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MAJOR ARTICLE

Coronavirus Disease 2019 (COVID-19) Infection Among People With Human Immunodeficiency Virus in New York City: A Population-Level Analysis of Linked Surveillance Data

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(See the Editorial Commentary by Triant and Gandhi on pages e1030–4.)

Background. New York City (NYC) was hard-hit by the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) pandemic and is also home to a large population of people with human immunodeficiency virus (PWH).

Methods. We matched laboratory-confirmed coronavirus disease 2019 (COVID-19) case and death data reported to the NYC Health Department as of 2 June 2020 against the NYC HIV surveillance registry. We describe and compare the characteristics and COVID-19–related outcomes of PWH diagnosed with COVID-19 with all NYC PWH and with all New Yorkers diagnosed with COVID-19.

Results. Through 2 June, 204 583 NYC COVID-19 cases were reported. The registry match identified 2410 PWH with diagnosed COVID-19 eligible for analysis (1.06% of all COVID-19 cases). Compared with all NYC PWH and all New Yorkers diagnosed with COVID-19, a higher proportion of PWH with COVID-19 were older, male, Black, or Latino, and living in high-poverty neighborhoods. At least 1 underlying condition was reported for 58.9% of PWH with COVID-19. Compared with all NYC COVID-19 cases, a higher proportion of PWH with COVID-19 experienced hospitalization, intensive care unit admission, and/or death; most PWH who experienced poor COVID-19–related outcomes had CD4 <500 cells/μL.

Conclusions. Given NYC HIV prevalence is 1.5%, PWH were not overrepresented among COVID-19 cases. However, compared with NYC COVID-19 cases overall, a greater proportion of PWH had adverse COVID-19–related outcomes, perhaps because of a higher prevalence of factors associated with poor COVID-19 outcomes. Given the pandemic's exacerbating effects on health inequities, HIV public health and clinical communities must strengthen services and support for people living with and affected by HIV.

Keywords. SARS-CoV-2; COVID-19; HIV; surveillance.

Early in the human immunodeficiency virus (HIV) epidemic in the United States, New York City (NYC) was the epicenter of HIV, and while the US epicenter has shifted geographically since the beginning of the epidemic, NYC remains home to an estimated 92 000 people living with HIV (PWH) in 2018 [1], representing 9% of the 1 million PWH nationally [2]. As the novel severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) pandemic hit the United States, NYC became the early epicenter. Through 8 July 2020, 214 570 New Yorkers were diagnosed with coronavirus disease 2019 (COVID-19) infection and 23 224 deaths were attributed to COVID-19 [3].

Given that HIV can compromise the immune system and that a rapidly growing number of people are being diagnosed with COVID-19, there is concern about whether PWH could be at higher risk for SARS-CoV-2 infection and that, compared with people without HIV, PWH could experience worse COVID-19–related clinical outcomes. Older age and coexisting chronic medical conditions, including those that affect the immune system such as diabetes mellitus, have been identified as potential risk factors for poor clinical outcomes after diagnosis with SARS-CoV-2 infection [4–6]. People living with HIV are aging and older compared with the general population, and medical comorbidities are common among PWH [7–9]. However, the intersection between HIV and COVID-19 has not yet been described at the population level. Such an analysis would be critical for several reasons. First, it would enable a comprehensive characterization of the sociodemographic characteristics and clinical outcomes of PWH who acquire SARS-CoV-2. Second,

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such a study would inform additional analyses to quantify the risk for COVID-19 among PWH, particularly in geographic areas and communities hard-hit by both conditions. Third, it would identify differences in COVID-19 clinical outcomes for people with and without diagnosed HIV infection. These reasons are even more compelling given the disproportionate impact of both HIV and COVID-19 on Black and Latino communities. Here we present results of a descriptive, population-level analysis of linked data from the NYC HIV surveillance and COVID-19 surveillance systems.

METHODS

Data Sources

Data sources for this analysis included the NYC Department of Health and Mental Hygiene's (DOHMH) HIV surveillance registry and the NYC DOHMH COVID-19 surveillance system. The DOHMH is authorized by state and local law to collect clinical and laboratory information for the HIV and COVID-19 surveillance systems for public health surveillance. Individual patient confidentiality for people whose information is maintained in the registries is protected by state and local public health law.

