Clinical Infectious Diseases

BRIEF REPORT

Population-Based Estimates of Coronavirus Disease 2019 (COVID-19)–like Illness, COVID-19 Illness, and Rates of Case Ascertainment, Hospitalizations, and Deaths—Noninstitutionalized New York City Residents, March–April 2020

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Using a population-based, representative telephone survey, ~930 000 New York City residents had COVID-19 illness beginning 20 March–30 April 2020, a period with limited testing. For every 1000 persons estimated with COVID-19 illness, 141.8 were tested and reported as cases, 36.8 were hospitalized, and 12.8 died, varying by demographic characteristics.

Keywords. COVID-19; burden; population-based survey; New York City; mortality.

New York City (NYC) was an early epicenter of the United States' coronavirus disease 2019 (COVID-19) outbreak. COVID-19 cases (ie, laboratory-confirmed COVID-19 diagnoses reported to the NYC Health Department) do not reflect the total COVID-19 burden of illness [1]. We conducted a population-based survey [2] to characterize the burden of COVID-19 during the initial phase of the epidemic in NYC, when healthcare and testing capacity were limited and just before the New York State Governor issued an executive order closing all nonessential businesses. We estimated percentage and number of NYC residents with COVID-19–like illness (CLI), and the subset with COVID-19 illness. We used COVID-19 surveillance and Vital Statistics data to calculate rates of COVID-19 case ascertainment, hospitalizations, and deaths per 1000 residents with COVID-19 illness.

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METHODS

We added questions to the NYC Community Health Survey (CHS) [3]. In this population-based, representative, annual, cross-sectional landline and cellular telephone survey, noninstitutionalized NYC adults (≥18 years) were interviewed in English, Spanish, Russian, and Chinese and asked about the adult survey respondent or a randomly selected child in their household. Questions included demographics, new COVID-19 symptoms 30 days or less before interview, and illness onset date. The CHS methodology is described elsewhere [3]; data were additionally weighted by person-time (Supplementary Methods).

The percentage of NYC residents with CLI was estimated using a NYC Health Department definition, defined as reporting 1 or more of the following new symptoms 30 days or less before interview: cough, subjective or measured fever (≥100.4°F or 38.0°C), shortness of breath/difficulty breathing, sore throat, loss of taste, and loss of smell. For interviews conducted 20 March–29 May 2020, we categorized people as having CLI if symptoms began during 20 March–30 April 2020. To account for people with CLI but not COVID-19, we used emergency department (ED) syndromic surveillance chief complaint and discharge diagnosis data [4]. Persons who sought ED care for CLI (Supplementary Table 1) were matched to persons reported via electronic laboratory reporting with a positive severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) polymerase chain reaction (PCR) test. We calculated the percentage of people with CLI who visited NYC EDs, were tested, and had a positive test. This percentage was multiplied by the weighted number of survey respondents with CLI to estimate the citywide number of residents with COVID-19 illness. Uncertainty intervals (UIs) were calculated, accounting for variability when combining this percentage with population estimates using Monte Carlo replicates [5] to simulate this product's distribution (Supplementary Methods).

We estimated case ascertainment, hospitalization, and death rates per 1000 residents with COVID-19 illness using reportable disease and Vital Statistics data. Institutionalized individuals who resided or died in congregate living facilities (eg, nursing homes, shelters, correctional settings) were excluded from all analyses. To align the survey data's illness onset timing with administrative data, we applied time lags between illness onset, date of diagnosis, hospitalization, and death.

We used 3 death definitions: decedents with confirmatory laboratory evidence of COVID-19 ("confirmed deaths"), decedents with "COVID-19" or related terminology on the death certificate for cause of death but without laboratory confirmation within 60 or fewer days of death ("probable deaths"),

and the estimated number of deaths beyond seasonally expected levels ("excess deaths") (Supplementary Methods) [6]. Excess deaths represent an upper possible boundary of deaths caused by COVID-19 illness, although this might reflect deaths attributable to reduced care seeking and non–COVID-19 causes. Analyses were conducted using SAS version 9.4.1 (SAS Institute), SUDAAN version 11.0.1 (RTI International), and R version 3.5.2 (R Foundation for Statistical Computing). Estimates accounted for complex sample design. We conducted 2-sided *t* tests of survey data. Small sample sizes prohibited age adjustment of stratified data. The CHS annual cooperation and response rates were calculated (Supplementary Methods).

