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In their own words: a qualitative survey of healthcare providers' experiences with personal protective equipment during the COVID-19 pandemic

Iris Becene[1], Aarushi Shah[2], Katie Nguyen[3], Madeline West[4], Jane Berrill[1,5], Jennifer Stuart[1,6], Christina Borba[7], Janet Rich-Edwards[1,6,*]

[1]Division of Women's Health, Department of Medicine, Brigham and Women's Hospital and Harvard Medical School, United States
[2]Columbia University Irving Medical Center, Sociomedical Sciences, 722 West 168th Street, New York, NY 10032-3784, United States
[3]Harvard College, Cambridge, MA, United States
[4]New York University, School of Global Public Health, New York, NY, United States
[5]Channing Division of Network Medicine, Department of Medicine, Brigham and Women's Hospital and Harvard Medical School, United States
[6]Department of Epidemiology, Harvard T.H. Chan School of Public Health, United States
[7]Boston University School of Medicine Boston, MA, United States
[*]Corresponding author: Email: jr33@partners.org

Abstract

Background: At the beginning of the coronavirus disease (COVID-19) pandemic, healthcare personnel (HCP) faced a dire shortage of personal protective equipment (PPE). This shortage has been identified as a major source of distress among HCP during the early COVID-19 pandemic, though the specific consequences of this shortage have not been identified in the qualitative literature.

Methods: We sought to fill this gap by conducting a qualitative analysis of PPE related free-text comments from online surveys completed by 923 HCP during Spring 2020.

Results: We found that HCP used words such as "required" and "had" to describe how their use of non-standard PPE was imposed on them by their workplace, suggesting that they felt little control over their protection at work. HCP described cleaning PPE with novel methods, such as bleach, alcohol, hydrogen peroxide, and UV light, in addition to creating their own PPE out of materials such as garbage bags, sheets, and cloth. Furthermore, HCP expressed frustration with PPE policies at their workplaces, which continued throughout the early pandemic due to the rapidly changing guidelines and the inability to express their opinions to their institutions. The combination of these concerns left HCP scared of being infected with COVID-19 while at work and subsequently infecting their loved ones at home.

Conclusion: It is critical that healthcare institutions understand HCP's experiences with and feelings towards PPE, as providing the proper protection is vital in ensuring an adequate HCP workforce.

Key words: content analysis; occupational exposure; occupational health; pandemic.

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What's Important About This Paper?

The shortage of personal protective equipment at the beginning of the COVID-19 pandemic was found to be a major source of distress among healthcare personnel (HCP), though it is unclear which aspects of the shortage were most distressing. The lack of PPE, use of non-standard PPE, and the shifting PPE policies imposed by workplaces left HCP feeling vulnerable to COVID-19 infection and unsupported by their administrations. Findings from this study should inform policies for protecting HCP during future pandemics and healthcare system strain.

Introduction

The rapid onset of the novel coronavirus disease (COVID-19) pandemic disrupted supply chains and placed a substantial burden on healthcare systems across the world, resulting in a critical and international shortage of personal protective equipment (PPE) (Cohen and Rodgers 2020). A large international sample of healthcare providers (HCP) reported that during the beginning of the pandemic in April 2020, 50% lacked at least one piece of standard PPE and 30% had to reuse and/or wash at least one piece of single use PPE (Tabah et al. 2020). In the United States, 22% of frontline HCP participating in the national Nurses' Health Studies (NHS2 and NHS3) and Growing Up Today Study (GUTS) reported sometimes or always lacking PPE in Spring 2020 (Rich-Edwards et al. 2021). Both the lack of PPE and the reuse of PPE had dangerous ramifications for healthcare workers and patients alike; recent research has found a dose–dependent relationship between the use of PPE, including masks, gloves, gowns, and eye protection, and decreased COVID-19 infection risk (Chou et al. 2020). Additionally, many methods used to sanitize PPE were not effective and placed HCP increased risk for infection compared to standard PPE (Lieu et al. 2020; Levine et al. 2021).

The increased risk of infection due to lack of PPE placed a significant mental toll on HCPs. Quantitative studies have found lack of appropriate HCP was associated with increased rates of depression, anxiety, posttraumatic stress disorder (PTSD), stress, and burnout among HCPs (Arnetz et al. 2020b; Coto et al. 2020; Firew et al. 2020; Giorgi et al. 2020; Morgantini et al. 2020; Survey: Nurses Fear Going to Work 2020; Burstyn and Holt 2021; Cag et al. 2021; Cyr et al. 2021; De Kock et al. 2021; Smith et al. 2021). Specifically, having inadequate PPE was associated with an almost two-fold increased odds of depressive symptoms, PTSD symptoms, and/or anxiety symptoms in a sample of 695 frontline nurses in Michigan (Arnetz et al. 2020b). Lack of PPE has been found to be one of the most salient risk factors for adverse mental health outcomes among HCP during the COVID-19 pandemic (De Kock et al. 2021). When asked about concerns regarding COVID-19, 74% of nurses in a nationwide survey stated that lacking adequate PPE was their primary concern Furthermore, 85% reported being afraid to go to their workplace and 64% reported fear of exposing family and friends (Survey: Nurses Fear Going to Work 2020).

The lack of PPE available to HCP is both an occupational health and public health issue. Infected HCP may transmit the virus to patients, further increasing demand for healthcare, while also decreasing the number of available HCP to treat infected patients (Cohen and Rodgers 2020). Thus, it is critical from both an occupational health stance and a public health stance to understand the PPE-related experiences of HCP during the onset of the pandemic. While having inadequate PPE, fear of being infected, and fear of infecting others have emerged through qualitative research as major sources of distress for HCP during the pandemic, few studies have investigated what specific aspects of inadequate PPE were most distressing (Arnetz et al. 2020a; Galehdar et al. 2020; Catania et al. 2021; Danesh, Garosi, and Golmohamadpour 2021; De Kock et al. 2021; Eftekhar Ardebili et al. 2021; Gray et al. 2021; Hoernke et al. 2021; Kea et al. 2021; Kellogg, Schierberl Scherr, and Ayotte 2021). The objective of the current study was to identify the specific aspects of having inadequate PPE that were distressing to frontline HCP early in the COVID-19 pandemic. Nine hundred twenty-three-text comments from surveys of HCP participants of the Nurses' Health Study 2 (NHS2), the Nurses' Health Study 3 (NHS3), and the Growing Up Today Study (GUTS) studies were qualitatively analyzed to identify prominent sources of PPE-related distress. Additionally, a mixed methods analysis was conducted to identify sociodemographic and mental health factors associated with the qualitative findings.