The HIV registry Enhanced HIV/AIDS Reporting System (eHARS) contains records for people diagnosed with HIV in NYC and reported to DOHMH. The registry contains information on all people diagnosed and reported with HIV infection (since 2000) or AIDS (since 1981) in NYC. Providers are required to report all new diagnoses of HIV and AIDS, and laboratories are required to report all positive HIV diagnostic test algorithms, qualitative and quantitative viral load test results (including those that are undetectable), CD4 test results, and the nucleotide sequence generated during HIV genotypic resistance testing ordered by NYC providers or for NYC residents. The registry receives more than 1 million laboratory reports per year for people living with diagnosed HIV and receiving HIV care in NYC. Surveillance staff verify all new HIV/AIDS diagnoses and collect sociodemographic and HIV-related clinical information for confirmed cases through medical chart review. Sociodemographic information in the registry includes age, sex at birth, race/ethnicity, and residential address, which are derived from patients' medical charts (recorded by the provider and/or collected from the patient directly) and laboratory test results. We use a measure of area-based poverty in this analysis, which is based on NYC zip code of residence and defined as the percentage of the population in a zip code whose household income is below the Federal Poverty Level (FPL). Categories include low poverty (<10% below FPL), medium poverty (10% to <20% below FPL), high poverty (20% to <30% below FPL), and very high poverty (≥30% below FPL).

Since March 2020, results of molecular-based diagnostic testing for SARS-CoV-2 have been reportable to DOHMH for purposes of citywide surveillance for SARS-CoV-2 infection. For this analysis, only "confirmed cases," defined as individuals with a positive polymerase chain reaction test for SARS-CoV-2, were included. Laboratory test result data are received via electronic reporting by testing laboratories. Laboratory tests include basic patient identifying and demographic information; supplemental demographic (eg, sex at birth, race/ethnicity) and clinical information, including hospitalization history, is extracted, when available, from multiple sources, including patients' medical records, patient interviews, death certificates, and from matches with other disease surveillance registries maintained by DOHMH. Information on previously diagnosed underlying conditions among people with diagnosed SARS-CoV-2 infection is also captured in the COVID-19 surveillance system when available, including asthma, cancer, diabetes, hepatic disease, heart disease, hypertension, immunodeficiency, kidney disease, lung disease, and other underlying conditions.

Several outcomes are captured in the COVID-19 surveillance dataset, including hospitalization, admission to an intensive care unit (ICU), and death. For this analysis, hospitalizations were those that occurred after an individual's COVID-19 diagnosis date for any reason. Intensive care unit admissions were included if an individual had been admitted to an ICU following hospitalization after COVID-19 diagnosis. Information on deaths attributed to SARS-CoV-2 infection is collected through routine linkage with mortality data from DOHMH's Office of Vital Statistics for "confirmed" COVID-19 deaths—those for people with a positive molecular-based diagnostic test for SARS-CoV-2—and through supplemental medical chart review for "probable" COVID-19 deaths—those for people with COVID-19 as a primary or contributing cause of death on their death certificate but without SARS-CoV-2–positive molecular-based diagnosis test results. This analysis included only "confirmed" COVID-19 deaths.

Registry Matching Methods

COVID-19 case and death data reported to DOHMH as of 2 June 2020 were matched to eHARS HIV registry data on 19 June 2020 and 2 July 2020, respectively. We used a standard 36-key deterministic algorithm for matching against the HIV registry, as previously described elsewhere [10]. Briefly, records that matched exactly on full first and last name and date of birth and those matching on keys 1–7 were accepted as a confirmed match. Records that matched on keys 8–36 ("fuzzy matches") were manually reviewed by 2 reviewers, with a third as a tie-breaker when needed, to make a final match determination. Surveillance staff involved in the manual match review process were highly experienced and trained.

Analysis

We used linked data along with additional data from the HIV registry (case and demographic data reported as of 30 March 2020

and HIV-related laboratory data reported as of 8 July 2020) to calculate the prevalence of HIV among people with confirmed COVID-19 and describe characteristics and COVID-19–related outcomes of PWH who were diagnosed with COVID-19. The analytic populations were restricted to people diagnosed with HIV and with a last known address in NYC as of 31 December 2019 and to people diagnosed with COVID-19 residing in NYC at the time of report with SARS-CoV-2 infection. The prevalence of HIV among COVID-19 cases was age-adjusted to the NYC population. All demographic and HIV-related variables for PWH with and without diagnosed COVID-19 were taken from the HIV registry. Demographic data for NYC COVID-19 cases and information on underlying conditions for all groups were taken from the COVID-19 surveillance system.

RESULTS

Among a total of 204 583 COVID-19 cases reported to DOHMH as of 2 June 2020, we identified 2447 people with diagnosed HIV reported to the HIV surveillance registry. After removing PWH whose current residence was outside NYC or unknown and duplicate records, a total of 2410 PWH with diagnosed COVID-19 infection were eligible for the analysis. The comparison populations were all NYC PWH excluding those diagnosed with COVID-19 infection (N = 113 907) and all NYC residents with diagnosed COVID-19 infection and without diagnosed HIV infection (N = 202 012). The age-adjusted prevalence of diagnosed HIV among confirmed NYC COVID-19 cases was 1.06%. There was no apparent difference in the timing with which COVID-19 diagnoses were made among PWH compared with people without diagnosed HIV infection in NYC (Figure 1).

