

Elevated COVID-19 outcomes among persons living with diagnosed HIV infection in New York State: Results from a population-level match of HIV, COVID-19, and hospitalization databases

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Abstract

Background

New York State (NYS) has been an epicenter for both COVID-19 and HIV/AIDS epidemics. Persons Living with diagnosed HIV (PLWDH) may be more prone to COVID-19 infection and severe outcomes, yet few population-based studies have assessed the extent to which PLWDH are diagnosed, hospitalized, and have died with COVID-19, relative to non-PLWDH.

Methods

NYS HIV surveillance, COVID-19 laboratory confirmed diagnoses, and hospitalization databases were matched. COVID-19 diagnoses, hospitalization, and in-hospital death rates comparing PLWDH to non-PLWDH were computed, with unadjusted rate ratios (RR) and indirect standardized RR (sRR), adjusting for sex, age, and region. Adjusted RR (aRR) for outcomes among PLWDH were assessed by age/CD4-defined HIV disease stage, and viral load suppression, using Poisson regression models.

Results

From March 1-June 7, 2020, PLWDH were more frequently diagnosed with COVID-19 than non-PLWDH in unadjusted (RR [95% confidence interval (CI)]: 1.43[1.38-1.48], 2,988 PLWDH), but not in adjusted comparisons (sRR [95% CI]: 0.94[0.91-0.97]). Per-population COVID-19 hospitalization was higher among PLWDH (RR [95% CI]: 2.61[2.45-2.79], sRR [95% CI]: 1.38[1.29-1.47], 896 PLWDH), as was in-hospital death (RR [95% CI]: 2.55[2.22-2.93], sRR [95% CI]: 1.23 [1.07-1.40], 207 PLWDH), albeit not among those hospitalized (sRR [95% CI]: 0.96[0.83-1.09]). Among PLWDH, hospitalization risk increased with disease progression from HIV Stage 1 to Stage 2 (aRR [95% CI]:1.27[1.09-1.47]) and Stage 3 (aRR [95% CI]: 1.54[1.24-1.91]), and for those virally unsuppressed (aRR [95% CI]: 1.54[1.24-1.91]).

Conclusion

PLWDH experienced poorer COVID-related outcomes relative to non-PLWDH, with 1-in-522 PLWDH dying with COVID-19, seemingly driven by higher rates of severe disease requiring hospitalization.

Introduction

Novel coronavirus disease 2019 (COVID-19) has resulted in the deaths of more than 1 million persons worldwide as of October 21, 2020, with the United States (US) leading the world in diagnosed cases (8,404,743) and deaths (223,000).¹ In addition to an older, male demographic distribution that favors increased COVID-19 diagnoses, persons living with diagnosed human immunodeficiency virus (HIV) infection (PLWDH) have higher prevalence of many underlying medical conditions associated with more severe COVID-19 illness.²⁻⁴

The Centers for Disease Control and Prevention (CDC) currently identifies older adults and those with underlying medical conditions including chronic kidney disease, chronic obstructive pulmonary disease, obesity, sickle cell disease, diabetes, transplant recipients and those with serious heart conditions to be at elevated risk for severe illness from COVID-19. PLWDH with a low CD4 cell count or not on HIV treatment are currently listed by the CDC as *possible* risk factors for severe illness from COVID-19.⁵ Little has been firmly established regarding the extent to which PLWDH are acquiring COVID-19, the severity of COVID-19 illness experienced by PLWDH, or how these distributions compare to the non-HIV population. Emerging literature is suggesting similar or better COVID-19 clinical outcomes for PLWDH compared to non-PLWDH.^{4,6-12} The majority of these studies have been small and limited to hospitalized populations of PLWDH, factors limiting generalizability and a more complete understanding of the population-based risk of developing severe COVID-19 disease requiring hospitalization. A few recent and larger studies have found increased hospitalization and mortality outcomes for PLWDH,¹³⁻¹⁵ although there remain no population-based studies from US jurisdictions.

New York State (NYS) has been an epicenter for both the US COVID-19 and HIV/AIDS epidemics, placing NYS in a unique position to speak to the intersection of these two epidemics. As of October 21, 2020, NYS has 490,134 diagnosed cases and leads the US in COVID-19 deaths at 33,396.¹ NYS, the epicenter of the HIV epidemic in the US for decades, ranked second in the number of PLWDH and first in

the rate per 100,000 population at the end of 2018.¹⁶ Like NYS's COVID-19 epidemic, HIV infection is concentrated in NY City (NYC), among older adults, and among racial and ethnic minorities: In 2018, 78% of PLWDH in NYS lived in NYC, 55% were over the age of 50, and 72% were either non-Hispanic Black (40%) or Hispanic (32%) persons.¹⁷

