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COVID-19 Testing, Epidemic Features, Hospital Outcomes, and Household Prevalence, New York State—March 2020

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(See the Editorial Commentary by Althoff et al on pages 1960–1.)

Background. The US' coronavirus disease 2019 (COVID-19) epidemic has grown extensively since February 2020, with substantial associated hospitalizations and mortality; New York State has emerged as the national epicenter. We report on the extent of testing and test results during the month of March in New York State, along with risk factors, outcomes, and household prevalence among initial cases subject to in-depth investigations.

Methods. Specimen collection for COVID-19 testing was conducted in healthcare settings, community-based collection sites, and by home testing teams. Information on demographics, risk factors, and hospital outcomes of cases was obtained through epidemiological investigations and an electronic medical records match, and summarized descriptively. Active testing of initial case's households enabled estimation of household prevalence.

Results. During March in New York State, outside of New York City, a total of 47 326 persons tested positive for severe acute respiratory syndrome coronavirus 2, out of 141 495 tests (33% test-positive), with the highest number of cases located in the metropolitan region counties. Among 229 initial cases diagnosed through 12 March, by 30 March 13% were hospitalized and 2% died. Testing conducted among 498 members of these case's households found prevalent infection among 57%, excluding first-reported cases 38%. In these homes, we found a significant age gradient in prevalence, from 23% among those < 5 years to 68% among those ≥ 65 years ($P < .0001$).

Conclusions. New York State faced a substantial and increasing COVID-19 outbreak during March 2020. The earliest cases had high levels of infection in their households and by the end of the month, the risks of hospitalization and death were high.

Keywords. COVID-19; testing; surveillance; prevalence.

The coronavirus disease 2019 (COVID-19) emerged in Wuhan, China, in December 2019 and was first diagnosed in the United States in Washington State on 20 January 2020 [1]. On 2 March, the first nontravel associated case of COVID-19 in New York State was diagnosed in Westchester County, adjacent to New York City. Following a 7 March declaration of emergency by the governor, which enhanced public health efforts by allowing expedited purchasing and an expanded testing protocol through multiple means, expanded access to testing was a priority in the New York State response effort [2]. By 31 March, New York State had the largest number of cases in the United States: 47 326 laboratory-confirmed cases (New York City had over 58 000 additional cases and reports). Although national reports have tracked the progression of diagnoses reported by states to the Centers for Disease Control and Prevention (CDC), which are subject to delays and incompleteness, and some states have set up provisional online "dashboards," no complete descriptions of diagnoses made in US states have been published [3]. Furthermore, published US data on total number of tests are lacking, precluding understanding of the extent of screening and the test-positive percent, which describes the yield of testing in discovering new cases and is a critical statistic for informing epidemic trajectory.

Although in the majority of cases, COVID-19 causes mild illness, more severe illness has been associated with older age and comorbidities such as chronic obstructive pulmonary disease, diabetes, hypertension, and coronary heart disease [4, 5]. A recent analysis of severe outcomes among 4226 COVID-19 cases described hospitalization among 12% of patients and intensive care unit (ICU) admissions among 2.9% of patients [5]. Few published studies exist on the distributions of demographics, comorbidities, and hospital outcomes, including deaths, in the US context, or those that exist have with high levels of

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missingness and have limited detail in each geographic setting, despite significant heterogeneity in the timing and magnitude of COVID-19 epidemics across US states [3, 5]. These outcomes are imperative for understanding healthcare burden due to COVID-19 and predicting future burden as the pandemic continues.

Person-to-person transmission of the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), the virus that causes COVID-19, is primarily from close contact with an infected person and subsequent exposure to respiratory droplets [6]. Given this, households represent a particularly high-risk transmission environment, and accordingly quarantine recommendations call for the isolation of infected household members while others in the household undergo quarantine [7]. Data on the prevalence or incidence of COVID-19 among household contacts or the efficacy of such quarantine measures remain lacking, yet analyses of test-results at the household level can fill this gap [8].

In this report, we provide an overview of SARS-CoV-2 testing in New York State through 31 March and describe the demographics, risk-factors, symptoms, comorbidities, and hospital outcomes for the first 229 COVID-19 cases, from epidemiological investigations and hospital record-linkage. Using address-linked testing data we assess the prevalence of COVID-19 among household contacts of these cases.

