Late HIV Diagnosis: Differences by Rural/Urban Residence, Florida, 2007–2011

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Abstract

The purpose of this retrospective cohort study was to identify individual-level demographic and community-level socioeconomic and health care resource factors associated with late diagnosis of HIV in rural and urban areas of Florida. Multilevel modeling was conducted with linked 2007–2011 Florida HIV surveillance, American Community Survey, Area Health Resource File, and state counseling and testing data. Late diagnosis (defined as AIDS diagnosis within 3 months of HIV diagnosis) was more common in rural than urban areas (35.8% vs. 27.4%) ($p < 0.0001$). This difference persisted after controlling for age, sex, race/ethnicity, HIV transmission mode, country of birth, and diagnosis year (adjusted OR 1.39; 95% CI 1.17–1.66). In rural areas, older age and male sex were associated with late HIV diagnosis; zip code-level socioeconomic and county level health care resource variables were not associated with late diagnosis in rural areas. In urban areas only, Hispanic and non-Hispanic black race/ethnicity, foreign birth, and heterosexual mode of transmission were additionally associated with late HIV diagnosis. These findings suggest that, in rural areas, enhanced efforts are needed to target older individuals and men in screening programs and that studies of psychosocial and structural barriers to HIV testing in rural and urban areas be pursued.

Introduction

EARLY DIAGNOSIS AND TREATMENT of human immunodeficiency virus (HIV) infection confers multiple benefits on the health of individuals as well as population health. People living with HIV infection who receive care and treatment have decreased morbidity and improved survival.^{1,2} The general population benefits because antiretroviral treatment can decrease a person's viral load and thus decrease the probability of transmission.^{3–5} Increasing the percentage of people living with HIV infection who are treated with antiretroviral therapy was associated with a decrease in community viral load and a decrease in the incidence of HIV in British Columbia and San Francisco.^{6,7} Additionally, it was estimated that for 2008, half of the HIV transmissions in the United States were from people with undiagnosed HIV infection.⁸ Studies indicate that awareness of HIV infection and counseling about transmission prevention lead to safer sexual practices among people living with HIV infection.⁹ There may also be long-term

cost savings associated with early diagnosis and treatment because people who present late for care have higher long-term direct medical costs.¹⁰

Despite the benefits of early diagnosis and treatment and substantial nationwide efforts to promote HIV counseling and testing, an estimated 18% of Americans infected with HIV were unaware of their infection as of 2009.¹¹ Data from the 2005–2009 Behavioral Risk Factor Surveillance System indicate that people living in rural areas, particularly remote rural areas, were less likely to be tested for HIV within the past year than those living in central urban areas, and that these differences persisted after controlling for demographic and self-reported risk factors.¹² A study of people diagnosed with HIV in South Carolina during 2001–2005 found that rural residence was associated with late HIV diagnosis,¹³ and a study of Veterans Administration patients found that rural residence was associated with late HIV care.¹⁴ We identified no studies in either rural or urban settings that examined the role of the availability of public HIV counseling and testing sites or other health care resources in late HIV diagnosis. The

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objective of this retrospective cohort study was to examine the role of individual demographic and community-level socioeconomic and health care resource factors in late diagnosis of HIV [defined as diagnosis of acquired immunodeficiency syndrome (AIDS) within 3 months of HIV diagnosis] in rural and urban areas of Florida.

Methods

Study sample

De-identified records of Florida residents aged 13 years or older who were reported with HIV infection that met the Centers for Disease Control and Prevention (CDC) case definition¹⁵ for the first time during 2007–2011 were obtained from the Florida Department of Health (DOH) Enhanced HIV/AIDS Reporting System (eHARS). The majority of data in eHARS come from health care provider reports, laboratory reports, and data abstracted from medical records by county health department staff. Records of diagnosed HIV cases with missing or invalid residential zip codes and records with HIV diagnoses made in a correctional facility were excluded from the analysis.

