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Factors associated with HIV prevalence among persons experiencing homelessness in Fulton County, Atlanta

By

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Master of Public Health

Global Epidemiology

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Factors associated with HIV prevalence among persons experiencing homelessness in Fulton County, Atlanta

By

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An abstract of
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Abstract

Factors associated with HIV prevalence among persons experiencing homelessness in Fulton County, Atlanta
By Anum Najeem Dilawar Khan

People who experience homelessness in the US are a high-risk group for HIV and are more adversely affected than the general population. This retrospective review of medical records evaluated factors associated with HIV prevalence among homeless persons in Fulton County, Atlanta to better inform health programs run by the Fulton County Board of Health (FCBOH). This study had two outcomes: 1) Self-reported or laboratory-confirmed HIV positive status and 2) Only laboratory-confirmed HIV positive status. This study included 3,902 homeless persons with a self-reported or laboratory-confirmed HIV status and 1,880 homeless persons with only a laboratory-confirmed HIV status, both cohorts having a HIV prevalence of 4%.After fitting adjusted logistic regression models, the odds of having a self-reported or laboratory-confirmed HIV positive status was 2.03 times higher among males versus females (95% CI: 1.19-3.47, P=0.010) and 2.90 times among those with a history of substance abuse compared to those without (95% CI: 1.59-5.28, P=0.001). A significant interaction between agency conducting screenings and race was identified where the odds of being HIV positive was 1.92 times higher among blacks screened by FCBOH compared to Mercy Care Atlanta (95% CI: 1.10-3.38, P = 0.023). Moreover, the odds of having laboratory-confirmed HIV positive status was 2.13 times higher among males versus females (95% CI: 1.17-3.88, P= 0.014) and 3.66 times higher among those aged 18-37 years versus >51 (95% CI: 1.86-7.20, P < 0.0001). Those screened in the field were 40% less likely to be HIV positive compared to those screened at the clinic (aOR: 0.60, 95% CI: 0.37-0.97, P= 0.039). This study shows that HIV related health programs should be targeted towards homeless persons who are male at birth, younger, and have a history of substance abuse. FCBOH should continue to improve its HIV screening efforts at the clinic and implement additional programs to improve substance abuse disorders. Future research with a larger population of homeless persons with laboratory-confirmed HIV statuses, more complete information on associated factors, and a focus on unsheltered homeless persons will provide FCBOH with a more complete understanding of HIV prevalence and risk factors among its homeless population.

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CHAPTER I: BACKGROUND/LITERATURE REVIEW

Human immunodeficiency virus (HIV) continues to be a major global public health concern [1]. 36.7 million people were estimated to be living with HIV in 2016 and the worldwide adult HIV prevalence was 0.8% with 30% of the same individuals unaware of their HIV status [1].

While HIV diagnoses in the United States (US) decreased between the years of 2011 and 2015, progress around the country has not been uniform; a greater HIV burden is observed among Southern states (Alabama, Arkansas, Delaware, District of Columbia, Florida, Georgia, Kentucky, Louisiana, Maryland, Mississippi, North Carolina, Oklahoma, South Carolina, Tennessee, Texas, Virginia, and West Virginia) as compared to other regions [2]. There were a total of 39,782 new HIV cases in the US in 2016 and the Southern States accounted for 52% of these new diagnoses, while only making up 38% of the national population [2, 3] . While the rate of HIV diagnoses in the US in 2016 was 12.3/100,000 persons, the rates for HIV diagnosis were 16.8/100,000 persons in the South, 11.2/100,000 persons in the Northeast, 10.2/100,000 persons in the West, and 7.5/100,000 persons in the Midwest, thus portraying the disparity in HIV rates across US regions with the Southern states being the most affected [3]. This also holds true for stage 3 (AIDS) cases as out of the 18,160 AIDS cases diagnosed in the US with a rate of 5.6/100,000 persons, 9584 (53%) were diagnosed in the South with a rate of 7.8/100,000 persons [4]. With respect to deaths due to HIV infection, while there were a total of 15,458 deaths in the US in 2015 among people with HIV and a subsequent death rate of 4.8/100,000 persons, the South comprised 7,602 (49%) of the total deaths among people with HIV with a death rate of 6.3/100,000 persons [4]. Lastly, by 2015, a total of 973,846 people were living with HIV infection in the US accruing to a rate of 303.5 per 100,000 people; the Southern states had a total of 434,853 people living with HIV infection with a rate of 359.3/100,000 persons, which was again greater than the national rate [4].

Within the South, Georgia and the City of Atlanta have high rates of HIV. In 2014, Georgia was ranked fifth among states with the highest number of total new HIV cases and had a rate of 26.3 new HIV cases/100,000 persons in 2016, compared to the national rate of 12.3/100,000 persons [4, 5]. Within Georgia, the Atlanta-Sandy Springs-Roswell Metropolitan Statistical Area had a HIV incidence of 29.4 cases/100,000 persons in 2016 and was ranked fourth among metropolitan statistical areas with the highest rates of HIV infection [4].

Persons who experience homelessness in the US are a high-risk group for HIV and are more adversely affected than the general population. The general overall rates of mortality are four times higher within the homeless population compared to the general population [6]. According to a systematic review, the worldwide prevalence ratio for HIV infection among persons who experience homelessness ranges from 0.3% to 21.1% and this prevalence is higher in the US compared to the rest of the world [6]. In 2006, 3.4% of the US homeless population was estimated to be infected with HIV compared to 0.4% in the general population [7].

Homelessness is also a widely prevalent condition in the US. According to the latest point-in-time estimates, on a single night in 2017, 553,742 people were experiencing homelessness in the US (17 per 100,000 individuals) [8]. 65% of all persons experiencing homelessness were residing in emergency shelters or transitional housing programs while 35% were unsheltered [8]. The number of people experiencing homelessness has increased by slightly less than 1% between 2016 and 2017, the first time in seven years that the US has experienced an increase in its homeless numbers [8]. This overall increase of almost 1% was due to a 9% increase in number of unsheltered people experiencing homelessness, which was partly offset by a 3% decrease in number of people experiencing homelessness in shelters [8].

Though Georgia is one of the states with the largest percentage decreases (21%) in people experiencing homelessness between 2016 and 2017, it still has a total of 10,174 individuals experiencing homelessness which accounts for 1-2.9% of the total homeless population in the US [8]. 10 in every 10,000 individuals were experiencing homelessness in Georgia at one point in time in 2017, with 65.4% residing in sheltered locations and 34.6% living in unsheltered conditions [8]. Based on point-in-time estimates of the total homeless population in Georgia in 2015, majority (65%) of the homeless population was African American, 4% of them were Hispanic or Latino and 13% of homeless population were aged between 18-24 [9]. Moreover, during a single point in 2015, 64% of the homeless population was male, where three out of four people living in unsheltered locations are male and three out of five people living in sheltered locations are male [9]. During the same time point in 2015, Fulton County in Atlanta, Georgia had a total homeless population of 473, comprising of 420 sheltered homeless persons and 53 unsheltered homeless persons [9].

