


BMJ Open Stress and safety of maternal and newborn healthcare workers early in the COVID-19 pandemic: a repeat cross-sectional analysis from a global online survey from March 2020 to March 2021

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ABSTRACT

Objectives This study aims to characterise the physical and psychological well-being of maternal and newborn healthcare workers (MNH CWs) during the COVID-19 pandemic.

Design Observational repeated cross-sectional study.

Setting An online questionnaire was distributed to MNHCWs around the globe in three separate rounds from March 2020 to March 2021.

Participants Total samples of N=1357 (round 1) and N=420 (round 3) primarily consisted of doctors, midwives and nurses in maternal and newborn specialties. Samples represented all WHO regions, with 33% (round 1) and 42% (round 3) from low- or middle-income countries (LMICs).

Primary and secondary outcome measures Responses from rounds 1 (March–June 2020) and 3 (December 2020–March 2021) were analysed to measure self-reported levels of relative stress and workplace protection from COVID-19, while associated factors were determined through multivariable ordinal logistic regression.

Results In round 1, 90% of MNHCWs reported increased stress levels and 45% reported insufficient personal protective equipment (PPE) access. Nurses and physicians were less likely to report increased stress than midwives at the pandemic onset. Factors associated with increased stress included being female, being from an LMIC and insufficient PPE. In round 3, 75% reported similar or increased stress while 10% reported insufficient PPE. In both rounds, over 50% of MNHCWs felt relatively or completely unprotected from COVID-19 in the workplace. Those from LMICs were more likely to report feeling unprotected, while receiving organisational information that valued safety was associated with better feelings of protection in the workplace.

Conclusions Among our international sample of MNHCWs, we observed high rates of self-reported stress increase at the start of the pandemic with persistence or increase up to a year later. High rates of feeling unprotected persisted even as PPE became more available. These results may inform interventions needed to support and protect MNHCWs during this and future pandemics.

STRENGTHS AND LIMITATIONS OF THIS STUDY

- ⇒ This study examines the physical and psychological conditions at both the start and 1 year into the pandemic for a diverse population of midwives, nurses and doctors in maternal and newborn specialties.
- ⇒ This was a voluntary, global, online survey which may skew the results towards healthcare workers with more free time to respond, those looking to report poor conditions and those with internet access.
- ⇒ Different samples were captured at each round due to cross-sectional survey design.
- ⇒ The stress outcome is relative and does not reflect absolute stress levels, though inferences can be drawn from studies during other pandemics and COVID-19.
- ⇒ Multivariable ordinal logistic regression models produced adjusted ORs to examine associations with the primary outcomes.

BACKGROUND

The COVID-19 pandemic has resulted in increased risks for healthcare workers (HCWs) through direct infections, supply chain shortages in personal protective equipment (PPE), overwhelming patient volumes and inconsistent care guidelines.^{1 2} Numerous studies have found these challenges to result in high rates of stress, burnout and consequent exit of HCWs during the pandemic.^{3–16} A growing number of studies have gone further to examine the demographic characteristics and workplace factors that may amplify this strain on HCW wellness. For example, many studies have found that female HCWs may have been more susceptible to stress during the pandemic,^{4 17–20} though there are also mixed findings.^{21 22} Additionally, working for government hospitals and in settings with high risk of COVID-19 infection may be associated with emotional exhaustion, hopelessness and

burnout.^{11 17} There is abundant evidence that HCWs in clinical roles have been more susceptible to stress during the pandemic,^{17 23} though there is little research that distinguishes these clinical occupations in maternal and newborn specialties. Importantly, the respondents for these studies are usually limited to specific geographic regions.

