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Cross-sectional study evaluating the seroprevalence of SARS-CoV-2 antibodies among healthcare workers and factors associated with exposure during the first wave of the COVID-19 pandemic in New York

Alexander Bryan ,[1,2] Kathleen Tatem,[2] Jillian Diuguid-Gerber,[1,3] Caroline Cooke,[2] Anya Romanoff,[4,5] Nandini Choudhury,[6] Michael Scanlon,[7] Preeti Kishore,[8] Elana Sydney,[8] Joseph Masci,[9,10] Parampreet Bakshi,[10,11] Sahithi Pemmasani,[12] Nichola J Davis,[2] Duncan Maru [13,14]

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For numbered affiliations see end of article.

Correspondence to
Dr Alexander Bryan; Alexander.Bryan@nyulangone.org

ABSTRACT

Objective Estimate the seroprevalence of SARS-CoV-2 antibodies among New York City Health and Hospitals (NYC H+H) healthcare workers during the first wave of the COVID-19 pandemic, and describe demographic and occupational factors associated with SARS-CoV-2 antibodies among healthcare workers.

Design Descriptive, observational, cross-sectional study using a convenience sample of data from SARS-CoV-2 serological tests accompanied by a demographic and occupational survey administered to healthcare workers.

Setting A large, urban public healthcare system in NYC.

Participants Participants were employed by NYC H+H and either completed serological testing at NYC H+H between 30 April 2020 and 30 June 2020, or completed SARS-CoV-2 antibody testing outside of NYC H+H and were able to self-report results from the same time period.

Primary outcome measure SARS-CoV-2 serostatus, stratified by key demographic and occupational characteristics reported through the demographic and occupational survey.

Results Seven hundred and twenty-seven survey respondents were included in analysis. Participants had a mean age of 46 years (SD=12.19) and 543 (75%) were women. Two hundred and fourteen (29%) participants tested positive or reported testing positive for the presence of SARS-CoV-2 antibodies (IgG+). Characteristics associated with positive SARS-CoV-2 serostatus were Black race (25% IgG +vs 15% IgG−, p=0.001), having someone in the household with COVID-19 symptoms (49% IgG +vs 21% IgG−, p<0.001), or having a confirmed COVID-19 case in the household (25% IgG +vs 5% IgG−, p<0.001). Characteristics associated with negative SARS-CoV-2 serostatus included working on a COVID-19 patient floor (27% IgG +vs 36% IgG−, p=0.02), working in the intensive care unit (20% IgG +vs 28% IgG−, p=0.03), being employed in a clinical occupation (64% IgG +vs 78% IgG−, p<0.001) or having close contact with a patient with COVID-19 (51% IgG +vs 62% IgG−, p=0.03).

Conclusions Results underscore the significance that community factors and inequities might have on SARS-CoV-2 exposure for healthcare workers.

Strengths and limitations of this study

- Strengths of this study included the sampling of a wide range of employees and healthcare occupations, and the utilisation of a detailed survey that allowed for stratification of SARS-CoV-2 serostatus by a wide range of demographic, occupational and exposure factors.
- Limitations of this study include the use of convenience sampling for enrollment, which we attempted to partially mitigate by comparing aggregate participant demographics with overall employee demographics.
- We were also unable to determine when employees with positive SARS-CoV-2 antibodies were infected, which limited interpretation of some of the data.

BACKGROUND

By the end of 2020, there were almost 85 million confirmed cases of SARS-CoV-2 and over 1.8 million deaths globally.[1] The pandemic has placed enormous strains on healthcare systems and healthcare workers (HCWs), including inpatient and community-based care providers as well as hospital administrators and support staff. As shown during prior infectious disease outbreaks, protecting HCW through adequate infection control and access to personal protective equipment (PPE) alongside general public health and preventative measures is critical to global pandemic response.[2] In many countries, however, the current COVID-19 pandemic has

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led to truly unprecedented conditions for HCW and their physical and mental well-being.[3]

Epidemiological and serological data on SARS-CoV-2 among HCW are essential to guide healthcare systems and public health policies and protect HCW.[4] Early data from China suggested that HCW were at high risk of SARS-CoV-2 infection,[5] and since then a significant body of literature has emerged on SARS-CoV-2 among HCW.[6 7] A systematic review and meta-analysis of 97 studies up through 8 July 2020 including 230 398 HCW found a pooled SARS-CoV-2 prevalence rate of 11% in studies using reverse transcription-PCR tests and 7% using serum antibody tests, but there were insufficient data in most studies to assess risk factors and exposure levels.[7] HCWs are at risk of occupational transmission of SARS-CoV-2 in inpatient and outpatient settings, particularly with inadequate PPE or infection control procedures.[8 9] HCWs are also at risk for community transmission of SARS-CoV-2,[10] while household members of HCW may be at higher risk compared with the general public.[11]

Among HCW, the risk of infection varies by demographic characteristics, cadre of HCW and work location, with systemic racism playing a clear role in inequities.[12] Additionally, among HCW with a job setting reported, most infections were associated with nursing and residential care facilities (67%) compared with hospital settings (18%). There are few data on SARS-CoV-2 among community-based HCW and other social service workers who may have different demographic and occupational risk profiles.[13]

Approximately 6 weeks into the pandemic, the largest public hospital system in the USA, New York City Health and Hospitals (NYC H+H), initiated universal, voluntary serological testing among all employees. We invited employees who were undergoing serological testing to participate in a survey to assess demographic and occupational factors associated with serostatus. Specifically, we aimed to: (1) estimate the seroprevalence of SARS-CoV-2 antibodies among NYC H+H HCW and (2) identify demographic and occupational factors associated with SARS-CoV-2 antibodies among NYC H+H HCW during the first wave of the COVID-19 pandemic.