RESULTS

During 20 March–29 May 2020, we interviewed 2757 respondents (Supplementary Figure 1). An estimated 13.8% (95% confidence interval [95% CI]: 11.4%, 16.7%) had CLI with onset during 20 March–30 April 2020 (Supplementary Table 2). The overall age-adjusted estimate was 13.6% (95% CI: 11.2%, 16.2%). Children aged 17 years or younger (8.3%; 95% CI: 5.1%, 13.2%) and adults aged 65–74 years (5.8%; 95% CI: 2.7%, 12.4%) and 75 years or older (3.5%; 95% CI: 2.0%, 6.2%) had a lower percentage of CLI than those aged 18–44 years (20.2%; 95% CI: 15.7%, 25.7%). The percentage of Bronx residents with CLI was nearly 2-fold higher compared with Manhattan residents, although not significantly different (20.1% [95% CI: 13.2%, 29.4%] vs 11.1% [95% CI: 6.7%, 17.8%]) (Supplementary Table 2). COVID-19–like illness percentage was similar by sex and race/ethnicity. The 2020 CHS cooperation and response rates were 74.4% and 7.4%, respectively.

Of people with CLI who presented to NYC EDs and were tested, 81.8% were diagnosed with COVID-19, ranging from 30.3% among 0 to 17-year-olds to 86.1% among 45 to 64-year-olds (Supplementary Table 3). Of 8 218 000 noninstitutionalized NYC residents, we estimated 930 000 (UI: 735 000–1 118 000) or 11.3% (UI: 9.0–13.6%) had COVID-19 illness beginning during 20 March–30 April 2020 (Table 1). For every 1000 estimated residents with COVID-19 illness, 141.8 people (14.2%) were

Table 1. Estimates of COVID-19 Illness That Began During 20 March–30 April 2020 and Hospitalization and Death Rates per 1000 Residents With Estimated COVID-19 Illness, New York City

