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PREVALENCE OF HUMAN IMMUNODEFICIENCY VIRUS
AMONG REPORTED TUBERCULOSIS CASES,
TEXAS 2000-2010

BY
Kathryn Clelia Pezzi
Degree to be awarded: M.P.H.
Career MPH

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# PREVALENCE OF HUMAN IMMUNODEFICIENCY VIRUS AMONG REPORTED TUBERCULOSIS CASES, TEXAS 2000-2010

BY
Kathryn Clelia Pezzi
M.P.H., Emory University, 2012
B.S., Emory University, 2006

Thesis Committee Chair: Kevin Sullivan, PHD, MPH, MHA

An abstract of
A Thesis submitted to the Faculty of the
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2012

**Abstract**

PREVALENCE OF HUMAN IMMUNODEFICIENCY VIRUS
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Kathryn Clelia Pezzi

The objective of this analysis was to understand the association between residence in U.S.-Mexico border region of Texas and TB and HIV coinfection. Globally, human immunodeficiency virus (HIV) is the leading contributor to the tuberculosis (TB) epidemic. In the United States the TB epidemic disproportionately affects foreign born; Mexican-born were the largest proportion of foreign born TB cases in 2010. The border region between the United States and Mexico is a socially and demographically unique region of the country with many potential risk factors for TB and HIV. This analysis used Texas statewide TB surveillance data from 2000 through 2010. Multivariable logistic regression was used to test the association between border residence and TB and HIV coinfection while controlling for a number of sociodemographic risk factors. Of 11,282 TB cases, 14.22% were infected with HIV at the time of TB reporting. TB cases reported in the Texas border region were significantly less likely to have concurrent HIV infection. Males, African Americans, injection and non-injection drug users, unemployed persons, and people age 30-49 are more likely to have concurrent TB and HIV infections. The large proportion of reported TB cases with unknown HIV status in Texas indicates that HIV screening in TB patients could be improved, and ongoing efforts to reduce TB and HIV coinfection in the border region should be continued, supported, and expanded.

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## Abstract

The objective of this analysis was to understand the association between residence in U.S.-Mexico border region of Texas and TB and HIV coinfection. Globally, human immunodeficiency virus (HIV) is the leading contributor to the tuberculosis (TB) epidemic. In the United States the TB epidemic disproportionately affects foreign born; Mexican-born were the largest proportion of foreign born TB cases in 2010 . The border region between the United States and Mexico is a socially and demographically unique region of the country with many potential risk factors for TB and HIV. This analysis used Texas statewide TB surveillance data from 2000 through 2010.. Multivariable logistic regression was used to test the association between border residence and TB and HIV coinfection while controlling for a number of sociodemographic risk factors. Of 11,282 TB cases, 14.22% were infected with HIV at the time of TB reporting. TB cases reported in the Texas border region were significantly less likely to have concurrent HIV infection. Males, African Americans, injection and non-injection drug users, unemployed persons, and people age 30-49 are more likely to have concurrent TB and HIV infections. The large proportion of reported TB cases with unknown HIV status in Texas indicates that HIV screening in TB patients could be improved, and ongoing efforts to reduce TB and HIV coinfection in the border region should be continued, supported, and expanded.

# Introduction

**Problem Statement**

Worldwide, tuberculosis (TB) is one of the most common causes of morbidity and mortality among patients infected with human immunodeficiency virus (HIV). In 2000, an estimated 9% of incident TB cases worldwide were directly attributable to HIV infection(1). In the U.S., the HIV epidemic in the 1980's and 90's along with a deteriorating TB control infrastructure led to a concurrent resurgence of TB incidence rates (2). Improved TB control programs and enhanced HIV treatment and prevention helped reverse the upward TB trend among the US-born population. However, among the foreign-born population, this decrease has occurred at a much slower rate (3).

In 2010, incidence rates of TB were the lowest they have been in the United States since national reporting started in 1953; however, foreign-born made up 60.5% (6,707) of the cases of TB in 2010 among individuals with a reported country of birth. The TB incidence rate among foreign born was 18.1 per 100,000 population TB compared to a rate of 1.6 cases per 100,000 population among US-born. Foreign-born from Mexico accounted for 23% (1,539) of all TB incidence among individuals born outside the United States, more than any other country of origin, and more cases of TB were reported among Hispanics than in any other race or ethnic group in the US (4).

In 2009, an analysis was conducted in San Diego County, California to determine trends in tuberculosis (TB) and HIV co-infection and to identify risk factors for TB/HIV co-infection. This investigation found that within the last decade, the TB and HIV co-infection burden decreased in non-Hispanic whites and African Americans, but remained constant in the Hispanic population. Also, the incidence of TB-HIV co-infection in San Diego County was almost double the national rate (0.87 per 100,000 population in San Diego; 0.5 per 100,000 population nationally). In San Diego, Hispanics had gone from accounting for 42% of co-infection cases in 1993 to representing 82% of cases in 2007 (5). These data indicate that current preventive measures are not benefitting the Hispanic population in San Diego County. The authors behind the study pointed out that this could be representative of what was happening in other US-Mexico border cities with large Hispanic populations, using El Paso and Texas as an example, but noted that similar analyses along the border had not been done for comparison.

A 2009 report from CDC's Division of Tuberculosis Elimination (DTBE) reported that in 2009, 17% of TB cases in Texas were co-infected with HIV (6). The same report shows that among foreign born TB cases in Texas, nearly 50% were born in Mexico. Data from the Texas Department of State of Health Services shows that 78.4% of TB cases in border counties are foreign born (7, 8). According to estimates based on census data from 2000, 26.8% of border residents are foreign born and 94.1% of the foreign born border residents were born in Mexico (9).

**Theoretical Framework**

There is an association between foreign birth, HIV status, and TB disease in the US. This association appears to have had a disproportionate impact on Hispanic immigrant and minority populations. The trends and risk factors for TB/HIV co-infection identified by Rodwell in his analysis could indicate that TB/HIV prevention and education needs in San Diego County, a border county with a large binational Hispanic population, are not being met. The same may be true in the Texas border region, an area with some comparable demographics and migration patterns, but a similar analysis has not been conducted in Texas. Further analysis of factors associated with TB/HIV co-infection in the border region, such as population mobility and proximity to Mexico could yield insights that could result in improved TB and HIV control efforts in the border region.

**Purpose Statement**

The purpose of this investigation is to determine the proportion of TB cases in Texas with a reported HIV co-infection; to compare the odds of HIV coinfection of TB patients in the Texas border region to the odds of reported coinfection in the rest of Texas, and to characterize clinical and sociodemographic factors associated with TB/HIV co-infection present in this population. This analysis could reveal whether or not there are factors associated with TB/HIV co-infection specific to the border region of Texas when compared to the rest of the state.

**Research Objectives**

This analysis has two objectives: 1) determine if TB cases in Texas border region have higher odds of HIV co-infection and 2) characterize the clinical and socio-demographic factors associated with HIV co-infection among individuals diagnosed with active TB in Texas and in Texas counties that border Mexico.

**Significance Statement**

This inquiry will analyze data collected during tuberculosis case investigations in Texas in order to compare TB/HIV co-infection in border counties and the rest of Texas. The findings of this investigation may allow increased insight into population-specific risks in Texas that have not been previously been identified. Results will be shared with Texas PH officials to help develop recommendations for targeted public health education and screening.

**Definition of Terms**

A case of tuberculosis can be confirmed according to clinical or laboratory findings. The CDC/CSTE clinical tuberculosis case definition for tuberculosis disease refers to a person who meets all of the following criteria: has a positive tuberculin skin test or positive gamma release assay for *Mycobacterium tuberculosis*, clinical symptoms consistent with TB (abnormal chest radiographis or other imaging study, or clinical evidence of disease), treatment with two or more TB medications, AND has a completed diagnostic evaluation. Laboratory criteria for diagnosis includes: isolation of *M. tuberculosis* from a clinical specimen (smear positive) OR demonstration of *M. tuberculosis* from a clinical specimen by nucleic acid amplification test (culture positive) OR demonstration of acid-fast bacilli in a clinical specimen when a culture could be obtained, is a false negative, or contaminated(10). A confirmed TB case meets the clinical case definition or is laboratory confirmed. A case of TB may also be referred to as active TB disease which may be infectious or non-infectious.

Latent tuberculosis infection (LTBI) occurs when a patient has been exposed to the *M. tuberculosis* bacilli and develops a positive response to the tuberculin skin test, but has no clinical symptoms of TB. They are infected with inactive TB organisms that could reactivate and cause TB disease at a later date. Persons with latent TB infection have negative chest radiographs and cannot transmit TB (11).

The CDC/CSTE case definition for an adult case of human immunodeficiency virus (HIV) refers to a person greater than or equal to 13 years of age who has a positive HIV antibody screening test and a positive confirmatory supplemental HIV antibody test OR a positive result or report of detectable levels of HIV virus from the following HIV virologic tests: HIV nucleic acid detection test, HIV p24 antigen test, or HIV isolation (viral culture). Tuberculosis disease is one of 26 AIDS-defining conditions identified by CDC/CSTE. Under this designation, a person diagnosed with both confirmed HIV infection and TB disease would be considered an AIDS case (12).

For the purpose of this analysis, a case of TB/HIV co-infection includes individuals who have active tuberculosis disease according to the CDC/CSTE case definitions given, as well as a report of HIV disease (according to CDC/CSTE definition) at the time of TB reporting. In addition, individuals with active TB disease who have an HIV positive status in the data shared from Texas will be considered TB/HIV coinfection cases.

A binational TB case refers to an individual who meets either the US or Mexican case definition for active TB disease and one of the following criteria: 1) the ideal approach to case management would involve collaboration with TB control programs or healthcare providers on the opposite side of the border OR 2) the case is a contact of a binational TB case or is TB source case for contacts on the opposite side of the US-Mexico border. Binational cases are not necessarily border crossers or people living in border regions. This definition is consistent with the definition used by the Texas Department of State Health Services.

The border region of Texas includes 32 counties identified as geographic border counties by the La Paz Agreement in 1983 (Appendix A). The decision to use this definition for public health purposes is based on recommendations from Texas State Health Services personnel who are well acquainted with the health and demographic profile of Texas.

# Review of Literature

### Tuberculosis Infection and Disease

The etiologic agent for tuberculosis disease spectrum is *Mycobaceterium tuberculosis*, an acid-fast bacillus. TB is spread from person to person through aerosolized microscopic, 1-5 μm particles called droplet nuclei. The small particles can be stay aloft in an enclosed environment for a long time, and transmission mostly occurs through air (13). Transmission depends on a number of factors including the duration and environment of exposure, the infectiousness of the source case, and the susceptibility of the exposed individual. The disease is moderately contagious, with an estimated 30% risk of infection for household contacts of TB cases (11). Individuals with cavitary lesions visible on a chest radiograph or sputum smears with visible acid-fast bacilli are most infectious since these individuals have high bacterial burdens in their tissues and respiratory secretions. These bacteria can be spread to others when infectious people sing, cough, sneeze, or speak (11, 14). Contacts are most at risk of infection when they spend extended periods of time, generally days or weeks, in enclosed environments with a person with pulmonary TB disease (11). While pulmonary TB is the most common form of TB, extrapulmonary TB (EPTB) can occur in all organs and tissues. Between 1993- 2006, 19% of reported TB cases in the United States were EPTB cases, and up to 50% of TB cases in HIV patients is EPTB (15, 16). Patients with late-stage HIV infection (CD4 > 200/$mm^3$) are more likely to have extrapulmonary TB (17, 18).

In the United States, populations with an elevated risk of TB disease include persons recently infected with TB and individuals with medical conditions that weaken the immune system. Recently infected individuals include: close contacts of TB cases, the homeless, injection drug users, recent migrants to the United States from areas with high TB rates, young children with TB infection, and persons who live or work in settings where TB transmission is high, such as hospitals, long-term care facilities, correctional facilities, nursing homes, and homeless shelters. Medical conditions that increase TB disease risk by compromising the immune system include diabetes mellitus, severe kidney disease, substance abuse, organ transplant recipients, conditions requiring the use of immunosuppressent drugs, low body weight, young age, and HIV, which is the single greatest risk factor for TB disease (19). Individuals within these risk populations or with these medical conditions are generally the focus of targeted screening programs.

Common symptoms of pulmonary TB disease include prolonged cough with or without hemoptysis, fatigue, fever, night sweats, weight loss, and chest pain. Hemoptysis, the coughing up of bloody sputum, can occur when small blood vessels are ruptured in the lungs as the disease progresses. If left untreated, TB disease can permanent lung damage or death (19).

When an individual inhales the TB droplet nuclei organisms enter the lung aveoli, sub-clinical infection can occur locally as small microscopic lesions with viable TB organisms form in the lungs and then heal (19). In most healthy individuals there is an estimated lifetime risk of around 10% of developing active TB disease from an initial TB infection and, of those individuals who develop TB disease, half will develop disease within the 2 years following their initial infection (19, 20). Certain subpopulations are at greater risk of experiencing a rapid progression to TB disease, particularly young children and immunocompromised individuals(19). There is a vaccine available for TB, the Bacille Calmette-Guérin (BCG) vaccine, but its protection varies widely among populations and is not complete (21). It is generally given to protect young children against tuberculosis meningitis and disseminated (miliary) tuberculosis, the two most deadly forms of childhood TB, but its efficacy against pulmonary TB is unreliable. The BCG vaccine is not routinely given in the United States and some countries in Europe where TB rates are low. However, global BCG coverage is quite high. The WHO estimated that global vaccination coverage of BCG was 89% in 2007 and the reported BCG coverage in Mexico was 98% in 2010 (22).

**Tuberculosis Testing**

TB infection can be detecting using multiple methods. A common method of screening for TB infection is the tuberculin skin test (TST). In this test, a small measured amount of purified protein derivative (PPD) tuberculin is injected just under the skin (Mantoux method). The skin reaction at the test site read within 48-72 hours to determine if the person is infected; the reaction should be measured in millimeters of induration (swelling) at the site of the PPD injection. The interpretation of the test depends on individual factors associated with the person being tested. For example, healthy adults without known TB risk factors would need to have 15 mm or more induration in order for their TSTs to be considered positive. A TST of 5 mm or more of induration is considered positive in individuals with HIV infection or other medical conditions that compromise the immune system, close contacts with known TB cases, and patients with chest x-rays suggestive of prior TB disease. The test in individuals with other known risk factors,

such as recent immigrants from high-burden countries, injection drug users, young children and lab personnel would be considered positive with 10 mm or more of induration (23). Both false negative and false positive reactions to the TST can occur, and one of the contributing factors to a false negative test is HIV infection; individuals with HIV infection may be anergic, i.e. unresponsive to antigens used in the Mantoux test. In these individuals, the use of PPD would not produce any response even if the patient was infected with TB. In a study of hospitalized patients, 63% of the HIV positive patients were anergic (24). In addition, false positives to the TST can occur in individuals previously vaccinated with BCG vaccine or infected with non-tubercular mycobacteria (14, 25). However, previous BCG vaccination is not a contraindication to TST and a positive TST reading in someone with previous BCG vaccination is presumed to indicate LTBI (26).

In addition to the TST, there are two FDA-approved interferon-gamma release assay (IGRA) tests for identifying TB infection, the QuantiFERON ® -TB Gold In-Tube test (GFT-GIT) and the T-SPOT®.TB (27). Testing with these methods requires only one visit to a physician since testing is conducted on a blood sample and no follow-up reading is required. Another benefit of this testing is its specificity; individuals with the BCG vaccine or most non-tuberculosis mycobacteria will not test positive when using either of these IGRA tests (27). CDC recommendations allow for the use of IGRA testing in place of a TST in all situations in which TSTs would be used to diagnose TB infection. CDC further recommends that IGRA testing be used in populations that have historically low rates of return to clinics for TST readings (such as the homeless) and in persons who have received the BCG vaccine (27). In a number of studies that compared TST tests to IGRA tests, IGRAs appeared to be a viable and cost effective alternative to TST screening when used for in low-prevalence countries like the U.S. for targeted TB testing of high-risk populations such as healthcare workers, foreign born from high prevalence countries, and close contacts of TB cases (28, 29). In addition, there is evidence that IGRA tests may be useful tools for identifying extrapulmonary TB disease (30).

These tests each provide evidence that an individual is infected with tuberculosis, but none of them distinguish between infection and active disease. To diagnose active TB disease, a positive culture of *M. tuberculosis* must be obtained from tissue or secretion samples. In a suspected case of pulmonary TB, three sputum samples are collected for laboratory confirmation of the presence of TB bacilli; smears can be done on directly on clinical samples or on amplified specimens.

Samples are stained by the Ziehl-Neelsen or fluorescent techniques for acid-fast bacteria (AFB) and examined microscopically. Smears are considered positive when there are visible acid-fast bacteria, although these smears are not specific for *M. tuberculosis* since the stains will also adhere to non-tuberculosis mycobacteria. In addition, the sensitivity of the test is low; up to 50% of patients with pulmonary TB can have negative AFB smears, and HIV positive patients often have negative smears (31). For this reason, smear results alone do not allow a definitive diagnosis, but the test is a good screening tool, with results in as little as 24 hours, and an assessment of number of bacilli present in the smear gives an indication of how infectious a patient might be (26).

Nucleic acid amplification (NAA) techniques are additional testing tools that can identify TB bacilli directly from clinical specimens without the need for culture. Culture takes longer than the other means of testing; depending on whether liquid or solid media is used it can take between 1-8 weeks to detect mycobacterial growth (32). In patients with suspect TB, NAA testing produces results in 24-48 hours. In addition, NAA tests have a positive predictive value (PPV) of >95% in individuals with AFB positive smears and a PPV 50%-80% in individuals with AFB negative smears. CDC considers a specimen that is smear- and NAA-positive to be a confirmed case of TB, but TB diagnosis cannot be ruled out solely on the basis of a negative NAA test (32). The gold standard in tuberculosis diagnostics remains culturing samples, and cultures should be done for any suspected case of tuberculosis. Cultures are also necessary for drug-susceptibility testing, speciation, and genotyping, all of which should be done to determine the best treatment course for a particular patient. If a patient has positive cultures, they are considered a confirmed active case of TB. In patients with extrapulmonary TB, diagnosis is more challenging. It may be difficult to obtain specimens of suspected TB disease from some sites in the body and specimens may lack adequate bacilli for testing (16). In individuals with EPTB, NAA testing may offer improved diagnostic capabilities for physicians when combined with clinical evaluation (16).

**Treating Latent Tuberculosis**

When an individual is diagnosed with latent TB infection, treatment is recommended to eliminate the infection and to prevent future progression to TB disease. Without treatment, TB infection could eventually lead to TB disease in around 10% of healthy adults (immunocompromised subgroups have higher risk of progression to TB disease). There are multiple recommended treatment regimens for individuals with LTBI; the preferred regimen consists of 9 months of daily

doses of isoniazid (INH) which is suitable for both HIV positive and negative individuals. Alternative treatments include different durations of treatment with INH and the use of other drugs, i.e. rifampin, and rifampin combined with pyrazinamide, and different durations of treatment, though the shortest treatment duration lasts at least two months. Non-INH-based treatments have unproven efficacy, may be more toxic, and are administered in the setting of INH resistance or intolerance. Some TB treatments can be administered concurrently with HIV treatments. However, treatment of TB/HIV co-infected patients is complicated and requires oversight of a healthcare provider throughout the treatment regimen to ensure patient compliance with treatment and to prevent dangerous drug interactions or side effects to treatment (33).

**Treating Tuberculosis Disease**

Treatment for tuberculosis disease is more complicated and consists of two phases; first, the initial phase that lasts around 8 weeks during which patients take a combination of 3-4 drugs. After this, patients enter the continuation phase where they continue taking two of the initial drugs. There are several regimens made up of different drugs or different dosing schedules, but most still involve multiple doses of the drugs each week. The continuation phase can last between 18 and 31 weeks. Lapses in drug treatment can lead to the development of drug resistant TB disease which is more difficult to treat. Due to the long duration of TB treatment, the need to prevent treatment interruptions and the need to monitor patients for potential side effects from drug toxicity, directly observed therapy (DOT) is recommended for all TB patients. In this form of treatment, healthcare practitioners watch TB patients take their doses of TB medications. This method improves treatment adherence and allows healthcare workers to assess patients for signs of adverse drug reactions, treatment failure, or non-compliance (34). Non-compliance with TB treatment is associated with an increased likelihood of the development of multi-drug resistant (MDR) TB which is more difficult and costly to treat (35). Treatment of TB in HIV patients is even more complicated and must be monitored closely to prevent drug interactions and to monitor events of immune reconstitution inflammatory syndrome (IRIS), an initial worsening of TB symptoms in patients whose immune systems return after HIV (36).

**Testing for HIV Co-infection**

In 2006 CDC released its latest guidelines on HIV testing in a healthcare setting. These guidelines recommend HIV testing become a routine part of all clinical care, including for patients being seen in a TB clinic. Under these new guidelines, all TB patients with unknown

HIV status should receive HIV testing when they enter the TB clinic unless they explicitly opt-out of testing (33). CDC guidelines also recommend that all HIV patients, regardless of risk, receive TB testing upon their HIV diagnosis. In addition, the guidelines recommend that HIV patients be tested annually for TB infection if they are at increased risk of exposure to active TB due to occupational, lifestyle, or demographic factors. The rationale behind these recommendations is to identify and treat TB infection in HIV patients since this population is at particular risk of progression to TB disease; and to identify TB disease as early as possible to improve treatment outcomes (36, 37).

