RACIAL/ETHNIC DISPARITIES IN THE HIV CARE CONTINUUM: BETTER TARGETS AND BETTER MEASURES

by

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Abstract

Background: The United States (US) National HIV/AIDS Strategy (NHAS) prioritized reductions in disparities in HIV care and improvements in HIV care retention, antiretroviral therapy (ART) use, and viral suppression particularly in key populations of persons with HIV (PWH). The goals of this dissertation are to describe the progress made in achieving NHAS goals and identify which subgroups of PWH experience the largest burdens of racial/ethnic disparities in HIV care.

Methods: We nested studies in the North American AIDS Cohort Collaboration on Research and Design. We estimated trends in racial/ethnic differences in retention in care, ART use, and viral suppression between 2004-2014 using log binomial regression models with generalized estimating equations accounting for repeated measures. Standard measures of retention in care were scrutinized in their ability to correlate with HIV care engagement (as measured by viral suppression) over time using Spearman correlations, sensitivity, specificity, *c*-statistic, and prevalence ratio (PR) for viral suppression. Racial/ethnic differences in the 5-year restricted mean person-time spent in care, on ART, and virally suppressed were assessed using nonparametric cumulative incidence curves of seven HIV care continuum stages.

Results: Among 19,006 participants, the proportion retained in care remained relatively stable at 65% over time. Between 2004-2014, ART use and viral suppression increased from 55.7% to 83.7% and 33.9% to 77.8%, respectively. Black men who have sex with men (MSM) had consistently lower percentages of ART use and viral suppression than white MSM over time. Standard measures of HIV care retention showed a poor or worsening correlation with HIV care engagement over time (Spearman correlation <0.40; c-statistic <0.675; PRs approached 1.0). Sex, age, and sexual HIV acquisition risk (i.e., MSM vs. men who have sex with women) modified the magnitude of racial/ethnic differences in mean person-time spent in HIV care continuum stages. The magnitude of the Black-white disparity increased in older ages among MSM.

Conclusions: Racial/ethnic disparities in the HIV care continuum persist and suggest the need for clinical and public health interventions targeted towards specific subgroups of PWH to achieve NHAS goals to reduce disparities in HIV care. Novel measures of retention are needed to better quantify HIV care engagement.

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CHAPTER ONE

Introduction

Overview and specific aims

Retention in care, antiretroviral therapy (ART) use, and viral suppression among persons with HIV (PWH) are critical to reduce HIV-related morbidity and mortality and prevent onward transmission. The United States (US) National HIV/AIDS Strategy (NHAS) set forth goals to improve the proportion of PWH achieving these HIV care milestones and to reduce HIV-related disparities in key populations, including 1) gay, bisexual, and other men who have sex with men (MSM), 2) Black women and men, 3) Hispanic men and women, and 4) young (ages 13 to 24 years) PWH.

This dissertation aims to monitor the progress made towards reducing racial/ethnic disparities in HIV care, assess whether current measures of retention in care are adequate in describing this progress, and identify groups defined by sex, age, and sexual HIV acquisition risk (i.e., MSM vs. men who have sex with women [MSW]) that can be targeted to reduce racial/ethnic disparities. Epidemiologic studies were nested in the North American AIDS Cohort Collaboration on Research and Design (NA-ACCORD), which has been identified as an appropriate data source for monitoring HIV care and represents the largest source of longitudinal information on PWH successfully linking into HIV care in the US.

The specific aims of this dissertation are:

Aim 1: To estimate trends in the percentage of women and MSM with HIV that were retained in HIV clinical care, on ART, and virally suppressed between 2004-2014

Hypothesis 1.1: Retention in care, ART use, and viral suppression increased over time.

Hypothesis 1.2: Racial/ethnic disparities in retention in care, ART use, and viral suppression decreased over time.

Aim 2: To scrutinize standard measures of retention in HIV clinical care in their ability to correlate with HIV care engagement over time

Hypothesis 2.1: Standard retention measures correlate poorly with HIV care engagement over time.

Hypothesis 2.2: Racial/ethnic differences in HIV care retention are less apparent using retention measures requiring fewer HIV care visits.

Aim 3: To examine racial/ethnic differences in retention in care, ART use, and viral suppression by sex, age, and sexual HIV acquisition risk

Hypothesis 3.1: The magnitude of racial/ethnic differences in retention in care, ART use, and viral suppression are dependent on sex, age, and sexual HIV acquisition risk.

Background

The HIV Care Continuum

The spectrum of care and treatment of PWH is termed the HIV care continuum (or HIV care cascade).[1] It is commonly defined by the following linear sequence of steps: 1) diagnosis of HIV infection, 2) linkage (or entry) to HIV clinical care, 3) retention in HIV clinical care, 4) prescription of ART, and 5) viral suppression. The last step, viral suppression, is the desired goal for all PWH and of HIV prevention efforts. Achieved through the consistent use of ART, viral suppression dramatically lengthens the life expectancy of PWH to near-normal levels.[2] Equally important, viral suppression reduces the probability of HIV transmission to others by 96%.[3]

Facilitating successful progression through all steps of the HIV care continuum to achieve viral suppression has recently become a high-priority public health strategy to improve HIV-related health outcomes and prevent ongoing HIV transmission. Over 1.23 million new HIV infections are expected in the US across a 20-year timeframe.[4] Studies suggest that intervening at various points in the HIV care continuum to maximize the proportion of PWH that are at each step could avert 9 out of every 10 of these new infections.[5]

The last three steps of the HIV care continuum are of special importance and will be the focus of this dissertation. Given their linear progression (i.e., a PWH must first be retained in care and receive ART to achieve viral suppression), these steps are HIV care milestones that must be achieved as soon as possible after linkage into HIV care to improve survival and prevent onward transmission. The percentage of PWH achieving these steps are significantly lower relative to earlier steps and thus represent critical intervention points for maximizing both public health and clinical benefits among PWH, particularly those who are new to HIV care.[6] Further, retention in care and ART use are the HIV care continuum steps most proximal to the ultimate goal of viral suppression, and joint examination of these three steps may provide additional insight into ways to improve viral suppression among PWH. Lastly, because achieving these three steps necessitates prior linkage and access to HIV care, PWH in these three steps can be more readily targeted by interventions to improve HIV outcomes.

Despite their unique importance, the percentage of PWH that have achieved these steps of the HIV care continuum and are ultimately virally suppressed in the US is suboptimal. National estimates show that 40% of PWH are retained in care and 37% are prescribed ART. Only 30% are virally suppressed.[6]

HIV Disparities in the United States

Health disparities in the HIV care continuum have been a defining feature of the HIV epidemic in US. According to Braveman, a health disparity is "a difference in which disadvantaged social groups … systematically experience worse health or greater health risks than more advantaged groups."[7] Such differences place potentially avoidable and typically unjust health burdens on the socially disadvantaged. Health disparities can be observed across a wide spectrum of sociodemographic characteristics, such as race, ethnicity, age, and sex. Among the most salient of these characteristics with regards to the US HIV epidemic are race and ethnicity, which will be the focus of this dissertation.

Originally intended to be a biologic term, race is more modernly regarded as a political and social construct referring to “populations that look different and have different ancestral roots.”[8] Individuals of Black race are the most disproportionately affected by HIV in the US. In 2014, the prevalence of HIV among Blacks was 1,025.2 per 100,000 population, the highest of any racial group in the US and nearly seven times greater than that among whites.[9] Black PWH also died at a rate that was over seven times greater than whites. Further, approximately half of all AIDS diagnoses in the US were among Black PWH.[9]

In contrast to race, ethnicity refers to social groups defined by “a mix of cultural and other factors including language, diet, religion, ancestry, and physical features traditionally associated with race.”[8] Hispanics/Latinos (hereinafter referred to as “Hispanics”), individuals of Latin American descent, comprise the largest ethnic group in the US.[8,10] The HIV epidemic has also had a staggering effect on Hispanics. Hispanics have had a three- to four-fold increased risk of acquiring HIV relative to non-Hispanic Whites.[11] In 2010, Hispanics accounted for 21% of all new HIV infections in the US, although as a whole, they comprised 16% of the total US population.[12] Hispanics are also more likely to have AIDS upon initial diagnosis of HIV infection than any other racial or minority group in the US and thus begin to receive care at later stages of infection.[13–15]

The National HIV/AIDS Strategy and key populations

In response to overall poor outcomes along the HIV care continuum and HIV-associated health disparities in the US, the White House Office of National AIDS Policy released the US NHAS in 2010.[16] Later updated in 2015, the NHAS is the US's first public health strategy designed to guide a national concerted effort to tackling the HIV epidemic. The four overall goals of the NHAS were to 1) reduce new HIV infections, 2) increase access to and improve HIV care among PWH, 3) reduce HIV-related disparities and health inequities, and 4) achieve a more coordinated national response to the HIV epidemic. The NHAS set forth three specific goals to increase the proportion of PWH that are at key steps of the HIV care continuum by 2020: 1) link at least 85% of HIV-diagnosed persons to HIV care, 2) retain in care at least 90% of HIV-diagnosed persons, and 3) increase the proportion of virally suppressed HIV-diagnosed persons to 80%.[16]

The NHAS highlighted several key populations that must receive special attention to achieve these specific goals. The NHAS-specified key populations that will be the focus of this dissertation are the following: 1) gay, bisexual, and other MSM, 2) Black men and women, 3) Hispanic men and women, and 4) young (age <30 years) PWH. The NHAS has also identified transgender women, people living in the Southern US, and people who inject drugs as populations of special concern. Specific racial/ethnic groups other than Blacks and Hispanics, such as individuals of mixed race, have also been disproportionately impacted by HIV.[9] These populations will not be examined in this dissertation, however, due to the limited availability of longitudinal epidemiologic data of sufficient size on PWH from these groups.

To reduce disparities in these key populations, both the NHAS and leaders at the National Institutes of Health (NIH) recommend focusing on and tailoring specific interventions to the populations most affected by the HIV epidemic.[16,17] The Centers for Disease Control and Prevention (CDC) are accordingly pursuing high-impact strategies to achieve NHAS goals.[6]

Dissertation overview

Public health and clinical interventions that specifically target key populations across the HIV care continuum are critical to achieving NHAS goals given that population-based, one-size-fits-all prevention strategies can prove inefficient and ineffective.[17] This dissertation aims to refine potential avenues for interventions to reduce racial/ethnic[*] disparities in the HIV care continuum among PWH from NHAS-specified key populations in the US. This dissertation begins with a description of trends in the proportions of PWH from key populations that achieve each of the last three steps of the HIV care continuum between 2004—2014 (Aim 1). We then determine whether current measures of retention in care can be used to adequately reflect HIV care engagement in the US and investigate the impact of measurement method on apparent racial/ethnic differences in retention (Aim 2). Lastly, the impact of sex, age, and sexual HIV acquisition risk on the magnitude of racial/ethnic disparities in the last three steps of the HIV care continuum will be investigated (Aim 3).

The three aims of this dissertation each correspond to Chapters 2, 3, and 4 of this dissertation, respectively, and will address the following three key questions concerning racial/ethnic disparities in the HIV care continuum in the US:

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[*] Because Hispanics can be of any race, the term "race/ethnicity" will refer to the following three populations of interest: 1) non-Hispanic Blacks, 2) non-Hispanic whites, and 3) Hispanics (of any race).

How have disparities in the proportion of PWH from key populations that are in the last 3 steps of the HIV care continuum changed over time?

Previous studies have characterized trends in the proportions of PWH from key populations at each HIV care continuum step over periods of time.[18–22] One study found that the percentage of MSM that are on ART and virally suppressed is increasing over time, although racial/ethnic disparities in viral suppression remained despite observed decreases over time.[21] Another study showed that whites had higher percentages of ART prescription and viral suppression than other racial/ethnic groups, with a decrease in the disparity over time.[20] These studies have been limited by the use of short timeframes or cross-sectional samples that may not be representative of PWH in the US. Chapter 2 aims to evaluate the progress made towards achieving the NHAS goals of improving retention in care, ART use, and viral suppression over time and reducing racial/ethnic disparities in key populations. Trends in these three HIV care continuum steps will be estimated specifically among MSM and women, stratified by age to highlight important age-related differences in trends within these populations. Identifying which racial/ethnic groups within key populations are lagging is an important step towards achieving NHAS goals by 2020.

Do standard measures of retention in care adequately depict HIV care engagement in the US over time?

As progress in achieving NHAS goals is monitored, it is important to use HIV care continuum measures that best operationalize the constructs they are intended to reflect. In contrast to ART use and viral suppression, various measures for retention in care are currently used in HIV research, and most rely on determining the frequency at which PWH attend HIV care visits.[23] As HIV clinical practice and guidelines evolve to allow for longer intervals between HIV care visits,[24] it is unknown whether such changes in HIV clinical practice impact the utility of current retention measures in tracking progress in HIV care engagement over time. Chapter 3 aims to describe temporal trends in the degree to which HIV care retention measures correlate with engagement in HIV care as determined through viral suppression. This chapter will also investigate the extent to which racial/ethnic disparities in retention in care vary according to various definitions for retention in care.

What is the impact of sex, age, and sexual HIV acquisition risk on the magnitude of racial/ethnic disparities in the last 3 steps of the HIV care continuum?

In addition to race/ethnicity, disparities with respect to sexual orientation, age, and sex in the US have also been documented. Men who have sex with men (MSM), for example, account for approximately 70% of all new HIV infections in the US.[9] Young PWH are the least likely to be retained in HIV care, on ART, and have a suppressed viral load,[25] and women have lower proportions of ART use and viral suppression relative to men.[20] Despite the substantial literature documenting disparities by race/ethnicity, sex, age, and other factors, it remains largely unknown how each of these characteristics interact with one another to influence racial/ethnic disparities. The aim of Chapter 4 is to determine the impact of sex, age, and sexual HIV acquisition risk on the magnitude of racial/ethnic disparities in retention in care, ART use, and viral suppression. A deeper understanding of the nuances of this impact would be instrumental in the development of targeted interventions designed to reduce racial/ethnic disparities in age- and sex-based risk groups with the highest burdens of disparity.

Data source

The source of epidemiologic data used throughout this dissertation is the North American AIDS Cohort Collaboration on Research and Design (NA-ACCORD).[26,27] The NA-ACCORD is the largest collaboration of interval and clinical cohorts of PWH in the US and is the North American member of the International Epidemiologic Databases to Evaluate AIDS (IeDEA) project sponsored by the NIH. Currently, 26 cohorts collect longitudinal data on >150,000 PWH contributing >1 million person-years of observation from >200 sites throughout the US and Canada. To be eligible for participation in the NA-ACCORD, PWH must successfully link into HIV care (defined as having ≥2 HIV care visits in 12 months from HIV care initiation) at one of these sites and must be ≥18 years old

The data collected in the NA-ACCORD includes both demographic (age, sex, race/ethnicity, HIV acquisition risk) and clinical information (clinical encounter dates, medical diagnoses and dates, laboratory values and dates, ART regimens and prescription dates). Individual cohorts collect these data using standardized, cohort-specific methods.

Each cohort transfers the data annually to the central Data Management Core at the University of Washington, where the data are harmonized and assessed for completeness and accuracy. Quality control procedures include correcting for the possibility that individuals received HIV care at more than one of the sites that are part of the NA-ACCORD. The data are then sent to the Epidemiology/Biostatistics Core at Johns Hopkins University for additional quality control checks, processing of analytic-ready summary files, and NA-ACCORD Steering Committee-approved epidemiologic analysis.

The NA-ACCORD is adequately positioned to investigate the aims presented in this dissertation for several reasons. First, participants in the NA-ACCORD have been shown to be demographically representative of all PWH in the US.[18] Given the focus on specific risk groups that are defined by combinations of demographic characteristics (e.g., young Black MSM) in this dissertation, generalizability of results is of paramount importance for this research. Second, the NA-ACCORD has been formally endorsed by the National Academy of Medicine as a source of data on PWH that is capable of assessing progress in HIV care continuum indicators in the US.[28] Third, the NA-ACCORD population represents a large, geographically diverse sample of PWH that have linked into and have access to HIV clinical care in the US in the modern treatment era, which is expressly the target population of each of the aims of this dissertation. The large size of the NA-ACCORD also allows for stratification of analyses by important combinations of demographic characteristics to isolate and independently examine the key populations of interest in this dissertation. Simply put, the NA-ACCORD is the most appropriate North American study population for the research questions of interest.

Study inclusion and exclusion criteria

Adult (≥18 years old) PWH from US-based clinical cohorts in the NA-ACCORD were included in Aims 1, 2, and 3 (Figure 1-1). PWH from cohorts that had an interval (i.e., classical) cohort design and that were not based in the US (i.e., Canadian cohorts) were excluded to allow for generalizability of findings specifically to PWH that are in HIV clinical care in the US.[29] For Aims 1 and 2, PWH with ≥1 HIV clinical encounter between 1 January 2004 and 31 December 2014 were included; for Aim 3, PWH linking into care in the NA-ACCORD between 1 January 2004 and 31 December 2014 were included.

For Aims 1 and 3, PWH who self-identified as Hispanic, non-Hispanic White, or non-Hispanic Black from cohorts with information on the following five categories of HIV acquisition risk were included: heterosexual contact, male-to-male sexual contact, injection drug use, other, or unknown. These aims were also restricted to the portion of the NA-ACCORD population that linked into HIV care for the first time, defined as having HIV RNA >200 copies/mL at enrollment in the NA-ACCORD, as well as no history of ART use (including mono- and dual therapy) and no history of AIDS prior to enrollment. For Aim 3, the additional criterion of having information on both HIV clinical encounters and HIV laboratory measurements (i.e., HIV RNA and CD4 count) was applied. Males with unknown transmission risk were also excluded from this aim to reduce the potential for misclassification between males with and without a history of male-to-male sexual contact.

Study variables and definitions

Information on the following individual-level characteristics were collected at enrollment in the NA-ACCORD: self-reported race/ethnicity (Hispanic, non-Hispanic White, non-Hispanic Black), sex (male, female), HIV acquisition risk (heterosexual contact, male-to-male sexual contact, injection drug use, other, or unknown), year of birth, CD4 count, and HIV RNA. Dates of HIV clinical encounters, ART prescriptions, and laboratory measurements were used to assess retention in care, ART use, and viral suppression, respectively. ART was any regimen comprised of a combination of ≥3 antiretroviral agents from ≥2 classes, or a triple nucleoside/nucleotide reverse transcriptase inhibitor regimen containing abacavir or tenofovir. Viral suppression was defined as an HIV RNA ≤200 copies/mL. In all three aims, death was considered a competing event as it precludes participants from being observed for retention in care, ART use, and viral suppression.

Additional considerations of race/ethnicity

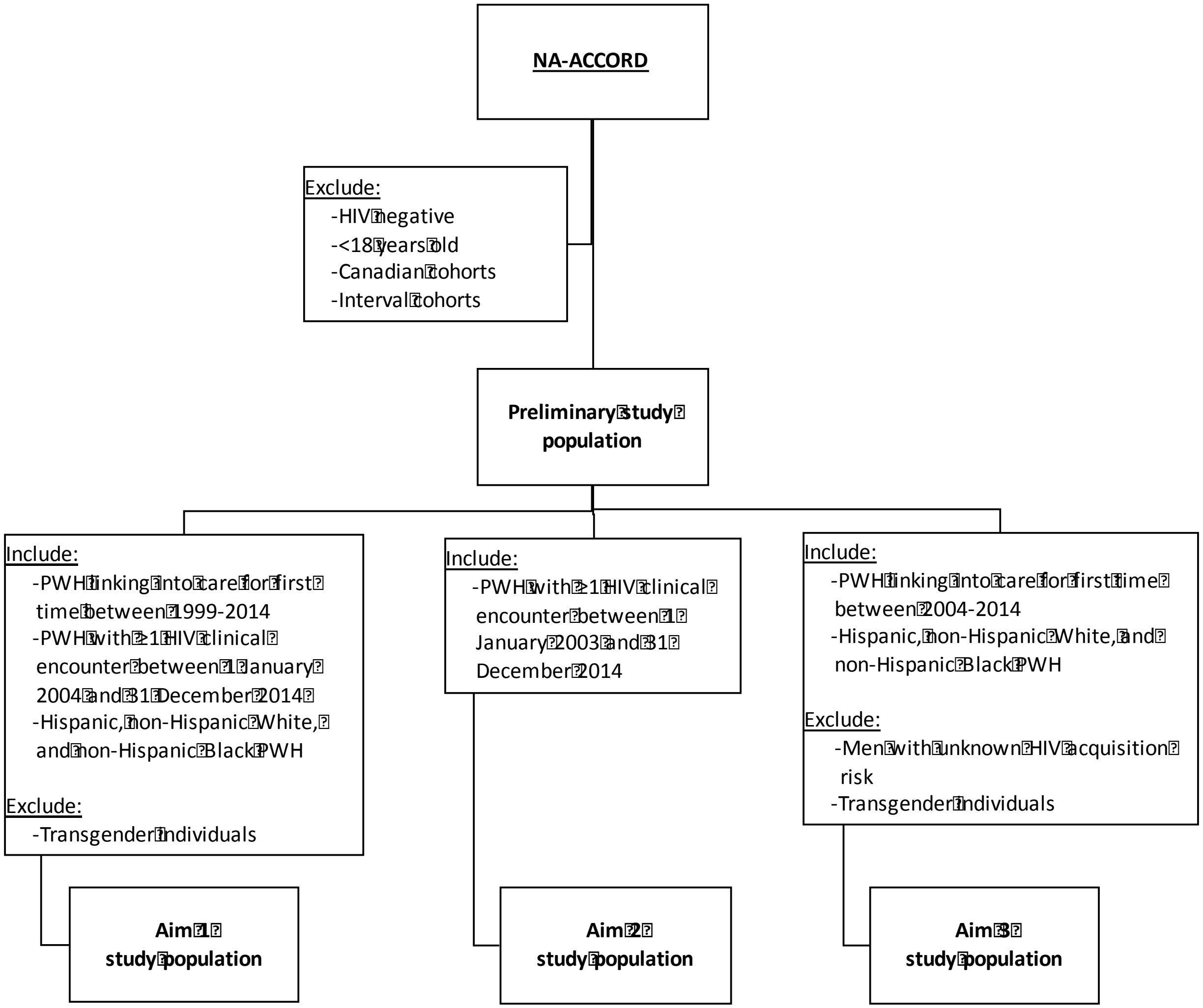
The causes of racial/ethnic health disparities have been a source of debate over the past several decades.[30] Some researchers have argued that differences in gene frequency give rise to racial/ethnic differences in health, whereas others have posited that variations in health outcomes are entirely reducible to socioeconomic differences between racial/ethnic groups.[31–33] The latter standpoint has prompted some epidemiologists to focus exclusively on measures of social inequality, rather than on race/ethnicity itself, by treating the latter as a proxy for socioeconomic determinants of health.[32,34] Other researchers argue that explicit examination of racial/ethnic groups is critical given the important role of persistent racism and interpersonal and structural discrimination in harming health.[32,33,35] Rather than isolate the root sources of race/ethnicity-related disparities in HIV care, this dissertation aims to characterize the progress made in reducing such disparities over time and identify subpopulations of PWH that may need intensified efforts for continued reductions. Although comparisons between racial/ethnic groups will be made, the causal role of race/ethnicity in HIV-related health disparities will not be expressly examined in this dissertation.

Significance of this research

Disparities in HIV care have placed a significant burden on minority and disadvantaged populations in the US since the beginning of the epidemic. Health disparities overall were shown to cost over $230 billion and over $1 trillion in direct and indirect costs over a 4-year period in the US, respectively.[7,36] Though there is some evidence to suggest that disparities have reduced in magnitude over time, most disparities have persisted for racial/ethnic groups.[37] The population of PWH in the US that are from racial/ethnic minority groups is expected to increase substantially in the next three decades.[38] HIV-related racial/ethnic disparities will continue to persist unless they are purposefully and effectively addressed.

Given the rise of PWH from minority groups and the stark HIV-related disparities associated with race and ethnicity, a deeper understanding of the factors that can be targeted to reduce disparities in the HIV care continuum among key populations of PWH is vital. The results of this research will inform clinical and public health programming efforts, such as enhanced individual-level HIV strategies geared towards key populations to achieve NHAS goals and improve levels of HIV care and treatment. Optimized strategies tailored to the populations most affected by disparities will increase the proportions of PWH from these groups that achieve and maintain viral suppression, which will, in turn, contribute to reduced onward HIV transmission and improved HIV-related health outcomes in these populations.

Figure 1-1. Source and study populations for Aims 1, 2, and 3.



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CHAPTER TWO

Trends in disparities in HIV care retention, antiretroviral therapy use, and viral suppression in key populations newly linked to care in the United States

Abstract

Background: Retention in care, antiretroviral (ART) use, and viral suppression among persons with HIV (PWH) must be achieved as soon as possible after linkage to care. The National HIV/AIDS Strategy targeted specific key populations, including men who have sex with men (MSM), Blacks, and Hispanics, to improve these HIV care outcomes and reduce racial/ethnic disparities.

Methods: MSM and women who successfully linked to HIV care for the first time in 11 US-based clinical cohorts in the North American AIDS Cohort Collaboration on Research and Design (NA-ACCORD) were followed for five years after linkage between 1 January 2004 and 31 December 2014. We estimated age-specific trends and racial/ethnic differences in the percentage of these groups who were retained in care, on ART, and virally suppressed between 2004-2014.

Results: A total of 13,614 MSM and 5,392 women were included. Retention in care remained stable or increased minimally over time, whereas ART use and viral suppression increased over time in all groups examined. Black and Hispanic MSM had consistently lower percentages of viral suppression than white MSM, with a worsening of the disparity among Black MSM aged 18 to 29 years. Although Hispanic women had higher percentages of retention in care than Black and white women, few disparities in ART use and viral suppression remained among women.

Conclusion: Despite increases in ART use and viral suppression over time and decreases in racial/ethnic differences, some disparities persist, particularly among Black MSM.

Targeted, intensified interventions are needed to improve the percentages of high-risk PWH that achieve these milestones.

Background

The HIV epidemic has differentially impacted specific subpopulations in the United States (US). Blacks and Hispanics, for example, share a disproportionate burden of both incident and prevalent HIV infections.[1] In 2015, the White House Office of National AIDS Policy provided an update to its National HIV/AIDS Strategy (NHAS), which had the primary goals of reducing new HIV infections and eliminating HIV-related health disparities by 2020.[2] Several key populations were identified in the NHAS, including gay, bisexual, and other men who have sex with men (MSM), Black and Hispanic men and women, and young persons with HIV (PWH).

The NHAS set forth specific benchmarks for improvements in retention in care, antiretroviral therapy (ART) use, and HIV viral suppression, which comprise the last three steps in the HIV care continuum.[3] These benchmarks included retaining in care at least 90% of HIV-diagnosed persons and increasing the percentage of virally suppressed HIV-diagnosed persons to 80%. Viral suppression has been associated with improved health outcomes and reduced HIV transmission risk.[4,5] Given the linear progression of these three HIV care indicators (i.e., a PWH must be retained in care and receive ART to achieve viral suppression), they are important milestones that must be achieved as soon as possible after linkage into HIV care to preserve healthy life and prevent ongoing transmission. The last three steps in the HIV care continuum thus represent critical intervention points for maximizing both public health and clinical benefits among PWH, particularly those who are new to HIV care.

Although several studies have reported on trends over time in retention in care, ART use, and viral suppression and on race/ethnicity-related disparities,[6–15] these indicators have not been examined specifically among PWH from key populations who have been newly linked to HIV care. This study is a necessary step to evaluate improvements in HIV care and treatment in the US and measure progress towards achieving NHAS goals. Our study objective was to assess the progress made between 2004-2014 towards increasing retention in care, ART use, and viral suppression and eliminating racial/ethnic disparities in NHAS-specified key populations of PWH newly linked to HIV care in the US.

Methods

Study Population

The North American AIDS Cohort Collaboration on Research and Design (NA-ACCORD) is a consortium of >20 interval and clinical cohorts collecting longitudinal clinical, laboratory, and treatment data on >150,000 HIV-infected individuals from >200 sites throughout the US and Canada.[16] The NA-ACCORD's methodology has been described elsewhere.[17] In brief, each contributing cohort uses standardized cohort-specific methods to collect data on HIV-infected individuals successfully engaged in care (defined as ≥2 clinical visits within 12 months). These data are submitted to the NA-ACCORD central Data Management Core at the University of Washington, where the data undergo quality control procedures for accuracy and completeness prior to being harmonized. The data are then transferred to the Epidemiology/Biostatistics Core for further quality control procedures and analyses. The Institutional Review Board from each participating cohort and the Johns Hopkins University School of Medicine have approved the human subject activities conducted within the NA-ACCORD.

Participants in the NA-ACCORD have been shown to be demographically representative of all PWH in the US.[6] According to the National Academy of Medicine, the NA-ACCORD is adequately positioned to monitor HIV care indicators among PWH in the US, including retention in care, ART use, and viral suppression.[18]

Our study included NA-ACCORD adult participants (≥18 years old) who successfully linked into HIV care for the first time between 1 January 1999 and 31 December 2014 in one of 11 clinical, US-based cohorts in the NA-ACCORD with information on HIV acquisition risk, race/ethnicity, and HIV primary care visits. Non-clinical and Canadian cohorts in the NA-ACCORD were excluded to allow for generalizability of findings specifically to PWH that are in HIV clinical care in the US. We defined successful first-time linkage to HIV care as having the following characteristics at enrollment in the NA-ACCORD (i.e., at the first of ≥2 HIV care visits in 12 months): 1) HIV RNA >200 copies/mL, 2) no history of an AIDS-defining illness, and 3) no history of ART use (including mono- and dual therapy). Individuals enrolling in the NA-ACCORD before the start of data collection in their respective clinical cohort were excluded from this analysis to further ensure first-time HIV care linkage.

To corroborate the external validity of our findings, we expanded a prior comparison of the demographic characteristics of NA-ACCORD participants to those of PWH who were reported to the Centers for Disease Control and Prevention HIV/AIDS Reporting System (HARS).[6] The expanded comparison was stratified by sex to ensure specific key populations of interest were represented. We compared demographic characteristics of 1) MSM and female NA-ACCORD participants who were alive and in care (i.e., having ≥1 HIV RNA or CD4 cell count measurement) through 31 December 2014 (the last year data was available in the NA-ACCORD) and 2) MSM and female HARS participants who were alive through 31 December 2016. We found that NA-ACCORD and HARS participants were qualitatively similar with respect to age, race/ethnicity, and HIV acquisition risk (see Appendix Table 2-1). The percentage of Hispanic MSM, Hispanic women, and women who inject drugs was lower among NA-ACCORD participants as compared to PWH reported to the HARS; the difference in the percentage of the total HARS versus NA-ACCORD study population that was from these three subgroups was 9.4%. All other subgroups represented 82.4% and 73.1% of the HARS and NA-ACCORD populations.

Key Populations

We specifically focused on 4 key populations: 1) non-Hispanic Black MSM, 2) Hispanic MSM, 3) non-Hispanic Black women, and 4) Hispanic women. Non-Hispanic white MSM and non-Hispanic white women served as the comparison group for their respective Black and Hispanic counterparts. To highlight important age-related differences, we stratified each key population by the following 4 age categories: 1) 18 to 29 years, 2) 30 to 39 years, 3) 40 to 49 years, and 4) ≥50 years. Sex (male or female), self-reported race/ethnicity, year of birth, and HIV acquisition risk were collected at enrollment into the individual clinical cohorts. Data on intersex and transgender adults were not available for the present study.

Outcomes

We estimated the percentage of participants who were 1) retained in HIV clinical care, 2) on ART, and 3) virally suppressed using standard definitions endorsed by the US Department of Health and Human Services for these HIV care indicators.[19] Participants who were "retained in care" in calendar year *x* were those who had ≥1 HIV care visit, ≥60 days apart, in 4 consecutive semesters (January–June and July–December) of a 2-year period (calendar year *x-1* and calendar year *x*), among patients with ≥1 visit in the first semester of year *x-1*. Participants were classified as "on ART" in calendar year *x* if they were prescribed ART for ≥1 month and had ≥1 HIV care visit that year. ART regimens were defined as a combination of ≥3 antiretroviral agents from ≥2 classes, or as a triple nucleoside/nucleotide reverse transcriptase inhibitor regimen containing abacavir or tenofovir. Viral suppression in calendar year *x* was defined as having HIV RNA ≤200 copies/mL at the last measurement in the calendar year and ≥1 HIV care visit that year.

Statistical Analysis

Individuals contributed to the present study from the date of enrollment in the NA-ACCORD (i.e., the first of ≥2 HIV care visits in 12 months) or 1 January 2004, whichever came later, until the date of death, date of last HIV care visit, five years after linkage to HIV care (to reflect recent HIV care linkage), or 31 December 2014, whichever occurred first. For participants who died during the study period, the year of death was excluded from analyses as death is a competing risk for these outcomes and precludes participants from being followed for the entire 1- or 2-year timespan specified by the Department of Health and Human Services indicators. Participants were excluded from viral suppression estimates for each calendar year ≥1 HIV RNA measure was not available.