METHODS

SARS-CoV-2 testing became available in New York State in early March under Food and Drug Administration emergency use authorization at the Wadsworth Center, the New York State Department of Health's (NYSDOH) public health laboratory, and quickly expanded to other public health, commercial, and hospital clinical laboratories over the month. Throughout March, COVID-19 home testing teams and alternative specimen collection sites enhanced community testing, improving individuals' access to testing, and decreasing healthcare system burden. We tabulated daily totals of SARS-CoV-2 tests performed, the number of positive results, and the test-positive percent, as well as cumulative numbers of positive results by day and region.

During investigations by county health departments and NYSDOH staff, additional demographic, exposure risk factors, symptomology, comorbidities, and hospitalization outcomes were collected from interviews, medical providers, and medical records and entered into a standardized case report form, based on CDC's form. We examined the first 229 reported cases from New York State, outside of New York City, from 2 March to 12 March 12 2020, which had relatively high investigation completion during this early portion of the outbreak. Cases were further matched against electronic medical record data from the Statewide Health Information Exchange (HIE) Network for New York: a listing of all inpatients with suspected or confirmed COVID-19, including date of admission, date of discharge, and disposition (discharged alive, still in-hospital, died in-hospital), was available from all hospitals in New York City, Nassau County, Suffolk County, and all but one in Westchester County. We summarized data overall and by age group, performing Fisher exact tests to assess key associations.

During this period, contract tracing and active case-finding was attempted by county and state health department staff, including for community members and household contacts of diagnosed persons. Beginning 5 March, all household contacts, irrespective of symptoms, were eligible for home testing for SARS-CoV-2, performed by health department staff. Using data through 17 March, positive and negative laboratory COVID-19 test results were grouped into households, as follows. Two reviewers manually assigned household IDs to all unique addresses, determined by a manual review of all sorted street addresses, which was feasible given the limited extent of testing during this period. In the event of nearly identical, but not exact, addresses, within a city, additional matches were made by correcting address errors and considering shared last names. We pooled persons across households to estimate overall COVID-19 prevalence among all households, including and excluding the first-reported case [9]. We compared pooled prevalence estimates by contact age and household, using χ^2 tests.

RESULTS

As of 31 March, in New York State, outside of New York City, 47 326 persons had tested positive for SARS-CoV-2 virus (Figures 1–2). By the end of the first week of March (7 March), 76 positive results were reported to NYSDOH. Positive results accrued daily to 1083 by the end of the second week (14 March, 14.3-fold increase), to 12 691 (21 March, 11.7-fold), to 32 121 (28 March, 2.5-fold). Per Figure 2, cases emerged earliest in the New York Metropolitan Region and remained most numerous in those counties (top 3 counties: Nassau (17 678), Suffolk (15 272), Westchester (14 601). During this period, a total of 141 495 tests were reported to New York State, from 15–31 March, an average of 8336 tests per day (range 2428–10 714), During the latter half of March, with stable testing numbers, the statewide positivity rate continued to climb, increasing from a minimum of 11% to 48% at the end of the month.

Among the first 229 cases reported through 12 March the median age was 43 years (interquartile range: 24–56 years, range: 1–96 years), and 129 (56%) were male (Table 1). Travel-associated risk factors were lower (recent travel reported outside the United States [9%] and outside New York State [21%]) than reporting contact with a confirmed case (79%). Sixteen percent were healthcare workers (HCW). Comorbidities were reported for 33 (30%) of 111 cases with completed comorbidity data and ranged from 0% among those < 5 years to 67% among those ≥ 65 years ($P = .0002$). Hypertension (39%), diabetes

