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Impacts of economic inequality on healthcare worker safety at the onset of the COVID-19 pandemic: Cross-sectional analysis of a global survey

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Impacts of economic inequality on healthcare worker safety at the onset of the COVID-19 pandemic: Cross-sectional analysis of a global survey

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ABSTRACT

Objectives To assess the extent to which protection of healthcare workers (HCWs) as COVID-19 emerged was associated with economic inequality among and within countries.

Design Cross-sectional analysis of associations of perceptions of workplace risk acceptability and mitigation measure adequacy with indicators of respondents' respective country's economic income level (World Bank assessment) and degree of within-country inequality (Gini index).

Setting A global self-administered online survey.

Participants 4,977 HCWs and healthcare delivery stakeholders from 161 countries responded to health and safety risk questions and a subset of 4,076 (81.2%) answered mitigation measure questions. The majority (65%) of study participants were female.

Results While the levels of *risk* being experienced at the pandemic's onset were consistently deemed as unacceptable across all groupings, participants from countries with less income inequality were somewhat less likely to report unacceptable levels of risk to HCWs regarding both workplace environment (OR=0.92, p=0.012) and workplace organizational factors (OR=0.93, p=0.017) compared to counterparts in more unequal national settings. In contrast, considerable variation existed in the degree to which *mitigation* measures were considered adequate. Adjusting for other influences through a logistic regression analysis, respondents from lower-middle and low-income countries were comparatively much more likely to assess both occupational health and safety (OR=10.91, p=<0.001) and infection prevention and control [IPC] (OR=6.61, p=<0.001) protection measures as inadequate, despite much higher COVID-19 rates in wealthier countries at the time of the survey. Greater within-country income inequality was also associated with perceptions of less adequate IPC measures (OR=0.94, p=0.025). These associations remained significant when accounting for country-level differences in occupational and gender composition of respondents, including specifically when only female care providers, our study's largest and most at-risk sub-population, were examined.

Conclusions Economic inequality threatens resilience of health systems that rely on health workers working safely to provide needed care during emerging pandemics.

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Strengths and limitations of this study

- A major strength of the study is its novel empirical testing of the "income inequality" hypothesis for a comparative cross-country analysis of a major global health challenge: protection for a workforce central to the provision of healthcare services during a pandemic.
- This study is based on a unique global self-administered online survey conducted by a network of occupational health experts coordinated by the World Health Organization (WHO) through a large array of professional networks and social media.
- A major limitation of the study is its character as a convenience sample with different compositions by gender and occupation among countries and small sample sizes in some countries; however access to gender and occupation identifiers of respondents has enabled adaptive strategies to take this into consideration.
- The study is exploratory in considering associations with economic inequality, but does not provide a way to consider pathways for this effect, so further research will be needed for this.

Keywords: COVID-19; Health Systems; Public Health; Other Study Design; Environmental Health

Occupational Health; Healthcare Workers

INTRODUCTION

As the COVID-19 pandemic emerged, attention was quickly drawn to risks faced by frontline healthcare providers [1,2] – and the urgent need to strengthen their protection [3,4]. By September 2020, it was estimated that 10% of global infections had been in health workers (HCWs), and over 7,000 had died [5,6]. Notwithstanding inconsistent reporting, Papoutsi and colleagues, in reviewing the global burden of COVID-19 for HCWs by country [6, 7], estimated the percentage of HCW cases among the total cases by April 2020 as ranging from less than 1% in Hong Kong and India, to 19% in Spain.

Despite 60 million people employed in the healthcare sector worldwide [8,9], a global shortage of HCWs persists and is especially critical in low-and middle-income countries (LMICs) [10], where the greatest global burden of disease exists [11]. Risk mitigation is marked by considerable variation [12], with shortcomings in infrastructure and mitigation programs contributing to higher burdens of disease and HCW risk in more poorly resourced settings [13]. The danger that HCWs face of acquiring COVID-19 adds to extensive existing risks in infectious disease endemic states, for example with tuberculosis in Sub-Saharan Africa [14].

While lack of personal protective equipment (PPE) was highlighted early in the COVID-19 pandemic, consideration of broader OHS factors and mitigation measures attracted less initial attention [7,8,15]. To ascertain the extent of OHS risk exposure and the adequacy of mitigation measures in place to meet the challenge of COVID-19, an Ad Hoc expert group of the WHO, the International Labour Organization (ILO) and the International Commission on Occupational Health (ICOH) prepared and circulated a questionnaire survey to identify HCWs perceptions of BMJ Open: first published as 10.1136/bmjopen-2022-064804 on 5 October 2022. Downloaded from http://bmjopen.bmj.com/ on April 23, 2024 by guest. Protected by copyright

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the most common threats to their health and safety as well as the adequacy of mitigation measures in the emerging pandemic [16].

Further to a preliminary analysis of survey results [16] regarding risk and adequacy of protection, we sought to ascertain the degree to which perceived risk exposure of HCWs and adequacy of mitigation measures is associated with a country's economic characteristics. Considerable attention, after all, has been given to the impact of economic disparity on health [17,18], especially in relation to Wilkinson's "economic inequality hypothesis" suggesting that greater inequality is associated with poorer health [19]. In recognition that "the traditional exposure-disease framework used in occupational health research is not equipped to address societal contexts in which work is embedded" [20], we sought to examine how such driving forces [21]as a country's economic inequality might be affecting the wellbeing of HCWs.

A variety of factors have been examined that might have influenced how the onset of the COVID-19 pandemic was experienced in different national settings, including consideration of cultural traits [22], specific government regulations and non-pharmaceutical interventions [23,24], and political leadership characteristics [25]. Our study sought to apply a cross-country perspective to consider the effects of economic inequality, recognizing this to be a dimension of considerable relevance in global public health research.

With this focus, we set out to first consider variation in perceptions of the acceptability of workrelated risks and the adequacy of mitigation measures that were being experienced by HCWs as COVID-19 emerged; and, second, to determine the extent to which variations were associated with a country's comparative income level and degree of income inequality.

METHODS Survey development

Shortly after the WHO Ad Hoc Study Group on Health and Safety of Health Workers was established when the COVID-19 pandemic emerged, it created an online survey aimed at HCWs from all WHO regions globally. In addition to the capture of demographic indicators of respondents, the survey contained 41 questions – 17 on health and safety risks and 24 on mitigation measures [16, Appendix]. Risk questions were grouped into those related to infectious disease transmission, physical work environment, psychological work environment and work organization. For each risk question, participants were asked "Think about the working conditions of health workers in your country, jurisdiction or health facility....; rate the current level of these risks, now during the COVID-19 pandemic." Questions regarding mitigation measures were divided into two groups: occupational health and safety (OHS) and infection prevention and control (IPC). Here, participants were similarly asked: "Think about the working conditions of health workers in your country, jurisdiction or health facility....rate the level of application of these measures according to your knowledge of the real situation now during the COVID-19 pandemic."

Patient and Public Involvement

The participation of health workers (whose wellbeing is the focus for this study in relation to their assessment of the adequacy of measures to protect them) was indirectly included through the participation of their representatives (unions within the ILO and other professional bodies) who were directly involved in the creation of the research instrument and in the dissemination of the online survey and its initial results.

Study population and inclusion criteria

Participants were recruited by convenience sampling, with dissemination through a large array of professional networks and social media. The survey, self-administered online to enable rapid low-cost recruitment, was available in Arabic, Chinese, English, French, German, Italian, Portuguese, Russian, Spanish and Swahili. A range of HCWs and stakeholders involved with healthcare delivery were invited to participate. In addition to HCWs in direct patient care in both formal and informal settings and in public and private facilities, respondents also included allied health and supporting staff, including OHS and IPC professionals, administration, management, drivers, public health workers, community health workers, and others as defined by the International Standard Classification of Occupations (ISCO-08). Data collection occurred between May 5th and June 25th, 2020. Participant results were excluded if they failed to complete demographic questions or if they failed to provide any responses to the risk and mitigation questions. As the survey was designed to be completed and submitted anonymously, no formal request for signed consent was solicited, with participants' submission itself indicating consent to use the information provided as anonymized aggregated data. The study proposal was approved by the Behavioural Research Ethics Board of the University of British Columbia (Ref. H20-01825). This work was supported by the International Development Research Centre (IDRC) under grant M20-00559 and the Canadian Institutes of Health Research (CIHR) under grant VS1-175519 for the "Protecting healthcare workers from COVID-19: a comparative contextualized analysis" research programme.

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Demographic information for individual survey respondents was collected on country, gender, and occupation – the latter separated into 13 categories and then grouped into patient care/health services; specialized technical support; clerical support/administration and management; and other. Details about the study sample population composition and demographic characteristics of participants are presented in Figure S1 and Table S1 respectively.

Our research group, drawn from two WHO Collaborating Centres participating in the survey process, conducted the analysis by consolidating respondents by their home country and then linking this to a WHO geographic region [26]; a comparative country-level economic classification by World Bank income groups based on the annual Atlas gross national income per capita estimates [26,27]; and the country's Gini index - a measure used for the analysis of income inequality present within a country, with a score of 0 representing perfect equality, and a score of 1 representing complete inequality [28]. Data for Gini and economic classification were taken from the World Bank, using the most recent data available. To take account of the variation across regions present during the initial phase of the pandemic, we also considered COVID-19 incidence per million (logarithmic scale) in each country at the time when the survey was completed, as an indicator of the intensity as of a particular date, using values for June 2020 drawn from the "Our World in Data" database [29].

Dependent variables

Acceptability of workplace risks and adequacy of mitigation measures – the dependent variables in this study – were derived from a factor analysis of individual survey responses, then

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aggregated to enable subsequent analysis of the effect of country-level characteristics. Factor analysis [16] was used to reduce the 41 survey questions into coherent groupings and principal component analysis with varimax rotation carried out to create factors from each set of workplace health and safety risk exposure questions (corresponding to workplace risk and workplace organization acceptability) and mitigation measure questions (corresponding to IPC and OHS adequacy); Table S2 summarizes the subject matter covered by the questions consolidated in each factor. Separate factor analyses were run on risk questions and preventive measure questions. Missing values were excluded in a listwise fashion. The rotated component matrix was used to identify factors. To measure scale reliability, Cronbach's Alpha was used for each individual factor. Scores over 0.7 are considered to be acceptable for internal consistency [30]. The results from the factor analysis are outlined further in our preliminary analysis [16].

The questions were administered as a 3-point Likert scale, then converted to a 10-point scale for clearer communication (i.e. midpoint of 2 becoming 5). Numerical scores were assigned to each answer to establish a scale for both the risk and mitigation measure factors, with higher scores corresponding to more desirable states. For health and safety risks, a score of 0 was assigned to "risk is not acceptable at all"; 5 to "risk is acceptable for a short time"; and 10 for "risk is negligible". For mitigation measures, a score of 0 was assigned to "does not exist at all"; 5 to "exists and offers some protection"; and 10 to "exists and offers full protection". Responses of "don't know/unsure" were assigned blanks. Factor scores were then calculated to form an individual respondent's factor score for each of the four groupings, i.e., work environment risk acceptability, work organization risk acceptability, OHS adequacy and IPC adequacy and then aggregated to generate a mean value for each country's respondents, so that inter-country

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Analysis

The mean country dependent variable factor scores derived from the aggregation of individual participants' responses served as the basis for considering associations by WHO region, economic classification, Gini coefficients and COVID-19 incidence. Comparisons of survey mean scores were carried out using ANOVA analysis, with an alpha of 0.05 used to test significance. To compare means for the continuous variable Gini coefficient and COVID incidence scores, we ordinally divided groups of countries into quartiles by values.

To ensure that intercountry variation was not purely explained by possible gender and occupational compositional differences among a particular country's respondents, we carefully examined possible sources of discrepancy (Table S3), using ANOVA analysis to consider effects that could complicate the cross-country comparison of all respondents. To minimize any such effect, we considered different ways to stratify our analysis of the study population, notably by focusing only on those populations that had the most direct workplace experience to personally being "at risk". Noting the presence of gender differences among patient care deliverers, we specifically isolated female respondents, who in fact constituted the largest demographic group of respondents in the study, representing 1,998 respondents from 112 countries (n=1,968 from 112 countries), the largest sub-population.

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Finally, to measure the effect that the interaction of independent variables had on the likelihood of workplace risks being considered as acceptable in a country setting as COVID was emerging, and workplace protection and control measures being deemed as adequate, we created and applied a logistic regression model. Preferred outcomes for this analysis were assessed as mean factor scores ≥ 5 , corresponding to assessments that mitigation "exists and offers some protection" or better; or "risk is acceptable for a short time" or better. All statistical analysis was done using R and SPSS Statistics software [31,32].

RESULTS Overall study population and survey responses

There were 4,977 participants who responded to health and safety risk questions and a subset of 4,076 (81.2%) who answered mitigation measure questions. The majority of study participants were female (65%), reflecting the make-up of the health sector workforce. Most participants were from the European region (35%), followed by the Americas (31%), the Western Pacific region (15%) and Africa (10%); the South East Asian (4%) and Eastern Mediterranean regions (3%) made up the smallest proportion of participants. In total there were 161 countries represented in the survey. Portugal (n=549, 11%), US (n=451, 9%), Brazil (n=373, 7%), Canada (n=263, 5%), and China (n=233, 5%) had the most participants. The majority of respondents were from countries of high-economic classification (59%), followed by upper-middle (27%), lower middle (10%) and low (4%). Most survey participants worked for a health services employer (61%), followed by government services (15%) and businesses and farms (10%). Those working in academia, professional associations, international organizations and non-government organizations each encompassed less than 10%. Finally, the type of occupation was predominantly patient care/health (56%) services, followed by 29% providing technical services

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such as IPC or OHS specialists, 7% in administration and 10% identified as working in other sectors (Table S1).

The largest percentage of countries were in Europe (30%) and over a third of all countries were high-income countries (35%). The average Gini index was 37.8 (SD=7.7) and the mean and median COVID-19 incidence rate per million was 1,360 and 278, respectively at the time the survey was conducted.

Table 1 illustrates that considerable variation exists in these variables across the different WHO regions, indicating the distinct characteristics and conditions present at the onset of the pandemic. It is especially noteworthy that case levels had been far greater in high-income country areas at the survey mid-point (June 1st, 2020). For example, the cases per million was 2,525 in Europe versus 119 in Africa; 5,408 in the United States; and only 138 in India and 97 in Indonesia.

	Number		Countries by income classification*					Study Population characteristics		
Region	of		T	T		Inequality	COVID	Gender	Occupation	
	countries	High	Upper- middle	Lower- middle	Low	Gini coefficient*	cases per million ^{a,*}	Female* (%)	Frontline Patient care* (%)	
Overall	161	57	42	36	26	37.8	1,360	65.5%	56.4%	
AFRO	37	0	6	12	19	43.2	119	44.8%	52.1%	
EMRO	20	6	3	7	4	35.2	2,407	39.8%	29.4%	
EURO	48	32	13	2	1	31.8	2,525	68.2%	64.4%	
РАНО	30	11	14	4	1	44.8	1,135	73.3%	46.5%	
SEARO	9	0	2	6	1	35.0	86	36.7%	56.3%	
WPRO	17	8	4	5	0	37.0	512	70.7%	68.8%	

Table 1: Country characteristics of different WHO regions

Abbreviations: AFRO: Africa; EMRO: Eastern Mediterranean; EURO: Europe; p: p-values; PAHO: Americas; SEARO: South-East Asian; WPRO: Western Pacific

Note: * p <0.001, a: COVID rates as of June 2020.

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As summarized in Table 2 (full table in appendix Table S4), the majority of respondents designated most of the health and safety risk parameters as "not acceptable at all". Circumstances most reported as such included bullying or psychological harassment in the workplace (54%), physical violence and assaults (54%), exposure to blood, bodily fluids, and other infectious materials (52%), inadequate sanitation facilities (52%), and sexual harassment (50%). In contrast, areas such as time pressure and high workload (38%), skin damage from PPE (33%) and shift work with night shifts (23%) were deemed to be less of a concern. There were no risk categories in which the most common response was "risk is negligible".

Mitigation measures related to the above areas of concern were seen as particularly lacking, with only the category of "policies for facilities for hand hygiene" designated as "exists and offers full protection" (full tables in appendix Table S5). For example, despite psychosocial-related risks, including bullying, harassment, physical violence, and sexual harassment ranked consistently high (54%, 54%, 50% respectively), only 21% indicated that corresponding policies "exist and offer full protection", with similar dissatisfaction for the adequacy of mitigation measures for other key areas such as IPC policy (28%), availability of PPE (34%) as well as training and education of workers about OHS (21%) and IPC (32%). Only in two mitigation measures areas – availability of facilities for hand hygiene, and policies for post-exposure prophylaxis (such as HIV or hepatitis B) – did most participants indicate that measures existed and offered full protection (54% and 42%, respectively). These results show an overwhelming majority of participants indicating that the risks they faced were not acceptable at all and that very few of the corresponding mitigation measures offered adequate protection to HCWs.

