**Methods Supplement**

Contents:

1. Description of cohorts from which the COVID-19 survey was drawn and exclusion criteria applied for the current analysis
2. Selected questions used in this analysis from the baseline COVID-19 survey in the Nurses’ Health Study II, Nurses’ Health Study 3 and Growing Up Today studies
3. Parameterization of lack of each PPE Item and of overall PPE access
4. Derivation of COVID-19 case status based on self-reported symptoms

**Methods Supplement 1**: Description of cohorts from which the COVID-19 survey was drawn and exclusion criteria applied for the current analysis

The Nurses’ Health Study II (NHSII) was initiated in 1989 with 116,429 female registered nurses (RNs) aged 25–42 living in 14 populous states. The Nurses’ Health Study 3 (NHS3) is an open cohort started in 2010 that continues to enroll nurses and nursing students age 18 and older, born after January 1, 1965, living in the US or Canada; the NHS3 cohort includes RNs, licensed practical and vocational nurses and specialized RNs (e.g. nurse practitioners, nurse midwives, and nurse anesthetists), and nursing students. In 2015, the NHS3 cohort was expanded to include male nurses. The Growing up Today Study (GUTS) is comprised of 27,793 female and male offspring of NHSII participants who were age 9–17 at the cohort’s baseline in 1996.

As detailed in manuscript Figure 1, we emailed the COVID-19 survey to cohort participants who had returned their most recent main cohort questionnaire (to avoid fielding simultaneous questionnaires), except those who lacked a valid email address, had opted out of substudies, were currently in another substudy, had requested paper questionnaires only, or who had self-reported dementia. We restricted the current analysis to participants living in the United States or its territories and who returned their baseline survey during April–May 2020. Frontline HCP are defined as those who physically worked or volunteered at a healthcare site since March 1, 2020 [Hospital - ER, OR or ICU; Hospital - Dedicated COVID-19 unit; Hospital - Other inpatient setting; Hospital - Other outpatient setting; Temporary COVID-19 facility; Healthcare clinic outside a hospital; Nursing home or group care facility; Home health; School clinic; Other healthcare facility] and did not indicate ‘Not employed in direct patient care since March 1, 2020.’ (See questions in **Methods Supplement 2**). A comparison of the participant characteristics of the source populations to those of the COVID-19 survey respondents is presented in **Methods Supplement Table 1**. Although COVID-19 survey respondents were slightly older and more likely to be NHS2 participants, the COVID-19 survey respondents are similar in other characteristics to the source population of the cohorts.

**Methods Supplement Table 1**. Comparison of participant characteristics in the source cohorts to those of COVID-19 baseline survey respondents

|  |  |  |
| --- | --- | --- |
|  | Baseline Cohorts | COVID-19 Survey Respondents |
| n (%) | 180,074 | 58,606  |
| Age (mean years, s.d.) at time of COVID-19 survey | 55.0 (14.4) | 56.4 (13.9) |
| Body Mass Index (kg/m2) at cohort baseline | 24.0 (5.6) | 23.9 (5.4) |
| Cohort, n (%) |
| Nurses’ Health Study II | 116,429 (65) | 39,564 (68) |
| Nurses’ Health Study 3 | 35,852 (20) | 12,317 (20) |
| Growing Up Today Study | 27,793 (15) | 6,725 (11) |
| Sex, n (%) |
| Women | 167,225 (93)  | 56,717 (97) |
| Men | 12,758 (7) | 1,889 (3) |
| Race, and Ethnicity, n (%) |
| White | 170,699 (95) | 56,486 (96) |
| Hispanic | 892 (0.5) | 206 (0.4) |
| Black  | 3,541 (2) | 712 (1) |
| Asian | 3,382 (2) | 255 (1) |
| Other race | 1,469 (1) | 108 (1) |
| Cigarette Smoking, n (%) |
| Current smoker | 7,439 (4) | 2,586 (4) |

Missing data from baseline cohorts: age (n=112), BMI (n=2189), and sex, race, smoking (n=91); from COVID-19 baseline: BMI (n=464)