Materials and methods

Aim

The aim of this study was to provide detailed insights into HCPs' experiences with PPE during the early COVID-19 pandemic.

Design

In response to the COVID-19 pandemic, 3 ongoing, large longitudinal cohorts in the United States launched a series of monthly and quarterly surveys to capture COVID-19

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related experiences of their participants: NHS2, NHS3, and GUTS (See Supplemental Methods, Bao et al. 2016). Participants who had responded to the most recent primary cohort questionnaire were invited via email between 21 April 2020, and 16 May 2020, to complete the COVID-19 baseline survey; responses to the baseline questionnaire were accepted through 31 May 2020. These data were collected and managed using REDCap electronic data capture tools hosted at Mass General Brigham (Harris et al. 2009, 2019). REDCap (Research Electronic Data Capture) is a secure, web-based software platform designed to support data capture for research studies, providing (i) an intuitive interface for validated data capture; (ii) audit trails for tracking data manipulation and export procedures; (iii) automated export procedures for seamless data downloads to common statistical packages; and (iv) procedures for data integration and interoperability with external sources. Details on the inclusion and exclusion criteria for this supplemental study are available elsewhere (Rich-Edwards et al. 2021). The Baseline survey was emailed to 105,662 participants across the three cohorts and a total of 58 606 participants (55% response rate) completed the COVID-19 Baseline survey. A month after returning the Baseline survey, participants were emailed the Month 1 survey: 47 298 participants responded to the Month 1 survey. Subsequent surveys were sent for a year after the Baseline survey at weekly, monthly, and quarterly intervals, depending on active HCP status. The data in this analysis are from the Baseline and Month 1 surveys.

Survey instrument

The COVID-19 surveys collected data across topics including mental health, occupational stressors, caregiving and relationships, health behaviors, and symptoms and diagnoses of COVID-19 through both close ended questions and free-text comment boxes.

The same 4 free-text comment boxes were included on both the Baseline and month one questionnaires, allowing participants to add additional prompted and unprompted comments. These included: (i) an unprompted box following questions regarding COVID-19 symptoms; (ii) an unprompted box following the dietary questionnaire; (iii) a directed box inviting the participants to "Please include any information about your use of improvised, non-standard PPE"; and (iv) a directed box at the conclusion of the survey stating "We are interested in learning more about your experiences during this pandemic. Please add anything else you would like to tell us here." All comment boxes were unlimited in length.

Quantative measures

Quantitative measures were collected on both the Baseline and Month 1 surveys. Baseline surveys were returned from 21 April 2020 to 15 May 2020, and Month 1 surveys were returned from 19 May 2020 to August 2020. Clinical role and type of clinical worksite were reported by all HCPs. Those who physically worked or volunteered in a clinical setting were considered to be frontline HCPs, regardless of patient contact. Frontline HCP were asked if they had had documented, presumed, or unknown contact ("not that I know of") with patients with COVID-19; this question format accommodated the fact that tests were often unavailable in clinical settings early in the pandemic.

PPE adequacy was assessed through a series of questions regarding availability of individual PPE items. Participants indicated if they "always," "sometimes," or "never" had access to specific items of PPE, which included surgical masks, N95 respirators, powered air-purifying respirators (PAPRs), face shield or goggles, protective gowns, and gloves. Participants reporting "sometimes" or "always" lacking an item of PPE that they deemed necessary for their role, they were defined as having inadequate PPE. Participants who always had access to the necessary PPE were defined as having adequate PPE.

Geographic mortality rates were utilized to represent local healthcare system burden from COVID-19 experienced by HCP. Residential COVID-19 mortality was derived from zip-code and date-specific COVID-19 mortality data from the COVID-19 Data Repository by the Center for Systems Science and Engineering at Johns Hopkins University (Dong et al. 2020). Mortality in the 13 days after they returned the survey was used to represent COVID-19 burden at the time of the survey, based on the estimated 13-day median hospital stay for fatal COVID-19 (Lewnard et al. 2020). Prospective residential mortality rate was categorized as no mortality, low mortality (>0 deaths and <0.25 deaths per 10 000 persons), medium mortality (greater than or equal to 0.25 deaths and <0.75 deaths per 10 000) and high mortality (greater than or equal to 0.75 deaths per 10 000).

Participants' concern regarding COVID-19 was assessed by the question "How worried are you about COVID-19 right now?," with participants responding if they were "very worried," "somewhat worried," "not very worried," or "not worried at all." COVID-19-related psychological distress was assessed by a revised Patient Health Questionnaire-4 (PHQ-4), in which participants indicated if they had experienced symptoms of depression and anxiety "not at all," "several days," "more than half the days," or "nearly every day" in the past 7 days, with scores ranging from 0 to 3, respectively (Kroenke et al. 2009). Anxiety symptoms included "feeling nervous, anxious, or on edge" and "not being able to stop or control worrying," and depression

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symptoms included "feeling down, depressed, or hopeless" or "having little interest or pleasure in doing things." A total PHQ-4 score was created by summing the scores of each of the 4 items, which was further classified as normal (0–2), mild (3–5), moderate (6–8), or severe (9–12) psychological distress. Anxiety and/or depression symptoms were indicated if a participant scored >=3 across the 2 respective measures.

Study sample

The percentage of respondents providing comments in at least one text box was 56% at Baseline (n = 32 941) and 43% for Month 1 (n = 20 355). Responses from these participants were sampled and qualitatively analyzed until theoretical saturation was reached. Participants were selected to ensure an adequate distribution across age, gender, and HCP occupation. In total, 923 comments from 923 frontline HCP were analyzed, with 705 comments coming from the Baseline questionnaire and 218 from the Month 1 questionnaire. Sampling is depicted in Fig. 1.