We conducted a population-level match of NYS's HIV registry against its COVID-19 diagnoses and hospitalization databases, to provide the first population-level comparison of COVID-19 outcomes between the PLWDH and non-PLWDH populations within a US jurisdiction. More specifically, we compare the continuum of rates of COVID-19 diagnoses, hospitalizations, and in-hospital deaths for PLWDH in NYS to the non-PLWDH population, and determine factors associated with these outcomes among PLWDH.¹⁸

Methods

Study Population and Data Source

This is a retrospective cohort study of individuals with polymerase chain reaction (PCR) confirmed SARS-CoV-2 infection, diagnosed between March 1, 2020 and June 7, 2020 in NYS. Data were abstracted from: 1) the NYS HIV surveillance registry, which receives name-based reports for all HIV-related laboratory tests for individuals who reside or receive HIV-related care in NYS;¹⁹⁻²⁰ 2) the NYS Electronic Clinical Laboratory Reporting System (ECLRS), an electronic system for secure and timely transmission of reportable clinical laboratory information; and 3) the State Health Information Network for NY (SHIN-NY), a public health information exchange network connecting NYS healthcare providers.

Outcomes

The following outcomes were evaluated among individuals with and without diagnosed HIV: 1) COVID-19 diagnoses; 2) hospitalizations; and 3) in-hospital deaths. People diagnosed with COVID-19 were identified from an ECLRS file of all PCR confirmed SARS-CoV-2 infection reported to the NYS

Department of Health (NYSDOH). The subset of individuals with HIV and diagnosed COVID-19 were identified by matching records from the ECLRS file of confirmed SARS-CoV-2 infection to the NYS HIV surveillance registry. Data were matched using a validated deterministic matching algorithm implemented using SAS DataFlux Data Management Studio 2.7.²¹ HIV surveillance data may require up to one year to ensure quality and completeness of information for individuals who are newly diagnosed. Therefore, PLWDH and residing in NYS as of December 2019 were included in these analyses.

COVID-19 hospitalizations are routinely identified by ongoing matching of ECLRS data to the SHIN-NY database.²² The SHIN-NY datafile contained hospital encounter data from January 1, 2020 to June 15, 2020 with admission dates 14 days prior to 30 days after a positive COVID-19 test result. Individuals were considered hospitalized due to COVID-19 if they had: 1) a positive COVID-19 test result ≤ 3 days after the discharge date; 2) an admission date up to 30 days after a positive COVID-19 test result; or 3) a positive COVID-19 test result during the hospital encounter period. An in-hospital death was defined by discharge status code of 20-21, 40-41 or 42, as defined by the HL7 v2.5 discharge disposition value set,²³ or a discharge description indicative of patient expiration.

Study Variables

The demographic variables included in all analyses were age, sex, and region of residence. For analyses among PLWDH, race and ethnicity, HIV transmission risk at diagnosis²⁴, in HIV-related care, stage of HIV infection at last test, and viral load suppression at last test were available. CD4, viral load and genotype tests in the 3 years prior to the study period were included for analysis. In care was defined as having a CD4, viral load or genotype test reported to the HIV surveillance registry in the 365 days prior to March 1; HIV disease stage at last CD4 and viral suppression < 200 copies/mL at last test were evaluated in the previous 3 years.^{25,26}

Statistical analyses

COVID-19 diagnoses, hospitalizations, and in-hospital deaths were evaluated between PLWDH and persons without diagnosed HIV (non-PLWDH).²⁷ Rates per 1,000 population, and rates per previous outcome (hospitalized per diagnosis, in-hospital death per hospitalization), and unadjusted rate ratios (RR) with 95% confidence intervals (CI) were calculated to evaluate associations between study variables and each outcome. Adjusted comparisons were made via indirect standardization, controlling for age, sex, and region.²⁸

Among PLWDH, rates per 1,000 population and per previous outcome, with unadjusted RRs with 95% CIs were assessed among levels of age, sex, region, race and ethnicity, transmission risk, care status, HIV stage, and viral suppression status. Adjusted RRs with 95% CI were calculated in multivariable Poisson regression models, which included covariates significant at $\alpha=0.05$ in bivariate analyses. All analyses were conducted using SAS software V9.4.²¹ For these models, missing values were imputed for HIV transmission risk (12%), race and ethnicity (<1%), and age (<1%) using fully conditional specification, implemented using SAS PROC MI.²⁹⁻³⁰ Multiple imputation was not implemented for laboratory variables with missing data. The NYSDOH IRB approved this study.

