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Original Article

Healthcare workers' experiences protecting themselves and their families during the COVID-19 pandemic in 2020–2021

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Abstract

We characterized experiences and strategies used by frontline healthcare workers to prevent severe-acute-respiratory-syndrome-related coronavirus transmission at work and to household members during the coronavirus disease pandemic. Alongside an online questionnaire (n = 234), remote semi-structured interviews (n = 23: 15 clinicians, 8 non-clinicians) were conducted in 2021. Mitigation challenges and facilitators were identified from data to represent experiences as a process considering the before, during, and after work shifts. Journey mapping was utilized to visually describe how healthcare workers experienced the stages of the work environment, leaving work, commuting home, and the home environment, and strategies implemented to stay safe. Major facilitators included the uptake of coronavirus disease vaccines and testing, information regarding virus transmission, and adequate personal protective equipment. The most critical challenges identified included a lack of designated areas for end-of-day disinfection, changing rooms, showers, and lockers in the leaving work stage. Psychosocial and environmental factors must be considered in future hospital pandemic preparations.

Key words: COVID-19; experiences; family; healthcare; journey maps; pandemic; SARS-CoV-2; take-home pathway; workers.

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What's important about this paper?

This study reinforced the need for better strategies for protecting healthcare workers and their families against the spread of infectious diseases by considering take-home exposure as a process. In preparation for future pandemics, hospitals must create appropriate spaces for decontamination at work during the final stages of a work shift and before workers head home.

Introduction

Frontline healthcare workers (HCW) faced conflicting responsibilities during the coronavirus disease (COVID-19) pandemic, as they simultaneously fulfilled their work duties while protecting their own and their families' health. Unlike remote workers who can isolate, frontline workers' duties involve proximity to others (CDC 2024a), putting them at greater risk for severe-acute-respiratory-syndrome-related coronavirus (SARS-CoV-2) exposure (Hanage et al. 2020; Rogers et al. 2020).

Take-home contaminants are occupational exposures, including pathogens, that can be inadvertently brought from the workplace to the home (Suarez-Lopez et al. 2018; Kalweit et al. 2020). HCWs' household transmission occurs through direct exposure to active SARS-CoV-2 virus through contact, droplet, or aerosolized pathways from an infected patient or through infectious surfaces or fomites (Jones and Burstyn 2020; Mizukoshi et al. 2021). In some reports from the early pandemic, workers indicated going to extraordinary lengths to avoid transmission to their families, such as isolating themselves from their families by sleeping in the basement apart from others, in hotels, or rental apartments (Çelik and Kilic 2022; Helou et al. 2022).

The concept of take-home exposures was originally framed when first discovered as a problem arising from unsanitary worker behavior (Chisolm 1978). In this more classic understanding, the locus of responsibility for household exposure lies with the workers themselves, and intervention efforts focus on worker behavior, both in the home and, also, the workplace. Rather than considering administrative or engineering controls to reduce or eliminate workplace exposure, efforts were focused on individual worker actions, such as laundry, shoe removal, and showering (Sathaye and Javadekar 2000). More recently, however, take-home exposures are considered a public health hazard and one of the many chronic pathways contributing to persistent health disparities among workers, their families, and communities (Kalweit et al. 2020; Ceballos et al. 2022; Ramezanifar et al. 2023). Notably, housing situations experienced by low-income HCWs may complicate household mitigation efforts, such as isolating. Thus, it is important to consider the role of work and social aspects of work as causal agents of community health disparities (Ahonen et al. 2018; Kalweit et al. 2020). Observations noted in the present study during the pandemic reinforce the value of take-home prevention efforts. Throughout the pandemic, frontline HCWs faced the threat of infection while needing to adapt to shifting protocols. Early studies showed that frontline HCWs experienced high rates of COVID-19 (Bird et al. 2020; Chen et al. 2020; Chu et al. 2020), particularly nurses and HCWs in respiratory wards (Bird et al. 2020; Luo et al. 2020; Méndez-Echevarría et al. 2021).

In addition to direct infection with SARS-CoV-2, frontline HCWs have suffered mental health consequences resulting from the stresses of the pandemic period. Inadequate access to personal protective equipment (PPE) and training was a notable source of stress in the early pandemic period for HCWs (Ayton et al. 2022; Elgibaly et al. 2021; Horneke et al. 2021; Wild et al. 2022). Several studies that have examined the effects of the pandemic on HCWs showed that HCWs have experienced high levels of burnout (Bogaert et al. 2021; Macaron et al. 2023). A review on burn out in nurses during the pandemic determined that the response to prolonged stress at the workplace was characterized by emotional exhaustion, depersonalization, and lack of personal accomplishments (Galanis et al. 2021). Most of this psychological stress stems from worry about the transmission of illness to themselves or family members (Tam et al. 2004; Styra et al. 2008; Cai et al. 2020). As a result, HCWs' mental health and well-being have become unanticipated urgent public health priorities (Søvold et al. 2021). Some studies have shown that with proper PPE, vaccinations, and isolation practices, HCWs have been able to reduce the risk of infecting their household members significantly (Dioscoridi and Carrisi 2020; Pratò et al. 2021), possibly leading to reduced stress and burnout.

While there is extensive literature on interventions and mitigations to reduce the risk of occupational exposure to COVID-19 at work, there is a research gap in understanding personal efforts by HCWs to reduce exposure risks to their families and households, which remain largely unexamined. For HCWs "to continue to provide uninterrupted, quality care," they must also be "empowered and encouraged to take care of themselves" (Shreffler et al. 2020). Therefore, evidence-based

interventions and programs are needed to improve HCWs' well-being (Søvold et al. 2021). Consequently, strategies to support HCWs during periods of increased stress or vulnerability, such as during a pandemic, may lead to decreased levels of psychological stress among HCWs, reduce job resignation, and help reduce the transmission of illness to household members.

These strategies may be easier to implement if healthcare providers understand better the experiences surrounding the exposure risks of HCW. Despite the importance placed on human experiences in social sciences (Heinonen and Lipkin 2023), limited literature in other sciences has emphasized the psychological-affective human dimensions of HWC's experiences. For example, Gu et al. (2023) considered affective components in a sample of HWCs. During the initial months of the COVID-19 pandemic, Australian general practitioners felt marginalized, uncertain, under-supported, undervalued, isolated, disrupted, and faced a significant toll on their well-being (Gu et al. 2023). However, there are still gaps in the exposure science literature to explore HCW beyond questionnaire data. Besides, existing qualitative or mixed-methods research has mainly concentrated on specific conditions such as mental health (e.g. McGlinchey et al. 2021; Werkmeister et al. 2023), including anxiety, depression (e.g. Burstyn and Holt 2022), and burnout (e.g. Macaron et al. 2023).

This study addresses these research gaps by answering the following research questions:

> RQ1: What were the most common take-home mitigation strategies utilized by HCWs during the early months of the COVID-19 pandemic?
>
> RQ2: How did frontline HCW describe their experiences in attempting to protect themselves and their families during the pandemic from contracting COVID-19 through a take-home pathway?

For RQ1, we hypothesized that mitigation strategies would differ by job (clinician versus non-clinician) and by income, which might reflect available options in the home for isolation protection. After the characterization of mitigation strategies throughout the stages of the take-home pathway, we aim to further understand the experiences of HCW during and after work, as well as before and after vaccination. Specifically, the study identifies facilitators and challenges preventing SARS-CoV-2 transmission at work and to household members to inform and better prepare hospitals for future pandemics. Findings from this study are needed to justify practical interventions related to health care that go beyond the workplace to strengthen infectious control and the well-being of workers in this industry and their families.

In recent decades, dozens of academic articles have emphasized understanding patients' healthcare experiences (Davies et al. 2023). However, limited literature has explored the experiences of the HCWs as an input to design and create positive experiences with healthcare encounters. This begs the question, "What if health providers would apply the same logic that has helped them improve their patients' experiences to optimize their employees'?" By viewing their employees—instead of their patients—as customers, healthcare providers can invest more wisely in purposefully redesigning and improving processes experienced by employees, such as the take-home pathway. The proposed emphasis on employees makes sense, as a recent review found that happier healthcare employees provided higher quality services (Muthuri et al. 2020). Consequently, the findings of this study can support healthcare providers in the challenging task of improving job satisfaction and attracting and retaining talent better, specifically during future contagion crises.