**Methods Supplement 2**: Selected questions from the baseline COVID-19 survey in the Nurses’ Health Study II, Nurses’ Health Study 3 and Growing Up Today studies

What is your current occupational status (include remote work from home)? (Select all that apply)

 [ ] Working full time

 [ ] Working part time

 [ ] Student

 [ ] In the military

 [ ] Volunteering

 [ ] On maternity/paternity leave

 [ ] Staying home with children/taking care of family

 [ ] Retired

 [ ] Retired but have returned to work during pandemic

 [ ] Unemployed, laid off, furloughed, looking for work

 [ ] Not working due to disability

 [ ] Other, Please describe:

[Those electing the highlighted response categories in the above question were given the following question about worksite]

Since March 1, 2020, have you physically worked or volunteered in: (Select all that apply)

 [ ] Hospital - ER, OR or ICU

 [ ] Hospital - Dedicated COVID-19 unit

 [ ] Hospital - Other inpatient setting

 [ ] Hospital - Other outpatient setting

 [ ] Temporary COVID-19 facility

 [ ] Healthcare clinic outside a hospital

 [ ] Nursing home or group care facility

 [ ] Home health

 [ ] School clinic

 [ ] Other healthcare facility

 [ ] Employed in healthcare, but working from home or other remote work arrangement since March 1, 2020

 [ ] Not employed in direct patient care since March 1, 2020

[For this analysis, we combined as one category Hospital - Dedicated COVID-19 unit’ and ‘Temporary COVID-19 facility’. Frontline Healthcare Personnel (HCP) were defined as those electing the highlighted response categories in the above worksite question; note that people working in these facilities were counted as frontline HCP, with or without direct patient contact.]

[Asked of frontline HCP] Have you ever interacted in person with patients with documented or presumed COVID-19 infection? (Select all that apply)

(NOTE: Only include those with a documented or presumed active infection at the time of your interaction.)

 [ ] Yes, documented COVID-19 cases

 [ ] Yes, presumed COVID-19 cases

 [ ] Not that I know of

 [ ] I don't work directly with patients

[Asked of frontline HCP] Excluding patients, have you ever interacted in person with someone with documented or presumed COVID-19 infection (such as co-workers, family members, or others)? (Select all that apply)

(NOTE: Only include those with a documented or presumed active infection at the time of your interaction.)

 [ ] Yes, documented COVID-19 cases

 [ ] Yes, presumed COVID-19 cases

 [ ] Not that I know of

[Asked of those who were not frontline HCP] Have you ever interacted in person with someone with documented or presumed COVID-19 infection (such as co-workers, family members, or others)? (Select all that apply)

(NOTE: Only include those with a documented or presumed active infection at the time of your interaction.)

 [ ] Yes, documented COVID-19 cases

 [ ] Yes, presumed COVID-19 cases

 [ ] Not that I know of

[Items in the following PPE section were asked only of frontline HCP]

Have you ever been fit-tested for an N95 mask (also called an N95 respirator)? (Select all that apply)

 [ ] Yes, within the past year

 [ ] Yes, more than a year ago

 [ ] No, I've never been fit tested

 [ ] Not applicable (I don't need an N95 mask for my job)

Have you ever been trained in procedures for donning and doffing PPE (personal protective equipment)? (Select all that apply)

 [ ] Yes, within the past year

 [ ] Yes, more than a year ago

 [ ] No, I've never been trained

 [ ] Not applicable (I don't need PPE for my job)

## PPE Reuse

Because of equipment shortages, some medical workers may have needed to REUSE PPE

without disinfection. Please indicate if you have had to do this since March 1, 2020.