Individual-level characteristics

Individual-level variables available in the eHARS dataset for cases included residential zip code and county at time of HIV diagnosis and AIDS diagnosis (if applicable); month and year of HIV diagnosis and AIDS diagnosis (if applicable); country of birth; age at HIV diagnosis; sex; race/ethnicity; HIV transmission mode; and whether the diagnosis was at a correctional facility. During 2007–2011, a case met the HIV case definition if the person's medical record or laboratory report indicated evidence of a confirmed positive HIV test or a detectable viral load; the AIDS case definition was met if the person's medical record indicated the development of an AIDS-defining illness, a CD4 lymphocyte count <200 cells/ μ L, or CD4% of total lymphocytes <14.^{16,17} People were classified as being born in the United States (US) if they were born in any of the 50 states, District of Columbia, or any US dependency. People with a reported mode of transmission of men who have sex with men (MSM) combined with injection drug use (IDU) were grouped with people whose reported mode of transmission was IDU only. Follow-up AIDS diagnosis data were available through December 2012, allowing for at least 1 year of follow up for all records.

Community-level characteristics

Five-year estimates of zip code-level socioeconomic data from the 2007–2011 American Community Survey were obtained from the US Census Bureau¹⁸ and linked using the zip code tabulation area (ZCTA).¹⁹ The US Census Bureau reports data by ZCTA. A ZCTA approximates a zip code and is built by aggregating US Census Bureau blocks based on the zip code of addresses in these blocks. Zip code-level poverty was measured using the 5-year estimate of the percentage of population living below the poverty line in that ZCTA. Unemployment was measured as the 5-year estimate of the percentage of people aged 16 and older in a ZCTA who were unemployed. Educational attainment was measured as the 5-year estimate of the percentage of the population aged 18 and older who were high school graduates in that ZCTA. Florida

ZCTAs were divided into rural and urban areas using the zip code approximation from Version 2.0 of Rural-Urban Commuting Area (RUCA) data codes developed at the University of Washington WWAMI Rural Research Center.^{20,21} There are several ways to categorize the codes into rural/urban areas. Categorization C was used because it groups zip codes for isolated small rural towns, other small rural towns, and large rural city/towns into one rural category.²¹ This was chosen because of the relatively small number of rural HIV cases in the isolated small rural town group ($n = 30$, 0.1% of all cases) and the other small rural town group ($n = 213$, 0.8% of all cases).

County level health care resources were obtained from the 2012–2013 Area Health Resource File.²² The Area Health Resource File is a dataset of county-level health care resource information that is assembled by the Health Resources and Services Administration from 50 different sources. From these data, we calculated the county-specific average number of short-term general hospitals per 100 square miles during 2006–2010, the number of hospitals with HIV/AIDS services per 100 square miles during 2010, and the average number of actively practicing medical doctors and doctors of osteopathy per 100 square miles during 2010–2011. The number of hospitals and physicians per square mile were considered because studies indicate that transportation tends to be a barrier to obtaining health care among people living with HIV infection.^{23,24} The distance between the health care provider and any given person's residence was not available, so the density of providers and hospitals was used as a proxy for travel distance as a barrier. The county-specific average number of HIV tests at publically funded counseling and testing sites during 2007–2011 was obtained from the Florida DOH,²⁵ as was the location of publically funded sites (Florida DOH, personal communication, August 15, 2013). If there were multiple test sites at a given physical location (e.g., both an anonymous HIV test site and a STD clinic test site located in a given health department building), the location was counted as one physical site in the calculation of density of counseling and testing sites (number of counseling and testing sites per 100 square miles). The distribution of values for ZCTA- and county-level factors was categorized into quartiles.

Late HIV diagnosis was defined as an AIDS diagnosis within 3 months of an HIV diagnosis. Other studies have variously defined a late diagnosis as a time period of 1, 3, or 12 months between HIV and AIDS diagnosis.²⁶ A 3-month time frame was chosen for this study based on a recommendation of the National HIV/AIDS Strategy to have people linked to care within 3 months²⁷ and a recommendation stemming from a population-based study similar to the current one that used surveillance data in another state.²⁸

Analytic plan

Associations between late HIV diagnosis and individual demographic characteristics, ZCTA-level socioeconomic, and county-level health care access factors were tested using the chi-square test for categorical variables and two-sample Wilcoxon Rank Sum tests for continuous variables. We considered any risk factor associated with screening in the bivariate analysis based on an $\alpha = 0.25$ as a candidate for inclusion in the multivariable logistic regression model.²⁹

Significant independent variables were included in multilevel logistic models, with the dependent variable being late diagnosis. We arrived at a parsimonious model through backward selection (of demographic socioeconomic, and health care access variables), removing variables that did not significantly change the fit of the model based on the log likelihood ratio test.²⁹ SAS Proc GLIMMIX was used for multilevel modeling. The model included three levels: individual, ZCTA, and county. In the model, the ZCTA was nested within the county. Clustering within ZCTA and county were accounted for through random intercepts. We conducted all analyses using SAS 9.2 (SAS Institute SAS Software, version 9.2. Cary, NC, 2002). The institutional review boards of Florida International University and the Florida Department of Health approved the study protocol.