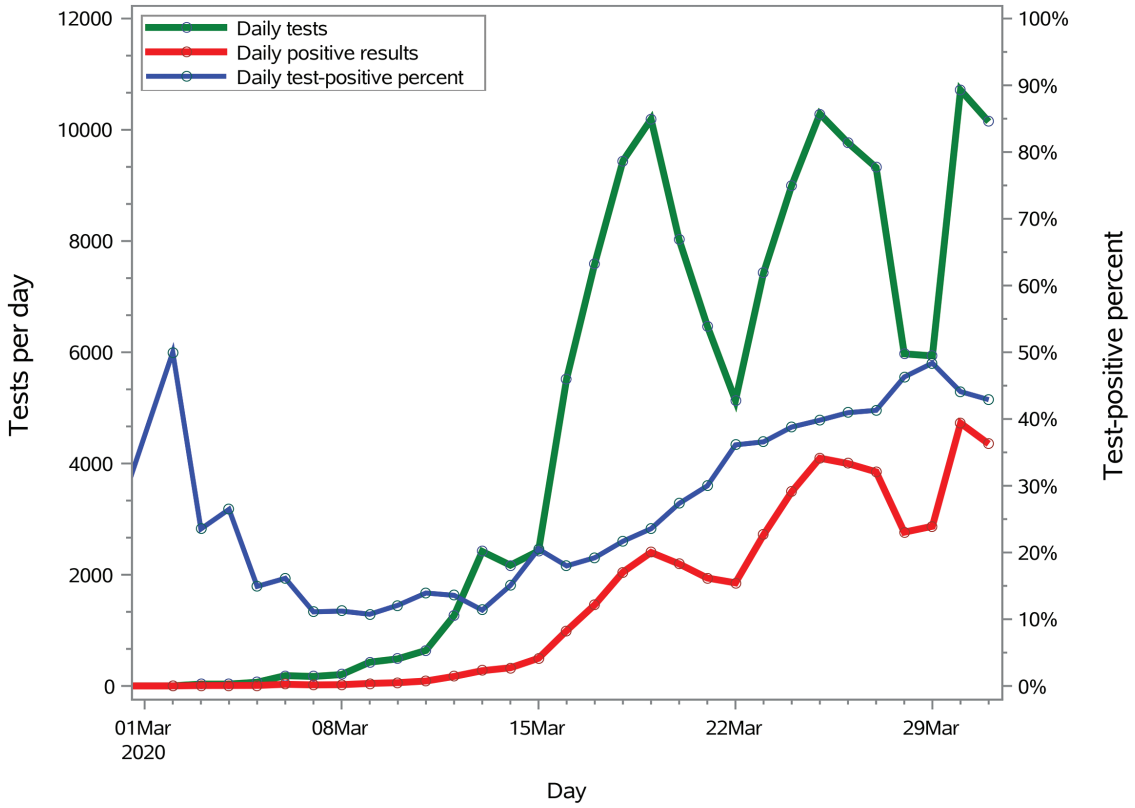

Figure 1. Testing for coronavirus disease 2019 (COVID-19), New York State (excluding New York City), March 2020.

(29%), and asthma (23%) were the most commonly reported conditions. Symptoms of fever, cough, or shortness of breath were reported by 112 (76.0%) of 148 cases with completed symptom data, with lower levels of these symptoms reported by those < 18 years versus those ≥18 years (25% [7/28] vs 88% [105/119], $P < .0001$).

Of 112 cases with complete epidemiological investigation data on hospitalization status, 16% were reported hospitalized, ranging from no cases < 18 years hospitalized to 44% of those ≥ 65 years ($P = .004$). Separately, matching 201 cases who reside in Nassau, Suffolk, and Westchester Counties to electronic HIE records, we found 27 (13%) were hospitalized through 30 March, with similar age patterns. Among those hospitalized, 56% were discharged alive after a median stay of 5 days, 30% were still in-hospital as of 30 March with a median stay of 17.5 days (maximum 23 days), and 4 died in-hospital (2.0% of cases [exact 95% confidence interval: [.5, 5.0] and 5% of those hospitalized). Two decedents were males, ages 78 and 84, who respectively died after 11 and 8 days after admission, with the older patient having known comorbidities of diabetes and pulmonary tuberculosis. The 2 females were ages 76 and 82 years with no reported comorbidities, who respectively died 8 and 15 days after admission.

Molecular SARS-CoV-2 testing was conducted for 498 total persons in the households of the initial 229 cases (Table 2). COVID-19 prevalence was 57% (286/498); excluding the first-reported case per household yielded 131/343 (38%) infected household contacts. Among 103 households with ≥ 1 member(s) other than the initial case tested, 26 (25.2%) had all members test positive, whereas in 40 (38.9%) households all tested negative. Among the 343 persons classified as household contacts of first-reported cases, 148 (43%) were tested on a different day after the first-reported case, at a mean of 3.7 days (standard deviation = 2.9; median = 3, maximum = 10 days) later. Prevalence significantly increased with age, ranging from 23% among those aged < 5 years to 68% among those 65 years or older ($P < .0001$).