Data analysis

Qualitative analysis

The framework method was utilized in the qualitative analysis to thematically analyze the content of the free-text comments. The 5 stages of this method included familiarization with data, open-coding, development of analytical framework, application of framework, and interpretation of data (Pope et al. 2000; Dong et al. 2020). To inductively derive codes, all comments from 200 surveys were independently analyzed by 5 coders to derive reoccurring themes. These themes were discussed and refined before incorporation into the codebook. As new responses were analyzed, the codebook was updated in an iterative process in which codes were added, removed, or merged as needed. Cohen's kappa was utilized to test for inter-rater reliability with each new version of the codebook and a kappa value of <0.60 was used to identify codes that needed reevaluation and modification. Theoretical saturation was reached after 7 iterations of the codebook, with the final codebook containing 165 codes. The final kappa was 0.54 among all 5 coders and the final percent agreement was 0.99. For the current analysis, we examined 6 codes relevant to experiences with PPE and concerns about virus exposure, as defined in Table 2.

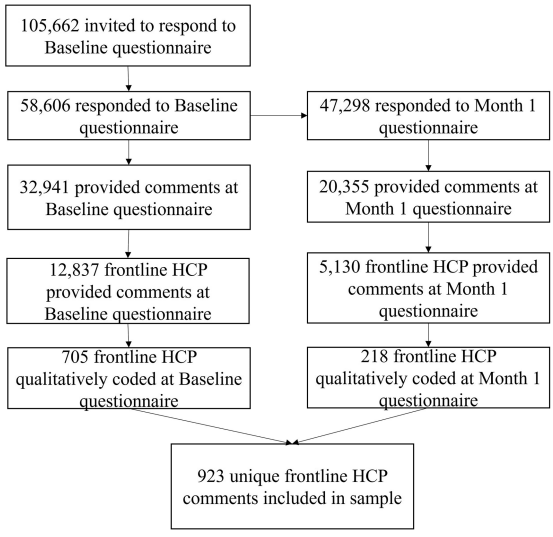

Fig. 1. Sampling of participants from the COVID-19 substudy of the Nurses' Health Study 2, Nurses' Health Study 3, and Growing Up Today cohorts.

Mixed methods analysis

To examine the distribution of the coded comments by the quantitative variables, we first collapsed the 6 codes into 2 broader themes: negative experiences with PPE in the workplace and exposure concern (Table 3). We used chi-square tests to compare the prevalence of these 2 themes by work facility, PPE adequacy, contact with COVID-19 patients, residential zip code mortality rate, COVID-19 worry, and COVID-19 related psychological distress. Missing data were excluded from the analyses. Analyses were performed using SAS 9.4 (SAS Institute, Cary, NC); P-values < 0.05 were considered statistically significant.

Results

Participant demographics

Characteristics of survey respondents are shown in Table 1. The mean age of frontline HCPs in the sample was 37.8 ± 8.8 years and roughly half of HCPs were nurses (53.2%, n = 491). The majority of HCPs were White (95.8%, n = 884) and female (90.6%, n = 836), reflecting the composition of the NHS2 and NHS3 cohorts. The most prevalent work facilities were inpatient hospital facilities (55.6%, n = 513) and outpatient clinics (25.1%, n = 232). Twenty percent of HCPs reported inadequate PPE (n = 187) and 36.6% of HCPs reported contact with documented or presumed COVID-19 cases (n = 1338).

Qualitative results

Six major themes were identified in the qualitative analysis as germane to PPE experience, including having insufficient PPE, altering PPE, experience stress due to PPE policies, distrusting PPE effectiveness, fear of being exposed to COVID-19 in the workplace, and fear of exposing others to COVID-19 (Table 2). There were not enough comments regarding positive experiences with PPE policies to warrant a code.

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Table 1. Age-adjusted[a] characteristics of 923 participants of frontline healthcare personnel in the Nurses' Health Study II, Nurses' Health Study 3, and the Growing Up Today Study, whose text comments were analyzed from 923 Baseline and Month 1 COVID-19 surveys.

	Frontline healthcare personnel whose comments at Baseline and/or Month 1 were coded (n = 923)
Age, *N* (%)	
<26 years	11 (1.2)
26-35 years	455 (49.3)
36-45 years	263 (28.5)
46-55 years	145 (15.7)
56-65 years	49 (5.3)
Questionnaire from which comment derived *N* (%)	
Baseline	705 (76.4)
Month 1	218 (23.6)
Cohort, *N* (%)	
GUTS	495 (53.6)
NHS2	55 (6.0)
NHS3	373 (40.4)
Sex, race, and ethnicity, *N* (%)	
Women	836 (90.6)
Caucasian	884 (95.8)
Hispanic	4 (0.4)
Black	9 (1.0)
Asian	14 (1.5)
Others	12 (1.3)
Clinical site of frontline healthcare personnel (HCP), *N* (%)	
Inpatient	513 (55.6)
Outpatient/clinic	232 (25.1)
Nursing home, group care, or home health	81 (8.8)
Other healthcare facility	97 (10.5)
Current or most recent occupation, *N* (%)	
LPN or ADN	3 (0.3)
BSN or RN	278 (30.1)
NP or CNM	79 (8.6)
Nurse, unknown type	131 (14.2)
MD, DDM, PA, or other clinicians	110 (11.9)
MA, EMT, EMR, paramedic, or other HCP	322 (34.9)
Residential county COVID-19 mortality/10 000, *N* (%)[c]	
0	161 (17.4)
>0 to <0.25	328 (35.5)
0.25 to <0.75	230 (24.9)
0.75 to 7.9	189 (20.5)
Missing	15 (1.6)
Census region *N*, (%)	
Northeast	237 (25.7)
Midwest	277 (30.0)
South	195 (21.1)
West	209 (22.6)
Missing	5 (0.5)
Interaction of frontline HCP with patients with COVID-19 infection, *N* (%)	
Patients with documented infection	112 (12.1)
Patients with presumed infection	226 (24.5)
Not that I know of	508 (55.0)
Do not work directly with patients	70 (7.6)
Missing	7 (0.8)
Adequacy of personal protective equipment[d], *N* (%)	
Adequate PPE	634 (68.7)
Inadequate PPE	187 (20.3)
Not applicable	65 (7.0)
Missing	37 (3.0)

[a]Percentages are standardized to the age distribution of the study population.
[b]Value is not age-adjusted.
[c]County- and date-specific COVID-19 mortality data from the COVID-19 Data Repository by the Center for Systems Science and Engineering at Johns Hopkins University were used to derive a measure of local COVID-19 burden. Based on an estimated 13-day median hospital stay for fatal COVID-19, we reasoned that the COVID-19 mortality in the 13 days following questionnaire return would represent the burden on local healthcare systems at the time of survey completion (Dong et al., 2020).
[d]Data on access to and use of specific PPE items (gloves, gowns, surgical masks, respirators, PAPRs) was combined to derive a summary variable representing PPE adequacy: "Adequate PPE" if no PPE item was lacking and "Inadequate PPE" if any item was used inconsistently because it was lacking or if any item was never used because it was lacking.

