Retention in HIV Care and Viral Suppression: Individual- and Neighborhood-Level Predictors of Racial/Ethnic Differences, Florida, 2015

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Abstract

The objective of this study was to estimate racial/ethnic differences in retention in HIV care and viral suppression and to identify related individual and neighborhood determinants. Florida HIV surveillance records of cases aged ≥ 13 years diagnosed during the years 2000–2014 were analyzed. Retention in care was defined as evidence of ≥ 2 or more laboratory tests, receipts of prescription, or clinical visits at least 3 months apart during 2015. Viral load suppression was defined as a viral load of < 200 copies/mL for the last test in 2015. Multi-level logistic regressions were used to estimate adjusted odds ratios (AORs). Of 65,735 cases, 33.3% were not retained in care, and 40.1% were not virally suppressed. After controlling for individual and neighborhood factors, blacks were at increased odds of nonretention in HIV care [AOR 1.29, 95% confidence interval (CI) 1.23–1.35] and nonviral suppression (AOR 1.55, 95% CI 1.48–1.63) compared with whites. Black and Latino males compared with their female counterparts had higher odds of nonretention and nonviral suppression. Compared with their US-born counterparts, foreign-born blacks and whites, but not Latinos, had higher odds of nonretention and nonviral suppression. Blacks and whites in urban compared with rural areas had higher odds of both outcomes. Disparities in retention in care and viral suppression persist and are not accounted for by differences in age, sex, transmission mode, AIDS diagnosis, neighborhood socioeconomic status, rural/urban residence, or neighborhood racial composition. Further, predictors of poor retention in care and viral suppression appear to differ by race/ethnicity.

Keywords: human immunodeficiency virus, retention in care, viral suppression, treatment cascade, neighborhood

Introduction

THE United States (US) National HIV/AIDS Strategy (NHAS) calls for supporting retention in HIV care to achieve viral suppression and for reducing HIV-related health disparities.¹ Recent reports using National HIV Surveillance System (NHSS) data from 11 states and the District of Columbia suggest that the proportion of non-Latino blacks (37.7%) who are consistently retained in HIV care (two or more CD4+ or viral load tests, three or more months apart in each of 3 years) is lower than among non-Latino whites (48.6%) and Latinos (49.5%).² Further, viral suppression among individuals in HIV care in the US is also lower among blacks (28%) than among whites (32%) and Latinos (31%).³

Missed HIV clinic appointments have been associated with nearly three times the hazard for mortality when compared with no missed visits.^{4,5} Similar findings have been reported with data from the Veterans Healthcare Administration where retention in care was independently associated with survival.⁶ Retention in care has also been associated with receipt of antiretroviral treatment and adherence,⁷ has been found to be important in achieving and maintaining viral suppression,^{8,9} and is predicted to avert the greatest number of infections and save the most US dollars per quality-adjusted life-year than any other level on the continuum of HIV care.¹⁰ Viral suppression has been associated with immunologic improvement and preservation^{11,12} and decreased risk of HIV transmission.¹³

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Numerous studies have examined retention in HIV care and viral suppression to both estimate retention in care for various racial/ethnic groups and examine predictors for the general HIV population. However, we were unable to identify population-based studies that examined the contribution of individual- and neighborhood-level characteristics to racial/ethnic disparities in retention in HIV care and viral suppression. Therefore, the objectives of this study were to (a) estimate racial/ethnic disparities in retention in HIV care and viral suppression, (b) estimate the contribution of individual- and neighborhood-level characteristics on racial/ethnic disparities, and (c) identify specific individual- and neighborhood-level determinants of retention in HIV care and viral suppression among racial/ethnic groups.

Methods

Datasets

Deidentified HIV surveillance records were obtained from the Florida Department of Health (FDOH) enhanced HIV/AIDS reporting system (eHARS). Cases aged ≥ 13 years who met the Centers for Disease Control and Prevention (CDC) HIV case definition¹⁴ during the years 2000–2014, had Florida as the most current state of residence, and were alive at the end of 2015 were analyzed. Cases with missing data on retention in HIV care during 2015, missing or invalid data for current ZIP code, a reported current ZIP code with a population of zero based on American Community Survey (ACS), and cases diagnosed in a correctional facility were excluded. The 2009–2013 ACS was used to obtain neighborhood-level data using ZIP code tabulation areas (ZCTAs).¹⁵ ZCTAs are used by the US Census Bureau to tabulate summary statistics and approximate US postal service ZIP codes.¹⁶

Individual-level variables

The following individual-level data were extracted from eHARS: ethnicity, race, HIV diagnosis year, sex at birth, age at HIV diagnosis, birth country, HIV transmission mode, AIDS diagnosis (if case progressed to AIDS by December 31, 2015), year of death, engagement in HIV care during 2015, retention in HIV care during 2015, HIV viral load suppression during 2015, current residential ZIP code, and whether the person was diagnosed at a correctional facility.