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Table 2: Risk acceptability and mitigation adequacy – selected worldwide survey responses

Risk acceptability	Risk is not acceptable at all	Risk is acceptable for a short time	Risk is negligible	Don't know/unsure
Infectious risk work environment				
Exposure to blood, body fluids, respiratory secretions, other potentially infectious materials	52%	29%	15%	4%
Inadequate sanitation facilities	52%	21%	23%	4%
Skin damage from personal protective equipment and/or frequent hand hygiene	33%	46%	16%	5%
Physical work environment				
Crowded workplace	42%	36%	18%	4%
Thermal discomfort (cold, heat, humidity)	25%	46%	24%	5%
Psychosocial work environment	•			
Bullying or psychological harassment	54%	18%	21%	7%
Sexual harassment	50%	10%	31%	9%
Work organization				
Time pressure, high workload	38%	49%	10%	3%
Shift work with night shifts	23%	48%	21%	8%

Mitigation measure adequacy	Does not exist at all	Exists and offers some protection	Exists and offers full protection	Don't know/ unsure
Infection prevention and control		D _		
IPC policy in the health facility	8%	60%	28%	4%
Personal protective equipment, e.g. masks, gloves, goggles, gowns are readily available	8%	55%	34%	3%
Training and education of workers about infection prevention and control	11%	54%	32%	3%
Facilities for hand hygiene (hand washing and disinfection) are readily available	3%	40%	54%	3%
Occupational health and safety				
Occupational health and safety policy and management system in the facility	14%	58%	22%	6%
Regular assessment of workplace health and safety risks and controls	22%	51%	21%	6%
Engineering controls, such as ventilation, physical barriers, safer devices	19%	54%	19%	8%
Prevention of workplace violence and security measures	21%	52%	21%	6%
Workplace policies against bullying, psychological and sexual harassment	27%	43%	21%	9%

Note: Most cited response highlighted in bold

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Associations with risk exposure acceptability and mitigation measure adequacy

Unacceptable levels of *risk* (i.e., factor scores below 5) were consistently reported for both Work Organization and Work Environment across geographic regions, economic income level categories, equity classifications and COVID-19 incidence rates, with no statistically significant differences observed within these categories (Table 3). However, we observed multiple significant differences in how the adequacy of OHS and especially IPC (overall mean of 4.67) *mitigation measures* were perceived. These apparent associations, observed to be present for all the explanatory factors we examined, drew attention to the need to consider the adjusted effect of each independent variable through the logistic regression analysis that we subsequently e lo_b. conducted.

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]	Risk acc	eptability		N	litigatior	n adequa	ıcy
Evaluation		Work environment		Work organization		IPC		OHS	
Explanatory Variable		mean	р	mean	р	mean	р	mean	Р
TOTAL	By country means	4.23		4.29		4.67		6.08	
	By individuals	3.88		3.87		4.79		6.28	
Region	AFRO	4.11	0.34	4.17	0.30	3.68	<0.01*	5.31	0.03*
	EMRO	4.01		4.25		5.02		6.33	
	EURO	4.47		4.24		5.28		6.54	
	РАНО	4.03		3.99		4.24		5.92	
	SEARO	3.44		4.76		5.11		6.30	
	WPRO	4.83		5.03		5.24		6.35	
Economic Classification	High	4.51	0.24	4.62	0.15	5.61	<0.01*	6.99	<0.01*
	Upper-middle	4.05		4.05		4.85		6.17	
	Lower-middle	3.78		4.05		3.58		5.15	
	Low	4.51		4.27		3.88		5.29	
Gini coefficient	Q1 [lowest]	4.80	0.11	4.51	0.34	5.26	0.01*	6.64	0.04
	Q2	4.10		4.29		4.31		5.81	
	Q3	3.90		4.04		4.72		6.20	
	Q4	3.98		3.80		3.89		5.55	
COVID-19 incidence rate	Q1 [lowest]	3.95	0.50	4.09	0.84	4.17	<0.01*	5.64	0.07
	Q2	4.18		4.25		4.39		5.95	
	Q3	4.50		4.39		4.66		6.10	
	Q4	4.19		4.16		5.44		6.62	

Table 3:Unadjusted risk acceptability and Mitigation adequacy associations

Abbreviations: AFRO: Africa; EMRO: Eastern Mediterranean; EURO: Europe; IPC: Infection protection and control; OHS: Occupational health and safety; p: p-values; PAHO: Americas; SEARO: South-East Asian; Q: Quartile; WPRO: Western Pacific

* Indicates statistical significance (p<0.05) of differences among the means of country mean values for category; significant values in bold

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To understand potential sources of difference that could be attributed to heterogeneous composition of country responses that is encountered in conducting a cross-country comparison such as the one we conducted. Table 4 presents a summary of the survey's individual level data to indicate how gender and occupation were associated with respondent perceptions of acceptability and adequacy. Females were somewhat more likely than males to report workplace risks being unacceptable (3.76 versus 4.11; p < 0.001), but the strong presence of frontline patient care providers in the gendered health workforce was largely responsible for this, as no statistically significant differences were observed within other occupation groupings (see Table S3). In fact, patient care providers themselves stood out as being the occupational grouping most critical of workplace risk acceptability as well as OHS and IPC measure adequacy. In contrast, male administrators/managers stood out as the most likely to indicate that acceptable risk exposure and adequate risk mitigation measures were present. This discrepancy is understandable as frontline workers, and women in this occupation grouping, represent those most directly experiencing the impact of the COVID pandemic. However, even in these more extreme circumstances where differences were observed, the comparative differences in mean scores (that were then aggregated in calculating country mean values) were not large. Moreover, the fact that the African region, where strongest concerns about unacceptable risk and inadequate mitigation were expressed, actually had proportionately fewer female respondents, indicates that even these regional concerns that we observed may well have been underrepresented in this unadjusted analysis.

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Table 4: Risk acceptability and mitigation adequacy associations ^a with gender and occupation

				Risk acc	eptability	y	Ν	litigation	adequacy	y
				/ork onment		ork ization	П	PC	OI	IS
Explanato	ry Variable	$\mathbf{n}^{\mathbf{d}}$	mean	р	mean	Р	mean	р	mean	Р
Gender ^b	Total	4863	3.88	<0.01*	3.87	0.40	4.79	0.09	6.28	0.07
	Female	3220	3.76		3.85		4.74		6.33	
	Male	1643	4.11		3.92		4.88		6.19	
		Þ								
Occupation ^c	Total	4916	3.88	0.04	3.87	0.10	4.79	<0.01*	6.28	0.19
	Patient Care	2792	3.91		3.88		4.63		6.27	
	Specialist	1404	3.84		3.80		4.90		6.30	
	Admin-Mgr	327	4.14		4.22		5.50		6.50	
	Other	393	3.55		3.82		5.03		6.08	

* Indicates statistical significance (p<0.05); significant values in bold

^a This table report on total respondents in each category, without any consideration for different mixes of gender within different occupations, and different mixes of occupation within genders; Supplementary table X provides results with full occupation and gender breakdowns

^b Only respondents indicating Male or Female were included in exploring differences;

^c Occupation was initially coded with finer detail but then consolidated in these composites for comparative analysis ^d total n varies by specific factor; this column refers to n for workplace environment, where response was greatest Abbreviations: IPC: Infection protection and control; Mgr: Manager ; OHS: Occupational health and safety

Influence of between-country and within-country income disparity

Table 5 summarizes the adjusted comparative effects of income level and income distribution disparity in each country setting while taking into consideration potential influences prompted by differing COVID-19 rates in the initial phase of the pandemic. While there was no difference between *higher and lower income countries* regarding the perception of unacceptable levels of *risks* in healthcare workplaces in all settings, *within-country inequality* was associated with a mildly increased likelihood of *unacceptable levels of risk* with regard to both workplace environment (OR=0.92; p=0.012) and workplace organizational (OR=0.93; p=0.017) factors.

riuj	usted m	ultivariable m	odel ^d
\$	OR ^d	95% CI	Р
15	1.24	0.70-2.20	0.708
13 187	0.92	0.70-2.20 0.89-0.95	0.708
83	1.09	0.78-1.51	0.801
	,		
641	0.71	0.42-1.21	0.52
76	0.93	0.90-0.96	0.017*
13	0.89	0.66-1.21	0.710
89	6.61	3.68-11.88	0.001*
36	0.94	0.91-0.96	0.025*
)64	0.76	0.55-1.03	0.373
89	10.91	5.63-21.12	<0.001*
009	0.99 1.08	0.96-1.02	0.779
70		0.77-1.52	0.816 < 05 ** <
79 CI		e Inferval * n	05
CI:	Confidenc	te Interval, * p: n; IPC: Infection	Preventior
CI: g.: or	Confidence ganization	ı; IPC: Infection	Preventior
CI: g.: or	Confidence ganization	e Interval, * p : n; IPC: Infection ow and Lower-N	Preventior
CI: g.: or tries varia	Confidence ganization versus "L ble;	ı; IPC: Infection	Preventior Aiddle Inco
CI: g.: or tries varia ; of th mea	Confidence ganization versus "L ble; te survey of n score \geq	n; IPC: Infection ow and Lower-N (taken June 1, 20 5 corresponding	Preventior Aiddle Inco 20); log va to assessm
CI: g.: or tries varia ; of th mea	Confidence ganization versus "L ble; te survey of n score \geq	n; IPC: Infection ow and Lower-N (taken June 1, 20	Preventior Aiddle Inco 20); log va to assessm
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CI: g.: or tries varia ; of th mea	Confidence ganization versus "L ble; te survey of n score \geq	n; IPC: Infection ow and Lower-N (taken June 1, 20 5 corresponding	Preventior Aiddle Inco (20); log va to assessm
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CI: g.: or tries varia g of th mea ssed	Confidence ganization versus "L ble; ne survey of n score \geq as "risk is stronge	a; IPC: Infection ow and Lower-N (taken June 1, 20 5 corresponding acceptable for a er divergence	Preventior Aiddle Inco (20); log va to assessm a short time e in
CI: g.: or tries varia g of th mea ssed	Confidence ganization versus "L ble; ne survey of n score \geq as "risk is stronge	n; IPC: Infection ow and Lower-M (taken June 1, 20 5 corresponding acceptable for a	Preventior Aiddle Inco (20); log va to assessm a short time e in
CI: g.: or tries varia g of th mea sssed uch	Confidence ganization versus "L ble; he survey of n score \geq as "risk is stronge <i>ome lev</i>	a; IPC: Infection ow and Lower-N (taken June 1, 20 5 corresponding acceptable for a er divergence	Preventior Aiddle Inco (20); log va to assessm a short time e in ne

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Unadjusted bivariate

UI	nadjusted biv	ariate	Adjusted multivariable model ^a				
O R ^d	95% CI	р	В	OR ^d	95% CI	Р	
1.56	1.08-2.27	0.231	0.215	1.24	0.70-2.20	0.708	
0.91	0.88-0.94	0.005*	-0.087	0.92	0.89-0.95	0.012*	
1.01	0.83-1.23	0.965	0.083	1.09	0.78-1.51	0.801	
0.83	0.59-1.17	0.587	-0.341	0.71	0.42-1.21	0.52	
0.94	0.91-0.97	0.028*	-0.076	0.93	0.90-0.96	0.017*	
0.8	0.67-0.97	0.243	-0.113	0.89	0.66-1.21	0.710	
6.8	1.36-34.60	0.006*	1.889	6.61	3.68-11.88	0.001*	
0.93	0.90-0.95	0.006*	-0.036	0.94	0.91-0.96	0.025*	
1.85	1.51-2.26	0.002*	-0.064	0.76	0.55-1.03	0.373	
		4					
8.91	5.76-13.80	<0.001*	2.389	10.91	5.63-21.12	<0.001*	
0.97	0.94-0.99	0.183	-0.009	0.99	0.96-1.02	0.779	
0.94	0.91-0.97	0.028*	0.079	1.08	0.77-1.52	0.816	
	OR ^d 1.56 0.91 1.01 0.83 0.94 0.8 6.8 0.93 1.85 8.91 0.97	J J OR ^d 95% CI 1.56 1.08-2.27 0.91 0.88-0.94 1.01 0.83-1.23 0.83 0.59-1.17 0.94 0.91-0.97 0.8 0.67-0.97 6.8 1.36-34.60 0.93 0.90-0.95 1.85 1.51-2.26 8.91 5.76-13.80 0.97 0.94-0.99	1.56 1.08-2.27 0.231 0.91 0.88-0.94 0.005* 1.01 0.83-1.23 0.965 0.83 0.59-1.17 0.587 0.94 0.91-0.97 0.028* 0.8 0.67-0.97 0.243 6.8 1.36-34.60 0.006* 0.93 0.90-0.95 0.006* 1.85 1.51-2.26 0.002* 8.91 5.76-13.80 <0.001*	ORd 95% CI p B 1.56 1.08-2.27 0.231 0.215 0.91 0.88-0.94 0.005* -0.087 1.01 0.83-1.23 0.965 0.083 0.83 0.59-1.17 0.587 -0.341 0.94 0.91-0.97 0.028* -0.076 0.8 0.67-0.97 0.243 -0.113 6.8 1.36-34.60 0.006* 1.889 0.93 0.90-0.95 0.006* -0.036 1.85 1.51-2.26 0.002* -0.064 8.91 5.76-13.80 <0.001*	ORd 95% CI p B ORd 1.56 1.08-2.27 0.231 0.215 1.24 0.91 0.88-0.94 0.005* -0.087 0.92 1.01 0.83-1.23 0.965 0.083 1.09 0.83 0.59-1.17 0.587 -0.341 0.71 0.94 0.91-0.97 0.028* -0.076 0.93 0.8 0.67-0.97 0.243 -0.113 0.89 6.8 1.36-34.60 0.006* 1.889 6.61 0.93 0.90-0.95 0.006* -0.036 0.94 1.85 1.51-2.26 0.002* -0.064 0.76 8.91 5.76-13.80 <0.001*	OR ^d 95% CI p B OR ^d 95% CI 1.56 1.08-2.27 0.231 0.215 1.24 0.70-2.20 0.91 0.88-0.94 0.005* -0.087 0.92 0.89-0.95 1.01 0.83-1.23 0.965 0.083 1.09 0.78-1.51 0.83 0.59-1.17 0.587 -0.341 0.71 0.42-1.21 0.94 0.91-0.97 0.028* -0.076 0.93 0.90-0.96 0.8 0.67-0.97 0.243 -0.113 0.89 0.66-1.21 6.8 1.36-34.60 0.006* 1.889 6.61 3.68-11.88 0.93 0.90-0.95 0.006* -0.036 0.94 0.91-0.96 1.85 1.51-2.26 0.002* -0.064 0.76 0.55-1.03 8.91 5.76-13.80 <0.001*	

Notes: OR: Odds Ratio, expressed as Exp(B) value in Logistic Regression analysis, CI: Confidence Interval, * $p \le .05$ ** <001 Abbreviations: B: Coefficient; OHS: Occupational Health and Safety mitigation; Org.: organization; IPC: Infection Prevention and control; Enviro.: environmental; WP: workplace

Variables where statistical significance is present are shown in bold

^a Country Income was coded as comparing "High and Upper-Middle Income" countries versus "Low and Lower-Middle Income" countries

^b Gini coefficient was considered in the logistic regression analysis as a continuous variable;

^c COVID levels where the log value of the rate of cases per million at the beginning of the survey (taken June 1, 2020); log values to smooth very high levels while taking variation into account

^d Odds Ratios were calculated by assessing the likelihood (OR) of the presence of a mean score \geq 5 corresponding to assessments that mitigation "exists and offers some protection" or better; or level of risk is assessed as "risk is acceptable for a short time" or better.

* Indicates statistical significance (p<0.05); also bolded

As was observed in unadjusted bivariate analyses, there was much stronger divergence in

perceptions of acceptable mitigation measures by both country income level and income

inequality, with an almost 7-fold greater likelihood of IPC measures (OR=6.61; p=0.001) being

considered adequate in wealthier countries, and over a ten-fold difference in adequacy of OHS

measures (OR=10.91; p<0.001), despite the greater intensity of COVID-19 in wealthier countries at the time of the survey. In fact, the counter-intuitive positive association that seemed to be present between intensity of COVID-19 and perceptions of adequacy disappeared in our adjusted multivariable analysis. And further to the observed unadjusted effect, higher inequality decreased the likelihood (OR=0.94; p=0.025) of deeming IPC measures to be adequate.

Analysis of the more homogeneously constituted population of female patient care provider respondents (Table S6) further revealed that this group's more critical assessment of risk that we had documented in Table 4 especially influenced perceptions of risk acceptability in settings where COVID-19 exposure had intensified. In this regard, workplace organizational factors, which included consideration of the workload being encountered, were substantially more likely to be seen as unacceptable (OR=0.44; p=0.034) by female patient care providers in countries with higher COVID presence; a perception reinforced by a further (albeit less pronounced) effect of in-country income inequality (OR=0.95; p=0.093).

As we had observed was the case for all respondents, female care providers in higher income countries were more likely to perceive mitigation measures to be adequate (OHS OR=3.94; p=0.047 and IPC OR=11.25; p=0.004) than those in more poorly resourced settings, and this was further accompanied by an effect of within-country inequality also contributing some explanatory power (OHS OR=0.92; p=0.020).

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DISCUSSION

High levels of concern about emerging threats to HCWs were widely published in the first year of the COVID-19 pandemic, providing extensive evidence about morbidity and mortality associated with healthcare work [33–35] as well as effects on job satisfaction [36]. Although meta-analyses have been conducted to synthesize such findings [37], our article provides one of the first worldwide examinations of contextual factors affecting the wellbeing of HCWs during the COVID-19 pandemic, enabling a comparative cross-country analysis. In doing so, it notably complements studies calling attention to inadequate implementation of OHS and IPC measures, for example in South Africa [38] as well as a need to consider the influence of structural determinants that affect how risks are experienced in specific health worker exposure contexts [39]. The results presented here contribute a theoretical and empirically-based understanding of the importance of inequality among and within countries in this regard. This has implications for preparedness for any future pandemic outbreaks.

Our findings clearly demonstrate that there is a strong need for improvements in OHS for HCWs not only to protect against infectious disease transmission but to also control the threat of psychosocial risks, a consideration that resonates with studies highlighting effects on mental health of HCWs as already stressed workplaces with intensifying pressures when pandemics emerge [40–44]. Widespread concerns about health risks identified in diverse locations such as Ethiopia, Turkey, Italy and Spain in many facets of health work [45–48] signal a strong rationale for international collaboration in seeking effective technical and policy approaches to best protect HCWs.

