

The impact of COVID-19 on health and care workers: a closer look at deaths

World Health Organization
Health Workforce Department

Working paper 1

September 2021



**World Health
Organization**

The impact of COVID-19 on health and care workers: a closer look at deaths

World Health Organization
Health Workforce Department

Working paper 1

September 2021

The impact of COVID-19 on health and care workers: a closer look at deaths.

© World Health Organization 2021.

Some rights reserved. This work is available under the CC BY-NC-SA 3.0 IGO licence.

WHO reference number: WHO/HWF/WorkingPaper/2021.1

Suggested citation. The impact of COVID-19 on health and care workers: a closer look at deaths. Health Workforce Department – Working Paper 1. Geneva: World Health Organization; September 2021 (WHO/HWF/WorkingPaper/2021.1). Licence: CC BY-NC-SA 3.0 IGO.

General disclaimers. The designations employed and the presentation of the material in this publication do not imply the expression of any opinion whatsoever on the part of WHO concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries. Dotted and dashed lines on maps represent approximate border lines for which there may not yet be full agreement.

The mention of specific companies or of certain manufacturers' products does not imply that they are endorsed or recommended by WHO in preference to others of a similar nature that are not mentioned. Errors and omissions excepted; the names of proprietary products are distinguished by initial capital letters.

All reasonable precautions have been taken by WHO to verify the information contained in this publication. However, the published material is being distributed without warranty of any kind, either expressed or implied. The responsibility for the interpretation and use of the material lies with the reader. In no event shall WHO be liable for damages arising from its use.

Technical editing by David FitzSimons

Design and layout by L'IV Com Sàrl, Switzerland

Contents

Acknowledgements	iv
Acronyms	iv
Key messages	1
Background	2
The uncertainties around the magnitude of Covid-19 deaths	3
Methods	4
Results	5
Discussion	8
Limitations	8
Conclusion	9
References	10
Annex 1: The inequitable distribution of HCWs regionally and by country income levels	12
Annex 2: Scoping review of SARS-CoV-2 infections and deaths from COVID-19 among HCWs	13
Annex 3: Three main steps to explain indirect standardization (by sex and age)	15
Annex 4: Estimated deaths in HCWs using the Institute for Health Metrics and Evaluation's estimated number of COVID-19 deaths globally	17

Acknowledgements

Based in the Health Workforce Department (HWF) of the World Health Organization (WHO), the lead authors of this working paper are Amani Siyam, Mathieu Boniol, Khassoum Diallo and Jim Campbell (with special support from Tapas Sadasivan Nair in the compilation of the literature, systematic reviews and anecdotal evidence). The lead authors received support and internal feedback from Maya Allan (Health Emergency Information and Risk Assessment) and Maja Lievre and Julia Fitzner (Global Influenza Programme). We are grateful for the departmental feedback from Giorgio Cometto (Health Workforce Policies and Standards) and Pascal Zurn (Health Labour Market and Partnerships).

We are grateful for the technical inputs throughout the analyses presented in this paper provided by Health Emergency Information and Risk Assessment Department (Oliver Morgan, Boris Pavlin, Olivier Le Polain), Integrated Health Services (Benedetta Allegranzi, Alessandro Cassini) and Maria van Kerkhove (Emerging Diseases and Zoonoses).

We acknowledge and appreciate the external review and feedback provided by Ties Boerma (University of Manitoba, Canada), Colin Mathers (Global Health Statistics), Paul Spiegel (Johns Hopkins Bloomberg School of Public Health, Baltimore, Maryland, United States of America) and Samuel Ho (Mohamed Bin Rashid University of Medicine and Health Sciences, Dubai, United Arab Emirates). We are also grateful for the comments received from Howard Catton (International Council of Nurses), Oliver Liang (International Labour Organization), Stefano Scarpetta (Organisation for Economic Co-operation and Development) and members of the Steering Committee of the International Year of the Health and Care Workers (2021).

Acronyms

COVID-19	The coronavirus disease 2019
HCW	Health and care worker
IHME	Institute for Health Metrics and Evaluation
ILO	International Labour Organization
SARS-CoV-2	The virus that causes COVID-19
WHO	World Health Organization

Key messages

- Between January 2020 and May 2021, surveillance data reported to WHO showed 3.45 million deaths due to COVID-19. Of these only 6643 deaths were identified as being in health and care workers (HCWs), but this figure significantly under-reports the burden of mortality world-wide in this group.
- From different analytical approaches, this working paper attempts to estimate the global number of deaths in HCWs due to COVID-19.
- Based on the International Labour Organization's estimated number of 135 million HCWs employed in human health and social activities and WHO's surveillance data on all deaths reported to be due to COVID-19, mixed analytical approaches present a range between 80 000 to 180 000 deaths globally with a central population-based estimate of 115 500 deaths.
- These figures, however, largely derive from the 3.45 million COVID-19-related deaths reported to WHO, a number that by itself is proving to be much lower than the actual death toll (60% or more than reported to WHO).
- High-quality recording and reporting of infections and deaths among HCWs are fundamental measures to enable appropriate protective steps to be instigated and to support calls for significant investments in integrating occupational data in death certification and surveillance reporting.
- In view of the mounting evidence that the number of deaths due to COVID-19 among HCWs is much greater than officially reported, the need for protection through vaccination cannot be overstated.
- In countries where vaccination rates of HCWs remain low, tailored communication strategies must be designed and actively pursued to increase uptake and avert vaccination hesitancy.