METHODS

Study setting

NYC H+H employs over 40 000 people in a wide range of clinical and non-clinical positions at 11 acute care hospitals and more than 70 community facilities across the city's five boroughs. This study leveraged universal, voluntary SARS-CoV-2 antibody testing which was available at NYC H+H during the first wave of the COVID-19 pandemic starting in April 2020. Testing was open to all employees of NYC H+H and was available at NYC H+H ambulatory settings across the city.

STUDY DESIGN

This was an observational, cross-sectional study using data from SARS-CoV-2 serological tests accompanied by a demographic and occupational survey administered to HCW at NYC H+H. The primary endpoint was SARS-CoV-2 serological testing outcome, stratified by key demographic and occupational characteristics reported through the survey.

Patients or the public were not involved in the design, or conduct, or reporting, or dissemination plans of our research.

To assess the risk of contracting COVID-19, we developed a modified survey based on the WHO's Protocol for assessment of potential risk factors for 2019-novel coronavirus (2019-nCoV) infection among HCWs in a healthcare setting.[4] Surveys were self-administered in paper form at testing sites or electronically through a REDCap (Research Electronic Data Capture) survey online. Survey respondents who completed SARS-CoV-2 antibody testing at NYC H+H were matched to serological results in the NYC H+H electronic health record (EHR). Results of SARS-CoV-2 rtPCR testing were included in secondary analyses when available.

STUDY POPULATION

Surveys were self-administered in paper form at testing sites, and an electronic version of the survey was emailed system-wide to all NYC H+H employees. All NYC H+H employees who had serological testing from 30 April 2020 to 30 June 2020 were invited to participate. Additionally, employees who received antibody testing outside of NYC H+H between 30 April 2020and 30 June 2020 could complete the survey and self-report serology results.

In order to be eligible for the study, participants needed to meet the following criteria:

1. Employed by NYC H+H and either (A) completed serological testing at NYC H+H or (B) completed SARS-CoV-2 antibody testing outside of NYC H+H and were able to self-report results.
2. 18 years of age or older.
3. Capable of providing consent to participate in the study, including English or Spanish fluency.

Additionally, limited data on demographics and seropositivity are included on all H+H employees who completed antibody testing from 30 April 2020 to 30 June 2020 but did not participate in the survey study.

KEY DEFINITIONS

SARS-CoV-2 antibody status

SARS-Cov-2 antibody status was assigned based on serological results from the NYC H+H EHR. Serological testing at NYC H+H was performed on Abbott i1000SR laboratory instruments using the ARCHITECT SARS-CoV-2 IgG chemiluminescence assay from Abbott Laboratories.

For participants who completed serological testing at an outside institution, self-reported results were used. Self-reported results were not independently verified. Under the Emergency Use Authorisation (EUA) issued on 4 February 2020 by the Secretary of the US Department

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of Health and Human Services, immunoassay tests could be offered based on manufacturer-reported data without formal U.S. Food and Drug Administration (FDA) clearance.[14] On 4 May 2020, the FDA issued an updated policy recommending a minimum sensitivity of 90% and specificity of 95% for EUA.[15]

Demographic characteristics

Demographic characteristics were self-reported. Sex was captured as male or female. Age was calculated from date of birth, and country of origin analysed as US born or non-US born. Participant zip code of primary residence was used to determine borough (ie, Manhattan, Brooklyn, Bronx, Queens, Staten Island, non-NYC). Race and ethnicity were reported separately and variables were combined together into one variable with mutually exclusive categories for analysis, with black representing non-Hispanic black participants and white representing non-Hispanic white participants.

Occupation

Participants selected occupation from a prespecified list or selected 'other' and provided a free text response answer. Free-text response answers were regrouped into existing or new categories when appropriate. The following additional groupings emerged: care coordination, pharmacy and counselling (distinct from social worker).

STATISTICAL ANALYSIS

We used descriptive statistics to explore demographic characteristics, case exposure, occupational setting and SARS-CoV-2 serological test results of the study population, and explored the association of serological test results with demographic (eg, zip code) and occupational characteristics and exposures. Continuous measures were expressed as means and SD, categorical variables as counts and proportions. We conducted bivariate analyses using Fisher's exact test for categorical variables and t-tests, as appropriate, with significance set at α=0.05. In addition, subsequent χ^2 tests were conducted for age using 21–34 as a reference group and for race using white as a reference group. Missing values were removed for all calculations resulting in differing denominators for each demographic question and exposure-related variable. R Studio V.1.3.1093 using the tidyverse and gmodels packages was used for statistical analysis.

RESULTS

In total, 19 107 staff completed antibody testing at NYC H+H from 30 April to 30 June. During that time, there were 1671 respondents to the demographic and occupational survey, and 727 survey respondents were matched to SARS-CoV-2 antibody results, either through the NYC H+H EHR or through self-report. Reasons for being unable to match survey respondents to serological results included surveys missing full name or date of birth (n=766), or name and date of birth match not found in EHR (n=178).

Participants had a mean age of 45.97 years (SD=12.19) and 543 (75%) were women. Two hundred and sixty-four (36%) self-reported as white, 146 (20%) as Hispanic, 128 (18%) as black, 148 (20%) as Asian, 19 (2.6%) as other, 11 (1.5%) as multiracial, 4 (0.6%) as Pacific Islander and 6 (0.8%) as missing. Of the 705 participants who reported their country of origin, 322 (46%) were US-born. Over 70 different countries of origin were reported. A total of 539 (75%) participants reported living in NYC. Over half of the sample, 407 (58%) participants, reported having known close contact with at least 1 SARS-CoV-2 positive patient, 254 (37%) noted close contact with materials of at least 1 SARS-CoV-2 positive patient, 210 (29%) reported living with someone experiencing COVID-19 symptoms and 76 (11%) reported living with someone with confirmed COVID-19.