Cross-sectional annual estimates of the percentage of participants that were retained in care, on ART, and virally suppressed were produced from 2004-2014 for each key population. To examine changes in racial/ethnic disparities over time, we also estimated the difference in the percentage of participants that were retained in care, on ART, and virally suppressed from 2004-2014, comparing Blacks and Hispanics versus whites.

Generalized linear models using an identity link with binomially distributed variance were used to assess temporal trends in the three outcomes of interest. Models were fit using generalized estimating equations with an unstructured working correlation within individuals to account for correlation resulting from an individual being able to contribute to outcome estimates in multiple calendar years.[20] To determine if there were racial/ethnic differences in improvements made in retention in care, ART use, and viral suppression over time, we estimated 1) the rate of change in outcome (defined as the average percent change in outcome over the 11-year study period) for each key population and 2) differences in the rate of change, comparing Blacks and Hispanics to whites, for MSM and for women.

To support our assertion that the time period following HIV care linkage is critical for public health and clinical interventions, we also conducted a sensitivity analysis without the requirement that PWH be newly linked to HIV care and without administrative censoring five years after HIV care linkage (see Appendix Tables 2-2 — 2-4 and Appendix Figures 2-1 — 2-2). All analyses were conducted using SAS software, version 9.4 (SAS Institute, Inc., Cary, North Carolina). A *p*-value <0.05 guided statistical interpretation.

Results

Participant characteristics

A total of 13,614 MSM and 5,392 women were newly linked to care between 2004-2014 or were within 5 years of first-time linkage into HIV care in the NA-ACCORD in 2004 (Table 2-1). Most MSM participants were white, whereas most female participants were Black. A minority of MSM and women were classified as having a history of injection drug use at enrollment. Most participants had a CD4 count <500 cells/mL at enrollment.

Retention in care, ART use, and viral suppression among MSM

There was a statistically significant, yet minor increase in the percentage of Hispanic MSM that were retained in care from 62.9% in 2004 to 70.2% in 2014 (rate of change: 0.8%; p-trend: 0.012); this percentage, however, remained stable among Black and white MSM at approximately 61% and 66%, respectively (Figure 2-1a, Table 2-2a). In age-stratified analyses, Hispanic MSM of ages 18 to 29 years and Black MSM of ages 30 to 39 years also experienced minor, statistically significant increases in retention percentages. Relative to white MSM of the same age group, increases in retention in care percentages were slightly greater among Black MSM of ages 30 to 39 years and Hispanic MSM of ages 40 to 49 years.

ART use among Black, Hispanic, and white MSM increased significantly from 56.0%, 57.2%, and 55.7% in 2004 to 83.3%, 87.1%, and 84.5% in 2014, respectively. Statistically significant increases in ART use also occurred within each age group over time. However, the rate of increase in ART use was 1.2% higher among white MSM of ages 18 to 29 years than Black MSM of the same ages (p-value = 0.003). Similarly, the percentage of Black, Hispanic, and white MSM that was virally suppressed increased significantly from 28.9%, 38.2%, and 39.8% in 2004 to 72.4%, 83.5%, and 83.7% in 2014, respectively. Viral suppression percentages increased over time within each age group, with white MSM of ages 18 to 29 years experiencing a higher increase than Black MSM of the same ages (difference in rate of change: -1.2%; p-value: 0.004).

Overall, Black MSM had consistently lower percentages of retention in care, ART use, and viral suppression relative to white MSM, with no statistically significant change in the disparity over time (Figure 2-2a). Relative to white MSM, Hispanic MSM, however, had higher overall percentages of retention in care, similar percentages of ART use, and lower percentages of viral suppression, with a significant increase in the Hispanic-white difference in retention in care over time. The disparity in retention in care decreased among Black MSM 30 to 49 years of age, whereas the difference in retention in care increased among Hispanic MSM of the same age range. The difference in ART use decreased among Black MSM 18 to 29 years of age and among Hispanic MSM 30 to 39 years of age. The Black-white viral suppression disparity increased over time among Black MSM of ages 18 to 29 years and decreased among those aged 30 to 39 years.

Retention in care, ART use, and viral suppression among women

The percentage of Black, Hispanic, and white women that were retained in care increased from 65.3%, 69.8%, and 61.8% in 2004 to 67.9%, 84.9%, and 65.2% in 2014, respectively (Figure 2-1b, Table 2-2b). This increase was statistically significant among Black and Hispanic women. Rates of increase in retention in care were 1.7% greater among Hispanic women relative to white women (p-value = 0.007). In age-stratified analyses, Hispanic women of ages 30 to 39 years and ≥50 years experienced a significant increase, whereas the percentage retained in care was stable in Black and white women of each age group. The percentage retained in care increased more rapidly among Hispanic women aged ≥50 years relative to white women of the same ages (difference in rate of change: 2.1%; p-value: 0.045).

ART use increased among Black, Hispanic, and white women from 53.8%, 56.9%, and 59.8% in 2004 to 79.9%, 84.2%, and 87.1% in 2014, respectively. Increases in ART use also occurred in each age group over time, although the rate of increase was 2.1% higher among Hispanic women 40 to 49 years of age relative white women in the same age group. Viral suppression percentages increased from 26.3%, 25.6%, and 34.7%

in 2004 to 71.6%, 76.9%, and 77.5% in 2014 among Black, Hispanic, and white women, respectively. Each age group experienced an increase in the percentage that was virally suppressed over time.

Relative to white women, Hispanic women had higher percentages of retention in care, with an increase in this difference over time (Figure 2-2b). This difference was largest and most stable over time in the 18-to-29 age group. However, the Hispanic-white difference increased over time among women aged ≥30 years. Although Black, Hispanic, and white women had similar overall percentages of ART use and viral suppression over time, Black women ≥50 years of age had consistently lower percentages of ART use and viral suppression relative to white women of the same age group; Hispanic women of ages 18 to 29 years had higher percentages of ART use and viral suppression relative to white women of the same age group.

Sensitivity analysis including all PWH under follow-up

We observed similar racial/ethnic patterns in retention in care, ART use, and viral suppression trends in a sensitivity analysis that also included PWH that were not newly linked to care, without censoring 5 years after linkage (Appendix Tables 2-2 — 2-4 and Appendix Figures 2-1 — 2-2). However, the percentages of retention in care, ART use, and viral suppression and the rates of change in these indicators were lower relative to PWH newly linked to HIV care. Relative to white MSM and women, Black and Hispanic MSM and women in several age categories also had higher rates of increase in these percentages.

Discussion

Since the original release of the NHAS in 2010, major public health efforts have focused on increasing the percentage of PWH that are retained in care, on ART, and virally suppressed, and on reducing racial/ethnic disparities in these outcomes. Given the need to achieve these HIV care milestones as soon as possible after linkage to care, a special emphasis on PWH from key populations that are new to HIV care is necessary. Our data indicate that, despite minimal temporal changes in retention in care, both ART use and viral suppression increased from 2004 to 2014 among MSM and women that were newly linked to HIV care. Among MSM, Blacks and Hispanics had persistently lower percentages of viral suppression than whites, with a worsening of this disparity among Black MSM of ages 18 to 29 years. Among women, however, few racial/ethnic disparities in ART use and viral suppression remained, though Hispanics had higher percentages of retention in care than Blacks and whites.

Our findings are consistent with previous studies reporting increases in ART use and viral suppression over time.[6,8,9,12–14] Improvements in the percentage of PWH on ART and with viral suppression are likely due to the use of more tolerable ART medications and the changing clinical practice of initiating treatment at any CD4 count; these changes in clinical practice likely began before formal changes to the HIV care guidelines to "treat all" in 2015.[21] Continued expansion of ART prescription immediately after linkage to HIV care is necessary to further improve the percentage of PWH that are on ART and to reach the NHAS's goal of 80% viral suppression among persons diagnosed with HIV.[2]

Although ART use and viral suppression increased over time, retention in care percentages remained constant or, at best, increased marginally in certain key populations. Increases in retention in care over time have been described in previous studies.[22–24] Given these previous findings and retention in care's association with a higher likelihood of ART use and viral suppression,[25,26] we anticipated a concomitant increase in all three HIV care indicators. It is possible that patients may be engaged in HIV care in ways that are not fully captured by the operational Department of Health and Human Services definition for retention in care, which requires an HIV care visit in 4 consecutive semesters over 2 years. For example, HIV care providers with patients with successful ART use and viral suppression may not encourage such patients to present for care as frequently. It is also possible that surrogates for face-to-face medical visits, such as regular phone calls or electronic communication, may be an important mode of interaction between patients and their HIV providers. These alternative measures of engagement in HIV care are not routinely captured in the medical record. As changing clinical guidelines call for longer intervals between HIV care visits and laboratory measurements,[21] future studies should include other measures of engagement in HIV care and investigate the impact of modifications to standard retention in care definitions on temporal trends in retention in care.

Despite promising increases in ART use and viral suppression and diminishing disparities, specific racial/ethnic disparities in these indicators were persistent over time. Black MSM, for example, had consistently lower proportions of ART use and viral suppression over time than white MSM, and there was no evidence of a reduction in this disparity. Among MSM ages 18 to 29 years, there was a slower rate of increase in ART use and viral suppression among Blacks relative to whites. Although the Black-white disparity in ART use decreased over time in this group, the disparity in viral suppression significantly increased. One study found that Black MSM have the highest HIV incidence of any risk group and that the HIV incidence among Hispanic MSM is currently increasing.[27] Since viral suppression vastly reduces the likelihood of HIV transmission, the lower viral suppression found among Blacks and Hispanics in our study may explain racial/ethnic differences in patterns of HIV incidence. Widening racial/ethnic disparities in viral suppression amidst overall increases in ART prescription may be due, in part, to differences in the prevalence of social factors among Blacks, Hispanics, and whites that can interfere with consistent ART use. These factors include homelessness, substance abuse, and metal health conditions, as well as provider-related factors, such as low cultural competency and communication ability.[28–31] One study, for example, found that culturally appropriate care with bilingual and bicultural staff can significantly improve adherence among Hispanic PWH.[32] Our findings highlight the continued need for tailored interventions that both comprehensively address these factors and target ART nonadherence among minority MSM.

Interestingly, Hispanic MSM had higher percentages of retention in care relative to white MSM amidst lower viral suppression percentages; Hispanic women had more rapid increases in retention in care over time than white women yet similar increases in ART use and viral suppression. Previous studies have found no Hispanic-white differences in these indicators,[7,11,12] whereas others have noted either lower[9,10,12,14,15] and/or higher[7,9,33] percentages among Hispanics relative to whites. HIV-related disparities affecting the Hispanic population reflect Hispanics' unique and complex set of barriers to HIV care and treatment. These barriers include varying acculturation levels, lack of health insurance, migration patterns, and language and geographic differences.[34–36] Inferior HIV care outcomes among Hispanics, for example, have been associated with immigration status, birthplace, and acculturation level.[37–39] Considering the substantial demographic heterogeneity found in Hispanic populations,[39–41] mixed findings in HIV care indicator disparities may be explained by varying study populations, in addition to differences in study design and measurement. Additional research is needed to explain varying HIV care indicator outcomes among Hispanics.

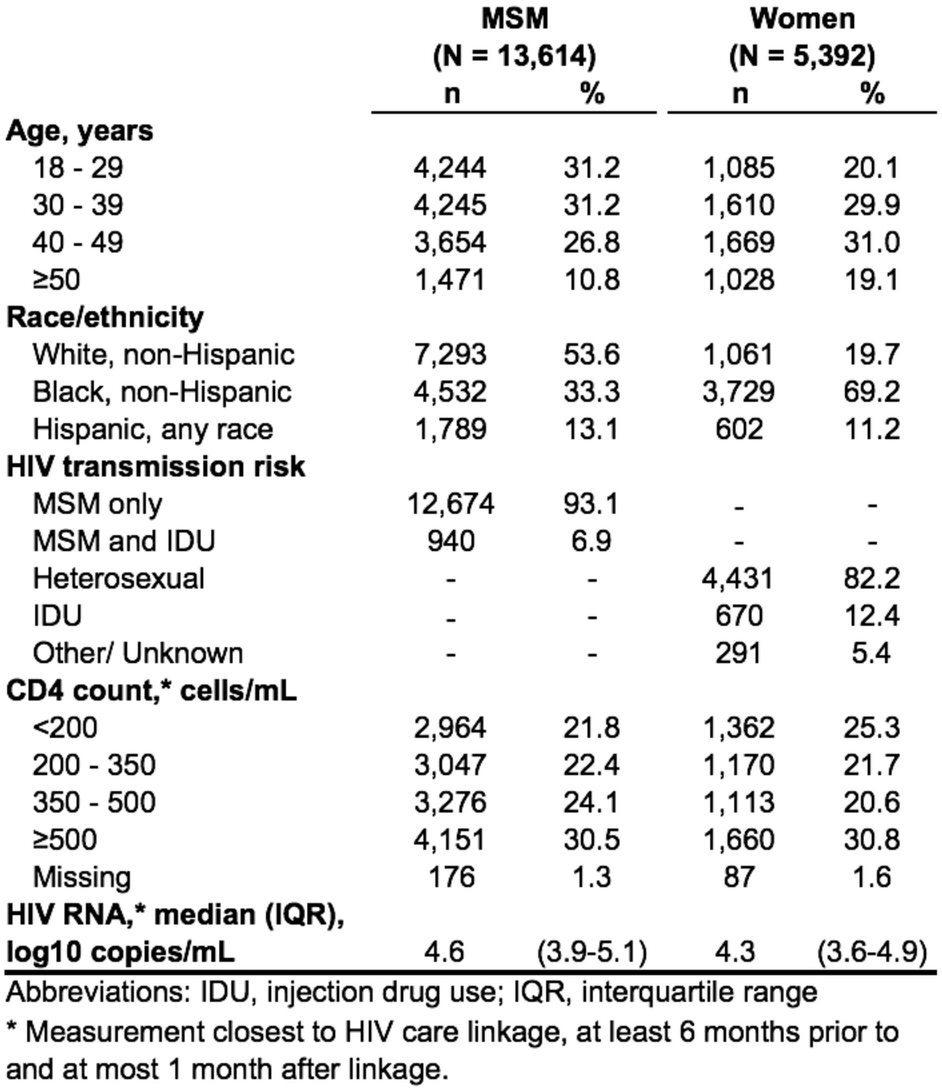
We also found important differences in analyses that included all PWH under follow-up in the NA-ACCORD. These follow up-based differences may suggest that time since HIV care linkage is an important factor to consider in studies regarding trends in disparities in HIV care indicators and that the first 5 years following linkage to care represent a critical timeframe for public health interventions to improve retention in care, ART use, and viral suppression and reduce disparities. Given the presence of age- and race/ethnicity-specific disparities in both types of analyses, our results also demonstrate the need to stratify future studies by these subgroups and by time since linkage to care.

Study strengths include our focus on PWH new to HIV care and our ability to stratify by race/ethnicity and age group among MSM and women, thereby elucidating HIV care trends in important key populations highlighted by the NHAS. We also used a large sample of demographically diverse MSM and women from a nationally representative cohort formally endorsed to assess progress towards achieving NHAS goals.

There were limitations to our study. First, we assumed that participants' enrollment in the NA-ACCORD represented their first linkage into HIV care after an HIV diagnosis. It is possible that participants may have received HIV care prior to enrollment in the NA-ACCORD. However, we removed those with a history of AIDS diagnoses, a history of ART use, and those with suppressed viral load to restrict the study population to those most likely linking into care for the first time. Our retention in care, ART use, and viral suppression estimates may also be subject to misclassification error due to possible receipt of HIV care outside of the NA-ACCORD contributing study; the extent to which this occurs is unknown.

In summary, our analysis demonstrates encouraging increases in ART use and viral suppression and reductions in racial/ethnic disparities over time among key populations of PWH newly linked to care. However, persistent disparities in these indicators, particularly in viral suppression among Black and Hispanic MSM, are a cause for concern. Such disparities are, in part, due to differences in access to and use of healthcare services.[42] Given the expected shift towards a larger proportion of PWH in the US that are from racial/ethnic minority groups,[43] HIV-related racial/ethnic disparities will continue to persist unless they are adequately addressed. Intensified, targeted interventions mitigating differences in access to care and consistent use of ART are needed to achieve the NHAS's 2020 goals among newly linked PWH from key populations.

Table 2-1. Baseline demographic and clinical characteristics of men who have sex with men (MSM) and women newly linked to HIV care, NA-ACCORD, 2004 – 2014



	MSM (N = 13,614)		Women (N = 5,392)	
	n	%	n	%
Age, years				
18 - 29	4,244	31.2	1,085	20.1
30 - 39	4,245	31.2	1,610	29.9
40 - 49	3,654	26.8	1,669	31.0
≥50	1,471	10.8	1,028	19.1
Race/ethnicity				
White, non-Hispanic	7,293	53.6	1,061	19.7
Black, non-Hispanic	4,532	33.3	3,729	69.2
Hispanic, any race	1,789	13.1	602	11.2
HIV transmission risk				
MSM only	12,674	93.1	-	-
MSM and IDU	940	6.9	-	-
Heterosexual	-	-	4,431	82.2
IDU	-	-	670	12.4
Other/ Unknown	-	-	291	5.4
CD4 count,* cells/mL				
<200	2,964	21.8	1,362	25.3
200 - 350	3,047	22.4	1,170	21.7
350 - 500	3,276	24.1	1,113	20.6
≥500	4,151	30.5	1,660	30.8
Missing	176	1.3	87	1.6
HIV RNA,* median (IQR), log10 copies/mL	4.6	(3.9-5.1)	4.3	(3.6-4.9)

Abbreviations: IDU, injection drug use; IQR, interquartile range

* Measurement closest to HIV care linkage, at least 6 months prior to and at most 1 month after linkage.

Table 2-2 a, b. Race/ethnicity-specific rates of change (RC) and differences in RC (DRC) for trends in retention in care, ART use, and viral suppression among (a) men who have sex with men and (b) women newly linked to HIV care, overall and by age group, NA-ACCORD, 2004 – 2014

a)

		Retention in Care				ART Use				Viral Suppression			
		RC	*P*value	DRC	*P*value	RC	*P*value	DRC	*P*value	RC	*P*value	DRC	*P*value
Overall	Black	0.04%	0.853	0.2%	0.489	**3.3%**	**<.0001**	0.1%	0.763	**4.5%**	**<.0001**	-0.1%	0.650
	Hispanic	**0.8%**	**0.012**	**0.9%**	**0.008**	**3.3%**	**<.0001**	0.1%	0.779	**4.8%**	**<.0001**	0.2%	0.458
	White	-0.1%	0.356	-		**3.2%**	**<.0001**	-		**4.6%**	**<.0001**	-	
18 to 29 years	Black	0.2%	0.619	-0.3%	0.626	**4.7%**	**<.0001**	**-1.2%**	**0.003**	**5.3%**	**<.0001**	**-1.2%**	**0.004**
	Hispanic	**1.6%**	**0.009**	1.1%	0.150	**5.6%**	**<.0001**	-0.3%	0.621	**5.9%**	**<.0001**	-0.6%	0.257
	White	0.5%	0.280	-		**5.9%**	**<.0001**	-		**6.5%**	**<.0001**	-	
30 to 39 years	Black	**0.9%**	**0.025**	**1.1%**	**0.026**	**3.6%**	**<.0001**	-0.2%	0.516	**5.2%**	**<.0001**	0.3%	0.394
	Hispanic	0.5%	0.280	0.7%	0.196	**3.1%**	**<.0001**	-0.7%	0.102	**4.8%**	**<.0001**	-0.06%	0.901
	White	-0.2%	0.476	-		**3.8%**	**<.0001**	-		**4.9%**	**<.0001**	-	
40 to 49 years	Black	0.4%	0.322	0.7%	0.130	**2.6%**	**<.0001**	0.1%	0.857	**4.1%**	**<.0001**	-0.2%	0.699
	Hispanic	1.0%	0.073	**1.3%**	**0.031**	**2.3%**	**<.0001**	-0.2%	0.679	**4.4%**	**<.0001**	0.1%	0.860
	White	-0.3%	0.202	-		**2.5%**	**<.0001**	-		**4.3%**	**<.0001**	-	
≥50 years	Black	0.1%	0.891	0.1%	0.868	**2.1%**	**0.000**	0.4%	0.490	**3.2%**	**<.0001**	-0.1%	0.858
	Hispanic	-0.2%	0.801	-0.2%	0.836	**1.9%**	**0.043**	0.2%	0.850	**4.1%**	**<.0001**	**0.9%**	0.357
	White	-0.03%	0.924	-		**1.7%**	**<.0001**	-		**3.3%**	**<.0001**	-	

Bold denotes statistical significance.

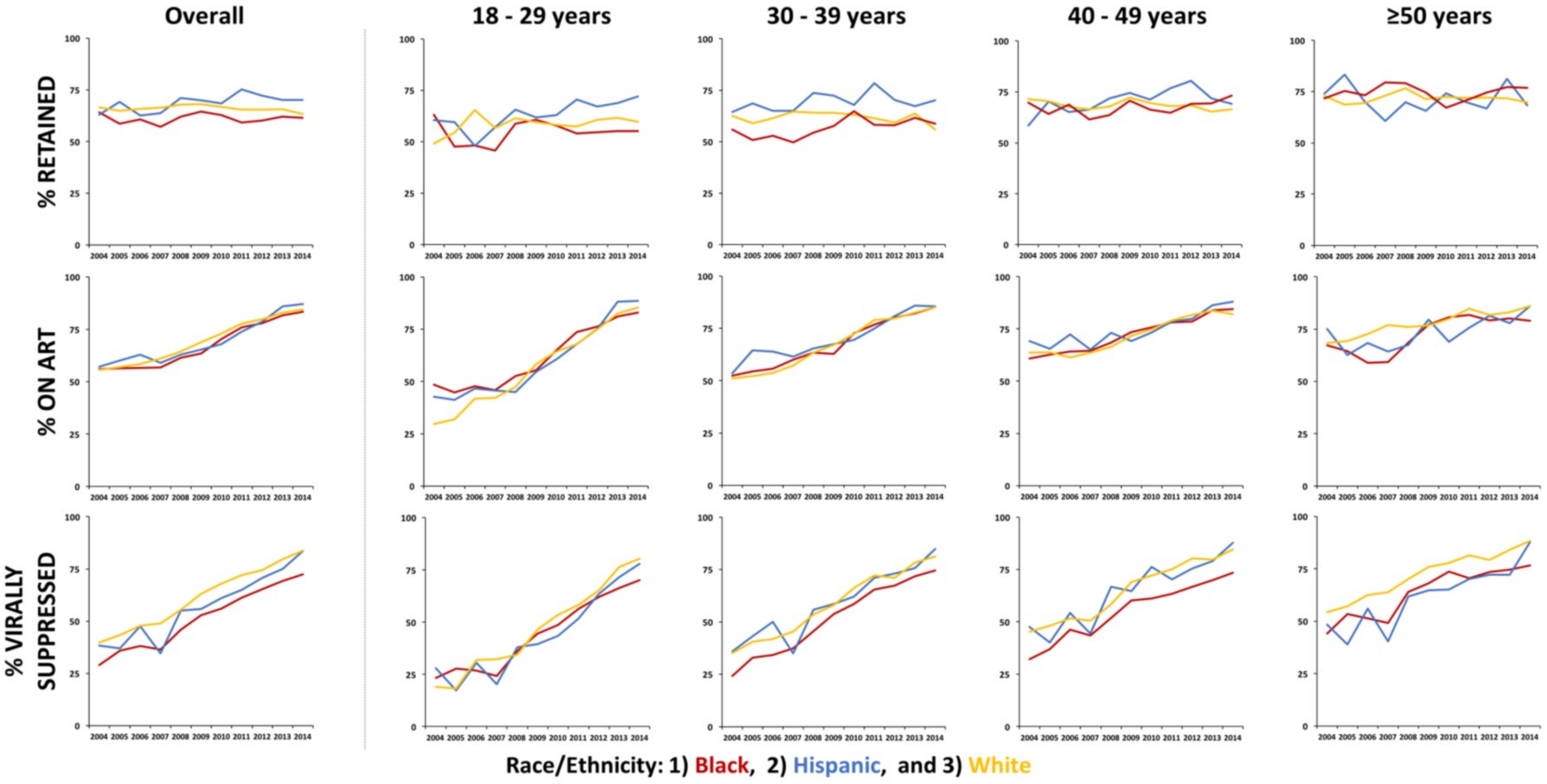
b)

		Retention in Care				ART Use				Viral Suppression			
		RC	*P* value	DRC	*P* value	RC	*P* value	DRC	*P* value	RC	*P* value	DRC	*P* value
Overall	Black	**0.7%**	**0.002**	0.9%	0.056	**3.1%**	**<.0001**	0.3%	0.487	**4.7%**	**<.0001**	0.1%	0.749
	Hispanic	**1.4%**	**0.002**	**1.7%**	**0.007**	**3.4%**	**<.0001**	0.6%	0.272	**5.1%**	**<.0001**	0.6%	0.284
	White	-0.3%	0.540	-		**2.8%**	**<.0001**	-		**4.5%**	**<.0001**	-	
18 to 29 years	Black	0.8%	0.197	2.4%	0.086	**4.1%**	**<.0001**	1.5%	0.120	**4.9%**	**<.0001**	**1.9%**	**0.049**
	Hispanic	-1.1%	0.327	0.5%	0.770	**2.2%**	**0.046**	-0.3%	0.816	**4.1%**	**<.001**	1.1%	0.462
	White	-1.6%	0.196	-		**2.6%**	**0.004**	-		**3.0%**	**<.001**	-	
30 to 39 years	Black	0.6%	0.165	0.2%	0.798	**2.7%**	**<.0001**	-0.2%	0.766	**4.3%**	**<.0001**	0.03%	0.963
	Hispanic	**2.4%**	**0.004**	2.1%	0.072	**3.1%**	**<.0001**	0.2%	0.858	**5.1%**	**<.0001**	0.9%	0.363
	White	0.3%	0.684	-		**2.9%**	**<.0001**	-		**4.2%**	**<.0001**	-	
40 to 49 years	Black	0.7%	0.051	1.0%	0.233	**3.2%**	**<.0001**	0.9%	0.176	**5.0%**	**<.0001**	-0.11%	0.866
	Hispanic	1.6%	0.068	1.8%	0.104	**4.4%**	**<.0001**	**2.1%**	**0.036**	**6.3%**	**<.0001**	1.2%	0.216
	White	-0.3%	0.721	-		**2.3%**	**<.0001**	-		**5.1%**	**<.0001**	-	
≥50 years	Black	-0.01%	0.986	0.7%	0.430	**2.5%**	**<.0001**	-0.5%	0.554	**4.2%**	**<.0001**	-0.03%	0.970
	Hispanic	**1.4%**	**0.040**	**2.1%**	**0.045**	**2.5%**	**0.005**	-0.4%	0.695	**3.4%**	**<.001**	-0.8%	0.517
	White	-0.7%	0.376	-		**3.0%**	**<.0001**	-		**4.2%**	**<.0001**	-	

Bold denotes statistical significance.

Figure 2-1 a, b. Race/ethnicity-specific temporal trends in the percentage of (a) men who have sex with men and (b) women newly linked to HIV care that were retained in care, on ART, and with suppressed HIV RNA, overall and by age, NA-ACCORD, 2004 – 2014

a)



b)