**TB/HIV Syndemic**

Screening HIV patients for TB infection and disease is necessary to control the TB/HIV syndemic that has resulted in a global increase in the burden of TB and significant morbidity and mortality. Syndemics are synergistic interactions between two or more diseases that results in an excess burden of disease in a population. HIV impairs the cell-medicated immune system of its host, which contributes to an increase in individuals in the population susceptible to TB infection. HIV accelerates the progression of TB infection to TB disease; TB disease likewise speeds the progression of HIV to AIDs (17, 37, 38). Among individuals with HIV, the lifetime risk of TB disease increases considerably. Individuals without HIV infection have an estimated 10% lifetime risk of developing TB disease; among people infected with HIV the estimated annual risk of developing TB disease is 5-10% (39).

In the United States, an estimated 26% of TB cases are attributable to HIV infection, higher than the estimated attributable risk in other industrialized countries, even those countries that have higher prevalence of both TB and HIV infection. This is likely due to the fact that HIV and TB infection tend to concentrate within the same high-risk subgroups in low-prevalence countries like the U.S., disproportionately affecting these populations (1). Groups particularly at risk of TB/HIV co-infection in the U.S.-Mexico border region include drug-abusers and the homeless (40). A study in Alameda County, California calculated that 93% of the incident TB cases among HIV positive individuals were attributable to HIV infection (41). Testing TB patients for HIV and HIV patients for TB are key steps to controlling the TB/HIV syndemic in the United States; routine testing can identify TB infection early, before it progresses to disease; and the disease can be treated to prevent progression and spread throughout vulnerable populations like HIV patients.

**TB/HIV and the U.S. Mexico Border**

The 100 km wide area on either side of the border between the United States and Mexico is a unique region with distinct characteristics differing from the non-border regions of the United States and Mexico. Poverty, strained infrastructure, social problems, lack of insurance and affordable healthcare, and movement back and forth across the border are all factors that may contribute to the higher incidence of a number of infectious diseases in the border region compared to non-border regions of both the U.S. and Mexico (5, 42). Poverty rates are higher in U.S. side the border region, and the population is highly mobile, moving back and forth between the two countries for work, school, family and healthcare, compared to non-border regions of the United States. In addition, the population on the U.S. side of the border region has increased significantly in the past decade, causing strain on the infrastructure of the border region, including healthcare resources (9, 43, 44). In a 2010 report from the Border Health Commission, Texas border counties had the lowest ratio of health providers per 100,000 population of any of the other borders states; the ratio of health professions in Texas border counties was less than half the ratio for the U.S. (9). Drug use and prostitution are also significant problems along the border since numerous drug and human trafficking routes run through this region from South and Central America and the interior of Mexico to the United States (45). While free TB treatment and HIV testing are readily available in both Mexico and the United States, undocumented residents living in the U.S. border region face challenges to accessing affordable healthcare in the United States and may avoid seeking testing or care for disease for fear of deportation (45). The deportation of migrants back to Mexico often results in populations of homeless migrants living in Mexican border cities; these populations are more likely to engage in HIV-related risk behaviors (45, 46).

Mobility back and forth across the border likely plays a significant role in infectious disease transmission in the region. In one study that compared characteristics of foreign born Hispanic TB patients who lived in U.S. border counties to Hispanic TB patients not living in border counties, Mexican-born border TB patients were significantly more likely to return to Mexico, and more likely to have visited Mexico within the 12 months prior to their TB diagnosis. In addition, more than a third of the border-county TB patients traveled into Mexico on a daily or weekly basis (44). Another study conducted in Texas comparing mobile to non-mobile border dwellers on the U.S. side of the border found that 20% of the population crossed the border at least once a week, and 30% of the population crossed the border at least once a month. Of the population identified as mobile, 62.3% said they were crossing the border for medical care or

supplies. Mobile border residents had a lower socio-economic than non-mobile border residents (47). In a telephone survey conducted in El Paso County, Texas found that 27% of the respondents reported crossing the border in the previous two years for some kind of health care (43). Health insurance coverage is low among foreign born Hispanics in the border region is particularly low compared to other populations; 62% lack health insurance coverage (48).

Deportation is another factor associated with increased occurrence of TB and HIV risk behaviors(45). Undocumented migrants apprehended by law enforcement in the U.S. are often repatriated across the border to cities like Tijuana and Ciudad Juarez with few resources; these migrants often opt to stay in these areas to make a later attempt to return to the United States (45). Repatriation of Mexican migrants to cities on the Mexican side of the border has been linked to increased HIV risk behaviors and transmission; in one study, male injection drug users who were deported from the United States had four times the odds of HIV infection than male IDUs without a history of deportation (49). Repatriation may also be associated with increased odds of TB infection; in another study on TB in injection drug users in Tijuana, individuals with a self-reported TB history were significantly more likely to have been deported from the United States than those without TB. In addition, individuals with TB history were six times more likely to have traveled to the United States than those without a history of TB (50).

The United States immigration policies may play a role in this relationship between deportation and TB; when undocumented migrants are detained in U.S. Immigration and Customs Enforcement (ICE) detention facilities they are screened for TB. ICE procedures focus on law enforcement as opposed to public health practices, and detainees may be deported before the results of their TB test are received, their TB treatment can be completed or continuity of care measures are arranged with Mexico. ICE is legally mandated to repatriate migrants within 3 months of their apprehension, an insufficient time to ensure TB treatment is completed. Public health authorities may request an ICE stay-of-removal consideration to ensure treatment completion in special situations, but this is difficult to carry out. (Personal communication, July 2012) In addition, residence in a detention center is a risk factor for tuberculosis, so detainees who may not have had prior TB disease may be exposed to TB disease while in detention (51). Texas county public health offices might receive a report of a TB case in a detainee only to find that the detainee was deported back to Mexico and lost to follow-up; these detainees may never find out they have TB disease (Personal communication, July 2012). This issue was cited as a

significant challenge for TB case management in the U.S.-Mexico border region by the Texas State TB Control Program Manager at the 2010 U.S.-México Border Tuberculosis Consortium (52).

In 2010, the reported incidence rate of TB in the United States was 4.1 per 100,000; prevalence was 4.8 per 100,000. In Mexico, the reported 2010 TB incidence and prevalence were 16 and 18 per 100,000, respectively. Incidence of TB co-infection in HIV positive individuals is more than twice as high in Mexico compared to the United States. In 2010, TB incidence in HIV positive individuals in Mexico was 0.81 per 100,000; in the United States it was 0.36/100,000 (53, 54). In 2010, in the U.S. more cases of TB were reported among Mexican-born than any other country of origin; 23% of foreign born TB cases were born in Mexico(55). In 2010 the TB incidence rate (9.9/100,000) for the Texas border region, with its highly mobile population and significant Mexican-born population, was almost twice as high as the TB incidence rate for the state of Texas (5.5/100,000)(56). In Mexico, screening for TB infection in populations at high risk of TB/HIV co-infection is uncommon, and the use of IGRA testing has been recommended over the use of TST in Mexico because the population's high BCG coverage that makes TST less useful at distinguishing true TB infection (40, 57).

While the reported incidence and prevalence of TB are higher in Mexico than in the U.S., the converse is true for HIV (53, 54, 58). According to the 2010 UNAIDS Global Report, Mexico is considered a low prevalence country for HIV (prevalence = 0.3%); the United States has twice the estimated prevalence of HIV infection as Mexico (0.6%) (58). However, there is ample evidence that subepidemics exist in regions and populations of Mexico where higher rates of HIV risk behaviors such as intravenous drug use and sex work take place and overlap (45, 49, 59-62). In Ciudad Juarez and Tijuana, the large Mexican border cities directly across from El Paso and San Diego, the prevalence of HIV are among the highest in Mexico, particularly in injecting drug users, men who have sex with men (MSMs), female sex workers, and female sex workers using injection drugs (45, 61). In a study that examined HIV prevalence in Tijuana and Ciudad Juarez, 2.8% of the IDUs tested in both cities were HIV positive (59).

Though TB and HIV prevalence in the U.S. and Mexico are both fairly low compared with burden of these diseases in other regions of the world, in countries with low prevalence of TB and HIV, subpopulations such as the homeless and drug users are at increased risk of TB/HIV

coinfection (40). A recent study found that the prevalence of TB infection, HIV infection, and TB/HIV coinfection in high-risk populations (injecting drug users, non-injecting drug users, prostitutes, and homeless) in Tijuana, Mexico was 57%, 4.2% and 2.2%, respectively (40). These prevalences were higher than those reported for the rest of the state and country, and indicate that there is an unmet need to provide screening to identify TB infections earlier in these high risk populations (63). In addition, there is evidence that this HIV sub-epidemic in high-risk populations has spilled over into the general public; in a 2006 study on women delivering infants at Tijuana General Hospital, 1.12% of screened labor/delivery patients were HIV positive, a higher proportion than previously established estimates in Mexico (64). In the United States there is evidence that the TB/HIV co-infection is disproportionately affecting Hispanics in the U.S.-Mexico border region; an analysis of co-infection in San Diego indicated that TB/HIV co-infection rates in all populations except for Hispanics had decreased between 1993-2007; co-infection rates among Hispanics did not change over the same time period. The majority of new TB/HIV cases in San Diego currently occur in Hispanics born in Mexico (5).

These statistics paint a picture of a region on either side of the border that is vulnerable to the TB/HIV syndemic. The higher HIV prevalence on the US side of the border, coupled with the higher prevalence of TB in Mexico, high level of cross-border mobility, vulnerability of populations on both sides of the border, and presence of HIV subepidemics in high-risk populations on the Mexican side of the border combine to create conditions that could theoretically contribute to the TB/HIV syndemic in the border region of Texas. Are individuals living in the border region of Texas more likely to have HIV infection alongside TB disease than non-border residents of Texas?

# Methods

### Population and Sample

This analysis used data obtained from Texas Department of State Health Services (DSHS). Active tuberculosis disease is a nationally reportable disease in the United States and case reporting of TB is required by law in Texas. When a suspected case of tuberculosis is identified in the state, local public health agencies use the standard, statewide forms (Texas 400A and 400B, Appendix B) to collect demographic and clinical data from the patient, including HIV status and other known TB risk factors. Texas currently uses the NEDSS Base System (NBS) Tuberculosis

Program Area Module (TB PAM) as its data management and reporting system for TB data. The TB PAM system permits direct reporting of TB cases in Texas to CDC.

Data collected prior to 2009 were stored in the Tuberculosis Information Management System (TIMS), a national surveillance and case management software application system that is no longer in use. A request was made to the Texas DSHS for access to the records for all confirmed cases of TB disease captured in either the TIMS or TB PAM databases between January 2000 and December 2010. When the request was granted, the Texas DSHS data manager merged datasets from both the TIMS and TB PAM databases to align the common variables from the two datasets and create a complete dataset for the appropriate time period. The data was shared with investigators after personal identifiers such as names, social security numbers, specific addresses, and case ID numbers were removed.

The population for this investigation includes all confirmed cases of TB disease according to the official CDC case definition that were reported in Texas between January 1, 2000 and December 31, 2010 in individuals 18 years or older at time of report (n=15,430). Tuberculosis cases included in this analysis had to be confirmed by laboratory, or by clinical provider diagnosis. This population does not include individuals with latent TB infection. Individuals were identified as co-infected if they had a 'Positive' HIV status in the TB case dataset shared by Texas.

In 2007, HIV testing of TB cases in Texas became standard and the majority of TB cases were referred for HIV testing; however, HIV testing for TB cases is not mandatory and TB patients may refuse testing. HIV status is captured as positive, negative, indeterminate, not offered, refused, unknown and missing in the database. For the purposes of this analysis, individuals with indeterminate, not offer, refused, unknown and missing HIV status were combined into a single 'Unknown' category and were not included in the multivariable analysis, though it is likely that this category included some co-infection cases. The final population for this analysis consisted of 11,282 reported cases of tuberculosis.

**Research Design**

Because the source of the data used in this analysis is reports from a TB program, the population and medical risk factor data collected primarily includes variables known to be associated with TB disease, not HIV disease, though there is some overlap in the risk factors and risk populations

for both diseases. Demographic variables included gender, race, ethnicity, age, county where case was reported, country of birth, and length of time in the US. Smaller ethnic groups ('Multi-racial,' 'Other,' 'American Indian or Alaskan Native,' 'Native Hawaiian or Other Pacific Islander' and 'Unknown') were also excluded from the analysis; each excluded race category had less than 35 records total (78 records were removed in total). TB risk factors included homelessness, drug and alcohol abuse, and residence in a prison or long-term care facility within the 12 months prior to TB diagnosis. These variables were coded as 'yes,' or 'no.' Employment status was coded as 'unemployed' or 'employed.' Individuals with unknown employment status (n=4) were excluded from the analysis. Year of diagnosis was included as well as clinical information on the site of TB disease, coded 'pulmonary,' 'extrapulmonary,' and 'both.'

**Data Analysis**

All analyses were performed using SAS software, Version 9.2/3 of the SAS System for Windows. Frequencies were calculated to describe the demographic characteristics of the study population. For the purposes of this analysis, HIV status was the outcome of interest, and border region residence, determined by county of disease report, was the exposure of interest. Chi-square tests from univariate analyses were used to identify factors significantly related to HIV infection for later inclusion in the multivariable models. Two-sided statistical tests were considered significant at $P < 0.05$.

Bivariate logistic regression identified significant ($P < 0.05$) effect modifiers in the relationship between border residence and HIV infection among reported TB cases. Effect modification was assessed using the Breslow-Day test for interaction; if the test had a p-value less than 0.05 the test was considered significant and the variable was included in the multivariable model as an interaction term. Multivariable logistic regression models were developed using backward elimination of terms; independent variables in the model included interaction terms identified from the bivariate analysis and all other variables assessed in the initial modeling. Confounding was assessed in the multivariable model by comparing the gold standard OR (from the multivariable model that included all variables but no non-significant interaction terms) to the OR obtained after dropping potential confounders that were not statistically significant predictors of the outcome, controlling for all remaining variables in the model. A variable was considered a confounder if removing it from the model resulted in a 10% or larger difference in the subsequent model's OR compared to the gold standard OR. The Hosmer-Lemeshow test for goodness of fit

was used to evaluate the model's fit. The final model was also run using the PROC GENMOD procedure in SAS to estimate the prevalence ratio to evaluate how accurately the odds ratio produced by the logistic regression model assessed the association between exposure and outcome. Output from the multivariable regression modeling is included in Appendix D.
This project was submitted to the Emory University Institution Review Board (IRB) for clearance as well as the Centers for Disease Control and Prevention IRB. Both reviews approved this project and returned a non-research determination.

**Limitations**

The data used in this analysis is cross-sectional in nature, so it is impossible to draw conclusions about whether HIV infection preceded TB infection. Individuals who may have been diagnosed with HIV infection prior to their TB diagnosis may not disclose their HIV infection to TB staff and can refuse testing, so their HIV status would remain unknown in the TB reporting. As a result, an unknown quantity of co-infection cases may not have been captured through the TB surveillance data alone, so these data do not represent all cases of TB/HIV co-infection in Texas.

This analysis uses data collected over 10 years of the Texas TB surveillance program. During that time period TB testing protocol, case definition, the Texas reporting system and the variables it collects, and HIV testing recommendations for TB patients took place. Changes in how TB cases foreign-born and foreign visitor TB cases could be counted by a reporting jurisdiction also changed; both of these of these categories would likely have an impact on the border region compared to other areas of the United States with a less mobile foreign-born population or fewer foreign visitors receiving treatment for TB (65).

**Delimitations**

This analysis was limited to individuals 18 years of age and older. A significant proportion of the TB cases (26.3%) were excluded from the analysis due to unknown HIV status. In addition, not all variables of interest were routinely collected or reported through the TB reporting system for every TB case and some of those cases were excluded from the multivariable analysis. A number of variables that are particularly interesting in the context of studying TB infection in the border, including variables designating a case a binational case or capturing visa status upon arrival to the U.S., were rarely collected and could not be included in this analysis. These factors all limit the conclusions that can be drawn from the study. Specifically, data on the HIV status of

TB patients should be interpreted with caution because these data are not representative of all TB/HIV co-infection cases for the state of Texas.

## Results

### Demographics

There were total of 16,895 reported cases of TB in Texas between January 1, 2000, and December 31, 2010, with 15,430 cases of TB disease reported in individuals 18 years or older. Of these cases, 1,618 (10.49%) of the cases were co-infected with HIV disease, and 4,063 (26.3%) cases did not have a known HIV status; the remaining reports were HIV negative. The border region had a lower proportion of TB cases with an unknown HIV status; this was true for all races and ethnicities. The cases with unknown HIV status were excluded from further analyses resulting in a total of 11,282 reported cases of TB.

Of the reported cases of TB disease included in the analysis, 1,604 (14.22%) cases were HIV positive (Table 1). Of all TB patients, 2,105 (18.66%) were reported from counties in the border region of Texas. Slightly more than half of Texas TB cases included in this analysis were Hispanic (5,755, 51.01%). There were nearly equal numbers of foreign born (5,599, 49.63%) and native (5,527, 50.37%) TB cases.

HIV prevalence was lower among border county residents (7.22%) than among non-border residents (15.80%). In the state of Texas, HIV prevalence was greatest among individuals between the ages of 30-39 (23.63%) and 40-49 (20.85%), and higher in men than women (16.15% vs. 9.85%). Prevalence of HIV was also lower in Hispanics (10.31%) compared to non-Hispanics (17.97%), and African Americans (26.99%) had the highest HIV prevalence compared to Asians (3.52%) and whites (10.90%). HIV prevalence was also higher in foreign born, injection drug users, non-injection drug users, the homeless, and individuals with extrapulmonary TB.

### Trends

Over the ten year time period, the proportion of each race and ethnic group with unknown HIV status decreased (Figures 2-6, Appendix C). African-Americans consistently had the lowest proportion of unknown HIV status, but over the period of this analysis the proportion of unknown

decreased from 19.76% to 13.3%. Hispanics had one of the largest decreases in the proportion of unknown HIV status; this population began the decade with 30.77% of the population reporting an unknown status; by 2010 down to 20.96% of Hispanics diagnosed with TB had an unknown HIV status. This proportion was lower than non-Hispanics with unknown HIV test results in 2010 (24.01%). Asians had this highest proportion of TB cases with unknown HIV status; 40.85% of this population had unknown HIV status in 2000. In 2010, the proportion of TB cases in Asians with unknown HIV status had decreased to 31.84%, but that was still the highest proportion of unknowns compared to all other race and ethnic groups.

**Multivariable Regression**

The bivariate analysis identified five potential interactions (Breslow-Day Test for interaction p-value was less than or equal to 0.05) with border residence: foreign birth, excess alcohol consumption in the past 24 months, length of time in the United States, correctional facility residence at time of diagnosis, and location of TB (pulmonary, extrapulmonary, or both). These interaction terms were included in the final multivariable model but none retained their significance and they were all dropped. After the interaction terms were dropped from the model, the remaining variables in the model were assessed for confounding using the technique described in the methods section; none of the variables removed from the model were confounders but the decision was made to report the results of the 'gold standard' model that contained all non-interaction terms. Most of the variables included in the model were frequently reported in the literature as being related to TB/HIV coinfection and were of interest in this analysis.

When controlling for the variables listed in Table 3 in a multivariable logistic regression model, a case of TB/HIV co-infection was less likely to be reported in the Texas border region (AOR 0.63; 95% CI: 0.511,0.776) (Table 2). In addition, a case of TB/HIV co-infection in Texas was more likely to be male (AOR 2.24; 95% CI:1.94, 2.59), African-American (AOR 2.04; 95% CI: 1.705, 2.441), and unemployed (AOR 1.98; 95% CI: 1.74, 2.24). Age was significantly associated with co-infection, with HIV positive cases most likely to be between 30 and 30 years old (AOR 12.68; 95% CI: 8.87, 18.15). Foreign birth, length of time in the US, and Hispanic ethnicity were not significantly associated with increased or decreased likelihood of HIV co-infection among TB patients in Texas.

The sole clinical variable included in the analysis, location of TB infection, was significant; cases TB/HIV co-infection were more likely to have extrapulmonary TB (AOR 2.45; 95% CI 2.12, 2.82) or both extrapulmonary and pulmonary TB (AOR 3.36; 95% CI 2.76, 4.09).

Among risk factors associated with HIV and TB, injection drug use was significantly associated with HIV co-infection in TB patients (AOR 2.37; 95% CI 1.83, 3.07). Non-injection drug users were also more likely to have HIV (AOR 1.59; 95% CI1.32, 1.91) than non-drug users. Correctional facility residents and heavy alcohol users were less likely to have a positive HIV test than people not reporting these risk factors in Texas. Long term care facility residence and homelessness were not associated with co-infection with HIV when controlling for all other variables.

The Hosmer-Lemeshow test for goodness of fit indicated a good fit ($x^2$=7.56, 8 d.f., p=0.48). In addition, the border prevalence ratio estimated from fitting the same model using PROC GENMOD indicated that the OR from the logistic regression did not overstate the association between border residence and HIV co-infection among TB patients (PR 0.63; 95% CI 0.51, 0.78).