Nearly three-quarters of PWH with and without diagnosed COVID-19 were assigned male sex at birth compared with just over half of all NYC COVID-19 cases (Table 1). People living with HIV with and without diagnosed COVID-19 were generally older than NYC COVID-19 cases overall—with, for example, 56.1% and 53.5% of PWH with and without COVID-19, respectively, aged 45–64 years versus 36.1% of all NYC COVID-19 cases; notably, however, a higher proportion of all NYC COVID-19 cases were in the oldest age group of 75 years and older (11.8%) compared with PWH with COVID-19 (5.2%). Among individuals with known race/ethnicity across all 3 groups, Black and Latino/Hispanic individuals were overrepresented. This disparity was pronounced among PWH with COVID-19, with 86.1% of PWH with COVID-19 identified as Black or Latino/Hispanic compared with 78.6% of PWH without COVID-19 and 62.5% of all NYC COVID-19 cases; including cases with unknown race/ethnicity, 33.1% of all NYC COVID-19 cases were Black or Latino/Hispanic. The distribution of NYC borough of residence also varied across the groups: a higher proportion of PWH with and without COVID-19 were residents of the Bronx and Manhattan compared with all NYC COVID-19 cases, and a lower proportion of PWH with and without COVID-19 were residents of Queens compared with all NYC COVID-19 cases. People living with HIV with COVID-19

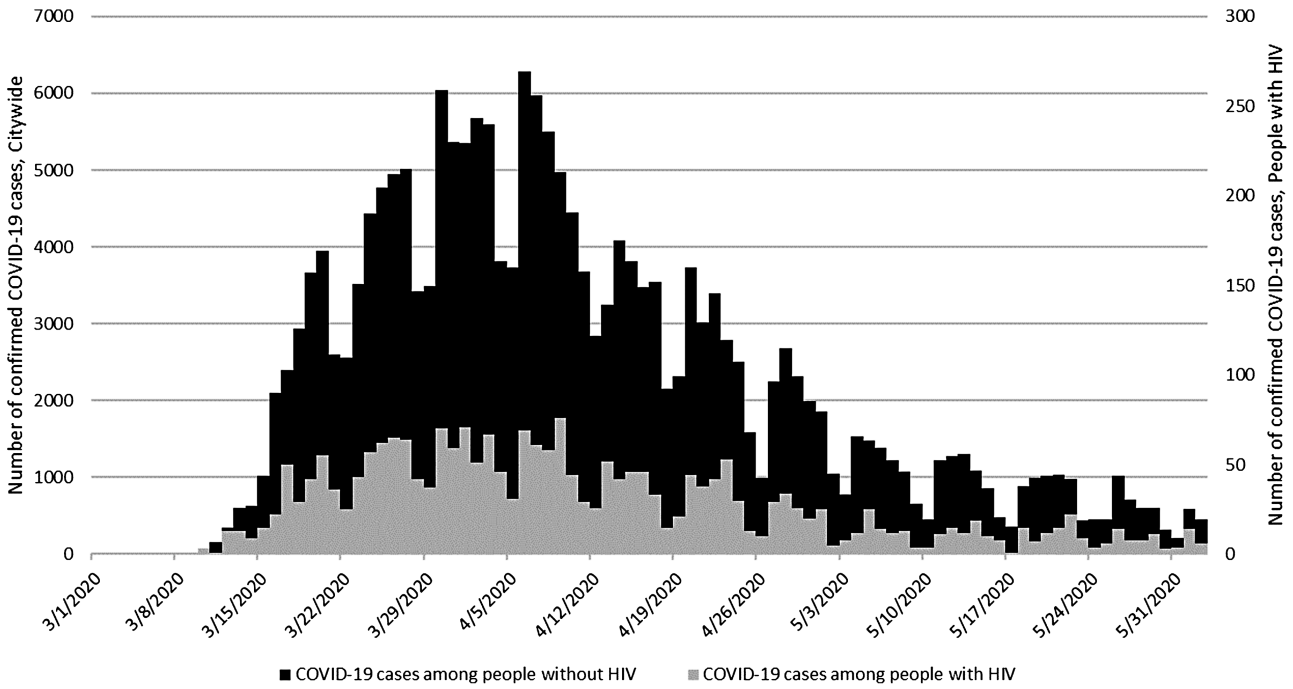

Figure 1. Epidemic curve of confirmed COVID-19 cases by date of diagnosis, citywide and among people with HIV: 1 March–2 June 2020, New York City. Abbreviations: COVID-19, coronavirus disease 2019; HIV, human immunodeficiency virus.

were more likely to be living in areas with high and very high poverty levels (56.9%) compared with 51.4% of PWH without COVID-19 and 39.9% of all NYC COVID-19 cases.