Despite a common assessment of unacceptable levels of risk everywhere, our study revealed important differences in the perceived adequacy of protective measures to meet this challenge. Such results point to the need to add explicit attention to OHS measures in the World Health Organization's call for better planning healthcare human resources [10] as well as the updating of the WHO's *Global Plan of Action for Occupational Health*, considering what this means for HCWs in light of the COVID-19 experience.

While the case prevalence in any one single country clearly influences the intensity of possible healthcare workplace exposure as a global pandemic emerges, HCWs in all countries face the same need for proper PPE, appropriate testing and vaccines as they compete in the same markets and the same supply chains [49,50]. While there is now appropriate attention focused on the need to address global inequities in vaccine accessibility [51], our study highlights other inequities that also need greater attention. Moreover, our analysis stands out by considering how variation in protecting HCWs may be associated with the presence of contextual social and economic inequities, itself an important social determinant of health that has been prominent in global health research literature. What is of particular relevance here is the vulnerability of HCWs as "canaries" in a workplace made vulnerable by the emergence of a novel infectious disease [52], where preparedness to meet a new challenge is critical.

While the presence of unacceptable risk was clearly identified in all countries, it was striking that the strongest concern about inadequate protection of HCWs came not from the HICs hit most intensely by the initial wave of COVID in early 2020, but rather less well-resourced settings that had yet to be as strongly affected. This vividly echoes pre-COVID findings that resource-poor BMJ Open: first published as 10.1136/bmjopen-2022-064804 on 5 October 2022. Downloaded from http://bmjopen.bmj.com/ on April 23, 2024 by guest. Protected by copyright

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countries have decreased capacities for protecting HCWs [13,14] even beyond needs for testing and contact tracing, and consistent with studies noting needs for training and PPE for HCWs [53]. This furthermore mirrors experience in previous pandemics such as Ebola in West Africa where meaningful investments in PPE were shown to be important elements in combatting the spread of disease [54], a matter that is now being observed with regard to COVID-19 [55]. Our finding that country income level is strongly associated with greater capacity to provide prevention and mitigation within a health system is thus not surprising.

Previous literature on the effects of income inequality within a society has however been less conclusive, at times contesting the implications of the Wilkinson's "economic inequality hypothesis". In this regard, Blázquez-Fernández and colleagues concluded that income inequality does not significantly reduce health in 'developed' societies [56] and Mellor and Milyo further argued that there is little support for relation between income inequality and individual or population health after fixed division effects were included [57]. However, when attention is paid to methodological concerns [17], strong evidence of the effect of economic inequality has been observed in Sub-Saharan African countries [58]. Looking beyond levels of economic indicators alone, a systematic study of "welfare regimes" (i.e. characterizations of policy orientations dominant in a country at a particular time) has suggested that precarious workers fare better in the context of "Scandinavian state" policies [59]. Indeed countries that recognized COVID-19 as a work-related disease and supported workers with compensation and appropriate absence policies, were reported to have reduced mental health stressors, pointing to opportunities for improving HCW well-being [60]. However, a systematic review of the impact

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of political economy on health observed substantial gaps in knowledge, calling for "higherquality reviews and empirical studies in this area" [61].

Our study suggests that societies marked by higher degrees of equality may be drawn to reinforcing policies that are more protective of vulnerable populations. As health worker protection is so strategically important to health system functioning in times of emerging pandemics, countries known to be highly unequal might accordingly be considered to be in need of even further technical assistance and attention to ensure that there is adequate protection. The evidence we observed that there is a positive association between levels of national inequality and the degree to which HCWs are protected from risk thus also draws attention to the need for better appreciation of the pathways that can explain this, as there is an iterative relationship between the presence of inequalities and the policy regimes that influence the reinforcement or remediation of how further effects are reproduced, for example as expressed in the conditions whereby marginalized groups of workers may encounter risks when a new threat such as a pandemic emerges.

As appreciation of the contribution of HCWs soared as the COVID pandemic advanced, our observations that economic inequality among and within countries is associated with the degree to which HCWs face unacceptable risk and inadequate protection signals a vital need to promote social justice for those who play such an important role in the care of populations *before* a new pandemic emerges. In light of this, from an analytical perspective, we strongly endorse the call for a new paradigm [62] to better understand how upstream and socio-political factors could be "affecting the nature of work and employment and their impact on the health of workers, the

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public, and the planet" [63]. This includes consideration of international cooperation not only with respect to vaccine supply, but also to ensure that less wealthy countries receive technical assistance in establishing protection and mitigation programs as well as attention to pathways sensitive to the offloading of risks to more marginalized worker populations.

Limitations and further research needs

Cross-country comparative studies such ours rely on a convenience sample, leading to some countries being over-represented while others were under-represented or non-existent. To address possible concerns about the influence of countries with low respondent counts, we examined this concern by conducting sensitivity analyses, summarized in Table S7, to consider possible implications, but concluded that this did not warrant a questioning of our findings. Additionally, the classification of countries purely by national income levels leads to designating some countries as high income in settings where national institutions may be minimally developed despite high levels of income earned through high value exports such as petroleum or in settings of small populations with externally controlled tourism sectors. As such, we developed grouping strategies to allow for a consideration of national contexts where resources could be considered comparatively more or less readily available to protect health workers. Stratification by WHO region was also important because these regions, while large and often heterogenous in nature, do constitute administrative units with an important governance role to play during the emergence of global outbreaks and pandemics.

It should also be acknowledged that differing perceptions of risks and mitigation measures around the world may be influenced by different HCW training and education standards, cultural nuances, and institutional expectations. For example, Senthi and colleagues observed that

workers in India found a high prevalence of workers unable to identify even immediate risks in an evidently hazardous environment [64]. Studies in the Middle East also reported gaps between actual hazards and HCW recognition [65,66]. Ndejjo and colleagues report similar findings in Uganda and across sub-Saharan Africa [67].

CONCLUSION

This study adds to the literature on how risks become unevenly distributed, focusing here on country income level but also on within-country income inequality. As noted by Gostin et al., 2020 [68], the WHO has an important role in supporting LMICs with technical guidance and operational assistance, while simultaneously meeting the needs of high-income countries for information sharing, research coordination, and convening authorities, despite lacking both the authority and the resources to mount a more effective response to a global emergency such as this. Our study strongly suggests that international agencies with mandates related to fair trading practices and economic aid have to step up to address the disparities that threaten the healthcare workforce, and ensure that there is sufficient resilience to retain health workers needed for broader delivery of health services. It is also a matter of social justice that they do so.

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Contributors SH, AY and JS conceptualised the research. AY and MZ participated in preparation of the original survey and its use. SH prepared the data and conducted the initial analysis. SH and JMS conducted subsequent data analyses and data interpretation. VLT conducted literature reviews. SH wrote the initial manuscript draft. SH, AY, VT, MZ and JMS reviewed and edited the manuscript. AY and JMS accept full responsibility for the finished work and/or the conduct of the study as guarantors, had access to the data, and controlled the decision to publish. All authors read and approved the final manuscript.

Competing interests None declared.

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Data availability statement Data are available in the Dryad data depository and are also available from the corresponding author.

Patient consent for publication Not required.

Ethics approval This study involves human participants and was approved by the Behavioural Research Ethics Board of the University of British Columbia (Ref. H20-01825) As the survey was designed to be completed and submitted anonymously, no formal request for signed consent was solicited, with participants' submission itself indicating consent to use the information provided as anonymized aggregated data.

APPENDIX

Study questionnaire. (Taken from Report on preliminary findings – ref 14.) (Pdf)

ONLINE SUPPLEMENTAL MATERIAL

SI Dataset. Data underlying the results of the study. (Excel Data file (XLS). – to be provided through Dryad data depository

- SI Figure. All supplemental figures.
 - Figure S1 Study Population diagram (pdf)
- SI Table. All supplemental tables. (pdf)
 - Table S1 Study population demographics
 - Table S2 Summary of factors and their constituent question areas
 - Table S3 Variation in factor scores by gender and occupation
 - Table S4 Responses to health and safety risk questions
 - Table S5 Responses to mitigation measure questions
 - Table S6 Factors associated with female patient care providers perceived risk acceptability and mitigation adequacy
 - Table S7 Sensitivity analysis considering minimum sample size for calculating country mean values

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Appendices

Survey instrument

Health and safety of health workers in COVID-19 Welcome to the survey on health and safety of health workers in COVID-19 Dear colleague,

This survey aims to identify the most common occupational risks for the health and safety of health workers and the measures for their prevention in the context of the ongoing pandemic of Corona Virus Infectious Disease (COVID-19).

In this survey we are interested in the health and safety of all health workers - all people engaged in the promotion, protection or improvement of the health of the population. This includes health workers involved in direct patient care, both formal and informal, in public and private facilities, including traditional medicine, as well as other assisting and supporting staff, including administration, management, ambulance drivers, public health workers, community health workers, and others.

The survey is intended for health workers, managers, and practitioners providing services for protecting the health and safety of workers in health facilities. The results will be used to inform action at all levels for improving the protection of health and safety of health workers in the ongoing response to COVID-19.

The survey has been developed by an international group of experts convened by the World Health Organization and the International Labour Organization and should take approximately 7 minutes to complete.

Your answers are completely confidential, and the data will be processed and analyzed in a way that will not link your answers to your identity.

B. About yourself and your area of work

1. In what country do you usually work? *Standard list of all countries in the world* Other (please specify)

* 2. Your gender? Male Female Other Prefer not to answer

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А	dministration and clerical support
A	llied health professional
C	ommunity health worker
In	fection prevention and control
М	lanagement and human resources
М	lental health and psychosocial support
0	ccupational and environmental health
	atient care (medicine, nursing, midwifery, entistry)
Pł	harmacy
Pι	ublic health
Sı	upport staff – cleaner, driver, food worker
0	ther
4. `	You work most of the time for: (responses below were randomized)
	You work most of the time for: (responses below were randomized) cademia, research
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C. Risks for health and safety of health workers

Think about the working conditions of health workers in your country, jurisdiction or health facility - those that you are most familiar with. No workplace is without risk, but some risks are negligible, or acceptable for a short time, and some are not acceptable at all. Below are some common risks for the health and safety of health workers; we are asking you to rate the current level of these risks, <u>now during the COVID-19 pandemic.</u>

5. How would you rate the level of these risks for health workers, now? (randomized)

. How would you rate the level of these risks for health workers, how? (randomized)						
Questions	Risk is negligible	Risk is acceptable for a short time	Risk is not acceptable at all	Don't know/Unsure		
Skin damage from personal protective equipment and/or frequent hand hygiene						
Needle-sticks and sharps injuries						
Inadequate sanitation facilities						
Insufficient access to facilities for personal hygiene, such as, shower and menstrual hygiene						
Exposure to blood, body fluids, respiratory secretions, and other potentially infectious materials						

6. How would you rate the level of these risks for health workers, now? (randomized)

Questions	Risk is negligible	Risk is acceptable for a short time	Risk is not acceptable at all	Don't know/Unsure
Back injury from manual handling of patients and heavy objects		(e		
Hazardous chemicals, drugs, cleaning and disinfection agents		.4.		
Slips, trips, and falls				
Crowded workplace			1	
Thermal discomfort (cold, heat, humidity)				

7. How would you rate the level of these risks for health workers, now? (randomized)

Questions	Risk is negligible	Risk is acceptable for a short time	Risk is not acceptable at all	Don't know/Unsure
Physical violence and assaults				
Bullying or psychological harassment at the workplace				
Sexual harassment				

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8. How would you rate the level of these risks for health workers, now? (randomized)

6. How would you rate the level of these fisks for health workers, how : (randofinzed)								
Questions	Risk is negligible	Risk is acceptable for a short time	Risk is not acceptable at all	Don't know/Unsure				
Regular long working hours (more than 48 hours a week)								
Time pressure, high workload								
Shift work with night shifts								
Insufficient time-off duty to rest (less than 11 hours between shifts)								

9. How would you rate the level of these risks for health workers, now? (randomized)

Questions	Risk is negligible	Risk is acceptable for a short time	Risk is not acceptable at all	Don't know/Unsure
Skin damage from personal protective equipment and/or frequent hand hygiene				
Needle-sticks and sharps injuries				
Inadequate sanitation facilities				
Insufficient access to facilities for personal hygiene, such as, shower and menstrual hygiene	Ľ			
Exposure to blood, body fluids, respiratory secretions, and other potentially infectious materials		2		

D. Preventive measures

There are measures for the prevention of most risks for health and safety at work, but these measures may not be fully implemented and not all workers may benefit from these measures. Think again about the working conditions of health workers in your country, jurisdiction or health facility - those that you are most familiar with. The following questions are about the preventive measures for their health and safety in the real situation, now, during the COVID-19 pandemic.

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Questions	Does not exist at all	Exists and offers some protection	Exists and offers <u>full</u> protection	Don't know/Unsure
Policy for infection prevention and control in the health facility				
Processes for triage of patient in place at the emergency room, including early detection and isolation of infectious patients				
Routine assessment of the risk of exposure to body substances or contaminated surfaces before any health care activity and use of appropriate measures for personal protection				
Regular environmental clean-up and disinfection				
Immunization of health workers				

10. How would you rate the level of application of these measures in the health services according to your knowledge? (randomized)

11. How would you rate the level of application of these measures in the health services according to your knowledge? (randomized)

Questions	Does not exist at all	Exists and offers some protection	Exists and offers <u>full</u> protection	Don't know/Unsure
Reporting of incidental exposures to blood, body fluids, or respiratory secretions		2		
Policies in place for post-exposure prophylaxis, such as, for HIV, Hepatitis B				
Facilities for hand hygiene (hand washing and disinfection) are readily available			1	
Personal protective equipment, such as masks, gloves, goggles, gowns are readily available				
Training and education of workers about infection prevention and control				

12. How would you rate the level of application of these measures in health services according to your knowledge? (randomized)

Questions	Does not exist at all	Exists and offers <u>some</u> protection	Exists and offers <u>full</u> protection	Don't know/Unsure
Prevention of workplace violence and security measures				
Management of working time, rest and recuperation				
Workplace policies against bullying, psychological and sexual harassment				
Human resource management of safe staffing and workload				
Psycho-social support and counselling				

13. How would you rate the level of application of these measures in the health services according to your knowledge? (randomized)

Questions	Does not exist at all	Exists and offers <u>some</u> protection	Exists and offers <u>full</u> protection	Don't know/Unsure
Occupational safety and health policy and management system in the facility		•		
Regular assessment of workplace health and safety risks and controls				
Engineering controls, such as ventilation, physical barriers, safer devices		1.0		
Ergonomic workplace design and furniture		4		
Devices for patient handling and lifting of loads				

14. How would you rate the level of application of these measures in the health services according to your knowledge? (randomized)

Questions	Does not exist at all	Exists and offers some protection	Exists and offers full protection	Don't know/Unsure
Regular medical check-ups of health workers				
Medical first aid kits				
Consultations between management and workers regarding health and safety at work				
Training and education of workers about occupational safety and health				
Other (please specify)	·			<u>.</u>

Group	Survey responses
Patient care/health services	Patient care (medicine, nursing, midwifery, dentistry)
	Allied health professional
	Mental health and psychosocial support
	Pharmacy
	Community health worker
Specialized support	Occupational and environmental health
	Public health
	Infection prevention and control
	Support staff - cleaner, driver, food worker
Clerical support/administration and management	Administration and clerical support
	Management and human resources

Table A 1: Survey options for occupation

Table A 2: Comparison between participants who answered risk and mitigation questions

	Variables	Those who responded to risk questions (n=4977)	Those who responded to mitigation measure questions (n=4076)
Countries by region	AFRO	10%	11%
	EMRO	4%	4%
	EURO	35%	36%
	РАНО	31%	31%
	SEARO	3%	3%
	WPRO	15%	16%
Economic Class	High	59%	60%
	Lower-middle	10%	10%
	Upper-middle	27%	10% 26% 4%
	Low	4%	4%
Sex	Male	33%	34%
	Female	65%	65%
	Other / prefer not to answer	1%	1%
Occupation	Patient care/health services	56%	58%
	Specialized support	29%	29%
	Clerical support/administration and management	7%	7%
	Other	8%	7%



Speak up for health worker safety!