Results

There were 27,424 records with a new HIV diagnosis among people 13 years of age or older between 2007 and 2011. Of these, 991 (3.6%) had an invalid zip code (post office box, nonexistent zip code, or no match with a ZCTA), and 848 (3.1%) were diagnosed in a correctional facility. Of the remaining 25,585 cases, 746 (2.9%) resided in a rural ZCTA at the time of diagnosis, and 24,839 (97.1%) resided in an urban ZCTA. Overall, 27.6% had a late HIV diagnosis. Those residing in a rural area were more likely to have a late HIV diagnosis (35.8%) than those in urban areas (27.4%) ($p < 0.0001$) (Table 1). After controlling for individual level factors of age, sex, race/ethnicity, HIV transmission mode, country of birth, and diagnosis year, HIV-positive individuals residing in rural areas had 1.39 greater odds of a late HIV diagnosis [95% confidence interval (CI) 1.17–1.66, $p < 0.0002$].

To identify differences in characteristics associated with late diagnosis, the subsequent analyses were stratified according to rural or urban area. In the bivariate analysis (Table 1), in rural areas, people with a late HIV diagnosis compared to those whose diagnosis was not late were more likely to be male, 40 years of age or older, and live in counties with a higher hospital density. In urban areas, those with a late HIV diagnosis were more likely to be non-Hispanic black, other/unknown race/ethnicity, be 40 years of age or older, not born in the US, and have the HIV transmission modes of heterosexual sex or other/unknown. In urban areas, the ZCTA-level factors of unemployment and high school graduation rate were associated with late diagnosis. Also in urban areas, the county-level factors of no hospitals with HIV/AIDS services, low hospital density, low physician density, low HIV counseling and testing rates, and low HIV counseling and testing site density were associated with late HIV diagnosis.

In the multilevel logistic regression model in rural areas, male sex, being 40–59 years of age vs. the referent group (13–19 years) and being 60 or older were significantly associated with a late HIV diagnosis [adjusted odds ratio (aOR) 1.85, 95% CI 1.29–2.65; aOR 7.47, 95% CI 2.78–20.04; and aOR 5.20, 95% CI: 1.70–15.85, respectively] (Table 2). In urban areas, eight variables met the inclusion criterion, and all but year of HIV diagnosis were associated with late HIV diagnosis, including male sex (aOR 1.36, 95% CI: 1.25–1.47), being age 60 or older (aOR 5.26, 95% CI: 4.20–6.60), being 40–59 years of age (aOR 4.25, 95% CI: 3.47–5.21), being 20–

39 years of age (aOR 2.23, 95% CI: 1.82–2.74), being Hispanic (aOR 1.14, 95% CI: 1.04–1.25), non-Hispanic black (aOR 1.17, 95% CI: 1.08–1.27), or other/unknown race/ethnicity (aOR 1.33, 95% CI: 1.08–1.64), not born in the US (1.14, 95% CI: 1.07–1.23), living in a ZCTA with the lowest quartile high school graduation rates vs. highest (the referent group) (aOR 1.17, 95% CI: 1.04–1.31), second lowest quartile (aOR 1.14, 95% CI: 1.02–1.28), third lowest quartile (aOR 1.21, 95% CI: 1.08–1.36) or in a county with the second highest quartile for doctor density compared to the highest (aOR 1.30, 95% CI: 1.13–1.50). There were, however, only 159 cases (0.6% of all urban cases) in the two lowest quartiles of doctor density. Relative to the mode of transmission of heterosexual sex, there was a lower adjusted odds of late HIV diagnosis among those with a transmission mode of MSM (0.65, 95% CI: 0.59–0.70) and transmission mode of injection drug use IDU (0.83, 95% CI: 0.73–0.93).