Compared with all H+H staff who completed serology testing between 30 April 20 and 30 June 2020 (n=19 107), and the overall H+H workforce (estimated 42 000), study participants were similar in sex (female 75% survey sample vs 70% tested workforce vs 69% total workforce). Race/ethnicity differed between the study participants, H+H staff completing serology testing, and the total H+H workforce, with study participants over-representing white employees and under-representing black employees (online supplemental efigure 1A–C).

Of the 727 participants included in the study, 658 (91%) participants completed an antibody test directly at an H+H site, and 69 (9.5%) participants reported antibody tests from an outside location. Overall, 214 (29%) participants tested positive or reported testing positive for the presence of SARS-CoV-2 antibodies. Comparatively, of the 19 107 H+H staff who completed serology testing between 30 April and 30 June, 4610 (24%) tested positive for the presence of SARS-CoV-2 antibodies. Online supplemental efigure A–C shows seropositivity of survey participants and 19 107 H+H staff by sex, race/ethnicity and age.

When comparing respondents by SARS-CoV-2 antibody status (SARS-CoV-2 IgG positive or negative), both groups were majority female (378 IgG– (75%) vs 164 IgG+ (78%)) (table 1), similar in age (mean (SD), 45[12] years IgG– vs 46[11] years IgG+) (online supplemental etable 1), and majority born in the USA (301 IgG– (61%) vs 121 IgG+ (58%)). Compared with those who were negative for SARS-CoV-2 antibodies, a larger percentage of respondents positive for SARS-CoV-2 antibodies were black (54 IgG+ (25%) vs 74 IgG– (15%)) (table 2), had someone in their household with COVID-19 symptoms (104 IgG+ (49%) vs 106 IgG– (21%)), and had a COVID-19 confirmed case in their household (52 IgG+ (25%) vs 24 IgG– (5%)). A lower percentage of respondents positive for SARS-CoV-2 antibodies had a clinical occupation (122 IgG+ (64%) vs 369 IgG– (78%)), worked on a COVID-19 patient floor (58 IgG+ (27%) vs 185 IgG– (36%)), in the intensive care unit (ICU) (43 IgG+ (20%) vs 143 IgG– (28%)) or had

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Table 1 Demographics, case exposure and occupational setting by SARS-CoV-2 antibody status

	Negative for SARS-CoV-2 IgG (n=513) (%)	Positive for SARS-CoV-2 IgG (n=214) (%)	Significance
Demographics			
Female*	378 (75)	165 (78)	0.50
Age† (mean, SD)	45.82 (12.50)	46.33 (11.43)	0.61
21–34	126 (25)	42 (20)	0.38§§
35–44	117 (23)	56 (26)	
45–54	118 (23)	56 (26)	
55–64	120 (24)	48 (23)	
65–74	30 (6)	11 (5)	
Combined race/ethnicity‡			
White	197 (39)	67 (31)	0.003¶¶***
Asian	114 (22)	34 (16)	
Hispanic	99 (20)	47 (22)	
Black	74 (15)	54 (25)	
Other	12 (2)	7 (3)	
Multiracial	7 (1)	4 (2)	
Pacific islander	4 (1)	1 (<1)	
US born§	301 (61)	121 (58)	0.56
Community exposure¶			
COVID-19 symptoms in household	106 (21)	104 (49)	<0.001***
COVID-19 case in household	24 (5)	52 (25)	<0.001***
Occupational setting(s)**			
COVID-19 patient floor	185 (36)	58 (27)	0.02***
Emergency department	117 (23)	43 (20)	0.49
Intensive care unit	143 (28)	43 (20)	0.03***
Outpatient unit	186 (36)	66 (31)	0.17
Regular patient floor	186 (36)	77 (36)	1.0
Patient homes/community	11 (2)	9 (4)	0.14
Other	70 (14)	32 (15)	0.64
None	55 (11)	34 (16)	0.06
Patient exposure			
Clinical occupation	369 (78)	122 (64)	<0.001***
Close Contact with COVID-19 patient(s)††	301 (62)	106 (51)	0.03***
Exposure to COVID-19 patient's materials‡‡	188 (39)	66 (32)	0.16

*Twelve participants were missing a response for sex in the survey resulting in a denominator of 715 participants.
†Three participants were missing a response for age in the survey resulting in a denominator of 724 participants.
‡Six participants were missing a response for race in the survey resulting in a denominator of 721 participants.
§Twenty-two participants were missing a response for country of origin in the survey resulting in a denominator of 705 participants.
¶Ten participants were missing a response for community exposure in the survey resulting in a denominator of 717 participants.
**Participants were asked to select all settings in which they interact with patients. Two participants did not complete this question resulting in a denominator of 725. Selecting 'None' indicates that while the participant worked for the health system, they were not working in a patient-facing setting during the study period.
††Thirty-one participants were missing a response for whether they had known close contact with a SARS-CoV-2 patient resulting in a denominator of 696 participants. This question included yes, no and unknown as response types.
‡‡Thirty-four participants were missing a response for whether they had known exposure to a SARS-CoV-2 patient's materials resulting in a denominator of 693 participants.
§§The Fisher's exact test for age collapsed ages 55–64 and 64–74 into one category for ages 55 and over.
¶¶The Fisher's exact test for race collapsed multiracial and pacific islander into the other category.
***Indicates significance at level of p<0.05.

