Estimating the period prevalence of SARS-CoV-2 infection during the Omicron (BA.1) surge in New York City (NYC), January 1-March 16, 2022

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Abstract

In a population-based survey of NYC adults, we assessed positive SARS-CoV-2 tests (including via exclusive at-home testing) and possible cases among untested respondents. An estimated 27.4% (95%CI: 22.8%-32.0%) or 1.8 million adults (95%CI: 1.6-2.1 million) had SARS-CoV-2 infection between January 1 and March 16, 2022.

Keywords: surveillance, prevalence, at-home rapid SARS-CoV-2 tests, population-based surveys

Introduction:

Routine case-based surveillance data on individuals who test or present to care for SARS-CoV-2 underestimate the true burden of SARS-CoV-2 infection in the general population due to 1) undiagnosed/untested cases[1]; and 2) the exclusive use of at-home rapid tests which are not reflected in routine case surveillance in the U.S.[2] The degree of underestimation could be differential by geographic and sociodemographic factors, and vary over time[3,4]. Concerns raised about the potential for biased interpretation of SARS-CoV-2 case counts, case rates, and test positivity rates recently led the Centers of Disease Control and Prevention (CDC) to update their guidelines for community COVID-19 metrics to inform community prevention measures, shifting emphasis to hospital admissions and deaths[2]. While important, elevated hospital admissions and deaths resulting from a surge lag behind increases in community transmission, resulting in missed opportunities for earlier mitigation of a surge.

Despite these national shifts in emphasis, the number of new cases and the test positivity rates among SARS-CoV-2 testers are still relied on by local governments, citizens, and the news media to infer levels of SARS-CoV-2 community transmission and to trigger action. This could be increasingly problematic, especially early in surges, due to time-varying factors such as decreased test-seeking behaviors and increased access to and availability of at-home testing, which complicate the interpretation of these metrics[5].

This study aimed to assess the extent to which routine case surveillance underestimated the burden of SARS-CoV-2 infections during the recent Omicron surge.

Methods

We conducted a cross-sectional survey March 14-16, 2022, of 1,030 adult New York City (NYC) residents. Respondents were asked about SARS-CoV-2 testing and related outcomes *since January 1, 2022,* which represents the second half of the Omicron BA.1 surge in NYC. Survey weights were applied to generate estimates for NYC residents aged 18+. Additional details on the survey design are included in the *Statistical Appendix*. The study protocol was approved by the City University of New York (CUNY) Institutional Review Board.

Period Prevalence Estimation

The survey questionnaire ascertained the types and results of viral diagnostic tests taken between January 1, 2022, and survey date (March 14-16, 2022), including PCR, rapid antigen and/or at-home rapid tests. The survey also captured information on COVID-19 symptoms among respondents during this time period, as well as known close contacts with a confirmed or probable case of SARS-CoV-2 infection. COVID-19 symptoms included any of the following: fever of 100°F or greater, cough, runny nose and/or nasal congestion, shortness of breath, sore throat, fatigue, muscle/body aches, headaches, loss of smell/taste, nausea, vomiting and/or diarrhea[6].

We estimated the number and proportion of respondents who likely had SARS-CoV-2 infection during the study period based on the following mutually exclusive, hierarchical case classification: 1) Confirmed case: self-report of one or more positive tests with a health care or testing provider; or 2) Probable case: self-report of a positive test result exclusively on at-home rapid tests (i.e. those that were not followed up with confirmatory diagnostic testing with a provider); or 3) Possible case: self-report of COVID-like symptoms and a known epidemiologic link (close contact) to one or more laboratory confirmed or probable (symptomatic) SARS-CoV-2 case(s)[6] in a respondent who reported never testing or only testing negative during the study period. Categories 1 and 2 of our case definition would likely capture some, but not all, of the estimated 20-30% of individuals whose SARS-CoV-2 infection may remain asymptomatic throughout their infection[7].

Statistical Analysis

We described the testing status and estimated period prevalence of SARS-CoV-2 by socio-demographic characteristics, geography, and vaccination status. Pearson's chi-squared test of independence was performed to assess group differences between testers and non-testers. Analyses were performed using SAS version 9.4.