Methods

This qualitatively driven mixed-methods research initially collected descriptive information on COVID-19 take-home prevention activities among frontline hospital workers at a large urban hospital using an online questionnaire. The goal of the questionnaire component of the study was to inform the later qualitative exploration to understand the HCW experience more comprehensively. Next, we conducted a qualitative study through semi-structured interviews with a subset of participants who completed the questionnaire. Mixed-methods research can provide a deeper and all-encompassing assessment of phenomena (Rossow and Baklien 2011) that examines affective as well as cognitive components of human experience by considering peoples' stories beyond descriptive statistics.

Background

This subsection provides context and theoretical foundations for the study design and to answer the research questions.

The take-home pathway as a process

We employed the Jones and Burstyn (2018) take-home pathway model as a framework for the study. Jones and Burstyn (2018) delineate 3 potential critical pathways for take-home exposure: external contamination, internal dose, and behavior change, arguing that minimizing the external contamination pathway is essential for reducing exposure and thus preventing potential internal dose and behavior change pathways that may impact family health. In our framework, we considered social vulnerability as a key mediator of the

relationships between exposure and family-level health impact, which is a central theme in the take-home conceptual framework from Kalweit et al. (2020). As a result, we considered analytically the role of lower income and job type (clinician versus non-clinician) in our analyses.

Applying concepts from the Jones and Burstyn (2018) take-home pathway model to SARS-CoV-2 take home specifically, "external contamination" of family members could be due to direct exposure through physical contact with the infected worker or indirect, where the virus is transferred to the car/home environment and can infect family members. A review by Wang et al. (2021) found that inhalation of the virus is the main route of exposure for SARS-CoV-2; thus, this pathway was critical for our study design. Transmission studies at the time of our study did not rule out fomite (surface) transmission as an important pathway of exposure (Mizukoshi et al. 2021), so we collected data about surface contact in our study. The "behavior change" of HCWs, given the high psychological demands of their job during the pandemic, could have negatively impacted their mental health and their relationships with family members, which in part can influence their energy level and behavior, as that documented by Cai *et al.*, (2020), likely also influencing preventive measures at work or home.

To better understand these models when applied to the HCWs' "going from work to home" process during the pandemic, we divided the process into sequential stages at work and after work. Work stages included "while at work" and "leaving work." After-work stages included "commuting" and "home," which included "getting home from work" and "being at home." From the exposure sciences, specifically industrial hygiene, processes are divided into smaller units, often called "units of operation" (Burgess 1995). Human exposure sources (i.e. generation and reservoirs) and pathways (i.e. transport and routes), as well as mitigation strategies to reduce exposure (i.e. controls), are better understood at the unit level (Burgess 1995). Similarly, healthcare services research has also studied stages of how patients enter, experience, and exit specific health services (Davies *et al.*, 2023). In addition, in social sciences, the seminal work of Teixeira et al. (2012) argues that customer experiences should be studied by systematically analyzing stages in the user process that could affect an overall customer evaluation of a service encounter, so we used this framing to conceptualize workers instead of patients experiences.

Understanding take-home pathway mitigations

During outbreak scenarios, the "gold standard" employer response to reduce the risk of outward transmission from a healthcare facility would be to provide workers with prepared protocols for transitioning from the workplace to the home, including organized and comprehensive decontamination areas, designated and supervised areas for doffing and showering, and specific work clothes that are left and laundered at the worksite (Fisher et al. 2015). During the early weeks and months of the COVID-19 pandemic, overburdened hospitals could not implement many of these interventions for employees, and much remained unknown about the transmissibility and high-risk exposures for this novel virus, which made it difficult to impose evidence-based strategies to prevent outward transmission (Bird et al. 2020). In this way, protecting family members from the worker's occupational exposures and potential infection became the responsibility of healthcare workers alone as individuals, without substantial guidance or resources from employers, during this period of great uncertainty and stress.

Our goal with the online questionnaire was to describe and assess the frequency of use of various at-home strategies frontline HCW employed to reduce take-home disease exposure to their household members. We focused on the "after work" stage of the take-home pathway to provide a more comprehensive understanding of mitigation actions in the home and complement a more substantial research based on the use of PPE during work. Our interests focused on household structures, including access to spare bedrooms and spare bathrooms that permitted isolation or separation, as well as within-home practices that encouraged transmission mitigation (such as separation of laundry and showering upon arrival at home). We also queried more extreme interventions, specifically living apart from family members—either sending family members to live elsewhere or living in isolation during periods of work—as a reflection of more significant concern regarding the take-home pathway.

To address RQ1, we proposed the following hypotheses: (i) high income would be associated with the implementation of a greater number of household isolation practices within the home, specifically, those that relied on larger living space, such as separate bedrooms or bathroom usage; and (ii) frontline clinicians were more likely to live apart from family members during periods of COVID-19 exposed work.

Healthcare worker experiences during the take-home pathway

The concept of experience and its dimensions are introduced to further support answering RQ2. Based on seminal work by Desmet and Hekkert (2007), an experience is an overarching concept encompassing affective responses derived from human interaction with objects or processes. For example, the interaction between an HCW and the take-home pathway during the

pandemic. Based on Roggeveen and Rosengren (2022), this overall experience considers everything that affects the interaction between an HWC and the take-home pathway, like contextual aspects such as the hospital, patients, and other staff, along with aspects related to the individual, like emotions, thoughts, and behaviors during the experience. As expected, emotions have a key role in judgment and decision-making and, therefore, behavior (Sharma et al. 2023). Thus, understanding experiences requires multidisciplinary efforts that generally focus on emotional and cognitive dimensions of the experience (Heinonen and Lipkin 2023) along with the identification of points of pain and gain, which relate to those identified parts of the process that involve either a problem or an innovation (Roggeveen and Rosengren 2022). For example, Ly et al. (2021) identified barriers (i.e. pain points) to adequate palliative care. Hence, they suggested that patients should be treated based on disease progression rather than mere medical history.

As for the emotional dimension, the fuzzy concept of emotions generally relates to a tendency toward or away from something. Whereas positive emotions reveal pleasant or desirable situational responses such as joy and satisfaction, negative emotions relate to unpleasant situations such as discontent (Sharma et al. 2023). These emotions have a valence, which relates to the direction of the response (positive versus negative) (Plutchik 2003). Regarding the cognitive dimension of the experience, mental processes such as memory retrieval, interpretation, and associations are also important because they bridge emotions with behavior (Desmet and Hekkert 2007).

Questionnaire design

Respondent profile and recruitment

To answer RQ1, we recruited a sample of frontline HCWs employed in a large urban hospital that serves as a regional safety-net hospital, serving predominantly low income and patients of color; approximately 70% of the patient population is from racial or ethnic underrepresented groups. Study participants were recruited through word of mouth, flyers, and an email list for Emergency Department (ED) employees. Eligibility requirements included being at least 18 yr of age, working at the hospital during the pandemic, and living with someone else at home. Outreach materials included a link or code to an online questionnaire, which took approximately 10 min to complete. Details on the recruitment resources used in this part of the study (Phase I) are in Supplementary Appendix I.