Previous infectious disease outbreaks, such as the Ebola epidemic, severely impacted the ability of HCWs to provide maternal and newborn services, an essential area of care that must be accessible and functional at all times. Major factors in this disruption included inadequate PPE, staff shortages, closure of health facilities, and loss of trust between community and HCWs.^{24 25} In the COVID-19 pandemic, maternal and newborn HCWs (MNHCWs) face risk of COVID-19 infection through direct patient care and other nosocomial sources such as infected colleagues. In April 2020, a survey by the Royal College of Midwives in England reported that 99% of midwives feared exposure to COVID-19 in their workplace, and over half of them did not feel safe carrying out home visits.²⁶ Ensuring the safety and well-being of maternal and newborn healthcare providers is critical to preventing the interruption of care and avoidable deaths of both patients and MNHCWs, especially during pandemics.^{27 28}

To better understand the experiences and challenges faced by MNHCWs, Semaan and colleagues initiated a voluntary global online survey early in the pandemic.^{29 30} The data collection was prospective and repeated in three consecutive rounds spanning from March 2020 to March 2021. In the first round of survey data (March to June 2020), machine learning models found the following to be associated with MNHCW perception of safety: information accessibility, clarity and quality; availability of support and means of protection; and COVID-19 epidemiology at the country. In the second survey round (July to December 2020), increased stress due to inconsistent information and protocols was found to be a significant barrier to care delivery.³¹

We present survey results from the first round (early in the pandemic) and third round (1 year into the pandemic) to understand patterns of self-reported stress and self-reported workplace protection from COVID-19 in MNHCWs. We explored factors associated with stress and protection including demographic characteristics, access to PPE and COVID-19 tests, and employer-provided information to identify potential areas for interventions.

METHODS

Study design, setting and participants

This is an observational repeated cross-sectional study of maternal and newborn healthcare providers (physicians, nurses and midwives) from around the world. We analysed survey responses from March 2020 to June 2020 and December 2020 to March 2021 to compare MNHCW

experiences at the start and 1 year into the COVID-19 pandemic.

Survey design

The questionnaire was developed by an international team that included healthcare professionals, infectious disease specialists, epidemiologists, sociologists, anthropologists and experts in maternal, sexual and reproductive health. Briefly, the questionnaire included four main sections about respondents' backgrounds, their reported preparedness for COVID-19, the workplace response and their work experience during the pandemic (see online supplemental material A for full questionnaires of included rounds). These main sections were present in all three survey rounds, with minor adaptations to the structure of some questions when necessary. The questionnaire was available in 13 languages in round 1, 11 in round 2 and 12 in round 3. The survey is described in detail in a thematic analysis by Semaan and colleagues.²⁹

Data collection

An invitation to complete the survey was distributed broadly using personal networks of research team members through social media platforms such as Facebook, Twitter and WhatsApp groups to ensure a broad representation of MNHCWs. Surveys were administered during three time periods: round 1 (24 March to 26 June 2020), round 2 (5 July to 3 December 2020) and round 3 (7 December 2020 to 23 March 2021). Respondents provided informed consent online by checking a box affirming that they voluntarily agreed to participate in the survey.

Measures

Our first primary outcome was self-reported change in stress levels. In round 1, this was measured with the question 'How would you rate your own levels of stress at this time?' Responses were recorded on a 3-point Likert Scale: 1—same; 2—somewhat higher than usual; 3—substantially higher than usual. This question was modified for round 3 to 'Compared with the beginning of the COVID-19 outbreak, how would you rate your own levels of stress in the past month?' The responses were recorded on a 5-point Likert Scale: 1—substantially lower; 2—somewhat lower; 3—same as the beginning of the outbreak; 4—somewhat higher; 5—substantially higher. Our second primary outcome was feeling protected from SARS-CoV-2 virus infection in the workplace, also collected on a 5-point Likert Scale: 1—not at all; 2—minimal protection; 3—some protection; 4—well protected; 5—completely protected.