Background

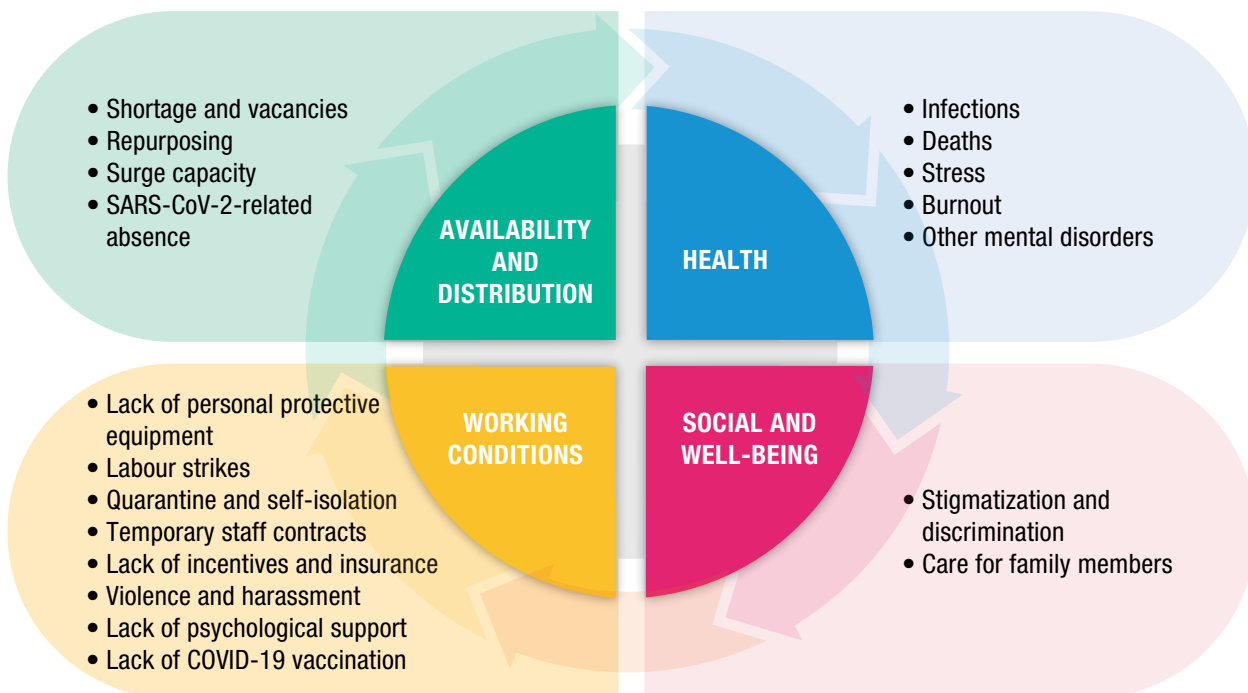
On 30 January 2020, the Director-General of the World Health Organization (WHO) declared the outbreak of disease due to a novel coronavirus a public health emergency of international concern: WHO's highest level of alarm (1). For health and care workers (HCWs) around the world the pandemic caused a heightened risk of occupational exposure to a new fast-spreading disease and created the need to adapt roles and responsibilities for a wide range of tasks and professional settings (2,3).

Intense global mobilization of public health and social measures in health facilities and communities followed, alongside the introduction of clinical protocols and individual risk assessment

in hospital settings (4). The pandemic resulted in many infections and deaths among HCWs and their households (5); the consequences continue to be measured by a diverse stream of anecdotal evidence and variable quality standards (6–9).

Undoubtedly, the health and care sector is one of the most severely hit by the pandemic as those employed or contracted in it face multiple hazards that affect their physical, mental and social well-being. HCWs have been documented to have a higher risk of infection with SARS-CoV-2 than the general population (10). Throughout 2020, the WHO Secretariat elaborated a framework to support the standardized measurement and reporting of the multidimensional impact of the pandemic on HCWs, including infection, death and mental health disorders but also the consequences of labour strikes and protests (Fig. 1) (11).

FIG. 1
Multidimensional factors related to COVID-19 that affect HCWs



BOX 1

Objectives of the campaign to support the International Year of Health and Care Workers



Concerns over the broader impact of the pandemic on HCWs and their crucial role at the forefront of the response were recognized by the Seventy-third World Health Assembly at its resumed session in November 2020 with the designation in decision WHA73(30) of 2021 as the International Year of Health and Care Workers (12). Shortly thereafter WHO launched a global campaign to support the International Year (13).

The objectives of the campaign (Box 1) include a focus on protecting HCWs from harm. The campaign prioritizes vaccination of HCWs against COVID-19, calls for the measuring of all deaths of HCWs from COVID-19, and emphasized the need for global governance to agree a compact that upholds the principle of the duty of care. Only by measuring the numbers of vaccinations, infections and deaths specifically by occupation for HCWs can national authorities implement appropriate policy measures and responses to reduce the risks of infection and death to HCWs.

As at the time of writing this working paper (7 July 2021), reports to WHO from more than 100 Member States indicate the uptake of COVID-19 vaccination by HCWs, although with considerable differences occurring across different WHO regions (14).

The uncertainties around the magnitude of Covid-19 deaths

At the outset of the pandemic, WHO established a coronavirus (COVID-19) surveillance and reporting system for its Member States, collating information into a database, and a corresponding dashboard (15). Globally, the surveillance data so collected retain a central importance in the count of infections and deaths. However, health data systems and capacities are limited in some regions when it comes to reporting vital statistics on deaths and cause of death. Before the pandemic, a global assessment revealed that four out of 10 deaths in the world are unregistered (16).

Predictably, the reported number of deaths due to COVID-19 has been regularly questioned, and different analyses have been put forward by WHO, the Institute for Health Metrics and Evaluation (IHME) and data journalism entities offering global and cross-country estimates (Table 1). By and large, these analyses used excess deaths – the number of deaths over and above what could normally be expected at the same time of year (17) – to assess both the direct and indirect impact of COVID-19. In spite of known limitations in comparisons

TABLE 1

Number of deaths due to COVID-19 reported, estimated and the estimated magnitude of under-reporting (January 2020–May 2021)

Scope	Reported to WHO COVID-19 surveillance	A summary of estimates derived from different sources ^a		
		Source (reference)	Value/range	Coverage/comments
Global (general population)	3.45 million COVID-19 deaths (reported until 16 May 2021)	WHO (18)	Three million deaths – 60% higher than the COVID-19 deaths reported to WHO (1 813 188) in 2020	Only the WHO Region of the Americas and the WHO European Region
		<i>Financial Times</i> (19)	60% higher than the reported data	14 countries (mainly European)
		IHME (20)	6.9 million – nearly twice the number of 3.45 million deaths reported to WHO	Based on excess-mortality ^b analysis methods and data from 56 countries (198 subnational units). The models estimate excess deaths confirmed as being directly due to COVID-19.
		<i>The Economist</i> (21)	10 million deaths (range 6–13 million) – nearly four times the number of 3.45 million deaths reported to WHO	Data from multiple sources for 200 countries (including China and India) and territories; based on a machine-learning model

^a These estimates are openly accessible from original sources (including data sets, methods, statistical codes and supporting materials), technical rigour and global representation.

^b Excess mortality is a measure of mortality over and above what could normally be expected for the period (for example using the average over the previous five years) that can show the impact – both direct and indirect – of COVID-19 (17).

of excess mortality across countries (17), the results of these analyses suggest that the number of deaths due to COVID-19 is at least 60% higher than reported (Table 1), and more likely even higher in countries with inadequate death registration systems or statistical infrastructure.

Information derived by the breakdown of the number of deaths by occupation introduces an additional level of uncertainty. For its surveillance data the WHO Secretariat asked countries to focus on the disaggregation of infections and deaths among HCWs. In the earliest months of the pandemic (March–May 2020), reports from Member States showed that HCWs experienced more than triple the risk of infection compared to that of the general population. However, significant gaps appeared in the reporting on deaths (22). As at 16 May 2021, the global number of HCWs' deaths due to COVID-19 reported to WHO was only 6643. This figure is inconsistent with those from almost all other data sources, including peer-reviewed manuscripts, reports from government bodies and health-care professional associations as well as press and media coverage within and across countries (6–9). Indeed, in some instances there are zero reported deaths from entire WHO regions (Table 2), despite such data being a focus of global

governance and essential as the basis for occupational health and safety measures (23).