While HIV can affect any individual regardless of demographic and social factors such as race, gender, age, sexual orientation, there are characteristics or behaviors that put individuals at a greater risk for HIV infection. For example, in the US, HIV is more prevalent among African Americans, male members and individuals aged 20-29 years, with a greater risk among men who have sex with men, sex workers and their clients, drugs users, people in prisons and other closed settings and the transgender population [4, 10, 11]. Moreover, certain behaviors such as having unprotected sex, sharing contaminated injecting equipment and drug solutions when injecting drugs, receiving unsafe blood transfusions and having another sexually transmitted infection increases the risk of contracting HIV [11, 12].

HIV is also associated with certain opportunistic infections which specifically target individuals with a weaker immune system and some of the most prevalent ones in the US include tuberculosis, pneumonia, salmonella, and candidiasis [13]. HIV infection is also found along with other sexually

transmitted diseases such as chlamydia, gonorrhea, human papillomavirus (HPV) infection, syphilis, Hepatitis B and Hepatitis C, since these infections also have the same risk factors of HIV which include injection drug use and unprotected sex [14]. Moreover, with the scale-up of antiretroviral therapy, HIV is now slowly becoming a more chronic disease in the US as people living with HIV are living longer, requiring long-term care and treatment and are also at an increased risk of chronic complications and comorbidities such as cardiovascular disease, kidney disease, bone disease, hyperlipidaemia, hypertension, diabetes, endochrine disease, liver disease and mental, neurological and substance-use disorders [15, 16]

Within the homeless population in the US, there are certain characteristics and factors that are associated with HIV which put these populations at increased risk for HIV infection. One reason homeless populations are at a higher risk for HIV than the general population is that they may engage in increased substance abuse and high risk sexual behaviors [17-21]. Substance abuse includes drug use, injecting drugs intravenously and sharing syringes or other drug paraphernalia, behaviors which are responsible for 13% of HIV/AIDS in the US [7]. High risk sex behaviors include men having sex with men, sexual contact with partners at high risk for HIV, exchanging sex for drugs, sex work, receptive anal sex, having multiple sexual partners and unprotected sex [7, 22].

Various studies conducted among persons experiencing homelessness in cities across the US have corroborated that substance abuse and high-risk sexual activities are widely prevalent behaviors among these populations. According to a study conducted across 14 cities in US between 1989 and 1992, the authors discovered that the risk for HIV was highest among homosexual and bi-sexual men, male homosexual and bisexual injection drug users and persons with sex partners at risk for HIV [17]. Another national study that used data from a large multi-site study to evaluate the association between HIV risk factors and housing status between 2000 to 2003 found that after

controlling for potential confounders, being homeless and having HIV were significant predictors of HIV risk behaviors such as having more sex partners, exchanging sex for money or drugs, partaking in unprotected sex with a partner whose HIV status was unknown, and having a history of drug and alcohol abuse [19]. Studies among homeless populations in New York and Boston found that being HIV positive was associated with intravenous drug use and that 28% of homeless intravenous drug users continued to inject drugs even after knowing their positive HIV status [23, 24]. This was also found in a study conducted among homeless youth in Washington D.C. between 1995 and 1996 where sexual relations with many partners, 'survival' sex in exchange for money and substance use disorders were common [25]. A study conducted among a sample of homeless youth in 10 urban shelters in Chicago showed that 83.7% of youth experiencing homelessness self-reported at least one of the major risk factors for HIV which included having multiple sex partners, sex with partners with high risk for HIV, inconsistent use of condoms, anal sex, having sex in exchange for money, and/or intravenous drug use [26]. An integration of administrative databases for HIV surveillance and utilization of homeless public shelters in Philadelphia to assess factors that were related to HIV risk among shelter users found that the risk for HIV was three times higher among those with a history of substance abuse [27]. This was also the case in San Francisco, where two studies found that HIV was most prevalent among those who injected drugs, men who have sex with men and those who exchange sex for money or drugs [20, 28].

Being African American and young is also associated with having HIV among homeless populations in the US. Studies conducted across different US cities and within Boston and San Francisco specifically found that homeless persons with HIV were more likely to be African American and less than 30 years of age [17, 20, 23]. In another national surveillance study that compared HIV prevalence and risk behaviors between older and younger injecting drug users in the US, identified younger injection drug users to have a lower HIV prevalence rate [29]. However,

even though they had a lower HIV prevalence, younger injection drug users were more likely to be homeless and to engage in HIV risk behaviors such as receptive syringe sharing and unprotected sex, placing them at a higher risk and leading to an increased spread of HIV infection in this at-risk population [29].

People experiencing homelessness also suffer from higher rates of mental illnesses and a history of poor mental health and mental health disorders have seen to be associated with HIV among this population [19, 20, 27]. HIV progression among persons who experience homelessness is also influenced by psychological distress such as stress, depression and other psychosocial factors [7]. Psychological distress has been found to shape certain behaviors that in turn affect the progression of HIV infection. For example, depression may decrease a person's willingness to adhere to HIV medication, an aspect necessary to treat and control the development of HIV [30].

A homeless person's gender is also associated with HIV status. However, results on this have been divergent. While some studies have found the male gender to be associated with HIV risk and infection among homeless populations, most other studies have found homeless women to be at higher risk for HIV. For example, according to a national study, heterosexual men had significantly higher HIV infection rates than homeless women [17]. This was also found to be true among shelter users experiencing homelessness in Philadelphia, where the male gender was significantly associated with the risk of HIV diagnosis [27]. However, a study that evaluated the San Francisco AIDS registry for individuals diagnosed between 1996 and 2006 found that HIV cases were more prevalent among women than men [20]. Another study that aimed to study the complex interactions among homelessness, HIV, substance abuse and gender among drug-abusing women in Miami found that HIV infection was significantly higher for homeless women and was 2.35 times more prevalent among homeless women than homeless men, proving that among women, homelessness and HIV have a highly interactive effect [31]. In most of these studies, HIV infection seemed to be

more prevalent among women than men due to factors that are commonly associated with homelessness that put women at greater risk for HIV [32]. While some of these factors such as substance abuse are predictive of HIV infection, certain factors that put women at greater risk of HIV are actually the result of experiencing homelessness itself which include engaging in transactional sex, having multiple sexual partners and unprotected sex, poor mental health, substance abuse disorders and having a history of child abuse and adult sexual assault [33]. For example, one study discovered that more than 50% of homeless women reported exchanging sex for money, food, and shelter and 48% reported exchanging sex for drugs [33]. A study conducted among homeless women in New York City also found that a history of childhood sexual abuse, arrest history, mental illness and substance abuse disorders lead to a greater risk of HIV infection [32]. In another study, African American and Hispanic homeless women were more likely to have had multiple sex partners in the recent past than housed women, which was partly explained by the effects of physical abuse and substance abuse disorders that they endured as a result of homelessness [21].

In addition to high risk behaviors and demographic characteristics, HIV among persons experiencing homelessness in the US is also associated with being co-infected with tuberculosis (TB). This is because individuals infected with HIV are at an increased risk for TB and become so within a few weeks of initial HIV infection which is further exacerbated as the CD4+ T cell counts decrease [34, 35]. Not only does HIV infection promote the progression of latent TB infection to active disease but TB is also known to accelerate the course of HIV, making these two diseases a deadly duo among homeless populations [36].