Since March 1, 2020, have you had to reuse GLOVES at work? (Select all that apply)

 [ ] Yes, after disinfection

 [ ] Yes, without disinfection

 [ ] No, I didn't have to reuse gloves

 [ ] Not applicable (I don't need gloves for my job)

Since March 1, 2020, have you had to reuse PROTECTIVE GOWNS at work? (Select all that apply)

 [ ] Yes, after disinfection

 [ ] Yes, without disinfection

 [ ] No, I didn't have to reuse protective gowns

 [ ] Not applicable (I don't need gowns for my job)

Since March 1, 2020, have you had to reuse N95 MASKS at work? (Select all that apply)

 [ ] Yes, after disinfection

 [ ] Yes, without disinfection

 [ ] No, I didn't have to reuse N95 masks

 [ ] Not applicable (I don't need N95 masks for my job)

Since March 1, 2020, have you had to reuse SURGICAL MASKS at work? (Select all that apply)

 [ ] Yes, after disinfection

 [ ] Yes, without disinfection

 [ ] No, I didn't have to reuse surgical masks

 [ ] Not applicable (I don't need masks for my job)

## PPE Use

Please indicate how often you have used PPE at work (for any reason) since March 1, 2020.

Since March 1, 2020, did you use GLOVES at work?

 [ ] Always

 [ ] Sometimes-> Select all that apply:

 [ ] I haven't always needed gloves

 [ ] There weren't enough gloves

 [ ] Never-> Select all that apply:

 [ ] I never needed gloves

 [ ] I needed gloves, but they were not available

 [ ] Not Applicable (I didn't need gloves for my job)

Since March 1, 2020, did you use PROTECTIVE GOWNS at work?

 [ ] Always

 [ ] Sometimes-> Select all that apply:

 [ ] I haven't always needed gowns

 [ ] There weren't enough gowns

 [ ] Never-> Select all that apply:

 [ ] I never needed gowns

 [ ] I needed gowns, but they were not available

 [ ] Not Applicable (I didn't need gowns for my job)

Since March 1, 2020, did you use a FACE SHIELD or GOGGLES at work? (NOT eyeglasses or contacts)

 [ ] Always

 [ ] Sometimes-> Select all that apply:

 [ ] I haven't always needed shields/goggles

 [ ] There weren't enough shields/goggles

 [ ] Never -> Select all that apply:

 [ ] I never needed shields/goggles

 [ ] I needed shields/goggles, but they were not available

 [ ] Not Applicable (I didn't need shields/goggles for my job)

Since March 1, 2020, did you use N95 MASKS at work?

 [ ] Always

 [ ] Sometimes -> Select all that apply:

 [ ] I haven't always needed N95 masks

 [ ] There weren't enough N95 masks

 [ ] Never -> Select all that apply:

 [ ] I never needed N95 masks

 [ ] I needed N95 masks, but they were not available

 [ ] Not Applicable (I didn't need N95 masks for my job)

Since March 1, 2020, did you use SURGICAL MASKS at work?

 [ ] Always

 [ ] Sometimes -> Select all that apply:

 [ ] I haven't always needed surgical masks

 [ ] There weren't enough surgical masks

 [ ] Never -> Select all that apply:

[ ] I never needed surgical masks

 [ ] I needed surgical masks, but they were not available

 [ ] Not Applicable (I didn't need surgical masks for my job)

Since March 1, 2020, did you use a POWERED AIR PURIFYING RESPIRATOR (PAPR) at work?

 [ ] Always

 [ ] Sometimes -> Select all that apply:

 [ ] I haven't always needed a PAPR

 [ ] There weren't enough PAPR

 [ ] Never -> Select all that apply:

[ ] I never needed a PAPR

 [ ] I needed a PAPR, but one was not available

 [ ] Not Applicable (I didn't need a PAPR for my job)

[Items in the following COVID-19 testing and symptoms section were asked of all participants]

Have you ever been tested for COVID-19 (include both active infection and antibody tests)?

 [ ] Yes, and I received results

 [ ] Yes, I was tested and results are pending

 [ ] No, I wasn't tested

How many test results have you received?