In this working paper we have therefore attempted to estimate the global number of deaths in HCWs due to COVID-19 through different analytical approaches. We have taken into account the pandemic's varied impact across regions and countries, and made adjustments for the proportion of the general population who are HCWs. For example, in most high-income countries affected by the pandemic, HCWs represent between 3% and 7% of the general population, whereas in almost all middle-income and low-income countries, where decades of underinvestment in the health workforce persist, HCWs constitute less than 3% of the general population (see Annex 1).

Methods

Data

Countries' reported numbers of infections and deaths between 1 January 2020 to 16 May 2021 were extracted from the WHO's surveillance database for COVID-19 (reported through the case report form and the weekly aggregated surveillance system (24)).

In this database, HCWs are defined as “all staff involved in the provision of care to a COVID-19 patient” and further include allied and auxiliary health workers such as cleaning and laundry personnel, X-ray physicians and technicians, clerks (including admission/reception clerks), phlebotomists, respiratory therapists, nutritionists, social workers, physical therapists, laboratory personnel, orderlies (including staff moving patients), and catering staff (23). This definition provides the best starting point, in terms of real-time data collection, to include as many health and care occupations involved in the COVID-19 response as possible. To analyse the data collected with this definition and how it might have been variously used by countries for their reporting, we considered the broader population of HCWs that encompassed all those employed in “human health and social activities” as classified by the International Standard Industrial Classification of All Economic Activities (24). For each country, this number was obtained from ILO’s database on labour statistics (ILOSTAT), which estimates¹ globally more than 135 million employed workers in 2020 (25). Population data for 2020 were extracted from the World Population Prospects 2019 of the United Nations statistics divisions (26). Summary statistics on the prevalence of infection with SARS-CoV-2 and the risk of death were extracted from a meta-analysis on the clinical outcomes and risk factors for SARS-CoV-2 infection among HCWs (see Annex 2 for more detail) (27, 28).

Methods for estimating deaths due to COVID-19 among HCWs

As a start, the number of deaths among HCWs was simply estimated by applying the crude mortality rate from each country (namely, the number of deaths reported to the WHO COVID-19 Dashboard (15) divided by the population size) to the estimated number of HCWs in each country derived from ILOSTAT (25). This simple estimation considers HCWs to have a similar exposure to SARS-CoV-2 infection and risk of death to that of the general population (regardless of age or sex). The unknown balancing act to this estimation is whether HCWs are expected to be younger and healthier² than the ages of maximum mortality risk, yet at presumably higher risk of infection compared to the general population (both at the

workplace and the community particularly in countries lacking practices, provisions and guidance on infection prevention and control).

This analysis was therefore refined with an age- and sex-indirect standardization by computing age- and sex-specific mortality (see Annex 3). The reported deaths were redistributed in each country on the basis of the age and sex distribution of deaths from COVID-19 reported for some countries to WHO. The ILO’s estimated numbers of HCWs (25) (disaggregated by sex) were redistributed according to the age and sex structure of the population size (26) in the age range 25–64 years. The age- and sex-specific mortality rates were then computed for each country and applied to the country’s redistributed HCW population. This approach still considers a similar risk of exposure for HCWs as that of the general population and does not account for any of the probable higher risks aforementioned.

A third approach builds on a systematic review of SARS-CoV-2 infections and deaths of HCWs (see Annex 2), which indicates that, in the period between March and July 2020, infections of HCWs amounted to 12.5% (confidence interval 6.2%, 23.5%) of all SARS-CoV-2 infections (28). Support for the lower bound of 6.2% of all infections is corroborated by the declining share of infections in HCWs of all SARS-CoV-2 infections reported to WHO (from 5.7% in May 2020 to 1.8% by May 2021). Infections in HCWs are therefore estimated as 6.2% of all SARS-CoV-2 infections reported by each country and the latter estimation was then multiplied by the prevalence of deaths among HCWs as estimated by the meta-analysis (see Annex 2) (28).

Results

Table 2 indicates that the population-based estimated number of deaths due to COVID-19 in HCWs is 115 493, a figure that effectively nullifies the total of 6633 such deaths reported to WHO’s COVID-19 surveillance database. As it stands, this population-based estimate is affected (with no feasible correction) by the under-reporting of COVID-19 deaths, particularly from WHO’s African, South-East Asia, Eastern Mediterranean and Western Pacific regions. One refinement (by indirect standardization for age and sex) estimates deaths in HCWs at 83 000, with males making up around 60% of those deaths (Table 2, Triangulation A).

¹ Data are derived from labour force surveys, other sufficiently comparable household surveys or population censuses.

² The health worker effect phenomenon is refutable in this context of multiple HCWs’ occupations facing a new and variant-evolving pandemic. Moreover, the latest evidence shows that the phenomenon “... is not uniform across age groups, gender, race, and types of occupations and nor is it constant over time” (29).

TABLE 2

Numbers of deaths of HCWs due to COVID-19: population-based estimates and with refinement (indirect standardization) (January 2020–May 2021)

WHO region	WHO COVID-19 surveillance data ^a		Population-based estimate ^b	Triangulation A Using indirect standardization (by sex and age)		
	All deaths	HCW deaths		HCW deaths	HCW deaths (all)	HCW deaths (males)
African	84 376	0	1134	2003	1173	830
Americas	1 575 005	4858	60 380	56 977	33 860	23 117
South-East Asia	335 603	0	1512	2717	1788	929
European	1 116 828	1395	49 374	17 805	8968	8837
Eastern Mediterranean	189 532	302	1804	2424	1792	632
Western Pacific	40 393	78	1289	1008	515	493
Global	3 341 737	6633	115 493	82 934	48 096	34 838

^a Data from WHO COVID-19 surveillance: case report forms and weekly aggregated reporting (Version 2); database accessed on 16 May 2021.

^b Based on country-specific report daily COVID-19 deaths divided by the population size in each country multiplied by the estimated number of HCWs in each country from the ILOSTAT.

Corroborating the estimate of 83 000, a separate estimation (see Annex 2) using meta-analysis summary statistics (Table 3) provides a global estimated total of 79 700 HCW deaths (with figures falling between 39 900 and 159 500). It can be argued, however, that the lowest estimate of the range, 39 900 HCWs (that is, the lowest rate of infection (6.2%) coupled with the lowest mortality rate (0.4%)), is the least likely, given that

HCWs remain considerably exposed to SARS-CoV-2 and their coverage by vaccination is in early stages or at unknown levels.