Retention in care during 2015 was defined as evidence of engagement in care two or more times at least 3 months apart during 2015. Engagement in care was defined and calculated by the FDOH on all persons diagnosed with HIV in Florida as having at least one laboratory test, a prescription fill through the AIDS Drug Assistance Program (ADAP; for those in ADAP), or physician visit documented in one of the Ryan White databases (for those in receiving services through the Ryan White HIV/AIDS program). HIV viral load suppression during 2015 was also defined and calculated by the FDOH as having a viral load of < 200 copies/mL in the last laboratory test performed during 2015. The last viral load test during the measurement year is used by the US Department of Health and Human Services HIV/AIDS Bureau to measure program performance.¹⁷

The mode of HIV transmission was self-reported during HIV testing, reported by a healthcare provider, or extracted

from medical chart reviews. Cases were coded as US-born if they were born in any of the 50 states, District of Columbia, Puerto Rico, or any US-dependent territory.

Neighborhood-level variables

Thirteen neighborhood-level socioeconomic status (SES) indicators were extracted from the ACS to develop an SES index of Florida neighborhoods (ZCTAs)¹⁸: percent of households without access to a car, percent of households with ≥ 1 person per room, percent of population living below the poverty line, percent of owner-occupied homes worth $\geq \$300,000$, median household income in 2013, percent of households with annual income $< \$15,000$, percent of households with annual income $\geq \$150,000$, income disparity (derived from percent of households with annual income $< \$10,000$ and percent of households with annual income $\geq \$50,000$), percent of population aged ≥ 25 with less than a 12th grade education, percent of population aged ≥ 25 with a graduate professional degree, percent of households living in rented housing, percent of population aged ≥ 16 years who were unemployed, and percent of population aged ≥ 16 years employed in high working class occupation (ACS occupation group: managerial, business, science, and arts occupations).

Income disparity was used as a proxy for the Gini coefficient. The Gini coefficient is a measure of a society's income inequality and quantifies the degree of concentration in income distribution (e.g., whether wealth is concentrated among only a few people or distributed evenly).¹⁹ Income disparity was calculated as the logarithm of 100 times the percent of households with annual income $< \$10,000$ divided by the percent of households with annual income $\geq \$50,000$. All neighborhood-level indicators were coded so that higher scores corresponded with lower SES (higher disadvantage); they were then standardized.

To calculate the SES index, we started by conducting a reliability analysis. Cronbach's alpha for all 13 indicators was 0.93. We selected seven indicators based on the correlation of the indicator with the total index (high correlation) and Cronbach's alpha if the item was deleted (low alpha). The seven indicators selected were percent below poverty, median household income, percent of households with annual income $< \$15,000$, percent of households with annual income $\geq \$150,000$, income disparity, percent of population aged ≥ 25 with less than a 12th grade education, and high-class work. The resulting Cronbach's alpha increased (0.94).

Second, we conducted a principal component analysis (PCA) with and without varimax rotation. The goal of PCA is to explain the maximum amount of variance with the fewest number of variables.²⁰ PCA revealed one component, which accounted for 73.49% of the variability in the indicators. Because all the original variables were highly correlated with the component (factor loadings between 0.80 and 0.93), we retained all seven indicators. Finally, we added the standardized scores for the seven variables and categorized the scores into quartiles.

Black segregation has been linked to HIV outcomes in a previous Florida study.²¹ Because segregation indices are not normally calculable for nonmetropolitan areas, we extracted the percent of the population who identified themselves as non-Latino black from the ACS to describe racial composition of neighborhoods, consistent with previous studies.^{22–25}

To categorize ZCTAs into rural or urban, we used Categorization C of Version 2.0 of the rural–urban commuting area (RUCA) codes developed by the University of Washington WWAMI Rural Research Center.²⁶

Statistical analyses

Individual- and neighborhood-level data were merged by matching the current ZIP code of each case with the ZIP

code's corresponding ZCTA. First, we compared individual- and neighborhood-level characteristics by race/ethnicity. We used the Cochran–Mantel–Haenszel general association statistic for individual-level variables controlling for ZCTA, and the chi-square test for neighborhood-level variables.