Quantitative data collection technique

After providing informed consent, the online questionnaire used Qualtrics and consisted of primarily closed-ended and multiple-choice questions. Content focused on workers' occupation, job-related responsibilities, exposure on the job to COVID-19 patients, household characteristics, take-home prevention behaviors in and outside of the home, and COVID-19 infections among the participant and their household members. Questions on take-home mitigation efforts focused on temporarily living apart from household members, sending household members away to live in a separate residence, showering upon arriving at home, wearing a mask in the house, sleeping in separate bedrooms, using separate bathrooms, and maintaining 6 feet or more from household members. Questions were derived in conversation with our interdisciplinary group of collaborators and through a review of the existing literature on take-home exposure pathways, and the growing literature on SARS-CoV-2 transmission, which remained incomplete at the time of the development of this survey. Our ED leadership and clinician collaborators supported efforts to clearly identify job tasks, responsibilities, and work areas within the hospital. Epidemiologists and exposure scientists within our team supported the development of evidence-based questions, which remained primarily descriptive in nature, focused on quick information-gathering from a very busy group of workers. The limited budget and timeframe of this pilot study precluded validation efforts for the survey. The questionnaire was live from September to November 2020, participation was anonymous, and a $10 e-gift card was given for completing the questionnaire. The online questionnaire is included in Supplementary Appendix II.

Questionnaire data analysis

Cleaned and validated quantitative data were analyzed descriptively using SAS 9.4 Software. Using univariate logistic regression, we compared specific mitigation strategies by participant subgroups (patient-facing clinicians versus non-patient-facing clinicians; lower vs. high income or ≥$75,000 in household annual income).

Qualitative design

Participant profile and recruitment

To answer RQ2, we then conducted a qualitative study with remote semi-structured interviews to explore the experiences of a range of participants in the earlier questionnaire study. Recruitment methods consisted primarily of announcements via hospital newsletters, flyers in different hospital areas, and word of mouth among hospital staff. Potential participants were contacted by phone or email to be screened. Eligibility requirements included being at least 18 yr of age, working at the hospital during the pandemic, and living with someone else at home. Interviews were audio recorded

with consent, anonymity was protected, and data security and storage adhered to the Institutional Review Board (IRB) requirements. Recruitment resources used in this part of the study (Phase II) are given in Supplementary Appendix I.

Qualitative data collection technique

Based on the questionnaire results and limitations, a semi-structured interview guide was developed to be conducted via phone or Zoom. Given the dynamic nature of the pandemic, interview questions were intended to elicit responses that would capture evolving perceptions and protocols. Although interviews were primarily conducted from July through October 2021, responses included experiences as early as March 2020. July 2021 had the lowest cases and mortality burden of the pandemic since the start of the pandemic, with the Delta variant leading to rapid case increases in late summer and early fall 2021. HCWs became eligible for vaccination in December 2020, and all participants were fully vaccinated by their interview.

We employed the at-work and after-work stages derived from our theoretical framework for the interview guide with questions delineating the different stages from work to home. The interview (20 to 45 min) included 6 sections, as outlined in Table 1. The interview guide design underwent multiple rounds of expert review to mitigate bias and improve facilitation. Sociodemographic data were purposefully not collected during interviews to optimize time during the interview and encourage full participation without identifiable information being disclosed. A $10 e-gift card was offered after completing the interview. The Zoom/Phone interview questions and script are included in Supplementary Appendix III.

Interview data analysis

Data consisted of interview notes, recordings, and transcriptions. Data were input into a spreadsheet to be categorized and coded; after that, the data underwent comparison and content and thematic analyses (Braun and Clarke 2006). For the thematic analysis, and through an iterative process, codes were refined to aggregate data into patterns of meaning, emerging themes were revealed, and similarities and differences were identified for interpretation purposes. One researcher and a research assistant initially did data categorization and coding, and then discussions among 3 researchers were held until a consensus was reached. Next, content analysis and themes were proposed by 3 researchers and socialized with the other researchers until agreement was achieved.

Journey mapping was then applied, which has been a novel approach to healthcare, allowing a visual narrative timeline of the interactions between a consumer (e.g. patient) and a service (e.g. palliative care) (Ly et al. 2021). However, this visualization analysis tool can also be applied to represent the experiences of individuals beyond patients, such as workers. We utilized journey maps to elucidate the experience behind workers' efforts to reduce transmission in 4 primary loci (i.e. work, leaving work, commute, and home). Based on this approach and the lessons learned from applying journey maps in health care (cf. Maddox

Table 1. Structure of the interview guide.

Interview section	Stage	Descriptor
1	Work environment	Participants were asked about their job role, whether they had received a COVID-19 vaccine, precautionary actions taken at work, changes in these actions over time, challenges preventing transmission at work, and concerns about getting COVID-19.
2	Leaving work	This section asked about participants' precautionary behaviors when preparing to leave work, changes in these behaviors over time, and any challenges experienced.
3	Commute home	This section inquired about their commute type, changes over time, precautionary actions used during the commute, and identified challenges.
4	Household members	Participants were asked about with whom they lived and whether they believed anyone in their household had an increased risk for severe illness if they got COVID-19, whether participants believed they or a household member had COVID-19 at any point, and whether they believed working at a hospital was a driver for infection.
5	Home environment	This section asked participants about their residence type, whether it was feasible to isolate at home if they got infected, whether they had stayed at a different location to mitigate bringing home the virus, and any precautionary procedures taken at home.
6	Closing	The closing section offered a final opportunity for participants to mention anything they had not had a chance to say earlier in the interview.

The full interview script can be seen in Supplementary Appendix III.

et al. 2019), journey maps were developed to depict each participant's experience, and a total of 23 journey maps were illustrated. For the emotional dimension of the journey maps, participants' responses were interpreted based on Plutchik's wheel of emotions (Plutchik 2003), which aims to bring clarity to emotions by categorizing them into 32 emotions that go beyond the basic eight of joy, trust, fear, surprise, sadness, anticipation, anger, and disgust.

Based on Maddox et al.'s (2019) suggestions and the original 23 journey maps, data patterns across individual journey maps (clinicians versus non-clinicians) were identified by data quantity, meaning figures were visually assessed to determine map subsections with more data/visuals versus little to none. Data patterns were also identified based on the type of content. For example, whereas content analysis via word clouds revealed the most prevalent emotions per stage (e.g. leaving work), thematic analysis was used for summarizing points of gain (e.g. positive aspects, supports) and pain (e.g. challenges), among other aspects. Two researchers were involved in identifying patterns and creating 2 figures summarizing the overall clinician and non-clinician experiences. The identified patterns were finally summarized in a single journey map presented in the results section. Raw data, data-analysis spreadsheet, and individual journey maps were revisited for verifying patterns, so creating these overall journey maps involved an iterative process. Then, various discussions were held among researchers to revise and improve figures until a consensus was reached.

Results

Questionnaire results

After restricting the study to individuals with distinct IP addresses, we limited participation in the analytic set to data collected from respondents who spent at least 3 min responding to study questions (n = 234), even if this led to missing data in some questions (missing data excluded from analyses). Our overall intention was to exclude as little data as possible, given the time stress our study population often experienced and the potential bias imposed by including only HCWs with extended time to complete a survey. This was decided upon in conjunction with our clinical collaborators. Approximately 60% (n = 137) of our sample were patient-facing clinicians, of whom 25% (n = 59) were physicians, 17% (n = 40) were nurses or nurse practitioners, 6% (n = 13) were medical students, 5% (n = 12) were physician or nurse assistants, and 6% reported other clinical roles (Table 2). Thirty-five percent (n = 81) of participants worked in the ED, and 21% (n = 50) reported working in the COVID-19 unit. Seven percent (n = 17) of participants reported cleaning rooms of COVID-19 patients as a job activity. Participants were primarily younger than 55 yr, with approximately 10% (n = 20) older than 55 yr, predominantly female (79%; n = 170) and white (62%; n = 135). Approximately 10% (n = 20) of participants reported Black identity, and 7% (n = 14) reported Latinx/Hispanic identity. Over 75% (n = 177) reported a combined household annual income of ≥$75,000/year.