Negative experiences with PPE

The most prominent of the 6 themes examined were related to having insufficient PPE and having to alter PPE, which were cited by 14.0% and 10.2% of the sample, respectively (Table 2). Stress due to PPE policies and distrust of PPE effectiveness also emerged as salient themes, though these were each reported by 5% or less of participants. These 4 themes were broadly classified as negative PPE-related experiences. Concerns of being exposed at the workplace and infecting others were also reported at 3.3% and 4.8%, respectively; these themes were classified as exposure concerns.

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Table 2. Main themes relevant to PPE use identified by qualitative content analysis.

Theme	Definition	*N* (%) endorsed (*n*=923)
Negative experiences with PPE		
Insufficient PPE	Negative feelings associated with the lack of PPE available and/or the reuse of PPE due to insufficiencies of PPE supplies.	129 (14.0)
Alterations to PPE	Alterations and innovations used to clean, reuse, or make PPE in the workplace during the pandemic.	94 (10.2)
Stress due to PPE policies	Negative feelings associated with workplace policy changes regarding the use of PPE and attempts to conserve PPE, including mandates to reuse PPE and restrictions to decrease the amount of PPE allocated to each department and/or HCP.	44 (4.8)
Distrust of PPE effectiveness	Feelings of distrust and/or skepticism with the efficacy of specific methods used to clean, reuse, or make PPE in the workplace during the pandemic.	20 (2.2)
Exposure concerns		
Workplace exposure concern	Stress, worry, and anxiety associated with fears of self-exposure and household member's exposure to the COVID-19 virus in the workplace.	30 (3.3)
Exposing others concern	Stress, worry, and anxiety associated with spreading COVID-19 to family members, friends, or community outside of the healthcare environment.	44 (4.8)

Insufficient PPE

The theme "Insufficient PPE" was assigned to comments that described negative feelings associated with the lack of PPE available and/or the reuse of PPE due to insufficient supply. This code was cited by 14% of the sample, making it the most prevalent PPE code endorsed by participants. Comments included participants providing and/or cleaning their PPE for work, reusing PPE, ill-fitting PPE, and policies that conserved or restricted PPE. Participants often used words like "required," "forced," "must," "told to," "had to," and "allow," which implied they felt that PPE conditions and rules were imposed upon them, with little chance for feedback.

One doctor was required to wear the same surgical masks for 2 weeks due to mask shortages:

"I was working at [state] hospital in March and had to wear the same masks for two weeks. We stored them in paper bags."(29-year-old White female working as an MD with presumed COVID contact in a Northeastern inpatient unit, May 2020)."

Similarly, a nurse described being given only 2 surgical masks each week and being expected to wear these masks with multiple different patients.

"Made to wear the same surgical masks all shifts even if being in OR for a surgery and going back into the OR. Only allowed 1 N95 per shift and only if doing an epidural or delivery. Must use for multiple deliveries and in multiple rooms. At beginning of April, we were only allowed 2 surgical masks per WEEK! They relaxed to one/day about the second week of April." (38-year-old White female working as a nurse with unknown COVID-19 contact in a Southern inpatient unit, May 2020).

One HCP described crying into one of her 3 N95 that were rotated during a 3-week period.

"I worked in NYC for 3 weeks on COVID Unit and only had 3 N95s the entire time. One which was saturated in my own snot from crying so hard. We reused goggles and gowns." (35-year-old White Female working as a HCP with documented cases in a Northeastern inpatient unit, May 2020).

Alterations to PPE

The theme "Alterations to PPE" was assigned to comments that described alterations and innovations used to clean, reuse, or make PPE in the workplace during the pandemic. Alterations to PPE were cited by 10.2% of the sample. HCP described procedures to disinfect their PPE, including bleach, alcohol, hydrogen peroxide, and UV treatment to increase the longevity of workplace-provided or community-donated surgical, N95, and KN95 masks as well as surgical caps, gowns, and eye coverings.

One nurse described using bleach and ethyl alcohol to disinfect gowns and eye coverings.

"We use washable gowns which we wash in bleach in a separate washer. N95 we have 3 we rotate through and they will be sterilized after 30 uses (per mask). No glove shortage. Sterilize eye coverings after each use with bleach wipe or EtOH" (31-year-old White Female working as a BSN/RN with unknown COVID contact in a Midwestern nursing home/group care/home care facility, June 2020).

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Another nurse washed her own N95 masks using bleach, though still felt as though they were soiled even after cleaning.

"Washing my n95s in colorsafe bleach at the end of the work week. I would rather have a clean(er) non-working n95 than have to keep putting the same dirty one on again and again." (36-year-old White Female working as a BSN/RN with presumed COVID contact in a Northeastern inpatient unit, May 2020).

Other HCP used hydrogen peroxide, isopropyl alcohol, and UV light in attempts to disinfect their PPE.

"I sprayed the surgical mask with H_2O_2 daily after use, and sprayed my shoes with isopropyl alcohol every day after work." (28-year-old White Male working as a HCP with unknown COVID contact in a Northeastern outpatient clinic, May 2020).

"We only have about 15 days of N95 masks and Gowns, and that's because they are re-using N95 masks for several days per person, then send for "decontamination" which is just a UV light before putting it back to use." (28-year-old White Female working as a HCP with presumed COVID contact in a Southern outpatient unit, May 2020)

In addition to cleaning hospital-issued PPE, many HCP described using homemade cloth masks and/or surgical caps for protection.

"Currently using homemade cloth masks and cloth surgical cap even in OR during cesarean sections." (36-year-old White Female working as a BSN/RN with presumed COVID contact, in a Southern inpatient unit May 2020).

"I used a homemade mask and I have also used an N95 originally purchased for use in woodworking neither of which were provided by the hospital which for some time issued 1 N95 (that I was not fitted to and was the incorrect size) which I was to use indefinitely." (29-year-old White Female working as a HCP with documented COVID contact in a Southern inpatient unit, May 2020).

One provider described how she was issued a cloth mask by her work facility.