Studies also show that HIV positive patients are 26 times more likely to develop active TB than HIV negative individuals [35]. In an HIV negative population, it is known that 5% of TB infected individuals would develop primary TB within the first two years of exposure, and an additional 5%

will develop post-primary TB at any successive time in their life [36]. However, in contrast to this, individuals co-infected with HIV and TB have a 5-10% yearly risk of re-activation of latent TB infection [36]. An HIV infected individual is also at greater risk to develop a new TB infection and is more likely to develop infection in extra-pulmonary sites [36]. Lastly, patients co-infected with TB and HIV also have a 4-fold higher mortality risk than those un-infected [37].

In the US, homelessness has been shown to be associated with a greater transmission of TB and HIV and HIV infection is one of the strongest risk factors for TB infection and progression among persons who experience homelessness [36, 38-40]. A study that evaluated an outbreak of TB among persons experiencing homelessness in North Carolina determined that majority of patients (56%) were also infected with HIV at the time of TB diagnosis [38]. Another retrospective cohort study of TB patients experiencing homelessness in Portugal between 2008 and 2014 showed that almost one-third of the TB patients who were experiencing homelessness were also co-infected with HIV [39].

The recent drug resistant TB outbreak among persons experiencing homelessness in Fulton County, Atlanta, Georgia between 2008-2015 is a prominent example of HIV infection being one of the strongest risk factors for TB infection and progression among persons who experience homelessness [40]. Of the 110 TB cases identified during this outbreak, 41 (37%) of those infected with TB were also infected with HIV, and only 8 of these were receiving antiretroviral treatment at the time of TB diagnosis [40]. Moreover, at the time of TB diagnosis during each outbreak phase, TB patients co-infected with HIV had a median CD4 cell count of less than 200 cells/mL and thus had a severely compromised immune system [40]. Lastly, of the twelve TB patients who died during the TB outbreak, 50% of these patients were also co-infected with HIV [40].

Given the high rates of HIV in the South, high HIV risk among homeless populations, magnitude of homelessness in Georgia and Fulton County and the high HIV and TB co-infection during the TB outbreak among the homeless in Fulton County, Atlanta, it is imperative for the Fulton County Board of Health (FCBOH) to improve its HIV prevention efforts among its homeless population. Since certain factors are highly associated with HIV among the homeless in the US, this study focuses on HIV as the outcome and aims to evaluate factors associated with prevalent HIV among persons experiencing homelessness in Fulton County, Atlanta. Understanding the factors associated with HIV among this homeless population will help FCBOH better design and target HIV programs and also provide information about additional health programs that can be implemented to reduce the risk of HIV among the homeless in Fulton County, Atlanta.

CHAPTER II: MANUSCRIPT

Title: Factors associated with HIV prevalence among persons experiencing homelessness in Fulton County

Authors: Khan, A.N., Wall, K.M.

Abstract: People who experience homelessness in the US are a high-risk group for HIV and are more adversely affected than the general population. This retrospective review of medical records evaluated factors associated with HIV prevalence among homeless persons in Fulton County, Atlanta to better inform health programs run by the Fulton County Board of Health (FCBOH). This study had two outcomes: 1) Self-reported or laboratory-confirmed HIV positive status and 2) Only laboratory-confirmed HIV positive status. This study included 3,902 homeless persons with a self-reported or laboratory-confirmed HIV status and 1,880 homeless persons with only a laboratory-confirmed HIV status, both cohorts having a HIV prevalence of 4%. After fitting adjusted logistic regression models, the odds of having a self-reported or laboratory-confirmed HIV positive status was 2.03 times higher among males versus females (95% CI: 1.19-3.47, P=0.010) and 2.90 times among those with a history of substance abuse compared to those without (95% CI: 1.59-5.28, P=0.001). A significant interaction between agency conducting screenings and race was identified where the odds of being HIV positive was 1.92 times higher among blacks screened by FCBOH compared to Mercy Care Atlanta (95% CI: 1.10-3.38, P = 0.023). Moreover, the odds of having laboratory-confirmed HIV positive status was 2.13 times higher among males versus females (95% CI: 1.17-3.88, P= 0.014) and 3.66 times higher among those aged 18-37 years versus >51 (95% CI: 1.86-7.20, P < 0.0001). Those screened in the field were 40% less likely to be HIV positive compared to those screened at the clinic (aOR: 0.60, 95% CI: 0.37-0.97, P= 0.039). This study shows that HIV related health programs should be targeted towards homeless persons who are male

at birth, younger, and have a history of substance abuse. FCBOH should continue to improve its HIV screening efforts at the clinic and implement additional programs to improve substance abuse disorders. Future research with a larger population of homeless persons with laboratory-confirmed HIV statuses, more complete information on associated factors, and a focus on unsheltered homeless persons will provide FCBOH with a more complete understanding of HIV prevalence and risk factors among its homeless population.

INTRODUCTION

Human immunodeficiency virus (HIV) continues to be a major public health concern [1]. While HIV diagnoses in the United States (US) decreased between 2011 and 2015, progress around the country has not been uniform; a greater HIV burden is observed among Southern states (Alabama, Arkansas, Delaware, District of Columbia, Florida, Georgia, Kentucky, Louisiana, Maryland, Mississippi, North Carolina, Oklahoma, South Carolina, Tennessee, Texas, Virginia, and West Virginia) as compared to other regions [2]. In 2016, the Southern states accounted for 52% of total new HIV cases in the US while only making up 38% of the national population [2, 3].

Within the South, Georgia and the City of Atlanta in particular have high rates of HIV. In 2014, Georgia was ranked fifth among states with the highest number of total new HIV cases and had a rate of 26.3 new HIV cases/100,000 persons in 2016, compared to the national rate of 12.3/100,000 persons [4, 5]. Within Georgia, the Atlanta-Sandy Springs-Roswell Metropolitan Statistical Area had a HIV incidence of 29.4 cases/100,000 persons in 2016 and was ranked fourth among metropolitan statistical areas with the highest rates of HIV infection [4].

Persons who experience homelessness in the US are a high-risk group for HIV and are more adversely affected than the general population. In 2006, 3.4% of the US homeless population was

estimated to be infected with HIV compared to 0.4% in the general population [7]. Homelessness is also a widely prevalent condition in the US. According to point-in-time estimates in 2017, 553,742 persons were experiencing homelessness in the US and this number has increased by almost 1% for the first time in seven years [8]. In 2017, the state of Georgia had a total of 10,174 individuals experiencing homelessness, accounting for 1-2.9% of the total US homeless population and in 2015, Fulton County in Atlanta, Georgia had a total homeless population of 473 [8, 9].

One reason homeless populations are at a higher risk for HIV than the general population is that they may engage in increased substance abuse and high risk sexual behaviors [17, 19-21, 23-28]. Being black, young and having a history of poor mental health are also associated with HIV among homeless populations in the US [7, 17, 19, 20, 23, 27, 29]. A homeless person's gender is also associated with HIV; however, results have diverged with respect to this risk factor by geographical context [17, 20, 27, 31]. In addition to high risk behaviors and demographics, HIV among homeless persons in the US is also associated with a co-infection of tuberculosis (TB) [34-36, 38-40]. The recent drug resistant TB outbreak among homeless persons in Fulton County, Atlanta is a prominent example of HIV being one of the strongest risk factors for TB [40].