Table 2. Healthcare worker participant characteristics from a questionnaire administered at a safety-net urban hospital, September–November 2020 (n = 234).

	n (%)[a]
Occupational characteristics	
Clinician (patient-facing)	137 (59.1)
Physician	59 (25.4)
Nurse or Nurse Practitioner	40 (17.2)
Physician or Nurse Assistant	12 (5.2)
Medical student or resident	13 (5.6)
Other clinical roles	13 (5.6)
Non-clinician/administrative role	82 (35.3)
Work unit	
Emergency department	81 (34.6)
COVID-19 unit	50 (21.4)
Cleaned rooms of COVID-19 patients	17 (7.3)
Demographics	
Age ≥55 yr	20 (9.6)
Female	170 (79)
Black/African American	20 (9.6)
Hispanic/Latino	14 (6.7)
White	135 (62)
Annual household income	
<$49,999	27 (12.0)
$50,000–74,999	30 (13.3)
>$75,000	177 (75.6)
Household characteristics	
Household size (mean; standard deviation)	2.9 (1.4)
At least one COVID-19 vulnerable household member[b]	76 (32.5)
Has separate/spare bedroom for use	147 (79.0)
Has separate/spare bathroom for use	81 (43.4)
COVID-19 infection	
Participant diagnosed with COVID-19	20 (8.7)
Participant suspected case of COVID-19	41 (17.4)
COVID-19 infection in household member (diagnosed or suspected)	21 (9.0)

[a]Columns do not all add to 100% because of missing responses.
[b]COVID-19 vulnerable household member defined as having a pre-existing condition, including old age, that puts them at elevated risk of severe COVID-19.

Table 3. Household mitigation strategies to reduce risk of "take-home" COVID-19 for healthcare workers at an urban safety-net hospital from a questionnaire (n = 234).

Strategy	Number (%)	Patient-facing Clinician Odds ratios (95% Confidence interval)[a]	High-income (≥$75,000) Odds ratios (95% Confidence interval)
Temporarily lived apart from household members	34 (14.5)	1.0 (0.5, 2.1)	1.4 (0.8, 2.7)
Sent other household members to live in a separate residence	17 (7.3)	2.7 (0.8, 9.7)	1.8 (0.7, 4.8)
Take a shower immediately upon arriving home from work	131 (56.0)	2.1 (1.2, 3.7)	1.2 (0.9, 1.8)
Change out of work clothes when get home from work	171 (73.1)	2.6 (1.4, 4.7)	1.3 (0.9, 1.8)
Wear a mask while in the house	62 (26.5)	1.1 (0.6, 2.0)	1.0 (0.7, 1.6)
Maintain distance of 6ft+ while in the house	61 (26.1)	1.1 (0.6, 2.0)	0.9 (0.6, 1.5)
Slept in a separate bedroom	147 (79.0)	0.5 (0.2, 1.2)	0.8 (0.5, 1.5)
Used a separate bathroom	81 (43.8)	1.8 (0.9, 3.3)	0.8 (0.5, 1.5)
Ate separately from household members	34 (14.5)	1.0 (0.5, 2.1)	1.3 (0.7, 2.4)

[a]Odds ratios calculated using univariate logistic regression, with referent categories defined dichotomously as the alternative (null) condition for each covariate.

Participants reported that the most common take-home mitigation strategies included sleeping in a separate bedroom from household members (79%; n = 147), changing out of work clothes immediately upon arriving home from work (73%; n = 171), and taking a shower immediately after arriving home from work (56%; n = 131) (Table 3). Approximately a quarter of participants reported wearing a mask in the house to protect family members (27%; n = 62) or maintaining more than a 6-feet distance from household members (26%; n = 61). A few participants reported temporarily living separately from household members (15%; n = 34) or sending household members to live elsewhere (7%; n = 17). Patient-facing clinicians were more likely than non-clinicians to report sending household members to live elsewhere (OR: 2.7 [0.8, 9.7]), showering immediately upon arrival at home (OR: 2.1 [1.2, 3.7]), changing out of work clothes immediately at home (OR: 2.6 [1.4, 4.7]), and using a separate bathroom (OR: 1.8 [0.9, 3.3]) (Table 3). We did not observe meaningful differences in the odds of temporarily living apart, masking, distancing, or eating separately between clinicians and non-clinicians. Higher-income respondents were marginally more likely to report sending household members to live elsewhere (OR: 1.8 [0.7, 4.8]) and temporarily living apart from household members themselves (OR: 1.4 [0.8, 2.7]).

Qualitative study results

Following purposive convenience sampling, 23 respondents were interviewed from the same hospital (Table 4) using the semi-structured interview design for clinician (n = 15) and non-clinician (n = 8) roles. The sample size was determined to be appropriate after data saturation was achieved when additional interviews no longer produced new information (Hodges 2011). Clinical roles of participants included physicians, nurses, and pharmacists. Non-clinician roles included medical assistants, administrative coordinators, and care managers. Eighteen women and 3 men were interviewed; 2 participants' gender was unknown. This sample is reflective of typical ratios in the industry—women hold 76% of all healthcare jobs (Cheeseman and Christnacht 2019). Most participants worked directly with COVID patients (n = 16), lived with children (n = 15), or lived with a partner at home (n = 18). A portion of the participants (n = 10) identified living with an at-risk individual (CDC 2024b). For this study, an individual was defined as being "at-risk" if they were over 60 yr of age and/or had an underlying health condition that would put them at higher risk for severe illness if they contracted COVID-19, as defined by the Centers for Disease Control and Prevention (CDC 2024b).

A journey map (Fig. 1) was created to represent the participants' overall experiences as healthcare workers from March 2020 through October 2021, including their take-home mitigation actions, emotions, and thought processes during and after work. Interview sections 1–4 (seen in Table 1) describe the visualized take-home pathway. For each stage, there are 4 subsections in Fig. 1: (1) Cognitive Dimension, (2) Emotional Dimension, (3) Gain and Pain Points, and (4) Protection Behaviors. Subsection 1 at the top of the figure,

"Cognitive Dimension," includes a brief description of the stage and verbatims covering the thinking process and mental procedures involved in the experience. The next subsection 2, "Emotional Dimension," represents the most relevant emotions (e.g. trust) experienced and their valence (e.g. negative). In the following subsection 3, "Gain and Pain Points," whereas "Positive aspects" (e.g. traffic got better) and "Supports" (e.g. vaccines) address the gain points described by the participants, "Challenges" (e.g. maintaining physical distancing) describe those aspects that were pain points in their experience. Lastly, at the bottom of the Figure, subsection 4, "Protection Behaviors," identifies the PPE (e.g. gloves) and actions (e.g. rolling down the car windows) used as mitigation strategies for transmitting the virus during the various stages.

Work environment

Participants described their work situations over time in the first take-home pathway stage, *Work Environment*. Negative emotions were mainly experienced during the initial stages of the pandemic, especially as participants had to prepare for an impending wave of infection. With time, however, knowledge regarding transmission improved, protocols were implemented accordingly, and COVID-19 vaccines were rolled out to HCWs. Consequently, participants reported contrasting emotional experiences. Whereas some experienced more negative than positive emotions in the work environment (e.g. terror, annoyance), others experienced more positive than negative emotions (e.g. acceptance, trust). Overall, this stage was represented as emotionally neutral in Fig. 1. As one participant described:

> *"[Initially] I was very concerned. I didn't want to get sick because then I'd take it home to my husband. But since I got the vaccine and stuff, I'm a little more relaxed."*

Participants indicated that standard precautions initially included mandatory masking, vaccines for those eligible starting in December 2020, patient COVID screenings, and paid hotel stays to quarantine. All types of PPE were used during work but changed over time as attention on mitigation focused on airborne pathways rather than via surfaces. Initially, clinician participants were instructed in proper donning and doffing with instructional videos and assistance. Clinicians utilized gowns, goggles, face shields, N95 masks, gloves, and head coverings. By the summer of 2021, some clinicians no longer utilized as many layers as possible of protection and targeted their use of N95s to situations with patients who tested positive or showed respiratory symptoms like sneezing or coughing.