Data analysis

We used descriptive statistics to summarise the survey responses. Some responses were recoded for analysis. For descriptive analysis, PPE questions originally asked about masks and gloves separately, though we consolidated these into a single variable. For multivariable analysis, PPE and COVID-19 testing variables were dichotomised

to reflect complete access. Responses for employer-provided information were also dichotomised as satisfactory ('good' or 'excellent') or unsatisfactory ('average', 'somewhat useful', or 'poor' or 'none'). The scale for workplace protection was reverse coded so that feeling unprotected had a higher score. Country income levels were based on World Bank classifications from 2020, though we combined lower middle and upper middle into one category due to low response rates.³²

We generated ordinal logistic regression models for explanatory multivariable analysis, with increased stress and feeling unprotected from COVID-19 as separate outcome variables. Respondents that did not identify as physicians, nurses or midwives were excluded from the analysis. We included respondent demographic characteristics, access to PPE and COVID-19 testing, and qualities of employer-provided information as covariates. Models were generated separately for rounds 1 and 3 of survey data to reflect the cross-sectional survey design and facilitate comparisons in responses between the early and later pandemic stages. Multicollinearity was assessed with generalized variance inflation factors and correlations between covariates. To uphold the proportional odds assumption of these models, a Brant test was performed on all independent variables with significant odds ratios (ORs). If a covariate failed the Brant test, the proportional odds assumption was assessed graphically. Since these models were not being used for predictive purposes, all covariates of interest that upheld the model's assumptions were included. Respondents were only included in the regression analysis if they provided responses to all questions contained in the final model. Covariates that substantially reduced the sample size of the model (>10%) due to missingness were removed from the model. The adjusted ORs from the models were used to estimate the associations with each covariate, with p values and 95% confidence intervals (CIs) to measure statistical significance. A forest plot was generated to visualise the effect sizes.

Feeling unprotected was not included as a covariate in the full stress model since it was associated with covariates of interest for increase in stress (ie, access to PPE, testing and information). We explored the association through a simple ordinal logistic regression model for the stress outcome, with feeling unprotected as the single covariate.

Data cleaning and descriptive statistics were done in SAS V.9.4. Ordinal logistic regression analyses were done with the *MASS* and *forestploter* packages in R 4.2.1.

Patient and public involvement

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

RESULTS

Sample description

The total number of survey responses were 1357 (round 1) and 420 (round 3). In both rounds 1 and 3, most

respondents were from high-income countries (67% and 58%, respectively) (table 1). The distribution of geographic regions was similar across both rounds, with representation from all WHO regions. Physicians (medical doctors of any specialty) and midwives (including nurse midwives) each represented about 40% of both samples, respectively. The sample included greater than 70% female participants across both rounds. Most respondents reported practicing in an urban area (>89%), being employed by public organisations (>67%) and providing inpatient or surgical maternal/newborn care (>80%).

Stress and workplace protection from COVID-19

Almost all (90%) participants in round 1 rated their stress level as somewhat or substantially higher than before the COVID-19 pandemic (table 2). In round 3, over half (57%) of respondents reported their stress as somewhat or substantially higher than at the start of the pandemic, with only one-quarter (25%) reporting that their stress level declined. In round 1, 34% of MNHCWs reported that they felt well or completely protected from COVID-19 in their workplace, while 29% reported minimal to no protection. The proportion that felt well or completely protected increased to 50% in round 3, with those reporting minimal to no protection decreasing to 19%.

PPE, COVID-19 testing, and workplace information and safety

In round 1, 45% of respondents reported not having access to both gloves and masks (table 2). This decreased to 20% in round 3. Handwashing access was greater than 95% throughout both survey rounds. Access to testing for COVID-19 was only measured in round 3 with 94% of MNHCWs reporting access, though only 40% reported access regardless of symptoms or exposure. In round 1, 90% of MNHCWs reported receiving information about providing care during COVID-19 from their employer or professional organisation, which decreased to 81% in round 3. Among MNHCWs who received information, in round 1, 52% found that it was good or excellent at valuing their safety, compared with 55% in round 3. In both rounds, one-third (36%) of respondents who received such information found that the materials were not very clear (average or worse).

Analytical findings

Employment type (public or private) was removed from the models as it accounted for a 15% reduction in sample size due to missing responses in round 3. All other covariates of interest were included in the full ordinal logistic regression models as they upheld the model's assumptions and no variables were found responsible for substantial reduction in sample size.