Results

The weighted characteristics of survey participants are shown in Table 1. We estimate that 27.4% (95% CI 22.8%-32.0%) of approximately 6.6 million adult New Yorkers may have had SARS-CoV-2 infection during January 1- March 16, 2022, corresponding to about 1.8 million adults (95%CI 1.6-2.1 million). The estimate of 27.4% includes: 1) 14.1% (95%CI 10.4%-17.8%) who were positive based on one or more tests with a health care or testing provider; 2) 5.2% (95%CI 3.1%-7.3%) who were positive exclusively based on one or more at-home rapid tests; and 3) 8.1% (95%CI 5.4%-10.9%) who met the definition for possible SARS-CoV-2 infection. The test positivity rate among those who tested with a healthcare or testing provider was 41.3% (95%CI 33.2% - 49.4%).

SARS-CoV-2 period prevalence during this was high among all groups but varied considerably by sociodemographic factors and geography. Importantly, SARS-CoV-2 prevalence was higher among groups that are more vulnerable to severe SARS-CoV-2 and death, including unvaccinated persons (21.7%, 95%CI 9.6%-33.8%) and those aged 65+ (17.8%, 95%CI 10.2-25.4%). Individuals who tested at all were more likely to be 18-34 years, Hispanic, and have higher education levels and combined household income of >$65K compared with non-testers.

Discussion

Our study found substantial prevalence of SARS-CoV-2 among adult New Yorkers during the second half of the city's Omicron BA.1 surge in January-mid March 2022 was 27.4%. Our estimate only covers the latter half of the BA.1 surge and would not have captured those with asymptomatic infections and those who didn't test during their infectious period. This estimate was higher than seroprevalence estimates from the first wave of SARS-CoV-2 in 2020 (23.6%) which would include infections among asymptomatic and asymptomatic individuals in the city[8]. We also found that the characteristics of adults testing with a health care or testing provider differ considerably from non-testers, highlighting the challenges of using surveillance data that are solely based on testing to gain insights into the burden and epidemiology of SARS-CoV-2 community transmission.

During the study period, routine case surveillance data from the NYC DOHMH reported 552,084 NYC residents of all ages (~6.7% of the NYC population of 8.3M) who tested positive for SARS-CoV-2 with a health care or testing provider by PCR or point of care rapid test[9]. The 7-day average test percent positivity during the study period ranged from 34.8% on January 1st to 1.6% on March 16th with 11.5% percent positivity among total testers during the entire period[9]. When compared with our estimate of 1.8 million adults infected during the same time period, our findings point to the extent to which official case counts underestimated the SARS-CoV-2 burden during the surge. This 'hidden prevalence' is due to both non-testing, exclusive at-home rapid testing, and testing too soon after exposure/symptom onset with either a point of care and at-home rapid tests[1,10]. Despite the substantial number of NYC adults who likely had SARS-CoV-2 during the BA.1 surge, it is likely that a substantial proportion did not, and remain susceptible to subsequent Omicron subvariant surges.

The recent CDC metrics may be inadequate for informing timely public health countermeasures such as testing and vaccination strategies and efforts to improve the uptake of oral antivirals to prevent severe outcomes. While wastewater surveillance is an important tool for early detection of a surge[11], surveillance methods like routinely and strategically deployed surveys enable an assessment of the prevalence of infection and improve our understanding of disparities across vulnerable populations, thereby providing critical epidemiological evidence between wastewater signals and possible spikes in hospitalizations.

While our study suggests a viable approach to gather timely information about the prevalence of SARS-CoV-2 infections among NYC adults, it also has limitations. First, we measured testing outcomes and symptoms via self-report over a long recall period, which is subject to recall bias. More frequent surveys with shorter recall periods (e.g., 7-14 days), could improve the accuracy of estimates. Our prevalence estimates also included possible cases based on having both self-reported symptoms and a known contact with a confirmed/probable case, which, even though both prevalence of exposures and attack rates were very high during the BA.1 Omicron surge[12], could lead to an overestimate of prevalence. Conversely, our estimates may not have captured some cases that are asymptomatic for their entire infection, resulting in an underestimate (e.g., by 10-30%)[7]. Differences between our survey case counts and those reported to the NYC DOHMH may be due to overestimation due to non-response bias (e.g., those who had SARS-CoV-2 infection are more likely to respond to and complete the survey), underreporting by provider and laboratories, or a combination of both. Passive surveillance relies on providers and laboratories across institutions to voluntarily report data, and to our knowledge, the completeness, representativeness, timeliness, and acceptability of passive SARS-CoV-2 reporting, including during surges, have not yet been systematically assessed in NYC or elsewhere around the U.S. Roughly one-third of our sample was recruited from an online opt-in panel, which may overrepresent the population with internet access. Finally, our survey excludes children and adolescents <18, and those who died (about 4,426 NYC residents) during the study period.