Second, we estimated crude and adjusted odds ratios and 95% confidence intervals for nonretention in care during 2015 and nonviral suppression during 2015, comparing cases by race/ethnicity. Multi-level (Level 1: individual; Level 2:

TABLE 1. CHARACTERISTICS OF INDIVIDUALS AGED 13 YEARS AND OLDER DIAGNOSED WITH HIV IN FLORIDA, 2000–2014

	Total, n (%)	Non-Latino black, n (%)	Latino, n (%)	Non-Latino white, n (%)	Other, n (%)
Total ^a	65,735	31,415	15,766	17,194	1360
Individual-level variables ^b					
Year of HIV diagnosis					
2000–2003	17,351 (26.4)	8916 (28.4)	3707 (23.5)	4349 (25.3)	379 (27.9)
2004–2007	16,476 (25.1)	7619 (24.3)	3830 (24.3)	4685 (27.3)	342 (25.2)
2008–2011	15,924 (24.2)	7784 (24.8)	3703 (23.5)	4137 (24.1)	300 (22.1)
2012–2014	15,984 (24.3)	7096 (22.6)	4526 (28.7)	4023 (23.4)	339 (24.9)
Sex					
Female	19,076 (29.0)	13,305 (42.4)	2710 (17.2)	2687 (15.6)	374 (27.5)
Male	46,659 (71.0)	18,110 (57.7)	13,056 (82.8)	14,507 (84.4)	986 (72.5)
Age group at diagnosis					
13–24 years	10,227 (15.6)	6338 (20.2)	2082 (13.2)	1558 (9.1)	249 (18.3)
25–49 years	44,790 (68.1)	19,958 (63.5)	11,588 (73.5)	12,288 (71.5)	956 (70.3)
50 years or older	10,718 (16.3)	5119 (16.3)	2096 (13.3)	3348 (19.5)	155 (11.4)
US- vs. foreign-born					
US-born	45,721 (69.6)	23,740 (75.6)	5942 (37.7)	15,174 (88.3)	865 (63.6)
Foreign-born	20,014 (30.5)	7675 (24.4)	9824 (62.3)	2020 (11.8)	495 (36.4)
Mode of HIV transmission					
IDU ^c	4811 (7.3)	2107 (6.7)	983 (6.2)	1618 (9.4)	103 (7.6)
MSM	31,107 (47.3)	8839 (28.1)	9763 (61.9)	11,811 (68.7)	694 (51.0)
Heterosexual	24,172 (36.8)	17,346 (55.2)	3712 (23.5)	2657 (15.5)	457 (33.6)
Other	5645 (8.6)	3123 (9.9)	1308 (8.3)	1108 (6.4)	106 (7.8)
AIDS ^d					
Yes	29,144 (44.3)	15,220 (48.5)	6282 (39.9)	6967 (40.5)	675 (49.6)
No	36,591 (55.7)	16,195 (51.6)	9484 (60.2)	10,227 (59.5)	685 (50.4)
ZCTA-level variables ^e					
SES index, quartiles					
1 (lowest SES)	27,226 (41.4)	17,033 (54.2)	6079 (38.6)	3655 (21.3)	459 (33.8)
2	17,178 (26.1)	8320 (26.5)	3710 (23.5)	4809 (28.0)	339 (24.9)
3	13,552 (20.6)	3981 (12.7)	3979 (25.2)	5250 (30.5)	342 (25.2)
4 (highest SES)	7779 (11.8)	2081 (6.6)	1998 (12.7)	3480 (20.2)	220 (16.2)
RUCA classification					
Rural	2319 (3.5)	1165 (3.7)	286 (1.8)	828 (4.8)	40 (2.9)
Urban	63,416 (96.5)	30,250 (96.3)	15,480 (98.2)	16,366 (95.2)	1320 (97.1)
Percent non-Latino black					
0–24%	36,370 (55.3)	10,546 (33.6)	11,696 (74.2)	13,304 (77.4)	824 (60.6)
25–49%	14,055 (21.4)	8800 (28.0)	2408 (15.3)	2546 (14.8)	301 (22.1)
50% or greater	15,310 (23.3)	12,069 (38.4)	1662 (10.5)	1344 (7.8)	235 (17.3)

Percentages may not add up to 100 due to rounding.

^aTotals are based on people who were alive in 2015 and had a current residential ZIP code in Florida and exclude cases diagnosed in a correctional facility ($n=2553$), cases with missing or invalid current ZIP code ($n=2075$), cases with current ZIP code with a total population of zero based on ACS estimates ($n=27$), cases diagnosed at <13 years of age ($n=463$), and cases missing retention in care data ($n=3$).

^bCochran–Mantel–Haenszel general association statistic was used to compare individual-level variables by race/ethnicity controlling for ZCTA. All comparisons were significant with a p value <0.0001.

^cIncludes those with a reported mode of HIV transmission as MSM and IDU.

^dMet AIDS definition by December 31, 2015.

^eChi-square test was used to compare neighborhood-level variables by race/ethnicity. All comparisons were significant with a p value <0.0001.