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Table 2 Exploratory post hoc analyses of combined race/ethnicity by SARS-CoV-2 antibody status

Combined race/ethnicity	Negative for SARS-CoV-2 IgG (n=513) (%)	Positive for SARS-CoV-2 IgG (n=214) (%)	Significance	Overall sig
				0.003
White	197 (39)	67 (31)	Ref	
Asian	114 (22)	34 (16)	0.63	
Hispanic	99 (20)	47 (22)	0.17	
Black	74 (15)	54 (25)	0.001*	
Other	23 (4)	12 (6)	0.31	

*Indicates significance at level of p<0.05.

close contact with a patient with COVID-19 (106 IgG+ (51%)) vs 301 IgG– (62%)).

Seven hundred and twenty respondents provided self-reported staff occupation. Self-reported occupations included 209 (28%) doctors, nurse practitioners (NPs) or physician assistants (PAs), 154 (21%) registered nurses (RNs), 87 (12%) administrators, 15 (2.1%) care coordinators, 15 (2.1%) pharmacy staff, 12 (1.7%) radiology staff and 8 (1.1%) in food services. Crude seropositivity rates for doctors, NPs and PAs (34 IgG+) was 16%, compared with 34% for RNs (52 IgG+), 39% for administrators (34 IgG+) and 62% for food services (5 IgG+) (figure 1).

The majority of respondents reported 'always' or 'most of the time' wearing a medical or surgical mask when indicated (681 respondents (98%)) (figure 2), with 627 (92.6%) reporting that they were available 'always' or 'most of the time' (figure 3). A total of 430 respondents reported 'always' or 'most of the time' (72%) wearing a respiratory mask (eg, N95), with 169 (28%) 'never', 'rarely' or 'occasionally' wearing the respiratory mask when indicated. The availability of the respiratory masks varied, with 180 (30%) saying it was 'always' available, and 235 (39%) reporting them available 'most of the time'. The crude seropositivity rates among the 169 that 'never', 'rarely' or 'occasionally' wore respiratory masks was 36.7%, compared with 26.3% for the 430 that wore a respiratory mask 'always' or 'most of the time'. For all other PPE, the majority of respondents 'always' wore PPE when indicated, except for impermeable gowns, coverall/body suits, shoe covers and high efficiency particulate air (HEPA) filters on endotracheal tube for intubated patients. Availability of PPE varied by PPE type, with most being available 'always' or 'most of the time,' except coverall/body suits.

The distribution of seropositive study participants by borough of primary residence in NYC was highest in Queens

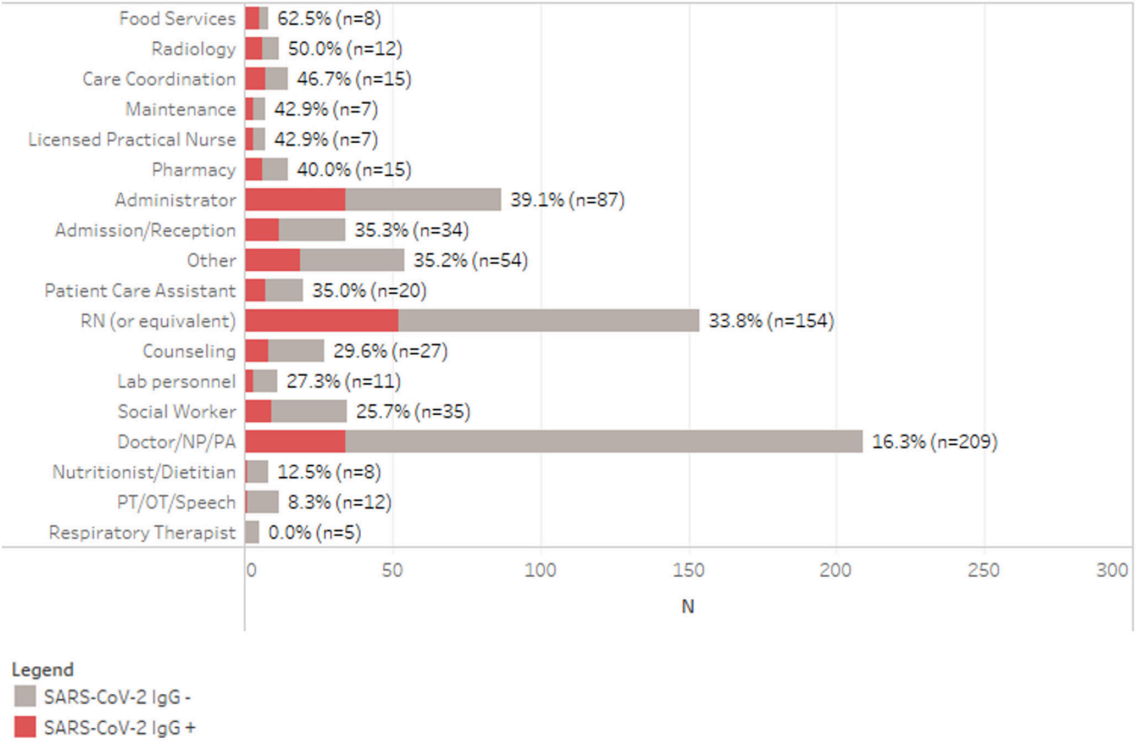

Figure 1 Per cent seropositive for SARS-CoV-2-IgG by reported staff occupation (n=720). NP, nurse practitioner; PA, physician assistant; RN, registered nurse; PT, physical therapy; OT, occupational therapy.