"I work in outpatient clinics. Some of the staff are given surgical masks to distribute once a week. I got one two weeks ago. We are expected to wear masks everyday and make the surgical mask last as long as possible. We were also given cloth masks made of material like that used for swimsuits. The one I received is so large it immediately slips off my nose and down to my chin." (42-year-old White Female working as a MD/DDM/PA with unknown COVID contact in a Western inpatient unit, May 2020).

Furthermore, HCP described using PPE made out of household materials, such as sheets, garbage bags, and ponchos.

"When we ran out of gowns- garbage bags were fair game" (36-year-old White Female working as a BSN/RN with presumed COVID contact in a Northeastern inpatient unit, May 2020).

"Rain ponchos used for gowns" (36-year-old White Male working as a HCP with presumed COVID contact in a Midwestern healthcare facility, May 2020).

"Isolation gowns not available. We are wearing a fabric hospital gown over our clothes." (36-year-old White Female working as a HCP with unknown COVID contact in a Western nursing home/group care/home health facility, June 2020).

"Made masks, gowns, and caps for office out of old sheets and scotch guard" (33-year-old White Female working as an NP/CNM with documented COVID contact in a Midwestern outpatient unit, May 2020).

"sometimes used shoe coverings in place of hair nets due to shortage; eventually purchased a cloth hair cap to reduce PPE use. initially wore my husband's hunting goggles/glasses until provided at work." (27-year-old White Female working as a HCP with documented COVID contact in Midwestern inpatient unit, May 2020).

Stress due to PPE policies

The theme "Stress Due to PPE Policies" was assigned to comments that described negative feelings associated with workplace policy changes regarding the use of PPE and attempts to conserve PPE, including mandates to reuse PPE and restrictions to decrease the amount of PPE allocated to each department and/or HCP. PPE policy frustrations were cited by 4.8% of participants in the sample. HCP described being forbidden to wear masks in the early stage of the pandemic to avoid spreading alarm and to conserve PPE, which left them feeling unsafe at their work facilities and unsupported by their administrations.

One provider wrote how her institution claimed HCP were "inciting panic" by wearing masks in the hallways of her healthcare facility.

"Early in March we were chastised for wearing droplet masks in hallways saying we were inciting panic among nurses and patients. At least 2 ICU nurses have tested positive where I work and one required hospitalization. I felt like we were the sacrificial lambs early in the pandemic. Of course now, we are instructed to wear masks all the time, but still disconcerting the way this was mishandled early on." (51-year-old White Female working as an NP/CNM with presumed COVID contact in a Midwestern inpatient unit, April 2020).

Additionally, multiple nurses described being "threatened" or "chastised" for wearing PPE to protect themselves, even when the PPE they were using was homemade.

"At first our institution was threatening us for wearing PPE we felt appropriate to situations, often

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saying we would scare the public and demanding it be removed. They have since allowed full time surgical masking, but are resistant to discuss supply levels or availability" (50-year-old White Female working as a BSN/RN with presumed COVID contact in a Midwestern inpatient unit, May 2020).

"We were told not to wear masks or home-made masks within the halls of the hospital and were chastised. Then 2 weeks later you have to wear a mask everywhere within hospital. Things changed almost every day and staff in the hospital are still restricted from having an N95 unless approved by leadership. We can walk on a unit with COVID and not be provided proper PPE." (45-year-old White Female working as a nurse with presumed COVID contact, in a Western inpatient unit, April 2020).

In addition to being told not to wear PPE, HCP also mentioned that they did not feel "heard" or lacked avenues to express their feelings towards workplace PPE policies.

"I resigned my position on [date in March 2020] after disagreement with manager regarding seriousness of need for increasing stock of PPE in preparation for spread of virus into our community. [My facility] was not staying up to date with CDC guidelines and I advocated for fellow staff and residents, and manager took as a personal attack, and 'forced' my resignation." (54-year-old White Female working as a BSN/RN with unknown COVID contact in a Northeastern nursing home/group care/home health facility, April 2020).

"Significant lack of physician leadership at my hospital both admin and clinical Zero moral support at my hospital. The people in charge of dictating PPE standards, do not do direct patient care, which makes me wonder if that's why our PPE standards are lower than what they should be" (34-year-old White Female working as a HCP with documented COVID contact in a Southern inpatient unit, May 2020).

HCP also described feeling unsafe due to the policies set forth by their workplaces.

"My employer doesn't value or adhere the standards set forth by the cdc and creates their own guidelines for employees to follow. We reuse the same surgical masks for over a month without replacement. Also, they do not care that employees with a higher risk should they contract Covid-19 remain on campus and work on the floors with known covid-19 positive patients." (36-year-old White Male working as a HCP with documented COVID contact in a Northeastern inpatient unit, May 2020).

"Our hospital policy is to only use surgical mask even when you are working closely with a covid (+) patient for prolonged periods. You only get an N95 for aerosolizing procedures. Seems inappropriate in light of more evidence coming out." (30-year-old White Female working as a HCP with documented COVID contact in a Western inpatient unit, June 2020).

Other HCP noted the stress of the rapidly changing PPE policies at the beginning of the pandemic.

"Decisions changed daily." We were told we could not use masks "as they need to be saved for doctors and important cases." Then we were encouraged to bring in our own masks if we had them. Then homemade masks. Then told homemade masks were to be laundered by facility before using them. Then homemade masks weren't good enough. Then certain areas got certain masks. Heading back tomorrow to who knows what the latest rule is..." (53-year-old White Female working as a BSN/RN with unknown COVID contact in a Midwestern healthcare facility, April 2020).

"The rules are changing everyday with regards to protecting ourselves at work. That has been stressful adjusting to constantly changing practices. We are only provided enough N95 masks per our weekly schedule but have to reuse them every week. I have been using the same 3 N95 masks for 2 months now without any disinfection." (28-year-old Asian Female working as a nurse with presumed COVID contact in a Northeastern inpatient unit, May 2020).

The rapid change to non-standard PPE use was shocking and stressful, as it violated previous PPE training.

"It is also stressful to consider being asked to do things you have been told never to do - like reuse an N95 mask." (36-year-old White Female working as a BSN/RN with unknown COVID contact in a Southern nursing home/group care/home health facility, April 2020).