In round 1, the adjusted ordinal logistic regression model for stress (N=1166) found that nurses (OR=0.66, 95% CI (0.46 to 0.94)) and physicians (OR=0.71, 95% CI (0.54 to 0.94)) were less likely to report an increase in stress compared with midwives (table 3). This was also true for MNHCWs who felt their employer or professional

**Table 1** Characteristics of responding maternal and newborn healthcare workers

Variables	Round 1 (N=1357)* n (%)	Round 3 (N=420)* n (%)
Dates of survey	24 March to 26 June 2020	7 December 2020 to 23 March 2021
Country income level		
Low income	124 (9.1)	70 (16.7)
Middle income†	317 (23.4)	107 (25.5)
High income	915 (67.5)	243 (57.9)
Did not respond	1	0
WHO Region		
East Asia and Pacific	145 (10.7)	15 (3.6)
Europe and Central Asia	513 (37.8)	167 (39.8)
Latin America and Caribbean	249 (18.4)	45 (10.7)
Middle East and North Africa	66 (4.9)	17 (4.1)
North America	86 (6.3)	25 (6.0)
South Asian	97 (7.2)	29 (6.9)
Sub-Saharan Africa	200 (14.7)	122 (29.1)
Did not respond	1	0
Role		
Midwife‡	496 (37.8)	166 (39.8)
Nurse	178 (13.6)	60 (14.4)
Physician§	549 (41.8)	167 (40.0)
Other	90 (6.9)	24 (5.8)
Did not respond	44	3
Gender		
Male	304 (22.7)	112 (26.9)
Female	1028 (76.7)	301 (72.4)
Prefer not to say	9 (0.7)	3 (0.7)
Did not respond	16	4
Type of area		
Urban (city or town)	1152 (89.6)	363 (89.6)
Rural	100 (7.8)	35 (8.6)
Other	33 (2.6)	7 (1.7)
Did not respond	72	15
Sector of employer/organisation		
Public	832 (69.6)	254 (76.7)
Private	363 (30.4)	77 (23.3)
Did not respond/self-employed	162	89
Type of maternal/newborn care provided		
Outpatient	215 (17.5)	74 (19.1)
Inpatient	706 (57.5)	198 (51.0)
Surgical	307 (25.0)	116 (29.9)
Did not respond	129	32

*Differential number of missing values across variables; percentages were calculated excluding missing values.

†Includes lower-middle and upper-middle income countries.

‡Includes nurse midwives.

§Includes anaesthesiologist, general practitioner, obstetrician/gynaecologist, neonatologist, paediatrician, surgeon, medical officer and medical doctor (other/no specialisation).

Table 2 Workplace conditions and experiences of responding maternal and newborn healthcare workers

	Round 1 (N=1357)* n (%)	Round 3 (N=420)* n (%)
Dates of survey	24 March to 26 June 26 2020	7 December 2020 to 23 March 2021
Access to PPE (hand gloves and face masks)		
None	168 (12.9)	29 (7.2)
Only masks	16 (1.2)	36 (8.9)
Only gloves	407 (31.1)	18 (4.5)
Both	716 (54.8)	321 (79.5)
Did not respond	50	16
Running water and soap always available when providing care		
Yes	1233 (95.2)	406 (97.8)
No/don't know	62 (4.8)	9 (2.2)
Did not respond	62	5
Possible to get tested for COVID-19 as a health worker		
No/do not know	–	24 (5.9)
Yes, regardless of symptoms	–	163 (39.9)
Yes, only if exposed	–	128 (31.3)
Yes, only if symptomatic	–	94 (23.0)
Did not respond	–	11
Received information about working during COVID-19 from employer/professional organisation during the previous month		
Yes	1186 (90.3)	333 (80.6)
No	127 (9.7)	80 (19.4)
Did not respond	44	7
Value of the information in making the HCW feel safe†		
Poor	102 (8.8)	15 (4.6)
Somewhat useful	147 (12.7)	41 (12.5)
Average	303 (26.3)	92 (28.0)
Good	455 (39.4)	146 (44.4)
Excellent	147 (12.7)	35 (10.6)
Did not respond	203	91
Clarity of information provided on providing care during COVID-19†		
Poor	46 (4.0)	7 (2.1)
Somewhat useful	111 (9.6)	21 (6.3)
Average	265 (22.8)	92 (27.8)
Good	560 (48.2)	173 (52.3)
Excellent	180 (15.5)	38 (11.5)
Did not respond	195	89
Helpfulness of information provided on providing care during COVID-19†		
Poor	43 (3.7)	5 (1.5)
Somewhat useful	108 (9.3)	29 (8.8)
Average	242 (20.8)	74 (22.4)
Good	577 (49.6)	172 (52.0)
Excellent	194 (16.7)	51 (15.4)
Did not respond	193	89
Perceived level of protection from infection with COVID-19 in the workplace		
None at all	123 (9.4)	22 (6.2)