Results

From March 1-June 7, 2020, among 108,062 PLWDH in NYS, 2,988 were diagnosed with COVID-19 (rate: 27.65/1,000), a rate 1.43-fold (95% CI: 1.38-1.48) that among non-PLWDH (rate: 19.40/1,000) (Table 1). Similarly, elevated rates were observed across age categories, except for persons age 40-59 years, sex, and region of residence at HIV diagnosis. Standardization for these factors yielded an overall adjusted diagnosis rate-ratio (sRR) of 0.94 (95% CI: 0.91-0.97), comparing PLWDH vs. non-PLWDH (Figure 1). Standardized RR were significantly above 1.0 in regions outside of NYC, but lower in NYC (Supplementary Table 1).

Per-population rates of COVID-19 hospitalization were significantly elevated among PLWDH (8.29/1,000) versus non-PLWDH (3.15/1,000, RR [95% CI]: 2.61 [2.45-2.79]) and consistently so across age, sex, and geography. In unadjusted analyses, relative hospitalization for PLWDH vs. non-PLWDH was highest for persons <40 years (RR [95% CI]: 3.08 [2.40-3.95]), females (RR [95% CI]: 3.19: [2.82-3.59]), and those living in rest of NYS (ROS) (RR [95% CI]: 3.51 [2.37-5.20]). Following standardization, the disparity in hospitalization between PLWDH and non-PLWDH diminished but remained significantly elevated (sRR [95% CI]: 1.38 [1.29-1.47]).

Overall, 207 PLWDH (rate: 1.92/1,000) had a COVID-19 diagnosis and died in-hospital, at 2.55-fold (95% CI: [2.22-2.93]) the rate of the non-PLWDH population. Unadjusted per-population relative mortality was highest among persons <40 years (RR: 5.74, 95% CI: 2.14-15.42), females (3.74 (2.94-4.77)), and residents of Long Island (RR [95% CI]: 2.42 [1.40-4.17]). Following adjustment, the standardized mortality ratio was 1.23 (95% CI: 1.13-1.48).

The conditional rates per previous outcomes stage for PLWDH vs. non-PLWDH are summarized in Figure 1, alongside population-level rates, and in Supplementary 2. Among those diagnosed with COVID-19, nearly one-third (299.87 per 1,000) of PLWDH were hospitalized, a rate 1.83-fold (95% CI: 1.72-1.96) that of non-PLWDH. Among those hospitalized with COVID-19, no differences were seen in in-hospital death, comparing PLWDH vs. non-PLWDH (rate-ratio: 0.98, 95% CI: [0.85-1.12], sRR: 0.96, 95% CI: [0.83-1.09]). Despite a lack of significant difference in adjusted in-hospital mortality conditional on hospitalization, the higher levels of hospitalization for PLWDH underpinned significantly higher mortality rates per-population (reported above) and per-diagnosis (case-fatality rate, 69.28/1,000 vs. 38.70/1,000, sRR: 1.30, 95% CI: [1.13-1.43]).

Among PLWDH, in bivariate analyses, COVID-19 diagnosis was associated with all factors examined, except for sex, which were included in a multivariable model (Table 2). In the adjusted model,

PLWDH of older age, race and ethnicity not white non-Hispanic, and living in the regions of metropolitan NYC were significantly more likely to be diagnosed with COVID-19. No significant differences were observed between the main HIV transmission risk groups. Controlling for these factors, having Stage 3 HIV infection (aRR [95% CI] vs. Stage 1: 1.38 [1.21-1.59]) was associated with increased COVID-19 diagnosis, whereas unsuppressed viral load (aRR [95% CI] vs. suppressed: 0.70 [1.21-1.59]) was associated with decreased COVID-19 diagnosis.

Further examining the risk-factors for hospitalization among PLWDH with diagnosed COVID-19, in adjusted analyses older age and region were associated with hospitalization, but not race, ethnicity or transmission risk (Table 3). Relative to Stage 1 infection, there was a gradient of increased hospitalization risk across Stage 2 (aRR [95% CI]: 1.27 [1.09-1.47]) and Stage 3 (aRR [95% CI]: 1.54 [1.24-1.91]). Those with unsuppressed viral load had 30% increased likelihood of hospitalization (aRR [95% CI]: 1.54 [1.24-1.91]). Among those hospitalized, only older age was associated with an increased likelihood of in-hospital death.

To probe the role of HIV stage and viral suppression in increasing hospitalization risk for PLWDH versus non-PLWDH, we conducted the per-population hospitalization standardized rate analysis classifying PLWDH persons into 2 categories: PLWDH Stage 1 and virally suppressed, PLWDH in other known care statuses. Relative to non-PLWDH, hospitalization risk was elevated even for PLWDH Stage 1 and virally suppressed (sRR [95% CI]: 1.19 [1.07-1.30]), along with PLWDH in other care statuses (sRR [95% CI]: 1.77 [1.61-1.93]).