Given the high rates of HIV in the South, high HIV risk among homeless populations, magnitude of homelessness in Georgia and Fulton County and the high HIV and TB co-infection during the TB outbreak among the homeless in Fulton County, Atlanta, it is imperative for the Fulton County Board of Health (FCBOH) to improve its HIV prevention efforts among its homeless population. Since certain factors are highly associated with HIV among the homeless in the US, this study focuses on HIV as the outcome and aims to evaluate factors associated with prevalent HIV among persons experiencing homelessness in Fulton County, Atlanta. Understanding the factors associated with HIV among this homeless population will help FCBOH better design and target HIV programs

and also provide information about additional health programs that can be implemented to reduce the risk of HIV among the homeless in Fulton County, Atlanta.

METHODS

Study Design and ethics: This was a retrospective review of electronic and written medical records for persons experiencing homelessness in Fulton County, Atlanta and was approved by the Institutional Review Board of Emory (IRB00095681) and the Institutional Review Board of Georgia Department of Public Health (Project no: 170603).

Study population: The study included routine clinical data on persons experiencing homelessness between May 1, 2015 and March 31, 2017 who were screened for HIV by the FCBOH or Mercy Care Atlanta (MCA), a Federally Qualified Health Center that runs Atlanta's only 'Healthcare for the Homeless program' [41]. This included those screened at FCBOH's HIV or TB clinic and those screened during targeted TB and HIV screening exercises at Fulton County homeless shelters by FCBOH's and MCA's outbreak teams. HIV screenings included running diagnostic tests or recording the subjects' self-reported HIV status. Only study subjects 18 years or older and who were residents at Fulton County homeless shelters at the time of HIV screening were included in the study.

Data collection: No separate contact was made with study subjects beyond review of existing medical records. Data was identified and abstracted from two sources – the Mitchell and McCormick electronic medical records system (EMR) used by the FCBOH for clinical records management and the Fulton County Outbreak Survey available in the State Electronic Notifiable Disease Surveillance System (SENDSS).

To retrieve data from the EMR and SENDSS, a data abstraction form was developed detailing the inclusion and exclusion criteria and variables of interest. These variables included: EMR medical record number, name, date of birth, sex at birth, race, shelter name, country of origin, self-reported HIV status, date sample collected for HIV screening, date HIV result was reported, HIV screening result, date screened for latent TB infection (LTBI), LTBI test type, date LTBI test was read, LTBI result, self-reported diabetes, self-reported history of substance abuse and self-reported recent incarceration. After confirming eligibility of study subjects based on the inclusion and exclusion criteria, the abstractor abstracted the data into a password-protected, comma separated variable spreadsheet.

We retained patient identifiers in the abstracted data to help with data cleaning and to identify duplicates. Duplicate entries were identified by matching the EMR record number, name, date of birth, race, and sex at birth of subjects. Since only one observation per subject was required, the encounter with a HIV test result was retained. If a subject did not have a test result across all encounters, the most recent encounter was retained.

Paper-based screening forms and FCBOH's online physician consultation forms were used in the field and the clinic, respectively, to collect information on self-reported diabetes, history of substance abuse and recent incarceration. These data were not entered into EMR or SENDSS, so this information was retrieved from original sources by matching with EMR medical record numbers. After all data were obtained, dates of birth were used to calculate age at HIV screening and the final analytic dataset was stripped of personal identifiers.

Data analysis: This study had two outcomes of interest: 1) Self-reported or laboratory-confirmed HIV positive status and 2) Only laboratory-confirmed HIV positive status. This study aimed to analyze if factors such as subjects' demographics (self-reported sex at birth, race and age), existing comorbidities (self-reported diabetes status and LTBI status), HIV risk behaviors (self-reported

substance abuse and recent incarceration), type of shelter (high barrier shelter with at least one entry requirement and low barrier shelters with no entry requirements), screening location (tested at the clinic and tested in the field) and agency conducting screening tests (government/FCBOH and private agency/MCA) were associated with each of the two outcomes.

The abstracted, cleaned and de-identified dataset was imported into the Statistical Analytical Software (SAS) version 9.4 (SAS Institute Inc., Cary, N.C. USA) for analyses. Before conducting any analysis, indicator variables denoting patients with a self-reported or laboratory-confirmed HIV positive or negative status (outcome 1) and patients with only a laboratory-confirmed HIV positive or negative status (outcome 2) were created. Indicator variables were also created to identify high versus low barrier shelters, individuals screened in the field versus at the clinic and those tested by the FCBOH versus by MCA. Given the small sample sizes, race was dichotomized into 'Black' and 'Non-black', and an unknown diabetes status, 'indeterminate' or 'unread' LTBI test results were set to missing. The continuous age variable was categorized into tertiles using dummy variables and all data was numerically coded for analysis.

The distributions for each factor and their respective categories were described (counts and percentages for categorical variables, means and standard deviations for continuous variables). Comparisons between subgroups were evaluated using the Chi-square test of proportions or Fisher's exact tests for categorical variables and t-tests for continuous variables. Bivariate analysis was conducted to evaluate crude associations and the odds of HIV infection with 95% confidence intervals (CI) and two-tailed p-values was reported. Additionally, each factor combination was tested for interaction and statistically significant interactions ($P<0.05$) for each level of tested factors were retained.

Independent variables with statistically significant p-values ($P<0.05$) via chi-square test of proportions, t-tests and bivariate regression analysis and statistically significant interactions were

identified and added to their respective multivariate regression models. These models were assessed for collinearity using condition indices (CIs) and variance decomposition proportions (VDPs), and if there were two or more variable with VDPs>0.5 associated with a CI>30, then one of those collinear variables was removed (the variable with the weakest association with the outcome). Since MCA, an agency conducting tests in the field, did not collect any data on history of substance abuse, recent incarceration and diabetes, this lead to collinearity issues in models that included the variables of agency conducting tests (FCBOH vs MCA) or screening location (tested in the field vs at the clinic). Only significant interactions were retained in the adjusted multivariate regression model.

Sub-models were created to evaluate the association between the two outcomes and collinear variables dropped out of initial models. Since these collinear variables were significantly associated with the outcomes during bivariate analysis, it was thus deemed important to observe their effect in multivariate regression models. These models were re-assessed for collinearity and interactions, and only non-collinear and statistically significant interactions were retained in final models.

RESULTS

Cohort description: A total of 3,902 homeless individuals in Fulton County, Atlanta with a self-reported or laboratory-confirmed HIV status were identified (outcome 1). Of these, 163 (4%) were deemed HIV positive and 3,739 (96%) were deemed HIV negative.

From the total cohort, we identified a sub-cohort of 1,880 (48%) homeless individuals in Fulton County, Atlanta who only had a laboratory-confirmed HIV status by Fulton County (outcome 2). Seventy (4%) of these were HIV positive and 1,810 (96%) were HIV negative (Table 1).