	Percentage of Residents With COVID-19 Illness		Hospitalizations[a]		Confirmed COVID-19 Deaths[b]		Confirmed and Probable COVID-19 Deaths[b]		Excess Deaths[b]	
	%	UI[c]	Per 1000	UI	Per 1000	UI	Per 1000	UI	Per 1000	UI
Total	11.3	(9.0, 13.6)	36.8	(30.6, 46.6)	10.4	(8.7, 13.2)	12.8	(10.7, 16.2)	14.1	(11.7, 17.8)
Age group (years)										
0–17	2.5	(1.3, 3.8)	6.9	(4.5, 13.7)	0.2	(0.1, 0.3)	0.2	(0.1, 0.4)	-0.3	(-0.9, 0.1)
18–44	15.9	(11.4, 20.4)	10.2	(7.9, 14.1)	0.8	(0.6, 1.1)	0.9	(0.7, 1.3)	1.0	(0.8, 1.4)
45–64	11.7	(6.6, 16.9)	51.2	(35.5, 90.7)	9.9	(6.9, 17.5)	12.4	(8.6, 22.0)	12.9	(8.9, 23.1)
65–74	5.1[d]	(1.4, 9.0)	222.3[d]	(125.3, 789.2)	73.4[d]	(41.4, 260.7)	88.1[d]	(49.6, 312.6)	93.0[d]	(52.4, 329.9)
≥75	2.9	(1.4, 4.3)	596.6	(394.7, 1000.0)	298.0	(197.2, 625.6)	367.3	(243.0, 770.9)	425.7	(281.3, 895.9)
Sex at birth										
Female	11.9	(8.7, 15.2)	28.7	(22.5, 39.3)	7.3	(5.8 10.0)	9.2	(7.2, 12.5)	10.2	(8.0, 14.0)
Male	10.6	(7.3, 13.6)	47.2	(36.5, 68.0)	14.4	(11.2, 20.8)	17.5	(13.6, 25.2)	19.1	(14.7, 27.4)
Race/ethnicity										
Asian or Pacific Islander	9.1[d]	(3.3, 14.8)	21.8[d]	(13.4, 59.0)	7.4[d]	(4.5, 19.9)	9.4[d]	(5.7, 25.3)	11.3[d]	(6.9, 30.8)
Black	10.8	(5.3, 16.0)	47.6	(31.9, 96.1)	13.6	(9.2, 27.5)	17.3	(11.6, 34.9)	18.8	(12.6, 38.0)
Latino/a	14.0	(9.3, 18.4)	31.2	(23.6, 46.8)	9.9	(7.5, 14.9)	11.9	(9.0, 17.8)	12.5	(9.5, 18.7)
White	10.8	(6.8, 14.7)	22.0	(16.1, 35.1)	7.6	(5.6, 12.1)	9.3	(6.8, 14.8)	10.4	(7.6, 16.5)
Borough of residence										
Bronx	16.6	(8.9, 24.2)	32.5	(22.4, 60.8)	8.5	(5.9, 16.0)	10.4	(7.1, 19.4)	11.4	(7.8, 21.2)
Brooklyn	9.8	(6.3, 13.5)	38.8	(28.3, 60.3)	13.0	(9.5, 20.2)	16.4	(12.0, 25.5)	18.1	(13.2, 28.2)
Manhattan	8.1	(3.8, 12.2)	39.0	(25.9, 83.7)	10.5	(6.9, 22.5)	12.8	(8.5, 27.4)	13.9	(9.2, 29.8)
Queens	13.9	(9.0, 18.8)	34.2	(25.3, 53.0)	8.7	(6.5, 13.5)	10.6	(7.8, 16.4)	11.7	(8.7, 18.1)
Staten Island	2.7[d]	(0.7, 4.9)	103.2[d]	(57.3, 396.0)	32.4[d]	(18.0, 124.3)	36.4[d]	(20.2, 139.7)	39.8[d]	(22.1, 152.8)

Data are from the New York City (NYC) 2020 Community Health Survey, syndromic surveillance, electronic laboratory reporting, reportable disease surveillance, and NYC Vital Statistics data.
Abbreviations: COVID-19, coronavirus disease 2019; UI, uncertainty interval.

[a]Hospitalizations among patients with laboratory-confirmed COVID-19 diagnosis admitted during 27 March–7 May 2020, accounting for 7-day median lag between illness onset during 20 March–30 April 2020 and diagnosis and 0-day median lag between diagnosis and hospital admission.

[b]Deaths during 4 April–15 May 2020 among patients with a laboratory-confirmed COVID-19 diagnosis ("confirmed deaths"), laboratory-confirmed COVID-19 diagnosis or COVID-19 or similar on the death certificate ("confirmed & probable deaths"), and excess deaths, accounting for 7-day median lag between illness onset during 20 March–30 April 2020 and diagnosis and 8-day median lag between diagnosis and death.

[c]Uncertainty intervals generated from Monte Carlo simulations and represent the 2.5th and 97.5th percentile of simulated distribution.

[d]Percentages and rates should be interpreted with caution as the denominator of estimated COVID-19 illness had either a relative standard error (a measure of estimate precision) that was >30%, the 95% confidence interval's half-width was >10, or the sample size was too small, making the estimate potentially unreliable.