Continued



Table 2 Continued

	Round 1 (N=1357)* n (%)	Round 3 (N=420)* n (%)
Minimal protection	259 (19.8)	45 (12.6)
Some protection	502 (38.3)	112 (31.5)
Well protected	356 (27.2)	143 (40.2)
Completely protected	70 (5.3)	34 (9.6)
Did not respond	47	64
Stress levels compared with before COVID-19 pandemic (round 1 only)		
Substantially higher	452 (34.4)	–
Somewhat higher	731 (55.6)	–
Same as usual	131 (10.0)	–
Did not respond	43	–
Stress levels compared with beginning of COVID-19 pandemic (round 3 only)		
Substantially higher	–	79 (19.8)
Somewhat higher	–	149 (37.4)
Same as usual	–	70 (17.6)
Somewhat lower	–	67 (16.8)
Substantially lower	–	33 (8.3)
Did not respond	–	22

Blank (–): question not asked in survey round.
 *Differential number of missing values across variables; percentage were calculated excluding missing values.
 †Among those who reported receiving information: n=1233 in round 1; n=406 in round 3.
 HCW, healthcare worker; PPE, personal protective equipment.

organisation provided information that had a value for their safety (OR=0.61, 95% CI (0.44 to 0.83)). Factors that made an MNHCW more likely to report increased stress included being female (OR=1.68, 95% CI (1.23 to 2.29)), being from a low- (OR=1.52, 95% CI (1.00 to 2.29)) or middle-income country (OR=1.33, 95% CI (1.00 to 1.77)) and reporting insufficient PPE (OR=1.67, 95% CI (1.31 to 2.13)). One year into the pandemic (round 3, N=346), respondents from low- (OR=0.44, 95% CI (0.23 to 0.84)) and middle-income countries (OR=0.55, 95% CI (0.33 to 0.91)) were less likely to report increased stress in comparison to the start of the pandemic.

The adjusted ordinal logistic regression model for feeling unprotected in round 1 (N=1169) found that physicians were less likely to feel unprotected from COVID-19 in comparison to midwives (OR=0.65, 95% CI (0.50 to 0.85)) (table 4). Feeling unprotected was less likely to be reported by respondents working for employers who provided information that was helpful with daily work (OR=0.44, 95% CI (0.32 to 0.62)) and made the MNHCW feel that their safety was valued (OR=0.39, 95% CI (0.28 to 0.53)). In contrast, MNHCWs were more likely to feel unprotected in their workplace if they reported inadequate PPE (OR=4.78, 95% CI (3.74 to 6.15)), or came from low- (OR=8.23, 95% CI (5.36 to 12.72)) or middle-income countries (OR=2.49, 95% CI (1.89 to 3.28)).