Put together (Table 4), the population-based estimate of about 115 500 HCWs deaths (given the unknown levels of under-reporting and limited reporting coverage) is a conservative one (with no assumptions of either exposure levels or settings,

TABLE 3

A comparison of the estimated numbers of deaths of HCWs derived by population-based and meta-analysis-based estimations (January 2020–May 2021)

WHO region	WHO COVID-19 surveillance data ^a		Population-based estimate ^b	Triangulation B Meta-analysis based on PCR Testing (assuming 6.2% of infections are in HCWs)			
	Reported deaths	Reported HCW deaths		HCW deaths	HCW deaths ^c		
					At 0.4%	At 0.8%	At 1.6%
African	84 376	0	1134	834	1663	3325	
Americas	1 575 005	4858	60 380	15 953	31 902	63 808	
South-East Asia	335 603	0	1512	6882	13 766	27 531	
European	1 116 828	1395	49 374	13 232	26 454	52 912	
Eastern Mediterranean	189 532	302	1804	2308	4610	9220	
Western Pacific	40 393	78	1289	666	1332	2658	
Global	3 341 737	6633	115 493	39 875	79 727	159 454	

^a Data from WHO COVID-19 surveillance: case report forms and weekly aggregated reporting (Version 2); database accessed on 16 May 2021.

^b Based on country-specific reported daily COVID-19 deaths divided by population size in each country multiplied by the estimated number of HCWs in each country from the ILOSTAT.

^c Indicates a prevalence of deaths among infected HCWs of 0.8% (confidence interval 0.4%, 1.6%).

TABLE 4

Estimates of the numbers of deaths in HCWs due to COVID-19 (January 2020–May 2021) using various methods

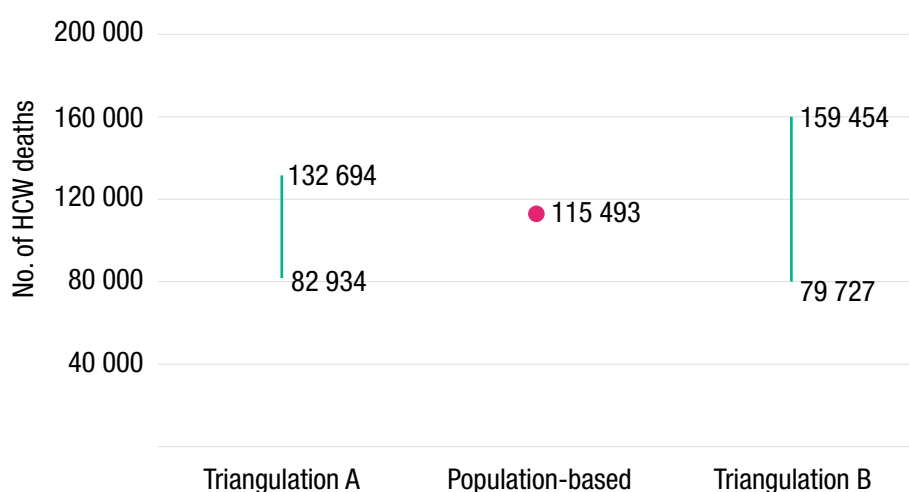
Scope	HCWs deaths reported to the WHO COVID-19 Surveillance	A summary of estimations		
		Value/range	Method	Comments
Global (HCWs)	6643	115 500	Population-based estimate	
		83 000 to 133 000	Triangulation A: Using Indirect standardization (by sex and age)	Upper range adjusts for the 60% under-estimation of deaths
		80 000 to 160 000	Triangulation B: Using results of meta-analysis (based on PCR testing)	
		179 500	Population-based estimate using IHME estimated overall deaths due to COVID-19	See Annex 4 (Table 1)

and inclusive of all HCWs employed in human health and social activities). The additional estimations converge to hedge the population-based estimate between 80 000 to 160 000 HCWs deaths (Fig. 2). The upper range of estimation could exceed 180 000 if the estimated overall deaths among the top-20 high burden countries (see Annex 4, Table 1) were to be taken into consideration. It is important to state that country-specific

comparisons (using estimated number of deaths in HCWs from all three approaches) and anecdotal data when available show no evidence of systematic bias across either methods or specific countries or regions. In the cases of some countries, all three estimates were lower than those provided by anecdotal evidence (for example, the numbers reported by medical associations, professional bodies or the general literature).

FIG. 2

Population-based estimates of COVID-19 related deaths in HCWs (January 2020–May 2021) and ranges of uncertainty



Discussion

Every health system had to face the burden of COVID-19 and had to take responsibility for its prevention and treatment. As the pandemic nears its third year, the health and well-being of HCWs remain a growing concern for multiple stakeholders, as does, more worryingly, the unmeasured level of excess deaths in HCWs attributable to COVID-19. Reporting the exact number of deaths due to COVID-19, let alone those among HCWs, is a significant challenge to all countries (even those with well-functioning death registration systems). Several reasons come into play, for instance:

- As countries have variable capacities of testing and tracking infections in and deaths of HCWs, with some only reporting deaths for which a COVID-19 test has confirmed that a patient was infected with SARS-CoV-2, untested individuals may not be included in the deaths counts. Therefore, using a population-based estimation in this situation would reduce the sensitivity to detection bias.
- Specific issues concern differences in COVID-19-testing strategies, case-management capacities, and age-reporting procedures as well as the outcome not being known for all cases (30).
- Countries may only be reporting deaths due to COVID-19 that occur in hospitals or health facilities; those in people dying from the disease elsewhere may not be recorded.
- Some countries may be reluctant to report SARS-CoV-2 and COVID-19 deaths in HCWs for numerous reasons, including their interest in maintaining access for their population to essential health services without hesitation nor fear.
- In the case of HCW deaths, just as with those in other sectors, occupational information is infrequently recorded on death certificates. For example, evidence from an independent report in the United Kingdom of Great Britain and Northern Ireland on COVID-19 and occupation (31) shows that the usual or longest-held job (particularly for women) may be reported rather than that immediately before death.

The population-based estimate and ranges of uncertainty we have presented serve two important goals:

- to approximate the level of mortality of HCWs in the context of all mortality due to COVID-19;
- to stimulate standardization of methods and investments into better measurement of infections and deaths of HCWs in the context of high-risk emergencies.

The COVID-19 pandemic has also revealed a series of weaknesses of surveillance systems stemming mainly from fragmented reporting systems (32). At a bare minimum, however, monitoring and coherently reporting infections in and deaths of HCWs disaggregated by age and sex should be a fundamental consideration of every surveillance system. These two measurements would still fall short in determining the broad impact the COVID-19 pandemic on HCWs as they continue to face increasing demand, fatigue, stress and burnout effects (see Fig. 1). Improving surveillance of the impact of COVID-19 by occupation and industry will benefit not only HCWs but all workers during the COVID-19 pandemic (33). For mortality among HCWs, such surveillance is unlikely to be embedded in the routine reporting of cause of deaths owing to the difficulty of identifying a reliable source for classifying occupation and industry. Therefore, dedicated instruments, standardized measurements and special investigations will be required to ensure a proper monitoring of the impact of COVID-19 on HCWs.

In sum, the results discussed in this paper reinforce the objectives of the IYHCW campaign. Greater efforts and continued advocacy through all known platforms must support the call for the equitable distribution of vaccines. In tandem, tailored communication strategies (34–36) must be designed and implemented to increase the uptake rate of COVID-19 vaccines among HCWs and reduce vaccination hesitancy.