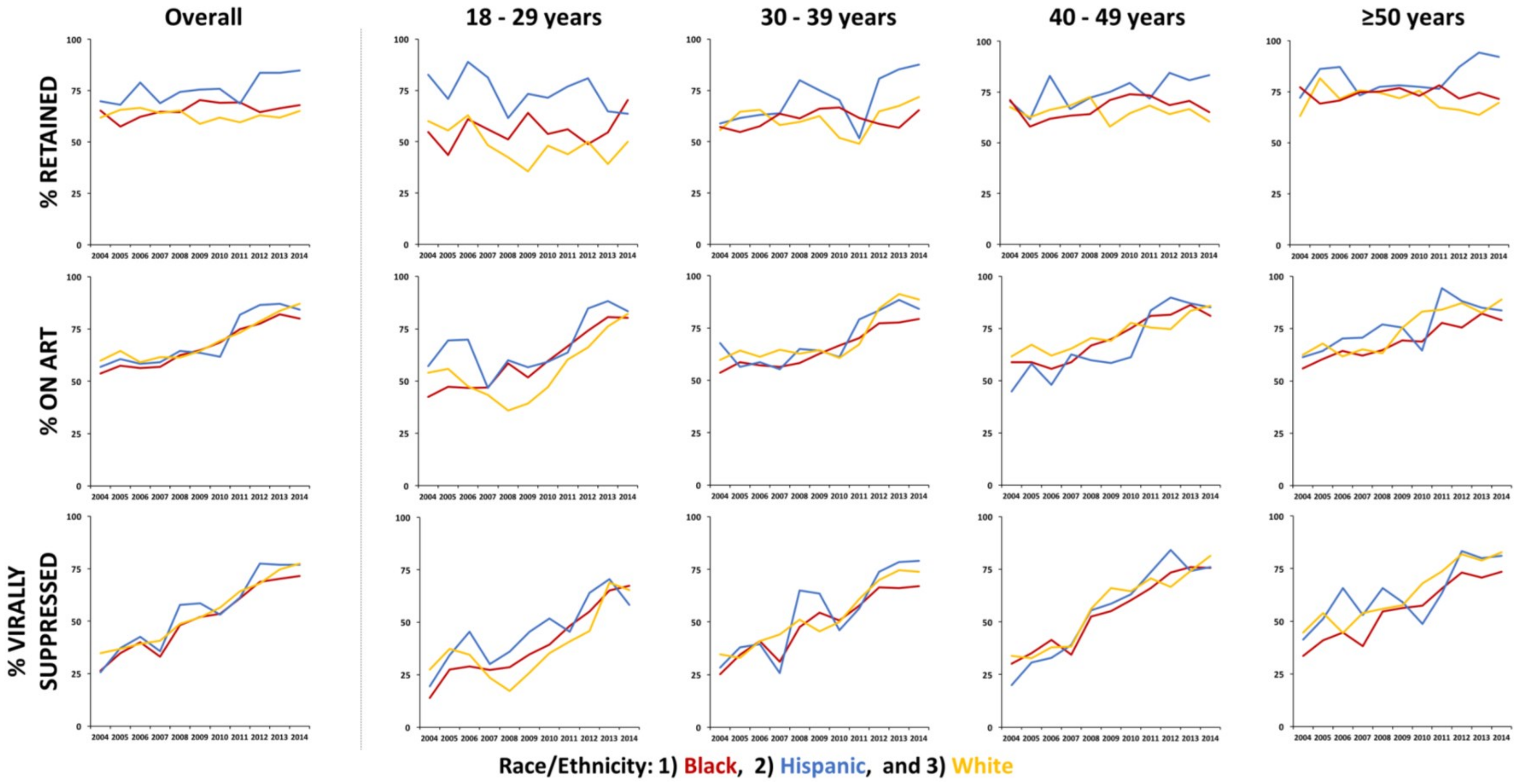
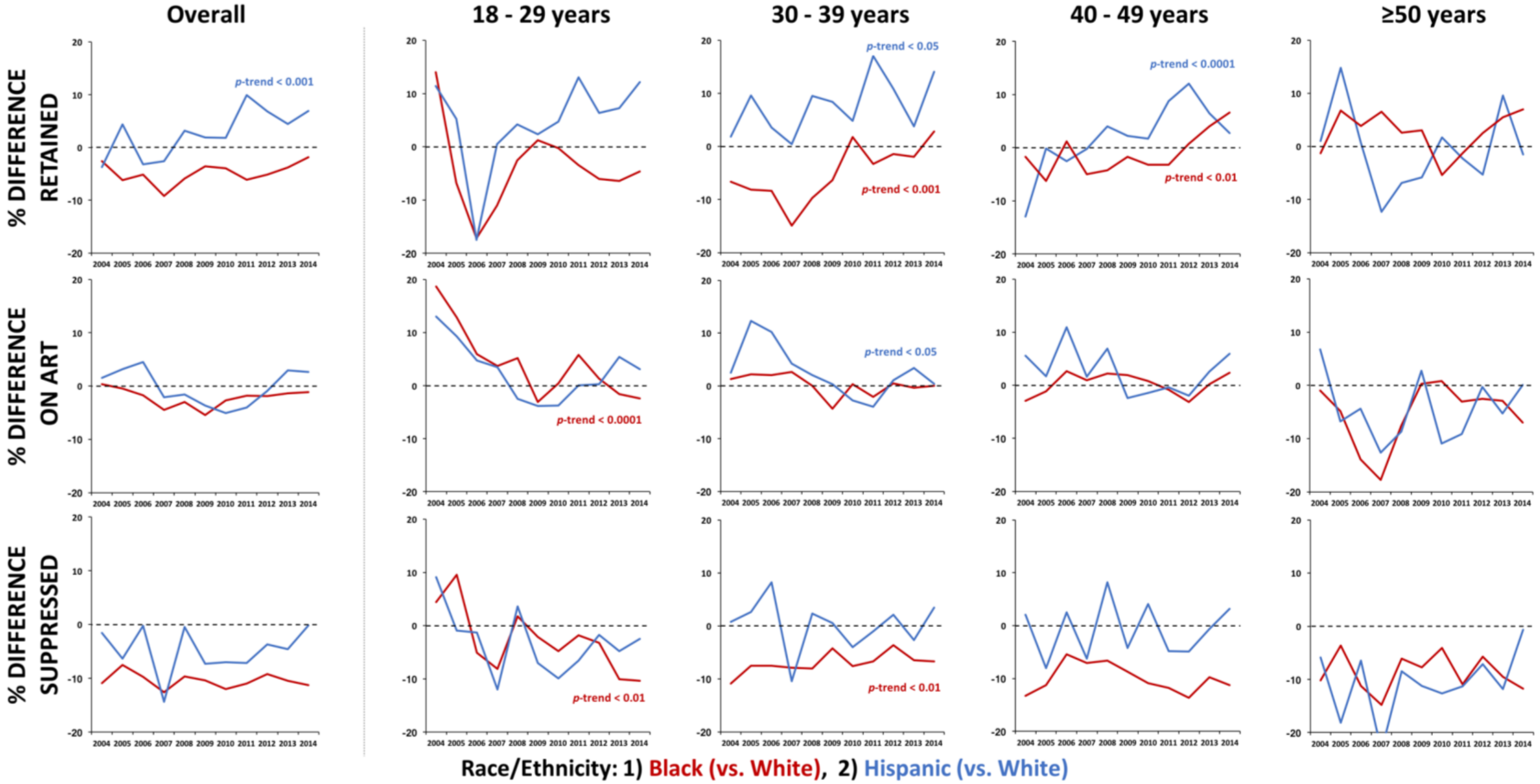
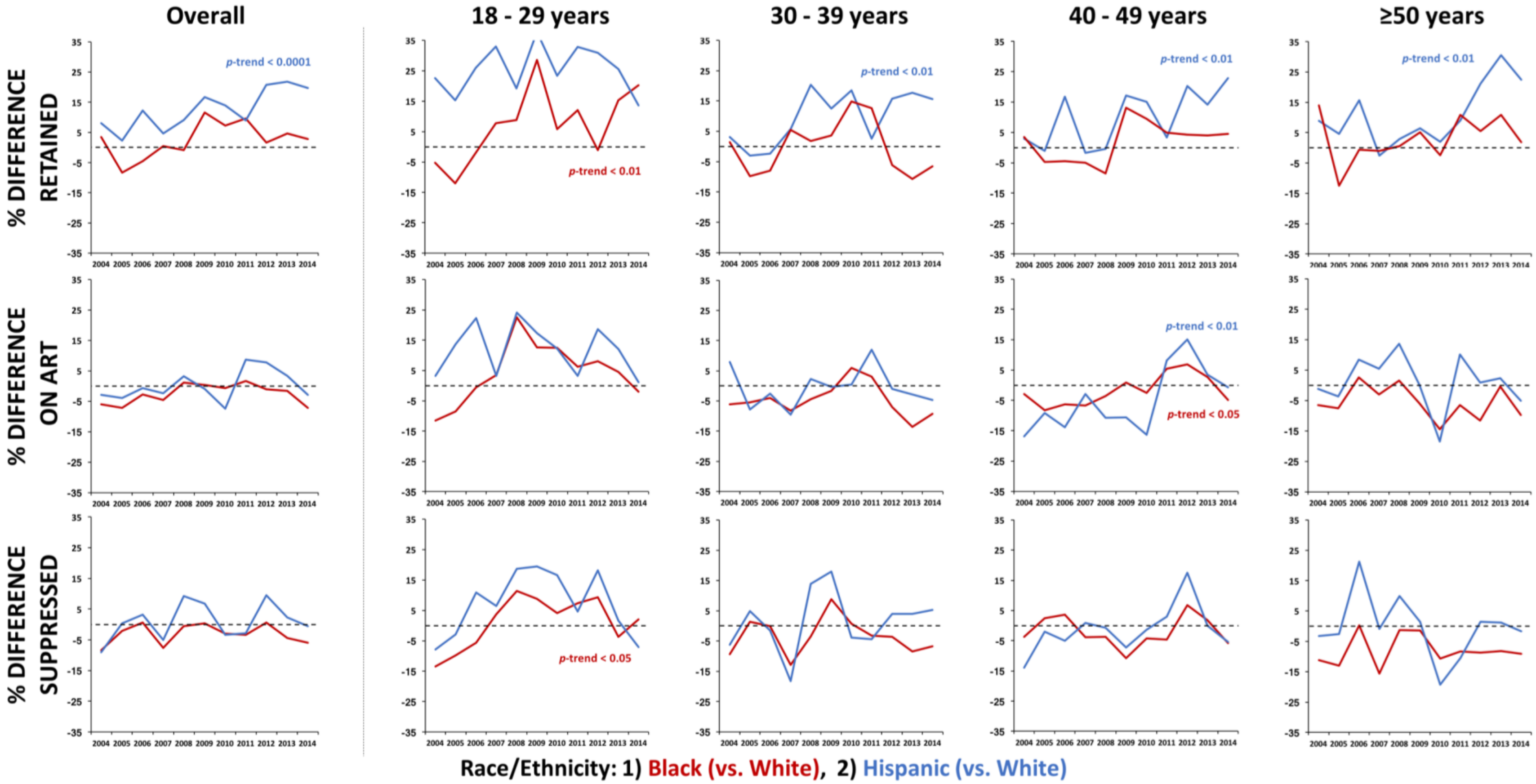

Overall
18 - 29 years
30 - 39 years
40 - 49 years
≥50 years
% RETAINED
% ON ART
% VIRALLY SUPPRESSED
0
25
50
75
100
2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014
Race/Ethnicity: 1) Black, 2) Hispanic, and 3) White

Figure 2-2 a, b. Temporal trends in racial/ethnic differences in the percentage of (a) men who have sex with men and (b) newly linked to HIV care that were retained in care, on ART, and with suppressed HIV RNA, overall and by age, NA-ACCORD, 2004 – 2014

a)



b)


Overall
18 - 29 years
30 - 39 years
40 - 49 years
≥50 years
% DIFFERENCE RETAINED
% DIFFERENCE ON ART
% DIFFERENCE SUPPRESSED
35
25
15
5
-5
-15
-25
-35
2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014
p-trend < 0.0001
p-trend < 0.01
p-trend < 0.01
p-trend < 0.01
p-trend < 0.01
p-trend < 0.01
p-trend < 0.01
p-trend < 0.05
p-trend < 0.05
Race/Ethnicity: 1) Black (vs. White), 2) Hispanic (vs. White)

Appendix

Appendix Table 2-1. Demographic characteristics of men who have sex with men and female NA-ACCORD participants in US clinical cohorts compared with PLWH-US as of December 31, 2014 and December 31, 2016, respectively

	Overall				MSM (including MSM/IDU)				Female			
Characteristic	**PLWH-US, n (%)**		**NA-ACCORD, n (%)**		**PLWH-US, n (%)**		**NA-ACCORD, n (%)**		**PLWH-US, n (%)**		**NA-ACCORD, n (%)**	
Total participants	741,127	-	33,552	-	525,373	-	23,981	-	215,754	-	9,571	-
Age, years												
18 - 19	2,560	0.3	37	0.1	1,440	0.3	27	0.1	1,120	0.5	10	0.1
20 - 24	26,942	3.6	1,058	3.2	20,780	4.0	872	3.6	6,162	2.9	186	1.9
25 - 29	53,765	7.3	2,828	8.4	42,536	8.1	2,304	9.6	11,229	5.2	524	5.5
30 - 34	63,918	8.6	3,261	9.7	46,533	8.9	2,482	10.3	17,385	8.1	779	8.1
35 - 39	71,134	9.6	3,362	10.0	47,499	9.0	2,272	9.5	23,635	11.0	1,090	11.4
40 - 44	89,535	12.1	4,118	12.3	59,652	11.4	2,803	11.7	29,883	13.9	1,315	13.7
45 - 49	120,386	16.2	5,578	16.6	85,322	16.2	3,948	16.5	35,064	16.3	1,630	17.0
50 - 54	129,738	17.5	5,917	17.6	93,783	17.9	4,251	17.7	35,955	16.7	1,666	17.4
55 - 59	88,899	12.0	3,761	11.2	62,060	11.8	2,588	10.8	26,839	12.4	1,173	12.3
60 - 64	51,691	7.0	2,144	6.4	36,077	6.9	1,448	6.0	15,614	7.2	696	7.3
≥65	42,560	5.7	1,488	4.4	29,692	5.7	986	4.1	12,868	6.0	502	5.2
Race/Ethnicity												
White, non-Hispanic	271,177	36.6	14,686	43.8	232,408	44.2	12,931	53.9	38,769	18.0	1,755	18.3
Black, non-Hispanic	309,151	41.7	13,905	41.4	172,257	32.8	7,445	31.0	136,894	63.4	6,460	67.5
Hispanic (any race)	160,799	21.7	4,961	14.8	120,708	23.0	3,605	15.0	40,091	18.6	1,356	14.2
HIV transmission risk												
MSM	476,936	64.4	22,363	66.7	476,936	90.8	22,363	93.3	-	-	-	-
MSM/IDU	48,436	6.5	1,618	4.8	48,436	9.2	1,618	6.7	-	-	-	-
IDU	48,406	6.5	1,071	3.2	-	-	-	-	48,406	22.4	1,071	11.2
Heterosexual contact	162,050	21.9	7,799	23.2	-	-	-	-	162,050	75.1	7,799	81.5
Other	1,570	0.2	363	1.1	-	-	-	-	1,570	0.7	363	3.8
Unknown	3,729	0.5	338	1.0	-	-	-	-	3,729	1.7	338	3.5

Abbreviations: MSM, male-to-male sexual contact; PLWH-US, persons living with HIV in the US; IDU, injection drug use

Note: Because column totals for PLWH-US numbers were calculated independently of the values for the subpopulations, the values in each column may not sum to the column total.

Appendix Table 2-2. Baseline demographic and clinical characteristics of men who have sex with men (MSM) and women, NA-ACCORD, 2004 – 2014

	MSM (N = 37,398)		**Women (N = 15,607)**	
	n	**%**	**n**	**%**
Age, years				
18 - 29	7,125	19.1	2,390	15.3
30 - 39	10,409	27.8	4,426	28.4
40 - 49	12,932	34.6	5,379	34.5
≥50	6,932	18.5	3,412	21.9
Race/ethnicity				
White, non-Hispanic	21,153	56.6	3,114	20.0
Black, non-Hispanic	11,133	29.8	10,256	65.7
Hispanic, any race	5,112	13.7	2,237	14.3
HIV transmission risk				
MSM only	34,635	92.6	-	-
MSM and IDU	2,763	7.4	-	-
Heterosexual	-	-	12,132	77.7
IDU	-	-	2,333	14.9
Other/ Unknown	-	-	1,142	7.3
CD4 count,* cells/mL				
<200	8,210	22.0	3,777	24.2
200 - 350	6,901	18.5	2,732	17.5
350 - 500	7,187	19.2	2,618	16.8
≥500	11,634	31.1	4,872	31.2
Missing	3,466	9.3	1,608	10.3
HIV RNA,*				
≤200	9,743	26.1	3,603	23.1
>200	22,708	60.7	9,576	61.4
Missing	4,947	13.2	2,428	15.6

Abbreviations: IDU, injection drug use

* Measurement closest to HIV care linkage, at least 6 months prior to and at most 1 month after linkage.

Appendix Table 2-3 a, b. Race/ethnicity-specific rates of change (RC) and differences in RC (DRC) for trends in retention in care, ART use, and viral suppression among all (a) men who have sex with men and (b) women, overall and by age group, NA-ACCORD, 2004 – 2014

a)

		Retention in Care				ART Use				Viral Suppression			
		RC	*P*value	DRC	*P*value	RC	*P*value	DRC	*P*value	RC	*P*value	DRC	*P*value
Overall	Black	0.1%	0.184	**0.5%**	**0.0001**	**1.9%**	**<.0001**	**0.4%**	**<.0001**	**4.0%**	**<.0001**	**0.4%**	**<.0001**
	Hispanic	**0.4%**	**0.004**	**0.7%**	**<.0001**	**2.0%**	**<.0001**	**0.4%**	**0.0002**	**4.2%**	**<.0001**	**0.6%**	**<.0001**
	White	**-0.3%**	**<.0001**	-		**1.5%**	**<.0001**	-		**3.6%**	**<.0001**	-	
18 to 29 years	Black	**0.7%**	**0.023**	0.4%	0.355	**4.0%**	**<.0001**	**-1.1%**	**0.001**	**4.9%**	**<.0001**	**-1.1%**	**0.001**
	Hispanic	**1.3%**	**0.004**	1.1%	0.069	**4.5%**	**<.0001**	-0.5%	0.244	**5.8%**	**<.0001**	-0.2%	0.641
	White	0.3%	0.486	-		**5.0%**	**<.0001**	-		**6.0%**	**<.0001**	-	
30 to 39 years	Black	0.3%	0.162	**0.9%**	**0.001**	**2.1%**	**<.0001**	0.02%	0.931	**4.4%**	**<.0001**	0.3%	0.228
	Hispanic	0.2%	0.410	**0.8%**	**0.009**	**2.1%**	**<.0001**	-0.03%	0.892	**4.3%**	**<.0001**	0.2%	0.440
	White	**-0.6%**	**0.0003**	-		**2.1%**	**<.0001**	-		**4.1%**	**<.0001**	-	
40 to 49 years	Black	0.07%	0.685	**0.8%**	**0.0001**	**1.5%**	**<.0001**	**0.5%**	**0.002**	**4.0%**	**<.0001**	**0.7%**	**<.0001**
	Hispanic	0.1%	0.593	**0.8%**	**0.001**	**1.2%**	**<.0001**	0.1%	0.437	**3.6%**	**<.0001**	0.31%	0.152
	White	**-0.7%**	**<.0001**	-		**1.1%**	**<.0001**	-		**3.3%**	**<.0001**	-	
≥50 years	Black	-0.2%	0.206	0.3%	0.135	**1.3%**	**<.0001**	**0.6%**	**0.0003**	**3.0%**	**<.0001**	**0.7%**	**0.001**
	Hispanic	0.3%	0.331	**0.8%**	**0.007**	**1.3%**	**<.0001**	**0.6%**	**0.012**	**3.2%**	**<.0001**	**0.9%**	**0.003**
	White	**-0.5%**	**<.0001**	-		**0.7%**	**<.0001**	-		**2.3%**	**<.0001**	-	

Bold denotes statistical significance.

b)

		Retention in Care				ART Use				Viral Suppression			
		RC	*P*value	DRC	*P*value	RC	*P*value	DRC	*P*value	RC	*P*value	DRC	*P*value
Overall	Black	**0.6%**	**<.0001**	**0.7%**	**0.0003**	**2.5%**	**<.0001**	**0.4%**	**0.017**	**4.4%**	**<.0001**	**0.4%**	**0.017**
	Hispanic	**0.8%**	**<.0001**	**0.9%**	**0.0003**	**2.7%**	**<.0001**	**0.6%**	**0.005**	**4.5%**	**<.0001**	**0.6%**	**0.017**
	White	-0.1%	0.487	-		**2.1%**	**<.0001**	-		**4.0%**	**<.0001**	-	
18 to 29 years	Black	0.6%	0.153	0.9%	0.288	**3.8%**	**<.0001**	0.5%	0.338	**4.7%**	**<.0001**	0.3%	0.607
	Hispanic	-0.11%	0.895	0.2%	0.836	**2.9%**	**<.0001**	-0.3%	0.669	**4.6%**	**<.0001**	0.3%	0.739
	White	-0.3%	0.649	-		**3.2%**	**<.0001**	-		**4.3%**	**<.0001**	-	
30 to 39 years	Black	0.1%	0.709	0.2%	0.673	**2.4%**	**<.0001**	0.4%	0.203	**4.1%**	**<.0001**	0.1%	0.703
	Hispanic	0.5%	0.238	0.6%	0.304	**2.4%**	**<.0001**	0.3%	0.385	**4.5%**	**<.0001**	0.5%	0.256
	White	-0.12%	0.777	-		**2.1%**	**<.0001**	-		**4.0%**	**<.0001**	-	
40 to 49 years	Black	**0.4%**	**0.010**	**1.1%**	**0.0019**	**2.3%**	**<.0001**	0.3%	0.197	**4.1%**	**<.0001**	0.5%	0.117
	Hispanic	**0.9%**	**0.002**	**1.5%**	**0.0002**	**2.8%**	**<.0001**	**0.8%**	**0.012**	**4.5%**	**<.0001**	**0.8%**	**0.050**
	White	**-0.7%**	**0.031**	-		**2.0%**	**<.0001**	-		**3.7%**	**<.0001**	-	
≥50 years	Black	0.2%	0.298	0.5%	0.138	**2.1%**	**<.0001**	0.4%	0.220	**3.8%**	**<.0001**	**0.7%**	**0.032**
	Hispanic	0.3%	0.192	0.7%	0.087	**2.6%**	**<.0001**	**0.9%**	**0.020**	**3.6%**	**<.0001**	0.4%	0.290
	White	-0.3%	0.258	-		**1.7%**	**<.0001**	-		**3.2%**	**<.0001**	-	

Bold denotes statistical significance.

Appendix Table 2-4 a, b, c. Number of participants included in the denominator for yearly estimates of the percentage of all men who have sex with men (MSM) and women that were (a) retained in care, (b) on ART, and (c) virally suppressed, by race/ethnicity and age, NA-ACCORD, 2004 – 2014

a)

			Retention in Care										
			2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
MSM	Overall	Black	2,006	2,135	2,148	2,322	2,464	2,674	3,038	3,315	3,695	4,040	4,328
		Hispanic	857	931	987	1,071	1,174	1,297	1,404	1,497	1,916	2,252	2,349
		White	4,940	5,272	5,451	5,797	6,112	6,232	6,638	6,874	7,360	7,792	7,942
	18 to 29 years	Black	174	184	179	246	277	335	445	569	671	704	769
		Hispanic	72	77	87	83	101	116	123	128	189	236	217
		White	154	191	196	217	229	254	284	314	354	374	366
	30 to 39 years	Black	614	589	529	503	505	544	593	648	746	826	980
		Hispanic	336	330	317	346	344	367	346	388	486	538	559
		White	1,299	1,268	1,192	1,145	1,162	1,030	1,037	952	1,005	1,065	1,075
	40 to 49 years	Black	853	930	939	1,017	1,076	1,086	1,161	1,144	1,194	1,219	1,092
		Hispanic	317	372	409	431	493	540	624	622	758	873	855
		White	2,323	2,461	2,527	2,669	2,723	2,719	2,744	2,698	2,653	2,491	2,244
	≥50 years	Black	365	432	501	556	606	709	839	954	1,084	1,291	1,487
		Hispanic	132	152	174	211	236	274	311	359	483	605	718
		White	1,164	1,352	1,536	1,766	1,998	2,229	2,573	2,910	3,348	3,862	4,257
Women	Overall	Black	2,422	2,592	2,521	2,789	2,981	3,231	3,501	3,669	3,837	3,976	4,159
		Hispanic	539	598	633	665	692	774	807	849	892	959	980
		White	745	808	837	864	898	979	1,013	1,032	1,061	1,038	1,072
	18 to 29 years	Black	218	232	182	204	208	200	219	227	230	228	226
		Hispanic	56	50	41	46	38	48	52	47	56	54	43
		White	60	60	62	63	53	58	59	61	65	60	56
	30 to 39 years	Black	781	739	680	735	715	691	748	735	725	700	715
		Hispanic	154	158	166	160	158	166	175	184	179	173	173
		White	229	229	224	226	224	215	204	201	186	182	173
	40 to 49 years	Black	944	1,034	1,015	1,085	1,160	1,228	1,276	1,292	1,317	1,312	1,292
		Hispanic	222	253	261	272	296	305	294	305	289	295	291
		White	302	346	349	345	353	396	386	368	371	332	325
	≥50 years	Black	479	587	644	765	898	1,112	1,258	1,415	1,565	1,736	1,926
		Hispanic	107	137	165	187	200	255	286	313	368	437	473
		White	154	173	202	230	268	310	364	402	439	464	518

b)

			ART Use										
			2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
MSM	Overall	Black	2,858	2,942	3,113	3,327	3,654	4,053	4,463	4,991	5,399	5,919	6,288
		Hispanic	1,219	1,282	1,405	1,514	1,677	1,802	1,972	2,620	2,842	3,004	3,084
		White	7,160	7,377	7,599	7,953	8,300	8,593	9,006	9,816	10,302	10,465	10,860
	18 to 29 years	Black	317	339	420	507	640	822	981	1,157	1,253	1,393	1,461
		Hispanic	132	151	161	181	211	223	257	356	394	420	387
		White	374	398	422	461	517	580	612	707	721	696	731
	30 to 39 years	Black	928	849	796	777	817	876	890	1,004	1,140	1,294	1,475
		Hispanic	503	487	489	504	520	527	548	720	750	745	758
		White	2,105	1,934	1,812	1,743	1,690	1,565	1,522	1,601	1,625	1,603	1,665
	40 to 49 years	Black	1,149	1,214	1,297	1,383	1,434	1,484	1,552	1,608	1,617	1,592	1,497
		Hispanic	432	464	534	576	655	734	788	1,003	1,071	1,094	1,085
		White	3,173	3,317	3,430	3,554	3,579	3,647	3,662	3,737	3,628	3,391	3,121
	≥50 years	Black	464	540	600	660	763	871	1,040	1,222	1,389	1,640	1,855
		Hispanic	152	180	221	253	291	318	379	541	627	745	854
		White	1,508	1,728	1,935	2,195	2,514	2,801	3,210	3,771	4,328	4,775	5,343
Women	Overall	Black	3,461	3,475	3,675	3,899	4,219	4,489	4,720	4,905	5,055	5,400	5,539
		Hispanic	764	814	866	896	971	1,014	1,077	1,114	1,138	1,166	1,208
		White	1,124	1,146	1,170	1,200	1,297	1,321	1,362	1,392	1,395	1,415	1,459
	18 to 29 years	Black	416	342	344	373	368	406	424	399	412	430	402
		Hispanic	92	80	75	70	75	87	96	91	82	75	69
		White	125	112	114	109	107	98	118	122	120	113	98
	30 to 39 years	Black	1,125	1,045	1,062	1,017	1,067	1,038	1,047	1,050	1,005	1,064	1,037
		Hispanic	222	221	227	238	228	230	243	242	234	236	227
		White	359	340	318	327	341	308	289	275	254	272	274
	40 to 49 years	Black	1,263	1,373	1,422	1,517	1,589	1,660	1,684	1,707	1,664	1,754	1,749
		Hispanic	303	333	352	361	398	394	381	390	369	358	360
		White	437	469	474	452	501	497	501	496	484	451	448
	≥50 years	Black	657	715	847	992	1,195	1,385	1,565	1,749	1,974	2,152	2,351
		Hispanic	147	180	212	227	270	303	357	391	453	497	552
		White	203	225	264	312	348	418	454	499	537	579	639

c)

			Viral Suppression										
			2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
MSM	Overall	Black	2,754	2,822	2,994	3,202	3,548	3,899	4,333	4,835	5,281	5,795	6,081
		Hispanic	1,184	1,226	1,356	1,480	1,631	1,741	1,908	2,487	2,789	2,958	3,025
		White	6,925	7,163	7,329	7,693	8,087	8,350	8,790	9,535	10,019	10,120	10,307
	18 to 29 years	Black	307	325	402	480	613	777	957	1,119	1,232	1,361	1,420
		Hispanic	129	135	153	175	205	213	247	331	385	411	381
		White	356	383	403	445	500	561	591	688	696	674	697
	30 to 39 years	Black	898	807	765	744	788	837	864	966	1,106	1,263	1,437
		Hispanic	488	473	469	492	507	506	531	682	732	733	743
		White	2,030	1,867	1,742	1,678	1,648	1,508	1,483	1,549	1,560	1,538	1,562
	40 to 49 years	Black	1,104	1,168	1,246	1,336	1,393	1,436	1,499	1,571	1,579	1,563	1,421
		Hispanic	418	446	520	566	635	711	764	964	1,054	1,082	1,064
		White	3,074	3,221	3,318	3,440	3,480	3,546	3,567	3,633	3,542	3,271	2,945
	≥50 years	Black	445	522	581	642	754	849	1,013	1,179	1,364	1,608	1,803
		Hispanic	149	172	214	247	284	311	366	510	618	732	837
		White	1,465	1,692	1,866	2,130	2,459	2,735	3,149	3,665	4,221	4,637	5,103
Women	Overall	Black	3,311	3,297	3,513	3,751	4,089	4,326	4,567	4,744	4,935	5,291	5,367
		Hispanic	731	763	820	868	940	970	1,010	1,076	1,122	1,152	1,179
		White	1,065	1,088	1,107	1,156	1,258	1,284	1,324	1,350	1,351	1,367	1,384
	18 to 29 years	Black	396	320	336	353	353	387	411	388	398	422	393
		Hispanic	88	73	74	69	74	82	93	91	80	74	67
		White	120	108	109	101	104	96	117	118	117	109	94
	30 to 39 years	Black	1,077	988	1,015	969	1,036	1,002	1,006	1,011	978	1,047	1,009
		Hispanic	211	206	217	231	217	220	231	234	231	233	223
		White	339	323	301	318	321	302	279	267	248	264	264
	40 to 49 years	Black	1,208	1,306	1,355	1,466	1,549	1,597	1,624	1,654	1,629	1,708	1,696
		Hispanic	288	314	330	347	389	377	357	372	367	354	353
		White	410	443	448	436	491	481	482	482	469	436	423
	≥50 years	Black	630	683	807	963	1,151	1,340	1,526	1,691	1,930	2,114	2,269
		Hispanic	144	170	199	221	260	291	329	379	444	491	536
		White	196	214	249	301	342	405	446	483	517	558	603

Appendix Table 2-5 a, b, c. Number of participants included in the denominator for yearly estimates of the percentage of men who have sex with men (MSM) and women newly linked to HIV care that were (a) retained in care, (b) on ART, and (c) virally suppressed, by race/ethnicity and age, NA-ACCORD, 2004 – 2014.

a)

			Retention in Care										
			2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
MSM	Overall	Black	529	582	564	604	626	673	752	878	938	946	923
		Hispanic	232	276	278	289	300	323	324	340	396	395	372
		White	1,310	1,398	1,397	1,442	1,474	1,390	1,391	1,340	1,338	1,242	1,171
	18 to 29 years	Black	84	103	110	149	160	214	292	387	423	408	404
		Hispanic	43	47	48	49	61	76	70	78	97	109	100
		White	104	127	130	143	150	168	191	195	221	221	199
	30 to 39 years	Black	186	187	170	159	180	182	179	203	245	263	277
		Hispanic	101	108	114	123	110	116	115	130	148	144	127
		White	478	470	437	435	460	420	411	394	377	335	325
	40 to 49 years	Black	185	207	202	208	195	187	202	179	172	170	130
		Hispanic	65	91	86	89	96	102	108	99	118	110	104
		White	525	556	569	571	557	498	480	466	447	393	349
	≥50 years	Black	74	85	82	88	91	90	79	109	98	105	112
		Hispanic	23	30	30	28	33	29	31	33	33	32	41
		White	203	245	261	293	307	304	309	285	293	293	298
Women	Overall	Black	720	799	645	711	694	650	645	689	697	651	605
		Hispanic	126	144	128	135	129	139	116	121	123	104	86
		White	207	213	204	204	199	209	194	188	170	157	132
	18 to 29 years	Black	95	101	87	107	90	78	78	91	88	90	74
		Hispanic	23	24	18	16	13	15	14	13	21	17	11
		White	25	27	27	29	26	31	25	25	24	23	16
	30 to 39 years	Black	245	243	198	212	202	186	186	185	172	155	141
		Hispanic	34	39	38	36	40	36	27	31	31	27	32
		White	70	65	61	55	57	56	54	51	37	40	32
	40 to 49 years	Black	249	290	230	246	226	200	196	221	222	198	180
		Hispanic	44	52	41	57	54	56	44	39	32	26	18
		White	74	83	74	79	73	76	62	57	53	39	38
	≥50 years	Black	131	165	130	146	176	186	185	192	215	208	210
		Hispanic	25	29	31	26	22	32	31	38	39	34	25
		White	38	38	42	41	43	46	53	55	56	55	46

b)

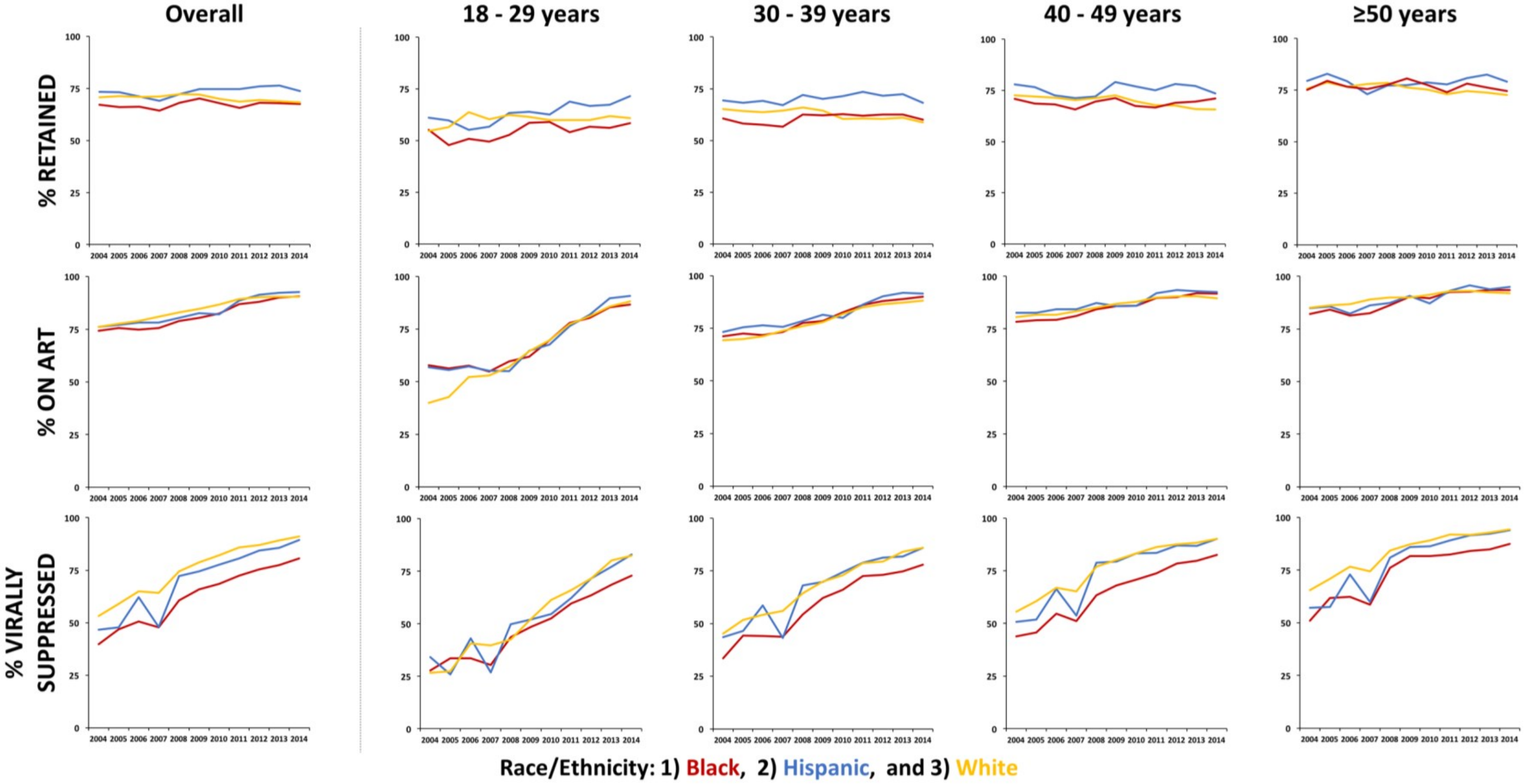
			ART Use										
			2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
MSM	Overall	Black	925	942	992	1,044	1,152	1,290	1,384	1,511	1,539	1,596	1,561
		Hispanic	404	436	463	486	522	536	556	639	614	621	582
		White	2,231	2,261	2,258	2,304	2,306	2,256	2,201	2,123	2,077	1,963	1,844
	18 to 29 years	Black	186	201	264	334	422	541	644	737	745	776	761
		Hispanic	82	85	101	114	129	143	157	190	189	192	190
		White	253	276	287	304	350	389	406	417	418	391	381
	30 to 39 years	Black	334	301	291	285	298	320	303	337	389	415	437
		Hispanic	183	192	191	195	191	197	200	232	219	206	200
		White	844	763	725	736	708	676	653	622	587	556	516
	40 to 49 years	Black	298	322	323	310	302	316	308	279	261	244	206
		Hispanic	107	119	130	135	153	162	154	168	163	169	142
		White	825	861	858	848	814	766	735	686	634	580	520
	≥50 years	Black	107	118	114	115	130	113	129	158	144	161	157
		Hispanic	32	40	41	42	49	34	45	49	43	54	50
		White	309	361	388	416	434	425	407	398	438	436	427
Women	Overall	Black	1,195	1,185	1,104	1,095	1,112	1,070	1,083	1,091	1,043	968	906
		Hispanic	204	221	219	203	206	198	191	188	155	131	120
		White	346	339	318	314	337	319	306	296	258	245	217
	18 to 29 years	Black	207	167	171	177	161	166	178	174	170	155	136
		Hispanic	42	36	33	30	25	23	27	33	26	17	12
		White	63	52	57	53	53	51	51	53	50	46	28
	30 to 39 years	Black	391	390	345	315	343	317	300	289	255	242	228
		Hispanic	62	62	70	67	60	53	54	48	48	43	44
		White	112	109	85	85	94	90	84	67	51	57	62
	40 to 49 years	Black	386	421	386	376	341	316	330	337	315	283	264
		Hispanic	69	81	79	72	82	77	62	55	39	31	27
		White	115	125	121	110	122	97	94	94	79	67	64
	≥50 years	Black	211	207	202	227	267	271	275	291	303	288	278
		Hispanic	31	42	37	34	39	45	48	52	42	40	37
		White	56	53	55	66	68	81	77	82	78	75	63

c)