Most PWH with and without diagnosed COVID-19 had male-to-male sexual contact (MSM), heterosexual contact, or a history of injection drug use (IDU) as their documented HIV transmission risk prior to HIV diagnosis. Compared with PWH without COVID-19, a lower proportion of PWH with COVID-19 were MSM (33.9% vs 41.4%) and a higher proportion had a history of IDU (15.1% vs 11.5%). In both groups of PWH, the majority (61.4% and 63.8%, respectively) had been diagnosed with HIV in the year 2000 or later.

Compared with all NYC COVID-19 cases, a substantially higher proportion of PWH with COVID-19 had documentation

Table 1. Intersection of Human Immunodeficiency Virus and COVID-19 in the New York City Population: Demographic Characteristics

	NYC PWH With Diagnosed COVID-19		NYC PWH Without Diagnosed COVID-19		New Yorkers With Diagnosed COVID-19, Excluding PWH	
	n	Col%	n	Col%	n	Col%
Total	2410	100	113 907	100	202 012	100
Sex at birth						
Male	1720	71.4	83 561	73.4	103 304	51.1
Female	690	28.6	30 346	26.6	98 588	48.8
Unknown	0	0	0	0	120	0.1
Age group (years)						
0–17	3	0.1	188	0.2	5653	2.8
18–44	557	23.1	35 947	31.6	74 505	36.9
45–64	1351	56.1	60 912	53.5	72 995	36.1
65–74	374	15.5	13 562	11.9	24 945	12.4
≥75	125	5.2	3298	2.9	23 914	11.8
Race/ethnicity[a]						
Black	1079	44.8	50 543	44.4	31 412	15.6
Latino/Hispanic	995	41.3	38 724	34.0	35 370	17.5
White	270	11.2	20 900	18.4	30 734	15.2
Asian/Pacific Islander	52	2.2	2825	2.5	8044	4.0
Native American	6	0.3	264	0.2	193	0.1
Multiracial	5	0.2	364	0.3	1226	0.6
Unknown	3	0.1	287	0.3	95 033	47.0
NYC borough of residence						
Bronx	815	33.8	30 518	26.8	45 343	22.5
Brooklyn	571	23.7	30 071	26.4	56 060	27.8
Manhattan	511	21.2	32 392	28.4	25 062	12.4
Queens	447	18.6	18 420	16.2	62 003	30.7
Staten Island	66	2.7	2506	2.2	13 544	6.7
Area-based poverty level[b]						
Low poverty (<10% below FPL)	211	8.8	11 250	10.0	31 449	15.6
Medium (10% to <20% below FPL)	824	34.3	43 496	38.6	83 737	41.5
High (20% to <30% below FPL)	607	25.3	29 653	26.3	48 134	23.8
Very high poverty (≥30% below FPL)	760	31.6	28 216	25.1	32 457	16.1
Area-based poverty level not available	8	0.3	1292	1.1	6235	3.1
HIV transmission risk[c]						
Men who have sex with men (MSM)	816	33.9	47 116	41.4	Not applicable	
Injection drug use history (IDU)	364	15.1	13 110	11.5		
MSM-IDU	74	3.1	2837	2.5		
Heterosexual contact	552	22.9	22 744	20.0		
Transgender people with sexual contact	25	1.0	1680	1.5		
Perinatal	14	0.6	2312	2.0		
Other/unknown	565	23.4	24 108	21.2		
Year of HIV diagnosis						
1990 or before	219	9.1	10 012	8.8	Not applicable	
1991–1999	712	29.5	31 269	27.5		
2000–2009	970	40.3	45 237	39.7		
2010–2020	509	21.1	27 389	24.1		

Table 1. Continued

	NYC PWH With Diagnosed COVID-19		NYC PWH Without Diagnosed COVID-19		New Yorkers With Diagnosed COVID-19, Excluding PWH	
	n	Col%	n	Col%	n	Col%
At least 1 underlying condition[d]	1549	64.3	Not available		71 526	35.4
Asthma	111	4.6			4855	2.4
Cancer	223	9.3			7805	3.9
Diabetes	664	27.6			38 529	19.1
Hepatic disease	600	24.9			6380	3.2
Heart disease	700	29.1			34 377	17.0
Hypertension	580	24.1			28 212	14.0
Immunodeficiency	950	39.4			3629	1.8
Kidney disease	263	10.9			7959	3.9
Lung disease	342	14.2			11 510	5.7
Other condition	472	19.6			24 199	12.0

Data sources include the NYC DOHMH HIV surveillance registry, with data as reported by 31 March 2020, and the NYC DOHMH COVID-19 surveillance system, with data as reported by 2 June 2020. All demographic and HIV-related variables for PWH with and without diagnosed COVID-19 are from the HIV surveillance registry; demographic data for NYC COVID-19 cases are from the COVID-19 surveillance system. Underlying condition data are from the COVID-19 surveillance system. All percentages are column percentages except for those for specific underlying conditions (see footnote d).