The majority of individuals with a self-reported or laboratory-confirmed HIV status were male at birth (67%), black (88%), 18-37 years of age (34%), not diabetic (90%), not recently incarcerated (79%), negative on LTBI (81%), resided in a low-barrier shelters (68%), screened in the field (75%), screened by the government/FCBOH (86%), had an average age of 44 (SD=13) and did not have a history of substance abuse (92%). A similar demographic profile was observed for the sub-cohort of individuals who had a laboratory-confirmed HIV status (Table 1).

Homeless individuals confirmed to be HIV positive via self-report or laboratory-testing were significantly (P< 0.0001) more likely to be male at birth and have a history of substance abuse compared to individuals confirmed to be HIV negative. Among those with a laboratory-confirmed HIV status, homeless individuals with HIV were significantly more likely to be male at birth (P=0.036), younger (P<0.0001), between the ages of 18-37 versus > 51 (P<0.0001), tested at the clinic versus in the field (P=0.020), and have a history of substance abuse (P=0.05) compared to homeless individuals without HIV (Table 1).

Bivariate unadjusted analysis and interaction assessment: For the first outcome, male sex at birth (crude odds ratio, cOR: 2.18, 95% CI: 1.47-3.24) and history of substance abuse (cOR: 3.18, 95% CI: 1.75-5.76) were significantly associated with having a self-reported or laboratory-confirmed HIV positive status (P<0.001). For the study's second outcome, male sex at birth (cOR: 1.87, 95% CI: 1.03-3.39, P=0.039), age as a continuous variable (cOR: 0.96, 95% CI: 0.94-0.98, P<0.001), age group of 18-37 versus > 51 (cOR: 3.37, 95% CI: 1.72-6.59, P<0.0001), history of substance abuse (cOR: 3.60, 95% CI: 1.11-11.70, P= 0.033) and screening in the field versus at the clinic (cOR: 0.57, 95% CI: 0.35-0.92, P= 0.021) were all significantly associated with being HIV positive (Table 2).

Among those with a self-reported or laboratory-confirmed HIV status, statistically significant interactions were identified between different levels of LTBI and race (P=0.002), shelter type and race (P=0.003), type of agency conducting screening and race (P=0.0003) and diabetes and recent incarceration (P=0.037). Among those with a laboratory-confirmed HIV status, a statistically significant interaction was observed between age and history of substance abuse (P=0.033).

Multivariate adjusted analysis for self-reported or laboratory-confirmed HIV positive status (Outcome 1): The final adjusted model included variables for sex at birth and history of substance abuse, with no statistically significant interactions identified (Model 1a, Table 3). Sex at birth was significantly associated with HIV positivity (P=0.010), where the odds of being HIV positive was 2.03 (95% CI: 1.19-3.47) times higher among males compared to females. Moreover, history of substance abuse was also significantly associated with HIV positivity (P=0.001), where the odds of being HIV positive was almost three-fold higher among those with a history of substance abuse compared to no history of substance abuse (adjusted odds ratio, aOR: 2.9, 95% CI: 1.59-5.28).

Since the variable 'agency conducting tests' was highly correlated with history of substance abuse, substance abuse was dropped in the second adjusted model that included a statistically significant interaction between agency conducting tests and race (P<0.0001) (Model 1b, Table 3).Like the previous model, male sex at birth was also significantly associated with being HIV positive (P<0.0001) and the odds of being HIV positive was 2.27 (95% CI: 1.52-3.38) times higher among males compared to females. Moreover, the type of agency conducting tests was also significantly associated with being HIV positive and its effect differed by race. Within blacks, the odds of being HIV positive was 1.92 times higher among those screened by FCBOH compared to those screened by MCA (95% CI: 1.10-3.38, P = 0.023). In contrast, non-blacks were 82% less likely to be HIV positive when screened by FCBOH compared to when screened by MCA (aOR: 0.18, 95% CI: 0.06-0.56, P = 0.003).

Multivariate adjusted analysis for a laboratory-confirmed HIV positive status (Outcome 2): The final adjusted model included variables of sex at birth, age (in tertiles) and history of substance abuse, with no statistically significant interactions (Model 2a, Table 4). While all variables demonstrated positive associations with HIV positivity, none were significant in the adjusted model. The odds of being HIV positive was 2.62 times higher among males compared to females (95% CI: 0.80-8.60, P= 0.114), was 2.84 times higher among those between 18-37 years (95% CI: 0.72-11.15, P= 0.120) and 1.5 times higher among those between 38-51 years (95% CI: 0.33-6.91, P= 0.853) compared to those aged 51 years or older, and was 3.26 times higher (95% CI: 0.98-10.90, P=: 0.055) among those with a history of substance abuse compared to those with no history of substance abuse.

Since the variable 'screening location' was highly correlated with history of substance abuse when initially fitted in model 2a, a second adjusted model with screening location instead of history of substance abuse was created (Model 2b, Table 3). The odds of being HIV positive was 2.13 (95% CI: 1.17-3.88, P= 0.014) times among males compared to females. The odds of being HIV positive was 3.66 times among those aged 18-37 (95% CI: 1.86-7.20, P < 0.0001) and 1.36 times among those aged 38-51 (95% CI: 0.63-2.97, P= 0.267) compared to those aged 51 years and above. Lastly, those screened in the field were 40% less likely to be HIV positive compared to those screened at the clinic (aOR: 0.60, 95% CI: 0.37-0.97, P= 0.039).

DISCUSSION

We found positive significant associations between HIV positivity and being male at birth, younger, screened at the clinic and having a history of substance abuse among persons experiencing homelessness in Fulton County, Atlanta. We also found that the effect of the agency conducing

screenings on HIV positivity differed significantly by race, as FCBOH was able to find more HIV positive cases among blacks compared to MCA.

This study found a positive significant association between being a homeless male and HIV, regardless of how HIV status was assessed. This finding is intriguing since most available evidence on the association between sex at birth and HIV status among homeless populations suggests a higher prevalence among women due to factors commonly associated with homelessness such as sex work, having multiple sexual partners, having unprotected sex, poor mental health, substance abuse disorders and history of sexual abuse [17, 20, 21, 27, 31-33]. A higher likelihood of HIV among homeless men in this study could be because the risk of HIV is higher among males in the general US population and also among men who have sex with men versus heterosexual males in the South [4, 10, 11]. However, since data on sexual behaviors was not collected, it is difficult to confidently attribute a higher prevalence of HIV among men as a result of their sexual preferences [7, 22].

Similarly, for both outcomes explored in this study, we found a significant relationship between history of substance abuse and HIV positivity. These findings align with previous studies among the homeless that also reported positive associations between substance abuse and HIV [17, 19, 20, 23-28]. Behaviors such as injecting drugs intravenously and sharing syringes or other drug paraphernalia give rise to HIV risk [7]. Homeless people are more prone to share drugs due to the risk of arrest for carrying drugs and drug paraphernalia [42]. Drug use within homeless populations is also challenging since homeless people find it difficult to access clean needles or receive drug education counseling [42].

Younger age was also found to be associated with a positive HIV status among the homeless in Fulton County. This result is in line with previous studies among US homeless populations, where

younger homeless persons had a higher HIV prevalence and were more likely to engage in HIV risk behaviors such as receptive syringe sharing and unprotected sex [17, 20, 23, 29].