**Table 1. Characteristics of Reported TB Cases and Prevalence of HIV by Characteristic Among TB Cases, Texas, 2000-2010.***

| Characteristic | TB Cases | | HIV Prevalence | |
|---|---|---|---|---|
| | n=11,282 | % | n=1604 | 14.22% |
| **HIV Status** | | | | |
| **Positive** | 1604 | *14.22* | - | - |
| **Negative** | 9678 | *85.78* | - | - |
| **Border County Resident** | | | | |
| **Yes** | 2105 | *18.66* | 152 | *7.22* |
| **No** | 9177 | *81.34* | 1452 | *15.80* |
| **Age at Diagnosis** | | | | |
| **18-29** | 2384 | *21.13* | 200 | *8.38* |
| **30-39** | 2374 | *21.04* | 562 | *23.63* |
| **40-49** | 2592 | *22.97* | 541 | *20.85* |
| **50-64** | 2660 | *23.58* | 264 | *9.92* |
| **65+** | 1272 | *11.27* | 37 | *2.91* |
| **Sex** | | | | |
| **Female** | 3453 | *30.61* | 340 | *9.85* |
| **Male** | 7829 | *69.39* | 1264 | *16.15* |
| **Ethnicity** | | | | |
| **Hispanic** | 5755 | *51.01* | 570 | *10.31* |
| **Non-Hispanic** | 5527 | *48.99* | 1034 | *17.97* |
| **Race** | | | | |
| **Asian** | 1250 | *11.08* | 44 | *3.52* |
| **African American** | 2897 | *25.68* | 782 | *26.99* |
| **White** | 7135 | *63.24* | 778 | *10.90* |
| **Foreign Born** | | | | |
| **Yes** | 5599 | *49.63* | 566 | *9.96* |
| **No** | 5683 | *50.37* | 1038 | *18.54* |
| **Length of Time in the US (n=5683)** | | | | |
| **<1 year** | 1014 | *9.01* | 97 | *9.57* |
| **1-4 years** | 1375 | *12.21* | 142 | *10.33* |
| **5-9 years** | 857 | *7.61* | 93 | *10.85* |
| **10-19 years** | 1100 | *9.77* | 112 | *10.18* |
| **20+ years** | 1313 | *11.66* | 117 | *8.91* |
| ***missing*** | 24 | | | |
| **Year of Diagnosis** | | | | |
| **2000** | 943 | *8.36* | 154 | *16.33* |
| **2001** | 973 | *8.62* | 169 | *17.37* |
| **2002** | 918 | *8.14* | 184 | *20.04* |
| **2003** | 980 | *8.69* | 163 | *16.63* |
| **2004** | 1136 | *10.07* | 144 | *12.68* |
| **2005** | 989 | *8.77* | 132 | *13.35* |
| **2006** | 1067 | *9.46* | 157 | *14.71* |
| **2007** | 1129 | *10.01* | 143 | *12.67* |
| **2008** | 1162 | *10.3* | 137 | *11.79* |
| **2009** | 1045 | *9.26* | 121 | *11.58* |
| **2010** | 940 | *8.33* | 100 | *10.64* |
| **Injection Drug Use**** | | | | |
| **Yes** | 371 | *3.29* | 126 | *33.96* |
| **No** | 10911 | *96.71* | 1478 | *13.55* |
| **Non Injection Drug Use**** | | | | |
| **Yes** | 1055 | *9.35* | 248 | *23.51* |
| **No** | 10227 | *90.65* | 1356 | *13.26* |
| **Excessive Alcohol Use**** | | | | |
| **Yes** | 2555 | *22.65* | 367 | *14.36* |
| **No** | 8727 | *77.35* | 1237 | *14.17* |
| **Homeless**** | | | | |
| **Yes** | 728 | *6.45* | 158 | *21.70* |
| **No** | 10554 | *93.55* | 1446 | *13.70* |

| | | | | |
|---|---|---|---|---|
| **Correctional facility resident†** | | | | |
| **Yes** | 1146 | *10.17* | 162 | *14.14* |
| **No** | 10122 | *89.83* | 1440 | *14.21* |
| ***missing*** | *14* | | | |
| **Long Term Care Facility Resident†** | | | | |
| **Yes** | 186 | *1.69* | 33 | *17.74* |
| **No** | 10841 | *98.31* | 1551 | *14.31* |
| ***missing*** | *255* | | | |
| **Employment**** | | | | |
| **Employed** | 4951 | *43.88* | 1052 | *16.62* |
| **Not Employed** | 6331 | *56.12* | 552 | *11.15* |
| **TB Location** | | | | |
| **Pulmonary** | 8589 | *76.13* | 964 | *11.22* |
| **Extrapulmonary** | 1967 | *17.43* | 439 | *22.32* |
| **Both** | 726 | *6.44* | 201 | *27.69* |

*Excludes TB case reports with unknown HIV status

**Engaged in this risk behavior in the 24 months prior to TB diagnosis

†At time of diagnosis

**Table 2. Final Full Model - Adjusted Odds of HIV among TB Cases in Texas with Known HIV Status, 2000-2010 (n=10,989*).**

| Characteristic | Adjusted Prevalence Odds Ratio | 95% Confidence Intervals | | p-value |
|---|---|---|---|---|
| Border | | | | |
| Yes | 0.63 | 0.51 | 0.78 | <0.01 |
| No | ref | | | |
| Foreign born | | | | |
| Yes | 1.23 | 0.97 | 1.58 | 0.09 |
| No | ref | | | |
| Ethnicity | | | | |
| Hispanic | 0.83 | 0.67 | 1.03 | 0.09 |
| Non-Hispanic | ref | | | |
| Race | | | | |
| Asian | 0.21 | 0.15 | 0.31 | <0.01 |
| Black | 2.04 | 1.71 | 2.44 | <0.01 |
| White | ref | | | |
| Sex | | | | |
| Female | ref | | | |
| Male | 2.24 | 1.94 | 2.59 | <0.01 |
| Age | | | | |
| 18-29 | 3.74 | 2.56 | 5.45 | <0.01 |
| 30-39 | 12.68 | 8.87 | 18.15 | <0.01 |
| 40-49 | 8.94 | 6.27 | 12.77 | <0.01 |
| 50-64 | 3.65 | 2.54 | 5.25 | <0.01 |
| 65+ | ref | | | |
| Length of Time in the US | | | | |
| <1 year | 0.79 | 0.57 | 1.09 | 0.15 |
| 1-4 years | 0.78 | 0.58 | 1.04 | 0.09 |
| 5-9 years | 0.87 | 0.64 | 1.20 | 0.40 |
| 10-19 years | 0.83 | 0.61 | 1.11 | 0.20 |
| 20+ years | ref | | | |
| Injection Drug Use** | | | | |
| Yes | 2.37 | 1.83 | 3.07 | <0.01 |
| No | ref | | | |
| Non-Injection Drug Use** | | | | |
| Yes | 1.59 | 1.32 | 1.91 | <0.01 |
| No | ref | | | |
| Excessive Alcohol Use** | | | | |
| Yes | 0.65 | 0.56 | 0.76 | <0.01 |
| No | ref | | | |
| Homeless† | | | | |
| Yes | 0.93 | 0.75 | 1.16 | 0.53 |
| No | ref | | | |
| Correctional facility resident† | | | | |
| Yes | 0.71 | 0.58 | 0.89 | <0.01 |
| No | ref | | | |
| Long Term Care Facility Resident† | | | | |
| Yes | 1.15 | 0.74 | 1.78 | 0.55 |
| No | ref | | | |
| Location | | | | |
| Extrapulmonary | 2.45 | 2.12 | 2.82 | <0.01 |
| Both | 3.36 | 2.76 | 4.09 | <0.01 |
| Pulmonary | ref | | | |
| Employment† | | | | |
| Not Employed | 1.98 | 1.74 | 2.24 | <0.01 |
| Employed | ref | | | |

*Number of observations (records) included in this model

**Engaged in this risk behavior in the 24 months prior to TB diagnosis

†At time of diagnosis

## Discussion

This analysis sought to compare the likelihood of prevalent HIV infection in TB cases reported in the U.S.-Mexico border region of Texas to non-border regions of Texas, controlling for common TB risk factors. The objective of making this comparison was to determine if the residence in unique environment of the U.S-Mexico border region contributes to increased odds of HIV co-infection. The population assessed for this analysis included all TB cases reported in Texas between 2000 and 2010. These data only include HIV infection reported in the context of the Texas Department of State Health Service's TB reporting program; cases of HIV reported through ongoing HIV surveillance and data collection in Texas were not included in the analysis.

**Conclusions**

The results of this analysis indicate that HIV infection in TB patients is less likely to be reported in the 32 border counties of Texas when compared with TB reporting in the rest of the state. In addition, Hispanics were no more likely to have HIV co-infection when compared to non-Hispanics. Foreign birth was also not significantly associated with HIV infection.

Almost 50% of all the TB and HIV co-infection cases reported for this 10 year span of data were reported in African-Americans (48.27%) even though they make up a smaller proportion of the Texas population (12%) than Hispanics (38%) or Non-Hispanic whites (44.8%) (66). African-Americans were also disproportionately affected by TB in Texas; African-Americans made up 23.1% of reported TB cases over the 10 year period. While Hispanics had lower odds of HIV than non-Hispanics, they are disproportionately affected by TB, making up 48.3% of TB cases during the same period.

The decision to leave the unknown HIV status population out of this analysis was a potential source of bias. The population with unknown status likely contained a combination of HIV positive and negative TB cases; the proportion of HIV positive TB cases among the unknowns likely changed over the ten year time period as testing recommendations and practices changed and HIV testing became more consistent in the general population. The different proportions of unknown HIV status between the various race/ethnic groups indicates that TB programs in Texas may either not offer HIV testing to some populations as frequently as others, and/or that HIV testing acceptability is lower among some populations compared to others. While the proportion of all race and ethnic groups with unknown HIV status decreased over the time period, there were

still fairly large proportions of Asians (over 30%), whites (~24%), and Hispanics (~21%) who had unknown HIV status, particularly in non-border regions of Texas. However, this could also be an issue of reporting; individuals may be getting tested for HIV, but reporting of HIV testing results through the TB reporting system may be incomplete.

In the case of Texas's border population, border residence may be protective against HIV infection, possibly because the close proximity to Mexico could facilitate more frequent travel to Mexico to see family and seek healthcare. A number of studies of migrant populations in the United States note that HIV risk is high for migrants to the United States compared to non-migrants in Mexico for many reasons – the U.S. has a higher HIV prevalence compared to Mexico, many migrants lack of access to healthcare and HIV testing, the social isolation of migration contributes to increased HIV risk behaviors such as use of male sexual partners, greater number of sexual partners, prostitution, and drug use (67-69). Migrants living in the border may not have as many of these risk factors because they are less isolated from family and protective cultural factors; frequent travel to visit family may be reduce some of the risk behaviors associated with HIV transmission. In addition, those migrants who are able to travel back and forth between the U.S. and Mexico likely represent migrants who have documents and are less vulnerable than undocumented migrants. At the same time, frequent visits to Mexico may also increase migrants' risk of exposure to TB infection.

There is extensive information and research reported in the literature on both TB and HIV in high-risk populations in Tijuana and San Diego. Less information is available in the literature on Ciudad Juarez and other border cities, and very little is present in the literature on the TB/HIV syndemic along other areas along the nearly 2,000 mile long U.S.-Mexico border. While much of the border runs through rural areas with extremely low population, there are still many cross-border sister cities throughout the region that have dynamic populations and may be host to the same risk factors for TB and HIV as those documented in the larger, well-studied cross-border metropolitan areas. In addition, traditional high risk groups for TB and HIV have been fairly well studied (sex workers, MSMs, IDUs) but less information is available on the TB/HIV syndemic in the general border population beyond these traditional risk groups. One of the few studies that looked at a non-high risk population (pregnant and delivering women in a Tijuana hospital) indicated that HIV prevalence was higher in that population that previously estimated (62). In a study of reported TB cases in San Diego, evidence that HIV co-infection disproportionately affects the general Hispanic population is another indication that the broader border population is

at increased risk from the TB/HIV syndemic (5), though the conclusions from this analysis did not find that Hispanic or border resident TB cases in Texas had a great odds of concurrent HIV infection compared to non-border or non-Hispanic Texas TB cases.

**Limitations**

This analysis used data collected by a surveillance system based on legally mandated notifiable disease reporting; TB is a notifiable disease in the state of Texas and any suspect or confirmed case of TB must be reported to the Texas Department of State Health Services (DSHS) (70). While there are some components of the Texas TB surveillance programs that target high-risk populations in the state of Texas for TB screening and testing, the system is a passive reporting system that relies on notifications from healthcare providers, laboratories, schools, and others. This type of system likely does not identify all cases of TB in the state of Texas, particularly in those individuals who may seek treatment for their illness another state or country. In addition, completeness can be a problem when following up on TB case reports; many of the records contained in the dataset used in this analysis did not include complete information for all variables. Because of TB's lengthy and complicated treatment regimen, TB surveillance data is reported and counted by the county that will handle at least 90 days of the treatment of the TB case and not necessarily the county in which the case acquired TB (4). If a TB case is identified in Texas but is treated elsewhere, the case would not be counted for Texas. This may result in an under- or overestimate of TB disease in some areas of Texas depending on where individuals are diagnosed vs. treated.

The data used in this analysis is cross-sectional in nature, so it is impossible to draw conclusions about whether HIV infection preceded TB disease, which does not allow for any conclusions to be made about whether or not HIV could have contributed to the TB disease. In addition, these data are reporting data, not clinical data, and they do not capture TB patients who eventually test positive for HIV after their TB infection is reported to the state. Also, no data from the Texas HIV surveillance system was included in the report. Theoretically, any case of TB identified through routine testing of HIV patients should also have been reported to the state of Texas, but this analysis did not cross-reference the TB and HIV reporting systems in Texas to determine if such reporting was done through the HIV program and to link patients reported to both disease reporting systems. HIV positive patients diagnosed with TB may know their HIV status prior to their TB diagnosis but choose to withhold that information from TB care providers and decline further HIV testing. Patients may also have been diagnosed with HIV outside of Texas (in

another state or country) and may not divulge HIV status to the Texas TB program at the time of their TB diagnosis. As a result, an unknown quantity of prevalent HIV cases may not have been captured, and these data do not represent all cases of TB/HIV co-infection in Texas. Finally, in the dataset used for this analysis, there was no way to distinguish between HIV status based on lab report or self-report, or how advanced the HIV disease was in the patient at the time of TB diagnosis.

This analysis was susceptible to selection bias; almost a third (26.3%) of all the reported TB cases were excluded from the analysis due to unknown HIV status. In addition, the decision to use the 'gold standard' model including all variables resulted in the further elimination of observations missing some of these variables, which could also introduce selection bias. Finally, racial groups with small numbers (>80 records total) present in the Texas reporting data were excluded from the analysis as well; including them would have resulted in small number or zero cells and hampered the analysis. A number of variables that are particularly interesting in the context of studying TB infection in the border, including variables designating a case a binational case or capturing visa status upon arrival to the U.S., were not consistently collected over the study period and could not be included in this analysis. These factors all limit the conclusions that can be drawn from the study. Specifically, data on the HIV status of TB patients should be interpreted with caution because these data are not representative of all TB/HIV co-infection cases for the state of Texas.

Also, HIV testing may not be as widely available in some areas of Texas compared to others. Differential availability of HIV testing may impact some populations more than others. For example, if rural counties do not have the capacity to routinely test for HIV in TB patients and most of the population they see is Hispanic, this could have resulted in fewer Hispanic TB patients being tested for TB compared with African-Americans whose populations are primarily concentrated in urban areas of the state where HIV testing is routinely available.

**Recommendations**

A number of recommendations can be made despite the narrow conclusions and significant limitations of this study. First, given the high proportion of the population that had unknown HIV test status at the time of TB reporting, continued effort needs to be made to comprehensively test and report HIV status of all TB cases when they present for TB care, regardless of historical status as a risk group. This may be improved by increasing targeted,

culturally sensitive education to specific groups to increase acceptance of HIV testing. In addition, it may be beneficial to provide better education to all healthcare providers diagnosing, reporting, and treating TB in Texas on the need to routinely screen all patients for HIV regardless of perceived HIV risk. The use of IGRA testing over TST testing should be emphasized in foreign born patients who commonly receive the BCG vaccine and populations at high risk of not returning to the clinic to have their TSTs read (homeless, migrants, drug users). The benefits will be twofold; patients will not have to return to clinics for a follow-up reading of the TST, reducing the burden on clinics and the number of patients lost to follow up. In addition, detection of LTBI will be better in populations (such as the Mexican-born) with high-levels of BCG vaccination.

Also, efforts to improve cross-border and binational case management for patients with TB and TB/HIV should be continued and strengthened. In addition to traditional health partners on both sides of the border, Immigrations and Customs Enforcement medical staff should continue to be involved in TB case management of detainees in custody to ensure that patients with TB and TB/HIV are identified prior to release from ICE custody and to improve planning for case management and treatment during and after deportation.

While this analysis found that individuals with TB disease in the border region were less likely to have concurrent HIV infection, the true extent of the TB/HIV syndemic in the region is not known, and could not be determined by this investigation. This leaves room for further exploration of the TB/HIV syndemic in this dynamic and epidemiologically distinct region.

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# Appendix A. Border Counties Defined by the 1983 La Paz Agreement

**Figure 1. 32 Texas Border Counties**

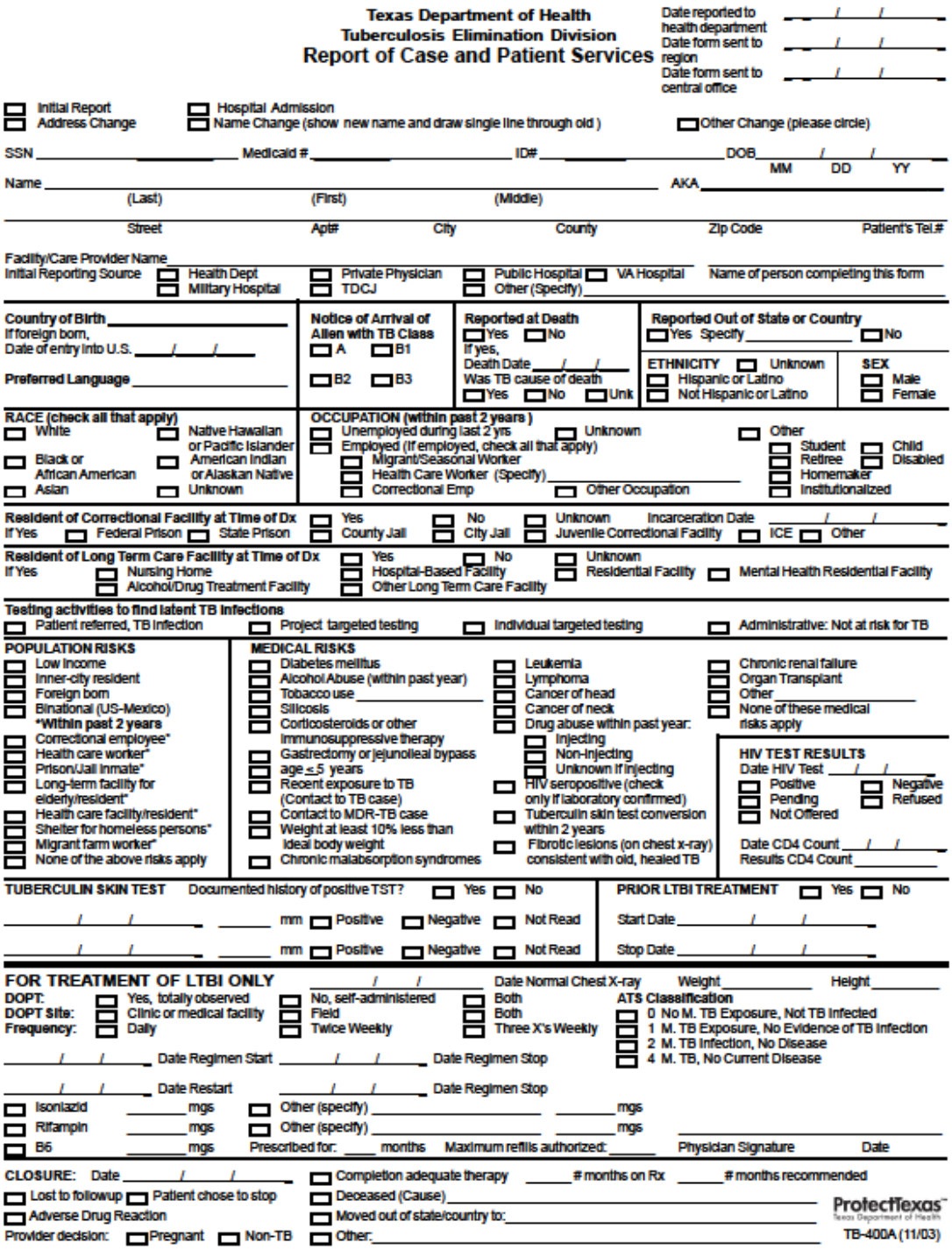
Map source: http://www.dshs.state.tx.us/borderhealth/countyfacts.shtm