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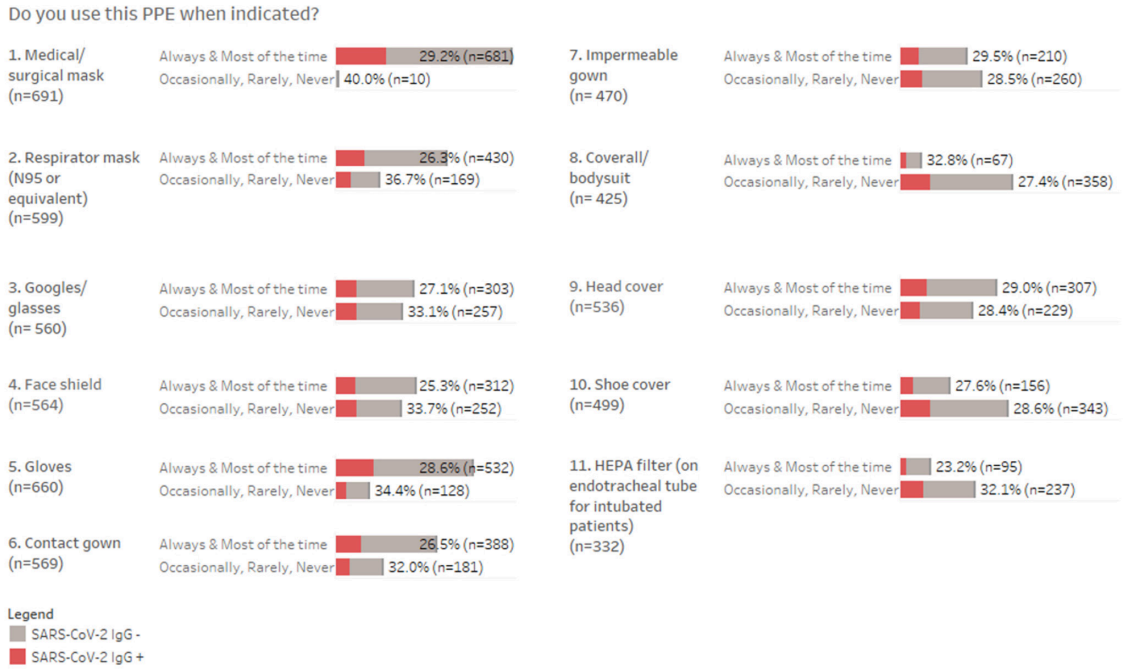


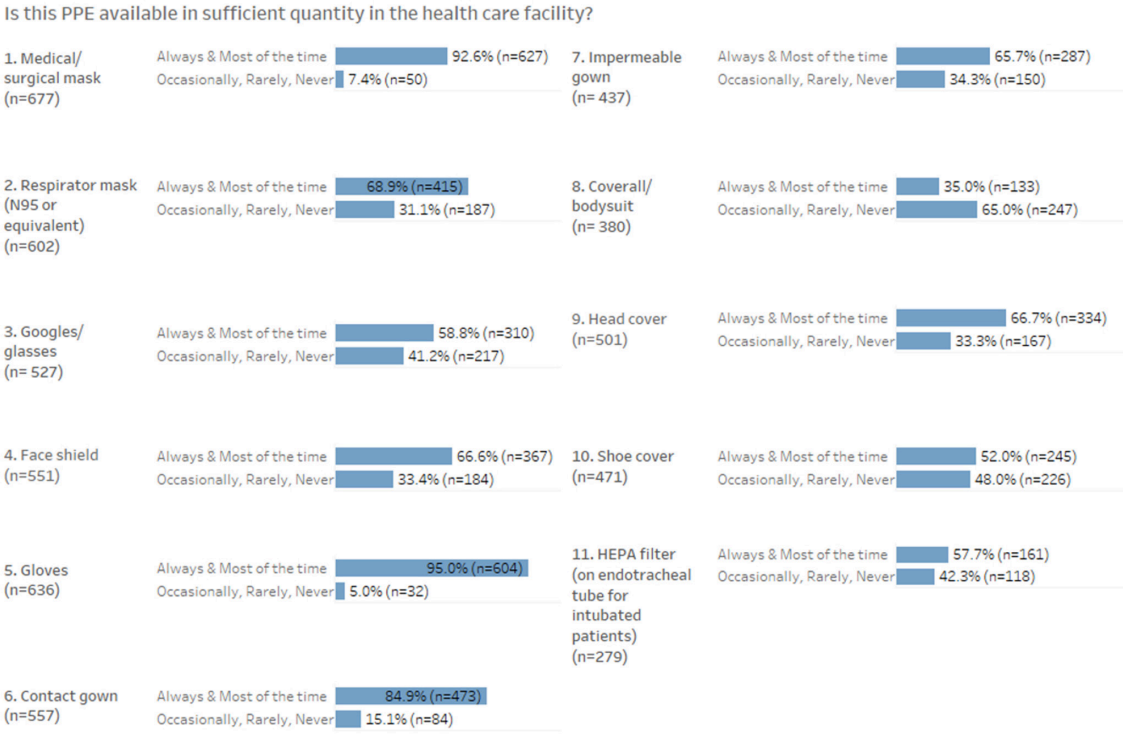
Excludes patients who noted PPE type was Not Applicable or missing.

Figure 2 Per cent seropositivity for SARS-CoV-2-IgG by how frequently PPE was used when indicated. PPE, personal protective equipment.

(34%), followed by Brooklyn (25%) and the Bronx (20%). The distribution of cumulative cases reported in NYC from 29 February 2020 to 30 June 2020 was also highest in Queens (30%), followed by Brooklyn (28%) and the Bronx (22%) (online supplemental etable 2).