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Health and safety of health workers in the context of COVID-19: A global survey

Sean P. Harrigan, Vivian W. L. Tsang, Jerry M. Spiegel, Annalee Yassi

September 15, 2020



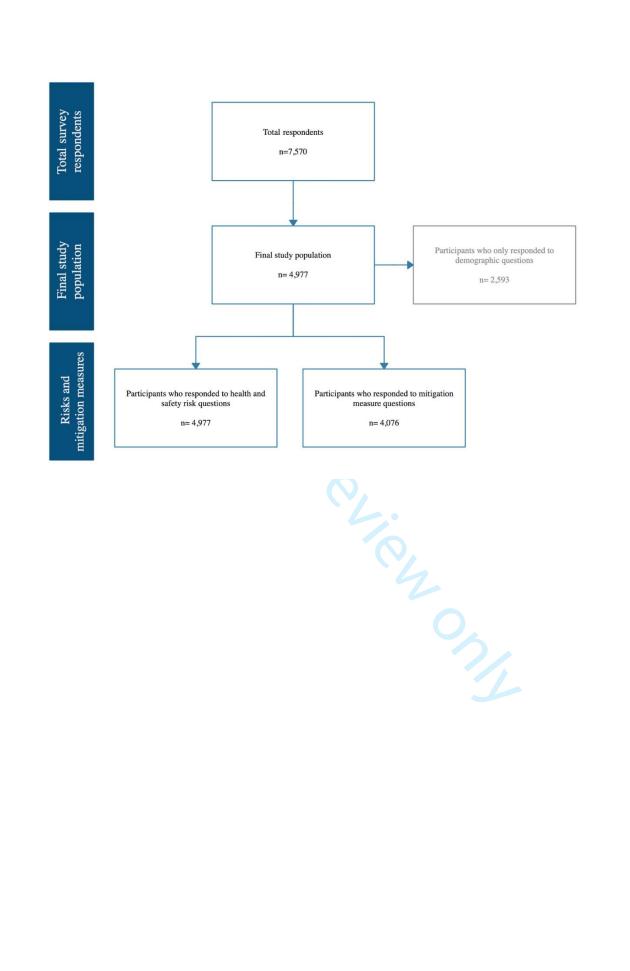
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ONLINE SUPPLEMENTARY INFORMATION

Table S1. Study population demographics

Variables		n	%
Total number of partie	cipants	4977	100%
Total who replied to the health and safety risks for health workers questions		4977	100%
Total who replied to t	he mitigation measures questions	4076	82%
Total number of coun	tries	161	100%
Countries by region	African region	516	10%
	Americas region	1565	31%
	Eastern Mediterranean region	221	4%
	European region	1757	35%
	South East Asian region	158	3%
	Western Pacific region	760	15%
Economic Class	High	2960	59%
	Lower-middle	480	10%
	Upper-middle	1324	27%
	Low	213	4%
Sex	Male	1654	33%
	Female	3259	65%
	Other / prefer not to answer	64	1%
Occupation	Patient care/health services	2805	56%
	Specialized support	1426	29%
	Clerical support/administration and management	341	7%
	Other	405	10%
Type of employer	Health services	3038	61%
	Government services	758	15%
	Business and farms	473	10%
	Academia	367	7%
	Professional associations	177	4%
	International organization/NGO and non-for-profit	51	1%
	Other	113	2%

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Survey area of focus	Factor	Description of question
Health and Safety Risks	Work Environment (Factor 1)	Blood and bodily fluids exposure Skin damage from PPE and hand hygiene Needlesticks and sharps injuries Sanitation facilities Personal hygiene Thermal discomfort Crowded workplace Slips trips & falls Back injury form heavy lifting Chemicals Bullying & harassment Sexual harassment
	Work Organization (Factor 2)	Physical violence and assaults Time pressure Shift work Long working hours Insufficient rest
Mitigation measures	Infection protection and control (Factor 3)	IPC policy Patient triage Standard precautions Cleanup & disinfection Immunization Reporting of blood exposure Policies for post-exposure prophylaxis Hand hygiene PPE IPC training
	Occupational health and safety (Factor 4)	OSH policy Occupational health and safety risk assessment Occupational health and safety engineering controls Ergonomic workplace design and furniture Safe patient handling Violence prevention Management of working time & rest Policy harassment Safe staffing & workload Psychosocial support Medical checkups Medical first aid kits Labour management consultation on OSH Occupational health and safety training

Table S3: Detailed breakdowns in individual level responses by occupation and gender

a. Detailed breakdowns in responses by occupation showing gender differences

					ability		Ν	Aitigation a	adequacy	
			Wor environ		Wo organiz		IPC		OHS [f	3]
Population characteristic		n ^c	mean	р	mean	р	mean	р	mean	Р
All Occupations		4916	3.88	0.04	3.87	0.101	4.79	<0.01	6.28	0.19
7 III Occupations	m	4710	4.11	<0.01	3.92	0.397	4.88	<u>0.089</u>	6.19	<u>0.17</u>
	f		3.76		3.85	0.007	4.74	0.000	6.33	0.07
- Patient Care		2792	3.92	0.001	3.88	0.296	4.63	0.76	6.27	0.092
	m		4.19		3.96		4.65		6.15	
	f		3.80		3.84		4.62		6.32	
- Specialist		1404	3.84	0.129	3.80	0.669	4.90	0.218	6.30	0.193
	т		3.97		3.77		5.00		6.20	
	f		3.73		3.83		4.81		6.39	
- Admin-Mgr		327	4.14	<u>0.06</u>	4.22	0.632	5.50	0.512	6.50	0.872
	m		4.65		4.33		5.65		6.54	
	f		3.92		4.17		5.43		6.48	
- Other		393	3.55	0.205	3.82	0.189	5.03	0.20	6.08	0.89
	т		3.82		4.10		5.30		6.11	
	f		3.43		3.69		4.90		6.08	

Note: Statistical significance at p<.05 level indicated by bold; statistical significance at p<.10 level indicated by underlining. Italic font is used for breakdown analysis (i.e. by gender) of population attribute (regular font) being analyzed (i.e. by occupation) and values are right-justified.

Regular font is used for analysis of the population attribute (regular font) being analyzed (i.e. by occupation).

Green colour indicates significant value deemed as associated with less risk (i.e. less unacceptable exposure; more adequate mitigation. Red colour indicates statistically significant value associated with more risk (i.e. more unacceptable exposure; less adequate mitigation.

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		F	lisk accep	tability			Mitigation a	adequacy	
		Woi environ		Wo organi		IPO	2	OHS [[f 3]
Population characteristic	n ^c	mean	р	mean	р	mean	р	mean	Р
Total	4863	3.88	<0.01*	3.87	0.4	4.79	<u>0.09</u>	6.28	<u>0.07</u>
Patient Care		3.91		3.88		4.63		6.27	
Specialist		3.84		3.80		4.90		6.30	
Admin-Mgr		4.14		4.22		5.50		6.50	
Other		3.55		3.82		5.03		6.08	
Female	3220	3.76	0.189	3.85	0.273	4.74	<0.01*	6.33	0.288
Patient Care		3.80		3.84		4.62		6.32	
Specialist		3.73		3.83		4.82		6.39	
Admin-Mgr		3.92		4.17		5.43		6.48	
Other		3.43		3.69		4.90		6.07	
Male	1643	4.11	<u>0.089</u>	3.92	0.166	4.88	0.001	6.19	0.527
Patient Care		4.19		3.96		4.65		6.15	
Specialist		3.97		3.77		5.00		6.20	
Admin-Mgr		4.65		4.33		5.65		6.54	
Other		3.82		4.10		5.30		6.11	

Note: Statistical significance at p<.05 level indicated by bold; statistical significance at p<.10 level indicated by underlining. Italic font is used for breakdown analysis (i.e. by occupation) of population attribute (regular font) being analyzed (i.e. by gender) and values are right-justified.

Regular font is used for analysis of the population attribute (regular font) being analyzed (i.e. by gender).

Green colour indicates significant value deemed as associated with less risk (i.e. less unacceptable exposure; more adequate mitigation). Red colour indicates statistically significant value associated with more risk (i.e. more unacceptable exposure; less adequate mitigation).

Table S4. Responses to health and safety risk questions

Question	Risk is not acceptable at all	Risk is acceptable for a short time	Risk is negligible	Don't know/unsur
Infectious risks				
Exposure to blood, body fluids, respiratory				
secretions, and other potentially infectious materials	52%	29%	15%	4%
Skin damage from personal protective equipment and/or frequent hand hygiene	33%	46%	16%	5%
Needle-sticks and sharps injuries	46%	21%	26%	7%
Inadequate sanitation facilities Insufficient access to facilities for personal	52%	21%	23%	4%
hygiene, such as, shower and menstrual hygiene	49%	22%	23%	6%
Physical work environment				
Thermal discomfort (cold, heat, humidity)	25%	46%	24%	5%
Crowded workplace	42%	36%	18%	4%
Slips, trips, and falls	34%	26%	33%	7%
Back injury from manual handling of patients and heavy objects	41%	34%	19%	6%
Hazardous chemicals, drugs, cleaning and disinfection agents	36%	36%	22%	6%
Psychosocial work environment				
Bullying or psychological harassment at the workplace	54%	18%	21%	7%
Sexual harassment	50%	10%	31%	9%
Physical violence and assaults	54%	16%	24%	6%
Work organization				
Time pressure, high workload	38%	49%	10%	3%
Shift work with night shifts	23%	48%	21%	8%
Regular long working hours (more than 48 hours a week)	38%	42%	15%	5%
Insufficient time-off duty to rest (less than 11 hours between shifts)	40%	36%	18%	6%

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Question	Does not exist at all	Exists and offers some protection	Exists and offers full protection	Don't know/ unsure
Infection prevention and control				
IPC policy in the health facility	8%	60%	28%	49
Patient triage	9%	54%	28%	99
Standard precautions	15%	53%	25%	79
Regular environmental clean-up and disinfection	6%	56%	34%	49
Immunization of health workers	19%	46%	26%	99
Reporting of incidental exposures to blood, body fluids, or respiratory secretions	10%	50%	32%	89
Policies in place for post-exposure prophylaxis, such as, for HIV, Hepatitis B	8%	41%	42%	99
Facilities for hand hygiene (hand washing	3%	40%	54%	39
and disinfection) are readily available				
Personal protective equipment, such as masks, gloves, goggles, gowns are readily	8%	55%	34%	39
available	070	5570	5470	5,
Training and education of workers about infection prevention and control	11%	54%	32%	3%
Occupational safety and health				
Occupational safety and health policy and management system in the facility	14%	58%	22%	69
Regular assessment of workplace health and safety risks and controls	22%	51%	21%	69
Engineering controls, such as ventilation,	19%	54%	19%	89
physical barriers, safer devices Ergonomic workplace design and furniture	33%	48%	12%	79
Devices for patient handling and lifting of				
loads	27%	48%	15%	10
Prevention of workplace violence and security measures	21%	52%	21%	69
Management of working time, rest and recuperation	20%	55%	19%	69
Workplace policies against bullying, psychological and sexual harassment	27%	43%	21%	99
Human resource management of safe	24%	52%	16%	89
staffing and workload Psycho-social support and counselling	32%	46%	15%	79
Regular medical check-ups of health	33%	43%	18%	6%
workers Medical first aid kits	15%	48%	30%	79
Consultations between management and				
workers regarding health and safety at work	25%	50%	19%	60
Training and education of workers about occupational safety and health	20%	54%	21%	5%

Table S5. Responses to mitigation measure questions

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Table S6: Comparing analyses of acceptability and adequacy in different stratified populations

	Patient Care Female			Patient Care All		Frontline ^e all		All occupations	
Countries included	112			133		156		161	
Explanatory Variable (organized by outcome area)	OR ^d	р	OR ^d	р	OR ^d	р	OR ^d	р	
Acceptable WP Enviro. Risk									
Country Income Level ^a	0.81	0.736	0.63	0.415	1.01	0.981	1.24	0.708	
Gini Coefficient ^b	0.98	0.609	0.96	0.1991	0.94	0.068**	0.92	0.012*	
COVID-Log °	1.12	0.777	1.33	0.398	1.22	0.549	1.09	0.801	
Acceptable WP Org. Risk									
Country Income Level ^a	1.30	0.657	1.57	0.446	1.06	0.926	0.71	0.52	
Gini Coefficient ^b	0.95	0.093**	0.93	0.024*	0.93	0.056**	0.95	0.017*	
COVID-Log ^c	0.44	0.034*	0.66	0.248	0.98	0.951	0.89	0.710	
Adequate IPC mitigation									
Country Income Level ^a	11.25	0.004*	7.48	0.006*	6.92	0.001*	6.61	0.001*	
Gini Coefficient ^b	0.95	0.220	0.95	0.125	0.95	0.047*	0.94	0.025*	
COVID-Log ^c	0.69	0.479	0.7	0.181	0.70	0.264	0.76	0.373	
Adequate OHS mitigation									
Country Income Level ^a	3.94	0.047*	5.86	0.004*	18.39	<0.001*	10.91	<0.001*	
Gini Coefficient ^b	0.92	0.020*	0.95	0.083**	0.99	0.755	0.99	0.779	
COVID-Log ^c	0.79	0.556	0.69	0.281	0.99	0.988	1.08	0.816	

^a Country Income was coded as comparing "High and Upper-Middle Income" countries versus "Low and Lower-Middle Income" countries

^b Gini coefficient was considered in the logistic regression analysis as a continuous variable;

^c COVID levels where the log value of the rate of cases per million at the beginning of the survey (taken June 1, 2020); log values to smooth very high levels while taking variation into account

^d Odds Ratios were calculated by assessing the likelihood (OR) of the presence of a mean scores \geq 5 corresponding to assessments that mitigation "exists and offers some protection" or better; or level of risk is assessed as "risk is acceptable for a short time" or better.

^e includes all patient care and workplace specialist support personnel such as OHS and IPC professionals

* Indicates statistical significance (p<0.05) and also bolded; ** p<.10 but >.05; indicated in italics and bold

		ent Care emale		nt Care male	Fro	ntline ^e	Fro	ntline ^e
Minimum country sample	2		all		4		all	
Countries included		80		112	1	101 161		61
Explanatory Variable (organized by outcome area)		р	OR ^d	р	OR ^d	р	OR ^d	р
Acceptable WP Enviro. Risk								
Country Income Level ^a	0.62	0.556	0.81	0.736	1.03	0.967	1.01	0.981
Gini Coefficient ^b	0.97	0.404	0.98	0.609	0.95	0.228	0.94	0.068**
COVID-Log	1.11	0.852	1.12	0.777	0.89	0.797	1.22	0.549
Acceptable WP Org. Risk								
Country Income Level ^a	1.2	0.830	1.30	0.657	1.33	0.736	1.06	0.926
Gini Coefficient b	0.97	0.487	0.95	0.093**	0.94	0.230	0.93	0.056**
COVID-Log	0.77	0.617	0.44	0.034*	0.42	0.457	0.98	0.951
Adequate IPC mitigation								
Country Income Level ^a	9.62	0.041*	11.25	0.004*	36.89	0.001*	6.92	0.001*
Gini Coefficient b	0.94	0.223	0.95	0.220	0.98	0.647	0.95	0.047*
COVID-Log	0.54	0.433	0.69	0.479	0.48	0.190	0.70	0.264
Adequate OHS mitigation								
Country Income Level ^a	3.00	0.153	3.94	0.047*	5.46	0.020*	18.39	<0.001*
Gini Coefficient ^b	0.94	0.077**	0.92	0.020*	0.94	0.061**	0.99	0.755
COVID-Log	0.67	0.392	0.79	0.556	0.56	0.152	0.99	0.988

 Table S7: Comparing analyses when minimum country sample size provisions are applied

^a Country Income was coded as comparing "High and Upper-Middle Income" countries versus "Low and Lower-Middle Income" countries

^b Gini coefficient was considered in the logistic regression analysis as a continuous variable;

^c COVID levels where the log value of the rate of cases per million at the beginning of the survey (taken June 1, 2020); log values to smooth very high levels while taking variation into account

^d Odds Ratios were calculated by assessing the likelihood (OR) of the presence of a mean scores \geq 5 corresponding to assessments that mitigation "exists and offers some protection" or better; or level of risk is assessed as "risk is acceptable for a short time" or better.

^e includes all patient care and workplace specialist support personnel such as OHS and IPC professionals

* Indicates statistical significance (p<0.05) and also bolded; ** p<.10 but >.05; indicated in italics and bold

Impacts of economic inequality on healthcare worker safety at the onset of the COVID-19 pandemic: Cross-sectional analysis of a global survey

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5	2	COVID-19 pandemic: Cross-sectional analysis of a global survey
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1 2		
3	39	ABSTRACT
4 5	40	Objectives To assess the extent to which protection of healthcare workers (HCWs) as COVID-19
6 7	41	emerged was associated with economic inequality among and within countries.
8 9	42	Design Cross-sectional analysis of associations of perceptions of workplace risk acceptability and
10 11	43	mitigation measure adequacy with indicators of respondents' respective country's economic income level
12 13	44	(World Bank assessment) and degree of within-country inequality (Gini index).
14 15	45	Setting A global self-administered online survey.
16 17	46	Participants 4,977 HCWs and healthcare delivery stakeholders from 161 countries responded to health
18	47	and safety risk questions and a subset of 4,076 (81.2%) answered mitigation measure questions. The
19 20	48	majority (65%) of study participants were female.
21 22	49	Results While the levels of risk being experienced at the pandemic's onset were consistently deemed as
23	50	unacceptable across all groupings, participants from countries with less income inequality were somewhat
24 25	51	less likely to report unacceptable levels of risk to HCWs regarding both workplace environment
26	52	(OR=0.92, p=0.012) and workplace organizational factors (OR=0.93, p=0.017) compared to counterparts
27 28	53	in more unequal national settings. In contrast, considerable variation existed in the degree to which
29 30	54	mitigation measures were considered adequate. Adjusting for other influences through a logistic
31	55	regression analysis, respondents from lower-middle and low-income countries were comparatively much
32 33	56	more likely to assess both occupational health and safety (OR=10.91, p=<0.001) and infection prevention
34	57	and control [IPC] (OR=6.61, p=<0.001) protection measures as inadequate, despite much higher COVID-
35 36	58	19 rates in wealthier countries at the time of the survey. Greater within-country income inequality was
37 38	59	also associated with perceptions of less adequate IPC measures (OR=0.94, p=0.025). These associations
39	60	remained significant when accounting for country-level differences in occupational and gender
40 41	61	composition of respondents, including specifically when only female care providers, our study's largest
42 43	62	and most at-risk sub-population, were examined.
44	63	Conclusions Economic inequality threatens resilience of health systems that rely on health workers
45 46	64	working safely to provide needed care during emerging pandemics.
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2 3 4 5	66	Strengths and limitations of this study
6 7	67	• A major strength of the study is its novel empirical testing of the "income inequality"
8	68	hypothesis for a comparative cross-country analysis of a major global health challenge:
9 10	69	protection for a workforce central to the provision of healthcare services during a pandemic.
11 12	70	• This study is based on a unique global self-administered online survey conducted by a
13 14	71	network of occupational health experts coordinated by the World Health Organization
15 16	72	(WHO) through a large array of professional networks and social media.
17	73	• A major limitation of the study is its character as a convenience sample with different
18 19	74	compositions by gender and occupation among countries and small sample sizes in some
20 21	75	countries; however access to gender and occupation identifiers of respondents has enabled
22 23	76	adaptive strategies to take this into consideration.
24	77	• The study is exploratory in considering associations with economic inequality, but does not
25 26	78	provide a way to consider pathways for this effect, so further research will be needed for this.
27 28	79	
29 30	80	Keywords: COVID-19; Health Systems; Public Health; Other Study Design; Environmental Health
31 32	81	Occupational Health; Healthcare Workers
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INTRODUCTION

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86	As the COVID-19 pandemic emerged, attention was quickly drawn to risks faced by frontline
87	healthcare providers $[1,2]$ – and the urgent need to strengthen their protection $[3,4]$. By
88	September 2020, it was estimated that 10% of global infections had been in health workers
89	(HCWs), and over 7,000 had died [5,6]. Notwithstanding inconsistent reporting, Papoutsi and
90	colleagues, in reviewing the global burden of COVID-19 for HCWs by country [6, 7], estimated
91	the percentage of HCW cases among the total cases by April 2020 as ranging from less than 1%
92	in Hong Kong and India, to 19% in Spain.
93	Despite 60 million people employed in the healthcare sector worldwide [8,9], a global shortage
94	of HCWs persists and is especially critical in low-and middle-income countries (LMICs) [10],
95	where the greatest global burden of disease exists [11]. Risk mitigation is marked by
96	considerable variation [12], with shortcomings in infrastructure and mitigation programs
97	contributing to higher burdens of disease and HCW risk in more poorly resourced settings [13].
98	The danger that HCWs face of acquiring COVID-19 adds to extensive existing risks in infectious
99	disease endemic states, for example with tuberculosis in Sub-Saharan Africa [14].
100	
101	While lack of personal protective equipment (PPE) was highlighted early in the COVID-19
102	pandemic, consideration of broader OHS factors and mitigation measures attracted less initial
103	attention [7,8,15]. To ascertain the extent of OHS risk exposure and the adequacy of mitigation
104	measures in place to meet the challenge of COVID-19, an Ad Hoc expert group of the WHO, the
105	International Labour Organization (ILO) and the International Commission on Occupational
106	Health (ICOH) prepared and circulated a questionnaire survey to identify HCWs perceptions of

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the most common threats to their health and safety as well as the adequacy of mitigationmeasures in the emerging pandemic [16].