DISCUSSION

Our report illustrates the large extent of COVID-19 in New York State outside of New York City during March 2020, particularly in the counties closest to New York City, but also accruing over time in other counties statewide. New York currently has the most diagnoses in the United States, which reflects both a significant epidemic and a marked scaling up of testing during March, to over 100 000 tests performed [10]. The positivity rate of COVID-19 disease tests performed in the state continued to increase, whereas the total number of tests was stable in the latter half of March. These data may suggest

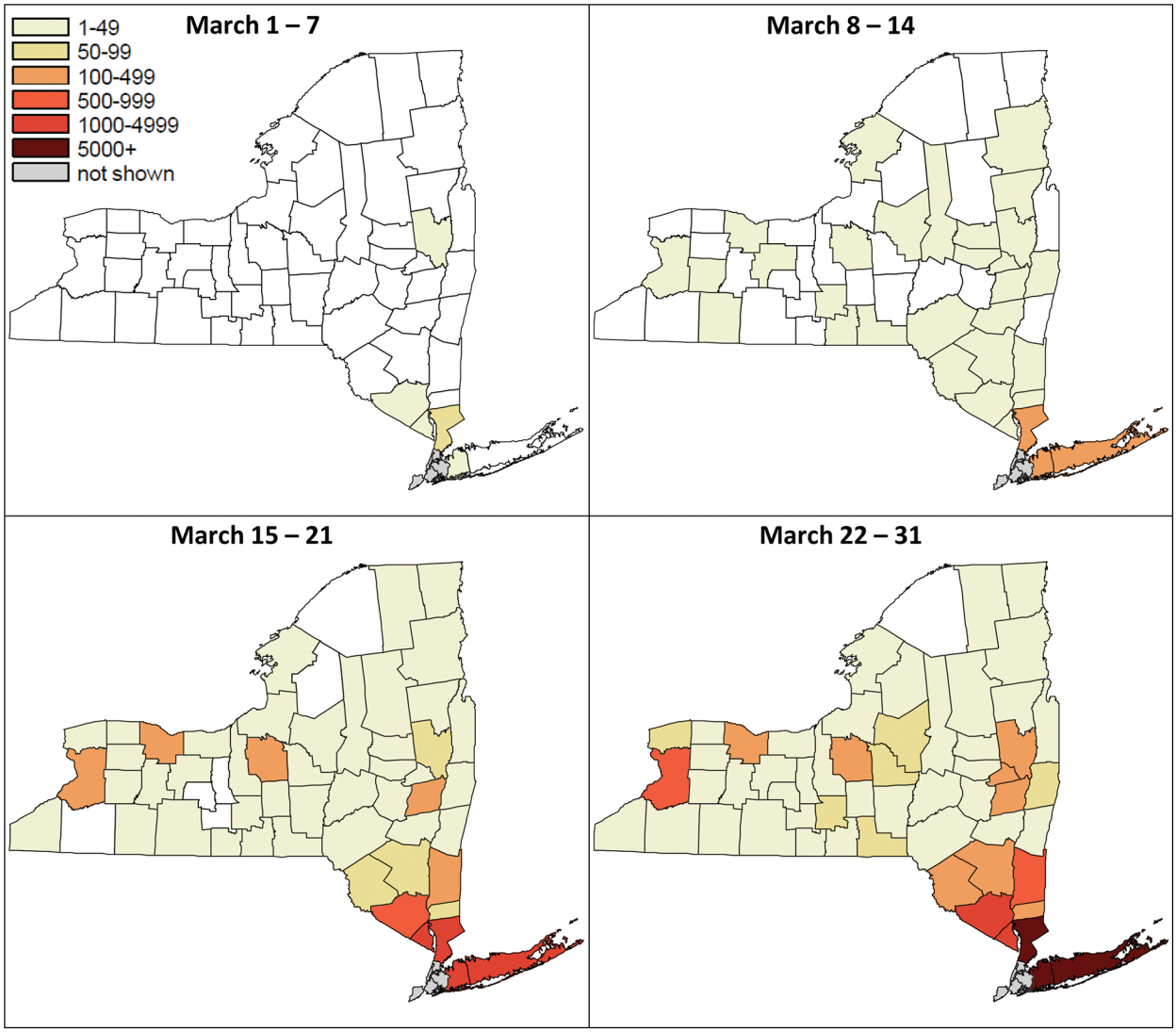

Figure 2. Cumulative diagnoses of COVID-19 by county and week, New York State (excluding New York City), March 2020. We note several milestones in the expansion of testing, 1 March: New York State (NYS) Wadsworth Center begins FDA-approved SARS-CoV-2 testing; 5 March: increased testing of close and community contacts of cases via home testing; 7 March: NYS governor emergency declaration expanded testing capacity; 9 March: expanded testing criteria includes contacts of cases, travelers from affected counties, symptomatic persons in quarantine, symptomatic persons and not positive for another infection; 13 March: beginning of community drive-through testing in most-affected counties. Abbreviations: COVID-19, coronavirus disease 2019; FDA, Food and Drug Administration; SARS-CoV-2, severe acute respiratory syndrome coronavirus 2.