Limitations

We have attempted to provide a credible range of number of deaths in HCWs due to COVID-19. In the midst of a pandemic and the absence of comparable data on public health and social measures, the analysis builds on the assumption that HCWs have the same level of exposure to infection and deaths as that of the general population in every country. This assumption could be challenged yet remains plausible given the results and ranges obtained from the best available data on deaths and methodology.

Many uncertainties and limitations surround measuring the death toll of HCWs due to COVID-19 that has been identified in

available studies that at times did not categorically differentiate between population groups compared (for instance, HCWs among themselves or compared to the general population). We are faced by various limitations. Conceptually, HCWs are expected to take more precautions (at the workplace with the increased use of measures to prevent and control infections) and in their communities (following other forms of public health and social measures). Albeit scarce, the available evidence seems to indicate that HCWs are being infected to a greater extent in the community than the workplace (37). Methodologically, HCWs are a unique group with no direct comparability (in terms of risk) to any other group or the general population. For instance, studies at the initial phase of the pandemic showed that HCWs were significantly more exposed and infected than the general population, which could be a detection bias of more HCWs being tested than was the case for the general population.

More complex is the measurement of the number of deaths of HCWs. Also, the cause of death will need to be investigated which may require a form of verbal autopsy from relatives or colleagues in a public health audit or enquiry. Given all these limitations and more, we have presented a set of conservative ranges in order to provide a probable order of magnitude for the number of deaths of HCWs due to COVID-19 that might have occurred.

Conclusion

Both retrospective analyses and observational research are needed to piece together a credible estimate of the excess deaths of HCWs attributable to COVID-19. In this paper, deaths were taken as a cumulative total between January 2020 and May 2021, an approach that by and large reduces the effect of delays in registering deaths, specifically those of HCWs. Out of the 3.45 million COVID-19-related deaths reported to WHO, only 6643 were in HCWs. At the most conservative level, a population-based estimate indicates that around 115 500 HCWs (ranging between 80 000–160 000¹) out of the global health and care workforce of 135 million people could have

lost their lives. The upper range of estimation could exceed 180 000 if the estimated overall deaths among the high-burden countries² are taken into consideration. This is an alarming picture of the impact of the pandemic on HCWs who need to be provided with better protection (including access to vaccines, personal protective equipment, training, testing and psychosocial support) and decent work conditions (including adequate remuneration and protection against excessive workloads) (38).

We have also demonstrated that the number of deaths among HCWs due to COVID-19 is much greater than officially reported. To date, few countries are able to provide complete counts of HCWs deaths related to COVID-19. Countries are urged to undertake retrospective audits of deaths through verbal autopsy methods to trace and record COVID-19 related deaths of HCWs.

Finally, the importance of HCWs protection through vaccination cannot be overstated to avert HCWs infections (and deaths). By May 2021, more than 100 WHO's Member States had started COVID-19 vaccination of their HCWs, but with considerable differences by WHO regions. Increased efforts and continued advocacy through all known platforms must be made to support the call for the equitable distribution of vaccines in order to ensure HCWs have access and protection. Following such an equitable provision of vaccines, just as necessary will be the tailored communication strategies to increase the uptake rate of COVID-19 vaccines among HCWs, particularly in low- and middle-income countries, and reduce hesitancy. Member States and other stakeholders must make a firm commitment to the care compact, called for in the International Year of Health and Care Workers in order to protect HCWs rights, decent work and practice environments.

¹ Using the latest available global estimations from living systematic review estimation (27,28).

² The top 20 countries account for 80% of the globally reported COVID-19 death toll.

References

1. Timeline: WHO's COVID-19 response (<https://www.who.int/emergencies/diseases/novel-coronavirus-2019/interactive-timeline>; accessed 7 July 2021).
2. WHO. Health workforce policy and management in the context of the COVID-19 pandemic response: interim guidance. Geneva: World Health Organization; 2020. License: WHO/2019-nCoV/health_workforce/2020.1 (https://apps.who.int/iris/bitstream/handle/10665/337333/WHO-2019-nCoV-health_workforce-2020.1-eng.pdf?sequence=1&isAllowed=y; accessed 7 July 2021).
3. WHO. COVID-19: occupational health and safety for health workers: interim guidance. Geneva: World Health Organization; 2021. License: CC BY-NC-SA 3.0 IGO (<https://apps.who.int/iris/handle/10665/339151>, accessed 7 July 2021).
4. WHO. Prevention, identification and management of health worker infection in the context of COVID-19. Interim guidance. Geneva: World Health Organization; 2020. License: WHO/2019-nCoV/HW_infection/2020.1 (<https://www.who.int/publications/i/item/10665-336265>; accessed 7 July 2021).
5. Risk of hospital admission with coronavirus disease 2019 in healthcare workers and their households: nationwide linkage cohort study. *BMJ* 2020;371:m3582 | doi: 10.1136/bmj.m3582
6. Amnesty International. COVID-19: Health worker death toll rises to at least 17000 as organizations call for rapid vaccine rollout. Press release, 5 March 2021 [website] (<https://www.amnesty.org/en/latest/news/2021/03/covid19-health-worker-death-toll-rises-to-at-least-17000-as-organizations-call-for-rapid-vaccine-rollout/>; accessed 7 July 2021).
7. International Council of Nurses (October 2020). ICN confirms 1,500 nurses have died from COVID-19 in 44 countries and estimates that healthcare worker COVID-19 fatalities worldwide could be more than 20,000. 28 October 2020 (<https://www.icn.ch/news/icn-confirms-1500-nurses-have-died-covid-19-44-countries-and-estimates-healthcare-worker-covid#:~:text=ICN%E2%80%99s%20own%20analysis%20suggests%20that%20about%2010%25%20of,2.6%25%20of%20those%2C%201.1%20million%2C%20resulting%20in%20deaths>; accessed 7 July 2021).
8. Erdem H, Lucey DR. Healthcare worker infections and deaths due to COVID-19: A survey from 37 nations and a call for WHO to post national data on their website. *Int J Infect Dis*. 2021 January; 102:239-241. doi: 10.1016/j.ijid.2020.10.064. Epub 2020 Oct 29. PMID: 33130210; PMCID: PMC7598357.
9. Bandyopadhyay S, Baticulon RE, Kadhum M, et al. Infection and mortality of healthcare workers worldwide from COVID-19: a systematic review. *BMJ Global Health* 2020;5:e003097.
10. Nguyen LH, Drew DA, Graham MS, et al. Risk of COVID-19 among front-line health-care workers and the general community: a prospective cohort study. *The Lancet Public Health*. 2020 Sep;5(9):e475-e483. doi: 10.1016/S2468-2667(20)30164-X. PMID: 32745512; PMCID: PMC7491202
11. WHO. Emergency situational updates - Weekly epidemiological update on COVID-19 - 30 March 2021 (<https://www.who.int/publications/m/item/weekly-epidemiological-update-on-covid-19---31-march-2021>; accessed 7 July 2021).
12. Decision WHA73(30). Human resources for health. In: Seventy-third World Health Assembly, Geneva, resumed 9-14 November 2020 (WHA73/2020/REC/1, [https://apps.who.int/gb/ebwha/pdf_files/WHA73/A73\(30\)-en.pdf](https://apps.who.int/gb/ebwha/pdf_files/WHA73/A73(30)-en.pdf)); WHO (Departmental News, November 2020). 2021 designated as the International Year of Health and Care Workers. <https://www.who.int/news/item/11-11-2020-2021-designated-as-the-international-year-of-health-and-care-workers>; accessed 7 July 2021).
13. WHO Year of Health and Care Workers 2021 Campaign. Protect. Invest. Together. Geneva: World Health Organization; 2021 (<https://www.who.int/campaigns/annual-theme/year-of-health-and-care-workers-2021>; accessed 7 July 2021).
14. WHO. Introducing WHO & UNICEF's new electronic Joint Reporting Form (eJRF)!. Geneva: World Health Organization; 2021 (https://cdn.who.int/media/docs/default-source/immunization/global_monitoring/ejrf_flyer_web_en.pdf?sfvrsn=a89167c7_14; accessed 7 July 2021).
15. WHO COVID-19 Dashboard. Geneva: World Health Organization, 2020. Available online: <https://covid19.who.int/>; Data accessed 16th May 2021
16. WHO. SCORE for health data technical package: global report on health data systems and capacity, 2020. Geneva: World Health Organization; 2021. License: CC BY-NC-SA 3.0 IGO (<https://www.who.int/publications/i/item/global-report-on-health-data-systems-and-capacity-2020> ; accessed 7 July 2021).
17. Morgan D, Ino J, Di Paolantonio G, Murtin F. Excess mortality: Measuring the direct and indirect impact of COVID-19. Paris: OECD Publishing; 2020. Health Working Papers, No. 122 (<https://doi.org/10.1787/c5dc0c50-en>, ; accessed 7 July 2021).
18. WHO. The true death toll of COVID-19 - Estimating global excess mortality. Geneva: World Health Organization; 2021 (<https://www.who.int/data/stories/the-true-death-toll-of-covid-19-estimating-global-excess-mortality>; accessed 7 July 2021).
19. Burn-Murdoch J, Romei V, Giles C. Global coronavirus death toll could be 60% higher than reported. *The Financial Times* (26 April 2020). (<https://www.ft.com/content/6bd88b7d-3386-4543-b2e9-0d5c6fac846c>; accessed 7 July 2021).
20. IHME. COVID-19 has caused 6.9 million deaths globally, more than double what official reports show. Seattle, Washington, United States of America: Institute for Health Metrics and Evaluation; May 2021 (<http://www.healthdata.org/news->