Location of screening was also associated with HIV status, where the odds of being HIV positive were higher if screened in the clinic versus the field. Being screened at the clinic requires homeless persons to travel to the clinic for care as opposed to being screened at their shelters. Even though majority of HIV screenings were conducted in the field, it could be that sicker patients or patients that considered themselves to be at higher risk were traveling to the clinic for testing.

This study also found a statistically significant interaction between agency conducting tests and race, where FCBOH identified more HIV+ blacks than MCA. FCBOH screens homeless persons at shelters in field and at their clinic, while MCA screens exclusively at shelters in the field. While both FCBOH and MCA saw a majority of black homeless persons, FCBOH sees a greater proportion of black homeless persons at its clinic than in the field ($P<0.0001$). Since FCBOH screens homeless persons at the clinic, an additional screening strategy than MCA which is also shown to be more effective at finding HIV positive cases than screening in the field, and HIV is known to be more prevalent among blacks in homeless populations across the US [17, 20, 23], these may be reasons as to why FCBOH found more HIV positive patients among blacks than MCA. Moreover, as the risk of HIV among blacks is well-known, it could also be that sicker and black patients who considered themselves at higher risk were more willing to travel to the clinic, giving FCBOH a higher chance than MCA of diagnosing HIV among blacks.

Unlike previous literature, this study did not find recent incarceration, low barrier shelters or diabetes to be associated with HIV positivity. Though incarcerated populations in the US are a high risk group for HIV, this study did not find an association between self-reported recent incarceration and HIV, perhaps due to the high amount of missingness on this variable and an underestimation

of incarceration due to stigma and social desirability bias [10]. Low barrier shelters were also assumed to be associated with HIV positivity since these shelters do not have any entry restrictions such as having no illnesses, no history of substance abuse, a clean criminal record, financial stability. Though it was unexpected for this study to not find an association between shelter type and HIV positivity, this might be reassuring since it shows that both HIV positive and negative patients had an equal chance of receiving shelter at any homeless facility in Fulton County without discrimination. Lastly, though research shows that people with HIV are living longer and are thus at an increased risk of diabetes [15, 16], this study did not find an association between HIV and self-reported diabetes. This could be due to misclassification error of diabetes status, high amount of missingness or because this study population may have had fewer older persons at risk for diabetes.

LTBI tests such as Quantiferon®- TB Gold (QFT) and tuberculin skin tests are less sensitive when conducted among HIV positive patients due to their low and impaired CD4+ cell counts [43]. Since these two tests were used to detect LTBI among the homeless, it is thus not surprising that this study did not find an association between LTBI and HIV. Moreover, given that studies across the US have shown homelessness to be associated with greater transmission of TB and HIV and that HIV was one of the strongest risk factors for TB infection during the recent drug resistant TB outbreak among homeless persons in Fulton County, Atlanta [36, 38-40], we have good reason to believe that there was a higher chance of false negative LTBI results among those who were HIV positive. Anergy skin testing in conjunction with PPD-tuberculin skin testing for HIV positive patients being evaluated for LTBI would provide greater insight on whether LTBI is actually associated with HIV among the homeless in Fulton County [44].

There are important limitations to this study. These results are limited to sheltered homeless people and did not include unsheltered homeless people, a characteristically different population with

different prevalences and risk factors of HIV [22, 45]. Since the first HIV outcome was self-reported, it is not as reliable as one determined by a diagnostic test. Homeless persons may not accurately report their HIV status due to associated stigma and social desirability bias [24, 46] and might have assumed that having HIV restricts entry into shelters. On the other hand, those with a self-reported HIV status may have refused testing because of already knowing their status from previous testing. Another limitation is the high amount of missingness for self-reported diabetes status, recent incarceration, history of substance abuse and LTBI test results. Information on recent incarceration, history of substance abuse and diabetes was not collected by MCA and was collected by FCBOH via self-administered questionnaires, leading to missing information. Since these were self-reported, these may be underestimating the true prevalence as homeless persons may not accurately report histories of incarceration and substance abuse due to associated stigma, social desirability bias and restrictions for entry at high-barrier shelters [42]. Moreover, self-reported diabetes status is also not a reliable measure of true prevalence in this population. Finally, since mental disorders and sexual orientation are associated with HIV among homeless populations [17-21, 27], and data was not collected on these factors, this study is limited in its understanding of relationships between these factors and HIV among the homeless population in Fulton County, Atlanta.

Despite these limitations, this is the first study to provide the FCBOH with important insights into factors associated with HIV among persons experiencing homelessness in Fulton County, Atlanta. The results show that HIV testing, counselling, and risk prevention interventions should be targeted towards high risk groups of homeless persons who are male at birth, younger and have a history of substance abuse. It also provides evidence that additional health programs focusing on improving substance abuse disorders will help reduce HIV risk in this community. Moreover, as screening at the clinic has a higher likelihood of finding HIV positive cases compared to screening in the field,

FCBOH should continue to increase and improve its HIV screening efforts at the clinic, offer clinic-based services for substance abuse disorders and outreach these to the homeless population. Lastly, since only 48% of those encountered during HIV screenings had a laboratory-confirmed HIV status, HIV testing among this population needs to be increased. Future research with a larger proportion of homeless persons tested for HIV, more complete information on associated factors and a focus on unsheltered homeless persons will provide FCBOH with a more complete understanding of HIV prevalence and risk factors among its homeless population.

REFERENCES

1. Avert. *Global HIV and AIDS statistics*. 2017; Available from: https://www.avert.org/global-hiv-and-aids-statistics.
2. Centers for Disease Control and Prevention, *HIV Surveillance Report*. 2016.
3. Centers for Disease Control and Prevention. *HIV in the United States by Geography*. 2018; Available from: https://www.cdc.gov/hiv/statistics/overview/geographicdistribution.html.
4. Centers for Disease Control and Prevention, *HIV Surveillance Report, 2016*, in *Diagnoses of HIV Infection in the United States and Dependent Areas, 2016*. 2017. p. 1-125.
5. Georgia Department of Public Health, *HIV Surveillance Summary, Georgia 2014*. 2016. p. 1-22.
6. Beijer, U., A. Wolf, and S. Fazel, *Prevalence of tuberculosis, hepatitis C virus, and HIV in homeless people: a systematic review and meta-analysis.* Lancet Infect Dis, 2012. **12**: p. 859–70.
7. National Coalition for the Homeless. *HIV/AIDS and Homelessness*. 2009; Available from: www.nationalhomeless.org/factsheets/hiv.html.
8. Henry, M., et al., *The 2017 Annual Homeless Assessment Report (AHAR) to Congress* 2017. p. 1-94.
9. Georgia Department of Community Affairs, *Georgia's 14,000 - 2015 Report on Homelessness*. 2015.
10. Centers for Disease Control and Prevention. *HIV by Group*. 2018; Available from: https://www.cdc.gov/hiv/group/index.html.

11. World Health Organization. *HIV/AIDS*. 2017; Available from: http://www.who.int/mediacentre/factsheets/fs360/en/.

12. Centers for Disease Control and Prevention. *HIV Risk Behaviors*. 2015; Available from: https://www.cdc.gov/hiv/risk/estimates/riskbehaviors.html.

