RESEARCH LETTER

Prevalence of SARS-CoV-2 Antibodies in Health Care Personnel in the New York City Area

The greater New York City (NYC) area, including the 5 boroughs and surrounding counties, has a high incidence of coronavirus disease 2019 (COVID-19),[1] and health care personnel (HCP) working there have a high exposure risk. HCP have expressed concerns about access to testing so that infection spread to patients, other HCP, and their families can be minimized.[2] The Northwell Health System, the largest in New York State, sought to address this concern by offering voluntary antibody testing to all HCP. We investigated the prevalence of antibodies against severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) among HCP and associations with demographics, primary work location and type, and suspicion of virus exposure.

Supplemental content

Methods | All Northwell HCP (employees) were provided with personal protective equipment from March 7, 2020, onward. SARS-CoV-2 testing by reverse transcriptase–polymerase chain reaction (PCR) began March 7, 2020, and was available for any HCP who had COVID-19–like symptoms or suspected exposure. From April 20, 2020, to June 23, 2020, all Northwell HCP were offered free, voluntary antibody testing, regardless of symptoms, at 52 sites in the greater NYC area. HCP missing all identifying data were excluded. Testing was for qualitative IgG or total immunoreactivity to SARS-CoV-2.[3] Seven different assays were used (eTable in the Supplement); Northwell Health Laboratories validated all testing.

The main outcome was seroprevalence. Seroprevalence with 95% confidence interval was calculated by the exact binomial technique. HCP reported demographics, primary work location, job function, direct patient care, work on a COVID or non-COVID unit, and their level of suspicion of virus exposure: "Do you believe you were infected with COVID-19?"

Table 1. Demographic Information for 40 329 Health Care Personnel Voluntarily Tested for COVID-19 IgG Antibodies in the Greater NYC Area[a,b,c]

	No. with SARS-CoV-2 IgG antibodies/total (%)		RR (95% CI)	
	Seroconversion present	Seroconversion absent	Bivariate	Multivariable
Total sample	5523/40 329 (13.7)	34 806/40 329 (86.3)		
Age group, y				
18-39	2723/18 193 (15.0)	15 470/18 193 (85.0)	1 [Reference]	1 [Reference]
40-49	1100/7829 (14.1)	6729/7829 (85.9)	0.94 (0.88-1.00)	1.01 (0.96-1.06)
50-59	1055/8550 (12.3)	7495/8550 (87.7)	0.82 (0.77-0.88)[d]	1.00 (0.96-1.05)
60-69	597/5215 (11.4)	4618/5215 (88.6)	0.76 (0.70-0.83)[d]	1.12 (1.05-1.19)[e]
≥70	48/542 (8.9)	494/542 (91.1)	0.59 (0.45-0.78)[d]	1.37 (1.04-1.81)[f]
Sex				
Women	4062/29 725 (13.7)	25 663/29 725 (86.3)	1 [Reference]	1 [Reference]
Men	1461/10 604 (13.8)	9143/10 604 (86.2)	1.01 (0.95-1.07)	1.04 (1.00- 1.09)
Race/ethnicity[g]				
American Indian	32/188 (17.0)	156/188 (83.0)	1.77 (1.29-2.44)[d]	1.29 (1.05- 1.60)[f]
Asian	722/6082 (11.9)	5360/6082 (88.1)	1.24 (1.14-1.34)[d]	1.10 (1.04- 1.16)[e]
Black	1513/6444 (23.5)	4931/6444 (76.5)	2.44 (2.30-2.60)[d]	1.21 (1.14- 1.28)[h]
Hispanic	1108/5653 (19.6)	4545/5653 (80.4)	2.04 (1.91-2.18)[d]	1.19 (1.12- 1.26)[d]
Pacific Islander	35/203 (17.2)	168/203 (82.8)	1.80 (1.33-2.43)[d]	1.25 (0.97-1.62)
White	2057/21 428 (9.6)	19 371/21 428 (90.4)	1 [Reference]	1 [Reference]
Other/multiracial[h]	56/331 (16.9)	275/331 (83.1)	1.76 (1.38-2.25)[d]	1.14 (1.00- 1.29)[f]
Borough/county of residence				
Bronx	164/722 (22.7)	558/722 (77.3)	1.87 (1.53-2.28)[d]	1.15 (0.94-1.41)
Brooklyn	304/1521 (20.0)	1217/1521 (80.0)	1.64 (1.38-1.96)[d]	1.11 (0.91-1.34)
Manhattan	158/1299 (12.2)	1141/1299 (87.8)	1 [Reference]	1 [Reference]
Queens	1353/7283 (18.6)	5930/7283 (81.4)	1.53 (1.31-1.78)[d]	1.08 (0.91-1.28)
Staten Island	539/3611 (14.9)	3072/3611 (85.1)	1.23 (1.04-1.45)[f]	1.12 (0.94-1.34)
Nassau	1669/13 557 (12.3)	11 888/13 557 (87.7)	1.01 (0.87-1.18)	1.06 (0.90-1.26)
Suffolk	988/9103 (10.9)	8115/9103 (89.1)	0.89 (0.76-1.04)	1.02 (0.86-1.22)
Other[i]	348/3233 (10.8)	2885/3233 (89.2)	0.88 (0.74-1.06)	1.00 (0.84-1.20)

Abbreviations: COVID-19, coronavirus disease 2019; NYC, New York City; RR, relative risk; SARS-CoV-2, severe acute respiratory syndrome coronavirus 2.