Further to a preliminary analysis of survey results [16] regarding risk and adequacy of protection, we sought to ascertain the degree to which perceived risk exposure of HCWs and adequacy of mitigation measures is associated with a country's economic characteristics. Considerable attention, after all, has been given to the impact of economic disparity on health [17,18], especially in relation to Wilkinson's "economic inequality hypothesis" suggesting that greater inequality is associated with poorer health [19]. In recognition that "the traditional exposure-disease framework used in occupational health research is not equipped to address societal contexts in which work is embedded" [20], we sought to examine how such driving forces [21] as a country's economic inequality might be affecting the wellbeing of HCWs.

A variety of factors have been examined that might have influenced how the onset of the COVID-19 pandemic was experienced in different national settings, including consideration of cultural traits [22], specific government regulations and non-pharmaceutical interventions [23,24], and political leadership characteristics [25]. Our study sought to apply a cross-country perspective to consider the effects of economic inequality, recognizing this to be a dimension of considerable relevance in global public health research.

With this focus, we set out to first consider variation in perceptions of the acceptability of workrelated risks and the adequacy of mitigation measures that were being experienced by HCWs as COVID-19 emerged; and, second, to determine the extent to which variations were associated with a country's comparative income level and degree of income inequality.

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3 4	129	METHODS
4 5 6	130	Survey development
7 8	131	Shortly after the WHO Ad Hoc Study Group on Health and Safety of Health Workers was
9 10	132	established when the COVID-19 pandemic emerged, it created an online survey aimed at HCWs
11 12 13	133	from all WHO regions globally. In addition to the capture of demographic indicators of
14 15	134	respondents, the survey contained 41 questions – 17 on health and safety risks and 24 on
16 17	135	mitigation measures [16, Appendix]. Risk questions were grouped into those related to infectious
18 19 20	136	disease transmission, physical work environment, psychological work environment and work
20 21 22	137	organization. For each risk question, participants were asked "Think about the working
23 24	138	conditions of health workers in your country, jurisdiction or health facility; rate the current
25 26	139	level of these risks, now during the COVID-19 pandemic." Questions regarding mitigation
27 28 29	140	measures were divided into two groups: occupational health and safety (OHS) and infection
30 31	141	prevention and control (IPC). Here, participants were similarly asked: "Think about the working
32 33	142	conditions of health workers in your country, jurisdiction or health facilityrate the level of
34 35 36	143	application of these measures according to your knowledge of the real situation now during the
30 37 38	144	COVID-19 pandemic."
39 40	145	COVID-19 pandemic." Patient and Public Involvement
41 42 43	146	Patient and Public Involvement
44	147	The participation of health workers (whose wellbeing is the focus for this study in relation to

The participation of health workers (whose wellbeing is the focus for this study in relation to their assessment of the adequacy of measures to protect them) was indirectly included through the participation of their representatives (unions within the ILO and other professional bodies) who were directly involved in the creation of the research instrument and in the dissemination of the online survey and its initial results.

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Study population and inclusion criteria

Participants were recruited by convenience sampling, with dissemination through a large array of professional networks and social media. The survey, self-administered online to enable rapid low-cost recruitment, was available in Arabic, Chinese, English, French, German, Italian, Portuguese, Russian, Spanish and Swahili. A range of HCWs and stakeholders involved with healthcare delivery were invited to participate. In addition to HCWs in direct patient care in both formal and informal settings and in public and private facilities, respondents also included allied health and supporting staff, including OHS and IPC professionals, administration, management, drivers, public health workers, community health workers, and others as defined by the International Standard Classification of Occupations (ISCO-08). Data collection occurred between May 5th and June 25th, 2020. Participant results were excluded if they failed to complete demographic questions or if they failed to provide any responses to the risk and mitigation questions. As the survey was designed to be completed and submitted anonymously, no formal request for signed consent was solicited, with participants' submission itself indicating consent to use the information provided as anonymized aggregated data. The study proposal was approved by the Behavioural Research Ethics Board of the University of British Columbia (Ref. H20-01825). This work was supported by the International Development Research Centre (IDRC) under grant M20-00559 and the Canadian Institutes of Health Research (CIHR) under grant VS1-175519 for the "Protecting healthcare workers from COVID-19: a comparative contextualized analysis" research programme.

1 2		
2 3 4	174	Independent variables
5 6	175	Demographic information for individual survey respondents was collected on country, gender,
7 8 9	176	and occupation - the latter separated into 13 categories and then grouped into patient care/health
10 11	177	services; specialized technical support; clerical support/administration and management; and
12 13	178	other. Details about the study sample population composition and demographic characteristics of
14 15 16	179	participants are presented in Figure S1 and Table S1 respectively.
17 18	180	
19 20	181	Our research group, drawn from two WHO Collaborating Centres participating in the survey
21 22 23	182	process, conducted the analysis by consolidating respondents by their home country and then
23 24 25	183	linking this to a WHO geographic region [26]; a comparative country-level economic
26 27	184	classification by World Bank income groups based on the annual Atlas gross national income per
28 29	185	capita estimates [26,27]; and the country's Gini index - a measure used for the analysis of
30 31 32	186	income inequality present within a country, with a score of 0 representing perfect equality, and a
33 34	187	score of 1 representing complete inequality [28]. Data for Gini and economic classification were
35 36	188	taken from the World Bank, using the most recent data available. To take account of the
37 38 20	189	variation across regions present during the initial phase of the pandemic, we also considered
39 40 41	190	COVID-19 incidence per million (logarithmic scale) in each country at the time when the survey
42 43	191	was completed, as an indicator of the intensity as of a particular date, using values for June 2020
44 45	192	drawn from the "Our World in Data" database [29].
46 47 48	193	
49 50	194	Dependent variables
51 52	195	Acceptability of workplace risks and adequacy of mitigation measures – the dependent variables
53 54 55	196	in this study – were derived from a factor analysis of individual survey responses, then
56 57		
58 59		For peer review, only, http://hmiepen.hmi.com/cite/ahout/guidelines.yhtml
60		For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

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aggregated to enable subsequent analysis of the effect of country-level characteristics. Factor analysis [16] was used to reduce the 41 survey questions into coherent groupings and principal component analysis with varimax rotation carried out to create factors from each set of workplace health and safety risk exposure questions (corresponding to workplace risk and workplace organization acceptability) and mitigation measure questions (corresponding to IPC and OHS adequacy); Table S2 summarizes the subject matter covered by the questions consolidated in each factor. Separate factor analyses were run on risk questions and preventive measure questions. Missing values were excluded in a listwise fashion. The rotated component matrix was used to identify factors. To measure scale reliability, Cronbach's Alpha was used for each individual factor. Scores over 0.7 are considered to be acceptable for internal consistency [30]. The results from the factor analysis are outlined further in our preliminary analysis [16]. The questions were administered as a 3-point Likert scale, then converted to a 10-point scale for clearer communication (i.e. midpoint of 2 becoming 5). Numerical scores were assigned to each answer to establish a scale for both the risk and mitigation measure factors, with higher scores corresponding to more desirable states. For health and safety risks, a score of 0 was assigned to "risk is not acceptable at all"; 5 to "risk is acceptable for a short time"; and 10 for "risk is negligible". For mitigation measures, a score of 0 was assigned to "does not exist at all"; 5 to "exists and offers some protection"; and 10 to "exists and offers full protection". Responses of "don't know/unsure" were assigned blanks. Factor scores were then calculated to form an individual respondent's factor score for each of the four groupings, i.e., work environment risk acceptability, work organization risk acceptability, OHS adequacy and IPC adequacy and then aggregated to generate a mean value for each country's respondents, so that inter-country

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1 2			
2 3 4	219	comparison could be conducted. The higher the scores, the greater the perceived adequacy of	
5 6 7	220	mitigation measures or acceptability of risk deemed as being experienced.	
7 8 9	221		
10 11	222	Analysis	
12 13 14	223	The mean country dependent variable factor scores derived from the aggregation of individual	
14 15 16	224	participants' responses served as the basis for considering associations by WHO region,	
17 18	225	economic classification, Gini coefficients and COVID-19 incidence. Comparisons of survey	
19 20 21	226	mean scores were carried out using ANOVA analysis, with an alpha of 0.05 used to test	
22 23	227	significance. To compare means for the continuous variable Gini coefficient and COVID	
24 25	228	incidence scores, we ordinally divided groups of countries into quartiles by values.	
26 27 28	229		
29 30	230	To ensure that intercountry variation was not purely explained by possible gender and	
31 32	231	occupational compositional differences among a particular country's respondents, we carefully	
33 34 35	232	examined possible sources of discrepancy (Table S3), using ANOVA analysis to consider effect	S
36 37	233	that could complicate the cross-country comparison of all respondents. To minimize any such	
38 39	234	effect, we considered different ways to stratify our analysis of the study population, notably by	
40 41 42	235	focusing only on those populations that had the most direct workplace experience to personally	
42 43 44	236	being "at risk". Noting the presence of gender differences among patient care deliverers, we	
45 46	237	specifically isolated female respondents, who in fact constituted the largest demographic group	
47 48 49	238	of respondents in the study, representing 1,998 respondents from 112 countries (n=1,968 from	
50 51	239	112 countries), the largest sub-population.	
52 53	240		
54 55 56			
57 58			
59		1	0

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Finally, to measure the effect that the interaction of independent variables had on the likelihood of workplace risks being considered as acceptable in a country setting as COVID was emerging, and workplace protection and control measures being deemed as adequate, we created and applied a logistic regression model. Preferred outcomes for this analysis were assessed as mean factor scores \geq 5, corresponding to assessments that mitigation "exists and offers some protection" or better; or "risk is acceptable for a short time" or better. All statistical analysis was done using R and SPSS Statistics software [31,32].

RESULTS

249 Overall study population and survey responses

There were 4,977 participants who responded to health and safety risk questions and a subset of 4,076 (81.2%) who answered mitigation measure questions. The majority of study participants were female (65%), reflecting the make-up of the health sector workforce. Most participants were from the European region (35%), followed by the Americas (31%), the Western Pacific region (15%) and Africa (10%); the South East Asian (4%) and Eastern Mediterranean regions (3%) made up the smallest proportion of participants. In total there were 161 countries represented in the survey. Portugal (n=549, 11%), US (n=451, 9%), Brazil (n=373, 7%), Canada (n=263, 5%), and China (n=233, 5%) had the most participants. The majority of respondents were from countries of high-economic classification (59%), followed by upper-middle (27%), lower middle (10%) and low (4%). Most survey participants worked for a health services employer (61%), followed by government services (15%) and businesses and farms (10%). Those working in academia, professional associations, international organizations and non-government organizations each encompassed less than 10%. Finally, the type of occupation was predominantly patient care/health (56%) services, followed by 29% providing technical services

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such as IPC or OHS specialists, 7% in administration and 10% identified as working in other

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5 6	265	sectors (Table S1).
7 8	266	
9 10	267	The largest percentage of countries were in Europe (30%) and over a third of all countries were
11 12 13	268	high-income countries (35%). The average Gini index was 37.8 (SD=7.7) and the mean and
14 15	269	median COVID-19 incidence rate per million was 1,360 and 278, respectively at the time the
16 17	270	survey was conducted.
18 19	271	
20 21	272	Table 1 illustrates that considerable variation exists in these variables across the different WHO
22 23 24	273	regions, indicating the distinct characteristics and conditions present at the onset of the
24 25 26	274	pandemic. It is especially noteworthy that case levels had been far greater in high-income
27 28	275	country areas at the survey mid-point (June 1st, 2020). For example, the cases per million was
29 30 31	276	2,525 in Europe versus 119 in Africa; 5,408 in the United States; and only 138 in India and 97 in
32 33 34	277	Indonesia.

Countries by income Mean **Study Population** classification* characteristics country values Number Occupation Gender Inequality COVID of Region Upper-Lower-Frontline countries High Low Gini cases per Female* middle middle Patient care* coefficient* million a,* (%) (%) Overall 161 57 42 36 26 37.8 1,360 65.5% 56.4% 52.1% 44.8% AFRO 37 0 6 12 19 43.2 119 39.8% 29.4% **EMRO** 20 3 7 4 35.2 2,407 6 68.2% 64.4% EURO 48 32 13 2 31.8 2,525 1 73.3% 46.5% PAHO 4 44.8 1,135 30 11 14 1 36.7% 56.3% SEARO 9 0 2 6 1 35.0 86 70.7% 68.8% WPRO 17 8 4 5 0 37.0 512 279 Abbreviations: AFRO: Africa; EMRO: Eastern Mediterranean; EURO: Europe; p: p-values; PAHO: Americas;

Table 1: Country characteristics of different WHO regions 278

54 280 55 SEARO: South-East Asian; WPRO: Western Pacific

56 281 Note: * p <0.001, a: COVID rates as of June 2020. 57

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1 2								
2 3 4	282							
5 6	283 284	As summarized in Table 2 (full table in appendix Table S4), the majority of respondents						
7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 20	285	designated most of the health and safety risk parameters as "not acceptable at all".						
	286	Circumstances most reported as such included bullying or psychological harassment in the						
	287	workplace (54%), physical violence and assaults (54%), exposure to blood, bodily fluids, and						
	288	other infectious materials (52%), inadequate sanitation facilities (52%), and sexual harassment						
	289	(50%). In contrast, areas such as time pressure and high workload (38%), skin damage from PPE						
	290	(33%) and shift work with night shifts (23%) were deemed to be less of a concern. There were						
	291	no risk categories in which the most common response was "risk is negligible".						
	292							
	293	Mitigation measures related to the above areas of concern were seen as particularly lacking, with						
	294	4 only the category of "policies for facilities for hand hygiene" designated as "exists and offers						
	295	protection" (full tables in appendix Table S5). For example, despite psychosocial-related risks,						
	296	including bullying, harassment, physical violence, and sexual harassment ranked consistently						
	297	high (54%, 54%, 50% respectively), only 21% indicated that corresponding policies "exist and						
	298	offer full protection", with similar dissatisfaction for the adequacy of mitigation measures for						
39 40 41	299	other key areas such as IPC policy (28%), availability of PPE (34%) as well as training and						
42 43	300	education of workers about OHS (21%) and IPC (32%). Only in two mitigation measures areas –						
44 45 46	301	availability of facilities for hand hygiene, and policies for post-exposure prophylaxis (such as						
40 47 48	302	HIV or hepatitis B) – did most participants indicate that measures existed and offered full						
49 50	303	protection (54% and 42%, respectively). These results show an overwhelming majority of						
51 52	304	participants indicating that the risks they faced were not acceptable at all and that very few of the						
53 54 55	305	corresponding mitigation measures offered adequate protection to HCWs.						
56 57 58								

58 59

Table 2

Table 2: Risk acceptability and mitigation adequacy – selected worldwide survey responses

Risk acceptability	Risk is not acceptable at all	Risk is acceptable for a short time	Risk is negligible	Don't know/unsure
Infectious risk work environment				
Exposure to blood, body fluids, respiratory secretions, other potentially infectious materials	52%	29%	15%	4%
Inadequate sanitation facilities	52%	21%	23%	4%
Skin damage from personal protective equipment and/or frequent hand hygiene	33%	46%	16%	5%
Physical work environment				
Crowded workplace	42%	36%	18%	4%
Thermal discomfort (cold, heat, humidity)	25%	46%	24%	5%
Psychosocial work environment	•			
Bullying or psychological harassment	54%	18%	21%	7%
Sexual harassment	50%	10%	31%	9%
Work organization	•			
Time pressure, high workload	38%	49%	10%	3%
Shift work with night shifts	23%	48%	21%	8%