In 1983, a federal designation was made to define "border" counties in U.S. It was called the "La Paz Agreement". This agreement states that a "border" county is any county which touches the international mark or touches a county which touches the international mark. There are 32 Texas border counties defined under this agreement and are comprised of:

- Brewster
- Brooks
- Cameron
- Crockett
- Culberson
- Dimmit
- Duval
- Edwards
- El Paso
- Frio
- Hidalgo
- Hudspeth
- Jeff Davis
- Jim Hogg
- Kenedy
- Kinney
- La Salle
- Maverick
- McMullen
- Pecos
- Presidio
- Real
- Reeves
- Starr
- Sutton
- Terrell
- Uvalde
- Val Verde
- Webb
- Willacy
- Zapata
- Zavala

# Appendix B. Texas TB Reporting Forms

**TB 400A**



**Texas Department of Health**
**Tuberculosis Elimination Division**
**Report of Case and Patient Services**

Date reported to health department ___/___/___
Date form sent to region ___/___/___
Date form sent to central office ___/___/___

☐ Initial Report ☐ Address Change ☐ Hospital Admission ☐ Name Change (show new name and draw single line through old) ☐ Other Change (please circle)

SSN _____ Medicaid # _____ ID# _____ DOB ___/___/___ (MM DD YY)

Name _____ (Last) (First) (Middle) AKA _____

_____ Street Apt# City County Zip Code Patient's Tel.#

Facility/Care Provider Name _____ Name of person completing this form _____

Initial Reporting Source ☐ Health Dept ☐ Private Physician ☐ Public Hospital ☐ VA Hospital ☐ Military Hospital ☐ TDCJ ☐ Other (Specify) _____

**Country of Birth** _____
If foreign born, Date of entry into U.S. ___/___/___
**Preferred Language** _____

**Notice of Arrival of Alien with TB Class** ☐ A ☐ B1 ☐ B2 ☐ B3

**Reported at Death** ☐ Yes ☐ No If yes, Death Date ___/___/___ Was TB cause of death ☐ Yes ☐ No ☐ Unk

**Reported Out of State or Country** ☐ Yes Specify _____ ☐ No

**ETHNICITY** ☐ Unknown ☐ Hispanic or Latino ☐ Not Hispanic or Latino

**SEX** ☐ Male ☐ Female

**RACE (check all that apply)**
☐ White ☐ Native Hawaiian or Pacific Islander ☐ Black or African American ☐ American Indian or Alaskan Native ☐ Asian ☐ Unknown

**OCCUPATION (within past 2 years)**
☐ Unemployed during last 2 yrs ☐ Unknown ☐ Employed (If employed, check all that apply) ☐ Migrant/Seasonal Worker ☐ Health Care Worker (Specify) _____ ☐ Correctional Emp ☐ Other Occupation
☐ Other ☐ Student ☐ Child ☐ Retiree ☐ Disabled ☐ Homemaker ☐ Institutionalized

**Resident of Correctional Facility at Time of Dx** ☐ Yes ☐ No ☐ Unknown Incarceration Date ___/___/___
If Yes ☐ Federal Prison ☐ State Prison ☐ County Jail ☐ City Jail ☐ Juvenile Correctional Facility ☐ ICE ☐ Other

**Resident of Long Term Care Facility at Time of Dx** ☐ Yes ☐ No ☐ Unknown
If Yes ☐ Nursing Home ☐ Alcohol/Drug Treatment Facility ☐ Hospital-Based Facility ☐ Other Long Term Care Facility ☐ Residential Facility ☐ Mental Health Residential Facility

**Testing activities to find latent TB infections**
☐ Patient referred, TB infection ☐ Project targeted testing ☐ Individual targeted testing ☐ Administrative: Not at risk for TB

**POPULATION RISKS**
☐ Low income
☐ Inner-city resident
☐ Foreign born
☐ Binational (US-Mexico)
*Within past 2 years
☐ Correctional employee*
☐ Health care worker*
☐ Prison/Jail inmate*
☐ Long-term facility for elderly/resident*
☐ Health care facility/resident*
☐ Shelter for homeless persons*
☐ Migrant farm worker*
☐ None of the above risks apply

**MEDICAL RISKS**
☐ Diabetes mellitus
☐ Alcohol Abuse (within past year)
☐ Tobacco use _____
☐ Silicosis
☐ Corticosteroids or other immunosuppressive therapy
☐ Gastrectomy or jejunoileal bypass
☐ age ≤ 5 years
☐ Recent exposure to TB (Contact to TB case)
☐ Contact to MDR-TB case
☐ Weight at least 10% less than ideal body weight
☐ Chronic malabsorption syndromes
☐ Leukemia
☐ Lymphoma
☐ Cancer of head
☐ Cancer of neck
☐ Drug abuse within past year: ☐ Injecting ☐ Non-Injecting ☐ Unknown if injecting
☐ HIV seropositive (check only if laboratory confirmed)
☐ Tuberculin skin test conversion within 2 years
☐ Fibrotic lesions (on chest x-ray) consistent with old, healed TB
☐ Chronic renal failure
☐ Organ Transplant
☐ Other _____
☐ None of these medical risks apply

**HIV TEST RESULTS**
Date HIV Test ___/___/___
☐ Positive ☐ Negative ☐ Pending ☐ Refused ☐ Not Offered
Date CD4 Count ___/___/___
Results CD4 Count _____

**TUBERCULIN SKIN TEST** Documented history of positive TST? ☐ Yes ☐ No
___/___/___ ___ mm ☐ Positive ☐ Negative ☐ Not Read
___/___/___ ___ mm ☐ Positive ☐ Negative ☐ Not Read

**PRIOR LTBI TREATMENT** ☐ Yes ☐ No
Start Date ___/___/___
Stop Date ___/___/___

**FOR TREATMENT OF LTBI ONLY**
___/___/___ Date Normal Chest X-ray Weight _____ Height _____
**DOPT:** ☐ Yes, totally observed ☐ No, self-administered ☐ Both
**DOPT Site:** ☐ Clinic or medical facility ☐ Field ☐ Both
**Frequency:** ☐ Daily ☐ Twice Weekly ☐ Three X's Weekly
**ATS Classification**
☐ 0 No M. TB Exposure, Not TB Infected
☐ 1 M. TB Exposure, No Evidence of TB Infection
☐ 2 M. TB Infection, No Disease
☐ 4 M. TB, No Current Disease

___/___/___ Date Regimen Start ___/___/___ Date Regimen Stop
___/___/___ Date Restart ___/___/___ Date Regimen Stop

☐ Isoniazid ___ mgs ☐ Other (specify) _____ ___ mgs
☐ Rifampin ___ mgs ☐ Other (specify) _____ ___ mgs
☐ B6 ___ mgs Prescribed for: ___ months Maximum refills authorized: ___ Physician Signature Date

**CLOSURE:** Date ___/___/___ ☐ Completion adequate therapy ___ # months on Rx ___ # months recommended
☐ Lost to followup ☐ Patient chose to stop ☐ Deceased (Cause) _____
☐ Adverse Drug Reaction ☐ Moved out of state/country to: _____
Provider decision: ☐ Pregnant ☐ Non-TB ☐ Other: _____

ProtectTexas Texas Department of Health
TB-400A (11/03)

**Texas 400B**

**Texas Department of Health**
**Tuberculosis Elimination Division**
## Report of Case and Patient Services

Date reported to health department ___/___/___
Date form sent to region ___/___/___
Date form sent to central office ___/___/___

☐ Initial Report ☐ Drug Resistance ☐ Followup or Medical Review ☐ Hospital Admission or Discharge

Name _____ DOB ___/___/___
(Last) (First) (Middle) MM DD YY

_____ SSN _____
Street Apt# City County Zip Code

Facility/Care Provider Name _____ _____
Facility responsible for patient care ☐ Public Health Clinic ☐ Private Physician ☐ Hospital ☐ Other (Specify) _____ Name of person completing this form

**Signs/Symptoms at DX**

| | | |
|---|---|---|
| Fever | ☐ Y | ☐ N |
| Chills | ☐ Y | ☐ N |
| Cough | ☐ Y | ☐ N |
| Productive Cough | ☐ Y | ☐ N |
| Hemoptysis | ☐ Y | ☐ N |
| Night Sweats | ☐ Y | ☐ N |
| Weight Loss (≥ 10%) | ☐ Y | ☐ N |
| Other: | | |

**Chest X-Ray**
Date ___/___/___
Results: ☐ Normal ☐ Abnormal ☐ Not Done ☐ Unk
**If Abnormal, check abnormality**
☐ Cavitary
☐ Non-cavitary, consistent with TB
☐ Non-cavitary, not consistent with TB
**Comments:**

**Status**
☐ Stable
☐ Worsening
☐ Improving
☐ Unknown

**If Pediatric TB Case (<15 Years Old)**
Country of birth for primary guardians:
Guardian 1) _____
Guardian 2) _____
Patient lived outside US for > 3 months
☐ Yes ☐ No ☐ Unknown
If yes, Country _____

**Status** ☐ New ☐ Recurrent ☐ Reopen
**Prior Therapy** ☐ Yes ☐ No Start Date ___/___/___
Stop Date ___/___/___

**ATS Classification**
☐ 0 No M. TB Exposure, Not TB Infected
☐ 1 M. TB Exposure, No Evidence of TB Infection
☐ 2 M. TB Infection, No Disease
☐ 3 M. TB Infection, Current Disease
☐ 4 M. TB, No Current Disease
☐ 5 M. TB Suspect, Diagnosis Pending

**Predominant Site: (Class 3, 4)** _____
**Significant Sites other than Predominant**

| | | | | | |
|---|---|---|---|---|---|
| 00 | ☐ | Pulmonary | 30 | ☐ | Bone and/or Joint |
| 10 | ☐ | Pleural | 40 | ☐ | Genitourinary |
| 20 | ☐ | Lymphatic | 50 | ☐ | Miliary/Disseminated |
| 21 | ☐ | Cervical | 60 | ☐ | Meningeal |
| 22 | ☐ | Intrathoracic | 70 | ☐ | Peritoneal |
| 23 | ☐ | Other | 80 | ☐ | Other (Specify)_____ |

**Other Diagnosis**

**Treatment for Active TB Disease** Weight ____ Height ____
Regimen Start ___/___/___ Regimen Stop ___/___/___
Restart ___/___/___ Stop ___/___/___

**Directly Observed Therapy (DOT) Doses:**
☐ Yes ☐ No If no, specify reason _____

**DOT Site:** ☐ Clinic or other medical facility ☐ Field ☐ Both
**Frequency:** ☐ Daily ☐ Twice Weekly ☐ Three X's Weekly

| | | | | | |
|---|---|---|---|---|---|
| ☐ | Isoniazid | ____ mgs | ☐ | Rifater | ____ mgs |
| ☐ | Rifampin | ____ mgs | ☐ | Levofloxacin | ____ mgs |
| ☐ | Rifamate | ____ mgs | ☐ | Gatifloxacin | ____ mgs |
| ☐ | Pyrazinamide | ____ mgs | ☐ | Moxifloxacin | ____ mgs |
| ☐ | Ethambutol | ____ mgs | ☐ | Rifapentine | ____ mgs |
| ☐ | Streptomycin | ____ mgs | ☐ | Clofazimine | ____ mgs |
| ☐ | Ethionamide | ____ mgs | ☐ | Cycloserine | ____ mgs |
| ☐ | Capreomycin | ____ mgs | ☐ | PAS | ____ mgs |
| ☐ | Amikacin | ____ mgs | ☐ | B6 | ____ mgs |
| ☐ | Ciprofloxacin | ____ mgs | ☐ | _____ | ____ mgs |
| ☐ | Ofloxacin | ____ mgs | ☐ | _____ | ____ mgs |
| ☐ | Rifabutin | ____ mgs | ☐ | _____ | ____ mgs |

Prescribed for: _____ months Maximum refills authorized: _____

**Closure:**
Date ___/___/___ ____ % doses taken by DOT
____ # doses taken ____ # doses recommended
____ # months on Rx ____ # months recommended
☐ Completion of adequate therapy ☐ Lost to followup
☐ Patient chose to stop ☐ Adverse drug reaction
☐ Deceased (Cause) _____
☐ Moved out of state/country to: _____
Date referral sent to Austin ___/___/___
Provider decision: ☐ Pregnant ☐ Non-TB ☐ Other: _____

**AFB Smear Results**
Current ___/___/___ ☐ Negative ☐ Positive ☐ Pending ☐ Not done
Specimen type: ☐ sputum ☐ urine ☐ bronchial washing ☐ biopsy ☐ other
If biopsy or other, list anatomic site of specimen: _____
If other than sputa, type of exam _____
Collection date of initial positive AFB smear: ___/___/___
Collection date of first consistently negative AFB smear: ___/___/___

**Nucleic Acid Amplification Test**
Current ___/___/___ ☐ Negative ☐ Positive ☐ Indeterminate ☐ Not done

**Culture Results**
Current ___/___/___ ☐ Negative ☐ Positive for M. TB ☐ Positive for Non-M. TB _____ ☐ Pending ☐ Not done
Specimen type: ☐ sputum ☐ urine ☐ bronchial washing ☐ biopsy ☐ other
If biopsy or other, list anatomic site of specimen: _____
Collection date of initial positive MTB culture: ___/___/___
Collection date of first consistently negative MTB culture: ___/___/___
Sputum culture conversion documented? ☐ Yes ☐ No ☐ NA
If no, then reason _____

**Susceptibility Results**
Date initial susceptibility culture was collected ___/___/___
Initial culture was resistant to: ☐ Isoniazid ☐ Rifampin ☐ Ethambutol
Date last positive culture was collected ___/___/___
Last culture was resistant to: ☐ Isoniazid ☐ Rifampin ☐ Ethambutol
☐ Other quinolone(s) _____
☐ Other(s) _____

Reason Therapy Extending > 12 months: _____
Hospitalization Advised: ☐ Yes ☐ No Control Order ___/___/___
Quarantine Advised: ☐ Yes ☐ No Court Action ___/___/___
Return for chest x-ray: ___/___/___ Compliant: ☐ Yes ☐ No
Collect next sputum on: ___/___/___ Other lab studies: ___/___/___
Return to MD clinic on: ___/___/___
Return to Nurse clinic on: ___/___/___

Nurse Signature Date

Physician Signature Date
_____ Authorize nurse to obtain informed consent
**General Comments:**

ProtectTexas™ Texas Department of Health
TB-400B (11/03)