ACS, American Community Survey; AIDS, acquired immunodeficiency virus; HIV, human immunodeficiency virus; IDU, injection drug use; MSM, men who have sex with men; RUCA, rural–urban commuting area; SES, socioeconomic status; ZCTA, ZIP code tabulation area.

neighborhood) logistic regression modeling was used to account for correlation among cases living in the same neighborhood. To estimate the contribution of individual and neighborhood factors on racial/ethnic disparities, we first estimated crude ORs (Model 1), followed by ORs controlled for individual factors (Model 2), and finally ORs controlled for both individual and neighborhood factors (Model 3).

Finally, to identify unique predictors of nonretention in care and nonviral suppression for each group, separate fully adjusted models (Model 3) were estimated stratifying by race/ethnicity. Odds ratios were calculated for year of HIV diagnosis, sex, age, US/foreign-born status, mode of HIV transmission, AIDS diagnosis before 2016, neighborhood SES (index of seven indicators), rural/urban status, and percent non-Latino black in the neighborhood. SAS software, version 9.4 (SAS Institute, Cary, NC, 2002), was used to conduct analyses. The Florida International University Institutional Review Board approved this study, and the Florida Department of Health Institutional Review Board designated this study to be nonhuman subjects research.

Results

Characteristics of participants

Of 70,783 HIV cases diagnosed in Florida during 2000–2014 who were alive during 2015 and had a current residential ZIP code in Florida, three had missing data on retention in HIV care during 2015, 463 were diagnoses among people <13 years of age, 2075 had missing or invalid data for current ZIP code, 27 had a ZIP code with a total population of zero based on ACS estimates, and 2553 were diagnosed in a correctional facility. Of the remaining 65,735 cases analyzed in this study, 33.3% were not retained in care, 40.1% were not virally suppressed, 47.8% were non-Latino black, 24.0% Latino, 26.2% non-Latino white, and 2.1% other race/ethnicity. The demographic characteristics of those in each racial/ethnic group are reported in Table 1.

Racial/ethnic disparities in retention in HIV care during 2015

In 2015, the proportion of cases not retained in care was higher for blacks (36.3%) and Latinos (32.4%) compared with whites (28.7%) (Table 2). The increased odds of nonretention in care among blacks compared with whites were significant after controlling for individual and neighborhood factors. The significant crude odds of nonretention in care among Latinos compared with whites became nonsignificant after controlling for individual-level variables.

The factors most strongly associated with nonretention in care across all racial/ethnic groups were being diagnosed with HIV during an earlier time period, being diagnosed at ages 13–24 compared with 25 or older, and not having an AIDS diagnosis before 2016 (Table 3). Additionally, being male was a risk factor for blacks and Latinos. Being foreign-born was a risk factor for blacks and whites, but not Latinos. Men who have sex with men as a mode of HIV transmission was a protective factor for blacks, Latinos, and whites. Residing in a rural area was protective for blacks and whites.

Racial/ethnic disparities in HIV viral suppression during 2015

In 2015, the proportion of cases not virally suppressed was higher among blacks (46.5%) and Latinos (36.6%) compared with whites (31.5%) (Table 2). The crude odds ratio for nonviral suppression was significantly higher among blacks and Latinos when compared with whites (Table 2). The disparity remained significant after controlling for both individual and neighborhood factors, although only marginally for Latinos.

Predictors of nonviral suppression were similar to those for nonretention in care for each racial/ethnic group. Males had higher odds of nonviral suppression compared with females among blacks and Latinos (Table 4). Foreign-born had higher

TABLE 2. DIFFERENCES IN RETENTION IN CARE AND VIRAL SUPPRESSION IN 2015 BY RACE/ETHNICITY AMONG INDIVIDUALS AGED 13 YEARS AND OLDER DIAGNOSED WITH HIV 2000–2014 IN FLORIDA

	Total, n	Not retained in care, n (%)	Model 1 Crude OR for nonretention in care (95% CI)	Model 2 Adjusted OR for nonretention in care (95% CI)	Model 3 Adjusted OR for nonretention in care (95% CI)
Retention in care					
Non-Latino black	31,415	11,407 (36.3)	1.42 (1.36–1.48)	1.31 (1.25–1.38)	1.29 (1.23–1.35)
Latino	15,766	5144 (32.4)	1.20 (1.14–1.25)	1.05 (0.99–1.10)	1.00 (0.95–1.06)
Non-Latino white	17,194	4929 (28.7)	Referent	Referent	Referent
Other	1360	428 (31.5)	1.14 (1.01–1.29)	1.09 (0.96–1.24)	1.07 (0.94–1.21)
	Total, n	Not virally suppressed, n (%)	Crude OR for nonviral suppression (95% CI)	Adjusted OR for nonviral suppression (95% CI)	Adjusted OR for nonviral suppression (95% CI)
Viral suppression					
Non-Latino black	31,415	14,616 (46.5)	1.89 (1.82–1.97)	1.66 (1.59–1.74)	1.55 (1.48–1.63)
Latino	15,766	5777 (36.6)	1.26 (1.20–1.32)	1.13 (1.07–1.19)	1.07 (1.02–1.13)
Non-Latino white	17,194	5421 (31.5)	Referent	Referent	Referent
Other	1360	516 (37.9)	1.33 (1.19–1.49)	1.22 (1.08–1.37)	1.17 (1.04–1.32)

Model 1: Crude rates.