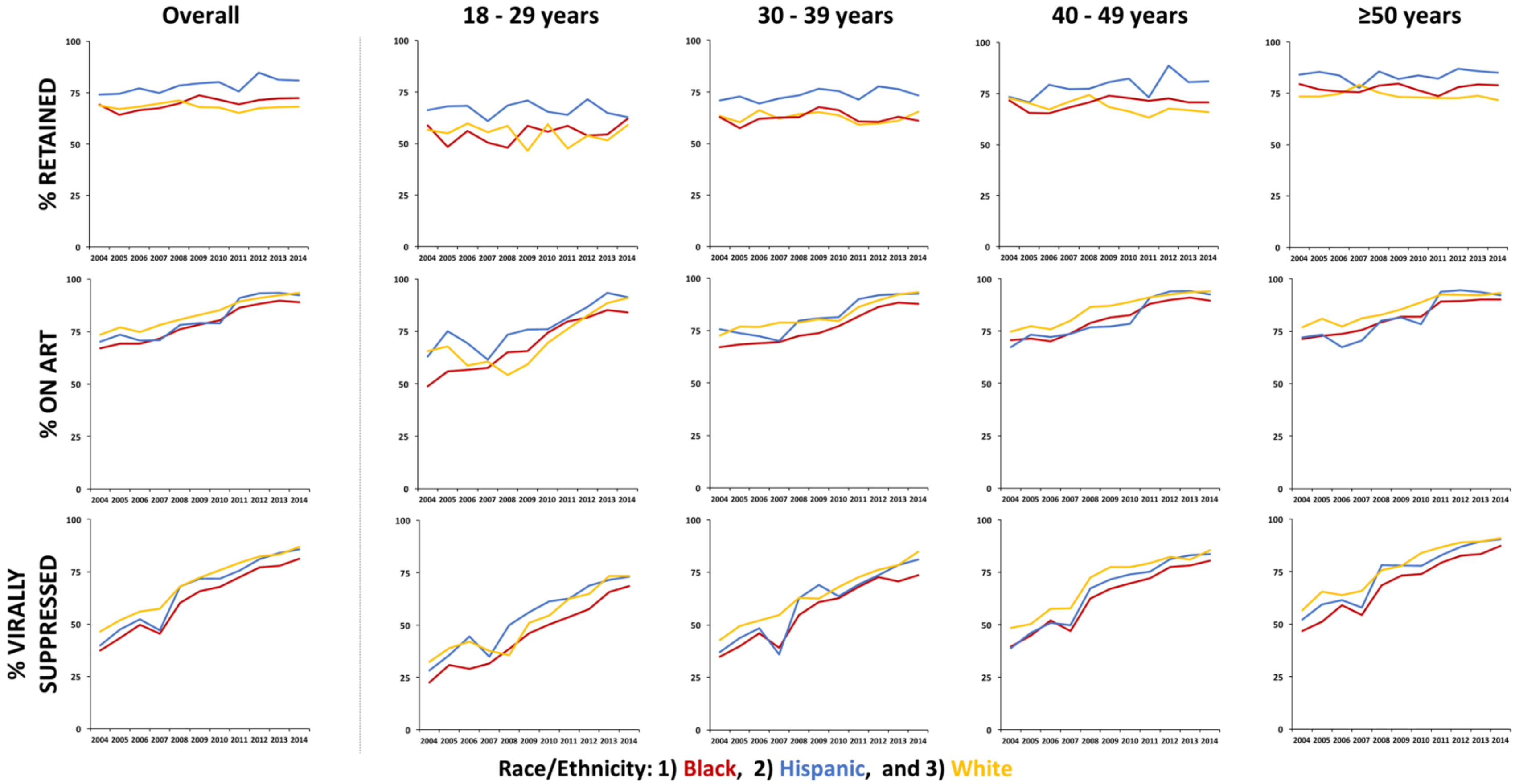
			Viral Suppression										
			2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
MSM	Overall	Black	901	916	963	1,008	1,130	1,250	1,362	1,475	1,511	1,562	1,502
		Hispanic	395	424	456	480	514	525	546	625	609	612	571
		White	2,174	2,207	2,194	2,251	2,263	2,211	2,151	2,076	2,024	1,888	1,737
	18 to 29 years	Black	184	198	261	322	415	526	637	719	736	757	732
		Hispanic	82	81	98	113	129	139	154	188	187	190	186
		White	243	269	279	297	343	384	393	411	404	377	363
	30 to 39 years	Black	326	288	280	275	290	312	297	330	377	405	421
		Hispanic	181	190	188	192	188	196	198	225	216	201	197
		White	826	748	706	721	695	661	638	607	566	535	481
	40 to 49 years	Black	289	314	313	301	297	302	299	273	258	243	199
		Hispanic	101	117	129	133	150	156	151	165	163	167	139
		White	801	836	835	826	799	751	720	668	625	556	487
	≥50 years	Black	102	116	109	110	128	110	129	153	140	157	150
		Hispanic	31	36	41	42	47	34	43	47	43	54	49
		White	304	354	374	407	426	415	400	390	429	420	406
Women	Overall	Black	1,154	1,145	1,059	1,065	1,088	1,039	1,064	1,063	1,017	957	879
		Hispanic	195	212	207	199	204	193	177	181	151	130	117
		White	334	328	308	307	333	315	301	285	250	237	204
	18 to 29 years	Black	200	160	166	169	157	161	175	170	165	152	132
		Hispanic	41	35	33	30	25	22	27	33	25	17	12
		White	62	51	55	51	52	50	51	49	48	45	26
	30 to 39 years	Black	377	378	330	305	338	305	290	279	250	239	224
		Hispanic	60	58	66	66	60	52	52	46	46	42	43
		White	107	106	83	84	92	90	82	64	50	55	61
	40 to 49 years	Black	371	409	366	366	335	308	327	330	308	279	254
		Hispanic	65	78	73	69	81	75	57	53	38	31	25
		White	109	119	116	107	121	97	93	92	75	66	59
	≥50 years	Black	206	198	197	225	258	265	272	284	294	287	269
		Hispanic	29	41	35	34	38	44	41	49	42	40	37
		White	56	52	54	65	68	78	75	80	77	71	58

Appendix Figure 2-1 a, b. Race/ethnicity-specific temporal trends in the percentage of all (a) men who have sex with men and (b) women that were retained in care, on ART, and with suppressed HIV RNA, overall and by age, NA-ACCORD, 2004 – 2014

a)

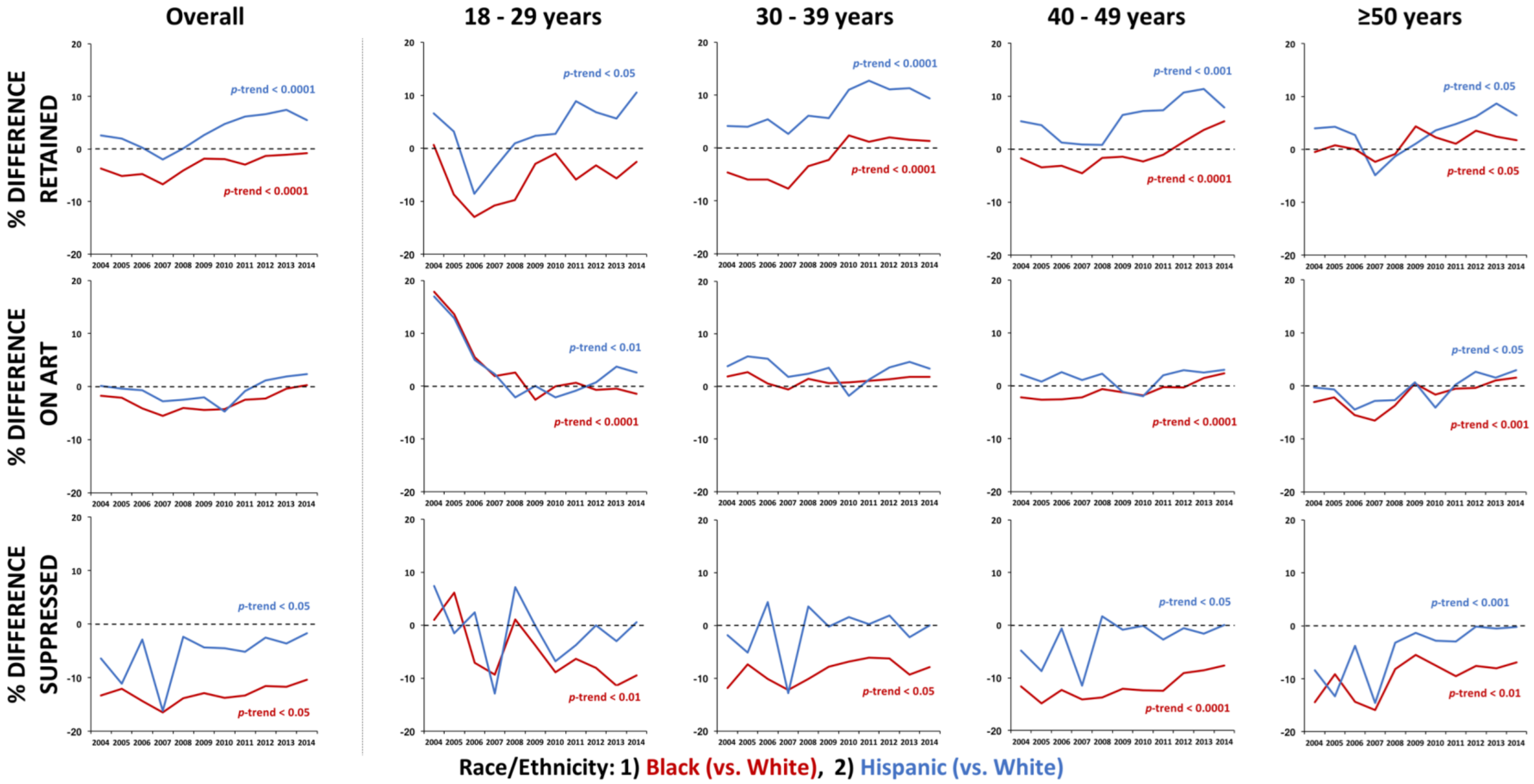


b)

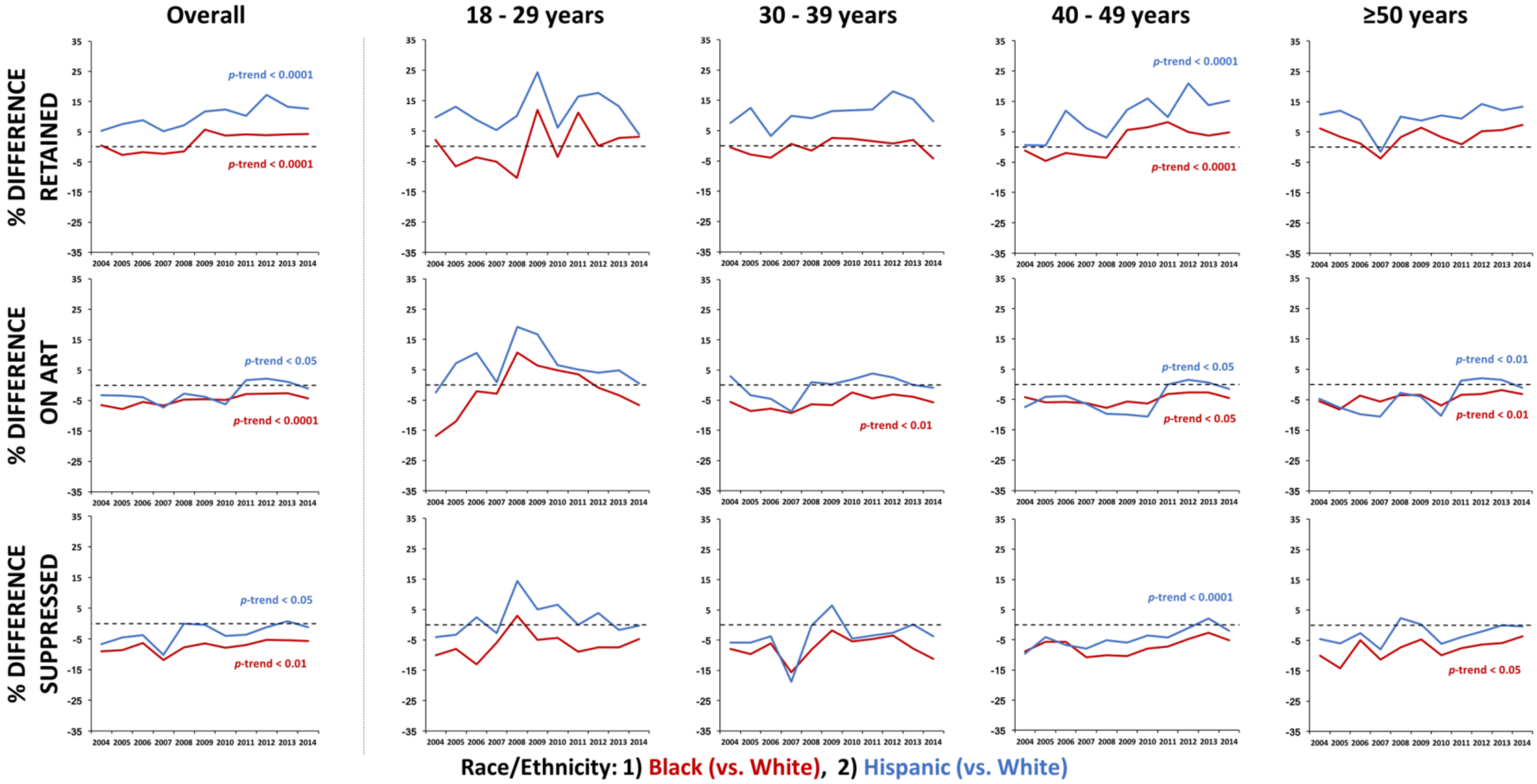

Overall
18 - 29 years
30 - 39 years
40 - 49 years
≥50 years
% RETAINED
% ON ART
% VIRALLY SUPPRESSED
100
75
50
25
0
2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014
Race/Ethnicity: 1) Black, 2) Hispanic, and 3) White

Appendix Figure 2-2 a, b. Temporal trends in racial/ethnic differences in the percentage of all (a) men who have sex with men and (b) that were retained in care, on ART, and with suppressed HIV RNA, overall and by age, NA-ACCORD, 2004 – 2014

a)



b)


Overall
18 - 29 years
30 - 39 years
40 - 49 years
≥50 years
% DIFFERENCE RETAINED
% DIFFERENCE ON ART
% DIFFERENCE SUPPRESSED
35
25
15
5
-5
-15
-25
-35
2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014
p-trend < 0.0001
p-trend < 0.0001
p-trend < 0.05
p-trend < 0.0001
p-trend < 0.05
p-trend < 0.01
p-trend < 0.01
p-trend < 0.0001
p-trend < 0.0001
p-trend < 0.05
p-trend < 0.05
p-trend < 0.0001
p-trend < 0.01
p-trend < 0.01
p-trend < 0.05
Race/Ethnicity: 1) Black (vs. White), 2) Hispanic (vs. White)

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CHAPTER THREE

Engaged but not retained: Do measures of retention in HIV care reflect engagement in care in the United States?

Abstract

Background: Changes in HIV care guidelines now recommending less frequent routine HIV laboratory measurements may impact the utility of current measures of retention in care in appropriately capturing HIV care engagement trends.

Methods: We estimated the percentage of patients who were retained in care in the NA-ACCORD annually between 2004-2014 using 2 measures for retention in care requiring ≥4 HIV care visits over 2 consecutive calendar years (Department of Health and Human Services [RIC_{DHHS}] and National Academy of Medicine [RIC_{NAM}]) and 1 modified measure that requires ≥2 visits over 2 years ("Clinical practice" [RIC_{CP}]). We also estimated the following associations between each retention measure and viral suppression in each year between 2004-2014: 1) Spearman correlation, 2) *c*-statistic, 3) prevalence ratio for viral suppression, 4) sensitivity, and 5) specificity.

Results: We included 100,807 patients. Retention percentages estimated using RIC_{CP} increased from 82.5% in 2004 to 92.5% in 2014 and were consistently higher than those estimated using RIC_{DHHS} and RIC_{NAM}. For each retention measure, the Spearman correlation and c-statistic were low (<0.40 and <0.675, respectively), and prevalence ratios approached 1.0 over time. The sensitivity for viral suppression using RIC_{DHHS} and RIC_{NAM} decreased over time yet remained high at approximately 94% using RIC_{CP}. The specificity using RIC_{DHHS} and RIC_{NAM} increased over time and was consistently higher than that estimated using RIC_{CP}.

Conclusion: Methodologic approaches used to measure retention in care must evolve in the "treat all" era of chronic HIV infection to better identify patients who are truly not engaged in care.

Background

Given its association with improved health outcomes, retention in HIV care is a critical component of the clinical care of persons with HIV (PWH).[1,2] Retention in care comprises the third step of what is termed the "HIV care continuum" and is characterized by the consistency of an individual's pattern of clinical HIV care visits over time.[3] The clinical and public health benefits of retention in care stem from its position in the HIV care continuum as a precursor to consistent antiretroviral therapy (ART) use and subsequent viral suppression, the desired goal for all PWH due to its effectiveness in both maintaining healthy life and preventing HIV transmission.[4,5]

Several measures of retention in care are used in HIV-related health services research. Among the most common are the standard measures endorsed by the United States (US) Department of Health and Human Services (DHHS) and the National Academy of Medicine (NAM).[6,7] These measures assess the frequency of HIV care visits at specified intervals to determine an individual's retention in care status in a given calendar year. Despite retention in care's central role in HIV care, a gold standard measure of retention in care has yet to be identified.[2] Further, clinical practice and HIV care guidelines have evolved over time to allow for longer intervals between HIV laboratory measurements, particularly among patients with sustained viral suppression.[8] These changes in HIV care may impact the utility of standard retention measures in accurately describing trends in engagement in HIV clinical care.

Updated in 2015, the US National HIV/AIDS Strategy set forth goals to increase the percentage of people diagnosed with HIV that are retained in care to at least 90% by

2020.[9] Prior studies have already documented promising increases in retention in care over time.[10–12] As clinical efforts focus on further increasing retention in care in patient populations, measures of retention in care that more closely represent current clinical practice and better correlate with viral suppression (a marker of HIV care engagement) are necessary. Our aim was to investigate the relationship between retention in care measures and HIV care engagement (as reflected by viral suppression) in each calendar year between 2004-2014.

Methods

Study Population

The North American AIDS Cohort Collaboration on Research and Design (NA-ACCORD) is a consortium of >20 interval and clinical cohorts collecting longitudinal data on >150,000 PWH living in the US and Canada.[13] The NA-ACCORD's methodology has been described previously.[14] In brief, contributing cohorts use standardized cohort-specific methods to collect data on PWH successfully engaged in care (defined as ≥2 clinical visits within 12 months of HIV care initiation). The NA-ACCORD Data Management Core (University of Washington) collects data from all cohorts, performs quality control procedures, and harmonizes the data. The data are then submitted to the NA-ACCORD Epidemiology/Biostatistics Core (Johns Hopkins University) for additional quality control procedures and analyses. The Institutional Review Board from each participating cohort and the Johns Hopkins University School of Medicine have approved the human subject activities conducted within the NA-ACCORD.

This study included adult (≥18 years old) PWH who had ≥1 HIV care visit between January 2003 and December 2014 in 13 US clinical cohorts in the NA-ACCORD with data on primary HIV care encounters and HIV RNA and CD4 count measurements. Sex, self-reported race/ethnicity, year of birth, HIV acquisition risk, CD4 count, and viral load were collected at enrollment into each clinical cohort.

Retention in HIV care definitions

Our study examined three measures for determining the percentage of patients who were retained in HIV clinical care in a given calendar year (see Appendix Figure 3-1). The first two measures of retention in care, RIC_{DHHS} and RIC_{NAM}, are based on the standard HIV care indicator definitions endorsed by the DHHS and the NAM, respectively.[6,7] To be classified as "retained in care," RIC_{DHHS} requires ≥4 HIV care visits over 2 consecutive calendar years and imposes semester-based time intervals over the two-year time span. RIC_{NAM} also requires ≥4 HIV care visits over 2 consecutive calendar years but does not specify semester-based time intervals (for the purposes of this study, the standard NAM definition, which measures retention in care over a single calendar year,[7] was modified to measure retention in care over 2 years so that it was more comparable to RIC_{DHHS}). We developed the third retention in care measure, "clinical practice" (RIC_{CP}), to reflect the increasing trend towards less frequent HIV RNA and CD4 count measurements. RIC_{CP} requires ≥2 HIV care visits over 2 consecutive calendar years and does not impose semester-based time intervals. For all retention measures, an HIV care visit was defined as a face-to-face HIV primary care encounter.

The numerators used for determining the percentage of patients who were retained in care in calendar year *x* were defined as follows:

1. RIC_{DHHS}: number of patients with ≥1 HIV care visit, ≥60 days apart, in 4 consecutive semesters (January–June and July–December) of a 2-year period (i.e., calendar year *x*-1 and calendar year *x*)
2. RIC_{NAM}: number of patients with ≥2 HIV care visits, ≥90 days apart, in year *x*-1 and in year *x*
3. RIC_{CP}: number of patients with ≥1 HIV care visit, ≥90 days apart, in year *x*-1 and in year *x*

To ensure comparability across these three measures of retention in care, we developed a common denominator that accounted for the NA-ACCORD's longitudinal design. For each retention in care measure, the denominator used to determine the percentage of patients who were retained in care in calendar year *x* was defined as the number of patients in year *x*-1 whose study entry year ≤ year *x*-1 ≤ study exit year. Patient study entry was the date of enrollment in the NA-ACCORD (i.e., the first of ≥2 clinical visits within 12 months of HIV care initiation) or 1 January 2003, whichever occurred later. Study exit was the date of death, cohort close date, or 31 December 2014, whichever occurred first.

Statistical Analysis

Patients contributed one person-year in each calendar year between their study entry and exit dates. Date of loss to follow-up was intentionally omitted from the study exit date definition; patients without an HIV care visit in a given 2-year timespan were included in the denominator and were classified as "not retained in care." For patients who died during the study period (2004-2014), the year of death was excluded from retention in care estimates as death is a competing risk for retention in care and precludes patients from being followed for the entire 2-year timespan required to generate retention in care estimates.

Cross-sectional annual estimates of the percentage of patients that were retained in care were produced from 2004-2014 using each retention measure. Generalized linear regression models with an identity link and binomially distributed variance were used to estimate temporal trends in retention in care. Generalized estimating equations (GEE) with an unstructured working correlation within individuals accounted for the correlation resulting from an individual being able to contribute to retention in care estimates in multiple calendar years. The regression models included an ordinal variable for calendar year to estimate the average percent change per year in retention in care over the 11-year study period. We also present trends in viral suppression over time. Viral suppression was defined as having HIV RNA ≤200 copies/mL at the patient's last measurement in the calendar year. Missing HIV RNA was imputed as "last observation carried forward" for missingness while in care (i.e., having ≥1 HIV care visit) and as "unsuppressed" for missingness in the absence of an HIV care visit.

To quantify the association between viral suppression and each retention in care measure, we estimated the following statistics in each calendar year between 2004-2014:

1) the Spearman correlation between each retention measure and viral suppression; 2) the sensitivity and 3) specificity of each retention measure for viral suppression; 4) the *c*-statistic assessing each retention measure's ability to discriminate between patients with and without viral suppression; and 5) the prevalence ratio for viral suppression comparing patients classified as "retained" by each retention measure versus those "not retained". *C*-statistics were derived from receiver operating characteristic curves constructed using logistic regression models with viral suppression as a binary outcome. A *c*-statistic of 1 suggests perfect discriminatory power, whereas a *c*-statistic of 0.5 suggests no discriminatory power. *C*-statistic and prevalence ratio estimates were adjusted for age, sex, race/ethnicity, HIV acquisition risk, and site.

To determine the effect of long-term ART use and stable viral suppression, we performed a sensitivity analysis restricting to a subset of the study population that was continuously on ART and virally suppressed during the first 24 months after ART initiation, among patients with ≥2 HIV RNA measurements, ≥90 days apart, in each of the first two years after ART initiation (see Appendix Tables 3-1— 3-2 and Appendix Figures 3-2 — 3-3). For this analysis, patient study entry was the date of ART initiation + 2 years, date of enrollment in the NA-ACCORD, or 1 January 2003, whichever occurred later.

Analyses were conducted using SAS software, version 9.4 (SAS Institute, Inc., Cary, North Carolina), and a *p*-value <0.05 guided statistical interpretation.

Results

Participant characteristics

Table 3-1 summarizes characteristics of the study population at enrollment in the NA-ACCORD. A total of 100,807 participants contributed a median of 7.7 person-years (interquartile range: 3.9, 10.2 person-years). Most participants were male, of black or white race/ethnicity, and 40 years of age or older. Male-to-male and heterosexual contact were the most common modes of HIV acquisition.

Trends in retention in care and viral suppression

Over time, the percentage of patients that were retained in care using the RIC_{CP} measure was, on average, 31% and 23% higher than the percentage estimated using the RIC_{DHHS} and RIC_{NAM} measures, respectively (Figure 3-1a). There was a statistically significant increase (from 82.5% in 2004 to 92.5% in 2014) in the percentage of patients that were retained in care using RIC_{CP} (Table 3-2). This percentage increased slightly over time using RIC_{NAM} at a rate of 0.2% percentage points per year and remained stable over time using RIC_{DHHS} (rate of change: 0.0%, $p = 0.69$). The percentage of patients with viral suppression increased significantly over time from 43.2% in 2004 to 84.9% in 2014 (Figure 3-1b).

Relative to the main study population, patients with consistent ART use and viral suppression in the first 2 years after ART initiation had higher percentages over time of retention in care using the three retention measures (Appendix Figure 3-2a). The percentage of patients that were retained in care decreased significantly over time using RIC_{DHHS} and RIC_{NAM} yet increased over time using RIC_{CP} (Appendix Table 3-2).

Associations between retention in care and viral suppression between 2004-2014

The Spearman correlation between viral suppression and retention in care was low for each retention measure in each calendar year. The correlation estimated using RIC_{CP} was consistently higher than that estimated using RIC_{DHHS} and RIC_{NAM}. The correlation first increased slightly to 0.22 and 0.23 in 2008 using RIC_{DHHS} and RIC_{NAM}, respectively, then decreased to 0.18 and 0.20 in 2014, respectively (Figure 3-2a). Using RIC_{CP}, it increased from 0.24 in 2004 to 0.41 in 2012, after which it declined to 0.27 in 2014.

The sensitivity for viral suppression using RIC_{CP} remained high in each calendar year at approximately 94% (Figure 3-2b). The sensitivity estimated using RIC_{DHHS} and RIC_{NAM}, however, decreased with increasing calendar year and was consistently lower than the sensitivity estimated using RIC_{CP}. The specificity estimated using RIC_{DHHS} and RIC_{NAM} increased with increasing calendar year through 2012 and was, on average, 32% and 25% higher than that estimated using RIC_{CP} (Figure 3-2c).

The c-statistic measuring the discriminatory power of each retention measure to predict viral suppression was relatively low (<0.675) in each calendar year for all three retention measures examined (Figure 3-2d). It increased through 2008, after which it began to decline through 2014 for each retention measure.

The prevalence ratio for viral suppression comparing patients retained in care to those not retained decreased and approached a value of 1.0 with increasing calendar year using all three retention in care measures (Figure 3-2e). Prevalence ratios estimated using RIC_{CP} were consistently higher than those estimated using RIC_{DHHS} and RIC_{NAM}.

We observed similar associations between retention in care and viral suppression among patients with consistent ART use and viral suppression in the first 2 years after ART initiation (Appendix Figure 3-3). However, the magnitude of calendar year-specific Spearman correlations, prevalence ratios, and specificities for viral suppression were lower relative to those observed in the main study population.

Discussion

Measuring retention in care using approaches that reflect changes in HIV care is critical to evaluating national retention in care trends. Our results demonstrate that temporal trends in retention in care are dependent on the specific measure of retention used. Retention in care percentages estimated using standard measures that require ≥4 HIV care visits over 2 consecutive calendar years (i.e., RIC_{DHHS} and RIC_{NAM}) were either stable or increased slightly over time. Relaxing the number of visits to ≥2 HIV care visits over 2 consecutive calendar years (i.e., RIC_{CP}) yielded 1) consistently higher percentages of retention in care over time and 2) increases in retention in care that more closely paralleled increases in percentages of viral suppression over time. Regardless of which retention measure was used, we also found that various measures of association of retention in care with viral suppression were either weak or appeared to be weakening with increasing calendar year.

The public health and clinical emphases on retention in care are based on the associations of retention in care with more consistent viral suppression among PWH. Our findings of 1) changes in retention in care percentages that do not closely parallel concomitant increases in viral suppression over time and 2) poor or weakening associations of retention in care with viral suppression may indicate that standard approaches to measuring HIV care retention are not capturing changing clinical constructs of retention over time. With the advent of more tolerable ART regimens and increased access to ART, patient adherence to ART is likely improving over time, leading to higher percentages of viral suppression despite minimal changes in retention in care. As viral suppression and overall survival improve among PWH in the US,[15–20] it is also possible that HIV care providers are becoming increasingly more comfortable with longer intervals between clinical encounters. In this case, retention measures that are based on HIV care visit frequency may yield decreasing percentages of patients that are retained in care over time and misleadingly suggest poor HIV care engagement. Our analyses restricting to patients with consistent ART use and viral suppression (i.e., patients with presumably good HIV care engagement) may demonstrate this possibility, as we found more rapid decreases over time in the percentage of patients retained in care when using standard retention measures.

Patients may also be increasingly engaged in care in ways that are not reflected in regular HIV laboratory measurements or clinical HIV care visits. One study found that a failure to account for changes in ART regimens (which typically require an interaction between patients and their providers) could lead to a misclassification of retention status, particularly among patients with viral suppression while on ART.[21] In addition to ART prescription changes, alternative forms of HIV care engagement could include regular phone calls, emails, text messages, or other modes of electronic communication between patients and their providers. Although these alternative forms of engagement are not accounted for in current measures of retention in care, they may represent increasingly important aspects of engagement in HIV care.

Our study findings call into question the utility of standard measures of retention in care in describing HIV care engagement in the US and in accurately identifying patients that are truly not in care. It may be necessary to develop novel, composite retention in care measures that extend beyond assessments of a single marker of HIV care engagement. Composite retention measures may incorporate two or more of the following features: 1) face-to-face primary HIV care visits, 2) HIV laboratory measurements, 3) changes in ART regimens, and 4) additional indices of engagement in care, such as phone calls and email communication with HIV care providers. Alternatively, continuing to investigate the meaning of a missed visit as a marker of disengagement from care may demonstrate a closer link to the construct of retention than the retention in care measures evaluated in our study.[22,23] It may also be necessary to consider time since HIV care initiation and stable viral suppression, as these factors may influence HIV care providers' preferred frequency of interaction with their patients.