# Appendix C. Trends in HIV Status

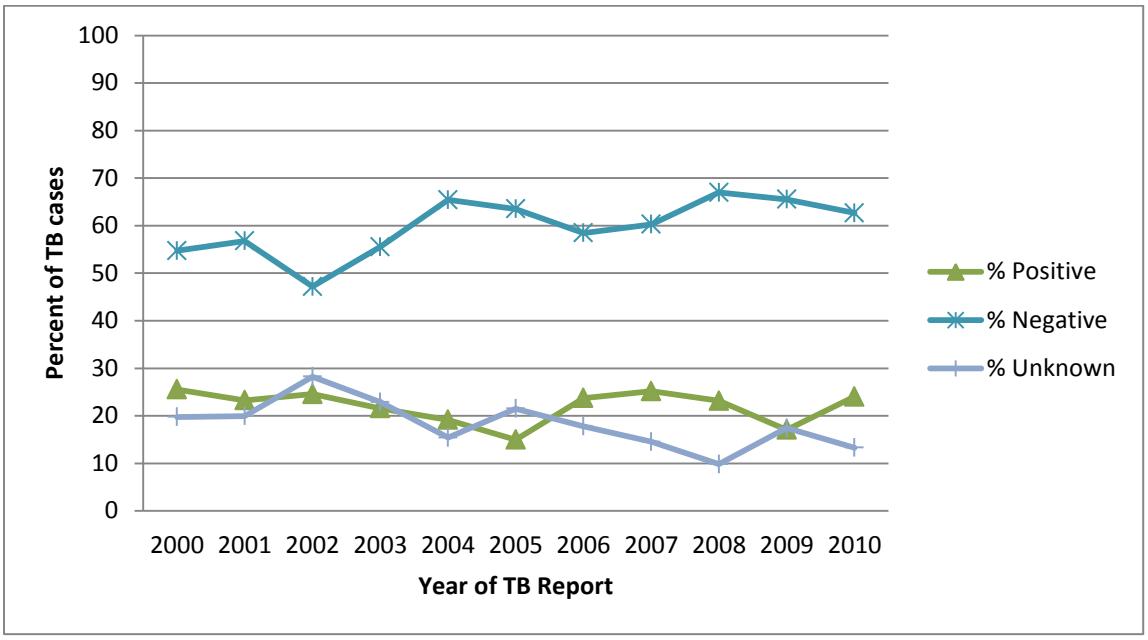



**Figure 2. Change in Reported HIV Status Proportions in African American TB Cases in Texas, 2000-2010**

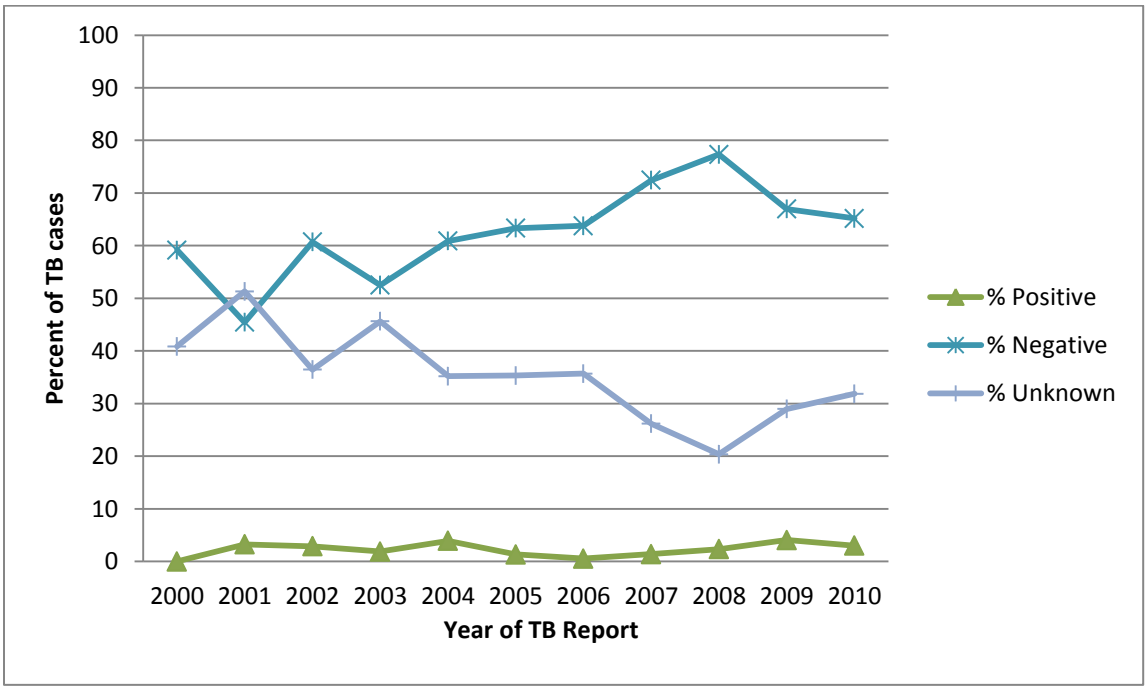



**Figure 3. Change in Reported HIV Status Proportions in Asian TB Cases in Texas, 2000-2010**

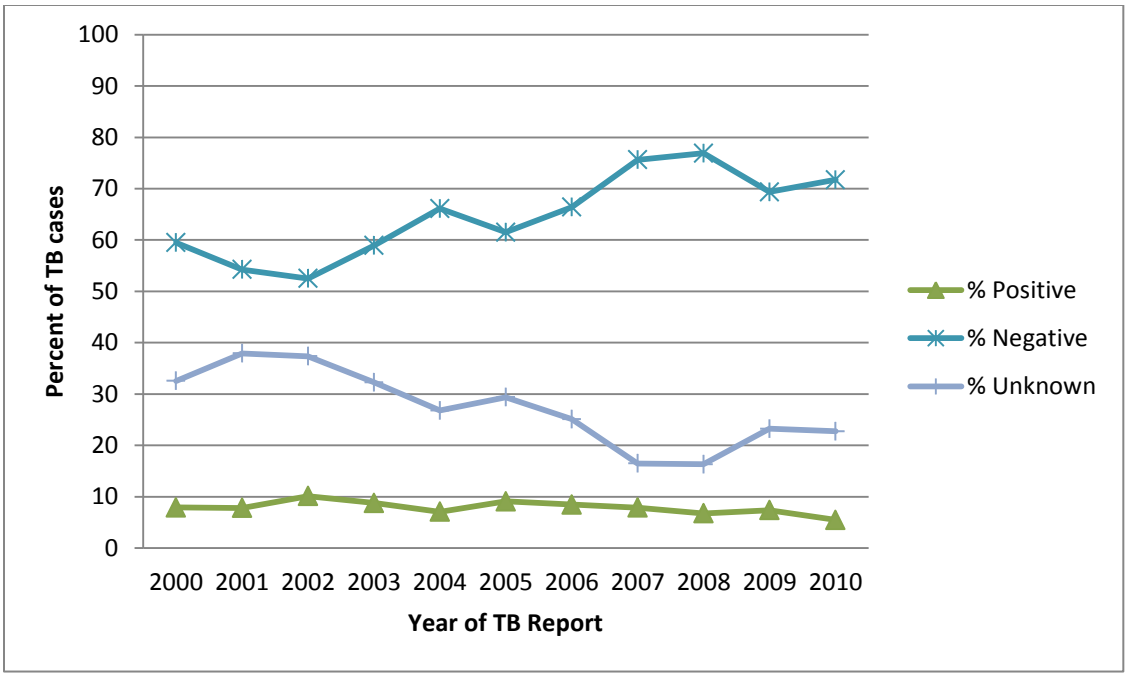



**Figure 4. Change in Reported HIV Status Proportions Caucasian TB Cases in Texas, 2000-2010**

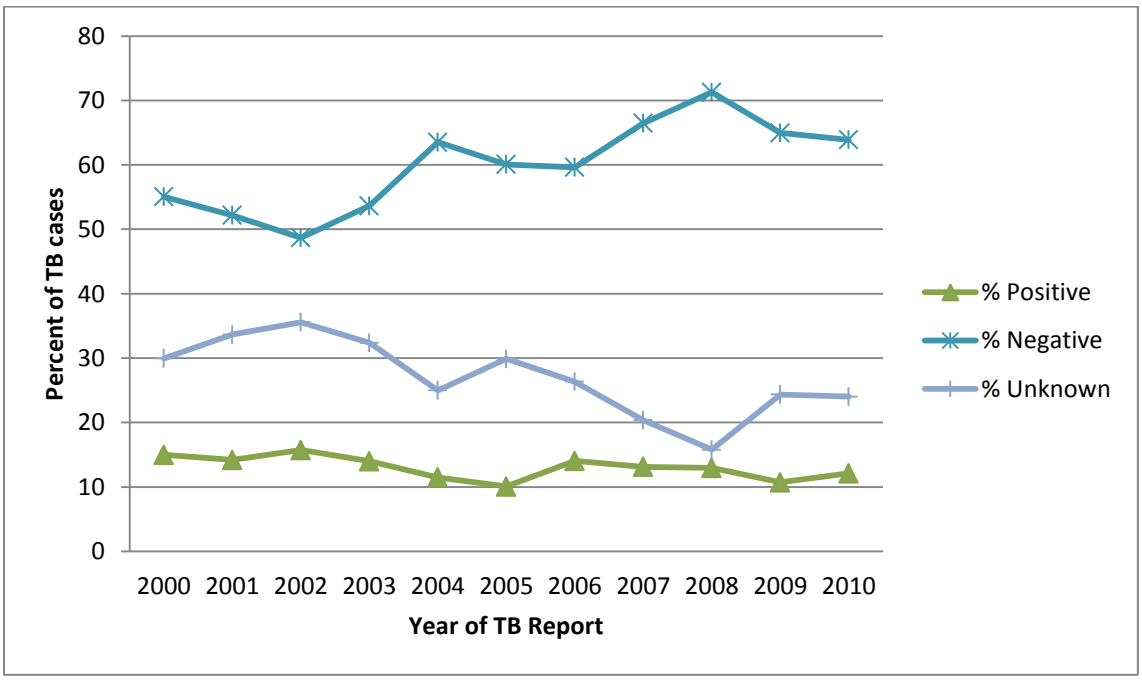



**Figure 5. Change in Reported HIV Status Proportions in Non-Hispanic TB Cases in Texas, 2000-2010**

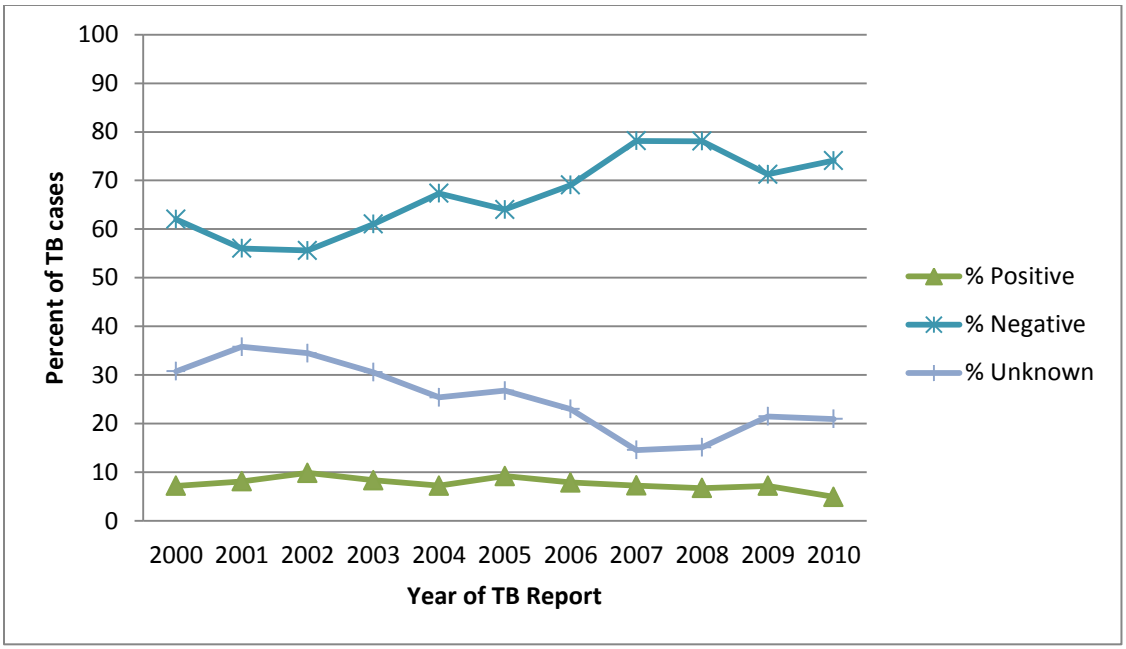



**Figure 6. Change in Reported HIV Status Proportions in Hispanic TB Cases in Texas, 2000-2010**

# Appendix D. SAS Output from Analysis

*This model is my first logistic regression model containing all two-way interaction terms identified in the previous bivariate analyses. In addition, all variables used in the analysis (significant or not in the univariate and bivariate analyses) are included in this model. I used this model to start a backwards elimination of non-significant variables, starting with the two-way interaction terms. Once I removed all non-significant interaction terms I assessed the goodness-of-fit of the model using the chi-square from the Hosmer-Lemeshow test.



The LOGISTIC Procedure

Model Information

| | |
|---|---|
| Data Set | TBHIV.LOGISTIC2 |
| Response Variable | HIV |
| Number of Response Levels | 2 |
| Model | binary logit |
| Optimization Technique | Fisher's scoring |

| | |
|---|---|
| Number of Observations Read | 11282 |
| Number of Observations Used | 10989 |

Response Profile

| Ordered Value | HIV | Total Frequency |
|---|---|---|

| | | |
|---|---|---|
| 1 | 0 | 9412 |
| 2 | 1 | 1577 |

Probability modeled is HIV=1.

NOTE: 293 observations were deleted due to missing values for the response or explanatory variables.

Class Level Information

| Class | Value | Design Variables | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| FB | 0 | 0 | | | | | | | | |
| | 1 | 1 | | | | | | | | |
| year_counted | 2000 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 2001 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 2002 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 2003 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 |
| | 2004 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 |
| | 2005 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| | 2006 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| | 2007 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 2008 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| 0 | | | | | | | | | | |
| | 2009 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1 | | | | | | | | | | |
| | 2010 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | | | | | | | | | | |
| | | | | | | | | | | |
| age1 | 25 | 1 | 0 | 0 | 0 | | | | | |
| | 35 | 0 | 1 | 0 | 0 | | | | | |
| | 45 | 0 | 0 | 1 | 0 | | | | | |
| | 55 | 0 | 0 | 0 | 1 | | | | | |

The LOGISTIC Procedure

Class Level Information

| Class | Value | Design Variables | | | | |
|---|---|---|---|---|---|---|
| | 65 | 0 | 0 | 0 | 0 | |
| USYEARs | 0 | 1 | 0 | 0 | 0 | 0 |
| | 1 | 0 | 1 | 0 | 0 | 0 |
| | 2 | 0 | 0 | 1 | 0 | 0 |
| | 7 | 0 | 0 | 0 | 1 | 0 |
| | 15 | 0 | 0 | 0 | 0 | 1 |
| | 20 | 0 | 0 | 0 | 0 | 0 |
| race2 | Asian | 1 | 0 | | | |
| | Black | 0 | 1 | | | |
| | White | 0 | 0 | | | |
| location | 1 | 0 | 0 | | | |
| | 2 | 1 | 0 | | | |
| | 3 | 0 | 1 | | | |
| Occupation | 0 | 1 | | | | |
| | 1 | 0 | | | | |

| | | |
|---|---|---|
| Ethnicity | 0 | 0 |
| | 1 | 1 |

Model Convergence Status

Convergence criterion (GCONV=1E-8) satisfied.

Model Fit Statistics

| Criterion | Intercept Only | Intercept and Covariates |
|---|---|---|
| AIC | 9041.095 | 7482.697 |
| SC | 9048.400 | 7796.797 |
| -2 Log L | 9039.095 | 7396.697 |

The LOGISTIC Procedure

Testing Global Null Hypothesis: BETA=0

| Test | Chi-Square | DF | Pr > ChiSq |
|---|---|---|---|
| Likelihood Ratio | 1642.3983 | 42 | <.0001 |
| Score | 1585.6167 | 42 | <.0001 |
| Wald | 1224.6354 | 42 | <.0001 |

Type 3 Analysis of Effects

| Effect | DF | Wald Chi-Square | Pr > ChiSq |
|---|---|---|---|
| BORDER | 1 | 17.2056 | <.0001 |
| FB | 1 | 2.2380 | 0.1347 |
| age1 | 4 | 400.6157 | <.0001 |
| year_counted | 10 | 36.7572 | <.0001 |
| sex | 1 | 118.7751 | <.0001 |
| Ethnicity | 1 | 2.2346 | 0.1350 |
| race2 | 2 | 199.1764 | <.0001 |
| IDU | 1 | 42.0527 | <.0001 |
| USYEARs | 4 | 4.0463 | 0.3998 |
| NoInject | 1 | 22.2425 | <.0001 |

| | | | |
|---|---|---|---|
| alcohol | 1 | 33.0347 | <.0001 |
| homeless | 1 | 0.3319 | 0.5645 |
| prison | 1 | 5.3360 | 0.0209 |
| LTCRes | 1 | 0.4329 | 0.5106 |
| location | 2 | 201.2183 | <.0001 |
| Occupation | 1 | 105.5128 | <.0001 |
| BORDER*FB | 1 | 0.0773 | 0.7811 |
| BORDER*alcohol | 1 | 3.2464 | 0.0716 |
| BORDER*USYEARs | 4 | 3.4812 | 0.4807 |
| BORDER*prison | 1 | 0.9764 | 0.3231 |
| BORDER*location | 2 | 5.4910 | 0.0642 |

*Based on these results, I decided to drop Border*FB (foreign birth) because this was the least significant interaction term in the model(p= 0.78).

NOTE: The following parameters have been set to 0, since the variables are a linear combination

of other variables as shown.

USYEARs0 = Intercept - FB1

USYEARs0BORDER = BORDER - FB1BORDER

The LOGISTIC Procedure

Analysis of Maximum Likelihood Estimates

| Parameter | | DF | Estimate | Standard Error | Wald Chi-Square | Pr > ChiSq |
|---|---|---|---|---|---|---|
| Intercept | | 1 | -5.0511 | 0.2400 | 443.1074 | <.0001 |
| BORDER | | 1 | -0.9238 | 0.2227 | 17.2056 | <.0001 |
| FB | 1 | 1 | 0.2155 | 0.1440 | 2.2380 | 0.1347 |
| age1 | 25 | 1 | 1.3181 | 0.1926 | 46.8570 | <.0001 |
| age1 | 35 | 1 | 2.5355 | 0.1829 | 192.1593 | <.0001 |
| age1 | 45 | 1 | 2.1824 | 0.1816 | 144.3766 | <.0001 |
| age1 | 55 | 1 | 1.2871 | 0.1851 | 48.3370 | <.0001 |
| year_counted | 2000 | 1 | 0.2937 | 0.1558 | 3.5509 | 0.0595 |
| year_counted | 2001 | 1 | 0.3560 | 0.1532 | 5.4011 | 0.0201 |
| year_counted | 2002 | 1 | 0.6301 | 0.1522 | 17.1329 | <.0001 |
| year_counted | 2003 | 1 | 0.3603 | 0.1539 | 5.4800 | 0.0192 |
| year_counted | 2004 | 1 | 0.0504 | 0.1550 | 0.1059 | 0.7448 |
| year_counted | 2005 | 1 | 0.1067 | 0.1585 | 0.4531 | 0.5009 |
| year_counted | 2006 | 1 | 0.2681 | 0.1541 | 3.0284 | 0.0818 |
| year_counted | 2007 | 1 | 0.2364 | 0.1557 | 2.3038 | 0.1291 |
| year_counted | 2008 | 1 | 0.0276 | 0.1563 | 0.0313 | 0.8596 |
| year_counted | 2009 | 1 | 0.1023 | 0.1645 | 0.3870 | 0.5339 |
| sex | | 1 | 0.8064 | 0.0740 | 118.7751 | <.0001 |
| Ethnicity | 1 | 1 | -0.1621 | 0.1084 | 2.2346 | 0.1350 |

| | | | | | | |
|---|---|---|---|---|---|---|
| race2 | Asian | 1 | -1.5195 | 0.1913 | 63.1165 | <.0001 |
| race2 | Black | 1 | 0.7113 | 0.0915 | 60.5022 | <.0001 |
| IDU | | 1 | 0.8598 | 0.1326 | 42.0527 | <.0001 |
| USYEARs | 0 | 0 | 0 | . | . | . |
| USYEARs | 1 | 1 | -0.2226 | 0.1882 | 1.3998 | 0.2368 |
| USYEARs | 2 | 1 | -0.2980 | 0.1663 | 3.2092 | 0.0732 |
| USYEARs | 7 | 1 | -0.2191 | 0.1813 | 1.4601 | 0.2269 |
| USYEARs | 15 | 1 | -0.3051 | 0.1736 | 3.0901 | 0.0788 |
| NoInject | | 1 | 0.4508 | 0.0956 | 22.2425 | <.0001 |
| alcohol | | 1 | -0.4825 | 0.0840 | 33.0347 | <.0001 |
| homeless | | 1 | -0.0635 | 0.1101 | 0.3319 | 0.5645 |
| prison | | 1 | -0.2773 | 0.1201 | 5.3360 | 0.0209 |
| LTCRes | | 1 | 0.1485 | 0.2257 | 0.4329 | 0.5106 |
| location | 2 | 1 | 0.8337 | 0.0768 | 117.9539 | <.0001 |
| location | 3 | 1 | 1.1884 | 0.1065 | 124.4833 | <.0001 |
| Occupation | 0 | 1 | 0.6712 | 0.0653 | 105.5128 | <.0001 |
| BORDER*FB | 1 | 1 | 0.0805 | 0.2898 | 0.0773 | 0.7811 |
| BORDER*alcohol | | 1 | 0.3739 | 0.2075 | 3.2464 | 0.0716 |
| BORDER*USYEARs | 0 | 0 | 0 | . | . | . |
| BORDER*USYEARs | 1 | 1 | 0.1375 | 0.4111 | 0.1118 | 0.7381 |
| BORDER*USYEARs | 2 | 1 | 0.3528 | 0.3696 | 0.9111 | 0.3398 |
| BORDER*USYEARs | 7 | 1 | 0.5216 | 0.4046 | 1.6619 | 0.1973 |
| BORDER*USYEARs | 15 | 1 | 0.5720 | 0.3515 | 2.6487 | 0.1036 |
| BORDER*prison | | 1 | -0.3279 | 0.3318 | 0.9764 | 0.3231 |
| BORDER*location | 2 | 1 | 0.5422 | 0.2314 | 5.4909 | 0.0191 |
| BORDER*location | 3 | 1 | 0.1704 | 0.3250 | 0.2750 | 0.6000 |

The LOGISTIC Procedure

Odds Ratio Estimates

| Effect | | Point Estimate | 95% Wald Confidence Limits | |
|---|---|---|---|---|
| age1 | 25 vs 65 | 3.736 | 2.562 | 5.449 |
| age1 | 35 vs 65 | 12.623 | 8.820 | 18.066 |
| age1 | 45 vs 65 | 8.868 | 6.212 | 12.659 |
| age1 | 55 vs 65 | 3.622 | 2.520 | 5.206 |
| year_counted | 2000 vs 2010 | 1.341 | 0.988 | 1.820 |
| year_counted | 2001 vs 2010 | 1.428 | 1.057 | 1.927 |
| year_counted | 2002 vs 2010 | 1.878 | 1.393 | 2.531 |
| year_counted | 2003 vs 2010 | 1.434 | 1.060 | 1.939 |
| year_counted | 2004 vs 2010 | 1.052 | 0.776 | 1.425 |
| year_counted | 2005 vs 2010 | 1.113 | 0.815 | 1.518 |
| year_counted | 2006 vs 2010 | 1.308 | 0.967 | 1.769 |
| year_counted | 2007 vs 2010 | 1.267 | 0.933 | 1.719 |
| year_counted | 2008 vs 2010 | 1.028 | 0.757 | 1.396 |
| year_counted | 2009 vs 2010 | 1.108 | 0.802 | 1.529 |
| sex | | 2.240 | 1.937 | 2.589 |
| Ethnicity | 1 vs 0 | 0.850 | 0.688 | 1.052 |
| race2 | Asian vs White | 0.219 | 0.150 | 0.318 |
| race2 | Black vs White | 2.037 | 1.702 | 2.437 |
| IDU | | 2.363 | 1.822 | 3.064 |

| | | | | |
|---|---|---|---|---|
| NoInject | | 1.570 | 1.301 | 1.893 |
| homeless | | 0.939 | 0.756 | 1.165 |
| LTCRes | | 1.160 | 0.745 | 1.805 |
| Occupation | 0 vs 1 | 1.957 | 1.721 | 2.224 |

Association of Predicted Probabilities and Observed Responses

| | | | |
|---|---|---|---|
| Percent Concordant | 79.5 | Somers' D | 0.593 |
| Percent Discordant | 20.2 | Gamma | 0.595 |
| Percent Tied | 0.4 | Tau-a | 0.146 |
| Pairs | 14842724 | c | 0.796 |

Partition for the Hosmer and Lemeshow Test

| | | HIV = 1 | | HIV = 0 | |
|---|---|---|---|---|---|
| Group | Total | Observed | Expected | Observed | Expected |
| 1 | 1099 | 18 | 12.62 | 1081 | 1086.38 |
| 2 | 1102 | 29 | 28.28 | 1073 | 1073.72 |
| 3 | 1100 | 47 | 44.33 | 1053 | 1055.67 |
| 4 | 1099 | 59 | 62.43 | 1040 | 1036.57 |
| 5 | 1099 | 69 | 87.24 | 1030 | 1011.76 |
| 6 | 1099 | 128 | 118.14 | 971 | 980.86 |
| 7 | 1098 | 148 | 159.48 | 950 | 938.52 |

The LOGISTIC Procedure

Partition for the Hosmer and Lemeshow Test

| | | HIV = 1 | | HIV = 0 | |
|---|---|---|---|---|---|
| Group | Total | Observed | Expected | Observed | Expected |
| 8 | 1102 | 226 | 221.18 | 876 | 880.82 |
| 9 | 1098 | 319 | 317.13 | 779 | 780.87 |
| 10 | 1093 | 534 | 526.17 | 559 | 566.83 |

Hosmer and Lemeshow Goodness-of-Fit Test

| Chi-Square | DF | Pr > ChiSq |
|---|---|---|
| 9.1101 | 8 | 0.3331 |

*The chi-square test for fit is not significant, so this model fits the data.

The LOGISTIC Procedure

Model Information

| | |
|---|---|
| Data Set | TBHIV.LOGISTIC2 |
| Response Variable | HIV |
| Number of Response Levels | 2 |
| Model | binary logit |
| Optimization Technique | Fisher's scoring |

| | |
|---|---|
| Number of Observations Read | 11282 |
| Number of Observations Used | 10989 |

Response Profile

| Ordered Value | HIV | Total Frequency |
|---|---|---|
| 1 | 0 | 9412 |
| 2 | 1 | 1577 |

Probability modeled is HIV=1.

NOTE: 293 observations were deleted due to missing values for the response or explanatory variables.