[a] Health care personnel without identification information (n = 4174) or those residing outside the greater NYC area (n = 1614) were excluded.

[b] Assays used, their methods, antigens targets, and sensitivity/specificity are reported in the Supplement.

[c] Greater NYC area defined as NYC, the 5 boroughs (Bronx, Brooklyn, Manhattan, Queens, Staten Island), and surrounding counties (Nassau, Suffolk, Fairfield, Kings, Orange, Putnam, Rockland, and Westchester).

[d] $P < .001$ (2-tailed).

[e] $P < .01$ (2-tailed).

[f] $P < .05$ (2-tailed).

[g] Data collected by health care personnel report in prespecified fixed categories and included to determine if seroprevalence to SARS-CoV-2 varied across these categories.

[h] One of several self-reported prespecified categories on the questionnaire provided to all health care personnel at time of testing; "other" denotes that the person does not fit into one of the other categories or self-identifies as "multicultural."

[i] See footnote c.

Table 2. Occupational Measures for 40 329 Essential Health Care Personnel Voluntarily Tested for COVID-19 IgG Antibodies in the Greater NYC Area[a]

	No./total (%) with SARS-CoV-2 antibodies		RR (95% CI)	
	Seroconversion present	Seroconversion absent	Bivariate	Multivariable
Total sample	5523/40 329 (13.7)	34 806/40 329 (86.3)		
Job function				
Allied health professionals[b]	949/8156 (11.6)	7207/8156 (88.4)	1 [Reference]	1 [Reference]
Administrative and clerical[c]	1217/9645 (12.6)	8428/9645 (87.4)	1.08 (1.00-1.17)[d]	1.05 (0.98-1.13)
Nurses	1503/11 468 (13.1)	9965/11 468 (86.9)	1.13 (1.04 -1.22)[e]	0.99 (0.94-1.05)
Physicians	327/3746 (8.7)	3419/3746 (91.27)	0.75 (0.67-0.85)[f]	0.88 (0.79-0.96)[e]
Service/maintenance[g]	1527/7314 (20.9)	5787/7314 (79.12)	1.79 (1.67-1.93)[f]	1.04 (0.98-1.11)
PCR test[h]				
Negative	402/3892 (10.33)	3490/3892 (89.7)	1 [Reference]	1 [Reference]
Positive	2044/2186 (93.5)	142/2186 (6.5)	9.05 (8.25-9.94)[f]	4.03 (3.50-4.64)[f]
Self-reported suspicion of virus exposure[i]				
Low	1177/22 155 (5.3)	20 978/22 155 (94.7)	1 [Reference]	1 [Reference]
Medium	1180/10 410 (11.3)	9230/10 410 (88.7)	2.13 (1.97-2.31)[f]	1.68 (1.28-2.20)[f]
High	2726/4604 (59.2)	1878/4604 (40.8)	11.15 (10.49-11.84)[f]	4.38 (3.32-5.77)[f]
Primary work location[j]				
Emergency department	533/3089 (17.3)	2556/3089 (82.7)	1 [Reference]	1 [Reference]
Intensive care unit	331/3355 (9.9)	3024/3355 (90.1)	0.57 (0.50-0.65)[f]	0.98 (0.89-1.07)
Hospital units (non-ICUs)	1706/9976 (17.1)	8270/9976 (82.9)	0.99 (0.91-1.08)	0.99 (0.93-1.05)
Other	2448/20 303 (12.1)	17855/20 303 (88.0)	0.70 (0.64-0.76)[f]	0.93 (0.87-0.99)[d]
Does your job entail direct patient care?[k]				
No	1562/12 803 (12.2)	11 241/12 803 (87.8)	1 [Reference]	1 [Reference]
Yes	3437/23 852 (14.4)	20 415/23 852 (85.6)	1.18 (1.12-1.25)[f]	0.99 (0.94-1.04)
Does your job entail working in a COVID-19–positive unit?[l]				
No	2247/18 332 (12.3)	16 085/18 332 (87.7)	1 [Reference]	1 [Reference]
Yes	2519/15 779 (16.0)	13 260/15 779 (84.0)	1.30 (1.24-1.37)[f]	0.98 (0.94 -1.02)

Abbreviations: COVID-19, coronavirus disease 2019; ICU, intensive care unit; NYC, New York City; PCR, polymerase chain reaction; RR, relative risk.