Mitigation measure adequacy	Does not exist at all	Exists and offers some protection	Exists and offers full protection	Don't know/ unsure
Infection prevention and control)		
IPC policy in the health facility	8%	60%	28%	4%
Personal protective equipment, e.g. masks, gloves, goggles, gowns are readily available	8%	55%	34%	3%
Training and education of workers about infection prevention and control	11%	54%	32%	3%
Facilities for hand hygiene (hand washing and disinfection) are readily available	3%	40%	54%	3%
Occupational health and safety				
Occupational health and safety policy and management system in the facility	14%	58%	22%	6%
Regular assessment of workplace health and safety risks and controls	22%	51%	21%	6%
Engineering controls, such as ventilation, physical barriers, safer devices	19%	54%	19%	8%
Prevention of workplace violence and security measures	21%	52%	21%	6%
Workplace policies against bullying, psychological and sexual harassment	27%	43%	21%	9%

- 52 308
 53 309
 Note: Most cited response highlighted in bold

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323 Table 3:Unadjusted risk acceptability and Mitigation adequacy associations

		Risk acceptability			Mitigation adequacy				
		Work environment		Work organization		IPC		OHS	
Explanatory Variable		mean	р	mean	р	mean	р	mean	Р
TOTAL	By country means	4.23		4.29		4.67		6.08	
	By individuals	3.88		3.87		4.79		6.28	
Region	AFRO	4.11	0.34	4.17	0.30	3.68	<0.01*	5.31	0.03
	EMRO	4.01		4.25		5.02		6.33	
	EURO	4.47		4.24		5.28		6.54	
	РАНО	4.03		3.99		4.24		5.92	
	SEARO	3.44		4.76		5.11		6.30	
	WPRO	4.83		5.03		5.24		6.35	
Economic Classification	High	4.51	0.24	4.62	0.15	5.61	<0.01*	6.99	<0.01
	Upper-middle	4.05		4.05		4.85		6.17	
	Lower-middle	3.78		4.05		3.58		5.15	
	Low	4.51		4.27		3.88		5.29	
Gini coefficient	Q1 [lowest]	4.80	0.11	4.51	0.34	5.26	0.01*	6.64	0.04
	Q2	4.10		4.29		4.31		5.81	
	Q3	3.90		4.04		4.72		6.20	
	Q4	3.98		3.80		3.89		5.55	
COVID-19 incidence rate	Q1 [lowest]	3.95	0.50	4.09	0.84	4.17	<0.01*	5.64	0.07
	Q2	4.18		4.25		4.39		5.95	
	Q3	4.50		4.39		4.66		6.10	
	Q4	4.19		4.16		5.44		6.62	

Abbreviations: AFRO: Africa; EMRO: Eastern Mediterranean; EURO: Europe; IPC: Infection protection and control; OHS: Occupational health and safety; p: p-values; PAHO: Americas; SEARO: South-East Asian; Q:

42 326 Quartile; WPRO: Western Pacific

327 * Indicates statistical significance (p<0.05) of differences among the means of country mean values for category;
 328 significant values in bold

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1 2		
2 3 4	331	
5	332	To understand potential sources of difference that could be attributed to heterogeneous
6 7 8	333	composition of country responses that is encountered in conducting a cross-country comparison
9 10	334	such as the one we conducted, Table 4 presents a summary of the survey's individual level data
11 12	335	to indicate how gender and occupation were associated with respondent perceptions of
13 14	336	acceptability and adequacy. Females were somewhat more likely than males to report workplace
15 16 17	337	risks being unacceptable (3.76 versus 4.11; p<0.001), but the strong presence of frontline patient
18 19	338	care providers in the gendered health workforce was largely responsible for this, as no
20 21	339	statistically significant differences were observed within other occupation groupings (see Table
22 23 24	340	S3). In fact, patient care providers themselves stood out as being the occupational grouping most
24 25 26	341	critical of workplace risk acceptability as well as OHS and IPC measure adequacy. In contrast,
27 28	342	male administrators/managers stood out as the most likely to indicate that acceptable risk
29 30 31	343	exposure and adequate risk mitigation measures were present. This discrepancy is
32 33	344	understandable as frontline workers, and women in this occupation grouping, represent those
34 35	345	most directly experiencing the impact of the COVID pandemic. However, even in these more
36 37	346	extreme circumstances where differences were observed, the comparative differences in mean
38 39 40	347	scores (that were then aggregated in calculating country mean values) were not large. Moreover,
41 42	348	the fact that the African region, where strongest concerns about unacceptable risk and inadequate
43 44	349	mitigation were expressed, actually had proportionately fewer female respondents, indicates that
45 46 47	350	even these regional concerns that we observed may well have been underrepresented in this
48 49	351	unadjusted analysis.
50 51	352	
52 53		
54 55		
56 57		
58		
59		17

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e (3.76 versus 4.11; p<0.001), but the strong presence of frontline patient
ndered health workforce was largely responsible for this, as no
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where differences were observed, the comparative differences in mean
aggregated in calculating country mean values) were not large. Moreover,
region, where strongest concerns about unacceptable risk and inadequate
sed, actually had proportionately fewer female respondents, indicates that
cerns that we observed may well have been underrepresented in this

1 2

354 Table 4: Risk acceptability and mitigation adequacy associations ^a with gender and occupation 6 7 **Risk acceptability** Mitigation adequacy 8 Work Work 9 IPC environment organization 10 11 Р **Explanatory Variable** nd mean p mean mean 12 Gender^b < 0.01* Total 4863 3.88 3.87 0.40 4.79 13 3220 Female 3.76 3.85 4.74 14 1643 15 Male 4.11 3.92 4.88 16 17 3.88 3.87 4.79 **Occupation**^c Total 4916 0.04 0.10 18 3.91 3.88 4.63 19 2792 Patient Care 20 1404 3.84 3.80 4.90 Specialist 21 327 4.14 4.22 5.50 Admin-Mgr 22 393 3.55 3.82 5.03 23 Other 24 355 * Indicates statistical significance (p<0.05); significant values in bold 25 356 ^a This table report on total respondents in each category, without any consideration for different mixes of gender 26 357 within different occupations, and different mixes of occupation within genders; Supplementary table X provides 27 358 results with full occupation and gender breakdowns 28 359 29 ^b Only respondents indicating Male or Female were included in exploring differences; 30 360 ^c Occupation was initially coded with finer detail but then consolidated in these composites for comparative analysis 31 361 ^d total n varies by specific factor; this column refers to n for workplace environment, where response was greatest 32 362 Abbreviations: IPC: Infection protection and control; Mgr: Manager; OHS: Occupational health and safety 33 363 34 35 364 36 365 Influence of between-country and within-country income disparity 37 366 38 367 Table 5 summarizes the adjusted comparative effects of income level and income distribution 39 40 41 368 disparity in each country setting while taking into consideration potential influences prompted by 42 43 369 differing COVID-19 rates in the initial phase of the pandemic. While there was no difference 44 45 370 between *higher and lower income countries* regarding the perception of unacceptable levels of 46 47 48 371 risks in healthcare workplaces in all settings, within-country inequality was associated with a 49 50 372 mildly increased likelihood of *unacceptable levels of risk* with regard to both workplace 51 52 373 environment (OR=0.92; p=0.012) and workplace organizational (OR=0.93; p=0.017) factors. 53 54 374 55 56 57 58 59 60

OHS

mean

6.28

6.33

6.19

6.28

6.27

6.30

6.50

6.08

р

0.09

< 0.01*

Р

0.07

0.19

Table 5: Factors associated with perceived risk acceptability and mitigation adequacy

		Unadjusted bivariate			nuj	Adjusted multivariable model ^d		
	xplanatory Variable organized by outcome area)	OR ^d	95% CI	р	В	OR ^d	95% CI	Р
<u> </u>	cceptable WP Enviro. Risk							
	Country Income Level ^a	1.56	1.08-2.27	0.231	0.215	1.24	0.70-2.20	0.708
	Gini Coefficient ^b	0.91	0.88-0.94	0.005*	-0.087	0.92	0.89-0.95	0.012
	COVID-Log ^c	1.01	0.83-1.23	0.965	0.083	1.09	0.78-1.51	0.801
A	cceptable WP Org. Risk							
	Country Income Level ^a	0.83	0.59-1.17	0.587	-0.341	0.71	0.42-1.21	0.52
	Gini Coefficient ^b	0.94	0.91-0.97	0.028*	-0.076	0.93	0.90-0.96	0.017
	COVID-Log ^c	0.8	0.67-0.97	0.243	-0.113	0.89	0.66-1.21	0.710
A	dequate IPC mitigation							
	Country Income Level ^a	6.8	1.36-34.60	0.006*	1.889	6.61	3.68-11.88	0.001
	Gini Coefficient ^b	0.93	0.90-0.95	0.006*	-0.036	0.94	0.91-0.96	0.025
	COVID-Log ^c	1.85	1.51-2.26	0.002*	-0.064	0.76	0.55-1.03	0.373
A	dequate OHS mitigation			4				
	Country Income Level ^a	8.91	5.76-13.80	<0.001*	2.389	10.91	5.63-21.12	<0.001
	Gini Coefficient ^b	0.97	0.94-0.99	0.183	-0.009	0.99	0.96-1.02	0.77
Not Abl con Var ^a Co	COVID-Log ^c tes: OR: Odds Ratio, expressed as breviations: B: Coefficient; OHS: ntrol; Enviro.: environmental; WP: riables where statistical significan ountry Income was coded as comp	0.94 Exp(B) Occupati workpla ce is pres	0.91-0.97 value in Logisti ional Health and ace sent are shown	0.028* c Regression a d Safety mitiga in bold	0.079 nalysis, CI: ntion; Org.: or	1.08 Confidenc ganization	0.77-1.52 the Interval, * p the provided and the second second the second secon	0.81€ ≤.05 ** Preventio
Not Abl con Van ^a Co cou ^b G ^c Co to s ^d O that	COVID-Log ^c tes: OR: Odds Ratio, expressed as breviations: B: Coefficient; OHS: ttrol; Enviro.: environmental; WP: riables where statistical significant ountry Income was coded as computive ini coefficient was considered in t OVID levels where the log value of smooth very high levels while taki dds Ratios were calculated by asset t mitigation "exists and offers son	0.94 Exp(B) Occupate workpla ce is pres- baring "F he logist of the rat ng variate essing th ne protect	0.91-0.97 value in Logisti ional Health and ace sent are shown High and Upper ic regression and to f cases per n tion into account e likelihood (O ction" or better;	0.028* c Regression a d Safety mitiga in bold -Middle Incom hillion at the bo tt R) of the prese or level of rist	0.079 nalysis, CI: ttion; Org.: or ne" countries attinuous varia eginning of the ence of a mea	1.08 Confidence ganization versus "L ble; ne survey of n score \geq	0.77-1.52 ce Interval, * p n; IPC: Infection ow and Lower-M (taken June 1, 20 5 corresponding	Preventio Middle Ind ()20); log
Not Abl con Var a Ce cou b G c Ce to s d Oe that bett * In	COVID-Log ^c tes: OR: Odds Ratio, expressed as breviations: B: Coefficient; OHS: ttrol; Enviro.: environmental; WP: riables where statistical significan ountry Income was coded as comp intries ini coefficient was considered in t OVID levels where the log value of smooth very high levels while taki dds Ratios were calculated by assist t mitigation "exists and offers son ter.	0.94 Exp(B) Occupat workpla ce is pres- paring "F he logist of the rat ng variat essing th ne protect	0.91-0.97 value in Logisti ional Health and ace sent are shown i High and Upper ic regression an e of cases per n tion into account e likelihood (O ction" or better; 5); also bolded	0.028* c Regression a d Safety mitiga in bold -Middle Incom nalysis as a com nillion at the bo tt R) of the prese or level of risi	0.079 nalysis, CI: ation; Org.: or ne" countries atinuous varia eginning of the ence of a mea k is assessed	1.08 Confidence ganization versus "L ble; he survey (n score \geq as "risk is	0.77-1.52 ce Interval, * p h; IPC: Infection ow and Lower-M (taken June 1, 20 5 corresponding acceptable for a	0.810 $\leq .05$ ** Prevention Middle In (220); log to assess a short tin
Not Abl com b G c Cu to s d Ou that bett * In	COVID-Log ^c tes: OR: Odds Ratio, expressed as breviations: B: Coefficient; OHS: ntrol; Enviro.: environmental; WP: riables where statistical significant ountry Income was coded as comp intries ini coefficient was considered in t OVID levels where the log value of smooth very high levels while taki dds Ratios were calculated by asso t mitigation "exists and offers son ter. ndicates statistical significance	0.94 Exp(B) · Occupation workpla ce is pres- baring "F he logist of the rating variate essing the protect e (p<0.0 ted bive	0.91-0.97 value in Logisti ional Health and ace sent are shown i High and Upper ic regression and to of cases per n tion into account e likelihood (O ction" or better; 5); also bolded variate analy	0.028* c Regression a d Safety mitiga in bold -Middle Incom hillion at the bo t R) of the prese or level of rist d	0.079 nalysis, CI: ttion; Org.: or ne" countries attinuous varia eginning of th ence of a mea k is assessed was much	1.08 Confidence ganization versus "L ble; ne survey of n score \geq as "risk is stronge	0.77-1.52 ce Interval, * p n; IPC: Infection ow and Lower-M (taken June 1, 20 5 corresponding acceptable for a er divergence	0.816 ≤ .05 ** Prevention Middle Ind (220); log (a to assess a short tin e in
Not Abl con Var ^a Co to s ^d O that bett * In As	COVID-Log ^c tes: OR: Odds Ratio, expressed as breviations: B: Coefficient; OHS: trol; Enviro.: environmental; WP: riables where statistical significan ountry Income was coded as comp intries ini coefficient was considered in t OVID levels where the log value of smooth very high levels while taki dds Ratios were calculated by assi- t mitigation "exists and offers son ter. ndicates statistical significance s was observed in unadjus	0.94 Exp(B) Occupate workpla ce is pres- paring "I he logist of the rat ng variate essing th ne protect e (p<0.0 ted biv <i>itigatic</i>	0.91-0.97 value in Logisti ional Health and ace sent are shown i High and Upper tic regression and to of cases per n tion into account e likelihood (O ction" or better; 5); also bolded variate analy on measures	0.028* c Regression a d Safety mitiga in bold -Middle Incom hillion at the bo tt R) of the prese or level of risi d	0.079 nalysis, CI: ation; Org.: or ne" countries atinuous varia eginning of th ence of a mea k is assessed was much ountry inc	1.08 Confidence ganization versus "L ble; ne survey of n score \geq as "risk is stronge <i>ome lev</i>	0.77-1.52 ce Interval, * p n; IPC: Infection ow and Lower-M (taken June 1, 20 5 corresponding acceptable for a er divergence cel and <i>incon</i>	0.810 $\leq .05$ ** Preventi Middle In ()20); log () to assess a short tin e in <i>ne</i>

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2 3 4	397	measures (OR=10.91; p<0.001), despite the greater intensity of COVID-19 in wealthier countries
5 6	398	at the time of the survey. In fact, the counter-intuitive positive association that seemed to be
7 8 9 10 11	399	present between intensity of COVID-19 and perceptions of adequacy disappeared in our adjusted
	400	multivariable analysis. And further to the observed unadjusted effect, higher inequality decreased
12 13	401	the likelihood (OR=0.94; p=0.025) of deeming IPC measures to be adequate.
14 15	402	
16 17	403	Analysis of the more homogeneously constituted population of female patient care provider
17 18 19	404	respondents (Table S6) further revealed that this group's more critical assessment of risk that we
20 21	405	had documented in Table 4 especially influenced perceptions of risk acceptability in settings
22 23 24	406	where COVID-19 exposure had intensified. In this regard, workplace organizational factors,
24 25 26 27 28	407	which included consideration of the workload being encountered, were substantially more likely
	408	to be seen as unacceptable (OR=0.44; p=0.034) by female patient care providers in countries
29 30 31	409	with higher COVID presence; a perception reinforced by a further (albeit less pronounced) effect
31 32 33	410	of in-country income inequality (OR=0.95; p=0.093).
34 35	411	
36 37 20	412	As we had observed was the case for all respondents, female care providers in higher income
38 39 40	413	countries were more likely to perceive mitigation measures to be adequate (OHS OR=3.94;
41 42	414	p=0.047 and IPC OR=11.25; p=0.004) than those in more poorly resourced settings, and this was
43 44	415	further accompanied by an effect of within-country inequality also contributing some
45 46 47	416	explanatory power (OHS OR=0.92; p=0.020).
47 48 49 50 51	417	
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2 3 4	418	DISCUSSION
5 6	419	High levels of concern about emerging threats to HCWs were widely published in the first year
0 7 8	420	of the COVID-19 pandemic, providing extensive evidence about morbidity and mortality
9 10	421	associated with healthcare work [33-35] as well as effects on job satisfaction [36]. Although
11 12	422	meta-analyses have been conducted to synthesize such findings [37], our article provides one of
13 14 15	423	the first worldwide examinations of contextual factors affecting the wellbeing of HCWs during
15 16 17	424	the COVID-19 pandemic, enabling a comparative cross-country analysis. In doing so, it notably
18 19	425	complements studies calling attention to inadequate implementation of OHS and IPC measures,
20 21	426	for example in South Africa [38] as well as a need to consider the influence of structural
22 23 24	427	determinants that affect how risks are experienced in specific health worker exposure contexts
25 26	428	[39]. The results presented here contribute a theoretical and empirically-based understanding of
27 28	429	the importance of inequality among and within countries in this regard. This has implications for
29 30 31	430	preparedness for any future pandemic outbreaks.
32 33 34	431	
35 36	432	Our findings clearly demonstrate that there is a strong need for improvements in OHS for HCWs
37 38 39	433	not only to protect against infectious disease transmission but to also control the threat of
40 41	434	psychosocial risks, a consideration that resonates with studies highlighting effects on mental
42 43	435	health of HCWs as already stressed workplaces with intensifying pressures when pandemics
44 45 46	436	emerge [40-44]. Widespread concerns about health risks identified in diverse locations such as
40 47 48	437	Ethiopia, Turkey, Italy and Spain in many facets of health work [45-48] signal a strong rationale
49 50	438	for international collaboration in seeking effective technical and policy approaches to best
51 52 53	439	protect HCWs.
53 54 55 56	440	

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441 Despite a common assessment of unacceptable levels of risk everywhere, our study revealed
442 important differences in the perceived adequacy of protective measures to meet this challenge.
443 Such results point to the need to add explicit attention to OHS measures in the World Health
444 Organization's call for better planning healthcare human resources [10] as well as the updating
445 of the WHO's *Global Plan of Action for Occupational Health*, considering what this means for
446 HCWs in light of the COVID-19 experience.