Class Level Information

| Class | Value | Design Variables | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| FB | 0 | 0 | | | | | | | | |
| | 1 | 1 | | | | | | | | |
| year_counted | 2000 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 2001 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 2002 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 2003 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 |
| | 2004 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 |
| | 2005 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| | 2006 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| | 2007 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| | 2008 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| | 2009 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 2010 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| age1 | 25 | 1 | 0 | 0 | 0 | | | | | |
| | 35 | 0 | 1 | 0 | 0 | | | | | |
| | 45 | 0 | 0 | 1 | 0 | | | | | |

| | | | | |
|---|---|---|---|---|
| 55 | 0 | 0 | 0 | 1 |
| 65 | 0 | 0 | 0 | 0 |

The LOGISTIC Procedure

Class Level Information

| Class | Value | Design Variables | | | | |
|---|---|---|---|---|---|---|
| USYEARs | 0 | 1 | 0 | 0 | 0 | 0 |
| | 1 | 0 | 1 | 0 | 0 | 0 |
| | 2 | 0 | 0 | 1 | 0 | 0 |
| | 7 | 0 | 0 | 0 | 1 | 0 |
| | 15 | 0 | 0 | 0 | 0 | 1 |
| | 20 | 0 | 0 | 0 | 0 | 0 |
| race2 | Asian | 1 | 0 | | | |
| | Black | 0 | 1 | | | |
| | White | 0 | 0 | | | |
| location | 1 | 0 | 0 | | | |
| | 2 | 1 | 0 | | | |
| | 3 | 0 | 1 | | | |
| Occupation | 0 | 1 | | | | |
| | 1 | 0 | | | | |
| Ethnicity | 0 | 0 | | | | |
| | 1 | 1 | | | | |

Model Convergence Status

Convergence criterion (GCONV=1E-8) satisfied.

Model Fit Statistics

| Criterion | Intercept Only | Intercept and Covariates |
|---|---|---|
| AIC | 9041.095 | 7482.697 |
| SC | 9048.400 | 7796.797 |
| -2 Log L | 9039.095 | 7396.697 |

Testing Global Null Hypothesis: BETA=0

| Test | Chi-Square | DF | Pr > ChiSq |
|---|---|---|---|
| Likelihood Ratio | 1642.3983 | 42 | <.0001 |
| Score | 1585.6167 | 42 | <.0001 |
| Wald | 1224.6354 | 42 | <.0001 |

The LOGISTIC Procedure

Type 3 Analysis of Effects

| Effect | DF | Wald Chi-Square | Pr > ChiSq |
|---|---|---|---|
| BORDER | 1 | 10.5998 | 0.0011 |
| FB | 1 | 2.2380 | 0.1347 |
| age1 | 4 | 400.6157 | <.0001 |
| year_counted | 10 | 36.7572 | <.0001 |
| sex | 1 | 118.7751 | <.0001 |
| Ethnicity | 1 | 2.2346 | 0.1350 |
| race2 | 2 | 199.1764 | <.0001 |
| IDU | 1 | 42.0527 | <.0001 |
| USYEARs | 4 | 4.0463 | 0.3998 |
| NoInject | 1 | 22.2425 | <.0001 |
| alcohol | 1 | 33.0347 | <.0001 |
| homeless | 1 | 0.3319 | 0.5645 |
| prison | 1 | 5.3360 | 0.0209 |
| LTCRes | 1 | 0.4329 | 0.5106 |
| location | 2 | 201.2183 | <.0001 |
| Occupation | 1 | 105.5128 | <.0001 |
| BORDER*alcohol | 1 | 3.2464 | 0.0716 |
| BORDER*USYEARs | 5 | 6.2207 | 0.2853 |
| BORDER*prison | 1 | 0.9764 | 0.3231 |
| BORDER*location | 2 | 5.4910 | 0.0642 |

*Based on these results, I decided to drop Border*prison because this was the least significant interaction term remaining in the model(p= 0.32).

NOTE: The following parameters have been set to 0, since the variables are a linear combination

of other variables as shown.

USYEARs0 = Intercept - FB1

Analysis of Maximum Likelihood Estimates

| Parameter | | DF | Estimate | Standard Error | Wald Chi-Square | Pr > ChiSq |
|---|---|---|---|---|---|---|
| Intercept | | 1 | -5.0511 | 0.2400 | 443.1074 | <.0001 |
| BORDER | | 1 | -0.8432 | 0.2590 | 10.5998 | 0.0011 |
| FB | 1 | 1 | 0.2155 | 0.1440 | 2.2380 | 0.1347 |
| age1 | 25 | 1 | 1.3181 | 0.1926 | 46.8570 | <.0001 |
| age1 | 35 | 1 | 2.5355 | 0.1829 | 192.1593 | <.0001 |
| age1 | 45 | 1 | 2.1824 | 0.1816 | 144.3766 | <.0001 |
| age1 | 55 | 1 | 1.2871 | 0.1851 | 48.3370 | <.0001 |
| year_counted | 2000 | 1 | 0.2937 | 0.1558 | 3.5509 | 0.0595 |
| year_counted | 2001 | 1 | 0.3560 | 0.1532 | 5.4011 | 0.0201 |
| year_counted | 2002 | 1 | 0.6301 | 0.1522 | 17.1329 | <.0001 |
| year_counted | 2003 | 1 | 0.3603 | 0.1539 | 5.4800 | 0.0192 |
| year_counted | 2004 | 1 | 0.0504 | 0.1550 | 0.1059 | 0.7448 |

The LOGISTIC Procedure

Analysis of Maximum Likelihood Estimates

| Parameter | | DF | Estimate | Standard Error | Wald Chi-Square | Pr > ChiSq |
|---|---|---|---|---|---|---|
| year_counted | 2005 | 1 | 0.1067 | 0.1585 | 0.4531 | 0.5009 |
| year_counted | 2006 | 1 | 0.2681 | 0.1541 | 3.0284 | 0.0818 |
| year_counted | 2007 | 1 | 0.2364 | 0.1557 | 2.3038 | 0.1291 |
| year_counted | 2008 | 1 | 0.0276 | 0.1563 | 0.0313 | 0.8596 |
| year_counted | 2009 | 1 | 0.1023 | 0.1645 | 0.3870 | 0.5339 |
| sex | | 1 | 0.8064 | 0.0740 | 118.7751 | <.0001 |
| Ethnicity | 1 | 1 | -0.1621 | 0.1084 | 2.2346 | 0.1350 |
| race2 | Asian | 1 | -1.5195 | 0.1913 | 63.1165 | <.0001 |
| race2 | Black | 1 | 0.7113 | 0.0915 | 60.5022 | <.0001 |
| IDU | | 1 | 0.8598 | 0.1326 | 42.0527 | <.0001 |
| USYEARs | 0 | 0 | 0 | . | . | . |
| USYEARs | 1 | 1 | -0.2226 | 0.1882 | 1.3998 | 0.2368 |
| USYEARs | 2 | 1 | -0.2980 | 0.1663 | 3.2092 | 0.0732 |
| USYEARs | 7 | 1 | -0.2191 | 0.1813 | 1.4601 | 0.2269 |
| USYEARs | 15 | 1 | -0.3051 | 0.1736 | 3.0901 | 0.0788 |
| NoInject | | 1 | 0.4508 | 0.0956 | 22.2425 | <.0001 |
| alcohol | | 1 | -0.4825 | 0.0840 | 33.0347 | <.0001 |
| homeless | | 1 | -0.0635 | 0.1101 | 0.3319 | 0.5645 |
| prison | | 1 | -0.2773 | 0.1201 | 5.3360 | 0.0209 |
| LTCRes | | 1 | 0.1485 | 0.2257 | 0.4329 | 0.5106 |

| | | | | | | |
|---|---|---|---|---|---|---|
| location | 2 | 1 | 0.8337 | 0.0768 | 117.9539 | <.0001 |
| location | 3 | 1 | 1.1884 | 0.1065 | 124.4833 | <.0001 |
| Occupation | 0 | 1 | 0.6712 | 0.0653 | 105.5128 | <.0001 |
| BORDER*alcohol | | 1 | 0.3739 | 0.2075 | 3.2464 | 0.0716 |
| BORDER*USYEARs | 0 | 1 | -0.0805 | 0.2898 | 0.0773 | 0.7811 |
| BORDER*USYEARs | 1 | 1 | 0.1375 | 0.4111 | 0.1118 | 0.7381 |
| BORDER*USYEARs | 2 | 1 | 0.3528 | 0.3696 | 0.9111 | 0.3398 |
| BORDER*USYEARs | 7 | 1 | 0.5216 | 0.4046 | 1.6619 | 0.1973 |
| BORDER*USYEARs | 15 | 1 | 0.5720 | 0.3515 | 2.6487 | 0.1036 |
| BORDER*prison | | 1 | -0.3279 | 0.3318 | 0.9764 | 0.3231 |
| BORDER*location | 2 | 1 | 0.5422 | 0.2314 | 5.4909 | 0.0191 |
| BORDER*location | 3 | 1 | 0.1704 | 0.3250 | 0.2750 | 0.6000 |

Odds Ratio Estimates

| Effect | | Point Estimate | 95% Wald Confidence Limits | |
|---|---|---|---|---|
| FB | 1 vs 0 | 1.240 | 0.935 | 1.645 |
| age1 | 25 vs 65 | 3.736 | 2.562 | 5.449 |
| age1 | 35 vs 65 | 12.623 | 8.820 | 18.066 |
| age1 | 45 vs 65 | 8.868 | 6.212 | 12.659 |
| age1 | 55 vs 65 | 3.622 | 2.520 | 5.206 |
| year_counted | 2000 vs 2010 | 1.341 | 0.988 | 1.820 |
| year_counted | 2001 vs 2010 | 1.428 | 1.057 | 1.927 |

The LOGISTIC Procedure

Odds Ratio Estimates

| Effect | | Point Estimate | 95% Wald Confidence Limits | |
|---|---|---|---|---|
| year_counted | 2002 vs 2010 | 1.878 | 1.393 | 2.531 |
| year_counted | 2003 vs 2010 | 1.434 | 1.060 | 1.939 |
| year_counted | 2004 vs 2010 | 1.052 | 0.776 | 1.425 |
| year_counted | 2005 vs 2010 | 1.113 | 0.815 | 1.518 |
| year_counted | 2006 vs 2010 | 1.308 | 0.967 | 1.769 |
| year_counted | 2007 vs 2010 | 1.267 | 0.933 | 1.719 |
| year_counted | 2008 vs 2010 | 1.028 | 0.757 | 1.396 |
| year_counted | 2009 vs 2010 | 1.108 | 0.802 | 1.529 |
| sex | | 2.240 | 1.937 | 2.589 |
| Ethnicity | 1 vs 0 | 0.850 | 0.688 | 1.052 |
| race2 | Asian vs White | 0.219 | 0.150 | 0.318 |
| race2 | Black vs White | 2.037 | 1.702 | 2.437 |
| IDU | | 2.363 | 1.822 | 3.064 |
| NoInject | | 1.570 | 1.301 | 1.893 |
| homeless | | 0.939 | 0.756 | 1.165 |
| LTCRes | | 1.160 | 0.745 | 1.805 |
| Occupation | 0 vs 1 | 1.957 | 1.721 | 2.224 |

Association of Predicted Probabilities and Observed Responses

| | | | |
|---|---|---|---|
| Percent Concordant | 79.5 | Somers' D | 0.593 |
| Percent Discordant | 20.2 | Gamma | 0.595 |
| Percent Tied | 0.4 | Tau-a | 0.146 |
| Pairs | 14842724 | c | 0.796 |

Partition for the Hosmer and Lemeshow Test

| | | HIV = 1 | | HIV = 0 | |
|---|---|---|---|---|---|
| Group | Total | Observed | Expected | Observed | Expected |
| 1 | 1099 | 18 | 12.62 | 1081 | 1086.38 |
| 2 | 1102 | 29 | 28.28 | 1073 | 1073.72 |
| 3 | 1100 | 47 | 44.33 | 1053 | 1055.67 |
| 4 | 1099 | 59 | 62.43 | 1040 | 1036.57 |
| 5 | 1099 | 69 | 87.24 | 1030 | 1011.76 |
| 6 | 1099 | 128 | 118.14 | 971 | 980.86 |
| 7 | 1098 | 148 | 159.48 | 950 | 938.52 |
| 8 | 1102 | 226 | 221.18 | 876 | 880.82 |
| 9 | 1098 | 319 | 317.13 | 779 | 780.87 |
| 10 | 1093 | 534 | 526.17 | 559 | 566.83 |

The LOGISTIC Procedure

Hosmer and Lemeshow Goodness-of-Fit Test

| Chi-Square | DF | Pr > ChiSq |
|---|---|---|
| 9.1101 | 8 | 0.3331 |

*Goodness-of-Fit test still shows that this model fits my data.

The LOGISTIC Procedure

Model Information

| | |
|---|---|
| Data Set | TBHIV.LOGISTIC2 |
| Response Variable | HIV |
| Number of Response Levels | 2 |
| Model | binary logit |
| Optimization Technique | Fisher's scoring |

| | |
|---|---|
| Number of Observations Read | 11282 |
| Number of Observations Used | 10989 |

Response Profile

| Ordered Value | HIV | Total Frequency |
|---|---|---|
| 1 | 0 | 9412 |
| 2 | 1 | 1577 |

Probability modeled is HIV=1.

NOTE: 293 observations were deleted due to missing values for the response or explanatory variables.

Class Level Information

| Class | Value | Design Variables | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| FB | 0 | 0 | | | | | | | | |
| | 1 | 1 | | | | | | | | |
| year_counted | 2000 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 2001 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 2002 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 2003 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 |
| | 2004 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 |
| | 2005 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| | 2006 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| | 2007 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| | 2008 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| | 2009 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 2010 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| age1 | 25 | 1 | 0 | 0 | 0 | | | | | |
| | 35 | 0 | 1 | 0 | 0 | | | | | |
| | 45 | 0 | 0 | 1 | 0 | | | | | |

| | | | | |
|---|---|---|---|---|
| 55 | 0 | 0 | 0 | 1 |
| 65 | 0 | 0 | 0 | 0 |

The LOGISTIC Procedure

Class Level Information

| Class | Value | Design Variables | | | | |
|---|---|---|---|---|---|---|
| USYEARs | 0 | 1 | 0 | 0 | 0 | 0 |
| | 1 | 0 | 1 | 0 | 0 | 0 |
| | 2 | 0 | 0 | 1 | 0 | 0 |
| | 7 | 0 | 0 | 0 | 1 | 0 |
| | 15 | 0 | 0 | 0 | 0 | 1 |
| | 20 | 0 | 0 | 0 | 0 | 0 |
| race2 | Asian | 1 | 0 | | | |
| | Black | 0 | 1 | | | |
| | White | 0 | 0 | | | |
| location | 1 | 0 | 0 | | | |
| | 2 | 1 | 0 | | | |
| | 3 | 0 | 1 | | | |
| Occupation | 0 | 1 | | | | |
| | 1 | 0 | | | | |
| Ethnicity | 0 | 0 | | | | |
| | 1 | 1 | | | | |

Model Convergence Status

Convergence criterion (GCONV=1E-8) satisfied.

Model Fit Statistics

| Criterion | Intercept Only | Intercept and Covariates |
|---|---|---|
| AIC | 9041.095 | 7481.699 |
| SC | 9048.400 | 7788.494 |
| -2 Log L | 9039.095 | 7397.699 |

Testing Global Null Hypothesis: BETA=0

| Test | Chi-Square | DF | Pr > ChiSq |
|---|---|---|---|
| Likelihood Ratio | 1641.3960 | 41 | <.0001 |
| Score | 1583.3554 | 41 | <.0001 |
| Wald | 1223.5380 | 41 | <.0001 |

The LOGISTIC Procedure

Type 3 Analysis of Effects

| Effect | DF | Wald Chi-Square | Pr > ChiSq |
|---|---|---|---|
| BORDER | 1 | 11.7055 | 0.0006 |
| FB | 1 | 2.1520 | 0.1424 |
| age1 | 4 | 400.8396 | <.0001 |
| year_counted | 10 | 36.9769 | <.0001 |
| sex | 1 | 118.8056 | <.0001 |
| Ethnicity | 1 | 2.1587 | 0.1418 |
| race2 | 2 | 199.5249 | <.0001 |
| IDU | 1 | 41.5251 | <.0001 |
| USYEARs | 4 | 4.0169 | 0.4037 |
| NoInject | 1 | 22.2336 | <.0001 |
| alcohol | 1 | 33.1815 | <.0001 |
| homeless | 1 | 0.3305 | 0.5654 |
| prison | 1 | 8.0599 | 0.0045 |
| LTCRes | 1 | 0.4253 | 0.5143 |
| location | 2 | 200.8913 | <.0001 |
| Occupation | 1 | 106.5139 | <.0001 |
| BORDER*alcohol | 1 | 3.2300 | 0.0723 |
| BORDER*USYEARs | 5 | 6.1534 | 0.2916 |
| BORDER*location | 2 | 6.3196 | 0.0424 |

*based on these results I decided to drop USYEARS from the model because it was the least significant interaction term left (p-value= 0.29).

NOTE: The following parameters have been set to 0, since the variables are a linear combination

of other variables as shown.

USYEARs0 = Intercept - FB1

Analysis of Maximum Likelihood Estimates

| Parameter | | DF | Estimate | Standard Error | Wald Chi-Square | Pr > ChiSq |
|---|---|---|---|---|---|---|
| Intercept | | 1 | -5.0486 | 0.2400 | 442.6620 | <.0001 |
| BORDER | | 1 | -0.8800 | 0.2572 | 11.7055 | 0.0006 |
| FB | 1 | 1 | 0.2112 | 0.1439 | 2.1520 | 0.1424 |
| age1 | 25 | 1 | 1.3158 | 0.1926 | 46.6894 | <.0001 |
| age1 | 35 | 1 | 2.5344 | 0.1829 | 191.9536 | <.0001 |
| age1 | 45 | 1 | 2.1821 | 0.1816 | 144.3139 | <.0001 |
| age1 | 55 | 1 | 1.2861 | 0.1851 | 48.2560 | <.0001 |
| year_counted | 2000 | 1 | 0.2960 | 0.1558 | 3.6070 | 0.0575 |
| year_counted | 2001 | 1 | 0.3558 | 0.1532 | 5.3926 | 0.0202 |
| year_counted | 2002 | 1 | 0.6327 | 0.1522 | 17.2725 | <.0001 |
| year_counted | 2003 | 1 | 0.3601 | 0.1540 | 5.4701 | 0.0193 |
| year_counted | 2004 | 1 | 0.0519 | 0.1550 | 0.1119 | 0.7380 |
| year_counted | 2005 | 1 | 0.1071 | 0.1585 | 0.4566 | 0.4992 |

The LOGISTIC Procedure

Analysis of Maximum Likelihood Estimates

| Parameter | | DF | Estimate | Standard Error | Wald Chi-Square | Pr > ChiSq |
|---|---|---|---|---|---|---|
| year_counted | 2006 | 1 | 0.2666 | 0.1541 | 2.9939 | 0.0836 |
| year_counted | 2007 | 1 | 0.2375 | 0.1558 | 2.3248 | 0.1273 |
| year_counted | 2008 | 1 | 0.0265 | 0.1563 | 0.0288 | 0.8653 |
| year_counted | 2009 | 1 | 0.1035 | 0.1646 | 0.3951 | 0.5296 |
| sex | | 1 | 0.8067 | 0.0740 | 118.8056 | <.0001 |
| Ethnicity | 1 | 1 | -0.1592 | 0.1083 | 2.1587 | 0.1418 |
| race2 | Asian | 1 | -1.5191 | 0.1913 | 63.0836 | <.0001 |
| race2 | Black | 1 | 0.7127 | 0.0914 | 60.7680 | <.0001 |
| IDU | | 1 | 0.8520 | 0.1322 | 41.5251 | <.0001 |
| USYEARs | 0 | 0 | 0 | . | . | . |
| USYEARs | 1 | 1 | -0.2214 | 0.1882 | 1.3842 | 0.2394 |
| USYEARs | 2 | 1 | -0.2966 | 0.1663 | 3.1797 | 0.0746 |
| USYEARs | 7 | 1 | -0.2173 | 0.1813 | 1.4366 | 0.2307 |
| USYEARs | 15 | 1 | -0.3043 | 0.1736 | 3.0739 | 0.0796 |
| NoInject | | 1 | 0.4507 | 0.0956 | 22.2336 | <.0001 |
| alcohol | | 1 | -0.4835 | 0.0839 | 33.1815 | <.0001 |
| homeless | | 1 | -0.0633 | 0.1102 | 0.3305 | 0.5654 |
| prison | | 1 | -0.3202 | 0.1128 | 8.0599 | 0.0045 |
| LTCRes | | 1 | 0.1473 | 0.2258 | 0.4253 | 0.5143 |
| location | 2 | 1 | 0.8331 | 0.0767 | 117.8244 | <.0001 |

| | | | | | | |
|---|---|---|---|---|---|---|
| location | 3 | 1 | 1.1866 | 0.1065 | 124.1841 | <.0001 |
| Occupation | 0 | 1 | 0.6738 | 0.0653 | 106.5139 | <.0001 |
| BORDER*alcohol | | 1 | 0.3733 | 0.2077 | 3.2300 | 0.0723 |
| BORDER*USYEARs | 0 | 1 | -0.0739 | 0.2899 | 0.0650 | 0.7988 |
| BORDER*USYEARs | 1 | 1 | -0.00581 | 0.3862 | 0.0002 | 0.9880 |
| BORDER*USYEARs | 2 | 1 | 0.3146 | 0.3681 | 0.7306 | 0.3927 |
| BORDER*USYEARs | 7 | 1 | 0.5128 | 0.4051 | 1.6027 | 0.2055 |
| BORDER*USYEARs | 15 | 1 | 0.5688 | 0.3518 | 2.6142 | 0.1059 |
| BORDER*location | 2 | 1 | 0.5768 | 0.2296 | 6.3081 | 0.0120 |
| BORDER*location | 3 | 1 | 0.2085 | 0.3231 | 0.4164 | 0.5187 |