Model 2: Controlling for individual-level variables.

Model 3: Controlling for individual-level variables and neighborhood-level variables.

CI, confidence interval; OR, odds ratio.

TABLE 3. ADJUSTED ODDS RATIOS AND 95% CONFIDENCE INTERVALS FOR NONRETENTION IN CARE IN 2015 AMONG INDIVIDUALS DIAGNOSED WITH HIV 2000–2014 AND AGED 13 YEARS AND OLDER, STRATIFIED BY RACE/ETHNICITY, FLORIDA

	<i>Non-Latino black, AOR (95% CI)</i>	<i>Latino, AOR (95% CI)</i>	<i>Non-Latino white, AOR (95% CI)</i>	<i>Other, AOR (95% CI)</i>
Individual-level variables				
Year of HIV diagnosis				
2000–2003	1.68 (1.56–1.80)	2.40 (2.16–2.66)	1.75 (1.57–1.94)	2.30 (1.58–3.34)
2004–2007	1.62 (1.50–1.74)	2.25 (2.03–2.49)	1.51 (1.37–1.67)	1.79 (1.23–2.60)
2008–2011	1.42 (1.32–1.53)	1.57 (1.42–1.74)	1.33 (1.20–1.48)	1.86 (1.29–2.68)
2012–2014	Referent	Referent	Referent	Referent
Sex				
Female	Referent	Referent	Referent	Referent
Male	1.40 (1.31–1.48)	1.38 (1.23–1.56)	1.10 (0.89–1.15)	0.78 (0.54–1.14)
Age group at diagnosis				
13–24 years	Referent	Referent	Referent	Referent
25–49 years	0.72 (0.68–0.77)	0.74 (0.66–0.82)	0.70 (0.62–0.79)	0.68 (0.50–0.94)
50 years or older	0.56 (0.51–0.61)	0.61 (0.53–0.70)	0.55 (0.48–0.63)	0.74 (0.47–1.19)
US- vs. foreign-born				
US-born	Referent	Referent	Referent	Referent
Foreign-born	1.28 (1.20–1.36)	1.07 (0.99–1.16)	1.40 (1.26–1.56)	1.33 (1.02–1.74)
Mode of HIV transmission				
IDU	0.92 (0.83–1.02)	1.10 (0.94–1.29)	1.09 (0.94–1.26)	1.37 (0.82–2.29)
MSM	0.75 (0.70–0.81)	0.65 (0.58–0.73)	0.83 (0.72–0.94)	1.30 (0.89–1.90)
Heterosexual	Referent	Referent	Referent	Referent
Other	2.72 (2.50–2.96)	3.06 (2.65–3.52)	2.76 (2.36–3.24)	2.97 (1.83–4.83)
AIDS ^a				
Yes	Referent	Referent	Referent	Referent
No	3.09 (2.93–3.26)	1.87 (1.73–2.01)	1.75 (1.63–1.89)	1.86 (1.44–2.41)
ZCTA-level variables				
SES index, quartiles				
1 (lowest SES)	0.96 (0.84–1.11)	0.98 (0.83–1.16)	1.02 (0.88–1.19)	0.72 (0.45–1.13)
2	0.90 (0.79–1.03)	0.92 (0.78–1.08)	0.90 (0.79–1.03)	0.45 (0.29–0.71)
3	0.97 (0.85–1.12)	0.98 (0.83–1.15)	0.93 (0.82–1.05)	0.69 (0.46–1.04)
4 (highest SES)	Referent	Referent	Referent	Referent
RUCA classification				
Rural	0.64 (0.54–0.76)	0.92 (0.69–1.24)	0.73 (0.60–0.89)	0.48 (0.20–1.12)
Urban	Referent	Referent	Referent	Referent
Percent non-Latino black				
0–24%	Referent	Referent	Referent	Referent
25–49%	1.04 (0.94–1.15)	1.00 (0.86–1.18)	0.98 (0.84–1.13)	1.20 (0.82–1.76)
50% or greater	1.00 (0.89–1.13)	1.07 (0.88–1.30)	1.14 (0.94–1.39)	0.83 (0.52–1.33)

Models adjusted for all variables in the column.

^aMet AIDS case definition by December 31, 2015.