A summary of changes in PPE usage over time reported by clinicians is presented in Table 5. Non-clinician participants were initially required to wear similar layers of PPE as clinicians if they worked directly with patients. By the summer of 2021, most mainly used surgical masks and wore N95s if they were seeing patients who tested positive or had respiratory symptoms. Participants in administrative and support roles heavily utilized disinfectant, sanitizer, and plastic guards. Non-clinician participants continued taking these precautions but expressed less anxiety and fear about getting COVID-19 at the time of the interview. A summary of changes in PPE usage reported by non-clinicians is contrasted to those reported by clinicians in Table 6. The main protective actions employed by all interviewees were hand washing and physical distancing.

Leaving work

For the second stage, *Leaving Work*, participants described how they modified their usual routine at the end of the workday. Examples included changing out of work scrubs and, when possible, leaving them at work to be laundered, changing out of work shoes, and sanitizing hands, one's workstation, and other items like wallets, cell phones, and work IDs before leaving the building. Participants who did not have an office or access to a locker room cited difficulty finding appropriate space for changing scrubs and taking off their PPE. As seen in Fig. 1, this stage was perceived overall as the most negative of all stages because this stage is where participants had the least amount of control over their exposures, especially early in the pandemic when there was heightened attention toward surfaces. Even after finishing their usual end-of-workday routines, participants reported having to be in small, enclosed elevators with others and touching high-contact surfaces, such as elevator buttons. In many cases, workers had to use their best judgment when navigating how to control potential contagion best. Additionally, the hospital's infrastructure was not designed to facilitate end-of-workday disinfection. Many participants cited the absence of changing rooms or locker rooms as a pain point and desired dedicated space to shower and change out of work clothes. For example:

> *"I don't have a locker… So, [I would] go into the staff bathroom, put a sheet on the floor, disrobe everything away from [my] body; it was all contaminated. Put on clean scrubs, put the dirty scrubs back into a bag that could be washed, and then wash my hands because we were worried that anything you touched could be spreading the virus. Then the sheet that I brought into the bathroom I'd put in the hospital laundry."*

Table 4. Characteristics of healthcare workers participating in qualitative interviews (n = 23).

#	Hospital role[a]	Role type	Perceived gender	Lived with partner	Lived with kids (number)	Individuals at-risk in household (number)	Worked with COVID-19 patients
1	Physician	Clinician	Woman	Yes	Yes (3)	No	Yes
2	Pharmacist	Clinician	Woman	Yes	Yes (2)	Yes (2)	Yes
3	Physician	Clinician	Woman	Yes	Yes (2)	No	Yes
4	Nurse	Clinician	Woman	Yes	No	Yes (1)	Yes
5	Nursing assistant	Clinician	Man	No	Yes (1)	Yes (1)	Yes
6	Pharmacist	Clinician	Unknown	Yes	Yes (2)	No	Unknown
7	Physician	Clinician	Woman	Yes	Yes (1)	No	Yes
8	Physician	Clinician	Woman	Yes	No	Yes (1)	Yes
9	Health fellow	Clinician	Man	Yes	Yes (3)	No	Yes
10	Manager	Clinician	Woman	Yes	Yes (2)	No	Yes
11	Nurse	Clinician	Woman	Yes	Yes (2)	No	Yes
12	Nurse	Clinician	Woman	No	Part-time (1)	Yes (1)	Yes
13	Nurse	Clinician	Woman	No	No	Yes (2)	Yes
14	Nurse	Clinician	Woman	Yes	No	No	Yes
15	Dietician	Clinician	Woman	Yes	Yes (3)	No	No
16	Director	Non-clinician	Man	Yes	Yes (2)	Yes (4)	No
17	Coordinator	Non-clinician	Woman	No	No	No	No
18	Coordinator	Non-clinician	Woman	Yes	No	No	No
19	Social worker	Non-clinician	Woman	Yes	Yes (2)	No	Yes
20	Medical assistant	Non-clinician	Woman	Yes	No	Yes (1)	Yes
21	Scheduler	Non-clinician	Woman	Yes	Yes (2)	No	No
22	Assistant	Non-clinician	Unknown	Yes	Yes (1)	Yes (1)	No
23	Manager	Non-clinician	Woman	No	Yes (3)	Yes (1)	Yes

[a]Roles were slightly modified for anonymity purposes.

By the time of the interview, interviewees expressed less fear and anxiety about contracting COVID-19 at the *Leaving Work* stage. PPE that was most consistently used were masks, hand sanitizer, and disinfectant wipes. Actions that were most consistently done throughout the pandemic included changing out of scrubs and washing hands before leaving work.

Commute home

Depending on the mode of transportation used for their commute, workers had different routines during the third stage, *Commute Home*. Most participants drove personal vehicles during the pandemic, but others used public transit, biked, or walked. For those who drove, many initially wiped down surfaces in their vehicles using sanitizing wipes; some would drive with their windows down, and if a household had more than one vehicle, they would designate a specific vehicle to be used by the HCW. Below is how one participant described her experience:

> *"I was driving to and from the hospital, and then when I got home, I was wiping down the interior of the car with a Clorox wipe just in case I had brought something home with me. And, for a long time, we are lucky we have two cars; basically, nobody else used [my] car."*

By the time of the interview, many expressed being less strict about disinfecting surface areas and no longer driving with the windows down. Almost all participants continued to keep hand sanitizer and masks in their vehicle. This stage generated more negative emotions in those participants who used public transportation. Many participants initially switched from taking public transit to using a personal vehicle if able. Participants who continued