Odds Ratio Estimates

| Effect | | Point Estimate | 95% Wald Confidence Limits | |
|---|---|---|---|---|
| FB | 1 vs 0 | 1.235 | 0.931 | 1.638 |
| age1 | 25 vs 65 | 3.728 | 2.556 | 5.437 |
| age1 | 35 vs 65 | 12.609 | 8.810 | 18.046 |
| age1 | 45 vs 65 | 8.865 | 6.210 | 12.656 |
| age1 | 55 vs 65 | 3.619 | 2.518 | 5.202 |
| year_counted | 2000 vs 2010 | 1.344 | 0.991 | 1.825 |
| year_counted | 2001 vs 2010 | 1.427 | 1.057 | 1.927 |
| year_counted | 2002 vs 2010 | 1.883 | 1.397 | 2.537 |
| year_counted | 2003 vs 2010 | 1.434 | 1.060 | 1.939 |

The LOGISTIC Procedure

Odds Ratio Estimates

| Effect | | Point Estimate | 95% Wald Confidence Limits | |
|---|---|---|---|---|
| year_counted | 2004 vs 2010 | 1.053 | 0.777 | 1.427 |
| year_counted | 2005 vs 2010 | 1.113 | 0.816 | 1.519 |
| year_counted | 2006 vs 2010 | 1.306 | 0.965 | 1.766 |
| year_counted | 2007 vs 2010 | 1.268 | 0.934 | 1.721 |
| year_counted | 2008 vs 2010 | 1.027 | 0.756 | 1.395 |
| year_counted | 2009 vs 2010 | 1.109 | 0.803 | 1.531 |
| sex | | 2.240 | 1.938 | 2.590 |
| Ethnicity | 1 vs 0 | 0.853 | 0.690 | 1.055 |
| race2 | Asian vs White | 0.219 | 0.150 | 0.318 |
| race2 | Black vs White | 2.039 | 1.705 | 2.440 |
| IDU | | 2.344 | 1.809 | 3.038 |
| NoInject | | 1.569 | 1.301 | 1.893 |
| homeless | | 0.939 | 0.756 | 1.165 |
| prison | | 0.726 | 0.582 | 0.906 |
| LTCRes | | 1.159 | 0.744 | 1.804 |
| Occupation | 0 vs 1 | 1.962 | 1.726 | 2.229 |

Association of Predicted Probabilities and Observed Responses

| | | | |
|---|---|---|---|
| Percent Concordant | 79.4 | Somers' D | 0.593 |
| Percent Discordant | 20.2 | Gamma | 0.595 |
| Percent Tied | 0.4 | Tau-a | 0.146 |
| Pairs | 14842724 | c | 0.796 |

Partition for the Hosmer and Lemeshow Test

| | | HIV = 1 | | HIV = 0 | |
|---|---|---|---|---|---|
| Group | Total | Observed | Expected | Observed | Expected |
| 1 | 1099 | 18 | 12.57 | 1081 | 1086.43 |
| 2 | 1099 | 29 | 28.24 | 1070 | 1070.76 |
| 3 | 1099 | 48 | 44.30 | 1051 | 1054.70 |
| 4 | 1100 | 57 | 62.43 | 1043 | 1037.57 |
| 5 | 1100 | 71 | 87.30 | 1029 | 1012.70 |
| 6 | 1097 | 128 | 118.01 | 969 | 978.99 |
| 7 | 1099 | 147 | 159.44 | 952 | 939.56 |
| 8 | 1100 | 227 | 220.55 | 873 | 879.45 |
| 9 | 1099 | 320 | 316.70 | 779 | 782.30 |
| 10 | 1097 | 532 | 527.47 | 565 | 569.53 |

The LOGISTIC Procedure

Hosmer and Lemeshow Goodness-of-Fit Test

| Chi-Square | DF | Pr > ChiSq |
|---|---|---|
| 8.9628 | 8 | 0.3454 |

Step 4 *Model with alcohol*USYEARS removed.

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The LOGISTIC Procedure

Model Information

| | |
|---|---|
| Data Set | TBHIV.LOGISTIC2 |
| Response Variable | HIV |
| Number of Response Levels | 2 |
| Model | binary logit |
| Optimization Technique | Fisher's scoring |

| | |
|---|---|
| Number of Observations Read | 11282 |
| Number of Observations Used | 10989 |

Response Profile

| Ordered Value | HIV | Total Frequency |
|---|---|---|
| 1 | 0 | 9412 |
| 2 | 1 | 1577 |

Probability modeled is HIV=1.

NOTE: 293 observations were deleted due to missing values for the response or explanatory variables.

Class Level Information

| Class | Value | Design Variables | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| FB | 0 | 0 | | | | | | | | |
| | 1 | 1 | | | | | | | | |
| year_counted | 2000 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 2001 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 2002 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 2003 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 |
| | 2004 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 |
| | 2005 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| | 2006 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| | 2007 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| | 2008 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| | 2009 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 2010 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| age1 | 25 | 1 | 0 | 0 | 0 | | | | | |
| | 35 | 0 | 1 | 0 | 0 | | | | | |
| | 45 | 0 | 0 | 1 | 0 | | | | | |

| | | | | |
|---|---|---|---|---|
| 55 | 0 | 0 | 0 | 1 |
| 65 | 0 | 0 | 0 | 0 |

The LOGISTIC Procedure

Class Level Information

| Class | Value | Design Variables | | | | |
|---|---|---|---|---|---|---|
| USYEARs | 0 | 1 | 0 | 0 | 0 | 0 |
| | 1 | 0 | 1 | 0 | 0 | 0 |
| | 2 | 0 | 0 | 1 | 0 | 0 |
| | 7 | 0 | 0 | 0 | 1 | 0 |
| | 15 | 0 | 0 | 0 | 0 | 1 |
| | 20 | 0 | 0 | 0 | 0 | 0 |
| race2 | Asian | 1 | 0 | | | |
| | Black | 0 | 1 | | | |
| | White | 0 | 0 | | | |
| location | 1 | 0 | 0 | | | |
| | 2 | 1 | 0 | | | |
| | 3 | 0 | 1 | | | |
| Occupation | 0 | 1 | | | | |
| | 1 | 0 | | | | |
| Ethnicity | 0 | 0 | | | | |
| | 1 | 1 | | | | |

Model Convergence Status

Convergence criterion (GCONV=1E-8) satisfied.

Model Fit Statistics

| Criterion | Intercept Only | Intercept and Covariates |
|---|---|---|
| AIC | 9041.095 | 7477.700 |
| SC | 9048.400 | 7747.972 |
| -2 Log L | 9039.095 | 7403.700 |

Testing Global Null Hypothesis: BETA=0

| Test | Chi-Square | DF | Pr > ChiSq |
|---|---|---|---|
| Likelihood Ratio | 1635.3954 | 36 | <.0001 |
| Score | 1578.6195 | 36 | <.0001 |
| Wald | 1221.3175 | 36 | <.0001 |

The LOGISTIC Procedure

Type 3 Analysis of Effects

| Effect | DF | Wald Chi-Square | Pr > ChiSq |
|---|---|---|---|
| BORDER | 1 | 23.6687 | <.0001 |
| FB | 1 | 2.5989 | 0.1069 |
| age1 | 4 | 400.6134 | <.0001 |
| year_counted | 10 | 37.5892 | <.0001 |
| sex | 1 | 118.7003 | <.0001 |
| Ethnicity | 1 | 2.9515 | 0.0858 |
| race2 | 2 | 207.6081 | <.0001 |
| IDU | 1 | 41.1365 | <.0001 |
| USYEARs | 4 | 3.0012 | 0.5576 |
| NoInject | 1 | 22.5512 | <.0001 |
| alcohol | 1 | 32.7800 | <.0001 |
| homeless | 1 | 0.3077 | 0.5791 |
| prison | 1 | 8.1568 | 0.0043 |
| LTCRes | 1 | 0.4061 | 0.5240 |
| location | 2 | 200.2052 | <.0001 |
| Occupation | 1 | 108.0638 | <.0001 |
| BORDER*alcohol | 1 | 2.7236 | 0.0989 |
| BORDER*location | 2 | 6.2356 | 0.0443 |

*Border*alcohol term will be dropped in the next model; it is least significant interaction term (0.10).

NOTE: The following parameters have been set to 0, since the variables are a linear combination

of other variables as shown.

USYEARs0 = Intercept - FB1

Analysis of Maximum Likelihood Estimates

| Parameter | | DF | Estimate | Standard Error | Wald Chi-Square | Pr > ChiSq |
|---|---|---|---|---|---|---|
| Intercept | | 1 | -5.0678 | 0.2398 | 446.5758 | <.0001 |
| BORDER | | 1 | -0.7352 | 0.1511 | 23.6687 | <.0001 |
| FB | 1 | 1 | 0.2023 | 0.1255 | 2.5989 | 0.1069 |
| age1 | 25 | 1 | 1.3094 | 0.1925 | 46.2675 | <.0001 |
| age1 | 35 | 1 | 2.5277 | 0.1829 | 191.0784 | <.0001 |
| age1 | 45 | 1 | 2.1850 | 0.1816 | 144.7231 | <.0001 |
| age1 | 55 | 1 | 1.2876 | 0.1851 | 48.3812 | <.0001 |
| year_counted | 2000 | 1 | 0.3122 | 0.1557 | 4.0220 | 0.0449 |
| year_counted | 2001 | 1 | 0.3666 | 0.1531 | 5.7330 | 0.0166 |
| year_counted | 2002 | 1 | 0.6433 | 0.1521 | 17.8803 | <.0001 |
| year_counted | 2003 | 1 | 0.3738 | 0.1538 | 5.9102 | 0.0151 |
| year_counted | 2004 | 1 | 0.0629 | 0.1550 | 0.1649 | 0.6847 |
| year_counted | 2005 | 1 | 0.1189 | 0.1584 | 0.5629 | 0.4531 |
| year_counted | 2006 | 1 | 0.2783 | 0.1540 | 3.2669 | 0.0707 |

The LOGISTIC Procedure

Analysis of Maximum Likelihood Estimates

| Parameter | | DF | Estimate | Standard Error | Wald Chi-Square | Pr > ChiSq |
|---|---|---|---|---|---|---|
| year_counted | 2007 | 1 | 0.2494 | 0.1557 | 2.5657 | 0.1092 |
| year_counted | 2008 | 1 | 0.0365 | 0.1562 | 0.0546 | 0.8152 |
| year_counted | 2009 | 1 | 0.1110 | 0.1646 | 0.4554 | 0.4998 |
| sex | | 1 | 0.8060 | 0.0740 | 118.7003 | <.0001 |
| Ethnicity | 1 | 1 | -0.1841 | 0.1072 | 2.9515 | 0.0858 |
| race2 | Asian | 1 | -1.5589 | 0.1899 | 67.4075 | <.0001 |
| race2 | Black | 1 | 0.7125 | 0.0914 | 60.8081 | <.0001 |
| IDU | | 1 | 0.8467 | 0.1320 | 41.1365 | <.0001 |
| USYEARs | 0 | 0 | 0 | . | . | . |
| USYEARs | 1 | 1 | -0.2149 | 0.1649 | 1.6969 | 0.1927 |
| USYEARs | 2 | 1 | -0.2345 | 0.1484 | 2.4971 | 0.1141 |
| USYEARs | 7 | 1 | -0.1236 | 0.1624 | 0.5794 | 0.4465 |
| USYEARs | 15 | 1 | -0.1833 | 0.1519 | 1.4556 | 0.2276 |
| NoInject | | 1 | 0.4535 | 0.0955 | 22.5512 | <.0001 |
| alcohol | | 1 | -0.4801 | 0.0839 | 32.7800 | <.0001 |
| homeless | | 1 | -0.0611 | 0.1101 | 0.3077 | 0.5791 |
| prison | | 1 | -0.3160 | 0.1106 | 8.1568 | 0.0043 |
| LTCRes | | 1 | 0.1438 | 0.2257 | 0.4061 | 0.5240 |
| location | 2 | 1 | 0.8303 | 0.0767 | 117.2121 | <.0001 |
| location | 3 | 1 | 1.1850 | 0.1065 | 123.9048 | <.0001 |

| | | | | | | |
|---|---|---|---|---|---|---|
| Occupation | 0 | 1 | 0.6776 | 0.0652 | 108.0638 | <.0001 |
| BORDER*alcohol | | 1 | 0.3391 | 0.2055 | 2.7236 | 0.0989 |
| BORDER*location | 2 | 1 | 0.5657 | 0.2276 | 6.1766 | 0.0129 |
| BORDER*location | 3 | 1 | 0.2425 | 0.3205 | 0.5726 | 0.4492 |

Odds Ratio Estimates

| Effect | | Point Estimate | 95% Wald Confidence Limits | |
|---|---|---|---|---|
| FB | 1 vs 0 | 1.224 | 0.957 | 1.565 |
| age1 | 25 vs 65 | 3.704 | 2.540 | 5.402 |
| age1 | 35 vs 65 | 12.524 | 8.752 | 17.923 |
| age1 | 45 vs 65 | 8.890 | 6.228 | 12.692 |
| age1 | 55 vs 65 | 3.624 | 2.521 | 5.209 |
| year_counted | 2000 vs 2010 | 1.366 | 1.007 | 1.854 |
| year_counted | 2001 vs 2010 | 1.443 | 1.069 | 1.948 |
| year_counted | 2002 vs 2010 | 1.903 | 1.412 | 2.564 |
| year_counted | 2003 vs 2010 | 1.453 | 1.075 | 1.964 |
| year_counted | 2004 vs 2010 | 1.065 | 0.786 | 1.443 |
| year_counted | 2005 vs 2010 | 1.126 | 0.826 | 1.536 |
| year_counted | 2006 vs 2010 | 1.321 | 0.977 | 1.786 |
| year_counted | 2007 vs 2010 | 1.283 | 0.946 | 1.741 |
| year_counted | 2008 vs 2010 | 1.037 | 0.764 | 1.409 |
| year_counted | 2009 vs 2010 | 1.117 | 0.809 | 1.543 |

The LOGISTIC Procedure

Odds Ratio Estimates

| Effect | | Point Estimate | 95% Wald Confidence Limits | |
|---|---|---|---|---|
| sex | | 2.239 | 1.937 | 2.588 |
| Ethnicity | 1 vs 0 | 0.832 | 0.674 | 1.026 |
| race2 | Asian vs White | 0.210 | 0.145 | 0.305 |
| race2 | Black vs White | 2.039 | 1.705 | 2.439 |
| IDU | | 2.332 | 1.800 | 3.021 |
| USYEARs | 1 vs 20 | 0.807 | 0.584 | 1.115 |
| USYEARs | 2 vs 20 | 0.791 | 0.591 | 1.058 |
| USYEARs | 7 vs 20 | 0.884 | 0.643 | 1.215 |
| USYEARs | 15 vs 20 | 0.833 | 0.618 | 1.121 |
| NoInject | | 1.574 | 1.305 | 1.898 |
| homeless | | 0.941 | 0.758 | 1.167 |
| prison | | 0.729 | 0.587 | 0.906 |
| LTCRes | | 1.155 | 0.742 | 1.797 |
| Occupation | 0 vs 1 | 1.969 | 1.733 | 2.238 |

Association of Predicted Probabilities and Observed Responses

| | | | |
|---|---|---|---|
| Percent Concordant | 79.4 | Somers' D | 0.591 |
| Percent Discordant | 20.3 | Gamma | 0.593 |

| | | | |
|---|---|---|---|
| Percent Tied | 0.4 | Tau-a | 0.145 |
| Pairs | 14842724 | c | 0.796 |

Partition for the Hosmer and Lemeshow Test

| | | HIV = 1 | | HIV = 0 | |
|---|---|---|---|---|---|
| Group | Total | Observed | Expected | Observed | Expected |
| 1 | 1101 | 19 | 12.84 | 1082 | 1088.16 |
| 2 | 1100 | 29 | 28.34 | 1071 | 1071.66 |
| 3 | 1099 | 50 | 44.80 | 1049 | 1054.20 |
| 4 | 1099 | 52 | 62.38 | 1047 | 1036.62 |
| 5 | 1101 | 78 | 87.42 | 1023 | 1013.58 |
| 6 | 1100 | 125 | 118.43 | 975 | 981.57 |
| 7 | 1100 | 143 | 160.13 | 957 | 939.87 |
| 8 | 1099 | 228 | 221.12 | 871 | 877.88 |
| 9 | 1099 | 321 | 317.07 | 778 | 781.93 |
| 10 | 1091 | 532 | 524.48 | 559 | 566.52 |

The LOGISTIC Procedure

Hosmer and Lemeshow Goodness-of-Fit Test

| Chi-Square | DF | Pr > ChiSq |
|---|---|---|
| 9.6685 | 8 | 0.2891 |

Step 5 *Border*alcohol dropped from this model

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The LOGISTIC Procedure

Model Information

| | |
|---|---|
| Data Set | TBHIV.LOGISTIC2 |
| Response Variable | HIV |
| Number of Response Levels | 2 |
| Model | binary logit |
| Optimization Technique | Fisher's scoring |

| | |
|---|---|
| Number of Observations Read | 11282 |
| Number of Observations Used | 10989 |

Response Profile

| Ordered Value | HIV | Total Frequency |
|---|---|---|
| 1 | 0 | 9412 |
| 2 | 1 | 1577 |

Probability modeled is HIV=1.

NOTE: 293 observations were deleted due to missing values for the response or explanatory variables.

Class Level Information

| Class | Value | Design Variables | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| FB | 0 | 0 | | | | | | | | |
| | 1 | 1 | | | | | | | | |
| year_counted | 2000 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 2001 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 2002 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 2003 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 |
| | 2004 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 |
| | 2005 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| | 2006 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| | 2007 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| | 2008 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| | 2009 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 2010 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| USYEARs | 0 | 1 | 0 | 0 | 0 | 0 | | | | |
| | 1 | 0 | 1 | 0 | 0 | 0 | | | | |
| | 2 | 0 | 0 | 1 | 0 | 0 | | | | |

| | | | | | |
|---|---|---|---|---|---|
| 7 | 0 | 0 | 0 | 1 | 0 |
| 15 | 0 | 0 | 0 | 0 | 1 |

The LOGISTIC Procedure

Class Level Information

| Class | Value | Design Variables | | | | |
|---|---|---|---|---|---|---|
| | 20 | 0 | 0 | 0 | 0 | 0 |
| age1 | 25 | 1 | 0 | 0 | 0 | |
| | 35 | 0 | 1 | 0 | 0 | |
| | 45 | 0 | 0 | 1 | 0 | |
| | 55 | 0 | 0 | 0 | 1 | |
| | 65 | 0 | 0 | 0 | 0 | |
| race2 | Asian | 1 | 0 | | | |
| | Black | 0 | 1 | | | |
| | White | 0 | 0 | | | |
| location | 1 | 0 | 0 | | | |
| | 2 | 1 | 0 | | | |
| | 3 | 0 | 1 | | | |
| Occupation | 0 | 1 | | | | |
| | 1 | 0 | | | | |
| Ethnicity | 0 | 0 | | | | |
| | 1 | 1 | | | | |

Model Convergence Status

Convergence criterion (GCONV=1E-8) satisfied.

Model Fit Statistics

| Criterion | Intercept Only | Intercept and Covariates |
|---|---|---|
| AIC | 9041.095 | 7478.390 |
| SC | 9048.400 | 7741.357 |
| -2 Log L | 9039.095 | 7406.390 |

Testing Global Null Hypothesis: BETA=0

| Test | Chi-Square | DF | Pr > ChiSq |
|---|---|---|---|
| Likelihood Ratio | 1632.7052 | 35 | <.0001 |
| Score | 1576.7572 | 35 | <.0001 |
| Wald | 1220.8425 | 35 | <.0001 |

The LOGISTIC Procedure

Type 3 Analysis of Effects

| Effect | DF | Wald Chi-Square | Pr > ChiSq |
|---|---|---|---|
| BORDER | 1 | 22.3428 | <.0001 |
| FB | 1 | 2.7122 | 0.0996 |
| age1 | 4 | 404.4143 | <.0001 |
| year_counted | 10 | 37.2144 | <.0001 |
| sex | 1 | 119.6223 | <.0001 |
| Ethnicity | 1 | 2.8748 | 0.0900 |
| race2 | 2 | 207.3826 | <.0001 |
| IDU | 1 | 42.6628 | <.0001 |
| USYEARs | 4 | 3.1344 | 0.5356 |
| NoInject | 1 | 23.3144 | <.0001 |
| alcohol | 1 | 30.4156 | <.0001 |
| homeless | 1 | 0.4728 | 0.4917 |
| prison | 1 | 8.3093 | 0.0039 |
| LTCRes | 1 | 0.4052 | 0.5244 |
| location | 2 | 201.4582 | <.0001 |
| Occupation | 1 | 108.8718 | <.0001 |
| BORDER*location | 2 | 6.0024 | 0.0497 |

*Border*location can be dropped; it rounds up to 0.05 and is not significant.

NOTE: The following parameters have been set to 0, since the variables are a linear combination

of other variables as shown.