Discussion

Our study represents the first population-level match of a US state's HIV registry against its COVID-19 diagnoses and hospitalization databases, establishing state-level rates of COVID-19 outcomes among the PLWDH population, and state-level comparisons of these rates to those observed in the overall population.

COVID-19 Diagnosis

2.8% of NYS's PLWDH population had been diagnosed with COVID through June 7, 2020, a rate nearly 40% higher than that observed in the non-PLWDH population. This disparity disappeared after standardization, a finding consistent with a meta-analysis of 14 smaller studies (8 from the US) finding a higher but not statistically different rate of COVID-19 diagnoses among PLWDH.³¹ After adjusting for age, region of residence, race and ethnicity, HIV transmission risk, and HIV stage at last test, COVID-19 diagnoses rates among PLWDH did not differ by sex at birth or transmission risk. Diagnosis rates were, significantly higher among PLWDH age 40 and over, a finding reported elsewhere.³² Consistent with a convenience sample of PLWDH,² our study found a higher-than-background rate of COVID-19 in PLWDH of color: Adjusted diagnosis rates were 1.6 times higher for non-Hispanic Blacks and 2.1 times higher for Hispanics compared to non-Hispanic Whites. This finding parallels the racial and ethnic differences in the distribution of HIV in NYS,¹⁷ and may reflect the impact of differential rates of COVID-19-enhancing comorbidities among PLWDH of color, and/or social and behavioral determinants of health associated with COVID-19 transmission in minority communities.³³⁻³⁶

COVID-19 diagnosis rates among PLWDH also varied by region. Consistent with overall population rates, we found significantly lower diagnoses rates among PLWDH in upstate New York (ROS). Diagnoses rates among PLWDH were significantly higher in the NYC-adjacent regions of Long Island and Mid-Hudson than they were in NYC. This finding may reflect lower COVID-19 testing

availability in NYC during the initial phase of the pandemic rather than a difference in background infection levels. Although there were no overall differences in COVID-19 diagnoses between PLWDH and non-PLWDH, PLWDH exhibited higher rates outside NYC and a lower rate within NYC. Because we were not able to standardize the comparative analyses by race and ethnicity, this finding may reflect differences in the racial and ethnic distribution of PLWDH relative to the overall population by region, rather than a substantive difference in diagnosis propensity among PLWDH.

The relationship between the management of HIV infection and COVID-19 diagnosis was not straightforward. Virally suppressed PLWDH were significantly *more* likely to have been diagnosed, as were PLWDH with CD4 counts below 200 cell/mm³. The increased diagnosis probability among virally suppressed persons may reflect a difference in test-seeking behavior or more interaction with the health care system among suppressed PLWDH rather than a difference in underlying COVID-19 prevalence. Alternatively, healthier PLWDH may place themselves at greater risk for acquiring COVID-19, although this interpretation is inconsistent with findings from one existing study.³

COVID-19 Hospitalization and Mortality

PLWDH were significantly more likely than non-PLWDH to be hospitalized with COVID-19, overall (sRR=1.38) and among diagnosed cases (sRR=1.47), suggesting higher rates of severe disease among PLWDH requiring hospitalization. Hospitalization rates among PLWDH were higher among those not virally suppressed and those with lower CD4 counts, suggesting that less controlled HIV virus may increase COVID-19 severity to where hospitalization is required. Supplemental data analyses found higher hospitalization rates compared to the non-PLWDH population persisted among the subset of PLWDH who were virally suppressed with high CD4 counts, suggesting that additional factors may explain elevated hospitalization rates among PLWDH, including other comorbidities, systemic stress of chronic viral infection, and social determinants of COVID-19 severity. Hospitalization rates were also

higher among those over 40 and those with a documented injection drug use history, the latter finding also observed in a non-HIV-focused case-control study spanning 50 US states.³⁷

We observed elevated population-level mortality for PLWDH which was driven by higher hospitalization rates and not higher mortality among hospitalized PLWDH. The unadjusted case fatality rate among PLWDH was nearly twice that exhibited in the non-PLWDH population, with a significant difference maintained but attenuated after statistical adjustment. The number of COVID-19 deaths among PLWDH constitutes a sizable increase over normal levels. There were 490 deaths among PLWDH from March 1-June 15, 2019. Against this backdrop, the 207 COVID-19-specific hospital deaths in our study represents a 42% addition to anticipated deaths during this period. Further analyses refining this estimate are needed.³⁸ Higher mortality among PLWDH was reported in a large population cohort study of health care facility attendees in Western Cape of South Africa,¹³ in cohorts of hospitalized patients in London¹⁴ **Error! Bookmark not defined.** and NYC,¹⁵ and in a study of PLWDH receiving antiretroviral therapy in 60 Spanish hospitals.¹² Contrary findings have been reported in a NYC study comparing 88 COVID-19 hospitalized PLWDH to a matched non-PLWDH control group.⁴