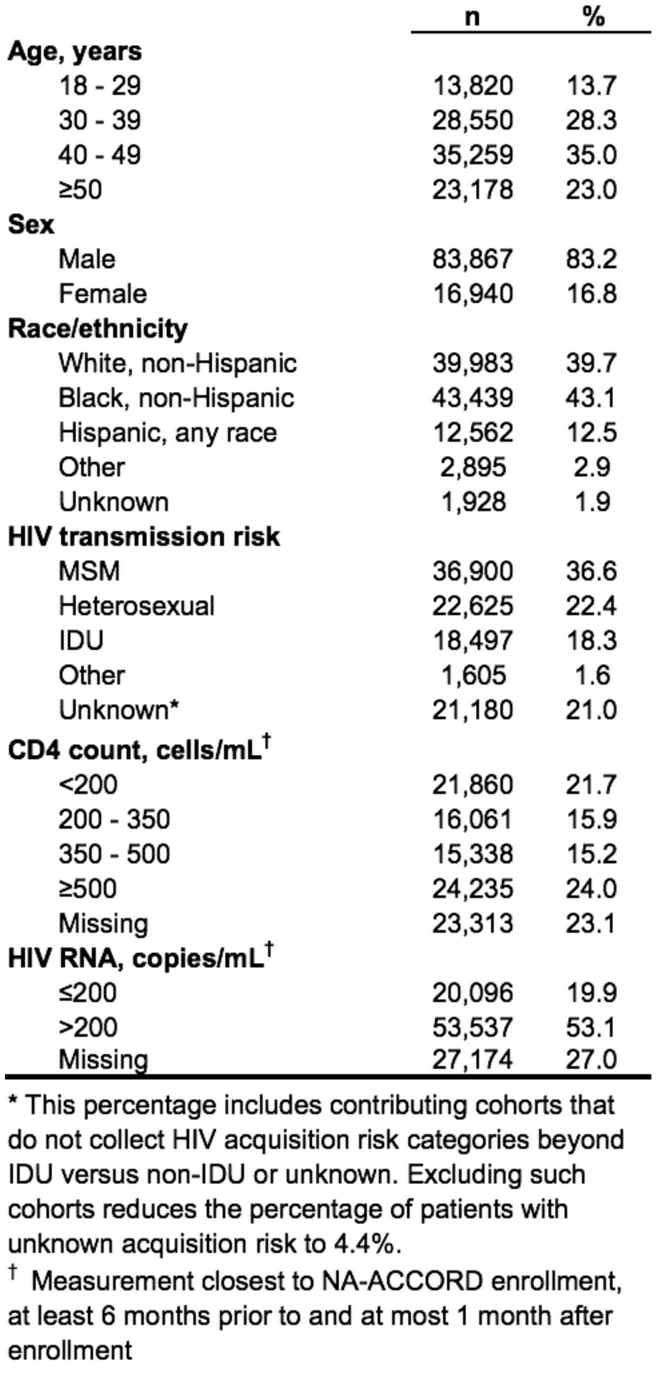
This study also highlights the importance of using appropriate denominators when estimating retention in care percentages over time in longitudinal cohorts. Standard denominators used to calculate retention in care percentages typically require ≥1 HIV care visit in either the calendar year of interest or in the previous calendar year. However, gaps in HIV care are common[21] and are intrinsically related to the construct of HIV care retention which these indicators are intended to measure. Denominators that require ≥1 HIV care visit may produce artificially inflated retention in care percentage estimates by excluding from the denominator patients that had a gap in HIV care. The denominator that we developed for this study incorporates HIV care gaps into percentage estimates of retention in care and more closely reflects the longitudinal nature of HIV care. Although this modified denominator may be better suited for longitudinal cohorts, its use in a strictly cross sectional setting would not be warranted.

This study has several strengths. We used a large sample of demographically diverse PWH from a longitudinal cohort that has been endorsed to evaluate important HIV care indicators, including retention in care. The cohorts investigated in this study represent a wide range of clinical settings, including Veterans Affairs facilities, local hospitals, private practices, and academically-affiliated HIV care centers, further strengthening the external validity of our findings. We were also able to elucidate long-term changes in HIV clinical care in the US by evaluating measures of retention in care over an 11-year study period.

Our study was limited by several factors. In analyses exploring calendar year-specific associations between retention in care and viral suppression, we assumed that person-time contributions were independent between calendar years; since patients could contribute person-time to ≥1 calendar year in the study period, methods that account for the correlation induced from repeated outcome measures may yield less biased results. We also assumed that gaps in HIV care reflected true losses to HIV care (i.e., patients not receiving any HIV care). Patients with observed gaps in care may have been concurrently accessing HIV care in sites not included in this study or while incarcerated, leading to potential underestimates of retention in care. We examined measures of retention in care that were based on observed HIV care encounters, rather than measures based on missed scheduled HIV care visits, which may provide a more complete picture of the construct of HIV care retention. We also focused on dichotomous measures of retention, which inherently have lower discriminatory capacity for viral suppression relative to polychotomous measures, such as those based on visit counts or missed visits.[2]

In summary, as clinical HIV management guidelines evolve and public health policies call for improvements in HIV care retention, the methodological approach to measuring retention in care will have important implications for epidemiologic assessments of HIV care engagement in the US. Current measures of retention in care may not adequately capture changing trends in clinical practice and engagement in care. To better identify patients that are truly not engaged in care, time since HIV care initiation and additional markers of engagement in HIV care may need to be considered in the development of future retention in care measures.

Table 3-1. Participant demographic and clinical characteristics at enrollment, NA-ACCORD, 2003 – 2014



	n	%
Age, years		
18 - 29	13,820	13.7
30 - 39	28,550	28.3
40 - 49	35,259	35.0
≥50	23,178	23.0
Sex		
Male	83,867	83.2
Female	16,940	16.8
Race/ethnicity		
White, non-Hispanic	39,983	39.7
Black, non-Hispanic	43,439	43.1
Hispanic, any race	12,562	12.5
Other	2,895	2.9
Unknown	1,928	1.9
HIV transmission risk		
MSM	36,900	36.6
Heterosexual	22,625	22.4
IDU	18,497	18.3
Other	1,605	1.6
Unknown*	21,180	21.0
CD4 count, cells/mL[†]		
<200	21,860	21.7
200 - 350	16,061	15.9
350 - 500	15,338	15.2
≥500	24,235	24.0
Missing	23,313	23.1
HIV RNA, copies/mL[†]		
≤200	20,096	19.9
>200	53,537	53.1
Missing	27,174	27.0

* This percentage includes contributing cohorts that do not collect HIV acquisition risk categories beyond IDU versus non-IDU or unknown. Excluding such cohorts reduces the percentage of patients with unknown acquisition risk to 4.4%.

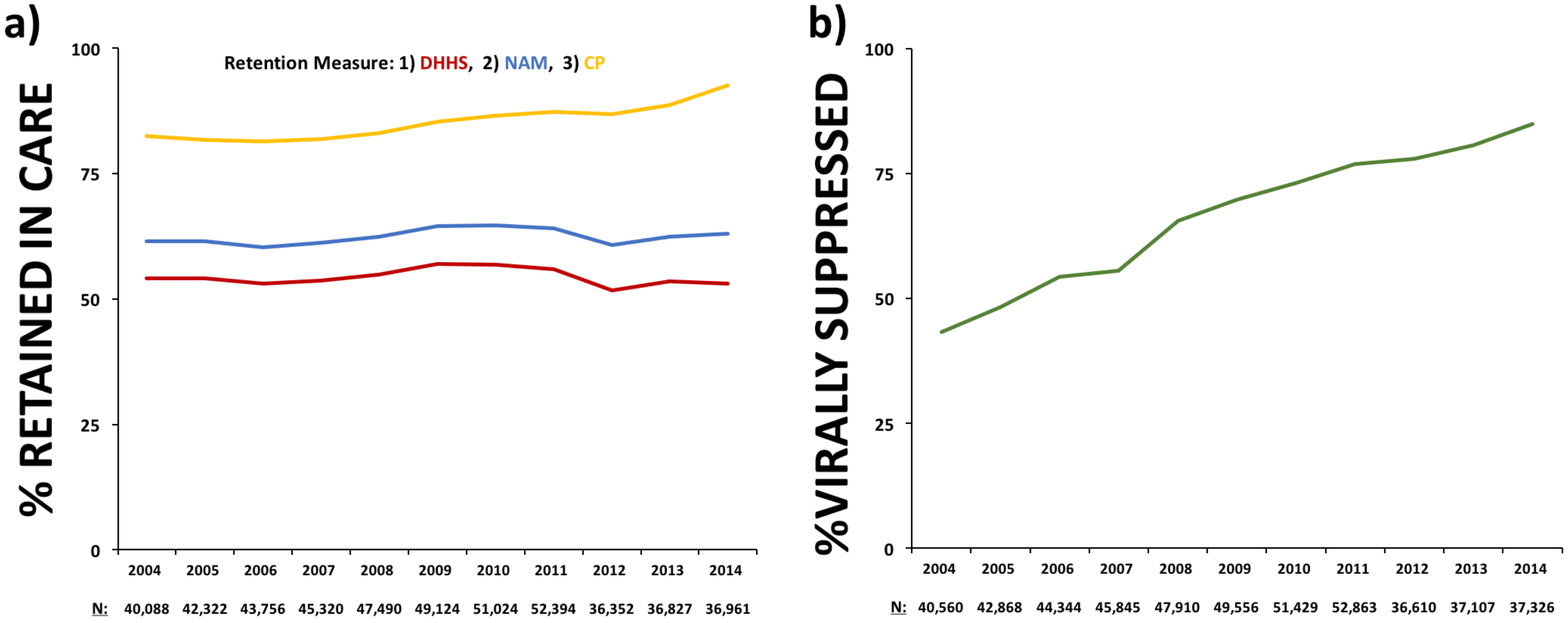
[†] Measurement closest to NA-ACCORD enrollment, at least 6 months prior to and at most 1 month after enrollment

Table 3-2. Average rate of change per year from 2004 – 2014 in the percentage of patients that were retained in care over time, estimated using three measures of retention in care, NA-ACCORD

Measure of retention in care	Rate of change	*P*-value
DHHS	-0.01%	0.6896
NAM	0.21%	<0.0001
CP	1.04%	<0.0001

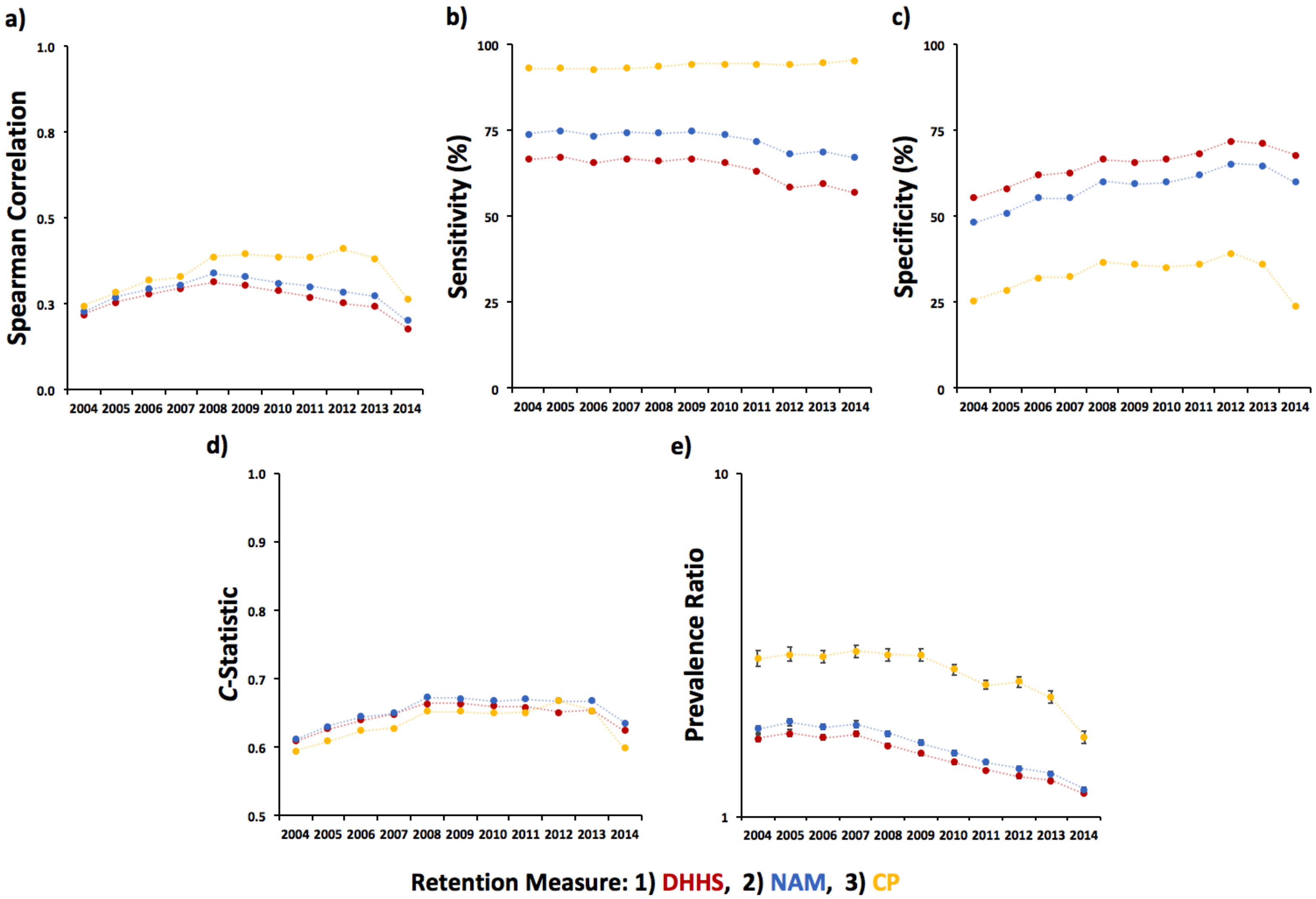
Abbreviations: DHHS, Department of Health and Human Services; NAM, National Academy of Medicine; CP, clinical practice

Figure 3-1 a, b. The percentage of patients that were (a) retained in clinical HIV care using three measures of retention in care and (b) virally suppressed over time, NA-ACCORD, 2004 – 2014



Abbreviations: DHHS, Department of Health and Human Services; NAM, National Academy of Medicine; CP, clinical practice

Figure 3-2 a, b, c, d, e. Annual estimates of three retention in care measures' (a) Spearman correlation with viral suppression, and (b) c-statistic, (c) prevalence ratio*, (d) sensitivity, and (e) specificity for viral suppression, NA-ACCORD, 2004 – 2014



Abbreviations: DHHS, Department of Health and Human Services; NAM, National Academy of Medicine; CP, clinical practice
* Comparing patients classified as "retained in care" versus those "not retained." Error bars on the figure represent 95% confidence intervals.

Appendix

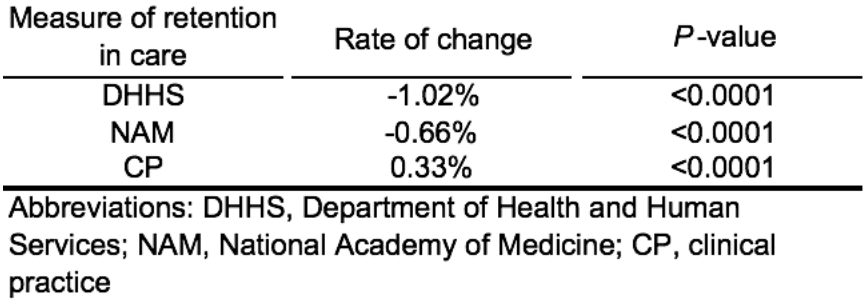
Appendix Table 3-1. Sensitivity analysis: Patient demographic and clinical characteristics at enrollment, among patients with consistent ART use and viral suppression in the first 2 years after ART initiation, NA-ACCORD, 2003 – 2014

	n	%
Age, years		
18 - 29	1,628	13.2
30 - 39	3,167	25.7
40 - 49	4,051	32.9
≥50	3,460	28.1
Sex		
Male	10,432	84.8
Female	1,874	15.2
Race/ethnicity		
White, non-Hispanic	5,531	44.9
Black, non-Hispanic	4,245	34.5
Hispanic, any race	1,716	13.9
Other	507	4.1
Unknown	307	2.5
HIV transmission risk		
MSM	5,897	47.9
Heterosexual	2,789	22.7
IDU	1,239	10.1
Other	187	1.5
Unknown*	2,194	17.8
CD4 count, cells/mL†		
<200	2,451	19.9
200 - 350	2,272	18.5
350 - 500	2,322	18.9
≥500	3,533	28.7
Missing	1,728	14.0
HIV RNA, copies/mL†		
≤200	3,972	32.3
>200	6,381	51.9
Missing	1,953	15.9

* This percentage includes contributing cohorts that do not collect HIV acquisition risk categories beyond IDU versus non-IDU or unknown. Excluding such cohorts reduces the percentage of patients with unknown acquisition risk to 4.4%.

† Measurement closest to NA-ACCORD enrollment, at least 6 months prior to and at most 1 month after enrollment

Appendix Table 3-2. Sensitivity analysis: Average rate of change per year from 2004 – 2014 in the percentage of patients with consistent ART use and viral suppression in the first 2 years after ART initiation that were retained in care over time, estimated using three measures of retention in care, NA-ACCORD



Measure of retention in care	Rate of change	*P*-value
DHHS	-1.02%	<0.0001
NAM	-0.66%	<0.0001
CP	0.33%	<0.0001

Abbreviations: DHHS, Department of Health and Human Services; NAM, National Academy of Medicine; CP, clinical practice

Appendix Figure 3-1. Comparison of standard versus study numerators and denominators used to determine the percentage of patients that are retained in clinical HIV care in calendar year *x*, by measure of retention in care

STANDARD MEASURE

DHHS:

$$\frac{\geq 1\text{ HIV care visit, } \geq 60\text{ days apart, in each semester of year } x\text{-1 and year } x}{\geq 1\text{ HIV care visit in the 1st semester of year } x\text{-1}} \times 100\%$$

NAM:

$$\frac{\geq 2\text{ HIV care visits, } \geq 90\text{ days apart, in year } x}{\geq 1\text{ HIV care visit in year } x} \times 100\%$$

STUDY MEASURE

DHHS:

$$\frac{\geq 1\text{ HIV care visit, } \geq 60\text{ days apart, in each semester of year } x\text{-1 and year } x}{\text{study entry year} \leq \text{year } x\text{-1} \leq \text{study exit year}} \times 100\%$$

NAM*:

$$\frac{\geq 2\text{ HIV care visits, } \geq 90\text{ days apart, in year } x\text{-1 and in year } x}{\text{study entry year} \leq \text{year } x\text{-1} \leq \text{study exit year}} \times 100\%$$

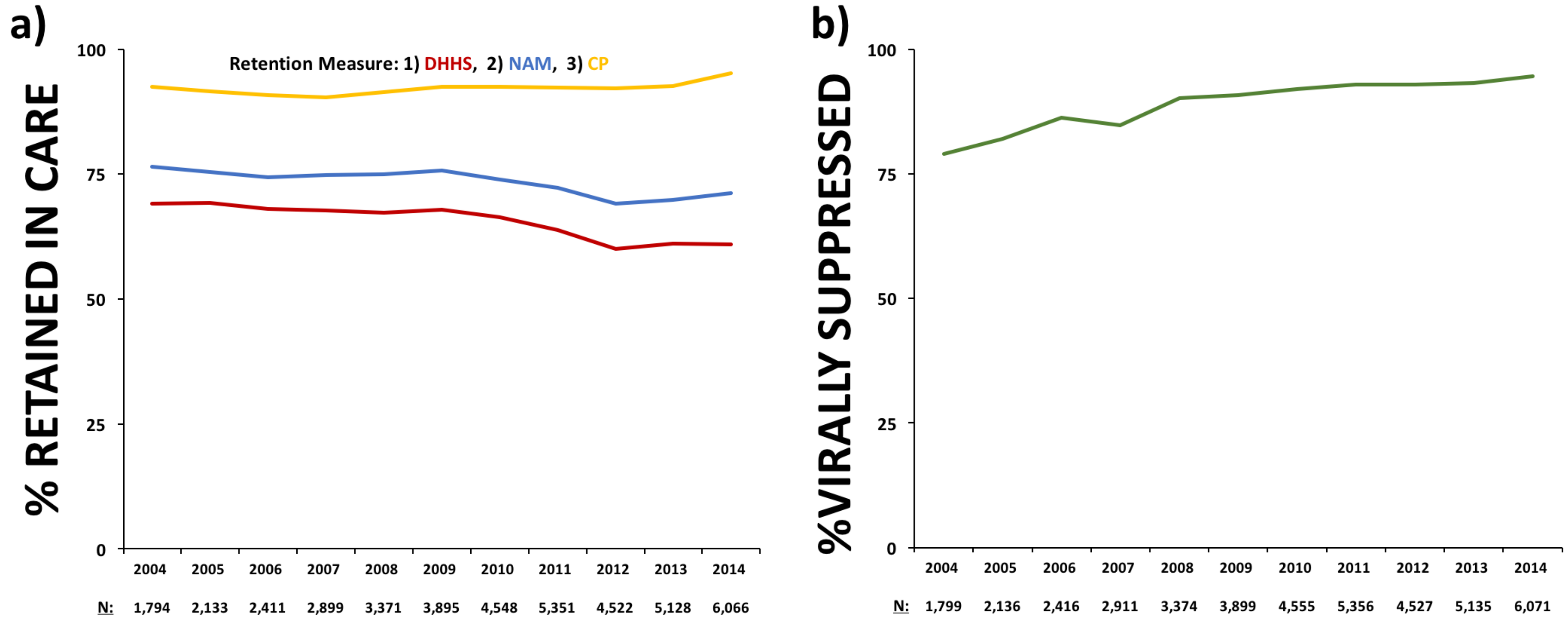
CP:

$$\frac{\geq 1\text{ HIV care visit, } \geq 90\text{ days apart, in year } x\text{-1 and in year } x}{\text{study entry year} \leq \text{year } x\text{-1} \leq \text{study exit year}} \times 100\%$$

Abbreviations: DHHS, Department of Health and Human Services; NAM, National Academy of Medicine; CP, clinical practice

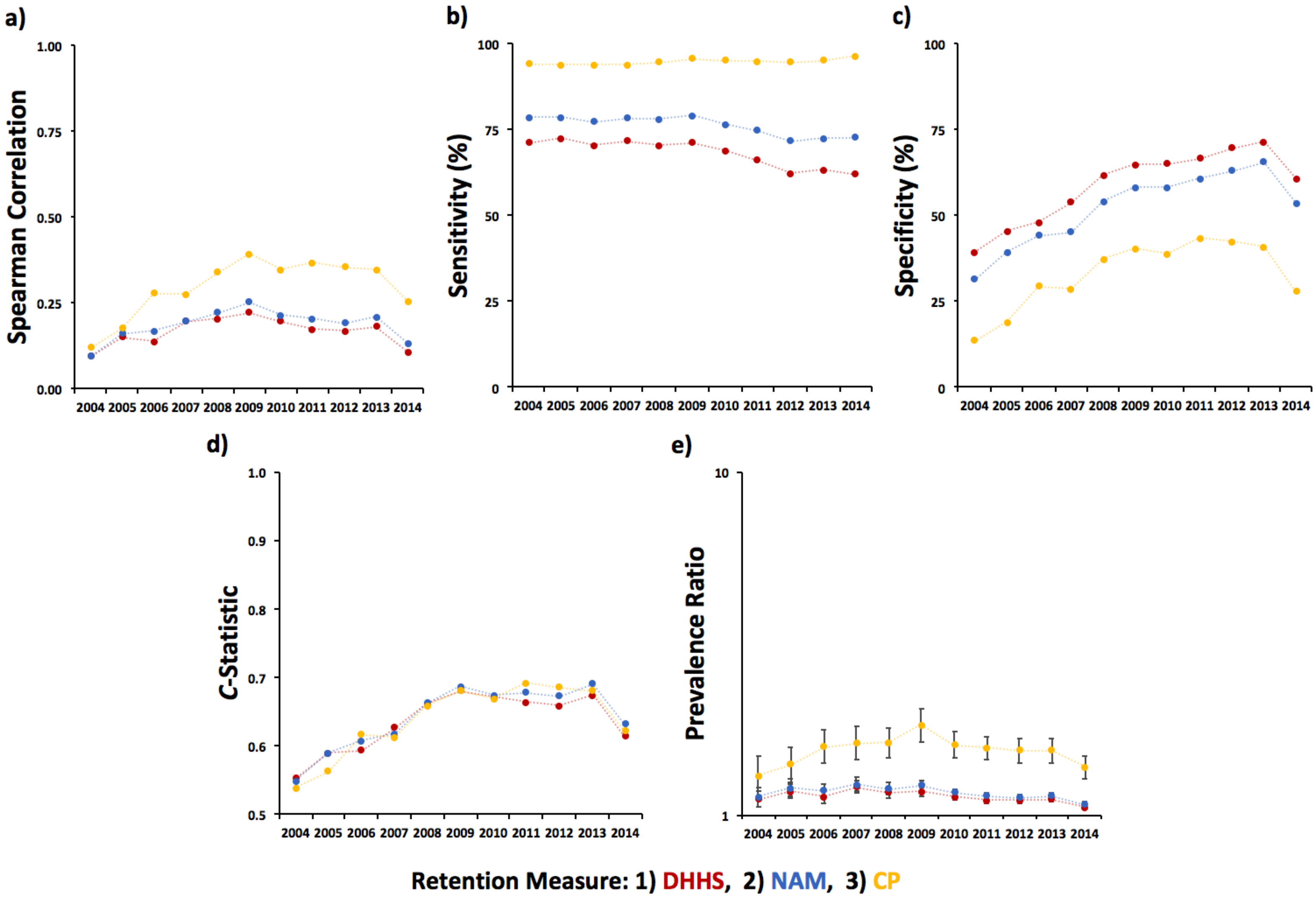
*Modified to measure retention in care over two consecutive calendar years.

Appendix Figure 3-2 a, b. Sensitivity analysis: The percentage of patients with consistent ART use and viral suppression in the first 2 years after ART initiation that were (a) retained in clinical HIV care using three measures of retention in care and (b) virally suppressed over time, NA-ACCORD, 2004 – 2014



Abbreviations: DHHS, Department of Health and Human Services; NAM, National Academy of Medicine; CP, clinical practice

Appendix Figure 3-3 a, b, c, d, e. Sensitivity analysis: Annual estimates of three retention in care measures' (a) Spearman correlation with viral suppression, and (b) c-statistic, (c) prevalence ratio, (d) sensitivity, and (e) specificity for viral suppression, among patients with consistent ART use and viral suppression in the first 2 years after ART initiation, NA-ACCORD, 2004 – 2014



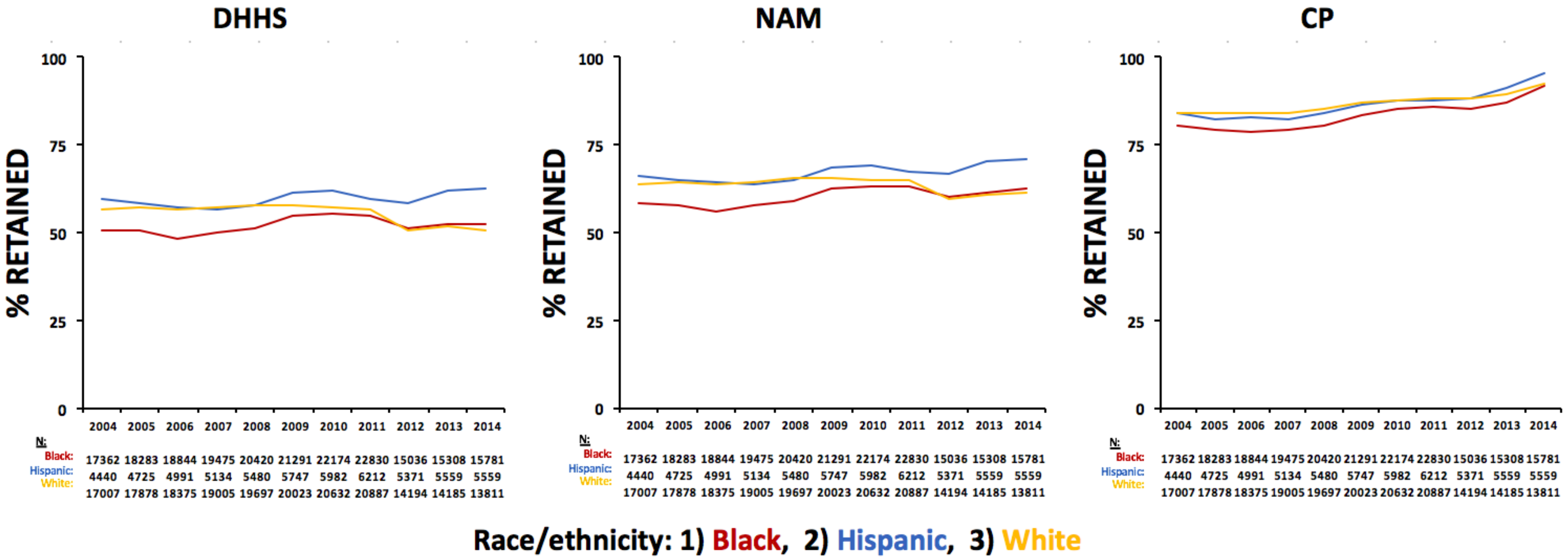
Abbreviations: DHHS, Department of Health and Human Services; NAM, National Academy of Medicine; CP, clinical practice

* Comparing patients classified as "retained in care" versus those "not retained." Error bars on the figure represent 95% confidence intervals.

Impact of retention measure on racial/ethnic differences in retention in HIV care

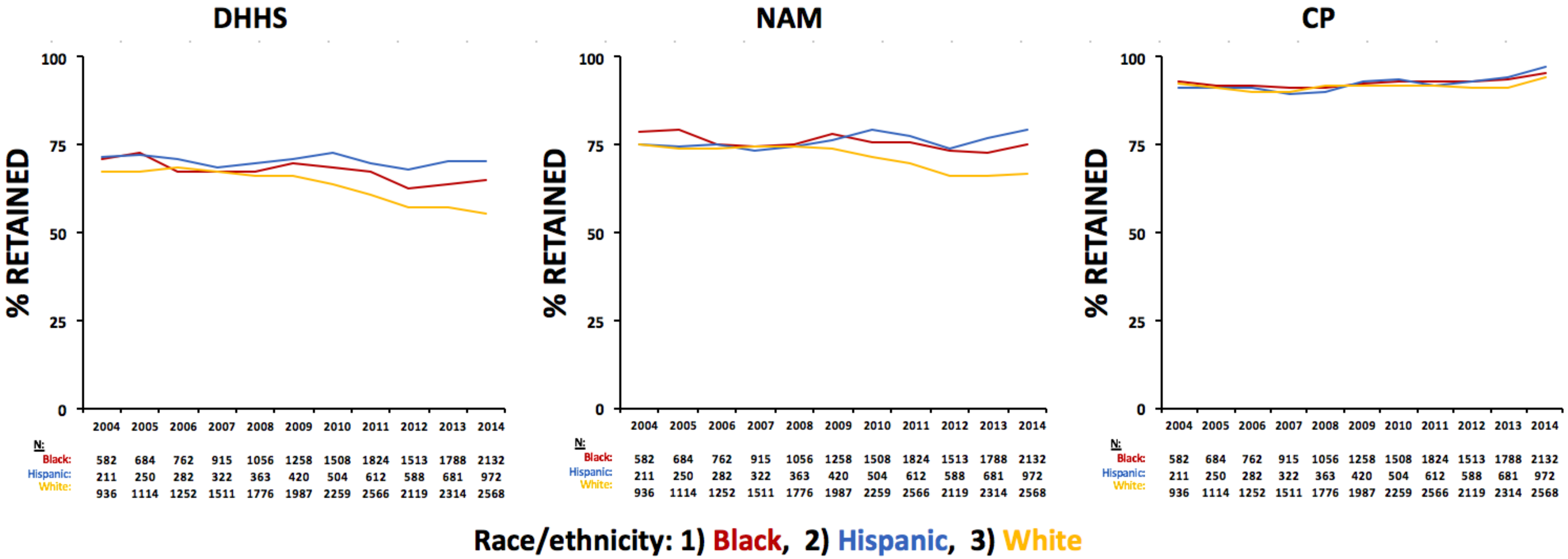
We sought to determine whether racial/ethnic differences in the proportion of patients that were retained in care differed based on the measure of retention used. We calculated race/ethnicity-specific cross-sectional annual estimates of the percentage of patients that were retained in care from 2004-2014 using RIC_{DHHS}, RIC_{NAM}, and RIC_{CP}. We found that racial/ethnic differences in the proportion of patients retained in care were less apparent using RIC_{CP} than those using RIC_{DHHS} and RIC_{NAM} (Appendix Figure 3-4). In an analysis restricting to individuals with consistent ART use and viral suppression in the first 2 years after ART initiation, we found that the proportion of white PWH that were retained in care decreased over time using RIC_{DHHS} and RIC_{NAM}, whereas the proportion of Black and Hispanic patients that were retained in care remained generally stable over time (Appendix Figure 3-5). These racial/ethnic differences were not apparent using RIC_{CP}.