DISCUSSION

In this system-wide survey of employees during the first wave of the COVID-19 epidemic in NYC, 29% of study participants tested positive for SARS-CoV-2 antibodies. This was similar to



Excludes patients who noted PPE type was Not Applicable or missing.

Figure 3 PPE availability. PPE, personal protective equipment.

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the overall seropositivity of employees tested at NYC H+H, and among the highest rates of employee seropositivity reported by health systems in the NYC area during this period.[16 17] One possible difference to explain these higher rates of seropositivity at NYC H+H compared with rates reported from health systems in Manhattan and Long Island could be the higher rates of community exposure at the time in Queens, Brooklyn and the Bronx, where the majority of NYC H+H employees live. Study participant seropositivity was highest for employees living in Queens, Brooklyn and the Bronx. And while city-wide seroprevalence data by borough was not yet available for direct comparison during this time period, the cumulative distribution of cases in NYC at the time closely followed this trend. Employee seropositivity may have been largely driven by community spread at this phase of the pandemic in NYC, as seropositivity was most strongly associated with household COVID-19 contact. However, a lack of temporal data limits whether this might be interpreted as community transmission to HCW or HCW transmitting to household members.

Doctor/NP/PA were the most frequently reported occupations among respondents, and they were among the lowest in seropositivity. This may reflect differing patient exposures or differing use of PPE, as RNs (or equivalent) were the second largest occupational group surveyed and had over double the seropositivity rate. A higher seropositivity for RNs was also noted in a larger study of 10 662 hospital staff in the UK, where seroprevalence was highest among nurses and healthcare assistants.[12] Similarly, in a systematic review of COVID-19 infection in HCW up through July of 2020, the largest occupational group of HCW testing positive for COVID-19 were nurses.[7] As the duties of RNs involve frequent contact with patients for tasks such as medication administration and other beside functions, these results suggest occupational exposure is a significant risk factor for infection. However, seropositivity rates were also higher among other large occupational groups surveyed such as administrator and admission/reception, which is notable as these are patient-facing but typically non-clinical occupation groups. In fact, working on a COVID-19 patient floor or ICU was associated with testing negative for SARS-CoV-2 antibodies, as was close contact with COVID-19 patients and being employed in a clinical occupation. These results potentially indicate greater adherence to PPE, greater availability of PPE or clearer recommendations on PPE usage for providers working in those settings, which offset patient exposure.

In examining employee use of PPE, consistent use of certain equipment was associated with lower reported rates of seropositivity. Most notably, employees who reported using an N95 mask 'always' or 'most of the time' when indicated had a seropositivity rate of 26.3%, while employees using an N95 'occasionally', 'rarely' or 'never' had seropositivity rates of 36.7%. Although a majority (58%) of respondents reported always wearing an N95 when indicated, only 30% reported an N95 was always available in sufficient quantity in the healthcare facility. This not only reflects the low supply of PPE in NYC at the height of the first wave of the pandemic, but also the shortfall in PPE that HCW needed to bridge by stretching available supplies. Practices to stretch PPE supply reported elsewhere in the literature included extended use, reuse, or decontamination procedures, and may account for this disparity in responses.[18 19]

Black race was strongly associated with employee seropositivity, echoing broader racial inequities seen in the community during the COVID-19 pandemic.[20 21] In the USA, among 100 570 cases of SARS-CoV-2 and 641 deaths among HCW up to 16 July 2020 that were reported to the Centers for Disease Control and Prevention, Asian and black HCW were over-represented among fatal cases, and healthcare support workers, nurses and administrative staff were the most common occupational types among those infected.[22] In a prospective cohort study using self-reported data through a smartphone application among almost 100 000 HCW in the UK and USA, Asian, black and other minority ethnic HCW were at higher risk of SARS-CoV-2 infection and more likely to report having inadequate access to PPE compared with white HCW.[23] These results underscore the connection between HCW and their communities with regard to these systemic inequities, and highlight the continued need to urgently address these disparities for the well-being of patients as well as the workers caring for those patients.

There were several limitations to our study. First, convenience sampling was used to enrol study participants, with less than 10% of employees with antibody testing results having completed our survey. And while we did not record reasons for non-response to the survey, we recruited study participants from a voluntary universal screening programme, and there was a potential for selection bias in terms of occupation type and level of exposure. There may have also been socioeconomic factors related to participation that could be strongly tied to demographic and occupational characteristics. We attempted to partially mitigate these limitations by comparing aggregate participant demographics with all employees undergoing antibody testing, as well as with overall NYC H+H employee demographics. This revealed under-representation of certain groups in the study participants, most notably black employees. Given that black employees were also found to be more likely to have SARS-CoV-2 antibodies, this may have skewed overall positivity rates and excluded differing exposure factors. We were also unable to determine when employees with positive SARS-CoV-2 antibodies were infected. And with continuously changing guidelines around PPE during the initial surge, it is difficult to link exposure and infection with evolving PPE practices. Furthermore, employees who were sick or were suspected to have SARS-CoV-2 may have been less likely to get serological testing, and participants who previously tested PCR positive for SARS-CoV-2 may or may not have chosen serological testing. Our study did not account for HCW who were currently hospitalised or had died. These factors may have further biased our sample and underestimated the burden of SARS-CoV-2 infection in this population. Sixty-nine respondents self-reported outside

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serology results, and while they made up a small proportion of total respondents, we were unable to adjust results of non-standardised serology testing due to limitations of study design, Finally, this was a descriptive analysis and it is possible that some findings may be due uncontrolled confounding factors.