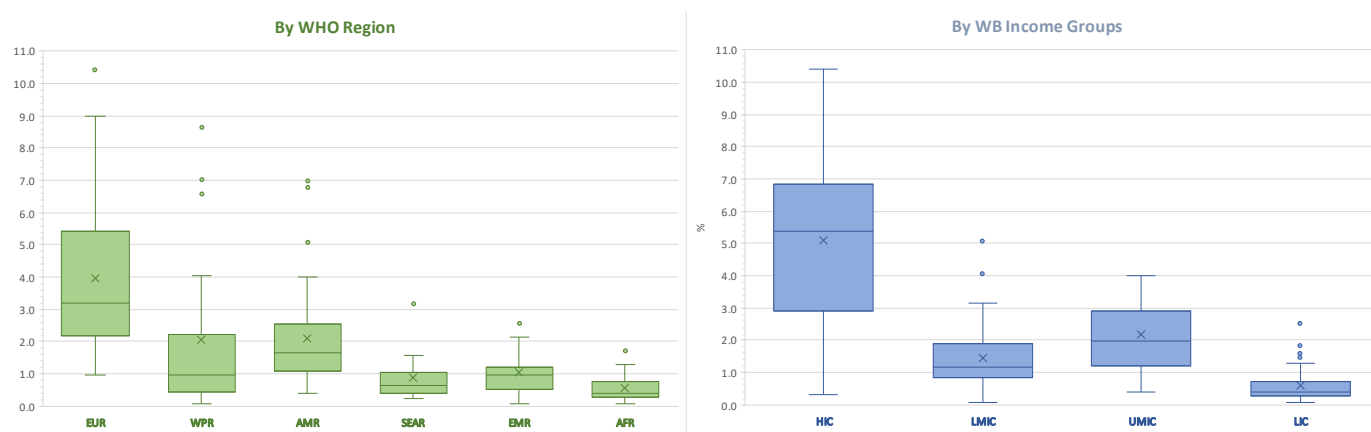
- release/covid-19-has-caused-69-million-deaths-globally-more-double-what-official-reports-show; accessed 7 July 2021).
21. Modelling covid-19's death toll - There have been 7m-13m excess deaths worldwide during the pandemic. *The Economist* (15 May 2021) (<https://www.economist.com/briefing/2021/05/15/there-have-been-7m-13m-excess-deaths-worldwide-during-the-pandemic>; accessed 7 July 2021).
 22. WHO. Emergency situational updates - Weekly epidemiological update - 2 February 2021. Geneva: World Health Organization; March 2021) (<https://www.who.int/publications/m/item/weekly-epidemiological-update---2-February-2021>; accessed 7 July 2021).
 23. WHO. Public health surveillance for COVID-19: interim guidance. COVID-19: Surveillance, case investigation and epidemiological protocols -. Geneva: World Health Organization; 16 December 2020).(<https://www.who.int/publications/i/item/who-2019-nCoV-surveillanceguidance-2020.8>; accessed 7 July 2021).
 24. United Nations Department of Economic and Social Affairs, Statistics Division (2008). International Standard Industrial Classification of All Economic Activities, Revision 4. Statistical Papers Series M No.4/Rev.4. New York: United Nations; 2008 (https://unstats.un.org/unsd/publication/seriesm/seriesm_4rev4e.pdf; accessed 7 July 2021).
 25. ILOSTAT. "Employment by sex and age – ILO modelled estimates." Geneva: International Labour Organization ILOSTAT; November 2020 Update (<https://ilostat.ilo.org/data>, accessed 7 February and 2 July 2021).
 26. United Nations, Department of Economic and Social Affairs, Population Division. World Population Prospects 2019. New York: United Nations; 2019. ST/ESA/SER. A/424 (<https://population.un.org/wpp/Download/Standard/Population/>; accessed 7 July 2021).
 27. Gholami M, Fawad I, Shadan S, et al. COVID-19 and healthcare workers: A systematic review and meta-analysis. *Int J Infect Dis.* 2021 March; 104:335-346. doi: 10.1016/j.ijid.2021.01.013. Epub 2021 Jan 11. PMID: 33444754; PMCID: PMC7798435
 28. Gholami M, Khamis AH, Ho SB. Response to "RE: COVID-19 and healthcare workers: A systematic review and meta-analysis." *Int J Infect Dis.* 2021 May; 106:140-141. doi: 10.1016/j.ijid.2021.03.034. Epub 2021 Mar 16. PMID: 33741486; PMCID: PMC7962501
 29. Chowdhury R, Shah D, Payal AR. Healthy Worker Effect Phenomenon: Revisited with Emphasis on Statistical Methods - A Review. *Indian J Occup Environ Med.* 2017 Jan-Apr;21(1):2-8. doi: 10.4103/ijoem.IJOEM_53_16. PMID: 29391741; PMCID: PMC5763838.
 30. Mathers CD, Fat DM, Inoue M, Rao C, Lopez AD. Counting the dead and what they died from: an assessment of the global status of cause of death data. *Bull World Health Organ.* 2005 Mar;83(3):171-7. Epub 2005 Mar 16. PMID: 15798840; PMCID: PMC2624200
 31. Industrial Inquiries Advisory Council. Independent report: COVID-19 and occupation: position paper 48. London: Department of Works and Pensions; 2021 (<https://www.gov.uk/government/publications/covid-19-and-occupation-iiac-position-paper-48/covid-19-and-occupation-position-paper-48>; accessed 7 July 2021).
 32. Morgan OW, Aguilera X, Ammon A, et al. Disease surveillance for the COVID-19 era: time for bold changes. *The Lancet.* 2021 Jun 19;397(10292):2317-2319. doi: 10.1016/S0140-6736(21)01096-5. Epub 2021 May 14. PMID: 34000258; PMCID: PMC8121493
 33. Hughes MM, Groenewold MR, Lessem SE, et al. Update: Characteristics of Health Care Personnel with COVID-19 – United States, February 12–July 16, 2020. *MMWR Morb Mortal Wkly Rep* 2020; 69:1364–1368. DOI: [http://dx.doi.org/10.15585/mmwr.mm6938a3external icon](http://dx.doi.org/10.15585/mmwr.mm6938a3external%20icon).
 34. Li M, Luo Y, Watson R, Zheng Y, Ren J, Tang J, Chen Y. Healthcare workers' (HCWs) attitudes and related factors towards COVID-19 vaccination: a rapid systematic review. *Postgrad Med J.* 2021 Jun 30;postgradmedj-2021-140195. doi: 10.1136/postgradmedj-2021-140195. Epub ahead of print. PMID: 34193545
 35. Maraqa B, Nazzal Z, Rabi R, Sarhan N, Al-Shakhra K, Al-Kaila M. COVID-19 vaccine hesitancy among health care workers in Palestine: A call for action. *Prev Med.* 2021 Aug;149:106618. doi: 10.1016/j.ypmed.2021.106618. Epub 2021 May 13. PMID: 33992654; PMCID: PMC8117476
 36. Paris C, Bénézit F, Geslin M, Polard E, Baldeyrou M, Turmel V, Tadié É, Garlantézec R, Tattevin P. COVID-19 vaccine hesitancy among healthcare workers. *Infect Dis Now.* 2021 May 5:S2666-9919(21)00104-4. doi: 10.1016/j.idnow.2021.04.001. Epub ahead of print. PMID: 33964486; PMCID: PMC8098031
 37. Jacob JT, Baker JM, Fridkin SK, et al. Risk Factors Associated With SARS-CoV-2 Seropositivity Among US Health Care Personnel. *JAMA Netw Open.* 2021;4(3):e211283. doi:10.1001/jamanetworkopen.2021.1283
 38. International Labour Conference.109/Resolution I (Jun 2021). Resolution concerning a global call to action for a human-centred recovery from the COVID-19 crisis that is inclusive, sustainable and resilient (https://www.ilo.org/wcmsp5/groups/public/---ed_norm/---relconf/documents/meetingdocument/wcms_806092.pdf; accessed 7 July 2021).