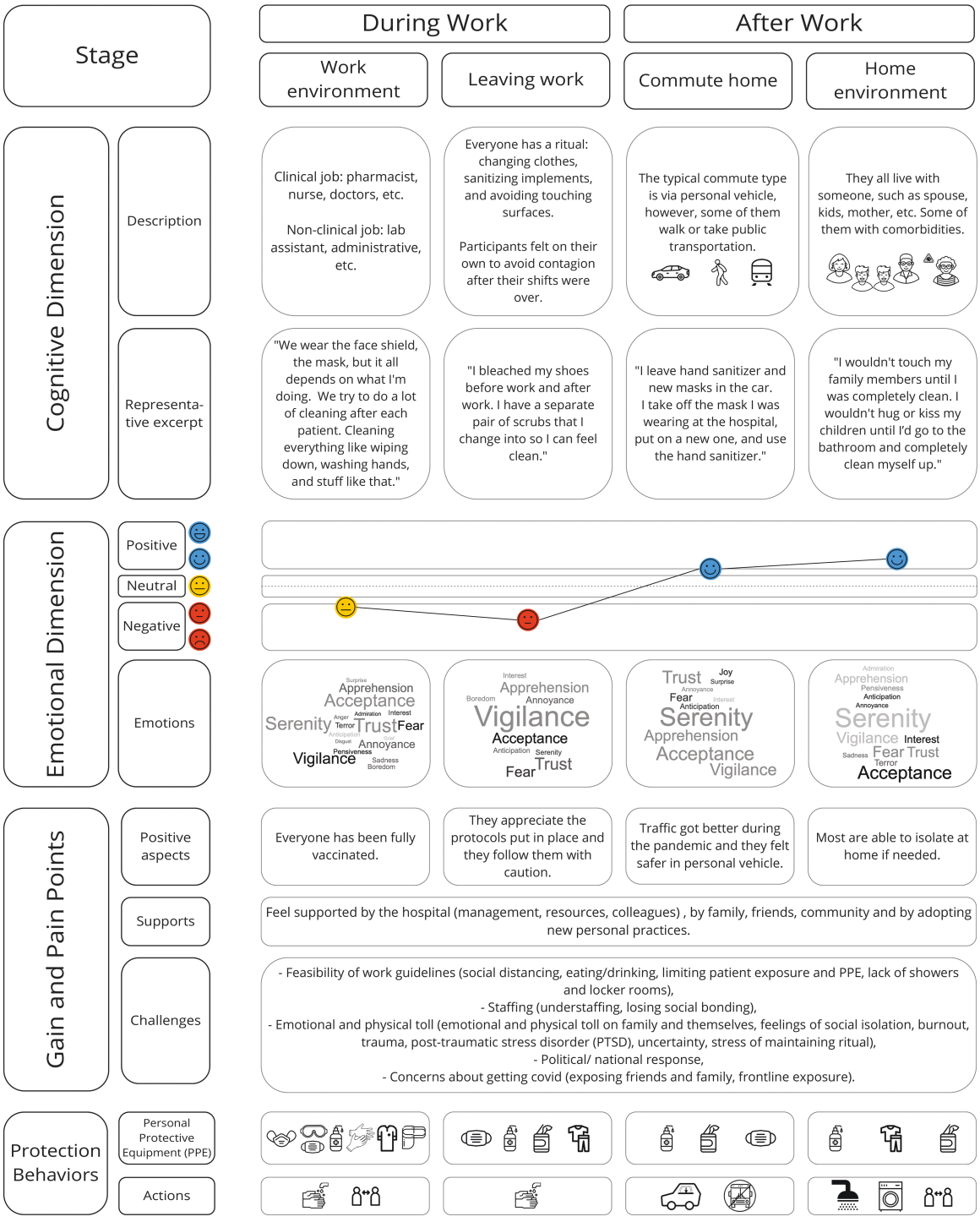

Fig. 1. Journey map summarizing 23 HCWs' (15 clinicians, 8 non-clinicians) overall experiences mitigating COVID-19 take-home exposure from approximately March 2020 through October 2021. Note: Icon meanings include at risk individual, N95, sanitizer/disinfectant, surgical mask, face shield, googles, gloves, gown, head covering, washing hands, social distancing, rolling down the car windows, not taking public transportation, taking a shower, and doing laundry.

Table 5. Comparison of personal protective equipment utilization at the onset of the pandemic with utilization at the time of interview by clinicians within the hospital environment (n = 15).

Setting of personal protective equipment usage—clinicians		
Personal protective equipment	**Onset of pandemic (Approximately Spring 2020)**	**Time of interview (Summer/Fall 2021)**
Sanitizer/disinfectant 	Consistently washed hands and sanitized workstations, chairs, pens, Ziploc baggie with personal items inside, and other items after each use.	Hand washing and sanitizing continued with less frequency, depending on the individual. No longer sanitizing pens, some have chosen to continue using and disinfecting a Ziploc baggie with personal items inside.
N95 	Clinicians were fit-tested for N95 masks and required to wear them. Many opted to wear during the entirety of their shift as a precaution because it was unknown which patients had COVID-19, and it was challenging to take on and off.	Targeted wearing in high-risk situations only. Examples include entering the room of a patient who has tested positive for COVID-19 or if a patient is coughing, sneezing, or showing other respiratory symptoms.
Surgical mask 	Worn at all times inside the hospital, typically as a second layer of protection in conjunction with N95s.	Main consistent personal protective equipment worn inside of the hospital, without the N95, when not in a room of a patient suspected to have COVID-19.
Face shield 	Worn as part of the donning and doffing process. Worn throughout the shift and in every single patient room as a precaution.	No longer mandated. Occasionally used when entering the room of a patient who tested positive for COVID-19, depending on the individual.
Goggles/eye protection 	Worn as part of the donning and doffing process. Worn throughout the shift and in every single patient room as a precaution.	Not mandated, but some opted to continue wearing eye protection when entering the room of a patient who tested positive or showed symptoms such as coughing or sneezing.
Gloves 	When entering a patient's room, clinicians had to be double-gloved. Gloves had to be changed frequently.	No longer mandated and no longer used.
Gown 	Worn as part of the donning and doffing process. Worn throughout an entire shift because it was difficult to take on and off. Caused extreme heat and sweating.	No longer used.
Hair/head covering 	It was not a requirement, but some clinicians chose to wear it when entering a patient's room because virus transmission was not well understood.	No longer used.

taking public transit experienced significant negative emotions when COVID-19 restrictions were relaxed, and subsequently, ridership increased, which were most likely non-clinicians. In addition to increased numbers of riders, mask mandates, although in place at the time of the interview, were challenging to enforce. One participant described their experience:

Table 6. Comparison of personal protective equipment utilization at the onset of the pandemic with utilization at the time of interview by non-clinicians within the hospital environment (n = 8).

Setting of personal protective equipment usage—non-clinicians		
Personal protective equipment	**Onset of pandemic (Approximately Spring 2020)**	**Time of interview (Summer/Fall 2021)**
Sanitizer/disinfectant 	Strict rules were in place regarding wiping down highly touched surfaces and workstations, especially if working with patients directly.	Many continue to wash their hands, and it is still technically policy to wipe surfaces as frequently as possible, but overall, people have become less strict about it.
N95 	Worn by participants who worked with patients one-on-one. Because of limited supply, those who did not work with patients directly did not wear them.	Targeted wearing by participants who work with patients directly who tested positive for COVID-19 or showed symptoms of coughing, sneezing, etc. Not worn by participants who do not work directly with patients.
Surgical mask 	Required to wear masks when inside the hospital.	No longer required inside of the hospital, it is up to the individual to decide. Most continue to wear them but have noted a more relaxed atmosphere overall.
Face shield 	Required to wear if working with patients directly. Otherwise, not required. The first point of contact staff may have a plastic guard at the workstation.	No longer required. Targeted wearing, but up to the individual, if someone is suspected to have been exposed to COVID-19 or tested positive for COVID-19.
Goggles/eye protection 	Required to wear if working with patients directly. Otherwise, not required.	No longer required, not really used.
Gloves 	Required to wear if working with patients directly. Otherwise, not required.	No longer required, not really used.
Gown 	Required to wear if working with patients directly. Otherwise, not required.	No longer required, not really used.
Hair/head covering 	Not used.	Not used.

> *"I use sanitizer when getting on and off the bus [and] I'm trying not to touch anything when I get on the bus. I was trying to stay socially distant on the bus as well. For a while, that was pretty easy because the traffic was so light, but now the buses are full again."*

These participants expressed mixed emotions as they felt some protection via their vaccinated status and apprehension about the Delta variant, which was on the rise at the time. For those who biked or walked, they described initially wearing masks, maintaining physical distance, and sanitizing their hands. They stopped wearing masks outdoors by the time of the interview.

Home environment

Participants explained how they modified their usual routines during the fourth stage, *Home Environment*. Many described a step-by-step procedure to prevent transmission to household members once they arrived home. While participants expressed fear of potentially infecting household members, many were also most comfortable at home because they were isolated from community members, confident in their ability to isolate from other household members if needed (i.e. most participants believed they could realistically isolate themselves within their home) and trusted their household members to follow precautions. In the early stages of the pandemic, because many participants did not have access to a locker room or changing room at work, their after-work routine included entering through the basement or garage, when possible, changing out of work clothes outside of the home, immediately starting a load of laundry of work clothes and taking a shower, and wiping down door handles and other highly touched surfaces. One participant said:

> *"I wouldn't even touch my kids or say hi to my kids. I'd run upstairs and take a shower; then I would come down. I would wipe off all my stuff, clean my shoes outside, wipe down my phone… I would have to ignore my kids and go upstairs and say that "I have to go shower, sorry, bye"."*

Participants who lived with no other HCW tried to separate personal items such as food and clothes to limit potential exposure. Many participants stayed elsewhere temporarily or requested that their family members move to a different location temporarily. HCWs who lived with extended family, such as grandparents and nieces and nephews, did face an additional challenge due to their number of household members limiting space for physical distancing. Some participants took advantage of the hospital's offer to book a hotel, while others stayed with friends who were also HCWs. Over time, with vaccinations, testing, and better information, people began to relax their behaviors, although many cited continuing the practice of washing their hands upon returning home.

