4.6 Conclusions and Future Directions

1. Rate of immune recovery was not significantly related to age, gender, and ethnicity. However, younger age and being female or White was associated with higher CD4 count after controlling for time.
2. Younger age was associated with slow clinical progression to AIDS and better survival outcomes. Compared with Whites, Hispanics were at greater risk for clinical progression to AIDS while Blacks had poor survival outcomes. These disparities were not found among those diagnosed between 2011 and 2013 (the fourth subcohort).
3. Although rate of immune recovery was not significantly associated with age, gender, and ethnicity, it was in the direction observed in the survival analyses of clinical progression to AIDS and death. This suggests clinical relevance of differential rate of immune recovery.

4. Overall, life expectancy among patients living with HIV was not comparable to that in the general population. Late diagnosis of HIV is a potential reason for this. Hence, an area of focus for future interventon may be HIV testing to identify infected persons sooner. Further studies are also needed to determine how soon antiretroviral therapy is initiated among patients following HIV diagnosis as there is evidence in the literature that early and successful therapy reduces years of life lost as a result of HIV.[58, 59, 113]

In summary, the disparities in health outcomes observed among patients living with HIV may be as a result of differential CD4 count after accounting for other factors. Early diagnosis and optimal drug therapy are possible strategies for improving life expectancy among patients living with HIV who reside in Texas.

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