The only statistically significant predictor of in-hospital mortality among hospitalized PLWDH was age, with those age 40 and older 3-4 times more likely to experience in-hospital death depending on age group. Given the well-established findings on elevated mortality by increasing age regardless of HIV-status^{13,32,39} this likely reflects an elevated risk of COVID-19 severity-enhancing comorbidities among older adults, including diabetes, hypertension, and chronic lung and cardiovascular disease. Also reported in the literature,^{12,40} we found that hospitalized and fatal COVID-19 cases were younger among PLWDH. This finding may lend support to the notion that HIV infection can accelerate biological aging.^{41,42}

Although non-Hispanic Black and Hispanic PLWDH were more likely to be diagnosed with COVID-19 than non-Hispanic white PLWDH, they were not more likely to be hospitalized once diagnosed, or to

die once hospitalized. This finding is partially consistent with COVID-19 studies finding racial and ethnic disparity present in hospitalization rates but not in mortality.^{18,43-45} Finally, despite RRs in the expected direction, CD4 count was not significantly related to in-hospital death. This finding is incongruent with at least 2 studies finding that CD4 counts less than 200 cell/mm³ were significant predictors of decreased survival probability among hospitalized PLWDH.^{13,32}

Limitations

This earliest outcome in this study is COVID-19 laboratory confirmed diagnosis and not infection. A statewide seroprevalence study estimated that about 9% of COVID-19 cases through March 2020 had been diagnosed in NYS.⁴⁶ Differences in diagnosis propensity among PLWDH or between PLWDH and the non-PLWDH population could alter the interpretation of some findings. Our analyses were limited to the demographic and laboratory data available in NYS's HIV surveillance and COVID-19 registries, precluding more in-depth investigations into the role played by co-morbidities and underlying medical conditions, COVID-19 risk behaviors, and social determinants of health. It is important to further investigate how the observed associations may be changed by information on co-morbidities and underlying medical conditions, COVID-19 risk behaviors, and social determinants of health with more comprehensive data sources such as medical chart reviews. Our denominator of PLWDH included people who died between January 1 and June 15, 2020 and excluded persons newly diagnosed with HIV during this same timeframe. Because these numbers have historically offset each other, the impact of this limitation is likely negligible.

Conclusion

Controlling for age, sex, and region, PLWDH in NYS were diagnosed with COVID-19 at roughly the same rate as non-PLWDH. Further, once hospitalized, PLWDH had similar mortality rates compared

to non-PLWDH. However, PLWDH were hospitalized at a 40% higher rate, with low CD4 and high VL linked to higher hospitalization, and ultimately deaths, among PLWDH, although persons with well-managed HIV per CD4 and viral load still had elevated hospitalization rates. This surveillance approach has illuminated increased COVID-19 morbidity and mortality for PLWDH, while highlighting the need to further understand the mechanisms underpinning this increased risk of severe disease.

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Table 1. COVID-19 diagnosis, hospitalization, and in-hospital death per 1,000, among persons living with and without diagnosed HIV infection - New York State (NYS), March 1 – June 7, 2020 ^a

	Population Size		Diagnosed with COVID-19					Hospitalized with COVID-19					In-hospital Death with COVID-19				
	<u>PLWDH</u> ^b		<u>non-PLWDH</u>		Rate Ratio (95% CI)	<u>PLWDH</u>		<u>non-PLWDH</u>		Rate Ratio (95% CI)	<u>PLWDH</u>		<u>non-PLWDH</u>		Rate Ratio (95% CI)		
	n	Rate/ 1,000	n	Rate/ 1,000		n	Rate/ 1,000	n	Rate/ 1,000		n	Rate/ 1,000	n	Rate/ 1,000			
Age in Years ^c																	
<40	27,154	9,902,345	492	18.12	121,871	12.31	1.47 (1.35-1.61)	62	2.28	7,346	0.74	3.08 (2.40-3.95)	4	0.15	254	0.03	5.74 (2.14-15.42)
40-<60	53,632	4,925,972	1,400	26.10	133,095	27.02	0.97 (0.92-1.02)	356	6.64	15,925	3.20	2.05 (1.85-2.28)	67	1.25	1,952	0.39	3.15 (2.47-4.02)
60+	27,274	4,517,182	1,096	40.18	119,291	26.41	1.52 (1.43-1.62)	478	17.53	38,096	8.38	2.08 (1.90-2.27)	136	4.99	12,316	2.71	1.83 (1.55-2.17)
Sex ^d																	
Female	30,331	9,975,384	879	28.98	182,440	18.29	1.59 (1.48-1.69)	265	8.74	27,366	2.74	3.19 (2.82-3.59)	66	2.18	5,802	0.58	3.74 (2.94-4.77)
Male	77,731	9,370,115	2,109	27.13	190,537	20.33	1.33 (1.28-1.39)	631	8.12	33,881	3.59	2.25 (2.08-2.43)	141	1.81	8,699	0.92	1.95 (1.65-2.31)
Region of Residence ^e																	
Long Island	5,709	2,827,816	252	44.27	79,874	28.25	1.56 (1.38-1.77)	53	9.28	12,113	4.27	2.17 (1.66-2.84)	13	2.28	2,666	0.94	2.42 (1.40-4.17)
Mid-Hudson	6,142	2,317,635	228	37.24	61,771	26.65	1.39 (1.22-1.59)	46	7.49	6,619	2.85	2.62 (1.96-3.51)	5	0.81	1,089	0.47	1.73 (0.72-4.17)
New York City	84,284	8,252,524	2,409	28.58	204,903	24.83	1.15 (1.11-1.20)	771	9.15	38,964	4.67	1.94 (1.80-2.08)	186	2.21	9,995	1.20	1.82 (1.58-2.11)
Rest of NYS (ROS)	11,916	5,947,524	88	7.37	23,395	3.93	1.88 (1.52-2.32)	25	2.10	3,558	0.60	3.51 (2.37-5.20)	3	0.25	742	0.12	2.02 (0.65-6.27)
Total	108,062	19,345,499	2,988	27.65	375,260	19.40	1.43 (1.38-1.48)	896	8.29	61,371	3.15	2.61 (2.45-2.79)	207	1.92	14,522	0.75	2.55 (2.22-2.93)