While the case prevalence in any one single country clearly influences the intensity of possible healthcare workplace exposure as a global pandemic emerges, HCWs in all countries face the same need for proper PPE, appropriate testing and vaccines as they compete in the same markets and the same supply chains [49,50]. While there is now appropriate attention focused on the need to address global inequities in vaccine accessibility [51], our study highlights other inequities that also call for greater attention. Moreover, our analysis stands out by considering how variation in protecting HCWs may be associated with the presence of contextual social and economic inequities, itself an important social determinant of health that has been prominent in global health research literature. What is of particular relevance here is the vulnerability of HCWs as "canaries" in a workplace made vulnerable by the emergence of a novel infectious disease [52], where preparedness to meet a new challenge is critical.

While the presence of unacceptable risk was clearly identified in all countries, it was striking that
the strongest concern about inadequate protection of HCWs came not from the HICs hit most
intensely by the initial wave of COVID in early 2020, but rather less well-resourced settings that
had yet to be as strongly affected. This vividly echoes pre-COVID findings that resource-poor

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464 countries have decreased capacities for protecting HCWs [13,14] even beyond needs for testing
465 and contact tracing, and consistent with studies noting needs for training and PPE for HCWs
466 [53]. This furthermore mirrors experience in previous pandemics such as Ebola in West Africa
467 where meaningful investments in PPE were shown to be important elements in combatting the
468 spread of disease [54], a matter that is now being observed with regard to COVID-19 [55]. Our
469 finding that country income level is strongly associated with greater capacity to provide
470 prevention and mitigation within a health system is thus not surprising.

Previous literature on the effects of income inequality within a society has however been less conclusive, at times contesting the implications of the Wilkinson's "economic inequality hypothesis". In this regard, Blázquez-Fernández and colleagues concluded that income inequality does not significantly reduce health in 'developed' societies [56] and Mellor and Milyo further argued that there is little support for relation between income inequality and individual or population health after fixed division effects were included [57]. However, when attention is paid to methodological concerns [17], strong evidence of the effect of economic inequality has been observed in Sub-Saharan African countries [58]. Looking beyond levels of economic indicators alone, a systematic study of "welfare regimes" (i.e. characterizations of policy orientations dominant in a country at a particular time) has suggested that precarious workers fare better in the context of "Scandinavian state" policies [59]. Indeed countries that recognized COVID-19 as a work-related disease and supported workers with compensation and appropriate absence policies, were reported to have reduced mental health stressors, pointing to opportunities for improving HCW well-being [60]. However, a systematic review of the impact

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2 3 4	486	of political economy on health observed substantial gaps in knowledge, calling for "higher-
5 6	487	quality reviews and empirical studies in this area" [61].
7 8 9	488	
10 11	489	Our study suggests that societies with greater national income equality may well be characterized
12 13	490	by policies that are more protective of vulnerable populations such as HCWs, a group whose
14 15 16	491	comparatively high occupational health risk is aggravated by the onset of pandemics. To better
17 18	492	understand the pathways and iterative relationships that can explain this, case study examinations
19 20	493	would certainly be of value. Moreover, with health worker protection so strategically important
21 22	494	to health system functioning during such crises that threaten global health equity, countries
23 24 25	495	known to be highly unequal might accordingly be deemed to be in need of even further technical
26 27	496	assistance and attention to ensure that adequate protection is provided to HCWs at risk.
28 29	497	
30 31 32	498	Recognizing that appreciation of the contribution of HCWs soared as the COVID pandemic
33 34	499	advanced, our observations that economic inequality among and within countries is associated
35 36	500	with the degree to which HCWs face unacceptable risk and inadequate protection signals a vital
37 38	501	need to promote social justice for those who play such an important role in the care of
39 40 41	502	populations before a new pandemic emerges. In light of this, from an analytical perspective, we
42 43	503	strongly endorse the call for a new paradigm [62] to better understand how upstream and socio-
44 45	504	political factors could be "affecting the nature of work and employment and their impact on the
46 47 48	505	health of workers, the public, and the planet" [63]. This includes consideration of international
49 50	506	cooperation not only with respect to vaccine supply, but also to ensure that less wealthy countries
51 52	507	receive technical assistance in establishing protection and mitigation programs as well as
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attention to pathways sensitive to the offloading of risks to more marginalized workerpopulations.

511 Limitations and further research needs

Cross-country comparative studies such as ours rely on a convenience sample, leading to some countries being over-represented while others were under-represented or non-existent. To address possible concerns about the influence of countries with low respondent counts, we examined this concern by conducting sensitivity analyses, summarized in Table S7, to consider possible implications, but concluded that this did not warrant a questioning of our findings. Additionally, the classification of countries purely by national income levels leads to designating some countries as high income in settings where national institutions may be minimally developed despite high levels of income earned through high value exports such as petroleum or in settings of small populations with externally controlled tourism sectors. As such, we developed grouping strategies to allow for a consideration of national contexts where resources could be considered comparatively more or less readily available to protect health workers. Stratification by WHO region was also important because these regions, while large and often heterogenous in nature, do constitute administrative units with an important governance role to play during the emergence of global outbreaks and pandemics.

527 It should also be acknowledged that differing perceptions of risks and mitigation measures 528 around the world may be influenced by different HCW training and education standards, cultural 529 nuances, and institutional expectations. For example, Senthi and colleagues observed that 530 workers in India found a high prevalence of workers unable to identify even immediate risks in 531 an evidently hazardous environment [64]. Studies in the Middle East also reported gaps between

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actual hazards and HCW recognition [65,66]. Ndejjo and colleagues report similar findings in
Uganda and across sub-Saharan Africa [67].

¹¹ 535 **CONCLUSION**

This study adds to the literature on how risks become unevenly distributed, focusing here on country income level but also on within-country income inequality. As noted by Gostin et al., 2020 [68], the WHO has an important role in supporting LMICs with technical guidance and operational assistance, while simultaneously meeting the needs of high-income countries for information sharing, research coordination, and convening authorities, despite lacking both the authority and the resources to mount a more effective response to a global emergency such as this. Our study strongly suggests that international agencies with mandates related to fair trading practices and economic aid have to step up to address the disparities that threaten the healthcare workforce, and ensure that there is sufficient resilience to retain health workers needed for broader delivery of health services. It is also a matter of social justice that they do so.

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11 12	555	reviewed and edited the manuscript. AY and JMS accept full responsibility for the finished work
13	555	and/or the conduct of the study as guarantors, had access to the data, and controlled the decision
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25 26	567 568	
27	569 570	Patient consent for publication Not required.
28	571	Ethics approval This study involves human participants and was approved by the Behavioural
29 30	572 573	Research Ethics Board of the University of British Columbia (Ref. H20-01825)
31	575 574	As the survey was designed to be completed and submitted anonymously, no formal request for signed consent was solicited, with participants' submission itself indicating consent to use the
32 33	575	information provided as anonymized aggregated data.
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3 4	577 578	APPENDIX
5	578 579	Study questionnaire. (Taken from Report on preliminary findings – ref 14.)
6 7 8	580 581	(Pdf)
9 10	582 583	ONLINE SUPPLEMENTAL MATERIAL
11 12 13	584 585 586	SI Dataset. Data underlying the results of the study. (Excel Data file (XLS). – to be provided through Dryad data depository
14 15 16 17 18	587 588 589 590	SI Figure. All supplemental figures. Figure S1 - Study Population diagram (pdf)
19 20	591 592	SI Table. All supplemental tables. (pdf)
21 22	593	Table S1 - Study population demographics
23 24	594	Table S2 - Summary of factors and their constituent question areas
25	595	Table S3 – Variation in factor scores by gender and occupation
26 27	596	Table S4 - Responses to health and safety risk questions
28 29	597	Table S5 - Responses to mitigation measure questions
30 31 32	598 599	Table S6 – Factors associated with female patient care providers perceived risk acceptability and mitigation adequacy
33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 9 50 51 52 53 54 55 56 57 58	600	Table S7 – Sensitivity analysis considering minimum sample size for calculating country mean values
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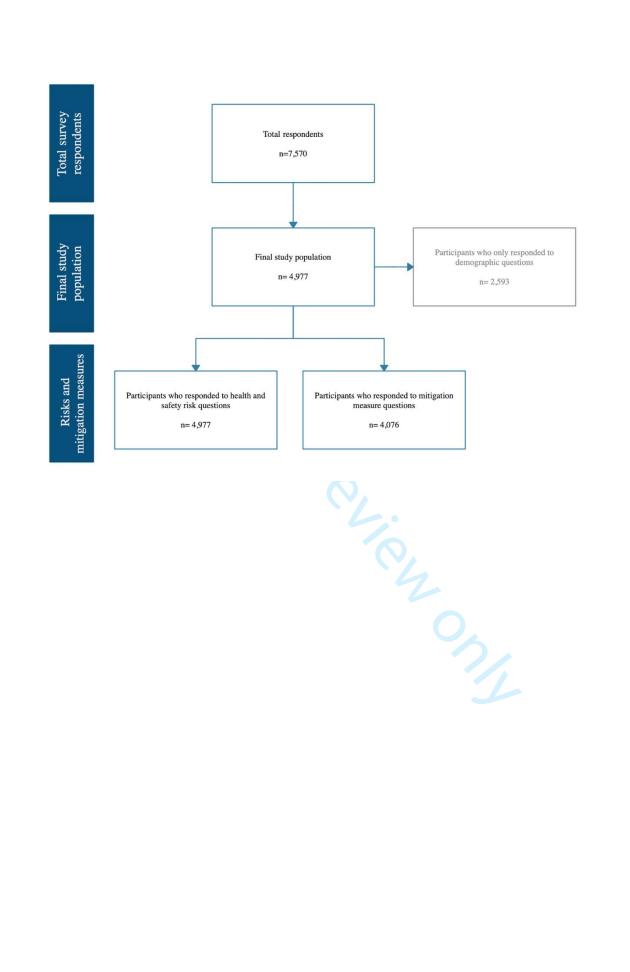
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Appendices

Survey instrument

Health and safety of health workers in COVID-19 Welcome to the survey on health and safety of health workers in COVID-19 Dear colleague,

This survey aims to identify the most common occupational risks for the health and safety of health workers and the measures for their prevention in the context of the ongoing pandemic of Corona Virus Infectious Disease (COVID-19).

In this survey we are interested in the health and safety of all health workers - all people engaged in the promotion, protection or improvement of the health of the population. This includes health workers involved in direct patient care, both formal and informal, in public and private facilities, including traditional medicine, as well as other assisting and supporting staff, including administration, management, ambulance drivers, public health workers, community health workers, and others.

The survey is intended for health workers, managers, and practitioners providing services for protecting the health and safety of workers in health facilities. The results will be used to inform action at all levels for improving the protection of health and safety of health workers in the ongoing response to COVID-19.

The survey has been developed by an international group of experts convened by the World Health Organization and the International Labour Organization and should take approximately 7 minutes to complete.

Your answers are completely confidential, and the data will be processed and analyzed in a way that will not link your answers to your identity.

B. About yourself and your area of work

1. In what country do you usually work? *Standard list of all countries in the world* Other (please specify)

* 2. Your gender? Male Female Other Prefer not to answer

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3. What is your primary area of work? (responses below were randomized)

Administration and clerical support

Allied health professional

Community health worker

Infection prevention and control

Management and human resources

Mental health and psychosocial support

Occupational and environmental health

Patient care (medicine, nursing, midwifery,

dentistry)

Pharmacy

Public health

Support staff - cleaner, driver, food worker

Other

4. You work most of the time for: (responses below were randomized)

Academia, research Business enterprise or farm Employers' association /hospital federation Healthcare facility - hospital, primary health-care centre, isolation camp Local community National government agency Other Professional association Social care facility (e.g. nursing home, home care). Sub-national (provincial, district) authority Trade union

C. Risks for health and safety of health workers

Think about the working conditions of health workers in your country, jurisdiction or health facility - those that you are most familiar with. No workplace is without risk, but some risks are negligible, or acceptable for a short time, and some are not acceptable at all. Below are some common risks for the health and safety of health workers; we are asking you to rate the current level of these risks, <u>now during the COVID-19 pandemic.</u>

5. How would you rate the level of these risks for health workers, now? (randomized)
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Questions	Risk is negligible	Risk is acceptable for a short time	Risk is not acceptable at all	Don't know/Unsure
Skin damage from personal protective equipment and/or frequent hand hygiene				
Needle-sticks and sharps injuries				
Inadequate sanitation facilities				
Insufficient access to facilities for personal hygiene, such as, shower and menstrual hygiene				
Exposure to blood, body fluids, respiratory secretions, and other potentially infectious materials				

6. How would you rate the level of these risks for health workers, now? (randomized)

Questions	Risk is negligible	Risk is acceptable for a short time	Risk is not acceptable at all	Don't know/Unsure
Back injury from manual handling of patients and heavy objects		(e		
Hazardous chemicals, drugs, cleaning and disinfection agents		5		
Slips, trips, and falls				
Crowded workplace			1	
Thermal discomfort (cold, heat, humidity)				

7. How would you rate the level of these risks for health workers, now? (randomized)

Questions	Risk is negligible	Risk is acceptable for a short time	Risk is not acceptable at all	Don't know/Unsure
Physical violence and assaults				
Bullying or psychological harassment at the workplace				
Sexual harassment				

8. How would you rate the level of these risks for health workers, now? (randomized)

6. How would you fall the level of th	ese mons for neu	ien workers, n	ow: (Iunuonn	200)
Questions	Risk is negligible	Risk is acceptable for a short time	Risk is not acceptable at all	Don't know/Unsure
Regular long working hours (more than 48 hours a week)				
Time pressure, high workload				
Shift work with night shifts				
Insufficient time-off duty to rest (less than 11 hours between shifts)				

9. How would you rate the level of these risks for health workers, now? (randomized)

Questions	Risk is negligible	Risk is acceptable for a short time	Risk is not acceptable at all	Don't know/Unsure
Skin damage from personal protective equipment and/or frequent hand hygiene				
Needle-sticks and sharps injuries				
Inadequate sanitation facilities				
Insufficient access to facilities for personal hygiene, such as, shower and menstrual hygiene		.0		
Exposure to blood, body fluids, respiratory secretions, and other potentially infectious materials		12		

D. Preventive measures

There are measures for the prevention of most risks for health and safety at work, but these measures may not be fully implemented and not all workers may benefit from these measures. Think again about the working conditions of health workers in your country, jurisdiction or health facility - those that you are most familiar with. The following questions are about the preventive measures for their health and safety in the real situation, now, during the COVID-19 pandemic.

10. How would you rate the level of application of these measures in the health services according to your knowledge? (randomized)

Questions	Does not exist at all	Exists and offers <u>some</u> protection	Exists and offers <u>full</u> protection	Don't know/Unsure
Policy for infection prevention and control in the health facility				
Processes for triage of patient in place at the emergency room, including early detection and isolation of infectious patients				
Routine assessment of the risk of exposure to body substances or contaminated surfaces before any health care activity and use of appropriate measures for personal protection				
Regular environmental clean-up and disinfection				
Immunization of health workers				
	.6	·		

11. How would you rate the level of application of these measures in the health services according to your knowledge? (randomized)

Questions	Does not exist at all	Exists and offers some protection	Exists and offers <u>full</u> protection	Don't know/Unsure
Reporting of incidental exposures to blood, body fluids, or respiratory secretions		2		
Policies in place for post-exposure prophylaxis, such as, for HIV, Hepatitis B		6		
Facilities for hand hygiene (hand washing and disinfection) are readily available			2	
Personal protective equipment, such as masks, gloves, goggles, gowns are readily available				
Training and education of workers about infection prevention and control				

12. How would you rate the level of application of these measures in health services according to	0
your knowledge? (randomized)	

Questions	Does not exist at all	Exists and offers <u>some</u> protection	Exists and offers <u>full</u> protection	Don't know/Unsure
Prevention of workplace violence and security measures				
Management of working time, rest and recuperation				
Workplace policies against bullying, psychological and sexual harassment				
Human resource management of safe staffing and workload				
Psycho-social support and counselling				
		•		

13. How would you rate the level of application of these measures in the health services according to your knowledge? (randomized)

Questions	Does not exist at all	Exists and offers <u>some</u> protection	Exists and offers <u>full</u> protection	Don't know/Unsure
Occupational safety and health policy and management system in the facility	~	•		
Regular assessment of workplace health and safety risks and controls				
Engineering controls, such as ventilation, physical barriers, safer devices		1.0		
Ergonomic workplace design and furniture		4		
Devices for patient handling and lifting of loads				

14. How would you rate the level of application of these measures in the health services according to your knowledge? (randomized)

Questions	Does not exist at all	Exists and offers some protection	Exists and offers full protection	Don't know/Unsure
Regular medical check-ups of health workers				
Medical first aid kits				
Consultations between management and workers regarding health and safety at work				
Training and education of workers about occupational safety and health				
Other (please specify)				

Group	Survey responses
Patient care/health services	Patient care (medicine, nursing, midwifery, dentistry)
	Allied health professional
	Mental health and psychosocial support
	Pharmacy
	Community health worker
Specialized support	Occupational and environmental health
	Public health
	Infection prevention and control
	Support staff - cleaner, driver, food worker
Clerical support/administration and management	Administration and clerical support
	Management and human resources

Table A 1: Survey options for occupation

Table A 2: Comparison between participants who answered risk and mitigation questions