Abbreviations: Col%, column percentage; COVID-19, coronavirus disease 2019; DOHMH, Department of Health and Mental Hygiene; HIV, human immunodeficiency virus; FPL, Federal Poverty Level; NYC, New York City; PWH, people living with HIV.

[a]Standard race/ethnicity classification in the HIV surveillance registry (www1.nyc.gov/assets/doh/downloads/pdf/ah/new_race_def_dec2010.pdf) was applied to this analysis for both PWH and NYC COVID-19 cases.

[b]Area-based poverty level is based on NYC zip code of most recent residence. For PWH, residential zip code is based on most recent record available in the surveillance registry (most recent record is >5 years old for 27% of PLH in 2019).

[c]HIV transmission risk information is based on exposures reported prior to HIV diagnosis. "Heterosexual contact" includes people who had heterosexual sex with a person they know to be living with HIV, a person who has injected drugs, or a person who has received blood products. For women only, also includes history of sex work, multiple sex partners, sexually transmitted disease, crack/cocaine use, sex with a bisexual man, probable heterosexual transmission as noted in a medical chart, or sex with a man and negative history of injection drug use. "Transgender people with sexual contact" includes people identified as transgender at any time by self-report, a medical provider or chart review, or ongoing data collection with sexual contact reported and negative history of injection drug use. "Other" includes people who received treatment for hemophilia, people who received a transfusion or transplant, people with other healthcare-associated transmission, and children with non-perinatal transmission risk.

[d]Data on underlying conditions come from the COVID-19 surveillance system, and reflect data available from medical records, patient interview, and registry matches. These data are recorded when available and are not complete for all people diagnosed with COVID-19. Information on individual conditions in the table is not mutually exclusive; multiple conditions can be collected for an individual. Percentages for specific conditions are for the number of people with each condition out of total PWH with COVID-19 (N = 2410) or total NYC COVID-19 cases (N = 202 012). "Immunodeficiency" refers to immune suppression resulting from a range of conditions including HIV; because data on underlying conditions are incomplete, the proportion of PWH with "immunodeficiency" recorded is <100%.

of at least 1 underlying condition (64.3% vs 35.4%). The frequency of specific underlying conditions varied across the 2 groups, and the rankings of most common conditions differed somewhat. The most common specific underlying conditions among PWH with COVID-19 after the general "immunodeficiency" category were heart disease, diabetes mellitus, hepatic disease, hypertension, and lung disease. Excluding PWH with only immunodeficiency documented, which was likely documented due to HIV status, 58.9% of PWH with COVID-19 had at least 1 underlying condition reported. Among all NYC COVID-19 cases, the most common specific underlying conditions were diabetes, heart disease, hypertension, and lung disease.

Compared with all NYC COVID-19 cases, a higher proportion of PWH with COVID-19 experienced COVID-19–related hospitalization, admission to an ICU, and death during this period (Table 2). Forty-two percent of PWH with COVID-19 were hospitalized (vs 26% of all cases), 5% were admitted to the ICU (vs 3% of all cases), and 13% died (vs 8% of all cases) (Figure 2). Generally, compared with all NYC COVID-19 cases, PWH with COVID-19 who experienced these COVID-19 outcomes were more likely to be older, Black or Latino/Hispanic, and living in high-poverty NYC neighborhoods. Compared with their representation among all PWH with COVID-19, higher proportions of Bronx residents experienced hospitalization, ICU admission, and death, and lower proportions of Manhattan and Queens residents experienced ICU admission and death; lower proportions of MSM experienced hospitalization, ICU admission, and death, while higher proportions of PWH with a history of IDU experienced hospitalization, ICU admission, and death. Compared with their proportions among all PWH with COVID-19, higher proportions of PWH who were hospitalized, admitted to the ICU, and died had earlier HIV diagnoses (eg, before 1990 or from 1991 to 1999); relatively small proportions of PWH diagnosed with HIV in the most recent decade (2010–2020) experienced these adverse COVID-19 outcomes (Table 2).