In round 3, female MNHCWs were less likely to feel unprotected from COVID-19 in the workplace than male

MNHCWs (OR=0.43, 95% CI (0.23 to 0.79)). This was also true for MNHCWs that received clear information (OR=0.37, 95% CI (0.19 to 0.72)) and received information that made their safety feel valued (OR=0.28, 95% CI (0.16 to 0.50)). MNHCWs were more likely to report feeling unprotected if they were from low- (OR=4.40, 95% CI (2.16 to 9.02)) or middle-income countries (OR=1.97, 95% CI (1.10 to 3.56)). Associations with both stress and protection are visualised in online supplemental material B to facilitate comparison between outcomes and timepoints.

Results from simple ordinal logistic regression analysis showed that feeling unprotected in the workplace was associated with higher odds of increased stress in round 1 only (crude OR=1.49, 95% CI (1.33 to 1.67)) (table 3).

DISCUSSION

We found high rates of self-reported increase in stress levels among a global sample of frontline MNHCWs soon after the pandemic start. These findings are similar to other research during the early COVID-19 pandemic, including a study from Egypt where a 98.5% prevalence of moderate-to-severe stress was reported in HCWs,³³ and a study in Vietnam by Nguyen and colleagues reporting that frontline HCWs were at heightened risk for psychological stress.³⁴ Because the stress variable in our survey was relative, our results expand on these studies with

Table 3 Adjusted associations with increases in stress among maternal and newborn healthcare workers

Variable	Increase in stress*			
	Round 1 (N=1166)		Round 3 (N=346)	
	Adjusted OR (95% CI)	P value	Adjusted OR (95% CI)	P value
Nurse	0.66 (0.46 to 0.94)	.02	1.14 (0.64 to 2.05)	.65
Physician	0.71 (0.54 to 0.94)	.02	0.94 (0.55 to 1.62)	.83
Midwife	Reference		Reference	
Female	1.68 (1.23 to 2.29)	.001	0.87 (0.51 to 1.48)	.60
Male	Reference		Reference	
Low Income	1.52 (1.00 to 2.29)	.05	0.44 (0.23 to 0.84)	.01
Middle Income	1.33 (1.00 to 1.77)	.05	0.55 (0.33 to 0.91)	.02
High income	Reference		Reference	
Rural area	0.74 (0.48 to 1.16)	.19	1.40 (0.72 to 2.74)	.33
City/town/other	Reference		Reference	
Inadequate PPE†	1.67 (1.31 to 2.13)	<.001	0.85 (0.47 to 1.54)	.59
Restricted COVID-19 testing access‡	Not asked		1.05 (0.70 to 1.57)	.82
Information: clarity§	0.91 (0.64 to 1.29)	.58	1.36 (0.75 to 2.46)	.31
Information: helpfulness for daily work§	1.31 (0.93 to 1.86)	.13	1.10 (0.61 to 1.97)	.76
Information: value in helping HCW feel safe§	0.61 (0.44 to 0.83)	.002	0.72 (0.42 to 1.21)	.21
Feeling unprotected from COVID-19 in the workplace¶	1.49 (1.34 to 1.66)	<.001	1.16 (0.96 to 1.40)	.14

Bold: p<0.05.
 *Increased since before pandemic (round 1) and increased since the start of the pandemic (round 3).
 †Personal protective equipment (PPE). Inadequate defined as not having access to both masks and gloves in the workplace.
 ‡Do not have access to testing, or only have access in the presence of symptoms or exposure.
 §Qualities of information provided by organisation on providing care during pandemic, rated as 'good' or 'excellent'.
 ¶Simple regression with crude ORs performed (not a covariate in full model). Round 1: N=1298; round 3: N=346.
 HCW, healthcare worker.

evidence that, for MNHCWs specifically, there were high rates of increased stress at the onset of the pandemic and low rates of stress reduction 1 year into the pandemic. It is particularly concerning that later in the pandemic, only a quarter of respondents reported a decrease in stress compared with the start of the pandemic, despite improvements in PPE and testing access. Considering stress's well-established correlation with burnout and workforce exit, this persistence of stress levels poses a great threat to the well-being of MNHCWs and the quality and availability of needed individuals for delivery of maternal and newborn care.^{15 16}