Distrust of PPE effectiveness

The theme "distrust of PPE effectiveness" was assigned to comments that described feelings of distrust and/or skepticism with the effectiveness of specific methods used to clean, reuse, or make PPE in the workplace during the pandemic. Distrust in PPE use was cited by 2.2% of the sample, particularly in the context of doubting the effectiveness of nonstandard PPE or of PPE sterilization techniques.

One nurse felt frustrated that HCP were being thanked for serving on the frontlines yet had to reuse PPE, especially because there was no data to suggest that reusing PPE was effective at preventing transmission.

"All I want is the proper PPE and not have to reuse one time use. I do not feel protected as we have no idea if the disposable one time use masks actually work that many times I am tired of hearing everyone thanking us yet no one is making sure we have proper PPE." (62-year-old White Female working as a BSN/RN with documented COVID contact in a Northeastern inpatient unit, May 2020).

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Another nurse questioned the virus' means of transmission and felt as if an N95 was warranted for all patient contact, rather than a surgical mask, given the possibility that COVID-19 may be an airborne infection as opposed to a droplet infection.

"I don't think it's ideal to be wearing one surgical mask for a 12 hour shift in a level-1 trauma ER. I swap it out for aerosolizing procedures with COVID patients with my n95, but ideally, it seems like we should all be wearing n95s all the time. I feel like this virus is airborne and we're treating it like a droplet infection, allowing rooms to be flipped to the next patient too quickly... The fall could be terrifying with large spikes in cases. I'm concerned." (37-year-old White Female working as a BSN/RN with presumed COVID contact in a Western inpatient unit, June 2020).

HCP whose work facilities attempted to disinfect the re-used PPE also expressed concerns with the effectiveness of these methods.

"The hydrogen peroxide sterilization of N95 masks-does it really work." (54-year-old White Female working as a nurse with unknown COVID contact in a Northeastern inpatient unit, May 2020).

One nurse was skeptical that the methods set forth by the institution to disinfect PPE were being used by her co-workers.

"New isolation gowns are very thin and cloth like. It gets wet or soiled it seeps thru to the clothes we are wearing. We are using virex to sanitize equipment. They are only located at the nursing station in an open bucket. There is a shortage or paper towels and cleaning cloths. The inconvenience of location and method to clean makes me skeptical that everyone is fully sanitizing equipment." (31-year-old Hispanic Female working as a BSN/RN with unknown COVID contact in a Western inpatient unit, June 2020).

Exposure concerns

Workplace infection concern

The "Workplace Exposure Concern" code was assigned to comments that described stress, worry, and anxiety associated with fears of self-exposure and/or a household member's exposure to the COVID-19 virus in the workplace. Workplace exposure concern was cited by 3.3% of the sample (Table 2). Though this code did not explicitly describe infection concern related to having inadequate PPE, the majority of comments mentioned fear of infection in tandem with a lack of PPE.

One nurse worried about her future exposure to a COVID-19 patient while lacking the appropriate N95 to protect herself.

"We do not have any n95 masks even if we needed them I have not been fit tested. I just know a patient is going to walk in someday and have symptoms and I am not going to have the proper mask to wear" (36-year-old White Female working as a BSN/RN with unknown COVID contact in a Midwestern outpatient unit, June 2020).

Another nurse was infected with COVID-19 after having to use the wrong size mask at her workplace. This resulted in significant physical, mental, and emotional distress.

"I had to use a wrong size mask because they did not have 3M size masks, which I was fitted for. I got infected at work from a COVID patient. I was placed on worker compensation. The most horrible experience in my life. After 4 weeks I am still at home. I still have anosmia, and I am afraid that my olfactory bulbs are permanently damaged by the virus." (47-year-old White Female working as a nurse with documented COVID contact in a Western inpatient unit, April 2020).

Exposing others concern

The code "Exposing Others Concern" was assigned to comments that expressed stress, worry, and anxiety associated with spreading COVID-19 to family members, friends, or community outside of the healthcare environment. Concern about exposing others was cited by 4.8% of the sample (Table 1).

One nurse compared her fears of being infected and spreading the virus to the moral parable of Damocles, who looked up from his throne to find a sword suspended only by a horsehair.

"I can't help but feel like Damocles, glancing nervously at the precarious sword just above our heads. Except, it's not just me on the throne. It's my coworkers and my husband and our children sitting there too. How can we protect each other? That's the question that spins around and around and around in my mind. Are we doing enough?" (37-year-old White Female working as a BSN/RN with presumed COVID contact in a Western inpatient unit, June 2020).

Another nurse worried about the possibility that transmitting the virus could result in the death of a loved one.

"I feel invincible while I am working. But the anxiety and fear of giving this crap to a family member is very high. The fear that you could be the one who gives a deadly version of this to a loved one is unreal. I have not been in my in laws house or seen my family besides my husband and daughter for 6 weeks now." (39-year-old White Female working as a BSN/RN with documented COVID contact in a Southern inpatient unit, April 2020).

Similarly, HCP whose loved ones were high risk for experiencing severe COVID-19 morbidity and mortality faced increased distress.

"I have a pregnant spouse at home. As a result, my anxiety level has increased considerably because of the risks to my household associated with caring for patients with COVID-19." (29-year-old Black Female

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working as a nurse with presumed COVID contact in a Northeastern inpatient unit, May 2020).

These fears led some HCP to isolate themselves from family and friends.

"My co-workers and I have regularly discussed re-locating ourselves from our families should the outbreak worsen and we have to work more frequently with COVID patients." (40-year-old White Female working as a BSN/RN with documented COVID contact in a Midwestern inpatient unit, May 2020).

"Due to concern for COVID exposure, my partner is living somewhere else temporarily while I am on an Emergency Medicine rotation (plus a short quarantine period after). It felt unsafe for us to share a small one-bedroom apartment while working closely with higher risk populations." (37-year-old White Female working as a HCP with presumed COVID contact in a Western inpatient unit, June 2020).

Mixed methods results

Overall, 17.2% of participants volunteered comments that were coded under the umbrella of 'Negative PPE Experiences' (Table 3). Although the frequency of such comments was unrelated to work facility, psychological distress, or local COVID-19 mortality at the time of questionnaire return, negative PPE comments were cited by 28.9% of HCP who reported inadequate PPE access and by 14.8% of HCP with adequate PPE access ($P < 0.0001$) and by 30.4% of HCP in contact with documented COVID-19 cases ($P < 0.0001$ across all patient contact categories). Negative PPE Experiences were also positively associated with COVID-19 worry ($P = 0.01$).