[a] Of these health care personnel, 6341 had previous PCR testing, 2186 (34.5%) were PCR positive, 3892 (61.4%) were PCR negative, and 263 (4.1%) had PCR equivocal results. Health care personnel without any identification information (n = 4174) or those residing outside the greater NYC area (n = 1614) were excluded. Assays used, their methods, antigens targets, and sensitivity/specificity are reported in the Supplement. See Table 1 footnotes for definition of greater NYC area.

[b] Includes all clinical professionals (such as physician assistants, physical therapists/occupational therapists, social workers, mental health, and 21 others) and allied health professionals (such as pharmacists, laboratory technicians, and 10 others).

[c] Includes nonclinical professionals (such as information technologists, personnel in human resources, medical records, and 23 others) and clerical professionals (such as billing clerk, telephone, and 8 others).

[d] $P < .05$ (2-tailed).

[e] $P < .01$ (2-tailed).

[f] $P < .001$ (2-tailed).

[g] Includes housekeepers, groundskeepers, medical assistants, and 21 others.

[h] A total of 6078 had PCR tests.

[i] Information missing for 3160 (7.8%).

[j] Information missing for 3606 (8.9%).

[k] Information missing for 3674 (9.1%).

[l] Information missing for 6218 (15.4%).

(range, 1-9; 1 = no; 9 = yes definitely; 7-9 = high suspicion). Associations among seroprevalence and these variables was assessed using Poisson logistic regression. All eligible persons were included in all analyses by creating a missingness subcategory for each variable. R version 4.0.1 (R Foundation for Statistical Computing) was used for analyses. $P < .05$ (2-sided) defined statistical significance. The Northwell Health institutional review board approved this research; all participants provided electronic informed consent.

Results | All Northwell HCP (n = 70 812) were invited: 46 117 (65.1%) were tested as of June 23, 2020. The final consented sample of 40 329 (57.0%) (median age, 42 [interquartile range, 31.5-54.5] years) included 73.7% women, 16.0% Black, 0.8% multiracial, and 14.0% Hispanic HCP (**Table 1**) and 28.4% nurses and 9.3% physicians (**Table 2**).

Overall, 5523 of 40 329 (13.7% [95% CI, 13.4%-14.0%]) HCP were seropositive. Of 6078 with previous PCR testing results, 2186 (36.0%) were PCR positive. Of these PCR-positive HCP, 2044 (93.5%) were also seropositive, leaving 142 (6.5%) with negative antibody test results. Of the 3892 PCR-negative HCP, 3490 (89.7%) were also seronegative. Of 34 251 with no PCR testing, 3077 (9.0%) were seropositive (Table 2).

Missing data ranged from 0% to 15.4%. Working in COVID-19 units or in direct patient care were each associated with seroprevalence in bivariate analyses but not in

multivariable analyses. In a fully adjusted model, several demographic variables (including increasing age and non-White race or ethnicity), a previous positive PCR test result (relative risk, 4.03 [95% CI, 3.50-4.64]; $P < .001$), and reported high suspicion of virus exposure (relative risk, 4.38 [95% CI, 3.32-5.77]; $P < .001$) were associated with seroprevalence (Table 2).

Discussion | A 13.7% prevalence of SARS-CoV-2 antibodies in this large cohort study of HCP in the greater NYC area was similar to that among adults randomly tested in New York State (14.0%)[4] but higher than among adults in Los Angeles (4.1%).[5] HCP in a single hospital in Belgium had lower seroprevalence (6.4%), which was significantly associated only with household contact.[6] In this study, high levels of HCP-reported suspicion of virus exposure and prior positive PCR testing results were most strongly associated with seropositivity.

Study limitations include voluntary testing, with only 56% of HCP participating; restriction to the greater NYC area; 7 different assays with variable sensitivity and specificity used; and time between PCR and antibody testing unknown and possibly too short to detect antibody response. Only HCP-reported suspicion of overall exposure was recorded, so distinguishing among community-, home-, and health care–acquired exposures was not possible.

Providing HCP with data about their SARS-CoV-2 virus exposure is important so they can protect themselves, their patients, their colleagues, and their families. High levels of HCP-reported suspicion of virus exposure may be useful as an indication for SARS-CoV-2 testing.

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Incidence of Malformations After Early Pregnancy Exposure to Modafinil in Sweden and Norway

Modafinil is used to improve wakefulness in adults with excessive sleepiness due to narcolepsy, for fatigue related to multiple sclerosis, and for the treatment of attention-deficit/hyperactivity disorder. In 2018, an interim report from a manufacturer-established pregnancy registry reported a prevalence of 15% for major malformation in infants exposed to modafinil during pregnancy, spurring regulatory bodies to amend product information.[1-3] Recently, a Danish study reported a major malformation rate of 12% (n = 6) among 49 infants exposed to modafinil during early pregnancy compared with 3.9% (n = 32 466) among 828 644 unexposed to modafinil (adjusted odd ratio, 2.7; 95% CI, 1.1-6.9).[4] To add to the emerging evidence, we investigated if modafinil use during early pregnancy was associated with major malformations in Norway and Sweden.