Discussion

In this study, we found that late HIV diagnosis occurred in about a quarter of the cases and was more common in rural areas than in urban areas. Furthermore, factors associated with late HIV diagnosis differed between rural and urban areas. In rural areas, none of the ZCTA-level socioeconomic factors or county-level physician, hospital, or public counseling and testing factors were associated with delayed diagnosis; while in urban areas, low ZCTA-level high school graduation and physician density were associated with late diagnosis. The individual-level characteristics of male sex and older age were associated with late diagnosis in both rural and urban areas. However, only in urban areas were the individual-level characteristics Hispanic and non-Hispanic black race/ethnicity, being foreign born, and heterosexual mode of HIV transmission associated with late diagnosis. While our study confirms the findings on the overall percentage of late diagnoses, the rural/urban differences in the percentage of late diagnoses and factors associated with late diagnosis are noteworthy.

With respect to the proportion of late diagnosis, the finding that 27.6% of all reported HIV diagnoses were late is similar to the 25.5% reported from a 2010 CDC study that used the same definition of late diagnosis (AIDS diagnosis within 3 months of HIV diagnosis) in 14 jurisdictions (12 states, the District of Columbia, and San Francisco).³⁰ In additional analyses using the 12-month definition of late diagnosis (diagnosis of AIDS within 12 months of HIV diagnosis), we found that 32.7% of diagnoses were late, which was very similar to what was estimated for the US (32.3%) and for Florida (30.1%).³¹ Using the 1-month definition, 21.8% were diagnosed late, which is similar to the 23.6% reported in a population-based study in the Bronx after a major enhancement of HIV testing.³² It should be noted that not all of these observed diagnosis delays may be preventable. An estimated 3.6–13.0% of HIV cases that were diagnosed with AIDS within 1 year in New York City were cases of accelerated progression of HIV, as opposed to being cases of late HIV diagnosis.³³

The finding that rural residence was associated with late diagnosis is consistent with data from a national representative sample that indicated rural residents are less likely to have ever been tested for HIV.¹² This finding is also

TABLE 1. CHARACTERISTICS OF PEOPLE WITH LATE HIV DIAGNOSIS (AIDS DIAGNOSIS WITHIN 3 MONTHS OF HIV DIAGNOSIS) VS. THOSE WITHOUT LATE DIAGNOSIS (NO AIDS DIAGNOSIS WITHIN 3 MONTHS AFTER HIV DIAGNOSIS), STRATIFIED BY URBAN VS. RURAL AREA OF RESIDENCE, FLORIDA, 2007–2011 (N = 25,585)