Overall, 5% of the cohort volunteered comments that were classified as Exposure Concerns (Table 3). Nearly 11% who had checked the box indicating that they were 'very worried' about COVID-19 wrote a comment about Exposure Concerns ($P < 0.0001$ for trend across COVID-19 worry categories). Though reports of exposure concern were highest among those experiencing severe (8.8%) or moderate psychological distress (7.4%) compared to 3.5% of those experiencing mild distress or 3.7% among those reporting no distress, this association was not significant ($P = 0.06$). As with Negative PPE Experiences, expressions of Exposure Concern were cited roughly twice as often by those with inadequate compared to adequate PPE, though this did not rise to the level of statistical significance ($P = 0.17$). Exposure Concerns were unrelated to Contact with COVID-19 patients, work facility, or residential COVID-19 mortality.

Discussion

The aim of this study was to provide detailed insights into HCPs' experiences with PPE during the early COVID-19 pandemic. This study utilized a mixed methods analysis in the largest United States sample of HCP to date to identify distressing PPE-related experiences that HCP faced due to the PPE shortage. Qualitative analysis found that the two most salient PPE-related stressors included having insufficient PPE provided at the workplace and having to alter PPE through the cleaning of single-use PPE and/or the creation of PPE with household materials. Previous qualitative studies have identified lacking PPE as a major concern for HCPs (Arnetz et al. 2020a; Galehdar et al. 2020; Catania et al. 2021; Eftekhar Ardebili et al. 2021; Gray et al. 2021; Hoernke et al. 2021; Kea et al. 2021; Ness et al. 2021) and quantitative studies have reported the same (Danesh et al. 2021). Our finding that the alteration of PPE and non-standard decontamination techniques were critical sources of distress is especially important given the widespread reuse of single-use PPE during the early pandemic (Tabah et al. 2020). The HCP's concerns are validated by recent studies noting decreased effectiveness of institutionally recommended decontaminated single-use PPE (Probst et al. 2021; Schumm et al. 2021). Although data regarding the effectiveness of PPE reuse strategies was unavailable during the early pandemic, HCPs were being told to use PPE in a manner that violated all the PPE practices they had been trained to use. The use of sheets, garbage bags, and cloth masks for protection was shocking for HCPs who had always used standard PPE.

Many HCP expressed stress and anxiety due to rapidly changing and unclear PPE guidelines in the workplace. HCPs also noted restrictions on PPE use in the early pandemic and questioned the motivation for the policies; many discussed being prohibited from wearing PPE due to the threat of future shortages and the risk of public hysteria. Previous qualitative studies in smaller samples ($n < 500$) of HCP noted similar findings (Arnetz et al. 2020b; Hoernke et al. 2021; Ness et al. 2021). HCPs felt unheard and unsupported by their institution's PPE policies and desired to be included in decision-making processes, as they were the ones putting their health at risk. Though data on union representation was not collected in the present study, it is important to note that these themes were likely more prevalent among those without union representation. Studies have found that unions helped advocate for their members to obtain adequate PPE during the pandemic (Llop-Gironés et al. 2021). Unions also offer workers the ability to respond to unsafe and unfair policies, giving workers a voice to advocate for their needs (Llop-Gironés et al. 2021).

The lack of PPE, use of non-standard PPE, and the shifting PPE policies imposed by workplaces left HCPs feeling distrustful that they were protected from

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Table 3. Frequency of qualitative codes related to 'Negative PPE Experiences' and 'Exposure Concerns' by participant characteristics.

	Reported Negative PPE experiences *N* (%)		**Reported exposure concerns *N* (%)**	
	159 (17.2%)	*P*[1]	44 (4.8%)	*P*[1]
Work facility		0.46		1.00
Inpatient	95 (18.5)		24 (4.7)	
Outpatient/clinic	37 (16.0)		11 (4.7)	
Nursing home, group care, or home health	15 (18.5)		4 (4.9)	
Other healthcare facility	12 (12.4)		5 (5.2)	
PPE adequacy		<0.0001		0.17
Adequate PPE	94 (14.8)		26 (4.1)	
Inadequate PPE	54 (28.9)		14 (7.5)	
Not applicable	4 (6.2)		3 (4.6)	
COVID contact		<0.0001		0.98
Confirmed cases contact	34 (30.4)		5 (4.5)	
Presumed cases contact	42 (18.6)		11 (4.9)	
Not that I know of	72 (14.2)		24 (4.7)	
Not direct work	10 (14.3)		4 (5.7)	
Residential county COVID-19 mortality/10 000		0.23		0.38
0	22 (13.7)		5 (3.1)	
>0 to <0.25	59 (18.0)		19 (5.8)	
0.25 to <0.75	37 (16.1)		8 (3.5)	
0.75 to 7.9	41 (21.7)		11 (5.8)	
COVID-19 worry		0.01		<0.0001
Very worried	39 (24.2)		17 (10.6)	
Somewhat worried	94 (17.3)		21 (3.9)	
Not very worried	20 (10.9)		4 (2.2)	
Not worried at all	6 (17.1)		2 (5.7)	
Psychological distress		0.62		0.06
Severe psychological distress	16 (20.0)		7 (8.8)	
Moderate psychological distress	36 (19.1)		14 (7.4)	
Mild psychological distress	55 (17.6)		11 (3.5)	
No psychological distress	50 (15.4)		12 (3.7)	

[1]*P*-value of 2-sided Fisher's exact test.

infection. Many questioned the effectiveness of institutionally recommended decontamination practices, such as UV light and vaporized hydrogen peroxide. While no qualitative studies have explicitly described distrust in non-standard PPE, one large (n = 2227), international study noted fear and anxiety as a result of inadequate PPE (Kea et al. 2021). HCP were aware that, early in the pandemic, little was known about the virus' mode of transmission as well as of effective methods to sanitize and reuse PPE; many felt that in the face of uncertainty, higher level airborne precautions should have prevailed (Probst et al., 2021; Schumm et al., 2021).

Fear of being exposed to COVID-19 in the workplace and fear of exposing others to COVID-19 also emerged as salient themes, which are also supported by the existing qualitative literature (Arnetz et al. 2020a; Iheduru-Anderson 2021; Kea et al. 2021). The gravity of these concerns was severe; fear of transmitting COVID-19 to others was found to be the most morally distressing situation for United States nurses during the pandemic. Thus, fear of infecting loved ones due to inadequate PPE took a significant toll on frontline HCPs (Lake et al. 2021).