Population-based representative surveys are an important adjunct surveillance tool to standard testing-based SARS-CoV-2 surveillance[13,14]. Surveys can be rapidly deployed and analyzed, as has been shown in the U.K.[13]. At this stage of the pandemic, the application of low-cost and low-resource intensive surveys may have a large impact on the efforts of governments and individuals to understand the disparities in infections across key sociodemographic characteristics which would inform the control and the primary and secondary prevention of community spread of SARS-CoV-2. Future surveys should capture additional detail on vulnerability to a severe COVID-19 outcome among those with SARS-CoV-2 infection.

NOTES

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Conflict of Interest:

SGK, DN and MMR report grants or contracts unrelated to this work from NIH (paid to institution) and Pfizer (payment to institution for CHASING COVID Cohort work). All other authors declare that they have no conflicts of interest.

References:

1. Wu SL, Mertens AN, Crider YS, et al. Substantial underestimation of SARS-CoV-2 infection in the United States. *Nat Commun.* 2020;11(1):4507.
2. CDC. COVID-19 Community Levels. https://www.cdc.gov/coronavirus/2019-ncov/science/community-levels.html. Accessed April 23, 2022.
3. Sherratt K, Abbott S, Meakin SR, et al. Exploring surveillance data biases when estimating the reproduction number: with insights into subpopulation transmission of COVID-19 in England. *Philos Trans R Soc Lond B Biol Sci.* 2021;376(1829):20200283.
4. Bien-Gund CH, Shah J, Ho JI, et al. The COVID-19 Self-Testing through Rapid Network Distribution (C-STRAND) trial: A randomized controlled trial to increase COVID-19 testing in underserved populations. *Contemp Clin Trials.* 2021;110:106585.
5. Rader B, Gertz A, Iuliano AD, et al. Use of At-Home COVID-19 Tests - United States, August 23, 2021-March 12, 2022. *MMWR Morb Mortal Wkly Rep.* 2022;71(13):489-494.
6. CSTE. Interim Position Statement: Update to COVID-19 Case Definition - Council of State and Territorial Epidemiologists. https://www.cste.org/news/520707/CSTE-Interim-Position-Statement-Update-to-COVID-19-Case-Definition.htm. Accessed April 23, 2022.
7. Oran DP, Topol EJ. The Proportion of SARS-CoV-2 Infections That Are Asymptomatic. *Ann Intern Med.* 2021;174(9):1344-1345.
8. Pathela P, Crawley A, Weiss D, et al. Seroprevalence of Severe Acute Respiratory Syndrome Coronavirus 2 Following the Largest Initial Epidemic Wave in the United States: Findings From New York City, 13 May to 21 July 2020. *J Infect Dis.* 2021;224(2):196-206.
9. COVID-19: Data trends and totals - NYC health. https://www1.nyc.gov/site/doh/covid/covid-19-data-totals.page. Accessed April 23, 2022. .
10. Qasmieh SA RM, Rane MS, et al. The Importance of Incorporating At-Home Testing into SARS-CoV-2 Point Prevalence Estimates: Findings from a U.S. National Cohort, February 2022. *JMIR Preprints.*
11. Kirby AE, Welsh RM, Marsh ZA, et al. Notes from the Field: Early Evidence of the SARS-CoV-2 B.1.1.529 (Omicron) Variant in Community Wastewater - United States, November-December 2021. *MMWR Morb Mortal Wkly Rep.* 2022;71(3):103-105.

12. Baker JM, Nakayama JY, O'Hegarty M, et al. SARS-CoV-2 B.1.1.529 (Omicron) Variant Transmission Within Households - Four U.S. Jurisdictions, November 2021-February 2022. *MMWR Morb Mortal Wkly Rep.* 2022;71(9):341-346.

13. ONS. Coronavirus (COVID-19) Infection Survey, UK: 8 July 2022. https://www.ons.gov.uk/peoplepopulationandcommunity/healthandsocialcare/conditionsanddiseases/bulletins/coronaviruscovid19infectionsurveypilot/8july2022. Published 2022. Accessed July 13, 2022.