AIDS, acquired immunodeficiency virus; AOR, adjusted odds ratio; CI, confidence interval; HIV, human immunodeficiency virus; IDU, injection drug use; MSM, men who have sex with men; RUCA, rural–urban commuting area; SES, socioeconomic status; ZCTA, ZIP code tabulation area.

odds among blacks and whites. Having a reported mode of HIV transmission as a history of injection drug compared with heterosexual contact was a risk factor for nonviral suppression for Latinos and whites. A mode of transmission of men who have sex with men was a protective factor for blacks, Latinos, and whites. As with retention in care, rural residence was protective for blacks and whites.

Discussion

During 2015, 33% of individuals diagnosed with HIV in Florida between 2000 and 2014, who met our inclusion criteria, and who were alive in 2015 were not retained in care, and 40% were not virally suppressed. Nonretention in care

and nonviral suppression were more likely among blacks compared with whites even after adjusting for individual and neighborhood factors. The strongest predictor of nonretention in care and nonviral suppression among all racial/ethnic groups was a lack of an AIDS diagnosis. Black and Latino males compared with their female counterparts were at increased risk of nonretention in care and nonviral suppression, while black and white foreign-born individuals were at increased risk. Men who have sex with men were at decreased risk of nonretention in care and nonviral suppression among blacks, Latinos, and whites. Finally, black and white individuals living in urban compared with rural areas appear to be at increased risk of both nonretention in care and nonviral suppression.

TABLE 4. ADJUSTED ODDS RATIOS AND 95% CONFIDENCE INTERVALS FOR NONVIRAL SUPPRESSION IN 2015 AMONG INDIVIDUALS DIAGNOSED WITH HIV 2000–2014 AND AGED 13 YEARS AND OLDER, STRATIFIED BY RACE/ETHNICITY, FLORIDA

	<i>Non-Latino black, AOR (95% CI)</i>	<i>Latino, AOR (95% CI)</i>	<i>Non-Latino white, AOR (95% CI)</i>	<i>Other, AOR (95% CI)</i>
Individual-level variables				
Year of HIV diagnosis				
2000–2003	1.36 (1.27–1.45)	1.80 (1.63–1.98)	1.50 (1.36–1.66)	1.60 (1.14–2.26)
2004–2007	1.37 (1.28–1.47)	1.70 (1.54–1.87)	1.27 (1.16–1.40)	1.32 (0.94–1.87)
2008–2011	1.27 (1.19–1.36)	1.23 (1.11–1.35)	1.16 (1.05–1.28)	1.64 (1.17–2.30)
2012–2014	Referent	Referent	Referent	Referent
Sex				
Female	Referent	Referent	Referent	Referent
Male	1.29 (1.22–1.37)	1.26 (1.12–1.41)	0.90 (0.79–1.01)	0.91 (0.65–1.29)
Age group at diagnosis				
13–24 years	Referent	Referent	Referent	Referent
25–49 years	0.60 (0.57–0.64)	0.62 (0.56–0.69)	0.63 (0.56–0.70)	0.58 (0.43–0.78)
50 years or older	0.44 (0.41–0.48)	0.49 (0.43–0.56)	0.47 (0.41–0.53)	0.71 (0.46–1.10)
US- vs. foreign-born				
US-born	Referent	Referent	Referent	Referent
Foreign-born	1.20 (1.13–1.27)	1.02 (0.95–1.10)	1.30 (1.17–1.44)	1.07 (0.83–1.38)
Mode of HIV transmission				
IDU	1.01 (0.92–1.12)	1.19 (1.02–1.39)	1.35 (1.18–1.54)	1.28 (0.80–2.04)
MSM	0.77 (0.71–0.82)	0.65 (0.58–0.72)	0.78 (0.68–0.88)	0.88 (0.62–1.24)
Heterosexual	Referent	Referent	Referent	Referent
Other	2.08 (1.91–2.26)	2.62 (2.28–3.02)	2.29 (1.96–2.67)	2.24 (1.41–3.56)
AIDS ^a				
Yes	Referent	Referent	Referent	Referent
No	1.96 (1.87–2.06)	1.47 (1.37–1.59)	1.45 (1.35–1.56)	1.49 (1.17–1.89)
ZCTA-level variables				
SES, quartiles				
1 (lowest SES)	1.11 (0.98–1.26)	1.16 (0.99–1.36)	1.11 (0.97–1.27)	0.75 (0.50–1.15)
2	1.01 (0.89–1.14)	1.03 (0.88–1.22)	0.97 (0.86–1.09)	0.48 (0.31–0.73)
3	1.03 (0.91–1.17)	1.05 (0.90–1.23)	0.96 (0.86–1.08)	0.82 (0.57–1.20)
4 (highest SES)	Referent	Referent	Referent	Referent
RUCA classification				
Rural	0.65 (0.56–0.75)	0.97 (0.73–1.28)	0.81 (0.68–0.97)	0.81 (0.40–1.65)
Urban	Referent	Referent	Referent	Referent
Percent non-Latino black				
0–24%	Referent	Referent	Referent	Referent
25–49%	1.08 (0.99–1.17)	1.07 (0.92–1.24)	1.02 (0.90–1.15)	1.40 (1.00–1.97)
50% or greater	1.08 (0.97–1.19)	1.17 (0.97–1.41)	1.19 (1.00–1.41)	1.15 (0.76–1.74)

Models adjusted for all variables in the column.