Characteristic	Rural				Urban			
	Total, n	AIDS diagnosis within 3 months of HIV diagnosis), n (%)	No AIDS diagnosis within 3 months of HIV diagnosis), n (%)	p Value	Total, n	AIDS diagnosis within 3 months of HIV diagnosis), n (%)	No AIDS diagnosis within 3 months of HIV diagnosis), n (%)	p Value
<i>Total^a</i>	746	267 (35.8)	479 (64.2)		24,839	6,793 (27.4)	18,046 (72.7)	
<i>Year of HIV diagnosis</i>				0.11				0.08
2007	181	53 (29.3)	128 (70.7)		5,740	1,496 (26.1)	4,244 (73.9)	
2008	160	57 (35.6)	103 (64.4)		5,467	1,539 (28.2)	3,928 (71.9)	
2009	138	55 (39.9)	83 (60.1)		4,832	1,363 (28.2)	3,469 (71.8)	
2010	149	63 (42.3)	86 (57.7)		4,371	1,188 (27.2)	3,183 (72.8)	
2011	118	39 (33.1)	79 (67.0)		4,429	1,207 (27.3)	3,222 (72.8)	
<i>Sex at birth</i>				<0.0001				0.80
Male	499	204 (40.9)	295 (59.1)		18,034	4,924 (27.3)	13,110 (72.7)	
Female	247	63 (25.5)	184 (74.5)		6,805	1,869 (27.5)	4,936 (72.5)	
<i>Race/ethnicity</i>				0.36				<0.0001
Hispanics	88	38 (43.2)	50 (56.8)		5,442	1,433 (26.3)	4,009 (73.7)	
Non-Hispanic blacks	370	131 (35.4)	239 (64.6)		11,923	3,424 (28.7)	8,499 (71.3)	
Non-Hispanic whites	282	95 (33.7)	187 (66.3)		6,985	1,785 (25.6)	5,200 (74.5)	
Other/unknown	6	3 (50.0)	3 (50.0)		489	151 (30.9)	338 (69.1)	
<i>Age group at diagnosis</i>				<0.0001				<0.0001
13–19 years	41	5 (12.2)	36 (87.8)		1,031	111 (10.8)	920 (89.2)	
20–39 years	317	80 (25.2)	237 (74.8)		11,548	2,414 (20.9)	9,134 (79.1)	
40–59 years	336	161 (47.9)	175 (52.1)		10,767	3,663 (34.0)	7,104 (66.0)	
60 years or older	52	21 (40.4)	31 (59.6)		1,493	605 (40.5)	888 (59.5)	
<i>Country of birth</i>				0.64				<0.0001
United States	632	224 (35.4)	408 (64.6)		17,450	4,600 (26.4)	12,850 (73.6)	
Not United States	114	43 (37.7)	71 (62.3)		7,389	2,193 (29.7)	5,196 (70.3)	
<i>Mode of transmission</i>				0.11				<0.0001
Men who have sex with men (MSM)	277	98 (35.4)	179 (64.6)		11,548	2,611 (22.6)	8,937 (77.4)	
Injection drug use (IDU)	71	26 (36.6)	45 (63.4)		1,631	481 (29.5)	1,150 (70.5)	
& MSM/IDU								
Heterosexual	293	95 (32.4)	198 (67.6)		8,613	2,684 (31.2)	5,929 (68.8)	
Other/unknown	105	48 (45.7)	57 (54.3)		3,047	1,017 (33.4)	2,030 (66.6)	
<i>Zip code tabulation area level variables</i>				0.88				0.241
Percent of population below poverty line (average 2007–2011), quartiles								
<8.7	21	6 (28.6)	15 (71.4)		2,087	553 (26.5)	1,534 (73.5)	
8.7–12.9	163	61 (37.4)	102 (62.6)		4,694	1,291 (27.5)	3,403 (72.5)	
13.0–19.3	189	67 (35.5)	122 (64.6)		7,320	1,952 (26.7)	5,368 (73.3)	
≥19.4	373	133 (35.7)	240 (64.3)		10,738	2,997 (27.9)	7,741 (72.1)	

(continued)

TABLE 1. (CONTINUED)