13. Centers for Disease Control and Prevention. *Opportunistic Infections*. 2017; Available from: https://www.cdc.gov/hiv/basics/livingwithhiv/opportunisticinfections.html.

14. U.S. Department of Health and Human Services. *HIV and Opportunistic Infections, Coinfections, and Conditions*. AIDS info 2018; Available from: https://aidsinfo.nih.gov/understanding-hiv-aids/fact-sheets/26/86/what-is-an-opportunistic-infection.

15. Highleyman, L., *Co-morbidities are common and rising among people with HIV in the US*. 2016, nam aidsmap.

16. Rodriguez-Penney, A.T., et al., *Co-morbidities in persons infected with HIV: increased burden with older age and negative effects on health-related quality of life.* AIDS Patient Care STDS, 2013. **27**(1): p. 5-16.

17. Allen, D.M., et al., *HIV infection among homeless adults and runaway youth, United States, 1989-1992. Field Services Branch.* AIDS, 1994. **8**(11): p. 1593-8.

18. Bowen, E.A., *A Multilevel Ecological Model of HIV Risk for People Who Are Homeless or Unstably Housed and Who Use Drugs in the Urban United States.* Soc Work Public Health, 2016. **31**(4): p. 264-75.

19. Kidder, D.P., et al., *Housing status and HIV risk behaviors among homeless and housed persons with HIV*. J Acquir Immune Defic Syndr, 2008. **49**(4): p. 451-5.

20. Schwarcz, S.K., et al., *Impact of housing on the survival of persons with AIDS.* BMC Public Health, 2009. **9**: p. 220.

21. Wolitski, R.J., D.P. Kidder, and K.A. Fenton, *HIV, homelessness, and public health: critical issues and a call for increased action.* AIDS Behav, 2007. **11**(6 Suppl): p. 167-71.

22. Badiaga, S., D. Raoult, and P. Brouqui, *Preventing and controlling emerging and reemerging transmissible diseases in the homeless.* Emerg Infect Dis, 2008. **14**(9): p. 1353-9.

23. Lebow, J.M., et al., *AIDS Among the Homeless of Boston: A Cohort Study*. JAIDS Journal of Acquired Immune Deficiency Syndromes, 1995. **8**(3): p. 292-296.

24. Torres, R.A., et al., *Human immunodeficiency virus infection among homeless men in a new york city shelter: Association with mycobacterium tuberculosis infection.* Archives of Internal Medicine, 1990. **150**(10): p. 2030-2036.

25. Bailey, S.L., C.S. Camlin, and S.T. Ennett, *Substance use and risky sexual behavior among homeless and runaway youth.* J Adolesc Health, 1998. **23**(6): p. 378-88.

26. Johnson, T.P., et al., *Self-Reported Risk Factors for AIDS among Homeless Youth.* AIDS Education and Prevention, 1996. **8**(4): p. 308-22.

27. Culhane, D.P., et al., *The co-occurrence of AIDS and homelessness: results from the integration of administrative databases for AIDS surveillance and public shelter utilisation in Philadelphia.* J Epidemiol Community Health, 2001. **55**(7): p. 515-20.

28. Hahn, J.A., et al., *HIV seroconversion among the homeless and marginally housed in San Francisco: a ten-year study.* J Acquir Immune Defic Syndr, 2004. **37**(5): p. 1616-9.

29. Broz, D., et al., *Prevalence of HIV infection and risk behaviors among younger and older injecting drug users in the United States, 2009.* AIDS Behav, 2014. **18 Suppl 3**: p. 284-96.

30. Gore-Felton, C. and C. Koopman, *Behavioral mediation of the relationship between psychosocial factors and HIV disease progression.* Psychosom Med, 2008. **70**(5): p. 569-74.

31. Metsch, L.R., et al., *HIV-related risk behaviors and seropositivity among homeless drug-abusing women in Miami, Florida.* J Psychoactive Drugs, 1995. **27**(4): p. 435-46.

32. Caton, C.L.M., et al., *Rates and Correlates of HIV and STI Infection Among Homeless Women.* AIDS and Behavior, 2013. **17**(3): p. 856-864.

33. Cederbaum, J.A., et al., *The HIV risk reduction needs of homeless women in Los Angeles.* Womens Health Issues, 2013. **23**(3): p. e167-72.

34. Centers for Disease Control and Prevention, *Mortality Among Patients with Tuberculosis and Associations with HIV Status — United States, 1993–2008.* Morbidity and Mortality Weekly Report, 2010. **59**(46): p. 1509-1513.

35. Tiberi, S., et al., *The cursed duet today: Tuberculosis and HIV-coinfection.* Presse Med, 2017. **46**(2 Pt 2): p. e23-e39.

36. Sharma, S.K., A. Mohan, and T. Kadhiravan, *HIV-TB co-infection: epidemiology, diagnosis & management.* Indian J Med Res, 2005. **121**(4): p. 550-67.

37. Fraimow, H.S. *Recent Developments in Tuberculosis and Tuberculosis-HIV Co-Infection.* 2017; Available from: http://ccoe.rbhs.rutgers.edu/online/ARCHIVE/15HC01/article1.htm.

38. Mcelroy, P.D., et al., *Outbreak of Tuberculosis Among Homeless Persons Coinfected with Human Immunodeficiency Virus.* Clinical Infectious Diseases, 2003. **36**(10): p. 1305-12.

39. Dias, M., et al., *Tuberculosis among the homeless: should we change the strategy?* Int J Tuberc Lung Dis, 2017. **21**(3): p. 327-332.

40. Powell, K.M., et al., *Outbreak of Drug-Resistant Mycobacterium tuberculosis Among Homeless People in Atlanta, Georgia, 2008-2015.* Public Health Rep, 2017. **132**(2): p. 231-240.

41. Mercy Care. *Mercy Care - About*. 2015; Available from: https://www.mercyatlanta.org/ABOUT.

42. Shlay, J.C., et al., *Human immunodeficiency virus seroprevalence and risk assessment of a homeless population in Denver.* Sex Transm Dis, 1996. **23**(4): p. 304-11.

43. QIAGEN. *Why should I screen for latent TB in HIV positive individuals?* 2018; Available from: http://www.quantiferon.com/products/quantiferon-tb-gold/hiv-and-tb/.

44. Centers for Disease Control and Prevention, *Anergy Skin Testing and Preventive Therapy for HIV-Infected Persons: Revised Recommendations*, in *MMWR*. 1997. p. 1-10.

45. Smereck, G.A. and E.M. Hockman, *Prevalence of HIV infection and HIV risk behaviors associated with living place: on-the-street homeless drug users as a special target population for public health intervention.* Am J Drug Alcohol Abuse, 1998. **24**(2): p. 299-319.

46. Johnston, L.G., et al., *The importance of assessing self-reported HIV status in bio-behavioural surveys.* Bull World Health Organ, 2016. **94**(8): p. 605-12.