Consistent with the findings of frontline HCWs in Vietnam, we found that at the beginning of the pandemic, lack of sufficient PPE (defined as access to both face masks and hand gloves in our study) was associated with higher odds of increased stress levels.³⁵ A year into the pandemic, self-reported PPE availability increased to nearly 80% and was no longer associated with levels of stress since the start of the pandemic. This finding highlights the importance of basic infection and prevention control as a protective measure for MNHCWs and their patients. Additionally, respondents who reported receiving information with value for their safety were less likely to experience increased stress at the start of the pandemic. This corroborates findings from a cross-sectional study on HCWs in

the Republic of Cyprus that found self-perceived organisational support to be significantly and negatively associated with psychological distress during the pandemic, specifically in relation to stress.³⁶ These findings emphasise the need for employers to deliver resources and educate MNHCWs on staying physically and psychologically safe during outbreaks like COVID-19.

Most survey respondents were female, consistent with estimates from the WHO that women make up about 70% of HCWs globally.³⁷ Our finding that female MNHCWs, controlling for cadre, were more likely to report increased stress at the start of the pandemic is similar to other studies, performed both before and during the COVID-19 outbreak, which found increased risk for women,^{6 36–40} though this gender-association was not found in round 3 of respondents. Additionally, we found that midwives were more likely than nurses and doctors to experience increased stress in the early days of the pandemic. Other studies have found that occupational stress and burnout increased during the pandemic for MNHCWs generally⁴¹ and for midwives specifically,⁴² though our findings indicate that this increase may have been more severe for midwives compared with other MNHCW occupations. This association was not seen later in the pandemic, with stress persistence or increase seen across all cadres. As our analyses lost statistical power between rounds due to

**Table 4** Adjusted associations with feeling unprotected from COVID-19 in the workplace among maternal and newborn healthcare workers

Variable	Feeling unprotected from COVID-19 in the workplace			
	Round 1 (N=1169)		Round 3 (N=308)	
	Adjusted OR (95% CI)	P value	Adjusted OR (95% CI)	P value
Nurse	0.90 (0.64 to 1.28)	.57	1.59 (0.84 to 3.02)	.16
Physician	0.65 (0.50 to 0.85)	.001	1.10 (0.61 to 2.00)	.75
Midwife	Reference		Reference	
Female	1.17 (0.87 to 1.57)	.30	0.43 (0.23 to 0.79)	.01
Male	Reference		Reference	
Low Income	8.23 (5.36 to 12.72)	<.001	4.40 (2.16 to 9.02)	<.001
Middle Income	2.49 (1.89 to 3.28)	<.001	1.97 (1.10 to 3.56)	<.001
High Income	Reference		Reference	
Rural area	1.02 (0.67 to 1.57)	.92	0.73 (0.34 to 1.53)	.40
City/town/other	Reference		Reference	
Inadequate PPE*	4.78 (3.74 to 6.15)	<.001	1.17 (0.58 to 2.37)	.67
Restricted COVID-19 testing access†	Not asked		1.30 (0.83,2.05)	.25
Information: clarity‡	0.76 (0.54 to 1.05)	.12	0.37 (0.19 to 0.72)	.004
Information: helpfulness for daily work‡	0.44 (0.32 to 0.62)	<.001	1.70 (0.87 to 3.36)	.12
Information: value in helping HCW feel safe‡	0.39 (0.28 to 0.53)	<.001	0.28 (0.16 to 0.50)	<.001

Bold: $p < 0.05$.

*Personal protective equipment (PPE). Inadequate defined as not having access to both masks and gloves in the workplace.

†Do not have access to testing, or only have access in the presence of symptoms or exposure.

‡Qualities of information provided by organisation on providing care during pandemic.

HCW, healthcare worker.

reduced sample size, further study into these subpopulations as the pandemic persists is needed.