that testing for COVID-19 disease had increasingly been used as a diagnostic strategy in New York State over this time period with prioritization of testing for healthcare workers and hospitalized patients, which may result in underestimation of total prevalence [11]. Although testing approaches used early on and modeling has been a primary method to estimate the number of nonhospitalized persons with COVID-19, other approaches such as seroprevalence studies should be considered as serologic tests are finalized, validated, and become more widely available.

Males were overrepresented among the first 229 cases observed in New York State at levels similar to but slightly lower than those reported in the outbreaks in China (58%) and Italy (60%) [12, 13]. The reasons for overrepresentation of males across different settings remain unclear, but this may be related to an increased likelihood of developing severe symptoms and presentation to care, although risk factors such as smoking have been proposed [14]. Travel histories reported by these cases are consistent with community transmission of SARS-CoV-2 [12, 15]. Our finding that 76% of cases experienced fever, cough, or shortness of breath is slightly lower than what is within the ranges reported elsewhere, possibly reflecting more mildly symptomatic cases identified through early case-finding efforts but is higher than those found through extensive screening in a Seattle-area nursing home [13, 16, 17].

Among these first 229 cases the extent of hospitalization, ICU admissions, and intubation were all high. Hospitalization rates

Table 1. Demographics, Risk Factors, Comorbidities, Symptoms, and Hospital Outcomes for Persons Diagnosed With Coronavirus Disease 2019 (COVID-19), New York State (Excluding New York City), 2–12 March 2020

Demographics	%	(n)
Sex		
Male	56.3	(129/229)
Female	43.7	(100/229)
Pregnant	5.9	(2/34)
Age (years)		
0 – 4	28.6	(2/7)
5 – 17	43.2	(16/37)
18 – 29	22.2	(4/18)
30 – 49	45.6	(36/79)
50 – 64	49.2	(29/59)
65+	48.2	(13/27)
Race/ethnicity		
Hispanic	13.6	(8/59)
Black, non-Hispanic	6.8	(4/59)
White, non-Hispanic	69.5	(41/59)
Other	10.2	(6/59)
Risk factors	%	(n)
Travel outside US within 14 days	9.0	(11/122)
Travel outside NYS within 14 days	21	(25/119)
Contact with lab-confirmed case	78.9	(82/104)
Is healthcare worker	16.2	(16/99)
Comorbidities	%	(n)
Any comorbidity reported	29.7	(33/111)
Chronic pulmonary disease	9.7	(3/31)
Diabetes	29.0	(9/31)
Cardiac disease	16.1	(5/31)
Immunocompromised	6.5	(2/31)
Hypertension	38.7	(12/31)
Asthma	22.6	(7/31)
Other comorbidity[a]	41.9	(13/31)
Symptoms	%	(n)
Any symptoms reported	82.6	(123/149)
Any fever, cough, shortness of breath	75.6	(112/148)
Fever	58.6	(85/145)
Cough	63.5	(92/145)
Shortness of breath	26.1	(31/119)
Other symptoms[b]	62.7	(89/142)
Hospital outcomes	%	(n)
Per epidemiological investigation[c]		
% Hospitalized	16.1	(18/112)
Stayed in ICU	64.3	(9/14)
Required intubation	42.9	(6/14)
Per Health Information Exchange[d]		
% Hospitalized	13.4	(27/201)
Disposition as of 30 March 2020		
Discharged alive	55.6	(15/27)
Still in-hospital	29.6	(8/27)
Died in-hospital	14.8	(4/27)
Length of stay, by disposition	Median	(Q1, Q3, max)
Discharged alive	5	(4, 7, 14)
Still in-hospital	17.5	(17, 18.5, 23)
Died in-hospital	9.5	(8, 13, 15)

Abbreviations: ICU, intensive care unit; NYS, New York State; US, United States.

[a]Other comorbidities: Alzheimer's disease, Crohn's disease, dementia, heart defect, hypothyroidism, leukopenia, myasthenia, non-Hodgkin's lymphoma, pheochromocytoma, prediabetes, prostate cancer, and breast cancer.