By HIV viral suppression status, the vast majority of PWH who were hospitalized, admitted to the ICU, and died were virally suppressed at last HIV viral load. By latest CD4+ cell count, among PWH with a history of hospitalization, most had 500 or more cells/μL; among those with a history of ICU admission, most PWH had less than 200 cells/μL. The majority of PWH with COVID-19 with these outcomes had a history of AIDS diagnosis per the HIV surveillance registry. Finally, the majority of PWH who were hospitalized and especially those who

Table 2. COVID-19–Related Outcomes Among People With Human Immunodeficiency Virus and COVID-19 in New York City

	Hospitalized (Ever)		Intensive Care Unit (Ever)		Deceased[a]	
	n	Col%	n	Col%	n	Col%
Total	1011	42.0	124	5.2	312	13.0
Sex at birth						
Male	720	71.2	90	72.6	224	71.8
Female	291	28.8	34	27.4	88	28.2
Age group (years)						
0–17	0	0	0	0	0	0
18–44	121	12.0	14	11.3	18	5.8
45–64	561	55.5	75	60.5	150	48.1
65–74	230	22.8	27	21.8	88	28.2
≥75	99	9.8	8	6.5	56	18.0
Race/ethnicity						
Black	504	49.9	53	42.7	153	49.0
Latino/Hispanic	394	39.0	60	48.4	124	39.7
White	92	9.1	8	6.5	31	9.9
Asian/Pacific Islander	16	1.6	3	2.4	4	1.3
Native American	3	0.3	0	0	0	0
Multiracial	2	0.2	0	0	0	0
Unknown	0	0	0	0	0	0
Current NYC borough of residence						
Bronx	370	36.6	59	47.6	121	38.8
Brooklyn	236	23.3	22	17.7	82	26.3
Manhattan	218	21.6	20	16.1	64	20.5
Queens	164	16.2	21	16.9	36	11.5
Staten Island	23	2.3	2	1.6	9	2.9
Area-based poverty level						
Low poverty (<10% below FPL)	77	7.6	3	2.4	17	5.5
Medium (10% to <20% below FPL)	318	31.5	38	30.7	94	30.1
High (20% to <30% below FPL)	271	26.8	31	25.0	73	23.4
Very high poverty (≥30% below FPL)	344	34.1	52	41.9	128	41.0
Poverty level not available	1	0.1	0	0	0	0
HIV transmission risk						
Men who have sex with men (MSM)	262	25.9	32	25.8	79	25.3
Injection drug use history (IDU)	202	20.0	27	21.8	71	22.8
MSM-IDU	37	3.7	7	5.7	7	2.2
Heterosexual contact	238	23.5	21	17.0	70	22.4
Transgender people with sexual contact	12	1.2	2	1.6	1	0.3
Perinatal	1	0.1	0	0	0	0
Other/unknown	259	25.6	35	28.2	84	26.9
HIV diagnosis year						
1990 or before	115	11.4	17	13.7	40	12.8
1991–1999	363	35.9	43	34.7	130	41.7
2000–2009	401	39.7	52	41.9	114	36.5
2010–2020	132	13.1	12	9.7	28	9.0
Most recent HIV viral load[b]						
<200 cc/mL	894	88.4	113	91.1	281	90.1
200–1499 cc/mL	38	3.8	4	3.2	10	3.2
1500–9999 cc/mL	13	1.3	0	0.0	2	0.6
10 000–99 999 cc/mL	32	3.2	3	2.4	4	1.3
≥100 000 cc/mL	17	1.7	3	2.4	5	1.6
No viral load reported	17	1.7	1	0.8	10	3.2
HIV virally suppressed at last viral load						
Yes	894	88.4	113	91.1	281	90.1
No	117	11.6	11	8.9	31	9.9
Most recent CD4 cell count[b]						
<200 cells/µL	237	23.4	43	34.7	99	31.7

Table 2. Continued

	Hospitalized (Ever)		Intensive Care Unit (Ever)		Deceased[a]	
	n	Col%	n	Col%	n	Col%
200–349 cells/μL	211	20.9	28	22.6	73	23.4
350–499 cells/μL	187	18.5	21	16.9	51	16.3
≥500 cells/μL	358	35.4	30	24.2	81	26.0
No CD4 reported	18	1.8	2	1.6	8	2.6
History of AIDS diagnosis						
Yes	742	73.4	94	75.8	249	79.8
No	269	26.6	30	24.2	63	20.2
At least 1 underlying condition						
Yes	893	88.3	116	93.6	292	93.6
No	118	11.7	8	6.5	20	6.4

See Table 1 footnotes for information on demographic variables. Percentages are row percentages for total, column percentages elsewhere.
Abbreviations: cc, copies; Col%, column percentage; COVID-19, coronavirus disease 2019; HIV, human immunodeficiency virus; FPL, Federal Poverty Level; NYC, New York City; PWH, people living with HIV.