Characteristic	Rural				Urban			
	Total, n	AIDS diagnosis within 3 months of HIV diagnosis), n (%)	No AIDS diagnosis within 3 months of HIV diagnosis), n (%)	p Value	Total, n	AIDS diagnosis within 3 months of HIV diagnosis), n (%)	No AIDS diagnosis within 3 months of HIV diagnosis), n (%)	p Value
Percent of population 16 and older who is unemployed (average 2007–2011), quartiles				0.95				<0.0001
<4.2	199	71 (35.7)	128 (64.3)		2,707	652 (24.1)	2,055 (75.9)	
4.2–5.5	166	58 (34.9)	108 (65.1)		3,889	1,012 (26.0)	2,877 (74.0)	
5.6–7.2	239	89 (37.2)	150 (62.8)		5,719	1,583 (27.7)	4,136 (72.3)	
≥7.3	142	49 (34.5)	93 (65.5)		12,524	3,546 (28.3)	8,978 (71.7)	
Percent of population 18 years and older that is a high school graduate (average 2007–2011), quartiles				0.09				<0.0001
≥92.1	25	9 (36.0)	16 (64.0)		3,017	723 (24.0)	2,294 (76.0)	
86.9–92.0	147	56 (38.1)	91 (61.9)		4,672	1,326 (28.4)	3,346 (71.6)	
80.4–86.8	185	52 (28.1)	133 (71.9)		7,586	2,050 (27.0)	5,536 (73.0)	
<80.4	389	150 (38.6)	239 (61.4)		9,564	2,694 (28.2)	6,870 (71.8)	
County level variables								
Number of hospitals with HIV/AIDS services during 2010				0.74				<0.0001
0	600	213 (35.5)	387 (64.5)		3,041	950 (31.2)	2,091 (68.8)	
≥1	146	54 (37.0)	92 (63.0)		21,798	5,843 (26.8)	15,955 (73.2)	
Number of hospitals per 100 square miles (average 2006–2010), quartiles				0.02				<0.0001
<0.1374	112	32 (28.6)	80 (71.4)		548	173 (31.6)	375 (68.4)	
0.1374–0.1966	280	89 (31.8)	191 (68.2)		538	168 (31.2)	370 (68.8)	
0.1967–0.4104	300	126 (42.0)	174 (58.0)		4,286	1,270 (29.6)	3,016 (70.4)	
≥0.4105	54	20 (37.0)	34 (63.0)		19,467	5,182 (26.6)	14,285 (73.4)	
Number of doctors per 100 square miles (average 2010–2011)				0.23				<0.0001
<2.128	123	34 (27.6)	89 (72.4)		26	7 (26.9)	19 (73.1)	
2.128–23.378	495	185 (37.4)	310 (62.6)		133	42 (31.6)	91 (68.4)	
23.379–92.539	87	33 (37.9)	54 (62.1)		2,898	991 (34.2)	1,907 (65.8)	
≥92.540	41	15 (36.6)	26 (63.4)		21,782	5,753 (26.4)	16,029 (73.6)	
Number of HIV tests per 1000 pop (average 2007–2011)				0.14				<0.0001
<14.021	125	50 (40.0)	75 (60.0)		1,609	525 (32.6)	1,084 (67.4)	
14.021–19.303	220	65 (29.6)	155 (70.5)		1,635	493 (30.2)	1,142 (69.9)	
19.304–24.800	165	62 (37.6)	103 (62.4)		12,613	3,336 (26.5)	9,277 (73.6)	
≥24.801	236	90 (38.1)	146 (61.9)		8,982	2,439 (27.2)	6,543 (72.9)	
Number of CT sites per 100 square miles (2012)				0.32				<0.0001
<0.1779	198	61 (30.8)	137 (69.2)		277	96 (34.7)	181 (65.3)	
0.1779–0.3416	244	89 (36.5)	155 (63.5)		746	228 (30.6)	518 (69.4)	
0.3417–0.7555	255	100 (39.2)	155 (60.8)		1,956	683 (34.9)	1,273 (65.1)	
≥0.7556	49	17 (34.7)	32 (65.3)		21,860	5,786 (26.5)	16,074 (73.5)	

^aThe *p*-value for rural-urban difference was (*p* < 0.0001).

TABLE 2. ADJUSTED ODDS RATIOS AND 95% CONFIDENCE INTERVALS FOR LATE HIV DIAGNOSIS (AIDS DIAGNOSIS WITHIN 3 MONTHS OF HIV DIAGNOSIS) AMONG PEOPLE REPORTED WITH HIV INFECTION, BY RURAL/URBAN RESIDENTIAL STATUS, 2007–2011, FLORIDA

<i>Characteristic</i>	<i>Rural (n = 746) Adjusted odds ratio^a (95% confidence interval)</i>	<i>Urban (n = 24,839) Adjusted odds ratio^a (95% confidence interval)</i>
<i>Year of HIV diagnosis</i>		
2007	0.82 (0.49–1.40)	0.90 (0.83–0.99)
2008	1.11 (0.65–1.89)	1.01 (0.92–1.11)
2009	1.53 (0.88–2.65)	1.03 (0.94–1.13)
2010	1.59 (0.93–2.71)	1.00 (0.91–1.10)
2011	Ref.	Ref.
<i>Sex</i>		
Male	1.85 (1.29–2.65)	1.36 (1.25–1.47)
Female	Ref.	Ref.
<i>Age group at diagnosis</i>		
13–19 years	Ref.	Ref.
20–39 years	2.65 (0.99–7.15)	2.23 (1.82–2.74)
40–59 years	7.47 (2.78–20.04)	4.25 (3.47–5.21)
60 years or older	5.20 (1.70–15.85)	5.26 (4.20–6.60)
<i>Race/ethnicity</i>		
Hispanic	^b	1.14 (1.04–1.25)
Non-Hispanic black		1.17 (1.08–1.27)
Other		1.33 (1.08–1.64)
Non-Hispanic white		Ref.
<i>Country of birth</i>		
United States	^b	Ref.
Not United States		1.14 (1.07–1.23)
<i>Mode of HIV transmission</i>		
Men who have sex with men (MSM)	^b	0.65 (0.59–0.70)
Injection drug use (IDU) & MSM/IDU		0.83 (0.73–0.93)
Heterosexual		Ref.
Other/unknown		1.00 (0.91–1.10)
<i>Percent of population in ZCTA 18 years and older that is a high school graduate (average 2007–2011), quartiles</i>		
< 80.4	^b	1.17 (1.04–1.31)
80.4–86.8		1.14 (1.02–1.28)
86.9–92.0		1.21 (1.08–1.36)
≥ 92.1		Ref.
<i>Number of doctors in county per 100 square miles (average 2010–2011)</i>		
< 2.128	^b	1.02 (0.41–2.56)
2.128–23.378		1.34 (0.88–2.05)
23.379–92.539		1.30 (1.13–1.50)
≥ 92.540		Ref.