Appendix Figure 3-4. The percentage of patients that were retained in clinical HIV care over time using three measures of retention in care, by race/ethnicity, NA-ACCORD, 2004 – 2014.



Abbreviations: DHHS, Department of Health and Human Services; NAM, National Academy of Medicine; CP, clinical practice

Appendix Figure 3-5. The percentage of patients that were retained in clinical HIV care over time using three measures of retention in care, among participants with consistent ART use and viral suppression in the first 2 years after ART initiation, by race/ethnicity, NA-ACCORD, 2004 – 2014.



Abbreviations: DHHS, Department of Health and Human Services; NAM, National Academy of Medicine; CP, clinical practice

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CHAPTER FOUR

One size fits (n)one: The impact of sex, age, and sexual HIV acquisition risk on racial/ethnic disparities in the HIV care continuum in the United States

Abstract

Background: Maximizing the amount of time spent in care, on antiretroviral therapy (ART), and virally suppressed is critical to improving the health of persons with HIV (PWH) and preventing transmission. The National HIV/AIDS Strategy set forth goals to reduce disparities in HIV care in the United States. Few studies have investigated the impact of age and sex on the magnitude of racial/ethnic disparities in HIV care.

Methods: We followed Black, Hispanic, and white women, men who have sex with men (MSM), and men who have sex with women (MSW) for 5 years after successful first-time linkage into HIV care in the North American Cohort Collaboration on Research and Design. We estimated racial/ethnic differences in the mean percentage of person-time spent retained in care, on ART, and virally suppressed in the first 5 years after linkage, by age.

Results: A total of 19,521 women (21.4%), MSM (59.0%), and MSW (19.6%) were included. Young white women spent 12.0% (95% confidence interval: 1.1%, 20.2%), 9.2% (0.4%, 20.4%) and 13.5% (2.7%, 22.5%) less person-time in care, on ART, and virally suppressed, respectively, than young Hispanic women. Among MSM, Blacks spent significantly less person-time in these stages than whites; the Black-white disparity increased with increasing age.

Conclusion: Age and sex are important modifiers of racial/ethnic differences in HIV care retention, ART use, and viral suppression. Targeted interventions that account for the intersectionality between age, sex, and sexual HIV acquisition risk are needed to reduce

racial/ethnic differences in these outcomes, particularly among young white women and older Black MSM.

Background

Disparities between racial/ethnic groups have been a defining feature of the HIV epidemic in the United States (US). The prevalence of HIV among Blacks, for example, is approximately 7 times higher than that among whites.[1] Persons with HIV (PWH) of Hispanic ethnicity are more likely to have AIDS upon initial diagnosis of HIV and thus begin to receive HIV care at later stages of disease progression.[2–4] Given the disproportionate impact of HIV on certain populations, targeted reductions in racial/ethnic disparities are one of the central tenets of the US National HIV/AIDS Strategy.[5] The HIV/AIDS Strategy, updated in 2015, identified several key subpopulations, including men who have sex with men (MSM), Black and Hispanic men and women, and young PWH.

Goals to improve HIV care retention, antiretroviral therapy (ART) use, and viral suppression by 2020 were set forth in the HIV/AIDS Strategy. These HIV care indicators are the last three steps of the "HIV care continuum."[6] Given their association with improved survival and reduced onward HIV transmission, it is critical that PWH achieve these HIV care milestones as soon as possible after linkage to HIV care.[7,8] Although these HIV care indicators have been most commonly evaluated using cross-sectional measures, longitudinal approaches that capture patients' transitions through continuum stages contribute to a better understanding of the HIV care continuum for clinicians and public health professionals.[9–11]

Disparities in HIV care retention, ART use, and viral suppression along racial/ethnic lines have been described extensively, yet few studies have sought to determine which demographic factors modify the magnitude of such disparities. A more nuanced understanding of these factors can elucidate additional intervention points for public health and clinical initiatives to reduce racial/ethnic disparities in the HIV care continuum more effectively. In this study, we use a patient-centric, longitudinal assessment of progression through the HIV care continuum to investigate racial/ethnic disparities in three sex- and sexual HIV acquisition risk-based groups: 1) MSM, 2) women, and 3) men who have sex with women (MSW). Our objective was to determine the extent of racial/ethnic differences in retention in HIV care, ART initiation, and viral suppression within these groups and by age.

Methods

Study Population

The North American AIDS Cohort Collaboration on Research and Design (NA-ACCORD) is a consortium of >20 interval and clinical cohorts collecting longitudinal data on PWH throughout the US and Canada.[12] The NA-ACCORD's methodology has been described elsewhere.[13] Briefly, each contributing cohort collects data on PWH engaged in care (defined as ≥2 clinical visits within 12 months of HIV care initiation) using standardized cohort-specific methods. Prior to being harmonized, these data undergo quality control procedures for accuracy and completeness at the NA-ACCORD central Data Management Core (University of Washington). The data then undergo additional quality control procedures and analyses at the Epidemiology/Biostatistics Core

(Johns Hopkins University). The institutional review boards at each participating cohort and at the Johns Hopkins University School of Medicine have approved all human subject activities conducted within the NA-ACCORD.

We included adult (≥18 years old) PWH who successfully linked for the first time into HIV care between 1 January 2004 and 31 December 2014 in 11 US clinical cohorts in the NA-ACCORD that had information on HIV acquisition risk, race/ethnicity, HIV clinical visits, and HIV laboratory measurements. Successful first-time linkage to HIV care was defined as having the following characteristics at enrollment in the NA-ACCORD (i.e., at the first of ≥2 HIV care visits in 12 months): 1) HIV RNA >200 copies/mL, 2) no history of an AIDS-defining illness, and 3) no history of ART use (including mono- and dual therapy). To further ensure first-time HIV care linkage, individuals enrolling in the NA-ACCORD before the start of data collection in their respective clinical cohort were excluded.

We examined non-Hispanic Black, Hispanic (of any race), and non-Hispanic white MSM, women, and MSW. MSW were defined as men with known HIV acquisition risk who did not have male-to-male-sexual contact as an acquisition risk factor at enrollment. Sex (male or female), self-reported race/ethnicity, year of birth, and HIV acquisition risk (heterosexual contact, male-to-male sexual contact, injection drug use, or other) were collected at enrollment into each clinical cohort. Participants with missing CD4 count or HIV RNA at HIV care linkage (up to 6 months before and up to 1 month after linkage) were excluded. Intersexed participants and those with unknown sex were not included due to incomplete data (these participants were initially excluded from the NA-ACCORD; exclusion criteria have since changed to include these groups).

Outcomes

We estimated the mean percentage of person-time spent in the following 3 HIV care continuum stages in the first 5 years after HIV care linkage: 1) retained in HIV clinical care, 2) on ART, and 3) virally suppressed. “In care” was defined as having ≥1 HIV care visit, CD4 count, or HIV RNA measure in 12 months. “On ART” was defined as being in care and having been prescribed for the first time a combination of ≥3 antiretroviral agents from ≥2 classes, or a triple nucleoside/nucleotide reverse transcriptase inhibitor regimen containing abacavir or tenofovir (regardless of whether an individual later discontinued or modified their therapeutic regimen) for ≥1 month. Viral suppression was defined as having an HIV RNA ≤200 copies/mL at the most recent measurement within the last 12 months.

Statistical Analysis

The longitudinal methodology used to estimate the mean percentage of person-time spent in HIV care continuum stages has been described previously.[11] In brief, participants contributed to this study beginning on the date of HIV care linkage until the first of the following: date of linkage + 5 years, date of cohort close, or 31 December 2014. We generated nonparametric cumulative incidence curves for 1) ART initiation, 2) death before and 3) after ART initiation, and each instance of the following events:

4) engagement in HIV care (i.e., ≥1 HIV care visit, CD4 count, or HIV RNA measure) before ART initiation,

5) engagement in HIV care after ART initiation,
6) disengagement from care (i.e., after initially being engaged in care, not having ≥1 HIV care visit, CD4 count, or HIV RNA measure in 12 months) before ART initiation,
7) disengagement from care after ART initiation,
8) viral suppression (i.e., HIV RNA ≤200 copies/mL) and
9) loss of viral suppression (i.e., HIV RNA >200 copies/mL after initial viral suppression [or disengagement from care while virally suppressed or death])

We accounted for the competing events of ART initiation and death for each event, as appropriate (see Appendix Table 4-1). We then added and subtracted these cumulative incidence curves as shown below to estimate the percentage of the population that was in each of the 7 HIV care continuum stages below at any time in the first five years after HIV care linkage:[14,15]

1) <u>dead before ART initiation</u> = cumulative incidence of death before ART initiation
2) <u>not engaged in care before ART initiation</u> = sum of cumulative incidences for disengagement from care before ART initiation, minus the sum of the cumulative incidences for engagement in care before ART initiation
3) <u>engaged in care and not on ART</u> = 1 minus the cumulative incidence of ART initiation, minus the cumulative incidence of death before ART initiation, minus the proportion not engaged in care before ART initiation (#2 in this list)
4) <u>engaged in care, on ART, and not virally suppressed</u> = cumulative incidence of ART initiation, minus the cumulative incidences of death after ART initiation,

disengagement from care after ART initiation, and viral suppression after ART initiation

5) <u>engaged in care, on ART, and virally suppressed</u> = sum of the cumulative incidences of viral suppression after ART initiation, minus the sum of the cumulative incidences of loss of viral suppression after ART initiation
6) <u>not engaged in care after ART initiation</u> = sum of cumulative incidences for disengagement from care after ART initiation, minus the sum of the cumulative incidences for engagement in care after ART initiation
7) <u>dead after ART initiation</u> = cumulative incidence of death after ART initiation

These percentages add up to 100% at any time point; we thus estimated the 5-year restricted mean percentage of person-time spent in each of the seven stages by integrating the area between adjacent curves. The mean percentage of person-time spent “in care” represented the sum of the area of stages #3-5 above. “On ART” represented the sum of the area of stages #4-5. “Virally suppressed” was equivalent to the 5-year restricted mean person-time spent in stage #5.

We estimated differences in the 5-year restricted mean percentage of person-time spent in care, on ART, and virally suppressed comparing Blacks versus whites, Hispanics versus whites, and Hispanics versus Blacks among MSM, women, and MSW. We present overall and age-stratified analyses to determine if age modifies the magnitude of racial/ethnic disparities in these indicators.

To assess whether the magnitude of any observed racial/ethnic disparities may have increased or decreased over the 11-year study period among MSM, women, and MSW, we stratified racial/ethnic percent differences by year of HIV care linkage. For this analysis, the study period was 2000 – 2010 to allow at least 5 years of follow-up (through 31 Dec 2014) after HIV care linkage.

We present both crude and adjusted person-time estimates; the former depict the current state of disparities in the HIV care continuum, whereas the latter show the extent to which these disparities are explained by other factors. For adjusted estimates, stabilized inverse probability of exposure group weighting was used to create a balanced distribution of the following potentially confounding factors among the three racial/ethnic groups of interest: age (to reduce confounding within age groups), a history of injection drug use, cohort (per standard NA-ACCORD analytic practice), CD4 count, and $\log_{10}$ HIV RNA at HIV care linkage.[16,17] Restricted quadratic splines with knots at the 5th, 35th, 65th, and 95th percentiles were included for all continuous factors (i.e., age, CD4 count, and $\log_{10}$ HIV RNA) in the logistic regression models used to generate the weights.[18]

We calculated 95% confidence intervals using the 2.5th and 97.5th percentiles of 1,000 non-parametric bootstrap estimates derived from unrestricted random sampling from the data.[19] For Black vs. white, Hispanic vs. white, and Hispanic vs. Black differences in person-time, confidence intervals that did not overlap 0% were considered statistically significant. Analyses were conducted using SAS software, version 9.4 (SAS Institute, Inc., Cary, North Carolina).

Results

Participant characteristics

A total of 11,510 (59.0%) MSM, 4,176 (21.4%) women, and 3,835 (19.6%) MSW successfully linked to HIV care for the first time in the NA-ACCORD between 1 January 2004 and 31 December 2014 (Table 4-1). Most MSM were white (51.3%), whereas most women and MSW were Black (69.8% and 61.2%, respectively). Black MSM, Hispanic MSM, and Black MSW tended to be from younger age groups than their white counterparts. The prevalence of a history of injection drug use was highest among MSW (20.7% versus 6.1% and 10.2% among MSM and women, respectively) and was also higher among whites than among Blacks and Hispanics.

Racial/ethnic differences among MSM

On average, Black MSM spent 2.7%, 2.2%, and 6.8% less person-time in care, on ART, and with viral suppression, respectively, in the first 5 years after linkage than white MSM (Table 4-2a, Figure 4-1a). The Black-white disparity in the percentage of person-time spent with viral suppression remained statistically significant at -4.7% after weighting for potential confounders. The magnitude of the Black-white disparity increased with older age, although it was attenuated slightly after weighting for potential confounders.

Overall, Hispanic MSM generally spent similar percentages of person-time in care, on ART, and virally suppressed as white MSM. However, in age-stratified analyses, Hispanic MSM aged ≥50 years spent significantly lower percentages of person-time in care (-7.7%), on ART (-10.6%), and with viral suppression (-10.7%) than white MSM in the same age group, though the disparity did not remain statistically significant after weighting for potential confounders. Compared to Black MSM, Hispanic MSM generally spent more time in the three stages of interest relative to Black MSM. Hispanic MSM of ages 40-49 years in particular spent 8.6% and 12.6% more person-time on ART and virally suppressed, respectively, than Black MSM of the same age group, a difference that remained statistically significant in the weighted analysis.

Racial/ethnic differences among women

In crude overall analyses, Black, Hispanic, and white women spent similar percentages of person-time in care, on ART, and virally suppressed (Table 4-2b, Figure 4-1b). In age-stratified analyses, Black and Hispanic women aged 18 to 29 years spent higher percentages of person-time on ART (8.0% and 10.8%, respectively) than white women of the same age range.

In weighted analyses, Black and Hispanic women of ages 30 to 39 years spent lower percentages of person-time in care, on ART, and virally suppressed than white women of the same age group, although these differences were not statistically significant. On the other hand, Black and Hispanic women of ages 18 to 29 and ≥50 years had higher percentages of person-time spent in care than white women in the same age groups. Similarly, Hispanic women of ages 18 to 29 years spent 9.0% and 13.5% more person-time on ART and virally suppressed, respectively, than white women of the same ages. Hispanic women generally spent similar percentages of person-time in care, on ART, and virally suppressed as Black women.

Racial/ethnic differences among MSW

Black MSW generally spent similar amounts of person-time in care as white MSW (Table 4-2c, Figure 4-1c). However, in crude overall analyses, Black MSW spent significantly less person-time on ART (-3.4%) and virally suppressed (-6.1%) than white MSW. Black MSW of ages 40 to 49 years spent 9.1% and 6.1% less person-time on ART and virally suppressed, respectively, than white MSW. These disparities remained statistically significant in weighted analyses.

Hispanic MSW generally spent similar percentages of person-time in care, on ART, and virally suppressed as Black and white MSW. However, Hispanic MSW specifically of ages 40 to 49 years spent 9.2% less person-time with viral suppression than white MSW, although this disparity was not statistically significant in weighted analyses.

Trends in racial/ethnic differences in retention in care, ART use, and viral suppression

Among MSM, differences in the percentage of person-time spent in care, on ART, and virally suppressed comparing 1) Blacks versus whites, 2) Hispanics versus whites, and 3) Hispanics versus Blacks were generally constant over time (Figure 4-2). Among women, Black-white and Hispanic-white percentage differences increased slightly over time in favor of Blacks and Hispanics. Among MSW, the magnitude of the Black-white and Hispanic-white percentage differences decreased until 2005, then increased slightly over time in favor of whites.

Discussion

Our study identified important age- and sex-based racial/ethnic differences in mean person-time retained in HIV care, on ART, and virally suppressed. Among MSM, the disparity between Blacks and whites in person-time spent in these stages was greatest in the oldest (≥50 years) age group. After adjustment for confounders, white women in the youngest and oldest age groups spent less time retained in HIV care, on ART, and virally suppressed than Hispanic women. Black MSW of ages 40 to 49 years spent less time on ART and virally suppressed than white MSW of the same ages, which elucidates disparities in an HIV transmission risk population that is often under-investigated.

Few studies have demonstrated the role of sex, age, and HIV acquisition risk in modifying HIV care outcomes. One study, for example, found that HIV care retention is more strongly associated with viral suppression at younger ages.[20] Another study demonstrated racial/ethnic differences in associations with HIV care discontinuity between MSM, women, and non-MSM.[21] We found that age affected the magnitude of racial/ethnic differences in person-time spent in care, on ART, and virally suppressed. We also found that among women and MSW, Blacks and Hispanics spent similar amounts of person-time in care, on ART, and virally suppressed; among MSM, however, Blacks of various age groups spent less person-time on ART and virally suppressed than Hispanics. These results highlight the importance of age-, sex-, HIV acquisition risk-stratification for understanding racial/ethnic differences in the HIV care continuum.

Of note, we found that among women, whites spent less person-time spent in care, on ART, and virally suppressed than Blacks and Hispanics. The Black-white and Hispanic-white difference in these outcomes also increased over time. In our study population, the prevalence of having a history of injection drug use among white women was over twice that in Black and Hispanic women. Injection drug use has been associated with significantly poorer HIV care outcomes.[11,22,23] Although we adjusted for a history of injection drug use, it is possible that poorer outcomes among white women can be more attributable to active injection drug use during study follow-up. In light of the burgeoning opioid epidemic in the US, future studies should investigate the impact of current versus former injection drug use on HIV care outcomes among white women versus women of color. This finding also calls into question the use of whites as the standard reference group in racial/ethnic disparities research under the common assumption of poorer HIV care outcomes in populations of color; our results specifically suggest careful consideration of the racial/ethnic comparison group among women.

To reduce disparities in the HIV care continuum, several public health entities advocate for a focus on interventions that are specifically tailored to the populations most affected by the HIV epidemic.[5,24,25] Our findings further underscore the need for novel, more nuanced interventions that consider the intersectionality between age, sex, and HIV acquisition risk to reduce racial/ethnic differences. However, the factors contributing to disparities in HIV care in the US are many and are not limited only to demography and HIV acquisition risk. These factors include poverty, substance abuse, mistrust in healthcare, and HIV stigma, among other social and structural determinants.[22,26–29] The racial/ethnic differences observed by sex and by age in this study suggest that these factors (which are unmeasured in our study) may impact specific sex- and age-based risk groups differentially and perhaps uniquely. Additional research is needed to identify which of these factors are the most important drivers of racial/ethnic disparities in sex- and age-based risk groups and subsequently determine how to reduce such disparities most effectively.

This study also had several limiting factors. As previously noted, we were unable to distinguish between former versus active injection drug use and did not have data on socioeconomic and health insurance status. As a prerequisite of enrollment in the NA-ACCORD, all patients included in this study successfully linked into and had access to HIV care, which may limit the generalizability of our results. It is possible that patients with person-time classified as "not retained in HIV care" may have accessed HIV care outside the sites investigated in this study, leading to potential under-ascertainment of HIV care outcomes. Lastly, race/ethnicity and sexual HIV risk behavior (e.g., heterosexual versus male-to-male sexual contact) may have been subject to potential misclassification error given that these exposures were obtained by self-report.

The strengths of this study are multi-fold. First, we used a nationally representative cohort endorsed by the National Academy of Medicine to evaluate HIV care continuum indicators.[10] Second, we used a longitudinal, patient-centered methodological approach that more closely represents the non-linear nature of progression through key stages of the HIV care continuum. Third, our ability to stratify analyses by age revealed important effect measure modification by age that can be leveraged by clinical interventions to more effectively reduce racial/ethnic differences in the outcomes examined in our study. Fourth, our exploration of the MSW risk group and examination of differences between Hispanic and Black PWH contribute to a deeper understanding of important racial/ethnic disparities in HIV care in the US.

In summary, age, sex, and sexual HIV acquisition risk are important modifiers of racial/ethnic disparities in HIV care retention, ART use, and viral suppression among PWH newly linked to care. Older Black MSM and white women from the youngest and oldest age groups appear to face greater challenges in achieving these HIV care milestones relative to their white and Hispanic counterparts. Tailored interventions that address the unique HIV care challenges of specific sex- and age-based risk groups may be necessary to effectively and efficiently reduce racial/ethnic differences in HIV care outcomes.

Table 4-1. Demographic and clinical characteristics of first-time HIV care initiators by key population, NA-ACCORD, 2004 – 2014

	MSM						**Women**						**MSW**					
	Black (N = 4,034)		**Hispanic (N = 1,576)**		**White (N = 5,900)**		**Black (N = 2,915)**		**Hispanic (N = 451)**		**White (N = 810)**		**Black (N = 2,348)**		**Hispanic (N = 671)**		**White (N = 816)**	
Age, years	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**
18 - 29	2,143	53.1	599	38.0	1,502	25.5	646	22.2	84	18.6	200	24.7	331	14.1	116	17.3	127	15.6
30 - 39	964	23.9	572	36.3	1,859	31.5	827	28.4	150	33.3	216	26.7	524	22.3	208	31.0	216	26.5
40 - 49	672	16.7	325	20.6	1,747	29.6	867	29.7	137	30.4	248	30.6	814	34.7	205	30.6	304	37.3
≥50	255	6.3	80	5.1	792	13.4	575	19.7	80	17.7	146	18.0	679	28.9	142	21.2	169	20.7
HIV transmission risk																		
MSM only	3,911	97.0	1,521	96.5	5,376	91.1	-	-	-	-	-	-	-	-	-	-	-	-
MSM and IDU	123	3.0	55	3.5	524	8.9	-	-	-	-	-	-	-	-	-	-	-	-
Heterosexual	-	-	-	-	-	-	2,515	86.3	377	83.6	606	74.8	1,832	78.0	497	74.1	478	58.6
IDU	-	-	-	-	-	-	224	7.7	36	8.0	167	20.6	396	16.9	136	20.3	261	32.0
Other	-	-	-	-	-	-	75	2.6	22	4.9	25	3.1	120	5.1	38	5.7	77	9.4
Unknown	-	-	-	-	-	-	101	3.5	16	3.5	12	1.5	-	-	-	-	-	-
CD4 count, cells/mL*																		
<200	861	21.3	328	20.8	1,157	19.6	770	26.4	115	25.5	195	24.1	802	34.2	264	39.3	295	36.2
200 - 350	971	24.1	387	24.6	1,246	21.1	644	22.1	114	25.3	162	20.0	509	21.7	168	25.0	161	19.7
350 - 500	1,052	26.1	405	25.7	1,457	24.7	630	21.6	85	18.8	165	20.4	492	21.0	108	16.1	160	19.6
≥500	1,150	28.5	456	28.9	2,040	34.6	871	29.9	137	30.4	288	35.6	545	23.2	131	19.5	200	24.5
HIV RNA, median (IQR), $\log_{10}$ copies/mL	4.5 (3.8, 5.0)		4.5 (3.9,5.0)		4.6 (4.0, 5.1)		4.2 (3.6, 4.8)		4.3 (3.5, 5.0)		4.4 (3.7, 4.9)		4.5 (3.9, 5.0)		4.6 (3.9, 5.1)		4.7 (4.1, 5.2)	

Abbreviations: MSM, male-to-male sexual contact; MSW, men who have sex with women; IDU, injection drug use; IQR, interquartile range

* Measurement closest to HIV care linkage, at least 6 months prior to and at most 1 month after linkage

Table 4-2 a, b, c. Crude and adjusted racial differences among (a) men who have sex with men, (b) women, and (c) men who have sex with women in the mean percentage (%, [95% CI]) of person-time spent in HIV care, on ART, and with VS in the first 5 years after HIV care linkage, overall and by age, NA-ACCORD, 2004-2014

a)

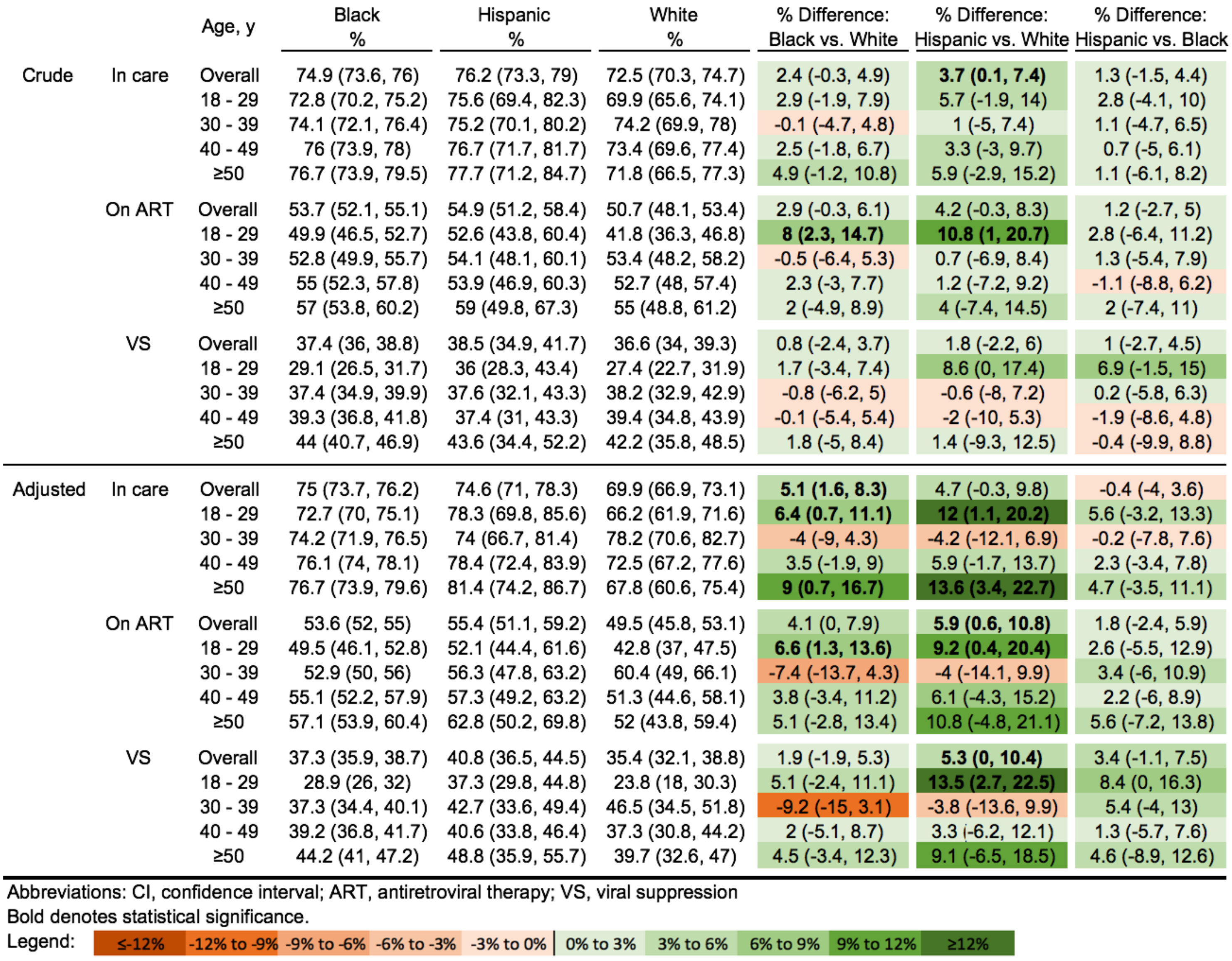
		Age, y	Black %	Hispanic %	White %	% Difference: Black vs. White	% Difference: Hispanic vs. White	% Difference: Hispanic vs. Black
Crude	In care	Overall	74.7 (73.7, 75.6)	76.9 (75.3, 78.4)	77.4 (76.6, 78.2)	**-2.7 (-3.9, -1.4)**	-0.5 (-2.1, 1.2)	**2.3 (0.4, 4)**
		18 - 29	75 (73.7, 76.3)	74.8 (72.5, 77.2)	74.8 (73.3, 76.4)	0.1 (-1.9, 2)	0 (-3, 3.1)	-0.1 (-2.9, 2.7)
		30 - 39	74 (71.9, 75.9)	77.1 (74.7, 79.5)	75.6 (74.2, 77.2)	-1.6 (-4.1, 0.8)	1.5 (-1.4, 4.2)	**3.2 (0, 6.4)**
		40 - 49	75 (72.5, 77.5)	81 (77.7, 84.2)	79.1 (77.6, 80.5)	**-4.1 (-6.7, -1.3)**	1.8 (-1.7, 5.2)	**5.9 (1.9, 9.8)**
		≥50	74.3 (70.3, 78.2)	74.9 (67.4, 81.8)	82.7 (80.6, 84.7)	**-8.4 (-13.1, -3.8)**	**-7.7 (-15.5, -0.3)**	0.6 (-8.2, 8.4)
	On ART	Overall	55.1 (53.9, 56.3)	57.9 (56, 59.7)	57.3 (56.2, 58.3)	**-2.2 (-3.7, -0.6)**	0.5 (-1.5, 2.7)	**2.7 (0.4, 5.1)**
		18 - 29	55.8 (53.9, 57.4)	54.7 (51.7, 57.7)	52 (50, 53.8)	**3.8 (1.3, 6.3)**	2.8 (-1, 6.4)	-1 (-4.4, 2.5)
		30 - 39	53.9 (51.2, 56.3)	57.6 (54.3, 60.5)	54.3 (52.5, 56.3)	-0.5 (-3.6, 2.6)	3.3 (-0.4, 6.9)	3.7 (-0.5, 8)
		40 - 49	55.3 (52.2, 58.4)	63.9 (59.8, 67.6)	60.6 (58.6, 62.4)	**-5.2 (-9, -1.7)**	3.3 (-1.3, 7.4)	**8.6 (3.1, 13.6)**
		≥50	53.6 (48.3, 58.1)	56.7 (46.6, 65.1)	67.3 (64.6, 69.7)	**-13.7 (-19.3, -8.6)**	**-10.6 (-21.3, -1.7)**	3.1 (-8.1, 13.5)
	VS	Overall	40.3 (39, 41.4)	46.9 (45, 48.8)	47.1 (46, 48)	**-6.8 (-8.2, -5.1)**	-0.1 (-2.2, 2)	**6.7 (4.4, 9)**
		18 - 29	40.6 (39, 42.2)	43.7 (40.7, 46.6)	41.8 (39.9, 43.5)	-1.2 (-3.6, 1.3)	1.9 (-1.9, 5.4)	3.1 (-0.4, 6.4)
		30 - 39	38.7 (36.2, 41)	46.9 (43.9, 50)	44.2 (42.4, 46)	**-5.5 (-8.5, -2.4)**	2.7 (-0.9, 6.4)	**8.2 (4.2, 12.3)**
		40 - 49	39.8 (36.8, 42.8)	52.4 (48.2, 56.2)	49.6 (47.8, 51.4)	**-9.8 (-13.2, -6.4)**	2.8 (-1.7, 6.8)	**12.6 (7.5, 17.5)**
		≥50	44 (38.9, 48.6)	47.1 (37.9, 55.2)	57.9 (55.2, 60.3)	**-13.8 (-19.1, -8.5)**	**-10.7 (-20.6, -2.1)**	3.1 (-7.3, 12.5)
Adjusted	In care	Overall	75.3 (74, 76.5)	75.8 (73.2, 78.5)	75.2 (74.2, 76.2)	0.1 (-1.5, 1.6)	0.6 (-2.2, 3.4)	0.5 (-2.4, 3.4)
		18 - 29	74.5 (72.6, 76.4)	72.9 (68.5, 77.1)	72.5 (70.4, 74.6)	2 (-0.9, 4.8)	0.4 (-4.3, 5.4)	-1.6 (-6.5, 3.1)
		30 - 39	74.9 (72.6, 77.1)	78.2 (75.1, 81.2)	74.2 (72.6, 75.8)	0.7 (-2.2, 3.4)	**4 (0.6, 7.3)**	3.3 (-0.6, 7)
		40 - 49	76.5 (73.6, 79.3)	79.3 (74.2, 84.7)	77.8 (76.2, 79.3)	-1.3 (-4.6, 2.1)	1.5 (-3.8, 6.9)	2.8 (-3.2, 9)
		≥50	75.5 (70.4, 80.3)	75.7 (65.3, 83.7)	81.9 (79.8, 84)	**-6.3 (-11.7, -1.3)**	-6.2 (-17, 2)	0.2 (-11.6, 9.1)
	On ART	Overall	54 (52.2, 55.7)	56.9 (53.7, 60.2)	55.2 (54, 56.3)	-1.1 (-3.4, 0.7)	1.8 (-1.5, 5.2)	2.9 (-0.8, 6.5)
		18 - 29	53.7 (51.6, 55.8)	52.2 (46.7, 57.7)	50.2 (47.6, 52.4)	**3.6 (0.3, 6.8)**	2 (-4.1, 8.3)	-1.6 (-7.5, 4.8)
		30 - 39	54.5 (51.6, 57.3)	59.7 (55.5, 63)	53.5 (51.5, 55.5)	1 (-2.6, 4.4)	**6.2 (1.5, 10.2)**	5.2 (0, 9.8)
		40 - 49	53.3 (49.7, 56.7)	63.5 (58.6, 68.4)	59.9 (58, 61.8)	**-6.6 (-10.5, -2.7)**	3.6 (-1.5, 9)	**10.2 (3.9, 16.4)**
		≥50	55.9 (49.1, 61.7)	58.7 (44.4, 68.2)	66.9 (64.2, 69.4)	**-11 (-18.1, -4.6)**	-8.2 (-22.6, 1.9)	2.8 (-12.4, 14.6)
	VS	Overall	40.1 (38.4, 41.7)	47.2 (44, 50.5)	44.8 (43.7, 45.9)	**-4.7 (-6.7, -2.8)**	2.4 (-0.9, 5.9)	**7.1 (3.6, 10.6)**
		18 - 29	40.6 (38.5, 42.7)	42.9 (37.9, 47.9)	40.1 (37.6, 42.5)	0.4 (-2.8, 3.6)	2.7 (-2.9, 8.5)	2.3 (-3.3, 8)
		30 - 39	39 (35.8, 41.8)	49.4 (45.2, 53.3)	43.4 (41.3, 45.2)	**-4.4 (-7.9, -1)**	**6.1 (1.4, 10.4)**	**10.4 (5, 15.4)**
		40 - 49	39.4 (36.2, 42.6)	52.1 (46, 58.1)	48.5 (46.4, 50.2)	**-9.1 (-12.5, -5.1)**	3.6 (-2.3, 9.8)	**12.7 (5.6, 19.3)**
		≥50	47.2 (40.8, 52.6)	50.9 (37.1, 60.8)	56.9 (54.2, 59.3)	**-9.7 (-16.8, -3.6)**	-6 (-19.9, 3.3)	3.7 (-11.4, 15.4)

Abbreviations: CI, confidence interval; ART, antiretroviral therapy; VS, viral suppression

Bold denotes statistical significance.