Facilitators to take-home exposure mitigation of SARS-CoV-2

Workers identified several facilitators that helped them mitigate take-home exposure. In terms of hospital-related facilitators, major supports included an improved supply of PPE, COVID-19 vaccines starting in December 2020, better information on transmission, the availability of testing for staff, inpatients, and relatives, trust in colleagues, and the ability to work from home (in some cases). After initially being limited in the supply of PPE, the hospital procured sufficient supplies for staff. A participant explained, "*I feel very confident that my hospital system did the absolute best it possibly could [to] get the protective equipment we needed*." This was true for different roles, including a participant who traveled to patients' homes. In this case, the hospital shipped PPE to her house. Participants reported feeling significant relief upon the rollout of vaccines and their eligibility to get vaccinated. When asked how concerned they were about getting COVID-19 from work, one physician responded that they were "*…pretty terrified until we got vaccinated*." As family members became eligible to receive the vaccine, participants expressed their gratitude to the hospital for offering vaccinations to their family members.

More accurate information regarding transmission also played an important role in participants' levels of concern; many participants relaxed their routines relating to disinfecting surface areas and focused on airborne precautions as it became more apparent that surface transmission was unlikely. A precaution that improved over time was the consistent availability of testing for staff and their families as well as routine testing of patients on hospital admission and COVID-19 screenings of outpatients. Lastly, new technologies were introduced to help limit exposure. Multiple participants cited the newly installed ScrubEx (i.e. scrub exchange) machines that allowed staff to leave their work scrubs to be laundered at the end of the workday and pick up a new pair at the start of their shift. The mobile Rover system allowed HCWs to use an iPhone versus a computer in patients' rooms, requiring staff to disinfect fewer surfaces. One participant shared:

> *"The hospital introduced for us the rover system on iPhone. We each had an iPhone going into the room, so we didn't have to bring our computers in and out…it was tremendously helpful not to be disinfecting a computer every time you walked in and out of a room."*

A participant's response, such as the following, shows trust in colleagues following protocols as best they could:

> *"I was somewhat relieved to know that my entire team was making all the possible efforts to ensure that no one was leaving loose ends. Like everyone followed the protocol throughout, it was quite comforting to know that if I'm doing my part a little bit less, somebody else is making sure they are doing their part 100%."*

Some workers had less contact with patients by working remotely, reducing their exposure risk. One doctor explained, "*…it [COVID-19 from work] hasn't been as much a problem for me because we did our rounds via Zoom.*" This was not possible for everyone, particularly clinicians who always had to see patients in person, such as those in the ED.

Challenges to take-home exposure mitigation of SARS-CoV-2

Several participants expressed frustration early in the pandemic over the rapidly changing or lack of messaging they received from leadership as information on SARS-CoV-2 transmission rapidly evolved. It created confusion for many workers, for example:

> *"At the very beginning, they were saying we shouldn't be wearing masks in the hallways, there's no need for that. And then the next day it would be "oh my god, you must have an N95 even if you're going to the bathroom." We had no way of knowing how it was spreading, if it was airborne, if it was droplets, or any of that. The constant changing of information was very upsetting to us."*

The feasibility of work guidelines proved to be a significant challenge. Participants experienced limited PPE at the onset of the pandemic and difficulty physically distancing during their shifts, especially when eating and drinking. Like many healthcare settings in the US, this hospital was not equipped with enough PPE at the onset of the pandemic. Non-clinicians were instructed to save specific PPE for clinicians dealing with COVID-19 patients directly. As a result, it was initially difficult for non-clinicians to find masks and disinfecting wipes. Initially, clinicians had to reuse N95 masks, even beyond the recommended usage time, and utilize donated materials that were not initially designed to be hospital gear. Some individuals had personal offices they could physically distance in, but most personnel had to find space in formerly common areas. A worker described:

> *"Unless you have your own office, there's nowhere to eat that's totally socially distanced. We would walk into the room, and some people would be eating; they would just put their masks back on. I feel bad because I once said something to a nurse who was eating at an [Intensive care unit] ICU station, and she was like "Where else am I supposed to go?"."*

Testimonies also relayed a physical toll from the PPE. In the early stages of the pandemic, clinicians wore multiple layers of PPE for hours on end. The PPE would make it difficult to eat or drink, caused rashes, bruising, and bleeding, caused people to overheat, and was challenging to put on and take off. As one emergency response (ER) physician described, she would end up "with a splitting headache from not drinking water or eating anything because it was really hard to get in and out of everything." Another one described:

> *"The tops of our ears would get raw. I had many instances, even with just the face masks, where my ears would begin to bleed. Then, for a while, we were using gowns made of recycled airbags... They were literally like body bags; they were like shower curtains. They were so hot and sweaty. I was in a room for four hours with a patient one day, and I came out of the room and collapsed because it was so hot."*

Lastly, the lack of changing rooms and locker rooms also contributed to HCWs' fears. Without a robust disinfection area, HCWs had to change out of their work scrubs in spaces that were not designated changing areas.

Discussion

This qualitatively driven mixed-methods study characterizes and describes hospital workers' efforts to protect themselves and their families during and after work from the onset of the COVID pandemic and through the following 18 mo. This report is one of a limited number focused on efforts to protect households of frontline workers and one of few employing a qualitative method to gain a deeper understanding of psychosocial and environmental factors associated with occupational exposure to SARS-CoV-2 beyond descriptive data. To address RQ1, we depicted "take-home" mitigation strategies to prevent transmitting SARS-CoV-2 to household members in the early months of the pandemic in 2020, when workplace protective equipment and knowledge about exposure pathways were limited. We then addressed RQ2 by describing facilitators and challenges (i.e. gain and

pain points) through the take-home exposure pathway by depicting in a journey map how HCWs experienced the cognitive and emotional aspects relative to the stages of work environment, leaving work, commuting home, and residing in the home environment.

In the questionnaire responses, we observed a diversity of mitigation strategies used by HCWs and their households. More than one-third of study participants reported a COVID-19 vulnerable household member, reinforcing the importance of assessing take-home prevention strategies. Most participants reported remaining in their homes and sleeping in separate bedrooms and engaged in other various mitigation measures within the house, including showering and changing clothing immediately upon arriving home, with patient-facing clinicians more likely to report engaging in such behaviors compared to those without patient contact. These observations reinforced our initial hypotheses, suggesting that HCWs with direct patient contact were more likely to engage in more substantive efforts to protect their families. Higher-income participants were more likely to report living apart or isolated from their household members themselves or sending household members to live elsewhere. Despite our initial hypothesis that higher income would be associated with greater implementation of mitigation strategies, higher income was in fact not a meaningful driver of most mitigation behaviors. Broadly, the array of take-home prevention strategies utilized by HCWs reinforces the pervasive stress they faced, especially early in the pandemic and the importance of considering the take-home pathway in developing mitigation strategies.

From the interview data, major facilitator strategies identified were the availability of the COVID-19 vaccine, better information regarding the importance of surface versus airborne virus transmission, adequate supplies of PPE, trust among colleagues, the ability to work from home, and the adoption of new technologies (e.g. the ScrubEx Machine and Rover app). The main challenges were the need for locker rooms, designated changing areas and showers, and difficulties maintaining physical distance in the workplace.

The questionnaire and interview data provided similar results regarding the most common take-home mitigation strategies used by HCWs to prevent transmitting SARS-CoV-2 during the pandemic. Nevertheless, a qualitative examination of these strategies was required to elucidate who, how, why, and when they were done, how participants thought and felt during their execution, and the main challenges they experienced. In this way, our findings shed light on the experiences of HCWs during the pandemic and their efforts to stay safe and protect their families. As Ly et al. (2021) proposed, applying journey mapping to interview data was an appropriate approach to contribute to healthcare research. This analytical tool allowed us to go beyond exploratory data and further understand the workers' experiences over time relative to mitigation strategies throughout the "take-home" pathway. Thus, this study goes beyond what other qualitative (e.g. Werkmeister et al. 2023) or mixed-method studies (e.g. Burstyn and Holt, 2022) have revealed about HWC during the COVID-19 pandemic by focusing on the employee as the protagonist of the healthcare service encounter while protecting themselves and their families. Analyzing this pathway as a step-by-step process provided opportunities for extending knowledge related to take-home exposures, specifically, the connection between environmental and occupational health, well-being research, and infectious disease preparedness in healthcare.