[a]Deaths include "confirmed" COVID-19 deaths (those for people with positive COVID-19 diagnostic tests) only.

[b]Laboratory data on viral load and CD4 count are reported as of 9 July 2020.

experienced ICU admission or death due to COVID-19 had at least 1 underlying condition documented in the COVID-19 surveillance database (88.3%, 93.6%, and 93.6%, respectively).

DISCUSSION

Our population-level analysis of matched surveillance data on HIV and SARS-CoV-2 infection in NYC found that people with diagnosed HIV comprised 1.06% of all confirmed COVID-19 cases in the first 14 weeks of the city's outbreak. Given that the overall prevalence of HIV in the NYC population was 1.5% in 2018 [11], this finding suggests that, compared with people without HIV, PWH might not be disproportionately vulnerable to SARS-CoV-2 infection. However, despite this encouraging finding, our analysis demonstrated that, compared with all NYC COVID-19 cases, a higher proportion of NYC PWH with COVID-19 were hospitalized for COVID-19, admitted to the ICU, and died due to COVID-19. This may not be due to HIV itself but to the fact that NYC PWH have characteristics in common with people who have been diagnosed with COVID-19 and had poor outcomes. Further analysis beyond this descriptive one is required to identify whether HIV infection is an independent risk factor for poor COVID-19–related outcomes. We also found that, compared with all NYC COVID-19 cases, a higher proportion of PWH with COVID-19 were male, older, and Black, and Latino/Hispanic, which is reflective of NYC PWH overall. However, compared with PWH without COVID-19, PWH with COVID-19 were more likely to be Latino and less likely to be White, suggesting pronounced inequities among PWH with COVID-19. More PWH with COVID-19 lived in

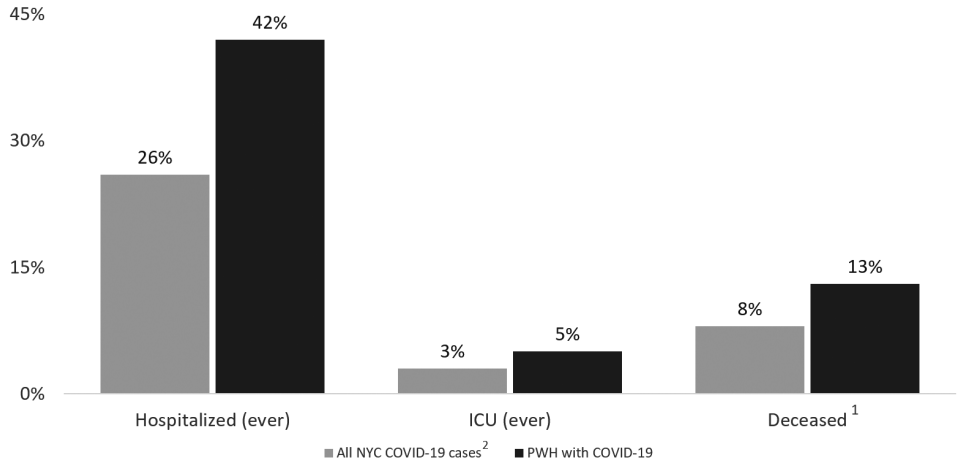

Figure 2. COVID-19–related outcomes among people with HIV and COVID-19 in NYC. [1]Deaths shown here are "confirmed" COVID-19 deaths (those among people with positive molecular-based diagnostic test for SARS-CoV-2). [2]Excludes people with diagnosed HIV. Abbreviations: COVID-19, coronavirus disease 2019; HIV, human immunodeficiency virus; ICU, intensive care unit; NYC, New York City; PWH, people living with HIV; SARS-CoV-2, severe acute respiratory syndrome coronavirus 2.

the Bronx, an NYC borough hit particularly hard by the NYC COVID-19 outbreak thus far.