Legend:	≤-12%	-12% to -9%	-9% to -6%	-6% to -3%	-3% to 0%	0% to 3%	3% to 6%	6% to 9%	9% to 12%	≥12%

b)



		Age, y	Black %	Hispanic %	White %	% Difference: Black vs. White	% Difference: Hispanic vs. White	% Difference: Hispanic vs. Black
Crude	In care	Overall	74.9 (73.6, 76)	76.2 (73.3, 79)	72.5 (70.3, 74.7)	2.4 (-0.3, 4.9)	**3.7 (0.1, 7.4)**	1.3 (-1.5, 4.4)
		18 - 29	72.8 (70.2, 75.2)	75.6 (69.4, 82.3)	69.9 (65.6, 74.1)	2.9 (-1.9, 7.9)	5.7 (-1.9, 14)	2.8 (-4.1, 10)
		30 - 39	74.1 (72.1, 76.4)	75.2 (70.1, 80.2)	74.2 (69.9, 78)	-0.1 (-4.7, 4.8)	1 (-5, 7.4)	1.1 (-4.7, 6.5)
		40 - 49	76 (73.9, 78)	76.7 (71.7, 81.7)	73.4 (69.6, 77.4)	2.5 (-1.8, 6.7)	3.3 (-3, 9.7)	0.7 (-5, 6.1)
		≥50	76.7 (73.9, 79.5)	77.7 (71.2, 84.7)	71.8 (66.5, 77.3)	4.9 (-1.2, 10.8)	5.9 (-2.9, 15.2)	1.1 (-6.1, 8.2)
	On ART	Overall	53.7 (52.1, 55.1)	54.9 (51.2, 58.4)	50.7 (48.1, 53.4)	2.9 (-0.3, 6.1)	4.2 (-0.3, 8.3)	1.2 (-2.7, 5)
		18 - 29	49.9 (46.5, 52.7)	52.6 (43.8, 60.4)	41.8 (36.3, 46.8)	**8 (2.3, 14.7)**	**10.8 (1, 20.7)**	2.8 (-6.4, 11.2)
		30 - 39	52.8 (49.9, 55.7)	54.1 (48.1, 60.1)	53.4 (48.2, 58.2)	-0.5 (-6.4, 5.3)	0.7 (-6.9, 8.4)	1.3 (-5.4, 7.9)
		40 - 49	55 (52.3, 57.8)	53.9 (46.9, 60.3)	52.7 (48, 57.4)	2.3 (-3, 7.7)	1.2 (-7.2, 9.2)	-1.1 (-8.8, 6.2)
		≥50	57 (53.8, 60.2)	59 (49.8, 67.3)	55 (48.8, 61.2)	2 (-4.9, 8.9)	4 (-7.4, 14.5)	2 (-7.4, 11)
	VS	Overall	37.4 (36, 38.8)	38.5 (34.9, 41.7)	36.6 (34, 39.3)	0.8 (-2.4, 3.7)	1.8 (-2.2, 6)	1 (-2.7, 4.5)
		18 - 29	29.1 (26.5, 31.7)	36 (28.3, 43.4)	27.4 (22.7, 31.9)	1.7 (-3.4, 7.4)	8.6 (0, 17.4)	6.9 (-1.5, 15)
		30 - 39	37.4 (34.9, 39.9)	37.6 (32.1, 43.3)	38.2 (32.9, 42.9)	-0.8 (-6.2, 5)	-0.6 (-8, 7.2)	0.2 (-5.8, 6.3)
		40 - 49	39.3 (36.8, 41.8)	37.4 (31, 43.3)	39.4 (34.8, 43.9)	-0.1 (-5.4, 5.4)	-2 (-10, 5.3)	-1.9 (-8.6, 4.8)
		≥50	44 (40.7, 46.9)	43.6 (34.4, 52.2)	42.2 (35.8, 48.5)	1.8 (-5, 8.4)	1.4 (-9.3, 12.5)	-0.4 (-9.9, 8.8)
Adjusted	In care	Overall	75 (73.7, 76.2)	74.6 (71, 78.3)	69.9 (66.9, 73.1)	**5.1 (1.6, 8.3)**	4.7 (-0.3, 9.8)	-0.4 (-4, 3.6)
		18 - 29	72.7 (70, 75.1)	78.3 (69.8, 85.6)	66.2 (61.9, 71.6)	**6.4 (0.7, 11.1)**	**12 (1.1, 20.2)**	5.6 (-3.2, 13.3)
		30 - 39	74.2 (71.9, 76.5)	74 (66.7, 81.4)	78.2 (70.6, 82.7)	-4 (-9, 4.3)	-4.2 (-12.1, 6.9)	-0.2 (-7.8, 7.6)
		40 - 49	76.1 (74, 78.1)	78.4 (72.4, 83.9)	72.5 (67.2, 77.6)	3.5 (-1.9, 9)	5.9 (-1.7, 13.7)	2.3 (-3.4, 7.8)
		≥50	76.7 (73.9, 79.6)	81.4 (74.2, 86.7)	67.8 (60.6, 75.4)	**9 (0.7, 16.7)**	**13.6 (3.4, 22.7)**	4.7 (-3.5, 11.1)
	On ART	Overall	53.6 (52, 55)	55.4 (51.1, 59.2)	49.5 (45.8, 53.1)	4.1 (0, 7.9)	**5.9 (0.6, 10.8)**	1.8 (-2.4, 5.9)
		18 - 29	49.5 (46.1, 52.8)	52.1 (44.4, 61.6)	42.8 (37, 47.5)	**6.6 (1.3, 13.6)**	**9.2 (0.4, 20.4)**	2.6 (-5.5, 12.9)
		30 - 39	52.9 (50, 56)	56.3 (47.8, 63.2)	60.4 (49, 66.1)	-7.4 (-13.7, 4.3)	-4 (-14.1, 9.9)	3.4 (-6, 10.9)
		40 - 49	55.1 (52.2, 57.9)	57.3 (49.2, 63.2)	51.3 (44.6, 58.1)	3.8 (-3.4, 11.2)	6.1 (-4.3, 15.2)	2.2 (-6, 8.9)
		≥50	57.1 (53.9, 60.4)	62.8 (50.2, 69.8)	52 (43.8, 59.4)	5.1 (-2.8, 13.4)	10.8 (-4.8, 21.1)	5.6 (-7.2, 13.8)
	VS	Overall	37.3 (35.9, 38.7)	40.8 (36.5, 44.5)	35.4 (32.1, 38.8)	1.9 (-1.9, 5.3)	**5.3 (0, 10.4)**	3.4 (-1.1, 7.5)
		18 - 29	28.9 (26, 32)	37.3 (29.8, 44.8)	23.8 (18, 30.3)	5.1 (-2.4, 11.1)	**13.5 (2.7, 22.5)**	8.4 (0, 16.3)
		30 - 39	37.3 (34.4, 40.1)	42.7 (33.6, 49.4)	46.5 (34.5, 51.8)	-9.2 (-15, 3.1)	-3.8 (-13.6, 9.9)	5.4 (-4, 13)
		40 - 49	39.2 (36.8, 41.7)	40.6 (33.8, 46.4)	37.3 (30.8, 44.2)	2 (-5.1, 8.7)	3.3 (-6.2, 12.1)	1.3 (-5.7, 7.6)
		≥50	44.2 (41, 47.2)	48.8 (35.9, 55.7)	39.7 (32.6, 47)	4.5 (-3.4, 12.3)	9.1 (-6.5, 18.5)	4.6 (-8.9, 12.6)

Abbreviations: CI, confidence interval; ART, antiretroviral therapy; VS, viral suppression

Bold denotes statistical significance.

Legend: ≤-12% | -12% to -9% | -9% to -6% | -6% to -3% | -3% to 0% | 0% to 3% | 3% to 6% | 6% to 9% | 9% to 12% | ≥12%

c)

		Age, y	Black %	Hispanic %	White %	% Difference: Black vs. White	% Difference: Hispanic vs. White	% Difference: Hispanic vs. Black
Crude	In care	Overall	70.7 (69.3, 72.1)	69.1 (66.6, 71.7)	71.2 (69, 73.6)	-0.5 (-3.1, 2.1)	-2.1 (-5.7, 1.3)	-1.6 (-4.2, 1.2)
		18 - 29	71.7 (68.4, 75.2)	68.4 (62.9, 74.2)	72.2 (67.3, 77.7)	-0.5 (-6.7, 5.1)	-3.8 (-12, 3.7)	-3.3 (-9.7, 3.6)
		30 - 39	69.6 (66.9, 72.3)	68.4 (63.9, 73)	68.4 (63.9, 72.8)	1.2 (-4.1, 6.2)	0 (-6.4, 6.7)	-1.2 (-6.3, 4.6)
		40 - 49	70.5 (68.1, 72.8)	69.5 (65.4, 73.9)	72.7 (69, 76.5)	-2.2 (-6.6, 2.1)	-3.2 (-8.9, 2.5)	-1 (-6.2, 4)
		≥50	71.4 (68.8, 73.9)	70.5 (65.3, 76.4)	71.3 (66.3, 76.5)	0.1 (-5.8, 5.8)	-0.7 (-8.2, 7.1)	-0.9 (-6.5, 5.1)
	On ART	Overall	51.2 (49.6, 52.8)	53.7 (50.7, 56.9)	54.6 (52.1, 57.4)	**-3.4 (-6.7, -0.4)**	-0.9 (-5.1, 3.1)	2.5 (-0.9, 6)
		18 - 29	47.9 (43.6, 51.9)	51.5 (44, 58.5)	49.5 (43.2, 56)	-1.6 (-9.6, 5.8)	2 (-8.7, 11.2)	3.6 (-5, 11.5)
		30 - 39	51 (47.5, 54.1)	51.8 (45.8, 56.8)	48.9 (43.4, 54.2)	2.1 (-4.3, 8.3)	2.9 (-4.8, 10.5)	0.8 (-5.7, 7)
		40 - 49	49.5 (46.6, 52.4)	53.9 (48.5, 59.1)	58.6 (54.2, 63)	**-9.1 (-14.4, -3.7)**	-4.7 (-11.9, 1.9)	4.3 (-2.1, 10.5)
		≥50	54.9 (52, 57.9)	57.5 (50.9, 64.2)	57.8 (51.8, 63.5)	-2.9 (-9.1, 3.9)	-0.4 (-9.4, 8.5)	2.6 (-4.6, 9.7)
	VS	Overall	35.7 (34.2, 37.2)	36.6 (33.7, 39.4)	41.8 (39.4, 44.5)	**-6.1 (-9.2, -3.2)**	**-5.2 (-9.2, -1.4)**	0.8 (-2.2, 4.1)
		18 - 29	32.2 (28.3, 35.9)	35.2 (28.9, 41.9)	37 (31, 43.5)	-4.8 (-12.1, 2.3)	-1.8 (-10.7, 7.2)	3 (-3.8, 10.5)
		30 - 39	34.3 (31.2, 37.5)	34.8 (29.9, 39.9)	36 (31.1, 40.6)	-1.6 (-7.4, 4)	-1.1 (-8, 5.8)	0.5 (-5.3, 6.4)
		40 - 49	33.4 (30.7, 35.9)	35.6 (30.7, 40.7)	44.8 (40.7, 49.1)	**-11.4 (-16.5, -6.5)**	**-9.2 (-15.9, -2.9)**	2.2 (-3.3, 7.9)
		≥50	41.2 (38.3, 43.9)	41.6 (35, 48)	47 (41.1, 53)	-5.9 (-12.5, 0.9)	-5.4 (-14.4, 3.5)	0.5 (-6.9, 7.1)
Adjusted	In care	Overall	70.5 (69.1, 72)	71.5 (68.3, 74.7)	70.8 (68, 73.7)	-0.3 (-3.6, 2.9)	0.7 (-3.4, 4.9)	1 (-2.3, 4.5)
		18 - 29	74.3 (70.3, 78.2)	71.7 (60.7, 78.7)	71.6 (63, 81.4)	2.7 (-8, 11.9)	0.1 (-15.5, 10.9)	-2.6 (-15, 5.7)
		30 - 39	70 (66.9, 73.1)	67.3 (62.2, 73.4)	65.9 (59.1, 73.5)	4 (-3.9, 11.4)	1.3 (-7.6, 10.1)	-2.7 (-8.5, 4.2)
		40 - 49	70 (67.4, 72.8)	71 (65.3, 76.4)	75.2 (70.3, 80.3)	-5.2 (-10.6, 0.5)	-4.2 (-11.9, 3.1)	1 (-5.5, 7)
		≥50	71.1 (68.4, 73.7)	72.9 (66.3, 79.6)	69.2 (63.1, 76.7)	1.9 (-6.2, 8.7)	3.7 (-6.4, 12.8)	1.8 (-5.1, 8.9)
	On ART	Overall	51.2 (49.5, 53.1)	56.6 (52.9, 59.9)	54.7 (51.2, 58.3)	-3.5 (-7.4, 0.4)	1.9 (-3.3, 6.7)	**5.4 (1.4, 9.1)**
		18 - 29	48.9 (43.4, 53.9)	54.6 (41.2, 62.9)	51.6 (39.2, 63.2)	-2.7 (-15.9, 9.1)	3 (-16.3, 16.6)	5.7 (-8.3, 14.4)
		30 - 39	51.3 (46.8, 55)	50.8 (45.1, 56.2)	45.6 (37.8, 52.8)	5.6 (-3.6, 13.9)	5.1 (-4.3, 14.4)	-0.5 (-6.9, 6.1)
		40 - 49	49.5 (46.1, 52.9)	54.5 (47.8, 60.5)	59.3 (52.5, 65.6)	**-9.8 (-16.5, -2.4)**	-4.8 (-14, 4)	5 (-2.5, 11.5)
		≥50	55.1 (52, 58)	60.7 (52.1, 67.2)	55.4 (47.9, 63.4)	-0.3 (-8.8, 7.7)	5.3 (-6.5, 16.2)	5.6 (-3.7, 12.5)
	VS	Overall	35.5 (33.9, 37.2)	38.9 (34.5, 42.8)	41.5 (38, 45)	**-6 (-9.6, -2)**	-2.6 (-8.3, 2.7)	3.4 (-1, 7.7)
		18 - 29	32.2 (28, 36.2)	40.7 (26.9, 49.6)	39.8 (27.8, 53.9)	-7.6 (-21.9, 5.1)	0.9 (-20.2, 15.4)	8.5 (-5.2, 17.9)
		30 - 39	34.4 (30.7, 37.8)	33.6 (28.4, 39.5)	33.5 (27, 40.2)	1 (-6.2, 8.1)	0.1 (-7.9, 9)	-0.8 (-6.7, 6.4)
		40 - 49	33.1 (30.2, 36)	38.3 (31.6, 43.6)	44.9 (37.5, 52)	**-11.9 (-19.3, -3.8)**	-6.7 (-16.1, 2.1)	5.2 (-1.7, 11.4)
		≥50	41.6 (38.6, 44.4)	43.8 (33.7, 53)	44.4 (37, 52.2)	-2.8 (-11.1, 5)	-0.6 (-14.1, 10.7)	2.2 (-7.9, 11.8)

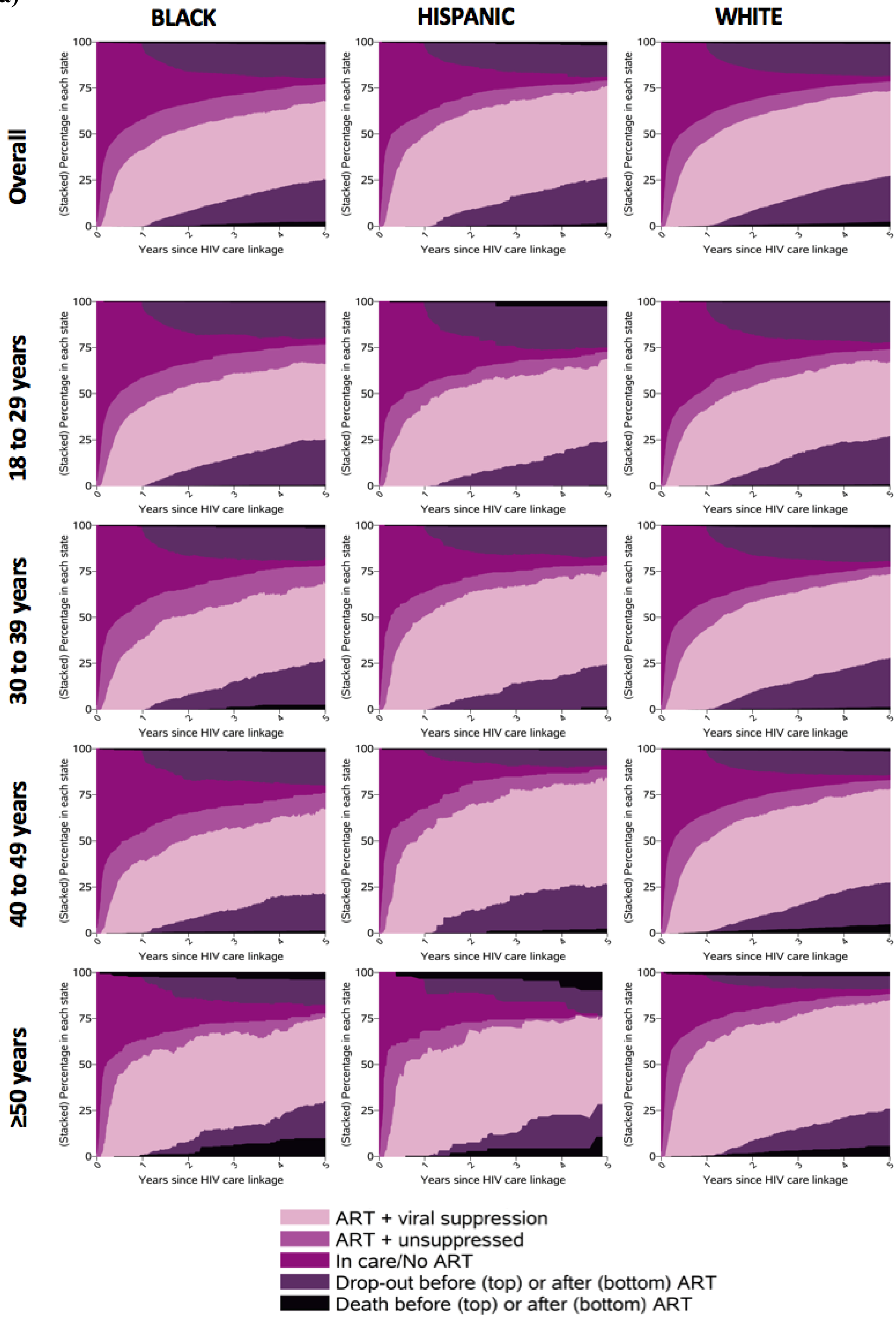
Abbreviations: CI, confidence interval; ART, antiretroviral therapy; VS, viral suppression

Bold denotes statistical significance.

Legend: ≤-12% | -12% to -9% | -9% to -6% | -6% to -3% | -3% to 0% | 0% to 3% | 3% to 6% | 6% to 9% | 9% to 12% | ≥12%

Figure 4-1 a, b, c. Adjusted percentage of (a) men who have sex with men, (b) women, and (c) men who have sex with women in seven HIV care continuum stages in the first 5 years after HIV care linkage, by race/ethnicity and age, NA-ACCORD, 2004 –2014

a)


BLACK
HISPANIC
WHITE
Overall
18 to 29 years
30 to 39 years
40 to 49 years
≥50 years
(Stacked) Percentage in each state
100
75
50
25
0
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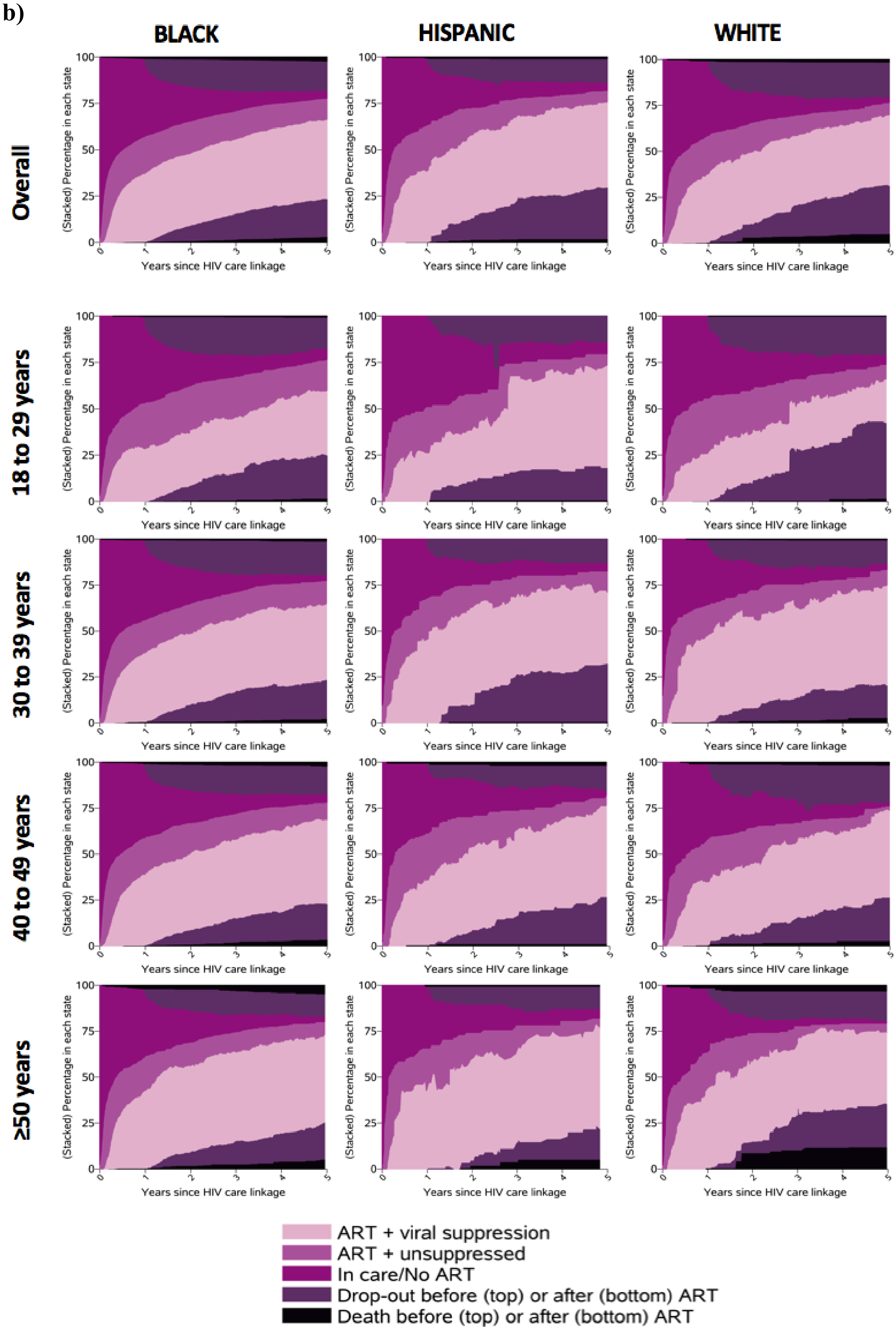
1
2
3
4
5
Years since HIV care linkage
ART + viral suppression
ART + unsuppressed
In care/No ART
Drop-out before (top) or after (bottom) ART
Death before (top) or after (bottom) ART

b)


BLACK
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18 to 29 years
30 to 39 years
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≥50 years
(Stacked) Percentage in each state
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0
Years since HIV care linkage
0
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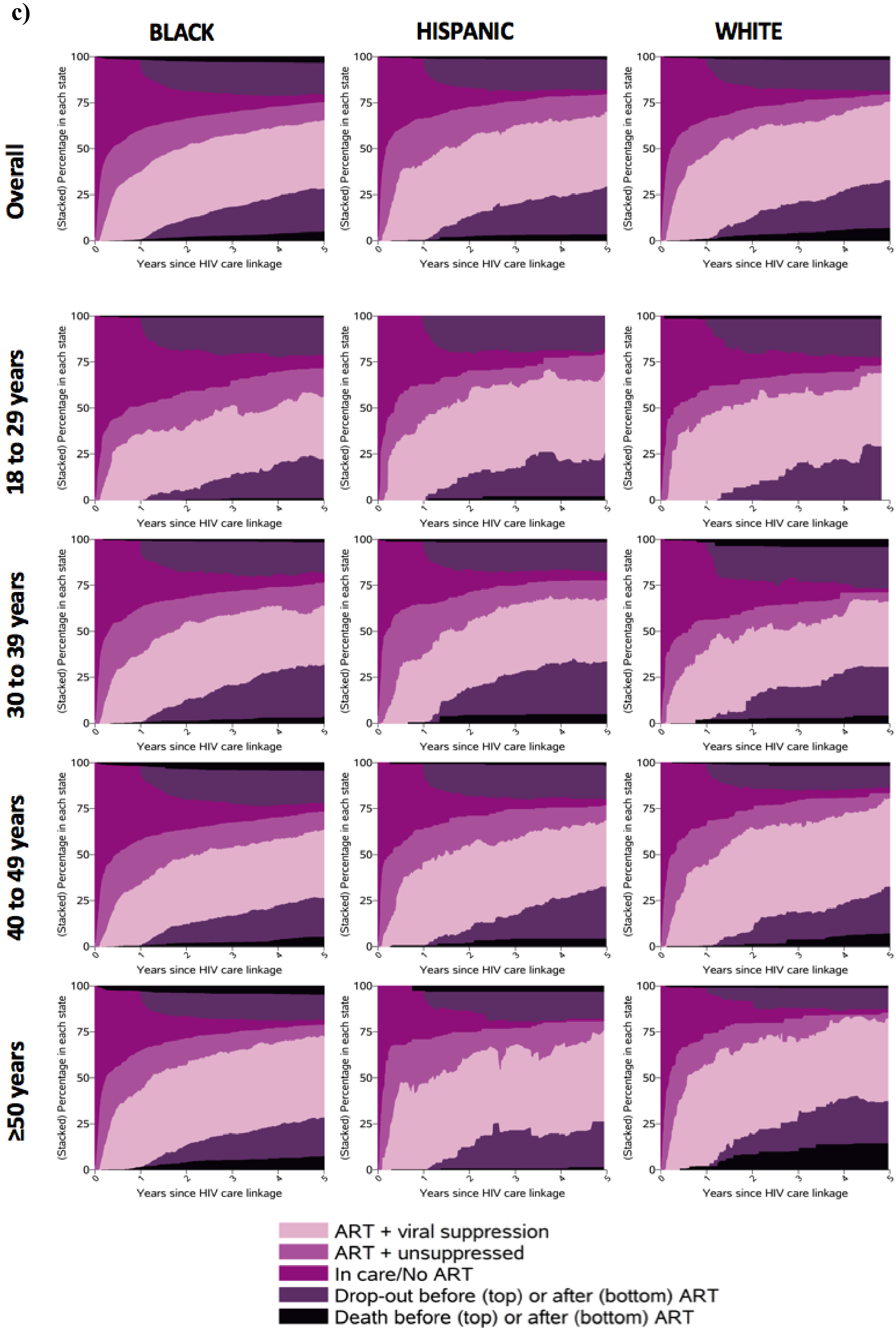
ART + viral suppression
ART + unsuppressed
In care/No ART
Drop-out before (top) or after (bottom) ART
Death before (top) or after (bottom) ART

c)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18 to 29 years
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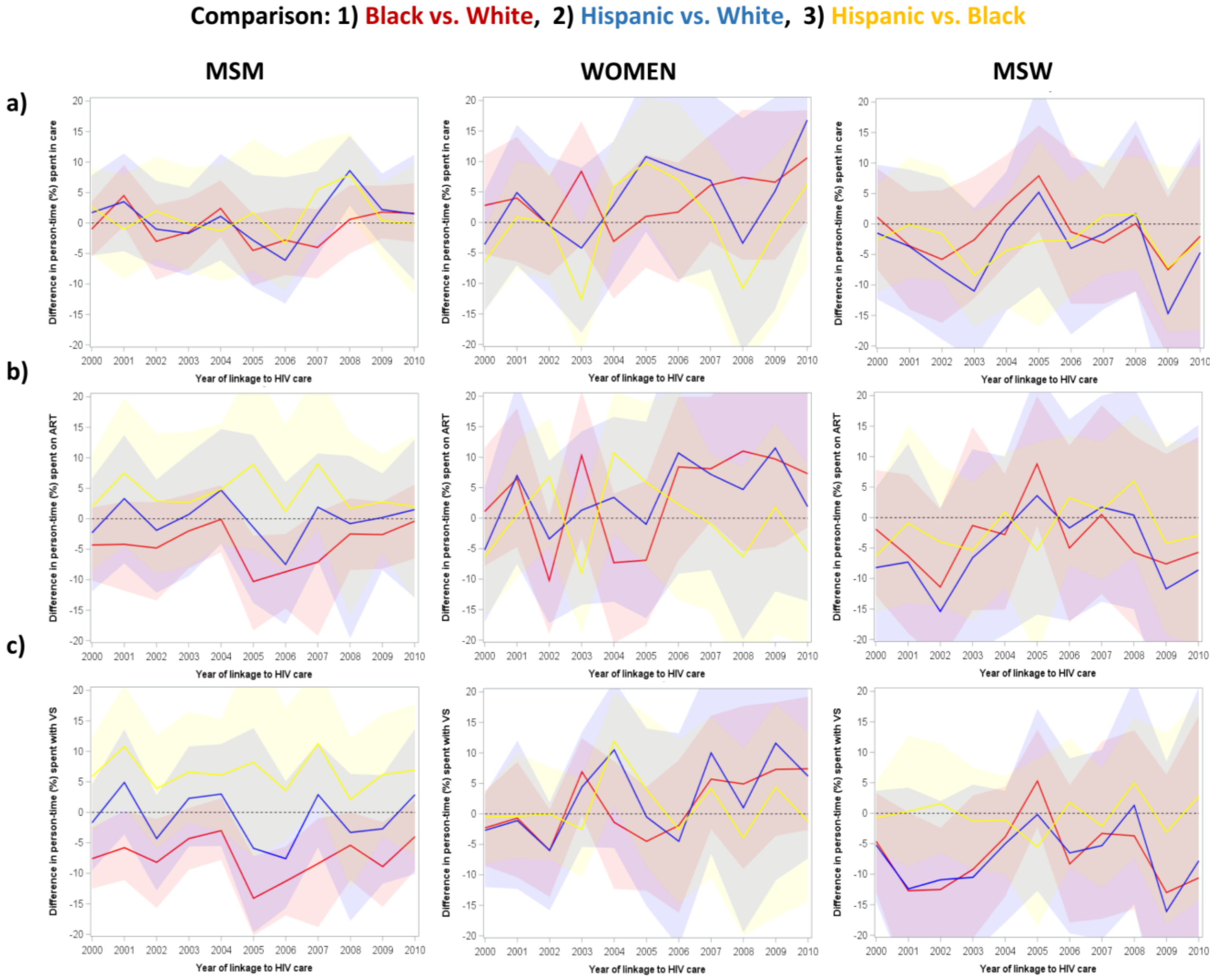
4
5
Years since HIV care linkage
ART + viral suppression
ART + unsuppressed
In care/No ART
Drop-out before (top) or after (bottom) ART
Death before (top) or after (bottom) ART

Figure 4-2. Adjusted racial differences in the percentage of 1) men who have sex with men, 2) women, and 3) men who have sex with women who were in care (a), on ART (b), and with VS (c) in the first 5 years after HIV care linkage, by year of HIV care linkage, NA-ACCORD, 2000 – 2010



Abbreviations: MSM, male-to-male sexual contact; MSW, men who have sex with women; ART, antiretroviral therapy; VS, viral suppression
Colored bands on the figure represent 95% confidence intervals.