Need for end-of-day disinfection standardized protocols

The potential to infect household members from occupational exposures to SARS-CoV-2 was a significant source of stress and anxiety for HCWs. Because of that, HCWs adopted many actions to reduce their take-home risks. These personal actions came with logistical challenges that exacerbated HCW stress. The journey map revealed that the stage with the most room for improvement was the *Leaving Work* stage. At this stage, HCWs had to navigate a way to disinfect themselves before returning home, often without much guidance, space, set protocols, or sufficient systemic support. Adapting the physical environment to meet the needs of HCWs would have required flexibility in space utilization but would have represented critical administrative support for workers. These findings confirm other studies' results, such as nurses and physicians in the United States reporting "worry about infecting family" as a source of anxiety (Werkmeister et al. 2023). Also, having adequate changing rooms and washing areas has positively affected occupational health during COVID-19 (Giorgi et al. 2020; Garzillo et al. 2022). Consequently, implementing adequate locker rooms, changing areas, and showers for end-of-day disinfection may relieve significant stress from HCWs as they try to prevent exposing their household members, especially when living with sensitive populations such as children, elder individuals, or the immunocompromised—regardless of their direct contact with COVID-19 patients. These changes would constitute a valuable step in improving HCWs' well-being moving forward and should be available for all HCWs, not just clinicians, before the next pandemic arrives—concepts aligned with an evolving understanding of workers' health known as "Total Worker Health®" (CDC 2024c).

Clear and consistent communication

Two crucial changes occurred from March 2020 to the time of interviews that shifted how HCWs perceived their risk of infecting household members: vaccinations for HCWs and better information regarding transmission. The pre-vaccination period and the time when transmission science was limited were regarded as the most challenging time for decision-making among several participants. Previous literature supports the role of information as vital to making individuals feel comfortable in their actions and giving them a sense of control (Klein and Cerully 2007; Williams and Noyes 2007). Clarity, consistency, and transparency are key when evidence-based information is lacking or quickly evolving (Capurro et al. 2021). Although many participants initially expressed frustration over quickly changing protocols or lack of messaging from leadership, participants also expressed appreciation for receiving weekly updates on the number of cases in the hospital and ICU. Consistent messaging helped staff feel that leadership had their interest in mind and gave workers the tools to assess the risks associated with different decisions.

Planning for future pandemics to reduce burnout

Our findings although specific to the take home pathway, confirm experiences similarly to those reported by HCW during the pandemic, such as that described by Gu et al. (2023). Our study provides a deeper understanding of psychosocial and environmental factors associated with occupational exposure to SARS-CoV-2 among healthcare workers, with insight for future hospital preparations. Specifically, in preparation for future public health crises, hospitals must build robust systems, be nimble, and adapt as conditions and knowledge change. In addition to burnout, HCWs were balancing the lack of institutional safety protocols and quickly evolving evidence. Without structural support, they had to recall each step of their individualized safety routines meticulously. Altogether, this created an undue mental burden for HCWs. The findings in this study support existing literature on participants experiencing burnout (Galanis et al. 2021) and stress (Werkmeister et al. 2023) during pandemics. To achieve a sustainable workforce and quality of care in the future, administrators can help relieve this mental load by implementing occupational health and safety engineering controls, i.e. changes in the workspace that do not solely rely on individual behaviors. Measures include maintaining an adequate supply of PPE and updating the physical infrastructure to reduce exposure risks (e.g. improved ventilation, disinfection infrastructure, safe spaces for eating/drinking/changing/showering). Because of the physical toll experienced by participants due to the PPE, which added to the burden on HCWs, PPE producers have and should further improve product designs that are more functional, ergonomic, and aesthetic; for example, the usage of lighter and fresher materials, more comfortable designs with higher perspiration and isolation of viruses, and easier to put on and take off.

Limitations and future studies

Our findings are limited in setting and scope yet may apply to healthcare facilities nationwide that faced similar issues and were ill-prepared for the pandemic. As the pandemic highlighted vulnerabilities that pervade hospital systems, this report's findings and discussion can better inform future action planning.

Limitations in the questionnaire study include sample size, which limited our ability to conduct adjusted regressions and consider confounding or stratification. Our sample included higher-income and better educated than the general healthcare workforce, reflecting our recruitment strategies that oversampled ED workers. HCWs are generally stressed for time, and while our questionnaire was short, the limited questions reduced our ability to garner detail in the questionnaire format. The time frame of the questionnaire reflected only the first 6 mo of the pandemic, and infections changed over time that we could not capture here. At the time of our interview, COVID-19 diagnostic tests were more limited than they later became, and although we asked about COVID-19 cases, symptoms, and diagnoses, a minority of participants reported COVID-19 testing in response to symptoms consistent with the infection. As a result, we did not use COVID-19 infection as an endpoint in statistical models to consider the association between behaviors and actual COVID-19 infection among our participants, although such an analysis had been our intention. In later work, confirmed COVID-19 diagnoses can support such assessments. Nevertheless, the questionnaire study achieved a strong response among a stressed and difficult-to-reach workforce at the pandemic's peak, with solid representation among highly exposed COVID-19 units and frontline workers. For the qualitative assessment, the timing of our interviews was both a limitation and a strength as aspects of the pandemic changed or evolved. Although the research team could not capture real-time perceptions from HCWs when the pandemic first hit the urban area using qualitative methods, we were able to capture the differing 2020 and 2021 including before and after vaccine experiences and conditions, as well as provide a valuable comparison and address many limitations of the questionnaire data.

Non-clinician participants, particularly those serving in support roles such as medical assistants, administrative coordinators, service representatives, and

care managers, were more likely to live with multigenerational family members beyond the nuclear family, such as grandparents, nephews, and nieces, many of whom were at-risk individuals. Coupled with the likelihood of a smaller physical space, given income differentials, this can lead to more challenges in protecting family members. While our questionnaire data did not indicate substantial differences, these issues are crucial for future hospital planning. In addition, some low-income workers did not have a personal car for commuting and usually relied on public transit, reflecting less control over individual exposures. Future studies focused on lower-income HCWs and their families would be beneficial to comprehensively understand disparities in experiences, as inequalities in the workplace are likely to be compounded given inequalities in the home environment. Future endeavors should also bolster efforts to connect with workers who speak a language other than English.

Conclusion

The questionnaire and interview results agreed that vaccination and testing combined with isolating, disinfecting, changing clothes, and using PPE at work, during commuting, and at home were the most used take-home mitigation strategies used by HCWs to prevent transmitting SARS-CoV-2 to their families during the pandemic. Nevertheless, a qualitative examination of these strategies, applying journey mapping to interview data, revealed healthcare workers' experiences during each of the stages of the take-home pathway. Many precautions usually went beyond protocols provided by employers and likely added to the stress and anxiety of healthcare workers during the pandemic, especially for those living in small spaces with infectious-disease-prone individuals at home. To better prepare for the next pandemics, our findings suggest further preventing the spread of COVID-19 from healthcare settings, explicitly providing more resources and consistency in the availability of end-of-work stage infection controls before going home, such as availability of lockers, space where to change into clean clothes and shower, and the ability to wash work clothes at work.

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Author contributions

DMC, JGG, and JHL conceptualized this work. DMC, JEN, JIL, and JHL lead development of questionnaire and interview instruments, which were reviewed by WEB and EMS. DMC and JEN obtained IRB approval and performed data collection. DMC, JEN, WEB, and EMS were involved in recruiting participants. DV, LMC, and JHL performed data cleaning, analysis, and interpretation with guidance from DMC and JIL. DMC, DV, LMC, and JHL wrote the manuscript, and all coauthors contributed significantly to the revisions.

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Conflict of interest

The authors report there are no competing interests to declare.

Ethics approval

The Boston University Medical Campus Institutional Review Board approved the study protocols before implementation (IRB Number: H-41073). All participants provided written or verbal informed consent prior to enrollment in the study.

Data availability

Due to the sensitive nature of the questions asked in this study, participants were assured that raw data would remain confidential and would not be shared. Interview data is not available. Questionnaire data is available upon request.

Supplementary material

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

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