Our study contributes to the limited published literature on the intersection of HIV and SARS-CoV-2 infection. The scientific community has conjectured that PWH may be especially vulnerable to poor outcomes after SARS-CoV-2 infection due to immunosuppression and/or the presence of other conditions—or, conversely, that PWH could potentially experience protection from the most serious sequelae of COVID-19 because of their history of immune response and/or because of the potential anti–SARS-CoV-2 activity of HIV antiretroviral treatments [12]. In our study, we did find that PWH who experienced poor COVID-19–related outcomes, particularly those who had been admitted to the ICU or died, had lower CD4 counts (majority had <500 cells/μL), and that PWH who had been diagnosed with HIV prior to the year 2000 were more heavily represented among those with poor COVID-19–related outcomes. Those with longer time since HIV diagnosis are more likely to be older and have other comorbid conditions, which could put them at higher risk for poor COVID-19–related outcomes. We also found a high prevalence of other comorbidities among PWH with COVID-19, which has been identified in other cohorts [13, 14]. We also saw high levels of HIV viral control in our population of PWH with COVID-19, which suggests high levels of antiretroviral coverage, and a relatively low proportion with very low CD4 cell counts. While we found that PWH and COVID-19 were more likely to have worse outcomes than COVID-19 cases overall, in a relatively small group of PWH hospitalized for COVID-19 infection in NYC Sigel et al [13] found no difference in the frequency of poor outcomes, including mechanical ventilation and death, for hospitalized PWH and non-PWH. Consistent with other studies, we found that PWH do not appear to be overrepresented among those who acquire SARS-CoV-2 infection, and in fact, the prevalence of HIV among NYC COVID-19 cases was slightly lower than NYC's overall HIV prevalence. This analysis did not examine risk for COVID-19 infection and whether risk among PWH may be influenced by differences in their likelihood to self-quarantine, especially if immunosuppressed.

This study's findings have important implications for the care of PWH. We found that racial and ethnic inequities in the NYC COVID-19 pandemic overall are mirrored—and even more pronounced—among PWH with COVID-19. Efforts to eliminate racial/ethnic inequities among PWH and for other individuals affected by HIV are central to achieving the goals of NYC DOHMH's ending the HIV epidemic (EtE) strategy [15]. Given the exacerbating effects of the COVID-19 pandemic on health inequities, including among PWH, this is a critical time for the HIV public health and clinical community to strengthen services and support for people living with and affected by HIV to protect and accelerate progress made thus far toward the EtE strategy. More rigorous exploration of COVID-19 outcomes among PWH compared with people without HIV is needed to understand which factors—older age, higher prevalence of comorbidities, and/or HIV itself—may be contributing to worse clinical outcomes. Additionally, the extent to which older age and accelerated aging related to HIV infection may contribute to these outcomes merits further investigation.

To our knowledge, this is among the largest population-level analyses to draw on data collected by surveillance systems for HIV and COVID-19, and its robustness and comprehensiveness are major strengths. Several limitations of the analysis are also noted. First, reporting lags in COVID-19 case and death data mean that very recently diagnosed individuals and deaths may have been missing from the 2 June dataset. Second, SARS-CoV-2 testing availability was not consistent throughout the analytic period; early COVID-19 cases are presumed to be under-ascertained. However, SARS-CoV-2 infection among PWH may have been more likely to be detected given their connection to healthcare. Third, there are important gaps in data collection and availability for NYC COVID-19 cases given that DOHMH is not able to investigate all cases to collect ancillary data; instead, COVID-19 laboratory test results are the primary data source and these data typically only contain limited personal information. Importantly, race/ethnicity is missing for 47% of cases in the COVID-19 surveillance dataset. We acknowledge the possibility that data are missing differentially for different race/ethnic groups depending on the data sources available (patient interview or electronic medical record if hospitalized [more complete] vs laboratory test result only [less complete]). In addition, information on underlying conditions is likely incomplete since this information is captured from clinical data, hospital records, or patient interview when available; the fact that only 39% of PWH with COVID-19 had information indicating immunodeficiency despite confirmed HIV status via the registry match suggests potentially substantial under-ascertainment of coexisting conditions in this dataset. Differential ascertainment of comorbidities is possible if PWH are more likely to be diagnosed with comorbidities since most are in continuous medical care that routinely screens for a range of comorbidities. Last, as this is a population-level analysis, we do not have data on potential differences in clinical practices that may exist across NYC hospitals with respect to criteria for hospitalization and ICU admission for COVID-19.

Conclusions

This large-scale, combined analysis of NYC COVID-19 and HIV surveillance data should inform the public health response to COVID-19 and shape approaches to service delivery and programming for people with and at risk for HIV and COVID-19 in NYC, and potentially in other jurisdictions as applicable. Even if PWH are not overrepresented among NYC COVID-19 cases thus far, their experience as a community of racism and other forms of structural oppression; their frequent exposure to poverty, housing insecurity, and other adverse socioeconomic conditions;

the high prevalence of comorbid conditions; and other challenges and vulnerabilities underscore the need to assess and respond to community needs during this time. Additional epidemiologic research on the intersection of HIV and COVID-19 is needed to inform the response, including to quantify risk for SARS-CoV-2 infection among PWH, and to identify risk factors associated with specific COVID-19–related outcomes among PWH.

Notes

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