Appendix

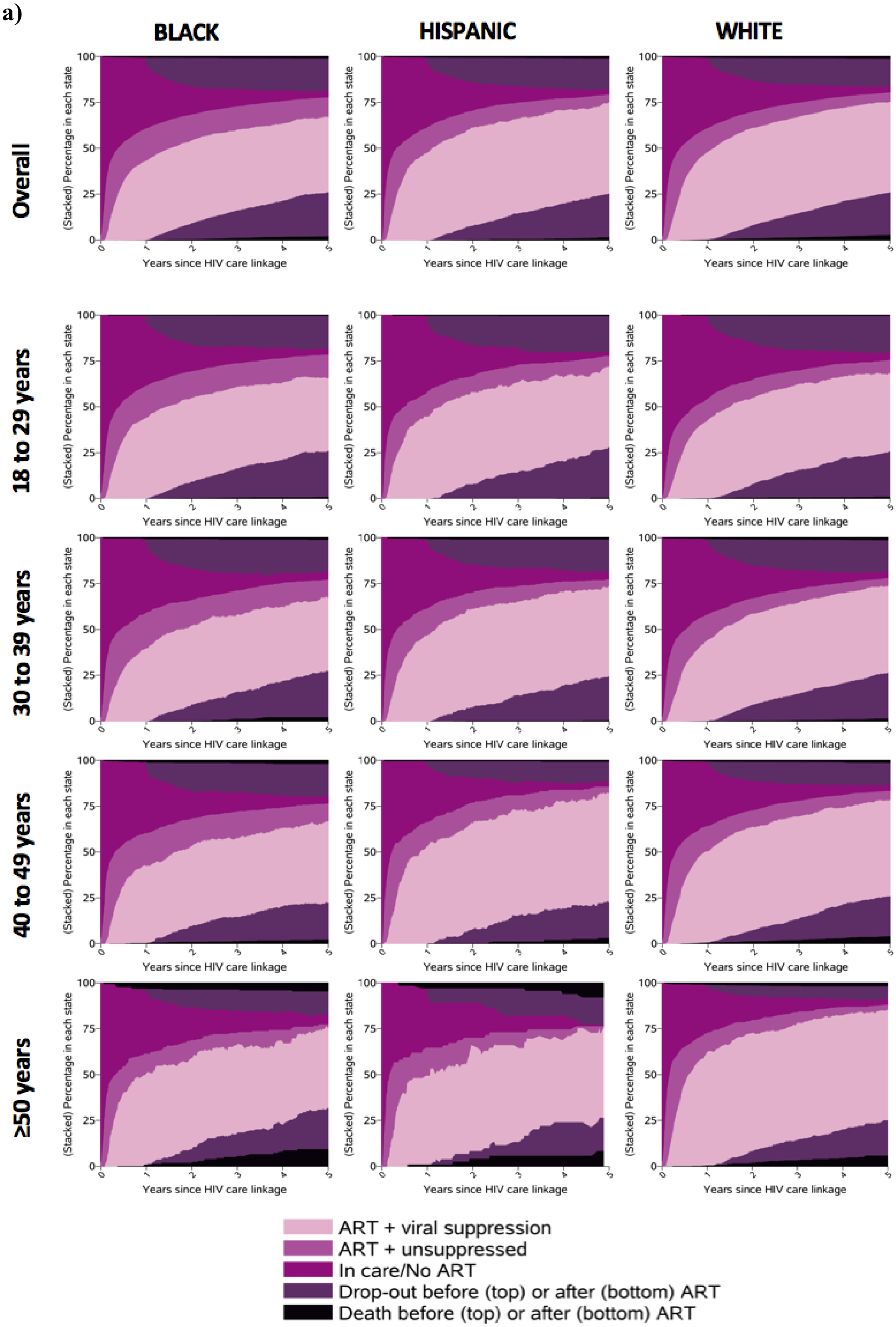
Appendix Table 4-1. Definition, competing risk(s), and maximum number of instances of nine HIV care continuum outcomes

Outcome	Definition	Competing risk(s)	Maximum # of instances outcome occurred
1) Death before ART initiation	date of death (prior to ART initiation)	ART initiation	1
2) Disengagement from care before ART initiation	date of 12 months after most recent HIV care visit, CD4 count, or HIV RNA measure (prior to ART initiation)	ART initiation; death before ART initiation	3
3) Engagement in HIV care before ART initiation	date of first HIV care visit, CD4 count, or HIV RNA measure after disengagement from care (prior to ART initiation)	ART initiation; death before ART initiation	3
4) ART initiation	date of first ART prescription	Death before ART initiation	1
5) Viral suppression on ART	date of HIV RNA ≤200 copies/mL (after ART initiation)	Death before ART initiation; death after ART initiation	7
6) Loss of viral suppression on ART	date of HIV RNA >200 copies/mL, date of death, or date of disengagement from care (after ART initiation and initial viral suppression)	Death before ART initiation; death after ART initiation	6
7) Disengagement from care after ART initiation	date of 12 months after most recent HIV care visit, CD4 count, or HIV RNA measure (after ART initiation)	Death before ART initiation; death after ART initiation	3
8) Engagement in HIV care after ART initiation	date of first HIV care visit, CD4 count, or HIV RNA measure after disengagement from care (after ART initiation)	Death before ART initiation; death after ART initiation	3
9) Death after ART initiation	date of death (after ART initiation)	Death before ART initiation	1

Abbreviations: ART, antiretroviral therapy

Appendix Figure 4-1 a, b, c. Crude percentage of (a) men who have sex with men, (b) women, and (c) men who have sex with women in seven HIV care continuum stages in the first 5 years after HIV care linkage, by race/ethnicity and age, NA-ACCORD, 2004 – 2014

a)


BLACK
HISPANIC
WHITE
Overall
18 to 29 years
30 to 39 years
40 to 49 years
≥50 years
(Stacked) Percentage in each state
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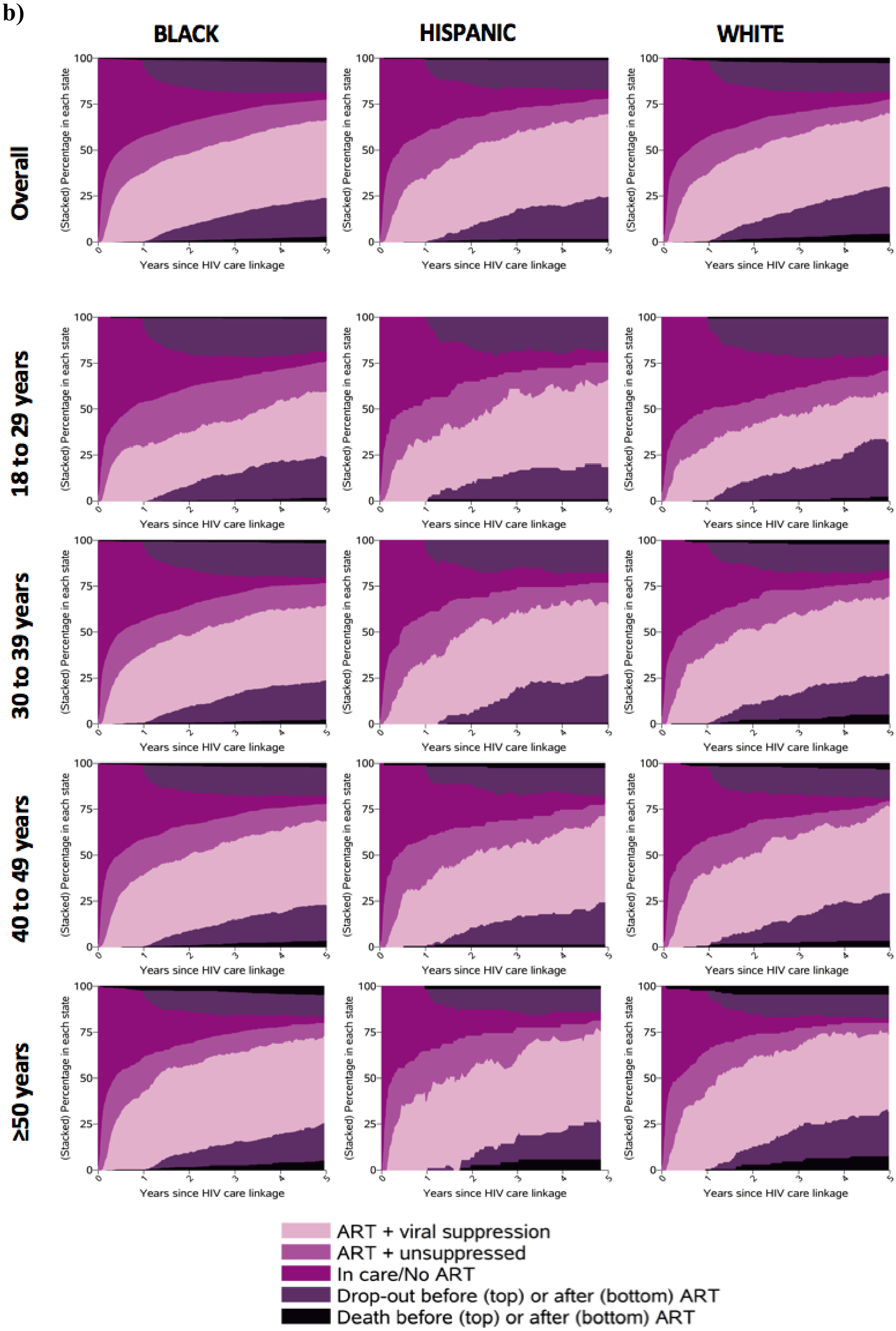
75
50
25
0
0
1
2
3
4
5
Years since HIV care linkage
ART + viral suppression
ART + unsuppressed
In care/No ART
Drop-out before (top) or after (bottom) ART
Death before (top) or after (bottom) ART

b)


BLACK
HISPANIC
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Overall
18 to 29 years
30 to 39 years
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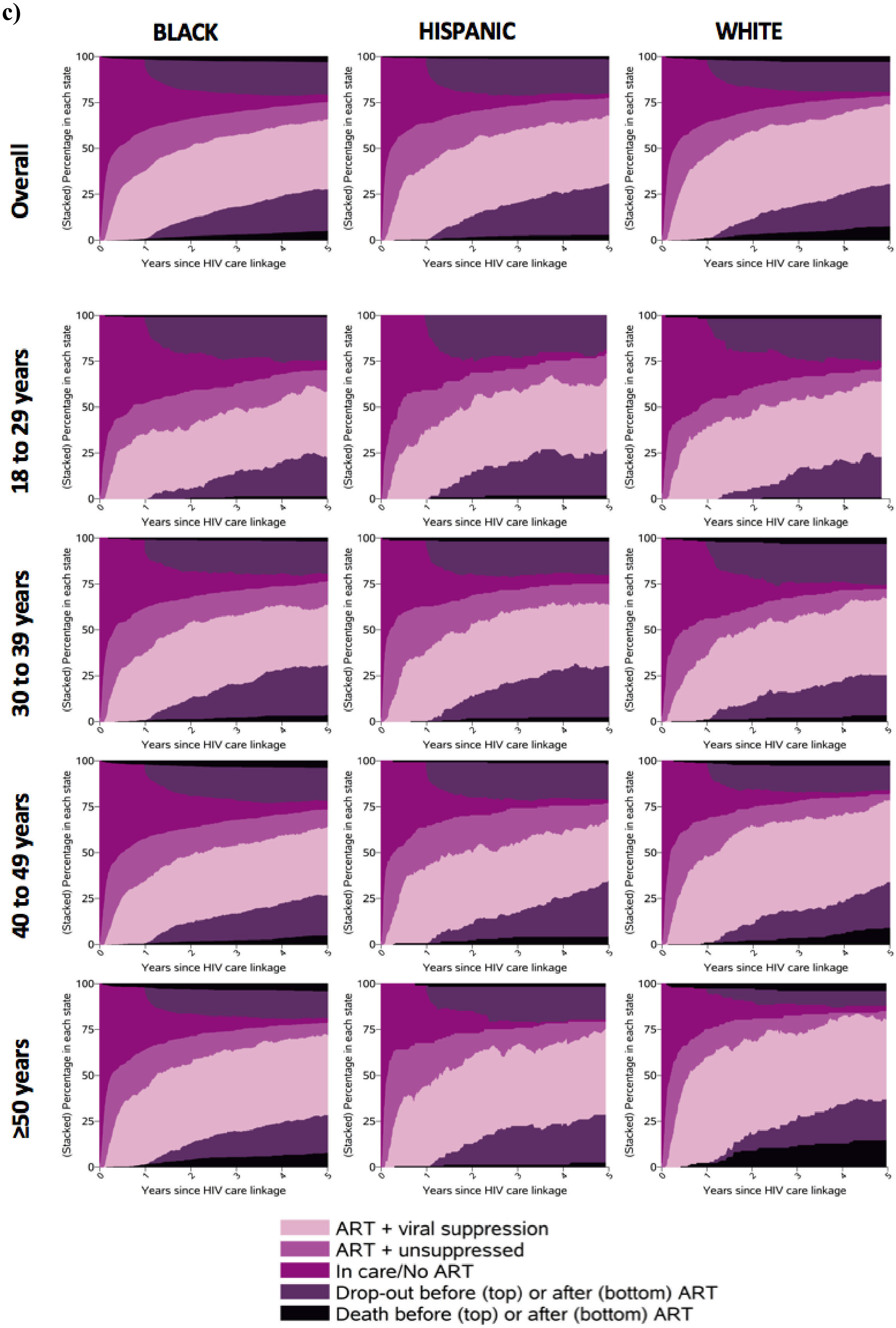
Years since HIV care linkage
ART + viral suppression
ART + unsuppressed
In care/No ART
Drop-out before (top) or after (bottom) ART
Death before (top) or after (bottom) ART

c)


BLACK
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18 to 29 years
30 to 39 years
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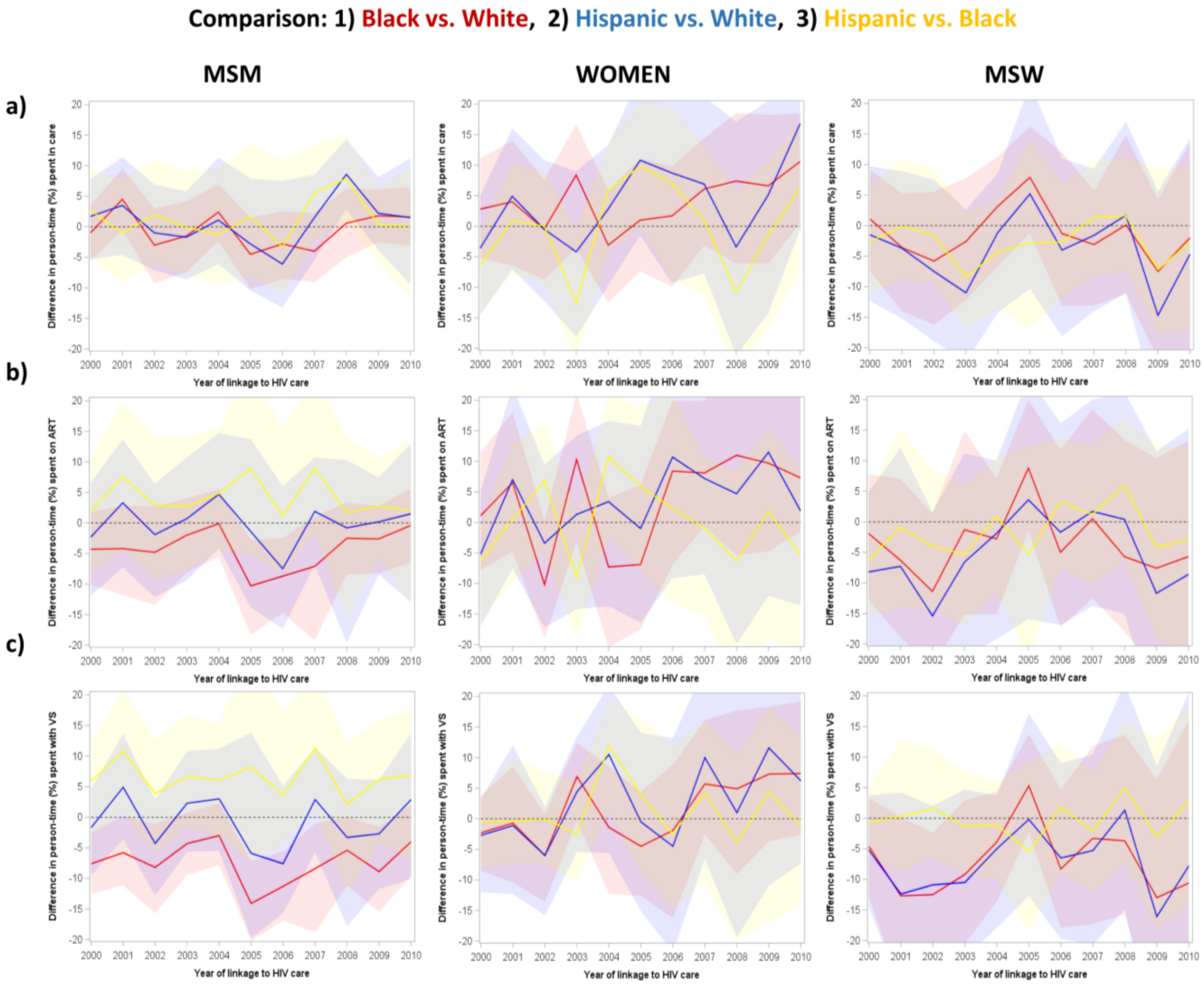
Appendix Figure 4-2. Crude racial differences in the percentage of 1) men who have sex with men, 2) women, and 3) men who have sex with women who were in care (a), on ART (b), and with VS (c) in the first 5 years after HIV care linkage, by year of HIV care linkage, NA-ACCORD, 2000 – 2010



Abbreviations: MSM, male-to-male sexual contact; MSW, men who have sex with women; ART, antiretroviral therapy; VS, viral suppression
Colored bands on the figure represent 95% confidence intervals.

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CHAPTER FIVE

Conclusions

Summary of findings

The release of the NHAS has increased efforts at both local and national levels to identify, link, and treat the most vulnerable populations of PWH.[1] *The preceding chapters of this dissertation have demonstrated potential avenues to inform these efforts and provide additional refinements to achieve the NHAS goals of improving HIV care and reducing disparities.*

Chapter 2 results indicated minimal changes in the proportion of MSM and women that were retained in care over time. In contrast, ART use and viral suppression among MSM and women significantly increased in all age and racial/ethnic groups examined. Racial/ethnic disparities also diminished over time. The Black-white disparity in ART use, for example, decreased among MSM of ages 30 to 49 years. However, some disparities persisted or worsened. Overall, Black MSM had consistently lower percentages of ART use and viral suppression than white MSM over time, with a worsening of this disparity among Black MSM of ages 18 to 29 years. White women also had consistently lower percentages of retention in care than Hispanic women, with a worsening of the disparity over time.

As in Chapter 2, Chapter 3 findings demonstrated that the proportion of PWH that were retained in care changed minimally over time when measured using standard HIV care retention indicators requiring 4 HIV clinical visits in 2 years; however, there was a statistically significant increase in retention in care percentages over time when using a retention measure that required only 2 HIV clinical visits in 2 years. Racial/ethnic differences in retention in care were less apparent using the latter retention measure. All three of the retention measures that were examined showed either a poor or worsening ability over time to correlate with HIV care engagement as determined through viral suppression.

In Chapter 4, we found that age and sex are important modifiers of the magnitude of racial/ethnic differences in the mean person-time spent in care, on ART, and virally suppressed. Among MSM, Blacks particularly of older ages spent less person-time than whites and Hispanics in these three stages of the HIV care continuum. Among women, Hispanics of the youngest and oldest age groups generally spent more person-time than whites yet similar amounts of person-time as Blacks of the same ages in these stages. Among MSW, Blacks generally spent less person-time than whites and similar amounts of person-time as Hispanics in these three stages.

Public health implications

The findings of this dissertation have important implications for public health. Chapters 2 and 4 of this dissertation underscore the need for a continued special focus on Black MSM, who were among the most afflicted by persistent racial/ethnic disparities in HIV care retention, ART use, and viral suppression. Our results indicate that the NHAS goal of eliminating racial/ethnic disparities among MSM, particularly disparities related to viral suppression, is not being met despite the added emphasis on this population. Chapters 2 and 4 also identified white women as a vulnerable population. Interestingly, this group has not been specifically named by the NHAS as a key population nor has it been the focus of previous disparities research.[1] Our findings indicate that young white women, in addition to Black MSM, should receive special attention with regards to achieving NHAS goals due lower levels of HIV care retention, ART use, and viral suppression relative to Hispanic women. Even though white women represent a minority of the total population of PWH in the US,[2] a directed focus would ensure that this population of PWH is not left behind as more progress is made over time towards achieving NHAS goals. Future studies should be dedicated to investigating factors influencing poorer HIV care outcomes in this understudied population.

The results for this dissertation call for intensified design, deployment, and evaluation of interventions and strategies that curtail these disparities. Such interventions must be expressly nuanced by taking into consideration important differences in racial/ethnic disparities according to age group, sex, and among men, sexual HIV acquisition. A more targeted and potentially effective approach, for example, would include specifically tailoring interventions to address the unique health needs and barriers confronting white women of ages 18 to 29 years, who experience suboptimal HIV care continuum outcomes relative to young Hispanic women. Similarly, to reduce disparities in these outcomes among MSM, intensifying efforts targeted to older Black MSM may be necessary.

A notable finding of Chapters 2, 3, and 4 is that, except for viral suppression among Hispanic MSM, Hispanic PWH generally experienced similar, if not better HIV care continuum outcomes than white PWH. However, a multitude of research studies has demonstrated inferior HIV care outcomes among Hispanics.[3–7] As discussed in Chapter 2, there is substantial heterogeneity in factors that may influence HIV care continuum disparities among Hispanics and account for mixed research findings. These factors include differing acculturation levels, migration patterns, and language differences.[8–10] Foreign-born Hispanics, for example, face socio-political marginalization and psychosocial barriers to healthcare that may not be as prevalent in other populations.[11,12] With regards to continuing disparities research, our findings confirm the notion that the term “Hispanic” should no longer be considered sufficiently descriptive on its own.[13] Whenever possible, data collection and subsequent demographic descriptions of Hispanic study populations in HIV research must include information on factors such as country of origin, English language ability, citizenship status, and time spent living in the US (if foreign-born), among others.[13] This additional level of description would provide the necessary insight into the composition of Hispanic study populations at hand needed to help pinpoint causes for mixed findings in HIV disparities research. More important, it would refine the design and potentially enhance the effectiveness of interventions tailored specifically to subgroups of PWH within the Hispanic population with unique HIV care needs.

The most recent year of data available in the NA-ACCORD at the time the analyses of this dissertation were conducted was 2014. The six years between 2014 and 2020, the proposed year for achievement of NHAS goals, indicate that additional changes to HIV care continuum outcomes and associated racial/ethnic disparities are certainly possible. Given the persistent disparities up through 2014 that have been identified in this dissertation, the ongoing monitoring of progress in improving HIV care continuum outcomes and reducing racial/ethnic disparities in key populations with the most recent data will be critical.

With regards to tracking progress specifically in retention care, results from Chapters 2 and 3 indicate that current visit frequency-based measures of retention may not be the most appropriate to track this progress likely due to temporal changes in HIV clinical practice. As clinical practice and guidelines continue to change, retention in care measures must continue to be scrutinized given that these measures may lose their value in the progression from retention in care to consistent ART use to subsequent viral suppression if they do not correlate with viral suppression (the ultimate goal of the HIV care continuum and measure of HIV care engagement). An eventual departure away from these measures towards ones that are more reflective of HIV care engagement may be necessary. Such measures may incorporate the use of missed visits and non-traditional markers of HIV care engagement. Where the requisite longitudinal data and statistical resources are available, measuring person-time spent in care, as done Chapter 4, may also be a more suitable approach. Given our findings that the specific measure of retention in care used factors into estimated racial/ethnic differences, special considerations of the effect of retention measures on observed racial/ethnic disparities are necessary in the development and use of novel measures.

Additional limitations and strengths

In addition to the limitations discussed in the preceding three chapters, several other limitations to this research should be considered. First, the NA-ACCORD study population consists of PWH that successfully linked into HIV care following an HIV diagnosis. Thus, our findings may not be generalizable to individuals with undiagnosed

HIV or individuals with diagnosed HIV but who have not linked into care. These PWH—who may potentially transmit HIV more readily due to unrecognized and untreated infection—are of paramount importance with regards to NHAS goals, as linking these individuals to care and treatment would prevent a substantial proportion of new HIV infections.[14] However, the outcomes investigated in this dissertation do not apply to such PWH. That is, "never-linked" individuals cannot be retained in care, on ART, and virally suppressed, since, by definition, these outcomes each require prior HIV care linkage[15] (save for viral suppression among elite controllers, who represent the <1% of PWH that may have a suppressed viral load without receiving treatment).[16,17] Further, by having successfully linked into HIV care, the NA-ACCORD study population may consist of PWH with greater access to clinical services, limiting our ability to generalize study findings to PWH with less access to care. It is possible that patterns of racial/ethnic differences in retention in care, ART use, and viral suppression may differ in the setting of reduced access to care. Other data sources have attempted to generate more representative samples of PWH with these characteristics;[18,19] however, these data sources are of cross-sectional design and lack the NA-ACCORD's geographic diversity.

The NA-ACCORD proves a useful source of data for the aims investigated in this dissertation given its overall representativeness (demonstrated both in a previous study[20] and in Chapter 2), its longitudinal design, and large sample of PWH that have linked to care (i.e., the target population of this dissertation). Despite the NA-ACCORD's large size, we were unable to examine racial/ethnic disparities by stratifying by additional key factors that are implicated in the HIV care continuum, such as injection drug use and transgender identity, due to small samples. Although persons who inject drugs and transgender individuals comprise a smaller proportion of all PWH in the US, these individuals are also less likely both to link into and stay in HIV clinical care and may thus have been underrepresented in our sample.[21,22] We were also unable to examine disparities stratified by US geographic region due to small samples of PWH living in the Midwest. Concerted efforts are necessary for future research to include and focus on these underrepresented, yet crucial populations to ensure racial/ethnic disparities are adequately scrutinized.

Further, validated information on several characteristics that influence HIV care continuum outcomes are not routinely collected by the NA-ACCORD. Individual-level factors include socioeconomic status, education level, housing status, and active substance abuse. Structural-level (i.e., perceived community-level HIV stigma and discrimination) and clinic-level (i.e., availability of culturally sensitive services and provider communication ability) factors are also not collected. Since race/ethnicity, age, and sex are non-modifiable characteristics, examination of these factors may provide additional insight into ways that HIV care continuum outcomes can be intervened upon to reduce differences by these characteristics within key populations. Lastly, engagement in steps of the HIV care continuum has been shown to improve during pregnancy among women with HIV yet decline in the postpartum period.[23–25] Since the NA-ACCORD currently does not collect pregnancy information, it was not possible to determine the proportion of women with HIV that were and were not pregnant during study follow-up.

Future directions

The studies comprising this dissertation will serve to guide the development of clinical and public health strategies aimed at reducing disparities in the HIV care continuum among MSM, women, and MSW. Future studies are needed to extend our work to other important populations, such as persons who inject drugs, transgender women, residents of the Southern US, and PWH of mixed race. More research is needed to describe disparities with better granularity in these understudied populations.

Qualitative research studies that can better target the root causes of disparities in HIV care for each population of concern may be conducted. Two qualitative studies, for instance, have documented the prominence of unique barriers to linkage to and retention in HIV care among Hispanic PWH, such as lack of Spanish-speaking providers, difficulty navigating the complicated healthcare system, perceived fear of deportation among undocumented Hispanics, and community-level stigma surrounding HIV.[26,27] Additional qualitative studies should examine other specific key populations in additional HIV care continuum steps.

Since the adoption of the HIV care continuum as a conceptual framework for assessments of HIV care quality, the use of "care continua" has grown in popularity to conceptualize the spectrum of care and treatment that is characteristic of other disease processes, including diabetes, hypertension, and cancer.[28–30] The cancer care continuum, for instance, can be described as the following series of steps: 1) risk assessment, 2) primary prevention, 3) detection, 4) diagnosis, 4) cancer or precursor treatment, 5) post-treatment survivorship, and 6) end-of-life care.[28] The use of these care continua has subsequently led to the identification of patterns of racial/ethnic disparities similar to those observed in the HIV care continuum. Previous studies, for example, have noted inferior hypertension care continuum outcomes (i.e., hypertension prevalence, awareness, treatment, and control) among Blacks and Hispanics relative to whites, despite overall improvements in hypertension care over time.[29,31,32] Similar patterns of racial/ethnic disparities across various care continua may reflect broader, more systemic contributors to health inequities, such as social inequality and racial discrimination.[33] Identifying interventions that address these factors and effectively reduce disparities in HIV care may subsequently better inform the development of interventions tailored to other diseases processes, and vice versa.

With regards to measures of retention in care, formal discussions between HIV care providers and HIV epidemiologists about the development of novel measures are needed. These discussions should entail agreeing upon practical, clinically relevant, and effective ways to measure HIV care retention amidst changes in HIV clinical practice in the US. To develop retention measures that specifically use unconventional markers of HIV care engagement (e.g., phone calls or emails), it would be vital from a clinical standpoint to make concerted efforts to improve documentation of such markers on medical records. Studies should test these refined retention measures against traditional ones to determine the extent of their ability to describe HIV care engagement.

Lastly, this research provided invaluable insight into HIV care in key populations that were within the first 5 years of first-time HIV care linkage. It demonstrated that this time period is a distinct, critical time during which to successfully enable PWH to achieve stable viral suppression. It may be necessary to develop and adopt novel HIV care continuum frameworks that measure HIV care quality after the first 5 years and after stable viral suppression has been achieved.

Final conclusions

In conclusion, this dissertation documents both successes and continued failures in efforts to reduce racial/ethnic disparities in the HIV care continuum. The drivers of disparities in HIV care are exceedingly complex, and more research and public health efforts are needed to deliver excellent, equitable HIV care and achieve the ultimate goal of HIV viral suppression for all PWH in the US. Although no simple solutions are readily available to resolve these issues, the results of this dissertation provide a meaningful framework with which to guide these efforts and ultimately achieve the 2020 NHAS goals of improving HIV care and reducing disparities.

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PUBLICATIONS

Desir FA, Lesko CR, Moore RD, Horberg, MA, Wong C, Crane H, Silverberg MJ, Thorne JE, Rachlis B, Rabkin C, Mayor AM, Mathews WC, and Althoff KN. One size fits (n)one: The impact of sex, age, and sexual HIV acquisition risk on racial/ethnic disparities in the HIV care continuum in the United States. *Submitted.*

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Desir FA, Lesko CR, Moore RD, Horberg MA, Rebeiro PF, Gill MJ, Kitahata M, Silverberg MJ, Levison JH, Klein M, Mayor AM, Justice AC, and Althoff KN. Trends in unsuppressed HIV RNA after linkage to care among key populations. Poster presentation at the *Conference on Retroviruses and Opportunistic Infections*. Boston, Massachusetts, USA. March 2018.

Desir FA, Lesko CR, Moore RD, Silverberg MJ, Rebeiro PF, Horberg MA, Kitahata M, Crystal S, Mayor AM, Klein M, Justice AC, Gill MJ, and Althoff KN. Age-dependent racial/ethnic disparities in longitudinal HIV care indicators. Poster presentation at the *Conference on Retroviruses and Opportunistic Infections*. Boston, Massachusetts, USA. March 2018.

Althoff KN, Hogan B, Wong C, **Desir FA**, Modur S, Jing Y, Zhang J, and You B. Using observation windows for improving ascertainment assumptions in clinical cohort studies: Illustration of ascertaining diabetes outcomes. Poster presentation at the 21st *International Workshop on HIV and Hepatitis Observational Databases*. Lisbon, Portugal. March 2017.

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