^aOdds ratios adjusted for all variables in column. ^bVariable not shown because $\alpha > 0.25$ in bivariate analysis or not retained in the final backwards selection model.

consistent with an earlier (2001–2005) population-based study in South Carolina that found rural residence was associated with late diagnosis¹³ and a study of veterans which found a later entry into care for rural residents relative to urban residents.¹⁴ Rural residents have also been less likely to receive other types of screening, such as breast and colorectal cancer screening, suggesting that this pattern is not unique to HIV care.^{34,35} The statistically significant rural-urban difference was also seen when using the 1- and 12-month definitions of late diagnosis in our study. The rural resident diagnosis disadvantage was somewhat unexpected, given the results of an earlier study in Florida finding no survival disadvantage between people in rural and urban areas diagnosed

with AIDS between 1993–2007.³⁶ However, that study used an earlier time period and examined survival from the time of AIDS and not the time of HIV diagnosis. Furthermore, survival is affected by care and treatment in addition to early diagnosis.

Proposed reasons for why rural residents may be more likely to be diagnosed late are less perceived risk, more stigma, fear of loss of confidentiality, lower education, poverty, and less access to screening services and health care.^{13,24,37–39} Even if counseling and testing sites are close to a rural resident's home, rural residents may prefer to be tested in a different community to ensure anonymity, which can result in delayed testing. Rural providers have suggested

that integrating HIV testing into other health services; rapid oral testing and community health education; outreach; and making HIV testing more convenient, accessible, and free are potential ways to decrease barriers.²⁴

With respect to community-level factors, we found that neither the density of public HIV counseling and testing sites nor public HIV counseling and testing rates was associated with late diagnosis in rural or urban areas in the multivariate analyses. We also found that physician density, hospital density, or having a hospital with HIV/AIDS services in the county was not associated with late diagnosis in rural areas. This suggests that health care resource disparities are not the underlying reason for late HIV diagnosis in rural areas. However, our variables related to HIV counseling and testing sites, HIV counseling and testing rates, physicians, and hospitals were at the county level. There is likely significant heterogeneity with regard to where these resources are distributed within counties such that the density of counseling and testing sites may not reflect well what a given person has access to. For example, a county may have several public HIV counseling and testing sites, but if they are clustered in one region of the county and the person diagnosed with HIV resides in a different part of the county, that person may not have had access to those sites. Additionally, our HIV counseling and testing data were only for testing at public counseling and testing sites and do not include testing by private providers. In a separate analysis, we found that the public HIV counseling and testing rate was actually slightly higher in counties classified as rural using the state of Florida statute's definition of rural counties⁴⁰ than in urban counties (median 20.4 tests vs. 18.0 tests per 1,000 population, respectively) (Wilcoxon Rank Sum $P=0.09$), suggesting that disparities in testing may be in private as opposed to public counseling and testing.

The individual-level factors that we found associated with late diagnosis are largely consistent with other studies. Late diagnosis has generally been found to be more common among men and older adults in multiple studies in the US, Australia, Europe, and Asia.^{13,28,41–51} Health care providers may be less likely to consider HIV infection in an older adult, and older adults may perceive themselves as at lower risk than younger adults.⁵¹ Rapid disease progression, which would appear as a late diagnosis, has been reported in older adults.^{44,47} The gender differences may be related to women having more frequent health care encounters, including family planning or antenatal care visits, that offer HIV screening.⁵²

Late diagnosis was more common among non-Hispanic blacks, Hispanics, and those in the "other" race/ethnic group in urban but not in rural areas. Other population-based studies conducted during the last 10 years, found Hispanic ethnicity to be associated with late diagnosis.^{11,13,28,53} Non-Hispanic black race/ethnicity was associated with late testing in population-based studies in South Carolina¹³ and California,⁵³ but not Harris County, Texas.²⁸ Our findings of a lack of association in rural areas may be due to the relatively small number of cases in rural areas or a weaker/nonexistent association in rural areas. None of the above cited studies examined rural areas separately from urban areas. Therefore, the association of race/ethnicity with delayed diagnosis in rural areas should be examined in other states.