Strengths of this study included the sampling of a wide range of employees and healthcare occupations, including both clinical and non-clinical occupations. This study also used a detailed survey that allowed for the stratification of SARS-CoV-2 serostatus by a wide range of demographic, occupational and exposure factors. Finally, this study included detailed questions on PPE use and availability, allowing for further description of serostatus by self-reported PPE use and availability during the first wave of the COVID-19 pandemic.

CONCLUSION

Employees at a large, public hospital system reported a seropositivity rate of 29% during the first wave of the COVID-19 epidemic in NYC. This was among the highest employee seropositivity rates reported in NYC, and the risk of exposure varied significantly by employee demographics, occupation and work location. Results underscore the need to address exposure risks for HCW across occupational settings, including appropriate PPE, as well as address broader inequities at the community level where HCW live.

Author affiliations
[1]Department of Medicine, NYU Grossman School of Medicine, New York, New York, USA
[2]Office of Ambulatory Care and Population Health, NYC Health + Hospitals, New York, New York, USA
[3]Department of Medicine, NYC Health + Hospitals/Woodhull, Brooklyn, New York, USA
[4]Department of Global Health and Health System Design, Icahn School of Medicine at Mount Sinai, New York, New York, USA
[5]Department of Surgery, Memorial Sloan Kettering Cancer Center, New York, New York, USA
[6]Arnhold Institute for Global Health, Icahn School of Medicine at Mount Sinai, New York, New York, USA
[7]Center for Global Health, Indiana University, Bloomington, Indiana, USA
[8]Department of Medicine, NYC Health + Hospitals/Jacobi, New York, New York, USA
[9]Department of Global Health, NYC Health + Hospitals/Elmhurst, Elmhurst, New York, USA
[10]Department of Medicine, Icahn School of Medicine at Mount Sinai, New York, New York, USA
[11]Department of Medicine, NYC Health + Hospitals/Queens, Jamaica, New York, USA
[12]Department of Pediatrics, Icahn School of Medicine at Mount Sinai, New York, New York, USA
[13]Departments of Global Health, Internal Medicine, and Pediatrics, Icahn School of Medicine at Mount Sinai, New York, New York, USA
[14]Departments of Medicine and Pediatrics, NYC Health + Hospitals/Elmhurst, Elmhurst, New York, USA

Twitter Duncan Maru @duncanmaru

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ORCID iDs
Alexander Bryan http://orcid.org/0000-0002-4497-5438
Duncan Maru http://orcid.org/0000-0002-5923-6910

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Supplements

eTable 1. Exploratory Post-Hoc Analyses of Age group by SARS-CoV-2 antibody status

eTable 2. Distribution of Positive SARS-CoV-2 Cases by Borough

eFigure1. Demographic characteristics of the study sample, H+H employee sample, and H+H workforce

eFigure2. Percent seropositivity by demographic characteristics of the study sample, H+H employee sample, and H+H workforce

eTable 1. Exploratory Post-Hoc Analyses of Age group by SARS-CoV-2 antibody status

Age Group	Negative for SARS-CoV-2 IgG (n=513)	Positive for SARS-CoV-2 IgG (n=214)	Significance	Overall Sig
				0.38
21-34	126 (25%)	42 (20%)	Ref	
35-44	117 (23%)	56 (26%)	0.15	
45-54	118 (23%)	56 (26%)	0.15	
55+	150 (30%)	59 (28%)	0.56	

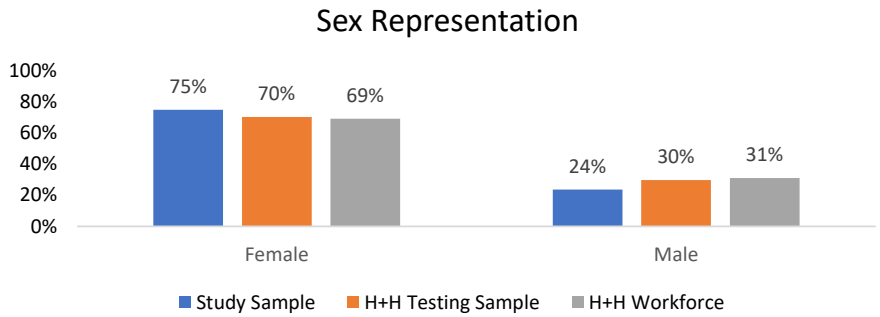
eTable 2. Distribution of Positive SARS-CoV-2 Cases by Borough

Borough	Study Distribution of Positive Antibody Tests (NYC residents only, n=166)[a]	City Distribution of Cumulative COVID Cases from 2/29/20-6/30/20[b]	Cumulative COVID Cases in NYC from 2/29/20-6/30/20[b]
Queens	34%	30%	74,542
Brooklyn	25%	28%	67,804
Bronx	20%	22%	53,842
Manhattan	18%	13%	31,204
Staten Island	3%	7%	17,014
Overall	100%	100%	244,415