 [ ] 1

 [ ] 2

 [ ] 3 or more

FIRST TEST: Type of test

 [ ] Active infection (swab of nose, mouth, or throat)

 [ ] Antibody (blood test)

FIRST TEST: Results

 [ ] Positive (infection or antibodies present)

 [ ] Negative (infection or antibodies not present)

FIRST TEST: Date of test

[Repeated if more than one test reported]

Since March 1, 2020, have you experienced any of the following symptoms? (Select all that apply)

 [ ] Persistent cough

 [ ] Shortness of breath or difficulty breathing

 [ ] Fever

 [ ] Sore throat

 [ ] Muscle aches

 [ ] Digestive symptoms (vomiting, diarrhea)

 [ ] Loss of taste

 [ ] Loss of smell

 [ ] Other symptoms consistent with COVID-19 infection

 [ ] None of the above

**Methods Supplement 3**: Parameterization of Lack of Each PPE Item and of overall PPE Access, based on the above PPE Use questions



\*If participants indicated there ‘weren’t enough’ sometimes-used items or never-used items that were ‘not available,’ they were scored as lacking access to the item, even if they also indicated they sometimes or never needed the item.

**Methods Supplement 4**: Derivation of symptom-predicted COVID-19 based on self-reported symptoms

This analysis was performed among the 58,606 participants who returned the baseline COVID-19 questionnaire during April 21–August 31, 2020 (99% of respondents replied by May 31). At this point, 4,450 participants (7.6%) had received the results of a SARS-CoV-2 infection or antibody test, among whom 430 (9.7%) had tested positive. Considering that testing was neither routine nor widespread early in the pandemic, we derived a symptom-based definition of COVID-19 status, following methods similar to those of Menni and colleagues.1

We randomly selected 80% of the sample (n = 3575, including 352 cases) to serve as the training set and reserved 20% as a test set. In the training set, we identified which of 9 self-reported COVID-19 symptoms (listed in Appendix 1) were most strongly and independently predictive of a positive SARS-CoV-2 test by comparing the Bayes Information Criterion for logistic regression models with varying combinations of age and symptoms identified using the SCORE option of PROC LOGISTIC procedure of SAS 9.4 (SAS Institute, Cary, N.C.) The following model, including age, fever, sore throat, muscle aches, loss of taste, loss of smell, and ‘other symptoms consistent with COVID-19 infection’ had the lowest Bayes Information Criterion:

Predicated log odds = -4.6167 +(0.0199\*age) + (0.7311\*fever) + (-1.0825\*throat) + (0.5978\*muscle) + (1.5348\*taste) + (2.0717\*smell) + (1.2952\*other)

We then transformed the predicted log odds into predicted probabilities for the entire cohort (tested and untested), using exp(*x*)/(1 + exp(*x*)) transformation. Within the training dataset, we then applied the Youden criteria (Youden’s J statistic) to detect the threshold of predicted probability with the optimized sensitivity and specificity against tested SARS-CoV-2 infection or antibody status; Youden’s J was maximized at 0.1. Symptom-predicted COVID-19 was assigned for predicted probabilities >0.1 and non-cases assigned for probabilities <0.1.

The model was then tested in the 20% validation set (n = 875, including 78 cases) as well as through leave-one-out cross-validation in the entire dataset of 4450 participants with tested SARS-CoV-2 infection status. In the validation set, the prediction model had an area under the curve (AUC) of the receiver operating characteristic curve (ROC) of 0.85 (95% CI: 0.79–0.90), a sensitivity of 0.76 (0.65–0.85), a specificity of 0.89 (0.87–0.91), a positive predictive value of 0.41 (0.35–0.47) and a negative predictive value of 0.97 (0.96–0.98). In leave-one-out cross-validation, the ROC-AUC was 0.87 (0.85–0.89) among all participants who had been tested for SARS-CoV-2.

In the entire dataset (tested and untested), fewer than 0.73% reported having had a positive SARS-CoV-2 infection or antibody test; based on the symptom-derived algorithm 3.7% were assigned symptom-predicted COVID-19.

**References**

1. Menni C, Valdes AM, Freidin MB, et al. Real-Time tracking of self-reported symptoms to predict potential COVID-19. Nature Medicine. 2020;26(7):1037-40. doi: 10.1038/s41591-020-0916-2.