^aMet AIDS case definition by December 31, 2015.

AIDS, acquired immunodeficiency virus; AOR, adjusted odds ratio; CI, confidence interval; HIV, human immunodeficiency virus; IDU, injection drug use; MSM, men who have sex with men; RUCA, rural–urban commuting area; SES, socioeconomic status; ZCTA, ZIP code tabulation area.

The proportion of individuals not retained in care in this Florida study (33%) was lower than for a study of 13 US jurisdictions that assessed persons living with HIV at the end of 2009 (55%)²⁷ and a study that assessed individuals diagnosed with HIV through 2009 in 19 US jurisdictions (49%).²⁸ It was also lower than a 2010 meta-analysis of individuals with HIV in the United States (46%).²⁹ This finding may be partially due to Florida's more comprehensive definition of retention in care that utilizes ADAP and Ryan White data to count HIV care services and prescriptions as indicators for retention in care. It is also possible that retention in care has improved in the years since these previous studies.

The proportion of individuals not virally suppressed during 2015 in Florida was higher compared with a previous national

study (Hall et al., 2012: 23% among persons retained in care²⁷; current study: 40%). The lower proportion of persons not virally suppressed reported by Hall et al. may be partially due to the study examining viral suppression only among persons in care during two subsequent years. Gray and colleagues (2014) also reported lower nonviral suppression when analyzing only those with a viral load test (27%), but higher nonviral suppression when analyzing the overall population with HIV (57%).²⁸

In the current study, a higher proportion of blacks was not retained in care compared with whites, and blacks were at increased risk for nonretention in care after adjusting for potential confounders. This is consistent with several studies.^{2,6,8,27,28} In a study of 13 US jurisdictions reporting HIV-

related laboratory tests, blacks had a lower prevalence of being retained in care compared with whites.²⁷ Black race was also associated with poor retention in care in a study using data from 2619 veterans in the Veteran's Healthcare System.⁶ A study by Colasanti et al.⁸ of HIV-infected individuals in care at a large urban clinic found 12-month retention in care to be similar between blacks and non-blacks, but 36-month retention to be lower among blacks (46%) than non-blacks (63%).⁸ The study found a time $\times$ race interaction,⁸ suggesting that disparities after initiating care may widen over time, something we were unable to test in our study. Disparities in consistent care over several years also seem to be wider than 1-year retention in care.²

It is worth noting that in our study, the increased odds of nonretention in care among blacks compared with whites were nearly unchanged after adjusting for individual and neighborhood factors, including neighborhood SES and percent of population that identifies as black. This suggests that other mechanisms that we were unable to measure are playing a role in racial disparities. Our findings for Latinos are also consistent with several previous studies that suggest that Latinos are at decreased risk for nonretention in care compared with whites in multivariate models.^{22,30,31}

Our findings suggest even larger racial disparities in viral load suppression. These disparities were only partially accounted for by the individual and neighborhood factors available in this study. A retrospective chart review of individuals with HIV in care found black race to be associated with continuous nonviral suppression over a 36-month period.⁸ A second study of individuals in care also found a significantly higher proportion of blacks and Latinos nonvirally suppressed compared with whites, but not when limiting the analysis to patients who filled an antiretroviral therapy prescription.²² We were unable to stratify by prescription of antiretrovirals, but the previous study suggests differences in care or access to medications rather than subsequent adherence to treatment. A third study of patients in care found blacks to be at increased odds of nonviral suppression when compared with whites, but not after controlling for missed clinic visits.³²

Our study also found a marginally increased risk of nonviral load suppression among Latinos when compared with whites. This finding differs from a national study,³ but is consistent with a second study conducted in clinics across the US of individuals in care, which found that differences in viral load suppression between Latinos and whites were significantly different, but were decreasing over time.²²

Black and Latino males were at increased odds of nonretention in care and nonviral suppression compared with their female counterparts. Gender differences were not observed among whites. Higher retention in care among females has been reported in a study of black individuals with HIV³³ and several studies of the general HIV population.^{22,27,31,34} Viral load findings in previous studies are mixed with some showing an advantage for men,²² others for black women,³³ and others showing no gender differences.⁸ However, we were unable to identify studies that compared gender differences in viral suppression for whites and Latinos separately.

Increasing age was a more consistent predictor of retention in care and viral suppression across racial/ethnic groups in the current study and is consistent with previous studies of the general HIV-infected population.^{6,22,31,34,35} A recent study found that black adolescents and young adults with HIV who

had higher psychological distress and reported higher frequency of cannabis use were less likely to be adherent to antiretroviral treatment.³⁶ It is possible that this and other factors may be driving the association between age and viral suppression.