TABLES

Table 1. Baseline characteristics of persons experiencing homelessness in Fulton County with a known HIV status

	Outcome 1 – Self reported or laboratory-confirmed HIV							Outcome 2 – Laboratory-confirmed HIV only						
	Individuals with known HIV status		HIV+		HIV-		P-value	Individuals tested for HIV		HIV+		HIV-		P-value
	n	%	n	%	n	%		n	%	n	%	n	%	
Total individual patients	3902		163	4%	3739	96%		1880	48%	70	4%	1810	96%	
Sex at birth														
Male	2604	67%	132	81%	2472	66%	<0.0001	1289	69%	56	80%	1233	68%	0.036
Female	1297	33%	31	19%	1266	34%		591	31%	14	20%	577	32%	

Race														
Black	3429	88%	149	91%	3280	88%	0.202	1693	91%	63	90%	1630	91%	0.876
Non-Black[1]	456	12%	14	9%	442	12%		177	9%	7	10%	170	9%	
Age														
18-37	1337	34%	67	41%	1270	34%		691	37%	43	61%	648	36%	
38-51	1260	32%	45	28%	1215	33%	0.159	618	33%	16	23%	602	33%	<0.0001
>51	1300	33%	51	31%	1249	33%		569	30%	11	16%	558	31%	
Age[2]	44 ± 13		42 ± 13		44 ± 13		0.125	43 ± 12		38 ± 11		43 ± 12		<0.0001
Diabetes														
Yes	197	10%	11	15%	186	10%	0.147	73	12%	2	13%	71	12%	1.000
No	1816	90%	64	85%	1752	90%		530	88%	14	88%	516	88%	

History of substance abuse														
Yes	152	8%	15	21%	137	8%	<0.0001	58	10%	4	27%	54	9%	0.050
No	1712	92%	57	79%	1655	92%		546	90%	11	73%	535	91%	
Recent incarceration														
Yes	93	21%	4	22%	89	21%	0.773	44	22%	2	33%	42	21%	0.612
No	357	79%	14	78%	343	79%		159	78%	4	67%	155	79%	
TB infection														
Positive	507	19%	17	16%	490	19%	0.421	182	15%	4	10%	178	15%	0.353
Negative	2180	81%	90	84%	2090	81%		1046	85%	37	90%	1009	85%	
Shelter type														
Low barrier	2655	68%	112	69%	2543	68%	0.867	1101	59%	40	57%	1061	59%	0.793
High barrier	1243	32%	51	31%	1192	32%		776	41%	30	43%	746	41%	

Screening status														
Screened in the field	2938	75%	118	72%	2820	75%	0.380	1087	58%	31	44%	1056	58%	0.020
Screened at clinic	964	25%	45	28%	919	25%		793	42%	39	56%	754	42%	
Agency conducting tests														
FCBOH	3363	86%	144	88%	3219	86%	0.415	1522	81%	60	86%	1462	81%	0.302
MCA	539	14%	19	12%	520	14%		358	19%	10	14%	348	19%	

[1] Includes Hispanic, Non-Hispanic/White, American Indian, Arab, Asian, Caribbean, Cherokee Indian, Hawaiian, Mixed, Multicultural, Native American, Other

[2] Age as a continuous variable, reporting mean $\pm$ standard deviation

FCBOH = Fulton County Board of Health; MCA= Mercy Care Atlanta; HIV+ = HIV positive; HIV- = HIV negative

Table 2. Bivariate unadjusted analysis between potential factors and HIV among persons experiencing homelessness in Fulton County

		Outcome 1 - Self reported or laboratory-confirmed HIV			Outcome 2 - Laboratory-confirmed HIV only		
Variable	**Comparison**	**cOR[1]**	**95% CI[2]**	**P-value**	**cOR[1]**	**95% CI[2]**	**P-value**
Gender	Male vs Female	2.18	(1.47, 3.24)	<0.001	1.87	(1.03, 3.39)	0.039
Race	Black vs. Non-Black	1.43	(0.82, 2.50)	0.204	0.94	(0.42, 2.08)	0.876
Age	18-37 vs >51	1.29	(0.89,1.88)	0.061	3.37	(1.72, 6.59)	<0.0001
	38-51 vs >51	0.91	(0.60, 1.37)	0.208	1.35	(0.62, 2.93)	0.314
Age	A continuous variable	0.99	(0.98, 1.00)	0.125	0.96	(0.94, 0.98)	<0.001
Diabetes	Yes vs No	1.62	(0.84, 3.12)	0.151	1.04	(0.23, 4.66)	0.960
History of substance abuse	Yes vs. No	3.18	(1.75, 5.76)	<0.001	3.60	(1.11, 11.70)	0.033

Recent incarceration	Yes vs. No	1.10	(0.35, 3.43)	0.868	1.85	(0.33, 10.42)	0.488
TB infection	Positive vs Negative	0.81	(0.48, 1.37)	0.422	0.61	(0.22, 1.74)	0.358
Shelter type	Low barrier vs. High barrier	1.03	(0.73, 1.44)	0.867	0.94	(0.58, 1.52)	0.793
Screening status	Screened in the field vs. Screened at clinic	0.86	(0.60, 1.21)	0.381	0.57	(0.35, 0.92)	0.021
Agency conducting tests	FCBOH vs. MCA	1.22	(0.75, 1.99)	0.416	1.43	(0.72, 2.82)	0.304

[1] Crude Odds Ratio

[2] 95% Confidence Intervals

FCBOH: Fulton County Board of Health; MCA: Mercy Care Atlanta

Table 3. Adjusted multivariate regression models for Outcome 1 – Self reported or laboratory-confirmed HIV

Model 1a				
Variable	**Comparison**	**aOR[1]**	**95% CI[2]**	**P-value**
Gender	Male vs Female	2.03	(1.19, 3.47)	0.010
History of substance abuse	Yes vs. No	2.90	(1.59, 5.28)	0.001

Model 1b				
Variable	**Comparison**	**aOR[1]**	**95% CI[2]**	**P-value**
Gender	Male vs Female	2.27	(1.52, 3.38)	<0.0001
Agency conducting tests	FCBOH vs. MCA			
Race = Black		1.92	(1.10, 3.38)	0.023
Race = Non-Black		0.18	(0.06, 0.56)	0.003

[1] Adjusted Odds Ratio

[2] 95% Confidence Intervals

FCBOH: Fulton County Board of Health; MCA: Mercy Care Atlanta

Table 4. Adjusted multivariate regression models for Outcome 2 - Laboratory-confirmed HIV only

Model 2a				
Variable	**Comparison**	**aOR[1]**	**95% CI[2]**	**P-value**
Gender	Male vs. Female	2.62	(0.80, 8.60)	0.114
Age (tertiles)	18-37 vs. >51	2.84	(0.72, 11.15)	0.120
	38-51 vs. >51	1.50	(0.33, 6.91)	0.853
History of substance abuse	Yes vs. No	3.26	(0.98, 10.90)	0.055

Model 2b				
Variable	**Comparison**	**aOR[1]**	**95% CI[2]**	**P-value**
Gender	Male vs. Female	2.13	(1.17, 3.88)	0.014
Age (tertiles)	18-37 vs. >51	3.66	(1.86, 7.20)	<0.0001
	38-51 vs. >51	1.36	(0.63, 2.97)	0.267
Screening location	Tested in field vs. Tested at clinic	0.60	(0.37, 0.97)	0.039

[1] Adjusted Odds Ratio

[2] 95% Confidence Intervals