[b]Other symptoms: Abdominal pain, chills, diaphoresis, diarrhea, fatigue, headache, muscle ache, nausea, sneezing, stuffed or runny nose, and vomiting.

[c]Based on findings from health department staff after the time of diagnosis, which may involve interviews with the case and healthcare providers, as well as examination of medical records.

[d]Based on record-linkage with 2 large Regional Health Information Organizations, representing the electronic medical records for all of Long Island and New York City and all but 1 hospital in Westchester County. This analysis is therefore limited to the 201/229 (88%) of cases reported from Nassau, Suffolk, and Westchester Counties.

were similar to those in a recent national report, although this analysis provides additional information on age groups, intubation, and length of stay. Although the majority of hospitalized patients were discharged within a week, 30% remained hospitalized at a median of 17.5 days. The proportion admitted to the ICU was higher in this sample and may be due to higher levels of testing among more severely ill persons in the earliest phase of the NYS outbreak. The proportion of cases who had died (2%) is consistent with estimates observed in the United States, although these estimates are subject to change over time [18].

Our finding that in households with cases over half of persons had COVID-19 aligns with a recent report from fewer households in Wuhan, China, and suggests substantial risk of transmission in this setting, although common sources cannot be ruled out [19]. These estimates can inform future follow-up studies to understand incidence in households and the effectiveness of and adherence to quarantine or other prevention strategies. We urge further action to develop and deploy effective strategies for home quarantine and caring for those ill, particularly in the context of limited personal protective equipment. Although the observed age gradient in symptom development has been noted by others, this together with our finding of an analogous age gradient in prevalence may help to further explain why children are less represented in diagnosed persons, particularly those presenting for care [20].

Our results are subject to several limitations. Responses for demographics, risk factors, comorbidities, and hospital outcomes were each available for about half of the cases, and for race/ethnicity specifically about one-quarter; those with complete information may differ from those with missing information. These completion levels are substantially higher than the only previous US report, and hospital outcomes align with that report and the more complete data from the HIE match [18]. Nonetheless, hospitalizations and deaths determined by that match may be lower-bound estimates, as cases may have

Table 2. Prevalence of Coronavirus Disease 2019 (COVID-19) in Households of Persons Diagnosed in New York State (excluding New York City), 2–13 March 2020

	All Household Members				All Household Members, Excluding First-reported Case			
	N	n	%	*P* value	N	n	%	*P* value
Overall (155 households)	498	286	57.4		343	131	38.2	
No. of persons tested in household				.10[a]				.065
1 (52 households)	52	52	100.0		...	...	...	
2 (31 households)	62	44	71.0		31	13	41.9	
3 (15 households)	45	33	73.3		30	18	60.0	
4 (14 households)	56	28	50.0		42	14	33.3	
≥5 (43 households)	283	129	45.6		240	86	35.8	
Households > 1 person	446	234	52.5	<.001	343	131	38.2	.002
0 to < 5 years	26	6	23.1		25	5	20.0	
5 to < 18 years	138	44	31.9		131	37	28.2	
18 to < 30 years	29	15	51.7		24	10	41.7	
30 to < 50 years	115	75	65.2		71	31	43.7	
50 to < 65 years	92	65	70.7		58	31	53.4	
65 + years	41	28	68.3		29	16	55.2	
Missing date of birth	5	1	20.0		5	1	20.0	

[a]Test excludes the 52 households with 1 case person only

attended hospitals outside the metropolitan NY catchment area represented in the HIE data and because more hospitalizations may accrue over time. Household prevalence results represent a period prevalence around the time of the first-diagnosed case in the home, and it is possible ongoing transmission occurred afterward. Furthermore, given the use of RNA-only testing, it is possible some household members cleared their infection, possibly differentially by age, and prevalence may have been higher, although 43% were tested on the same day as the first case and half within 4 days.

New York State continues to be heavily impacted by COVID-19 and is implementing a variety of nonpharmaceutical interventions to control the disease, including school closures, restrictions on mass gatherings, remote work requirements for nonessential employees, and other actions. Estimates in this report can be used to inform ongoing response efforts as well as other states' responses and parameterize models of epidemic extent and healthcare resources required to accommodate surge periods. Follow-up studies are underway to understand the spectrum of symptoms, illness, hospital utilization, and potential treatment approaches for persons with COVID-19 in New York State.

Notes

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