USYEARs0 = Intercept - FB1

Analysis of Maximum Likelihood Estimates

| Parameter | | DF | Estimate | Standard Error | Wald Chi-Square | Pr > ChiSq |
|---|---|---|---|---|---|---|
| Intercept | | 1 | -5.0918 | 0.2395 | 451.8612 | <.0001 |
| BORDER | | 1 | -0.6202 | 0.1312 | 22.3428 | <.0001 |
| FB | 1 | 1 | 0.2065 | 0.1254 | 2.7122 | 0.0996 |
| age1 | 25 | 1 | 1.3176 | 0.1924 | 46.8774 | <.0001 |
| age1 | 35 | 1 | 2.5389 | 0.1827 | 193.0145 | <.0001 |
| age1 | 45 | 1 | 2.1923 | 0.1816 | 145.7323 | <.0001 |
| age1 | 55 | 1 | 1.2919 | 0.1851 | 48.7121 | <.0001 |
| year_counted | 2000 | 1 | 0.3086 | 0.1557 | 3.9282 | 0.0475 |
| year_counted | 2001 | 1 | 0.3616 | 0.1531 | 5.5798 | 0.0182 |
| year_counted | 2002 | 1 | 0.6403 | 0.1521 | 17.7144 | <.0001 |
| year_counted | 2003 | 1 | 0.3729 | 0.1538 | 5.8767 | 0.0153 |
| year_counted | 2004 | 1 | 0.0633 | 0.1550 | 0.1668 | 0.6830 |
| year_counted | 2005 | 1 | 0.1175 | 0.1585 | 0.5504 | 0.4582 |
| year_counted | 2006 | 1 | 0.2794 | 0.1540 | 3.2902 | 0.0697 |
| year_counted | 2007 | 1 | 0.2494 | 0.1557 | 2.5642 | 0.1093 |

The LOGISTIC Procedure

Analysis of Maximum Likelihood Estimates

| Parameter | | DF | Estimate | Standard Error | Wald Chi-Square | Pr > ChiSq |
|---|---|---|---|---|---|---|
| year_counted | 2008 | 1 | 0.0349 | 0.1562 | 0.0501 | 0.8229 |
| year_counted | 2009 | 1 | 0.1128 | 0.1646 | 0.4694 | 0.4932 |
| sex | | 1 | 0.8086 | 0.0739 | 119.6223 | <.0001 |
| Ethnicity | 1 | 1 | -0.1817 | 0.1072 | 2.8748 | 0.0900 |
| race2 | Asian | 1 | -1.5521 | 0.1899 | 66.8269 | <.0001 |
| race2 | Black | 1 | 0.7153 | 0.0914 | 61.3073 | <.0001 |
| IDU | | 1 | 0.8610 | 0.1318 | 42.6628 | <.0001 |
| USYEARs | 0 | 0 | 0 | . | . | . |
| USYEARs | 1 | 1 | -0.2213 | 0.1647 | 1.8041 | 0.1792 |
| USYEARs | 2 | 1 | -0.2382 | 0.1482 | 2.5820 | 0.1081 |
| USYEARs | 7 | 1 | -0.1268 | 0.1623 | 0.6103 | 0.4347 |
| USYEARs | 15 | 1 | -0.1880 | 0.1518 | 1.5338 | 0.2155 |
| NoInject | | 1 | 0.4608 | 0.0954 | 23.3144 | <.0001 |
| alcohol | | 1 | -0.4348 | 0.0788 | 30.4156 | <.0001 |
| homeless | | 1 | -0.0755 | 0.1098 | 0.4728 | 0.4917 |
| prison | | 1 | -0.3187 | 0.1106 | 8.3093 | 0.0039 |
| LTCRes | | 1 | 0.1435 | 0.2255 | 0.4052 | 0.5244 |
| location | 2 | 1 | 0.8348 | 0.0767 | 118.5264 | <.0001 |
| location | 3 | 1 | 1.1864 | 0.1065 | 124.1214 | <.0001 |
| Occupation | 0 | 1 | 0.6799 | 0.0652 | 108.8718 | <.0001 |

| | | | | | |
|---|---|---|---|---|---|
| BORDER*location 2 | 1 | 0.5522 | 0.2265 | 5.9450 | 0.0148 |
| BORDER*location 3 | 1 | 0.2382 | 0.3197 | 0.5555 | 0.4561 |

Odds Ratio Estimates

| Effect | | Point Estimate | 95% Wald Confidence Limits | |
|---|---|---|---|---|
| FB | 1 vs 0 | 1.229 | 0.962 | 1.572 |
| age1 | 25 vs 65 | 3.735 | 2.561 | 5.446 |
| age1 | 35 vs 65 | 12.666 | 8.853 | 18.121 |
| age1 | 45 vs 65 | 8.956 | 6.274 | 12.785 |
| age1 | 55 vs 65 | 3.640 | 2.532 | 5.231 |
| year_counted | 2000 vs 2010 | 1.361 | 1.003 | 1.847 |
| year_counted | 2001 vs 2010 | 1.436 | 1.063 | 1.938 |
| year_counted | 2002 vs 2010 | 1.897 | 1.408 | 2.556 |
| year_counted | 2003 vs 2010 | 1.452 | 1.074 | 1.963 |
| year_counted | 2004 vs 2010 | 1.065 | 0.786 | 1.443 |
| year_counted | 2005 vs 2010 | 1.125 | 0.824 | 1.534 |
| year_counted | 2006 vs 2010 | 1.322 | 0.978 | 1.788 |
| year_counted | 2007 vs 2010 | 1.283 | 0.946 | 1.741 |
| year_counted | 2008 vs 2010 | 1.036 | 0.762 | 1.406 |
| year_counted | 2009 vs 2010 | 1.119 | 0.811 | 1.545 |
| sex | | 2.245 | 1.942 | 2.595 |
| Ethnicity | 1 vs 0 | 0.834 | 0.676 | 1.029 |

The LOGISTIC Procedure

Odds Ratio Estimates

| Effect | | Point Estimate | 95% Wald Confidence Limits | |
|---|---|---|---|---|
| race2 | Asian vs White | 0.212 | 0.146 | 0.307 |
| race2 | Black vs White | 2.045 | 1.710 | 2.446 |
| IDU | | 2.366 | 1.827 | 3.063 |
| USYEARs | 1 vs 20 | 0.802 | 0.580 | 1.107 |
| USYEARs | 2 vs 20 | 0.788 | 0.589 | 1.054 |
| USYEARs | 7 vs 20 | 0.881 | 0.641 | 1.211 |
| USYEARs | 15 vs 20 | 0.829 | 0.615 | 1.116 |
| NoInject | | 1.585 | 1.315 | 1.911 |
| alcohol | | 0.647 | 0.555 | 0.756 |
| homeless | | 0.927 | 0.748 | 1.150 |
| prison | | 0.727 | 0.585 | 0.903 |
| LTCRes | | 1.154 | 0.742 | 1.796 |
| Occupation | 0 vs 1 | 1.974 | 1.737 | 2.242 |

Association of Predicted Probabilities and Observed Responses

| | | | |
|---|---|---|---|
| Percent Concordant | 79.4 | Somers' D | 0.591 |
| Percent Discordant | 20.3 | Gamma | 0.593 |
| Percent Tied | 0.4 | Tau-a | 0.145 |

| | | | |
|---|---|---|---|
| Pairs | 14842724 | c | 0.796 |

Partition for the Hosmer and Lemeshow Test

| | | HIV = 1 | | HIV = 0 | |
|---|---|---|---|---|---|
| Group | Total | Observed | Expected | Observed | Expected |
| 1 | 1100 | 19 | 12.90 | 1081 | 1087.10 |
| 2 | 1099 | 31 | 28.53 | 1068 | 1070.47 |
| 3 | 1101 | 50 | 44.78 | 1051 | 1056.22 |
| 4 | 1098 | 51 | 62.48 | 1047 | 1035.52 |
| 5 | 1096 | 79 | 87.15 | 1017 | 1008.85 |
| 6 | 1101 | 124 | 118.28 | 977 | 982.72 |
| 7 | 1099 | 144 | 159.80 | 955 | 939.20 |
| 8 | 1099 | 230 | 220.25 | 869 | 878.75 |
| 9 | 1099 | 313 | 316.33 | 786 | 782.67 |
| 10 | 1097 | 536 | 526.50 | 561 | 570.50 |

Hosmer and Lemeshow Goodness-of-Fit Test

| Chi-Square | DF | Pr > ChiSq |
|---|---|---|
| 9.8948 | 8 | 0.2725 |

*Goodness of fit test is not as good as the full model with all interaction terms, but is still insignificant.

Step 6: Gold Standard Model  *this is my Gold Standard Model that includes all variables but doesn't include any interaction terms; I will use the OR from this model to assess confounding (this will be the OR that I compare other ORs to as I drop variables from my model;

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The LOGISTIC Procedure

Model Information

| | |
|---|---|
| Data Set | TBHIV.LOGISTIC2 |
| Response Variable | HIV |
| Number of Response Levels | 2 |
| Model | binary logit |
| Optimization Technique | Fisher's scoring |

| | |
|---|---|
| Number of Observations Read | 11282 |
| Number of Observations Used | 10989 |

Response Profile

| Ordered Value | HIV | Total Frequency |
|---|---|---|

| | | |
|---|---|---|
| 1 | 0 | 9412 |
| 2 | 1 | 1577 |

Probability modeled is HIV=1.

NOTE: 293 observations were deleted due to missing values for the response or explanatory variables.

Class Level Information

| Class | Value | Design Variables | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| FB | 0 | 0 | | | | | | | | |
| | 1 | 1 | | | | | | | | |
| year_counted | 2000 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 2001 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 2002 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 2003 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 |
| | 2004 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 |
| | 2005 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| | 2006 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| | 2007 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| | 2008 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 2009 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1 | | | | | | | | | | |
| | 2010 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | | | | | | | | | | |
| USYEARs | 0 | 1 | 0 | 0 | 0 | 0 | | | | |
| | 1 | 0 | 1 | 0 | 0 | 0 | | | | |
| | 2 | 0 | 0 | 1 | 0 | 0 | | | | |
| | 7 | 0 | 0 | 0 | 1 | 0 | | | | |
| | 15 | 0 | 0 | 0 | 0 | 1 | | | | |



The LOGISTIC Procedure

Class Level Information

| Class | Value | Design Variables | | | | |
|---|---|---|---|---|---|---|
| | 20 | 0 | 0 | 0 | 0 | 0 |
| age1 | 25 | 1 | 0 | 0 | 0 | |
| | 35 | 0 | 1 | 0 | 0 | |
| | 45 | 0 | 0 | 1 | 0 | |
| | 55 | 0 | 0 | 0 | 1 | |
| | 65 | 0 | 0 | 0 | 0 | |
| race2 | Asian | 1 | 0 | | | |
| | Black | 0 | 1 | | | |
| | White | 0 | 0 | | | |

| | | | |
|---|---|---|---|
| location | 1 | 0 | 0 |
| | 2 | 1 | 0 |
| | 3 | 0 | 1 |
| Occupation | 0 | 1 | |
| | 1 | 0 | |
| Ethnicity | 0 | 0 | |
| | 1 | 1 | |

Model Convergence Status

Convergence criterion (GCONV=1E-8) satisfied.

Model Fit Statistics

| Criterion | Intercept Only | Intercept and Covariates |
|---|---|---|
| AIC | 9041.095 | 7480.241 |
| SC | 9048.400 | 7728.600 |
| -2 Log L | 9039.095 | 7412.241 |

Testing Global Null Hypothesis: BETA=0

| Test | Chi-Square | DF | Pr > ChiSq |
|---|---|---|---|
| Likelihood Ratio | 1626.8537 | 33 | <.0001 |
| Score | 1574.3059 | 33 | <.0001 |
| Wald | 1223.3705 | 33 | <.0001 |



The LOGISTIC Procedure

Type 3 Analysis of Effects

| Effect | DF | Wald Chi-Square | Pr > ChiSq |
|---|---|---|---|
| BORDER | 1 | 18.7470 | <.0001 |
| FB | 1 | 2.8260 | 0.0928 |
| age1 | 4 | 403.9406 | <.0001 |
| year_counted | 10 | 37.7005 | <.0001 |
| sex | 1 | 118.9423 | <.0001 |
| Ethnicity | 1 | 2.9498 | 0.0859 |
| race2 | 2 | 207.3788 | <.0001 |
| IDU | 1 | 43.0944 | <.0001 |
| USYEARs | 4 | 3.5278 | 0.4737 |
| NoInject | 1 | 23.4284 | <.0001 |
| alcohol | 1 | 30.1381 | <.0001 |
| homeless | 1 | 0.4004 | 0.5269 |
| prison | 1 | 9.4440 | 0.0021 |

| | | | |
|---|---|---|---|
| LTCRes | 1 | 0.3591 | 0.5490 |
| location | 2 | 245.4490 | <.0001 |
| Occupation | 1 | 109.1809 | <.0001 |

NOTE: The following parameters have been set to 0, since the variables are a linear combination of other variables as shown.

USYEARs0 = Intercept - FB1

Analysis of Maximum Likelihood Estimates

| Parameter | | DF | Estimate | Standard Error | Wald Chi-Square | Pr > ChiSq |
|---|---|---|---|---|---|---|
| Intercept | | 1 | -5.1065 | 0.2396 | 454.2827 | <.0001 |
| BORDER | | 1 | -0.4627 | 0.1069 | 18.7470 | <.0001 |
| FB | 1 | 1 | 0.2102 | 0.1251 | 2.8260 | 0.0928 |
| age1 | 25 | 1 | 1.3185 | 0.1925 | 46.9140 | <.0001 |
| age1 | 35 | 1 | 2.5402 | 0.1827 | 193.2306 | <.0001 |
| age1 | 45 | 1 | 2.1909 | 0.1816 | 145.6124 | <.0001 |
| age1 | 55 | 1 | 1.2948 | 0.1850 | 48.9624 | <.0001 |
| year_counted | 2000 | 1 | 0.3120 | 0.1557 | 4.0146 | 0.0451 |
| year_counted | 2001 | 1 | 0.3646 | 0.1531 | 5.6683 | 0.0173 |
| year_counted | 2002 | 1 | 0.6420 | 0.1521 | 17.8037 | <.0001 |
| year_counted | 2003 | 1 | 0.3808 | 0.1538 | 6.1273 | 0.0133 |
| year_counted | 2004 | 1 | 0.0648 | 0.1550 | 0.1747 | 0.6760 |
| year_counted | 2005 | 1 | 0.1177 | 0.1585 | 0.5517 | 0.4576 |

| | | | | | | |
|---|---|---|---|---|---|---|
| year_counted | 2006 | 1 | 0.2812 | 0.1541 | 3.3320 | 0.0679 |
| year_counted | 2007 | 1 | 0.2514 | 0.1558 | 2.6043 | 0.1066 |
| year_counted | 2008 | 1 | 0.0330 | 0.1562 | 0.0447 | 0.8325 |



The LOGISTIC Procedure

Analysis of Maximum Likelihood Estimates

| Parameter | | DF | Estimate | Standard Error | Wald Chi-Square | Pr > ChiSq |
|---|---|---|---|---|---|---|
| year_counted | 2009 | 1 | 0.1165 | 0.1646 | 0.5011 | 0.4790 |
| sex | | 1 | 0.8071 | 0.0740 | 118.9423 | <.0001 |
| Ethnicity | 1 | 1 | -0.1842 | 0.1072 | 2.9498 | 0.0859 |
| race2 | Asian | 1 | -1.5594 | 0.1900 | 67.3824 | <.0001 |
| race2 | Black | 1 | 0.7130 | 0.0914 | 60.8137 | <.0001 |
| IDU | | 1 | 0.8631 | 0.1315 | 43.0944 | <.0001 |
| USYEARs | 0 | 0 | 0 | . | . | . |
| USYEARs | 1 | 1 | -0.2381 | 0.1642 | 2.1042 | 0.1469 |
| USYEARs | 2 | 1 | -0.2525 | 0.1478 | 2.9176 | 0.0876 |
| USYEARs | 7 | 1 | -0.1365 | 0.1620 | 0.7098 | 0.3995 |
| USYEARs | 15 | 1 | -0.1929 | 0.1515 | 1.6211 | 0.2029 |
| NoInject | | 1 | 0.4613 | 0.0953 | 23.4284 | <.0001 |
| alcohol | | 1 | -0.4327 | 0.0788 | 30.1381 | <.0001 |
| homeless | | 1 | -0.0695 | 0.1098 | 0.4004 | 0.5269 |

| | | | | | | |
|---|---|---|---|---|---|---|
| prison | | 1 | -0.3384 | 0.1101 | 9.4440 | 0.0021 |
| LTCRes | | 1 | 0.1351 | 0.2255 | 0.3591 | 0.5490 |
| location | 2 | 1 | 0.8940 | 0.0725 | 151.9128 | <.0001 |
| location | 3 | 1 | 1.2120 | 0.1008 | 144.5507 | <.0001 |
| Occupation | 0 | 1 | 0.6806 | 0.0651 | 109.1809 | <.0001 |

Odds Ratio Estimates

| Effect | | Point Estimate | 95% Wald Confidence Limits | |
|---|---|---|---|---|
| BORDER | | 0.630 | 0.511 | 0.776 |
| FB | 1 vs 0 | 1.234 | 0.966 | 1.577 |
| age1 | 25 vs 65 | 3.738 | 2.563 | 5.451 |
| age1 | 35 vs 65 | 12.682 | 8.865 | 18.145 |
| age1 | 45 vs 65 | 8.943 | 6.265 | 12.765 |
| age1 | 55 vs 65 | 3.650 | 2.540 | 5.246 |
| year_counted | 2000 vs 2010 | 1.366 | 1.007 | 1.854 |
| year_counted | 2001 vs 2010 | 1.440 | 1.067 | 1.944 |
| year_counted | 2002 vs 2010 | 1.900 | 1.410 | 2.560 |
| year_counted | 2003 vs 2010 | 1.463 | 1.083 | 1.978 |
| year_counted | 2004 vs 2010 | 1.067 | 0.787 | 1.446 |
| year_counted | 2005 vs 2010 | 1.125 | 0.825 | 1.535 |
| year_counted | 2006 vs 2010 | 1.325 | 0.979 | 1.792 |
| year_counted | 2007 vs 2010 | 1.286 | 0.948 | 1.745 |
| year_counted | 2008 vs 2010 | 1.034 | 0.761 | 1.404 |
| year_counted | 2009 vs 2010 | 1.124 | 0.814 | 1.551 |
| sex | | 2.241 | 1.939 | 2.591 |
| Ethnicity | 1 vs 0 | 0.832 | 0.674 | 1.026 |
| race2 | Asian vs White | 0.210 | 0.145 | 0.305 |
| race2 | Black vs White | 2.040 | 1.705 | 2.441 |

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The LOGISTIC Procedure

Odds Ratio Estimates

| Effect | Point Estimate | 95% Wald Confidence Limits | |
|---|---|---|---|
| IDU | 2.371 | 1.832 | 3.067 |
| USYEARs 1 vs 20 | 0.788 | 0.571 | 1.087 |
| USYEARs 2 vs 20 | 0.777 | 0.581 | 1.038 |
| USYEARs 7 vs 20 | 0.872 | 0.635 | 1.198 |
| USYEARs 15 vs 20 | 0.825 | 0.613 | 1.110 |
| NoInject | 1.586 | 1.316 | 1.912 |
| alcohol | 0.649 | 0.556 | 0.757 |
| homeless | 0.933 | 0.752 | 1.157 |
| prison | 0.713 | 0.575 | 0.885 |
| LTCRes | 1.145 | 0.736 | 1.781 |
| location 2 vs 1 | 2.445 | 2.121 | 2.818 |
| location 3 vs 1 | 3.360 | 2.758 | 4.094 |
| Occupation 0 vs 1 | 1.975 | 1.738 | 2.244 |

Association of Predicted Probabilities and Observed Responses

| | | | |
|---|---|---|---|
| Percent Concordant | 79.3 | Somers' D | 0.590 |
| Percent Discordant | 20.3 | Gamma | 0.593 |
| Percent Tied | 0.4 | Tau-a | 0.145 |
| Pairs | 14842724 | c | 0.795 |

Partition for the Hosmer and Lemeshow Test

| | HIV = 1 | | | HIV = 0 | |
|---|---|---|---|---|---|
| Group | Total | Observed | Expected | Observed | Expected |
| 1 | 1102 | 20 | 13.40 | 1082 | 1088.60 |
| 2 | 1100 | 32 | 29.34 | 1068 | 1070.66 |
| 3 | 1099 | 46 | 45.12 | 1053 | 1053.88 |
| 4 | 1099 | 50 | 63.21 | 1049 | 1035.79 |
| 5 | 1099 | 84 | 87.94 | 1015 | 1011.06 |
| 6 | 1099 | 119 | 118.04 | 980 | 980.96 |
| 7 | 1099 | 150 | 158.59 | 949 | 940.41 |
| 8 | 1099 | 224 | 219.23 | 875 | 879.77 |
| 9 | 1101 | 321 | 316.21 | 780 | 784.79 |
| 10 | 1092 | 531 | 525.93 | 561 | 566.07 |

Hosmer and Lemeshow Goodness-of-Fit Test

| Chi-Square | DF | Pr > ChiSq |
|---|---|---|
| 7.5575 | 8 | 0.4778 |

*Goodness-of-Fit test – the p-value is less significant, indicating a better fit than the models containing interaction terms.

***Gold standard OR = 0.630 (CI 0.511, 0.776)