- Persons diagnosed with COVID-19 through June 7, hospitalized through June 15.
- Persons living with diagnosed HIV infection (PLWDH) as of the end of December 2019, per data as of July 2020. 2 persons had unknown age and 11 were living in NYS as of the end of 2019 but living out of state at COVID-19 diagnosis, classifying them as out of state for “region of residence”.
- Age was at diagnosis for those with diagnosed COVID-19. For individuals with diagnosed HIV but not diagnosed COVID-19, age as of 12/31/2019 was used. Individuals under age 18 are included in the “<40” group. Among non-PLWDH, 1,003 diagnosed and 4 hospitalized had unknown age.
- Sex at birth was used for PLWDH, sex for non-PLWDH may include current gender identity. Among non-PLWDH, 18 diagnosed and 1 hospitalized had ‘other’ sex; 2,265 diagnosed, 123 hospitalized, and 21 with in-hospital death had unknown sex.
- Region of residence was defined as follows: For persons with and without HIV diagnosed with COVID-19, region was defined based on the county of residence at COVID-19 diagnosis. For persons with an HIV diagnosis, but not diagnosed with COVID-19, region was based on the last known county of residence recorded in the HIV surveillance registry as of year-end 2019. Among non-PLWDH, 3,875 diagnosed, 36 hospitalized, and 7 with in-hospital death were out of state residents; 1,442 diagnosed, 81 hospitalized, and 23 with in-hospital death had ‘unknown’ region of residence.

Table 2. Factors associated with stages of COVID-19 diagnosis, hospitalization, and in-hospital death among persons living with diagnosed HIV infection - New York State (NYS), March 1 – June 7, 2020 ^a