Those who made comments regarding negative PPE experiences were twice as likely to report lacking

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adequate PPE compared to those with adequate PPE. It was perhaps more surprising that negative PPE comments were made by as many as 14.8% of those with adequate access to PPE. This suggests that factors beyond PPE availability itself, such as not reusing PPE and being involved in setting PPE policies were and are important to HCPs satisfaction with PPE. HCPs treating documented COVID-19 patients were nearly twice as likely to indicate negative PPE experiences as those treating presumed cases; this may reflect greater lack of PPE supplies at facilities with the earliest cases, or more anxiety about PPE in the face of higher transmission risk. In this cohort, HCP with inadequate PPE, especially who were in contact with presumed or documented patients with COVID-19, had at least double the risk of being infected (Rich-Edwards et al. 2021).

Notably, neither negative PPE experiences nor exposure concerns varied by type of work facility, contact with COVID-19 patients, or residential COVID-19 mortality. This suggests that, even before the pandemic had reached all corners of the nation, HCP were reacting to the nature of the virus itself and the unknown risks of infection associated with being a healthcare worker. HCP concerns appeared to be impacted by other factors, such as pre-existing medical conditions or family member vulnerability. Exposure concerns were prevalent among HCPs experiencing severe or moderate psychological distress, which is consistent with findings from several other studies noting associations between inadequate PPE and mental health (Arnetz et al. 2020b; Morgantini et al. 2020; Bajo et al. 2021; Burstyn and Holt 2021; Cag et al. 2021).

This study is the largest analysis to date investigating U.S. HCPs' experiences with PPE during the early COVID-19 pandemic. Responses came from a diverse range of HCPs, including nurses, nurse practitioners, physicians, physician assistants, medical assistants, emergency medical technicians, and others, who worked at various healthcare facilities, including inpatient facilities, outpatient clinics, nursing homes, group care facilities, and home health agencies. Furthermore, this sample included participants from all geographic regions within the United States. Despite these strengths, limitations do exist. First, the majority of participants identified as non-Hispanic White, which is not representative of the racial and ethnic status of the HCP population in the United States In a large sample of HCPs across the United States, fear of exposure was most prevalent among Black and Latinx workers (Prasad et al. 2021); thus it is likely that the magnitude of exposure concerns was underrepresented in our study. Additionally, 90% of the sample identified as female, though estimates suggest that women comprise 75% of HCP in the United States (Rho, Fremstad, and Brown 2020). It is important to note that women comprise the majority of HCP working in close proximity with patients, placing them at increased risk of exposure to COVID-19 in the workplace (Bureau 2019, p. 76). Thus, it is important to understand female HCPs' experiences with PPE during the COVID-19 pandemic. Lastly, open-text comment boxes offer less detail than structured interviews. Though there was no text limit on comment boxes, the majority of participants responded with a paragraph or less. Despite this limitation, the analysis of comment boxes allowed for a large number of experiences to be considered.

Conclusions

The range of themes expressed in the qualitative responses of HCP reveals insights about preparation for navigating future pandemics or other sources of strain on the healthcare system in the United States. Having inadequate PPE has been identified as a disincentive to participate in future frontline healthcare work (Gray et al. 2021). During the pandemic, almost 20% of HCP left their jobs, creating a shortage of HCP across the nation (Galvin 2022). With the threat of other pandemics in the future, it is critical to have a sufficient workforce of healthcare professionals. Ultimately, this research has revealed significant gaps in the types of support that healthcare workers need and allows us to consider the ways in which we can prevent negative experiences in the future. The words of these HCP demonstrate that, regardless of local COVID-19 mortality and proximity to COVID-19 patients, HCP in an evolving pandemic are distressed by inadequate PPE, inappropriate sterilization/reuse of PPE, and ill-fitting PPE. HCP were angered by rationing of PPE and orders not to use PPE and felt that, in the absence of evidence, precaution should have been the rule. They were frustrated by shifting policies and felt excluded from decisions critical to their health, the health of their colleagues, and the health of their families. The inclusion of HCP in decisions regarding PPE, as well as clear and open communication about PPE availability and policies in the future is vital to ensure that HCPs on the frontlines are adequately protected.

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Author Contributions

For research articles with several authors, a short paragraph specifying their individual contributions must be provided. The following statements should be used

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"Conceptualization, I.B. and J.R.E.; methodology, I.B., C.B., and J.R.E.; software, I.B. and K.N..; validation, K.N.; formal analysis, I.B., A.S., K.N., M.W., J.B., and J.R.E..; investigation, I.B., A.S., K.N., M.W., and J.B.; resources, I.B. and K.N..; data curation, I.B., K.N., and J.R.E.; writing—original draft preparation, I.B.; writing—review and editing, I.B., A.S., K.N., M.W., J.B., J.S., C.B., and J.R.E.; supervision, J.S., C.B., and J.R.E.; project administration J.R.E.; funding acquisition, J.R.E. All authors have read and agreed to the published version of the manuscript.

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Conflict of Interest

The authors declare no conflict of interest.

Institutional Review Board

The study was conducted in accordance with the Declaration of Helsinki and approved by the Institutional Review Board of Brigham and Women's Hospital (Partners Health Care protocol 2020P001042, dated April 14, 2020).

Informed Consent

Informed consent was obtained from all subjects involved in the study.

Data Availability

Our public website includes a brief description of the Nurses' Health Study cohorts, all questionnaires, and a description of resource sharing procedures. An automated online form requests the applicant to briefly describe the hypothesis and aims, variables needed, etc. Requests are presented to the cohort investigator meetings every other week, and replies are provided within 2 weeks. After appropriate institutional IRB approvals, data access occurs in one of three ways: (i) the external investigator, with a password-protected login to our system, securely accesses and analyzes cohort data/specimen results; (ii) the external investigator requests collaboration with or support of an internal investigator and/or programmer who conducts the analyses on the external investigator's behalf; or (iii) a specific dataset and data dictionary are created to send to the external collaborator. Nurses' Health Studies is described at https://www.nurseshealthstudy.org/researchers (email: nhsaccess@channing.harvard.edu).

Supplementary material

Supplementary material is available at *Annals of Work Exposures and Health* online.

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