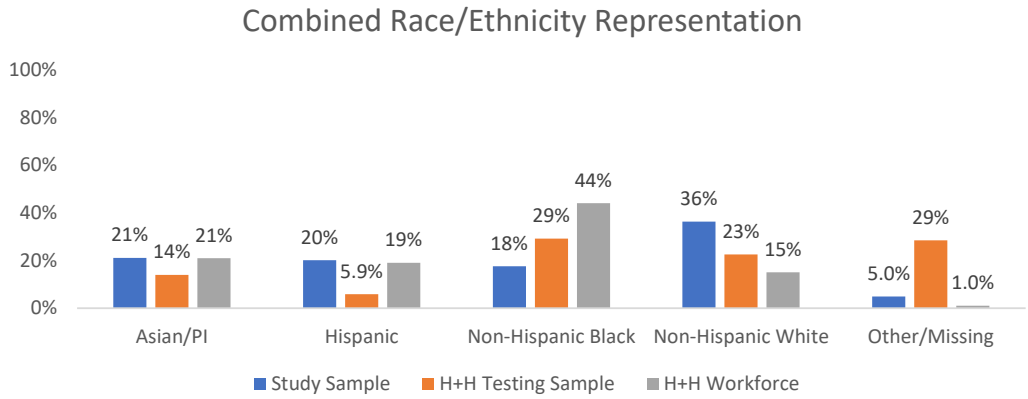
[a]Percentages are column percentages.
[b]Data retrieved from the New York City Department of Health and Mental Hygiene's publicly available GitHub website: https://github.com/nychealth/coronavirus-data

eFigure1. Demographic characteristics of the study sample, H+H employee sample, and H+H workforce.

A: Distribution of sex by study sample, H+H employee sample, and H+H workforce

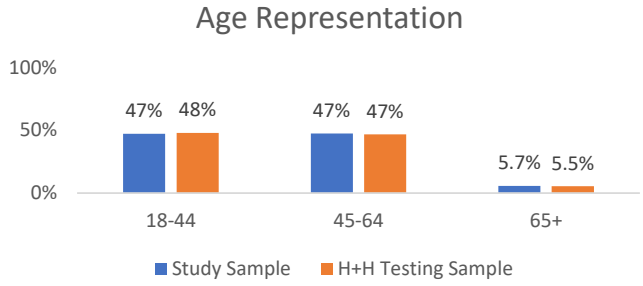


B: Distribution of race/ethnicity by study sample, H+H employee sample, and H+H workforce



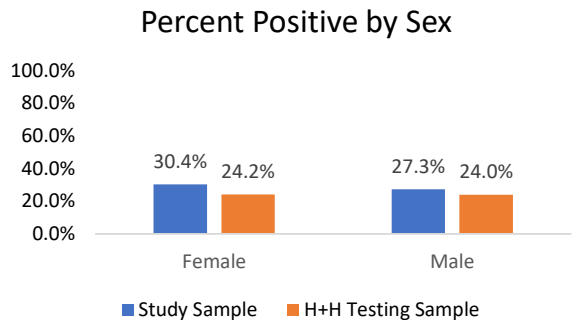
Of note, the overall H+H testing sample also included American Indian (n=152), but it has been collapsed into other since it was not recorded in the study sample or overall workforce demographics. In addition, the study sample included Pacific Islander (n=5) and Multiracial (n=11) as separate categories, but they have been collapsed into Asian/Pacific Islander and Other respectively to more easily compare to the other groups.

C: Distribution of age by study sample and H+H employee sample. Age distribution data was not available for H+H workforce.

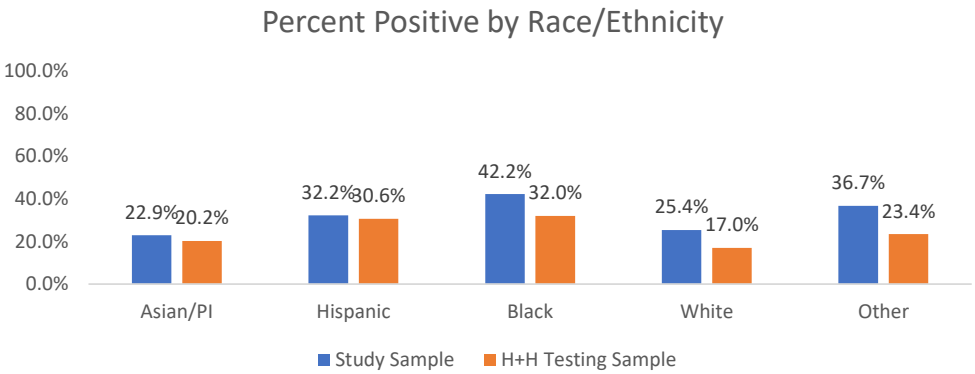
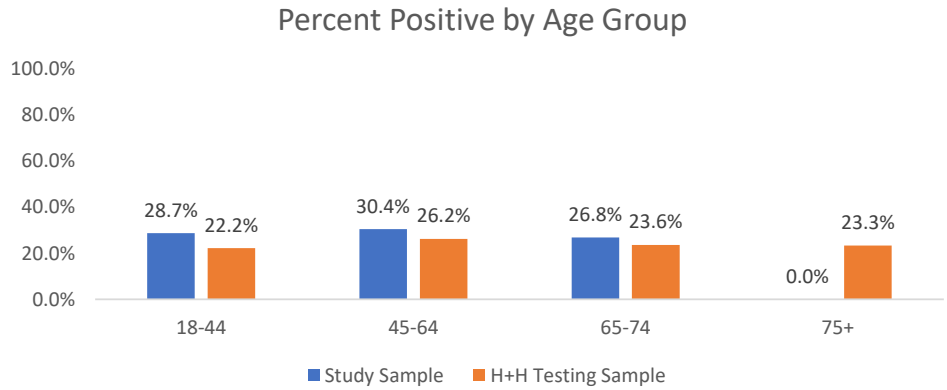


eFigure2. Percent seropositivity by demographic characteristics of the study sample, H+H employee sample, and H+H workforce.

A: Percent seropositivity by sex



B: Percent seropositivity by race/ethnicity



C: Percent seropositivity by race/ethnicity for Study Sample and H+H Testing Sample. Age distribution data was not available for H+H workforce.