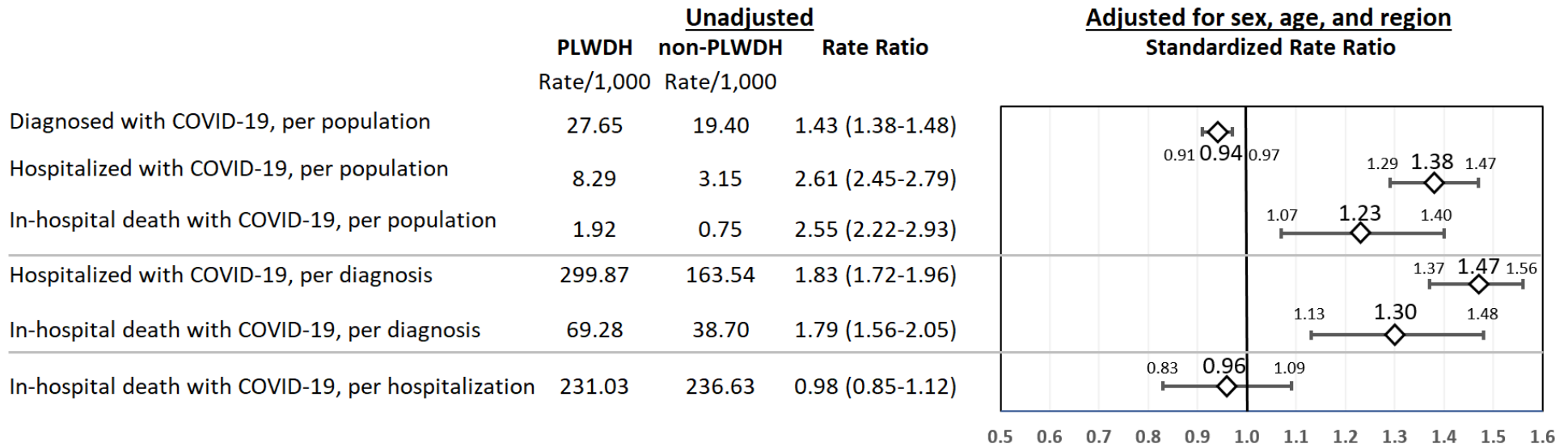
	Population Size ^b	Diagnosed with COVID-19				Hospitalized with COVID-19				In-hospital Death with COVID-19		
		n	Rate/ 1,000 PLWDH	Unadjusted Rate Ratio (95% CI)	Adj. Rate Ratio ^c (95% CI)	n	Rate/ 1,000 diag.	Unadjusted Rate Ratio (95% CI)	Adj. Rate Ratio ^c (95% CI)	n	Rate/ 1,000 hosp.	Unadjusted Rate Ratio (95% CI)
Age in Years												
<40	27,154	492	18.12	Ref	Ref	62	133.50	Ref	Ref	5	80.65	Ref
40-<60	53,632	1,400	26.10	1.44 (1.30-1.60)	1.35 (1.21-1.51)	356	253.30	2.02 (1.54-2.64)	1.88 (1.42-2.50)	68	191.01	2.92 (1.06-7.99)
60+	27,274	1,096	40.18	2.22 (1.99-2.47)	2.01 (1.78-2.26)	478	441.80	3.46 (2.66-4.51)	3.23 (2.43-4.29)	134	280.33	4.41 (1.63-11.92)
Sex												
Female	30,331	879	28.98	1.07 (0.99-1.16)	-	265	300.00	1.01 (0.87-1.16)	-	66	249.06	1.12 (0.84-1.50)
Male	77,731	2,109	27.13	Ref	-	631	299.20	Ref	-	141	223.45	Ref
Region of Residence at Diagnosis												
Long Island	5,709	252	44.27	1.54 (1.36-1.76)	1.61 (1.40-1.84)	53	212.80	0.66 (0.49-0.87)	0.74 (0.56-0.99)	13	245.28	1.02 (0.58-1.78)
Mid-Hudson	6,142	228	37.24	1.30 (1.13-1.49)	1.26 (1.10-1.46)	46	206.70	0.63 (0.47-0.85)	0.62 (0.45-0.86)	5	108.70	0.45 (0.19-1.09)
New York City	84,284	2,409	28.58	Ref	Ref	771	317.90	Ref	Ref	186	241.25	Ref
Rest of NYS (ROS)	11,916	88	7.37	0.26 (0.21-0.32)	0.27 (0.21-0.34)	25	270.30	0.89 (0.60-1.32)	1.01 (0.66-1.54)	3	120.00	0.50 (0.16-1.56)
Race/Ethnicity												
White Non-Hispanic	20,563	337	16.39	Ref	Ref	86	255.20	Ref	Ref	20	232.56	Ref
Black, Non-Hispanic	43,143	1,146	26.56	1.62 (1.44-1.83)	1.61 (1.41-1.83)	364	317.60	1.25 (0.98-1.57)	1.13 (0.88-1.46)	85	233.52	1.00 (0.62-1.63)
Hispanic	35,914	1,256	34.97	2.13 (1.89-2.41)	2.10 (1.85-2.39)	371	295.40	1.16 (0.92-1.46)	1.10 (0.86-1.42)	92	247.98	1.07 (0.66-1.72)
Other	8,329	246	29.54	1.80 (1.53-2.12)	1.87 (1.58-2.22)	75	304.90	1.20 (0.88-1.63)	1.18 (0.86-1.63)	10	133.33	0.57 (0.27-1.23)
HIV Transmission Risk ^d												
Heterosexual	30,578	913	29.86	1.32 (1.21-1.44)	1.02 (0.93-1.13)	257	281.50	1.19 (1.00-1.42)	0.97 (0.81-1.47)	62	241.25	1.12 (0.78-1.61)
IDU	11,432	439	38.40	1.70 (1.52-1.89)	1.13 (1.00-1.27)	190	432.80	1.83 (1.52-2.21)	1.13 (0.93-1.37)	55	289.47	1.34 (0.92-1.95)
MSM	46,741	1,059	22.66	Ref	Ref	250	236.10	Ref	Ref	54	216.00	Ref
MSM/IDU	4,118	130	31.57	1.39 (1.16-1.67)	1.18 (0.98-1.42)	48	369.20	1.56 (1.15-2.13)	1.12 (0.83-1.52)	7	145.83	0.68 (0.31-1.48)
Other	2,324	27	11.62	0.51 (0.35-0.75)	0.59 (0.40-0.87)	4	148.10	0.63 (0.23-1.69)	0.87 (0.32-2.37)	-	0.00	-
Unknown	12,869	420	32.64			147	350.00			29	197.28	
In care, previous 12 months ^e												
Yes	93,704	2,834	30.24	Ref		844	297.80	Ref	844	196	232.23	Ref
No	14,243	154	10.81	0.36 (0.30-0.42)		52	337.70	1.13 (0.86-1.50)	52	11	211.54	0.91 (0.50-1.67)
Stage of HIV Infection, at last test ^f												
Stage 1	63,712	1,774	27.84	Ref	Ref	437	246.30	Ref	Ref	94	215.10	Ref
Stage 2	27,905	843	30.21	1.08 (0.99-1.18)	1.05 (0.97-1.14)	298	353.50	1.44 (1.24-1.66)	1.27 (1.09-1.47)	71	238.26	1.11 (0.81-1.51)