	Variables	Those who responded to risk questions (n=4977)	Those who responded to mitigation measure questions (n=4076)
Countries by region	AFRO	10%	11%
-	EMRO	4%	4%
	EURO	35%	36%
	РАНО	31%	31%
	SEARO	3%	3%
	WPRO	15%	16%
Economic Class	High	59%	60%
	Lower-middle	10%	10%
	Upper-middle	27%	10% 26% 4%
	Low	4%	4%
Sex	Male	33%	34%
	Female	65%	65%
	Other / prefer not to answer	1%	1%
Occupation	Patient care/health services	56%	58%
	Specialized support	29%	29%
	Clerical support/administration and management	7%	7%
	Other	8%	7%

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Health and safety of health workers in the context of COVID-19: A global survey

Sean P. Harrigan, Vivian W. L. Tsang, Jerry M. Spiegel, Annalee Yassi

September 15, 2020



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ONLINE SUPPLEMENTARY INFORMATION

Table S1. Study population demographics

Variables		n	%
Total number of partie	4977	100%	
Total who replied to t	4977	100%	
Total who replied to the mitigation measures questions		4076	82%
Total number of coun	161	100%	
Countries by region	African region	516	10%
	Americas region	1565	31%
	Eastern Mediterranean region	221	4%
	European region	1757	35%
	South East Asian region	158	3%
	Western Pacific region	760	15%
Economic Class	High	2960	59%
	Lower-middle	480	10%
	Upper-middle	1324	27%
	Low	213	4%
Sex	Male	1654	33%
	Female	3259	65%
	Other / prefer not to answer	64	1%
Occupation	Patient care/health services	2805	56%
	Specialized support	1426	29%
	Clerical support/administration and management	341	7%
	Other	405	10%
Type of employer	Health services	3038	61%
	Government services	758	15%
	Business and farms	473	10%
	Academia	367	7%
	Professional associations	177	4%
	International organization/NGO and non-for-profit	51	1%
	Other	113	2%

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Survey area of focus	Factor	Description of question
Health and Safety Risks	Work Environment (Factor 1)	Blood and bodily fluids exposure Skin damage from PPE and hand hygiene Needlesticks and sharps injuries Sanitation facilities Personal hygiene Thermal discomfort Crowded workplace Slips trips & falls Back injury form heavy lifting Chemicals Bullying & harassment Sexual harassment
	Work Organization (Factor 2)	Physical violence and assaults Time pressure Shift work Long working hours Insufficient rest
Mitigation measures	Infection protection and control (Factor 3)	IPC policy Patient triage Standard precautions Cleanup & disinfection Immunization Reporting of blood exposure Policies for post-exposure prophylaxis Hand hygiene PPE IPC training
	Occupational health and safety (Factor 4)	OSH policy Occupational health and safety risk assessment Occupational health and safety engineering controls Ergonomic workplace design and furniture Safe patient handling Violence prevention Management of working time & rest Policy harassment Safe staffing & workload Psychosocial support Medical checkups Medical first aid kits Labour management consultation on OSH Occupational health and safety training

Table S3: Detailed breakdowns in individual level responses by occupation and gender

a. Detailed breakdowns in responses by occupation showing gender differences

			R	lisk accept	ability		Mitigation adequacy			
				Work Work environment organization			IPC		OHS [f	OHS [f3]
Population characteristic		n ^c	mean	р	mean	р	mean	р	mean	Р
All Occupations		4916	3.88	0.04	3.87	0.101	4.79	<0.01	6.28	0.19
7 III Occupations	m	4710	4.11	<0.01	3.92	0.397	4.88	<u>0.089</u>	6.19	<u>0.17</u>
	f		3.76		3.85	0.007	4.74	0.000	6.33	0.07
- Patient Care		2792	3.92	0.001	3.88	0.296	4.63	0.76	6.27	0.092
	m		4.19		3.96		4.65		6.15	
	f		3.80		3.84		4.62		6.32	
- Specialist		1404	3.84	0.129	3.80	0.669	4.90	0.218	6.30	0.193
	т		3.97		3.77		5.00		6.20	
	f		3.73		3.83		4.81		6.39	
- Admin-Mgr		327	4.14	<u>0.06</u>	4.22	0.632	5.50	0.512	6.50	0.872
	m		4.65		4.33		5.65		6.54	
	f		3.92		4.17		5.43		6.48	
- Other		393	3.55	0.205	3.82	0.189	5.03	0.20	6.08	0.89
	т		3.82		4.10		5.30		6.11	
	f		3.43		3.69		4.90		6.08	

Note: Statistical significance at p<.05 level indicated by bold; statistical significance at p<.10 level indicated by underlining. Italic font is used for breakdown analysis (i.e. by gender) of population attribute (regular font) being analyzed (i.e. by occupation) and values are right-justified.

Regular font is used for analysis of the population attribute (regular font) being analyzed (i.e. by occupation).

Green colour indicates significant value deemed as associated with less risk (i.e. less unacceptable exposure; more adequate mitigation. Red colour indicates statistically significant value associated with more risk (i.e. more unacceptable exposure; less adequate mitigation.

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	Risk acceptability Mitigation adequacy								
		Work Work environment organization			IPC		OHS [f3]		
Population characteristic	n ^c	mean	р	mean	р	mean	р	mean	Р
Total	4863	3.88	<0.01*	3.87	0.4	4.79	<u>0.09</u>	6.28	<u>0.07</u>
Patient Care		3.91		3.88		4.63		6.27	
Specialist		3.84		3.80		4.90		6.30	
Admin-Mgr		4.14		4.22		5.50		6.50	
Other		3.55		3.82		5.03		6.08	
Female	3220	3.76	0.189	3.85	0.273	4.74	<0.01*	6.33	0.288
Patient Care		3.80		3.84		4.62		6.32	
Specialist		3.73		3.83		4.82		6.39	
Admin-Mgr		3.92		4.17		5.43		6.48	
Other		3.43		3.69		4.90		6.07	
Male	1643	4.11	<u>0.089</u>	3.92	0.166	4.88	0.001	6.19	0.527
Patient Care		4.19		3.96		4.65		6.15	
Specialist		3.97		3.77		5.00		6.20	
Admin-Mgr		4.65		4.33		5.65		6.54	
Other		3.82		4.10		5.30		6.11	

Note: Statistical significance at p<.05 level indicated by bold; statistical significance at p<.10 level indicated by underlining. Italic font is used for breakdown analysis (i.e. by occupation) of population attribute (regular font) being analyzed (i.e. gender) and values are right-justified.

Regular font is used for analysis of the population attribute (regular font) being analyzed (i.e. by gender).

Green colour indicates significant value deemed as associated with less risk (i.e. less unacceptable exposure; more adec Red colour indicates statistically significant value associated with more risk (i.e. more unacceptable exposure; less adea

Table S4. Responses to health and safety risk questions

Question	Risk is not acceptable at all	Risk is acceptable for a short time	Risk is negligible	Don't know/unsure
Infectious risks				
Exposure to blood, body fluids, respiratory				
secretions, and other potentially infectious materials	52%	29%	15%	4%
Skin damage from personal protective equipment and/or frequent hand hygiene	33%	46%	16%	5%
Needle-sticks and sharps injuries	46%	21%	26%	7%
Inadequate sanitation facilities Insufficient access to facilities for personal	52%	21%	23%	4%
hygiene, such as, shower and menstrual hygiene	49%	22%	23%	6%
Physical work environment				
Thermal discomfort (cold, heat, humidity)	25%	46%	24%	5%
Crowded workplace	42%	36%	18%	4%
Slips, trips, and falls	34%	26%	33%	7%
Back injury from manual handling of patients and heavy objects	41%	34%	19%	6%
Hazardous chemicals, drugs, cleaning and disinfection agents	36%	36%	22%	6%
Psychosocial work environment				
Bullying or psychological harassment at the workplace	54%	18%	21%	7%
Sexual harassment	50%	10%	31%	9%
Physical violence and assaults	54%	16%	24%	6%
Work organization				
Time pressure, high workload	38%	49%	10%	3%
Shift work with night shifts	23%	48%	21%	8%
Regular long working hours (more than 48 hours a week)	38%	42%	15%	5%
Insufficient time-off duty to rest (less than	40%	36%	18%	6%

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Question	Does not exist at all	Exists and offers some protection	Exists and offers full protection	Don't know/ unsure
Infection prevention and control				
IPC policy in the health facility	8%	60%	28%	4%
Patient triage	9%	54%	28%	9%
Standard precautions	15%	53%	25%	7%
Regular environmental clean-up and disinfection	6%	56%	34%	4%
Immunization of health workers	19%	46%	26%	9%
Reporting of incidental exposures to blood, body fluids, or respiratory secretions	10%	50%	32%	8%
Policies in place for post-exposure prophylaxis, such as, for HIV, Hepatitis B	8%	41%	42%	9%
Facilities for hand hygiene (hand washing and disinfection) are readily available	3%	40%	54%	3%
Personal protective equipment, such as masks, gloves, goggles, gowns are readily	8%	55%	34%	3%
available Training and education of workers about infection prevention and control	11%	54%	32%	3%
Occupational safety and health				
Occupational safety and health policy and management system in the facility	14%	58%	22%	6%
Regular assessment of workplace health and safety risks and controls	22%	51%	21%	6%
Engineering controls, such as ventilation, physical barriers, safer devices	19%	54%	19%	8%
Ergonomic workplace design and furniture	33%	48%	12%	7%
Devices for patient handling and lifting of loads	27%	48%	15%	10%
Prevention of workplace violence and security measures	21%	52%	21%	6%
Management of working time, rest and recuperation	20%	55%	19%	6%
Workplace policies against bullying, psychological and sexual harassment	27%	43%	21%	9%
Human resource management of safe staffing and workload	24%	52%	16%	8%
Psycho-social support and counselling	32%	46%	15%	7%
Regular medical check-ups of health workers	33%	43%	18%	6%
Medical first aid kits	15%	48%	30%	7%
Consultations between management and				
workers regarding health and safety at work Training and education of workers about	25%	50%	19%	6%
occupational safety and health	20%	54%	21%	5%

Table S5. Responses to mitigation measure questions

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Patient Care Patient Care Frontline^e All occupations Female All all **Countries included** 112 133 156 161 **Explanatory Variable OR**^d **OR**^d **OR**^d **OR**^d р р р р (organized by outcome area) Acceptable WP Enviro. Risk Country Income Level ^a 0.81 0.736 0.63 0.415 1.01 0.981 1.24 0.708 0.98 Gini Coefficient b 0.609 0.96 0.1991 0.94 0.068** 0.92 0.012* COVID-Log ^c 1.12 0.777 1.33 0.398 1.22 0.549 1.09 0.801 Acceptable WP Org. Risk 0.657 1.30 Country Income Level a 1.57 1.06 0.926 0.52 0.446 0.71 Gini Coefficient b 0.95 0.093** 0.024* 0.93 0.93 0.056** 0.95 0.017* 0.034* COVID-Log^c 0.44 0.66 0.248 0.98 0.951 0.89 0.710 **Adequate IPC mitigation** Country Income Level ^a 11.25 0.004* 0.001* 7.48 0.006* 6.92 0.001* 6.61 Gini Coefficient b 0.95 0.220 0.95 0.047* 0.94 0.025* 0.95 0.125 0.479 COVID-Log c 0.69 0.7 0.70 0.264 0.181 0.76 0.373 **Adequate OHS mitigation** Country Income Level ^a 3.94 0.047* 5.86 0.004* 18.39 <0.001* 10.91 <0.001* Gini Coefficient b 0.92 0.020* 0.95 0.083** 0.99 0.99 0.779 0.755 COVID-Log^c 0.79 0.556 0.99 0.69 0.281 0.988 1.08 0.816

Table S6: Comparing analyses of acceptability and adequacy in different stratified populations

^a Country Income was coded as comparing "High and Upper-Middle Income" countries versus "Low and Lower-Middle Income" countries

^b Gini coefficient was considered in the logistic regression analysis as a continuous variable;

^c COVID levels where the log value of the rate of cases per million at the beginning of the survey (taken June 1, 2020); log values to smooth very high levels while taking variation into account

^dOdds Ratios were calculated by assessing the likelihood (OR) of the presence of a mean scores \geq 5 corresponding to assessments that mitigation "exists and offers some protection" or better; or level of risk is assessed as "risk is acceptable for a short time" or better.

^e includes all patient care and workplace specialist support personnel such as OHS and IPC professionals

* Indicates statistical significance (p<0.05) and also bolded; ** p<.10 but >.05; indicated in italics and bold

	Patient Care Female		Patient Care Female		Frontline ^e		Frontline ^e		
Minimum country sample		2		all		4	:	all	
Countries included		80 112		101		161			
Explanatory Variable (organized by outcome area)	OR ^d	р	OR ^d	р	OR ^d	р	OR ^d	р	
Acceptable WP Enviro. Risk									
Country Income Level ^a	0.62	0.556	0.81	0.736	1.03	0.967	1.01	0.981	
Gini Coefficient ^b	0.97	0.404	0.98	0.609	0.95	0.228	0.94	0.068**	
COVID-Log	1.11	0.852	1.12	0.777	0.89	0.797	1.22	0.549	
Acceptable WP Org. Risk									
Country Income Level ^a	1.2	0.830	1.30	0.657	1.33	0.736	1.06	0.926	
Gini Coefficient b	0.97	0.487	0.95	0.093**	0.94	0.230	0.93	0.056**	
COVID-Log	0.77	0.617	0.44	0.034*	0.42	0.457	0.98	0.951	
Adequate IPC mitigation		$\mathbf{\nabla}$							
Country Income Level ^a	9.62	0.041*	11.25	0.004*	36.89	0.001*	6.92	0.001*	
Gini Coefficient ^b	0.94	0.223	0.95	0.220	0.98	0.647	0.95	0.047*	
COVID-Log	0.54	0.433	0.69	0.479	0.48	0.190	0.70	0.264	
Adequate OHS mitigation		•							
Country Income Level ^a	3.00	0.153	3.94	0.047*	5.46	0.020*	18.39	<0.001*	
Gini Coefficient ^b	0.94	0.077**	0.92	0.020*	0.94	0.061**	0.99	0.755	
COVID-Log	0.67	0.392	0.79	0.556	0.56	0.152	0.99	0.988	

Table S7: Comparing analyses when minimum country sample size provisions are applied

^a Country Income was coded as comparing "High and Upper-Middle Income" countries versus "Low and Lower-Middle Income" countries

^b Gini coefficient was considered in the logistic regression analysis as a continuous variable;

^c COVID levels where the log value of the rate of cases per million at the beginning of the survey (taken June 1, 2020); log values to smooth very high levels while taking variation into account

^d Odds Ratios were calculated by assessing the likelihood (OR) of the presence of a mean scores \geq 5 corresponding to assessments that mitigation "exists and offers some protection" or better; or level of risk is assessed as "risk is acceptable for a short time" or better.

^e includes all patient care and workplace specialist support personnel such as OHS and IPC professionals

* Indicates statistical significance (p<0.05) and also bolded; ** p<.10 but >.05; indicated in italics and bold

	Item No	Recommendation	Page No
Title and abstract	1	(<i>a</i>) Indicate the study's design with a commonly used term in the title or the abstract	1 & 2
		(b) Provide in the abstract an informative and balanced summary of	2-3
		what was done and what was found	
Introduction			1
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	4-5
Objectives	3	State specific objectives, including any prespecified hypotheses	5
Methods			
Study design	4	Present key elements of study design early in the paper	5
Setting	5	Describe the setting, locations, and relevant dates, including periods	6-7
C		of recruitment, exposure, follow-up, and data collection	
Participants	6	(a) Give the eligibility criteria, and the sources and methods of selection of participants	6-7
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	8-10
Data sources/	8*	For each variable of interest, give sources of data and details of	7-9
measurement	0	methods of assessment (measurement). Describe comparability of	
measurement		assessment methods if there is more than one group	
Bias	9	Describe any efforts to address potential sources of bias	9,10,17
Study size	10	Explain how the study size was arrived at	6, 11-12
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	8-10
Statistical methods	12	(<i>a</i>) Describe all statistical methods, including those used to control for confounding	9-11
		(b) Describe any methods used to examine subgroups and interactions	9-11
		(c) Explain how missing data were addressed	9
		(<i>d</i>) If applicable, describe analytical methods taking account of sampling strategy	n/a
		(<u>e</u>) Describe any sensitivity analyses	25
Results			1
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	11
		(b) Give reasons for non-participation at each stage	6-7
		(c) Consider use of a flow diagram	Fig S1
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	11-12
		(b) Indicate number of participants with missing data for each variable of interest	n/a

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Outcome data	15*	Report numbers of outcome events or summary measures	
Main results	16	(a) Give unadjusted estimates and, if applicable, confounder-adjusted	11-18
		estimates and their precision (eg, 95% confidence interval). Make	
		clear which confounders were adjusted for and why they were	
		included	
		(b) Report category boundaries when continuous variables were	18-20
		categorized	
		(c) If relevant, consider translating estimates of relative risk into	n/a
		absolute risk for a meaningful time period	
Other analyses	17	Report other analyses done-eg analyses of subgroups and	18-20
		interactions, and sensitivity analyses	
Discussion			
Key results	18	Summarise key results with reference to study objectives	21-22
Limitations	19	Discuss limitations of the study, taking into account sources of	25-26
		potential bias or imprecision. Discuss both direction and magnitude	
		of any potential bias	
Interpretation	20	Give a cautious overall interpretation of results considering	21-25
		objectives, limitations, multiplicity of analyses, results from similar	
		studies, and other relevant evidence	
Generalisability	21	Discuss the generalisability (external validity) of the study results	26
Other information			
Funding	22	Give the source of funding and the role of the funders for the present	7
		study and, if applicable, for the original study on which the present	
		article is based	

*Give information separately for exposed and unexposed groups.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.