As with race/ethnicity, being born outside the US was associated with delayed diagnosis in urban but not rural areas,

which may be due to the relatively small number of foreign-born people in rural areas. Studies in the US and in Europe have consistently found that foreign birth is associated with delayed diagnosis.^{41,42,53–59} Having an undocumented immigration status was associated with not ever being tested for HIV in a study in South Florida.⁵² Reasons identified in other studies for foreign birth being associated with delayed diagnosis include stigma,^{56,60,61} language barriers,^{58,61} and less knowledge about HIV.^{56,61}

Late HIV/AIDS diagnosis in urban areas was associated with heterosexual compared with MSM and IDU modes of HIV transmission. Late HIV/AIDS diagnosis has been associated with heterosexual transmission in several other studies in the US, Australia, and Europe.^{28,45,49,53,57,62,63} This may be due to people with high risk heterosexual activity not perceiving themselves to be at high risk of HIV.

There are several additional limitations that need to be noted for this study. First, there are relatively few rural HIV cases that may have limited our power to find factors associated with late diagnosis in rural areas. This is partially due to only 7.0% of Florida's population living in rural areas.⁴⁰ Second, we may have incomplete ascertainment of AIDS diagnoses. The CD4 values were missing for 30.3% of cases. Although these people were probably less likely to have AIDS than the group as a whole because they presumably were not sick enough to seek care, some may have met the AIDS case definition within 3 months of their HIV diagnosis. A missing CD4 count or percent test was less common in rural areas (22.1%) than in urban areas (30.6%) ($p<0.0001$), so it is possible that some of the rural/urban difference was related to better identification of AIDS cases in rural areas. Third, because HIV infection reporting was not mandated in Florida prior to July 1997, and because reporting was not implemented retroactively, some cases might appear to be diagnosed with HIV at a more recent time than actually happened. This could bias the time to AIDS diagnosis or death by making it appear to be shorter in such cases. However, all cases in this investigation were diagnosed from 2007 to 2011. The likelihood that they were actually diagnosed more than 10–15 years prior to this study is probably small and unlikely to differ by rural/urban status. Fourth, we had no measures of individual reasons for not having an HIV test such as lack of perceived risk or fear of the test result. Rural/urban differences in these individual reasons should be further explored to find potential points for intervention in improving HIV testing rates. Fifth, although we found no association between community-level socioeconomic factors and late diagnosis in rural areas, we cannot conclude that individual level SES is not important in predicting HIV counseling and testing behavior or access to HIV counseling and testing because we had no measures of individual level socioeconomic status. Finally, the rural/urban categorization was at the ZCTA level, and the health care provider and counseling and testing variables were at the county level. It would have been preferable to have data on health care provider and counseling and testing at the ZCTA level too, but they were only available at the county level.

In summary, the findings of this study indicate that late HIV diagnosis is relatively common, particularly among older and among male rural residents. The gender difference was particularly large in rural areas and merits further investigation.

These findings suggest that in rural areas in Florida enhanced efforts be made to target older individuals and men in screening programs. Additional studies of delayed diagnosis are needed in rural areas of other states, particularly states with more small and isolated rural areas, to determine if similar characteristics are associated with delayed diagnosis. If possible, such studies should analyze actual travel distances from rural residence to closest counseling and testing facilities. In urban areas late HIV diagnosis also was associated with belonging to a racial/ethnic minority groups and being foreign born. Studies of psychosocial barriers and structural barriers to HIV counseling and testing in rural and urban areas in the groups more likely to have an HIV diagnosis should be pursued. Lastly, when planning, implementing, and evaluating HIV and AIDS prevention, screening, and care efforts, it is important to consider rural/urban differences.

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