tested and reported as cases, 36.8 (3.7%) were hospitalized, and there were 10.4 (1.1%) confirmed deaths, 12.8 (1.3%) confirmed and probable deaths, and 14.1 (1.4%) excess deaths (Table 1, Supplementary Figure 2, Supplementary Table 4). Residents aged 75 years and older had hospitalization rates more than 50 times higher than those aged 18–44 years (596.6 [UI: 394.7–1000.0] vs 10.2 [UI: 7.9–14.1]) and confirmed and probable death rates more than 400 times higher than those aged 18–44 years (367.3 [UI: 243.0–770.9] vs 0.9 [UI: 0.7–1.3]). Despite similar estimates of COVID-19 illness in males compared with females (11.9% [UI: 8.7–15.2%] vs 10.6% [UI: 7.3–13.6%]), males had higher hospitalization rates (47.2 [UI: 36.5–68.0] vs 28.7 [UI: 22.5–39.3]) and confirmed and probable death rates (17.5 [UI: 13.6–25.2] vs 9.2 [UI: 7.2–12.5]). Hospitalization rates were highest among Black (47.6; UI: 31.9–96.1) and Latino/a (31.2; UI: 23.6–46.8) residents compared with White residents (22.0; UI: 16.1–35.1), and similar inequities were observed in death rates (Table 1, Supplementary Table 4).

DISCUSSION

We used population-based survey data to estimate that more than 900 000 NYC residents had COVID-19 illness beginning during 20 March–30 April 2020. Our case ascertainment rate was 14.2%, meaning that for each confirmed COVID-19 case, there were an estimated 7 residents with COVID-19 illness. Asymptomatic SARS-CoV-2 infections represent as many as 40–45% of all infections [7] and would not be detected by this study. Antibody testing captures asymptomatic and symptomatic cases, so it follows that our estimate is lower than that from a serologic study of NYC residents during 23 March–1 April (11.9 infections/case) [8].

The COVID-19 outbreak has illuminated substantial health inequities [9]. No differences were noted in CLI by race/ethnicity, an unexpected finding considering Black and Latino/a residents are overrepresented among essential workers and multigenerational households [9, 10]. Our point estimates of hospitalization and death rates among Black and Latino/a persons, however, were highest despite wide UIs. Systemic racism and social determinants of health, including access to care, underlying health conditions, and age distribution differences, might contribute to varying disease severity across NYC populations [9].

COVID-19–like illness definition accuracy could not be assessed; however, we calculated a similar CLI percentage, 13.9% (95% CI: 11.4%, 16.7%), using the Council of State and Territorial Epidemiologists definition (Interim-20-ID-02) with our survey data [11]. For specificity, our CLI definition did not include rare COVID-19 manifestations (eg, neurologic or multisystem inflammatory symptoms). Institutionalized adults, who represent populations with substantial COVID-19 burden, were not included, likely decreasing our estimates [12, 13]. Potential nonresponse bias could not be assessed. NYC residents who died outside of NYC were not reflected in the Vital Statistics data. We assumed the same percentage of test positivity among people with CLI who received a SARS-CoV-2 test and those who did not visit an ED, likely inflating our estimates, because people with severe illness were more likely to seek emergency care. Small sample sizes in stratified data limited point estimate comparisons and age adjustments. Lastly, these data did not contribute to real-time situational awareness because of the time needed to collect survey data, calculate survey weights, and estimate time lags between illness onset, date of diagnosis, hospitalization, and death.

Burden of disease studies help quantify how many people became sick during an outbreak and the differential burden among populations. The NYC Health Department rapidly added questions to an existing general health surveillance survey to capture population-based data on symptoms and healthcare seeking during a period of limited testing. When responding to future emerging infectious diseases, adding questions to an existing survey platform can aid in measuring the burden of illness when testing is limited. We recommend asking about illness onset in the prior calendar month instead of the past 30 days to simplify calculating the percentage and number of residents with new symptoms. An ongoing serosurvey linked to this population-based survey will aid in more completely characterizing the direct and indirect effects of the COVID-19 outbreak; findings are forthcoming.

Supplementary Data

Supplementary materials are available at *Clinical Infectious Diseases* online. Consisting of data provided by the authors to benefit the reader, the posted materials are not copyedited and are the sole responsibility of the authors, so questions or comments should be addressed to the corresponding author.

Notes

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