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	Population Size ^b	Diagnosed with COVID-19				Hospitalized with COVID-19				In-hospital Death with COVID-19		
		n	Rate/ 1,000 PLWDH	Unadjusted Rate Ratio (95% CI)	Adj. Rate Ratio ^c (95% CI)	n	Rate/ 1,000 diag.	Unadjusted Rate Ratio (95% CI)	Adj. Rate Ratio ^c (95% CI)	n	Rate/ 1,000 hosp.	Unadjusted Rate Ratio (95% CI)
Stage 3	7,498	270	36.01	1.29 (1.14-1.47)	1.38 (1.21-1.59)	126	466.70	1.89 (1.55-2.31)	1.54 (1.24-1.91)	34	269.84	1.26 (0.85-1.86)
Other	8,947	101	11.29	-	-	35	346.50	-	-	8	228.57	-
Viral Suppression, at last test^f												
Yes	87,480	2,628	30.04	Ref	-	756	287.70	Ref	Ref	180	238.10	Ref
No	12,027	267	22.20	0.74 (0.65-0.84)	0.70 (0.61-0.80)	105	393.30	1.37 (1.11-1.68)	1.30 (1.04-1.62)	21	200.00	0.84 (0.54-1.32)
Other	8,555	93	10.87	-	-	35	376.30	-	-	6	171.43	-
Total	108,062	2,988	27.65	-	-	896	299.87	-	-	207	231.03	-

- a. Persons diagnosed with COVID-19 through June 7, hospitalized through June 15
- b. Persons living with HIV infection (PLWDH) diagnosed as of the end of December 2019, per data as of July 2020. 2 persons had unknown age, 11 were living in NYS at the time of HIV diagnosis but living out of state at COVID-19 diagnosis, classifying them as out of state for “region of residence”, 113 had unknown race/ethnicity, 115 unknown in-care status (NYC cases not linkable to the statewide HIV registry). Individuals under age 18 are included in the “<40” group.
- c. Model adjusted for age, region of residence, race/ethnicity, HIV Transmission risk (Other includes pediatric, blood products), and Stage at last test in the 3 years before March 1, 2020
- d. IDU = injection drug use, MSM = men who have sex with men
- e. In care status based on any laboratory report received to the NYS HIV surveillance registry in the 12 months prior to 03/01/2020
- f. Stage and viral suppression are based on most recent test received to the NYS HIV surveillance registry in the 36 months prior to the study period. Stage of HIV infection was based on the CDC case definition for adults and children, where Stage 1: CD4 ≥500 cells/mm³ or ≥26% of total lymphocytes (age ≥6 years), CD4 ≥1,000 cells/mm³ or ≥30% of total lymphocytes (age 1-5 years); Stage 2: CD4 200-499 cells/mm³ or 14-25% of total lymphocytes (age ≥6 years), CD4 500-999 cells/mm³ or 22-29% of total lymphocytes (age 1-5 years); Stage 3: CD4 <200 cells/mm³ or <14% of total lymphocytes (age ≥6 years), CD4 <500 cells/mm³ or <22% of total lymphocytes (age 1-5 years).²⁵ Persons classified as “Other” include those out of care for >36 months, who have moved out of state, and who have not moved but are receiving care out of state.

Figure: Summary of rates and rate ratios for COVID-19 diagnosis, hospitalization, and in-hospital death, comparing persons living with and without diagnosed HIV infection, by region - New York State, March 1 – June 7, 2020 ^a



a. Persons diagnosed with COVID-19 through June 7, hospitalized through June 15. Standardized rate ratios adjusted for age, sex, and region.