14. Dean N. Tracking COVID-19 infections: time for change. *Nature.* 2022;602(7896):185.

Table 1.Select socio-demographic characteristics for survey respondents by testing status and period prevalence of SARS-CoV-2, January-March 16th, 2022

	Weighted Frequencies	Testers	Non-Testers	Estimated period prevalence (%) of SARS-CoV-2 infection[‡] (95% CI)
	N (%)	**N (%)**	**N (%)**	
Total	1030	555 (53.9)	475 (46.1)	27.4 (22.8-32.0)
Characteristics				
Age[†]				
18-24	110 (10.7)	78 (14.0)	33 (6.9)	16.9 (3.7 - 30.1)
25-34	219 (21.3)	120 (21.6)	99 (20.9)	37.3 (26.6 - 48.0)
35-44	185 (18.0)	98 (17.7)	87 (18.3)	27.8 (17.5 - 38.1)
45-54	166 (16.1)	95 (17.1)	71 (15.0)	36.8 (21.3-52.3)
55-64	149 (14.4)	70 (12.6)	78 (16.5)	22.8 (14.3 - 31.4)
65+	201 (19.5)	94 (17.0)	107 (22.5)	17.8 (10.2 - 25.4)
Gender[*]				
Male	484 (47.0)	247 (44.4)	234 (50.1)	29.2 (22.1 - 36.4)
Female	530 (51.5)	299 (53.8)	232 (48.8)	26.0 (19.9 - 32.1)
Non-binary	8 (0.8)	7 (1.3)	1 (0.2)	22.8 (0.0 - 55.8)
Race/Ethnicity[†]				
Black NH	180 (17.5)	88 (15.9)	92 (19.3)	20.3 (13.2 - 27.5)
White NH	405 (39.1)	197 (35.6)	205 (43.2)	21.2 (16.4 - 26.0)
Hispanic	286 (27.8)	176 (31.7)	110 (23.2)	41.1 (28.0 - 54.1)
Asian/Pacific Islander	122 (11.8)	74 (13.4)	48 (10.1)	27.3 (13.6 - 41.1)
Other	39 (3.8)	19 (3.5)	20 (4.2)	24.2 (8.5 - 39.8)
Years of education[*†]				
Some HS and below	150 (14.5)	91 (16.4)	58 (12.3)	34.9 (19.9 - 50.2)
HS Grad	274 (26.6)	127 (23.0)	146 (30.8)	25.5 (14.5 - 36.5)
Some college and above	594 (57.7)	329 (59.4)	265 (55.8)	26.7 (22.2 - 31.2)

Income				
Below 25K	298 (29.0)	146 (26.4)	152 (32.1)	20.2 (13.2 - 27.3)
25,001 - 45,000	189 (18.3)	105 (18.9)	84 (17.7)	33.4 (21.3 - 45.6)
45,001 - 65,000	181 (17.6)	100 (18.1)	81 (17.0)	27.7 (19.0 - 36.3)
Above 65,000	362 (35.1)	203 (36.6)	158 (33.3)	30.1 (21.3 - 38.9)
Borough†				
Bronx	176 (17.1)	77 (13.9)	99 (20.9)	21.6 (10.2 - 32.9)
Brooklyn	317 (30.8)	176 (31.6)	141 (29.8)	27.3 (20.4 - 34.2)
Manhattan	200 (19.4)	108 (19.5)	92 (19.3)	21.6 (13.6 - 29.7)
Queens	279 (27.1)	165 (29.7)	114 (24.0)	35.2 (24.7 - 45.7)
Staten Island	58 (5.6)	29 (5.3)	29 (6.0)	28.3 (14.0 - 42.7)
Vaccination status†††				
Boosted	667 (64.8)	396 (71.4)	271 (57.1)	29.2 (23.6 - 34.7)
Fully vaccinated not boosted	167 (16.2)	81 (14.6)	86 (18.1)	27.1 (16.4 - 37.9)
Not vaccinated	196 (19.0)	78 (14.0)	118 (24.8)	21.7 (9.6 - 33.8)
Case Classification				
Total	282			27.4 (22.8-32.0)
Tested with health or testing provider	145			14.1 (10.4 - 17.8)
Exclusive at-home testers	53			5.2 (3.1 - 7.3)
Possible cases	84			8.1 (5.4 - 10.9)

† < 0.05, †† < 0.001, ††† < 0.0001

‡ For the period January 1-March 16th, 2022. Cases were defined as either a self-report of 1) testing positive on point-of-care rapid antigen test or PCR diagnostic test; 2) exclusively on an at-home rapid test; and 3) COVID-like symptoms <u>and</u> an epidemiologic linkage with a close contact with confirmed or probable COVID-19.

*1 case excluded due to missing gender information and 2 cases excluded due to missing information on education level