We found that almost all factors associated with stress in the early pandemic were no longer significant in the third survey round. This may reflect changes in workplace factors including PPE availability, infection rates and the relative nature of the stress question. Interestingly, respondents from LMICs were more likely to report increased stress at the start of the pandemic, but less likely to report further increase 1 year into the pandemic. This suggests no further worsening in the psychological well-being of MNHCWs in LMICs as the pandemic progressed, but remains of concern given the high rates of stress increase at the pandemic onset. The overall persistence or increase of stress levels 1 year into the pandemic despite improvements in PPE is evidence that further work is needed to address underlying causes of stress at the individual and system levels.

Overall, while we observed an improvement in self-reported protection from COVID-19 in the workplace between rounds 1 and 3, 50% of respondents reported only some, minimal or no protection 1 year into the pandemic. Unsurprisingly, inadequate PPE and restricted access to COVID-19 testing were associated with lower levels of protection from COVID-19 in both rounds. Conversely, respondents working for employers who provided more effective information on care delivery during COVID-19 (clarity, helpfulness and valuing HCW

safety) were more likely to report higher levels of workplace protection. Similar results are reflected in a meta-analysis of countries with the highest COVID-19 mortality rates (ie, Italy, China, Spain, USA and France) which found that major contributors to frontline HCW infection included misunderstanding the disease, inadequate PPE use and inconsistent diagnostic protocols.⁴³ We also found that the proportion of MNHCWs that received information about providing care during the pandemic decreased over time, with 20% receiving no information a year into the pandemic. Our findings highlight the critical need for organisations to strengthen their strategies for MNHCW education and support, in preparation for and throughout the course of pandemics.

Numerous studies describe how LMICs struggled to ensure safety for HCWs at the start of the COVID-19 pandemic due to lack of PPE, appropriate protocols and effective communication.^{44 45} Interestingly, we found that, while controlling for these factors, MNHCWs from LMICs were still significantly more likely to report feeling unprotected in the workplace at both points in the pandemic. This suggests that there are additional factors, besides typical determinants of COVID-19 preparedness and protection, that need to be addressed to improve sense and reality of infection protection for MNHCWs in LMICs.

Our study had several limitations. Most importantly, rounds represented cross-sectional responses and

different populations were captured at each round, with a significant reduction in sample size between rounds 1 and 3. This change likely influenced our results, and our ability to adjust for respondent type was limited. Additionally, the questionnaires could not be validated in the short window of time between the COVID-19 pandemic onset and our desired period of collection. Another limitation is that this data sample was voluntary and therefore may have biased the results to either individuals under higher stress looking to report or those less stressed with time to respond. Due to the online dissemination methods used, response rates could not be determined and may have been lower than desired.⁴⁶ Since the survey was distributed online, it also excludes those without internet access. Combining lower-middle and upper-middle countries into the same income category prevented analysis into differences between these income classifications. We acknowledge that these sources of survey bias and the cross-sectional design of data collection limit our ability to generalise our results and explore causal relationships. In addition, our stress outcome measured changes in relative stress, so we cannot make conclusions on the absolute level of participant stress or variables like burnout which were not explicitly measured. This is particularly important in round 3, where it is possible that a proportion of those who did not report a change in stress were still experiencing higher levels compared with the pre-pandemic. Moreover, the questionnaire did not distinguish between types of stress such as physical, emotional or financial. Factors such as access to PPE, information and testing were self-reported and could not be validated. Finally, we did not collect data on some stress and safety-related factors such as teamwork, COVID-19 stigma, workplace design, altering schedules and fear of transmission to family members.

CONCLUSION

We found that across a diverse, global set of HCWs engaged in maternal and newborn healthcare delivery, increased stress and feeling unprotected from COVID-19 in the workplace persisted 1 year into the pandemic. Our results encourage special consideration and further study on subpopulations including women, midwives and MNHCWs from LMICs. It is crucial that organisations ensure MNHCW knowledge and safety protocols are effectively delivered, both in preparation for and throughout pandemics, to minimise stress, improve MNHCW protections and reduce associated burnout and workforce exit. These changes are critically needed given the evidence of physical and emotional harm to MNHCWs, as well as disruptions in maternal and newborn care.

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