Our study also found foreign-born blacks and whites to be at increased odds of nonretention in care and nonviral suppression compared with their US-born counterparts. It is possible that differences between foreign-born black and white patients and providers may introduce cultural and trust barriers to retention in care that may be facilitated for Latino patients in Florida where there are a large number of Latino and Spanish-speaking providers.^{37,38}

Black, Latino, and white individuals in our study with a mode of HIV transmission as men who have sex with men were at decreased odds of nonretention and nonviral suppression. This finding is consistent with previous studies.^{3,32,39} Those with a history of injection drug use were at increased odds of nonviral suppression for Latinos, and whites, consistent with studies of the general HIV population.³² This may be partially due to biological interactions between illicit drug use and HIV treatment, poor antiretroviral treatment adherence, and poor immunologic response.⁴⁰

The strongest individual-level predictor of nonretention in care and nonviral suppression across all racial/ethnic groups was an HIV only (no AIDS) diagnosis. Among black individuals, those who did not have an AIDS diagnosis had three times the odds of nonretention in care and nearly two times the odds of nonviral suppression compared with blacks with an AIDS diagnosis. AIDS diagnosis has been associated with increased prevalence of being retained in care in a 2009 study of 13 US jurisdictions.²⁷ This finding may reflect a heightened level of concern and need to see an HIV provider regularly and to adhere to antiretroviral treatment after being diagnosed with AIDS.

Although higher individual-level income has been associated with decreased likelihood of missing an appointment,³⁹ we were unable to find an association between neighborhood-level SES and retention in care or viral suppression. Individual-level income may be important for paying clinic visit and prescription copayments, thereby affecting access to care and antiretroviral therapy, particularly those who have not accessed the Ryan White Program. Neighborhood-level disadvantage may be more important in availability of HIV care. Because disadvantaged areas are most affected by the HIV and drug epidemics, these areas may be highly targeted and well resourced in terms of availability of HIV care and case management services. Percent black in the neighborhood also was not a significant predictor.

Among blacks and whites, residing in a rural area was protective for both outcomes. Higher odds of nonretention in care and nonviral suppression in urban areas may reflect the syndemic effect of factors particularly associated with urban life, such as increased alcohol and drug use,⁴¹ stress,⁴² unaffordable and poor housing,⁴³ and high crime.⁴⁴ Coping with these problems may hinder a person's ability to obtain care and treatment. In addition to the neighborhood factors examined in this study, it is also important to note that other community-level factors may be important such as community-level stigma, social support, and suboptimal housing.⁴⁵ Finally, while we were unable to examine factors at the healthcare system level, institutional stigma and discrimination in healthcare settings have been reported among black women with HIV living in the South.⁴⁵

Our study has two main limitations. First, individuals in our surveillance dataset who do not have evidence of being engaged in care may be getting care outside of Florida or outside the US (particularly foreign-born individuals). This also affects our findings for viral load suppression since our study assumes that individuals who are not engaged in care are not virally suppressed. Second, we were only able to assess 1-year retention in care, while consistent long-term retention may be of most importance in the lifelong care of HIV infection.²

The current study suggests persistent racial disparities in retention in care and viral suppression in 2015 for individuals diagnosed with HIV since the year 2000. These disparities are not accounted for by differences in age, sex, mode of HIV transmission, or AIDS diagnosis. Further, this study is the first to assess the contribution of neighborhood characteristics on these disparities. We found that neighborhood SES, rural/urban residence, and neighborhood racial composition plays only a small role on racial/ethnic disparities in retention in care and viral suppression among individuals with HIV in Florida. This study is also the first to suggest increased odds of non-retention in care and nonviral suppression among blacks in urban areas compared with blacks in rural areas, and the same with whites. The inequalities in care and treatment between blacks and whites by geographic area should be further explored.

Future studies should also examine the role of psychosocial factors and access to and quality of care, including trust in healthcare providers³⁷ and satisfaction with HIV care³⁸ on racial disparities in these outcomes. Our study also suggests that predictors of poor retention in care and viral suppression differ by race/ethnicity. Therefore, future studies and interventions need to be racially and ethnically relevant. HIV-infected peer navigators with similar cultural and socioeconomic backgrounds as the patient have been recommended to improve engagement in HIV care.⁴⁶ Such an approach has shown some preliminary efficacy^{47,48} and may be a promising racial/ethnic sensitive approach to decrease disparities. Technology-based retention in care interventions is also showing preliminary promise⁴⁹ and could be combined with culturally tailored interventions to provide the individualized and real-time HIV care possibly needed to bridge racial/ethnic gaps in HIV outcomes.

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