Annex 1: The inequitable distribution of HCWs regionally and by country income levels

ILO's labour statistics (ILOSTAT) for each country's estimate of the number of HCWs employed in the sector of human health and social activities (24, 25) and population size (26) were used to demonstrate (Fig. 1) the variations in the distribution of HCWs between and within WHO regions and income groups as classified by the World Bank. The percentage of the population so employed ranged from 0.07% (in Burundi) to 10.4% (in Norway). For most countries in the WHO European Region, HCWs constitute between 2.5% and 5.5% of the general population, whereas in almost all other regions the percentage of HCWs falls below 3% of the general population. Similarly, in most high-income countries, HCWs represent between 3% and 7% of the general population, whereas in almost all other countries the percentage of HCWs falls far below 3% of the general population.¹

ANNEX 1. FIG. 1.

The percentage of the population employed in the human health and social activities, by WHO region and World Bank income groups (2020)



Key:

WHO regions: EUR, European Region; WPR, Western Pacific Region; AMR, Region of the Americas; SEAR, South-East Asia Region; EMR, Eastern Mediterranean Region; AFR, African Region.
World Bank income groups: HIC, high-income countries; LMIC, lower-middle income countries; UMIC, upper-middle income countries; LIC, low-income countries.

¹ With the exception of Belarus, Cuba, Czechia, Hungary, Latvia, Lithuania, Maldives, Russian Federation and Uruguay.

Annex 2¹: Scoping review of SARS-CoV-2 infections and deaths from COVID-19 among HCWs

Several studies and systematic reviews have been rapidly undertaken to describe infections with SARS-CoV-2 and deaths from COVID-19 in HCWs in different exposure settings. These broadly fall into two groups, inclusive of cross-sectional and short-term observational studies:

- those based on results from PCR (or similar) testing (1, 2) comparing infected HCWs to all HCWs exclusively or to the broad population of all patients;
- those based on results from seropositive (antibodies) testing (3) where the purpose is mainly to investigate “short-term” immunity among HCWs.

Both groups generated significant findings about the levels of risks experienced by HCWs and the subsequent decline in risk as more measures of protection were introduced in the workplace (specifically through the adoption of infection prevention and control practices, including the use of personal protective equipment) (4). However, they share some key characteristics and limitations, namely that:

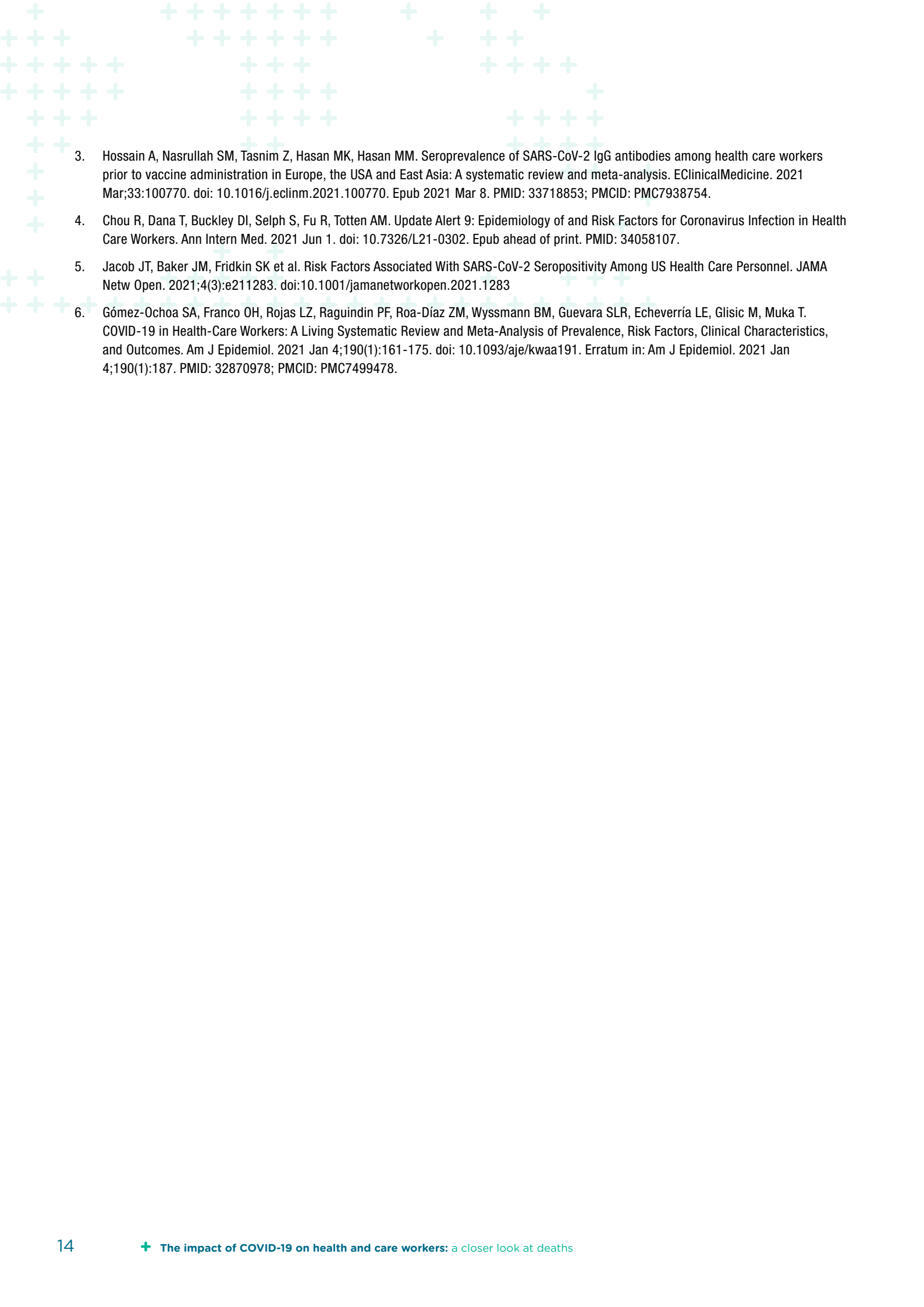
- (i) most studies are context-specific, mostly relating to a workplace setting (for example, hospitals of different scales and specific health worker occupations);
- (ii) the ambiguity in separating the levels of risks in comparisons of the workplace and community exposures (5);
- (iii) the limited evidence to encompass the range of occupations comprising COVID-19-related services (from intensive care unit specialists to hospital porters, to care workers in residential homes); and
- (iv) the sizeable heterogeneity (as pointed out in several meta-analyses, especially those involving seroprevalence surveys) in terms of HCWs groups (for example, those in direct-patient care and use or not of personal protective equipment), study design sizes, settings and geographical coverage, making it difficult to determine period-specific point estimates of the prevalence of infections and death of HCWs.

Overall, comparable statistics on the prevalence of deaths among HCWs are scarce and available mainly in cross-sectional studies based on PCR testing. To date the best available evidence has been obtained from a meta-analysis (2) which estimates that HCWs infections amount to 12.5% (confidence interval 6.2%, 23.5%) of all SARS-CoV-2 infections, in the period between March and July 2020. The lower bound of this meta-analysis estimate (6.2%) is applied to each country’s number of reported cases of COVID-19. The meta-analysis further indicates a prevalence of deaths among infected HCWs of 0.8% (confidence interval 0.4%, 1.6%), which is supported by a similar systematic review (6) and was subsequently applied to each country’s estimated number of SARS-CoV-2 infections of HCWs.

Annex 2 (References)

1. Gholami M, Fawad I, Shadan S et al. COVID-19 and healthcare workers: A systematic review and meta-analysis. *Int J Infect Dis.* 2021 March; 104:335-346. doi: 10.1016/j.ijid.2021.01.013. Epub 2021 Jan 11. PMID: 33444754; PMCID: PMC7798435
2. Gholami M, Khamis AH, Ho SB. Response to “RE: COVID-19 and healthcare workers: A systematic review and meta-analysis.”. *Int J Infect Dis.* 2021 May; 106:140-141. doi: 10.1016/j.ijid.2021.03.034. Epub 2021 Mar 16. PMID: 33741486; PMCID: PMC7962501

¹ See separate references at the end of the annex.

- 
3. Hossain A, Nasrullah SM, Tasnim Z, Hasan MK, Hasan MM. Seroprevalence of SARS-CoV-2 IgG antibodies among health care workers prior to vaccine administration in Europe, the USA and East Asia: A systematic review and meta-analysis. *EClinicalMedicine*. 2021 Mar;33:100770. doi: 10.1016/j.eclinm.2021.100770. Epub 2021 Mar 8. PMID: 33718853; PMCID: PMC7938754.
 4. Chou R, Dana T, Buckley DI, Selph S, Fu R, Totten AM. Update Alert 9: Epidemiology of and Risk Factors for Coronavirus Infection in Health Care Workers. *Ann Intern Med*. 2021 Jun 1. doi: 10.7326/L21-0302. Epub ahead of print. PMID: 34058107.
 5. Jacob JT, Baker JM, Fridkin SK et al. Risk Factors Associated With SARS-CoV-2 Seropositivity Among US Health Care Personnel. *JAMA Netw Open*. 2021;4(3):e211283. doi:10.1001/jamanetworkopen.2021.1283
 6. Gómez-Ochoa SA, Franco OH, Rojas LZ, Raguindin PF, Roa-Díaz ZM, Wyssmann BM, Guevara SLR, Echeverría LE, Glisic M, Muka T. COVID-19 in Health-Care Workers: A Living Systematic Review and Meta-Analysis of Prevalence, Risk Factors, Clinical Characteristics, and Outcomes. *Am J Epidemiol*. 2021 Jan 4;190(1):161-175. doi: 10.1093/aje/kwaa191. Erratum in: *Am J Epidemiol*. 2021 Jan 4;190(1):187. PMID: 32870978; PMCID: PMC7499478.

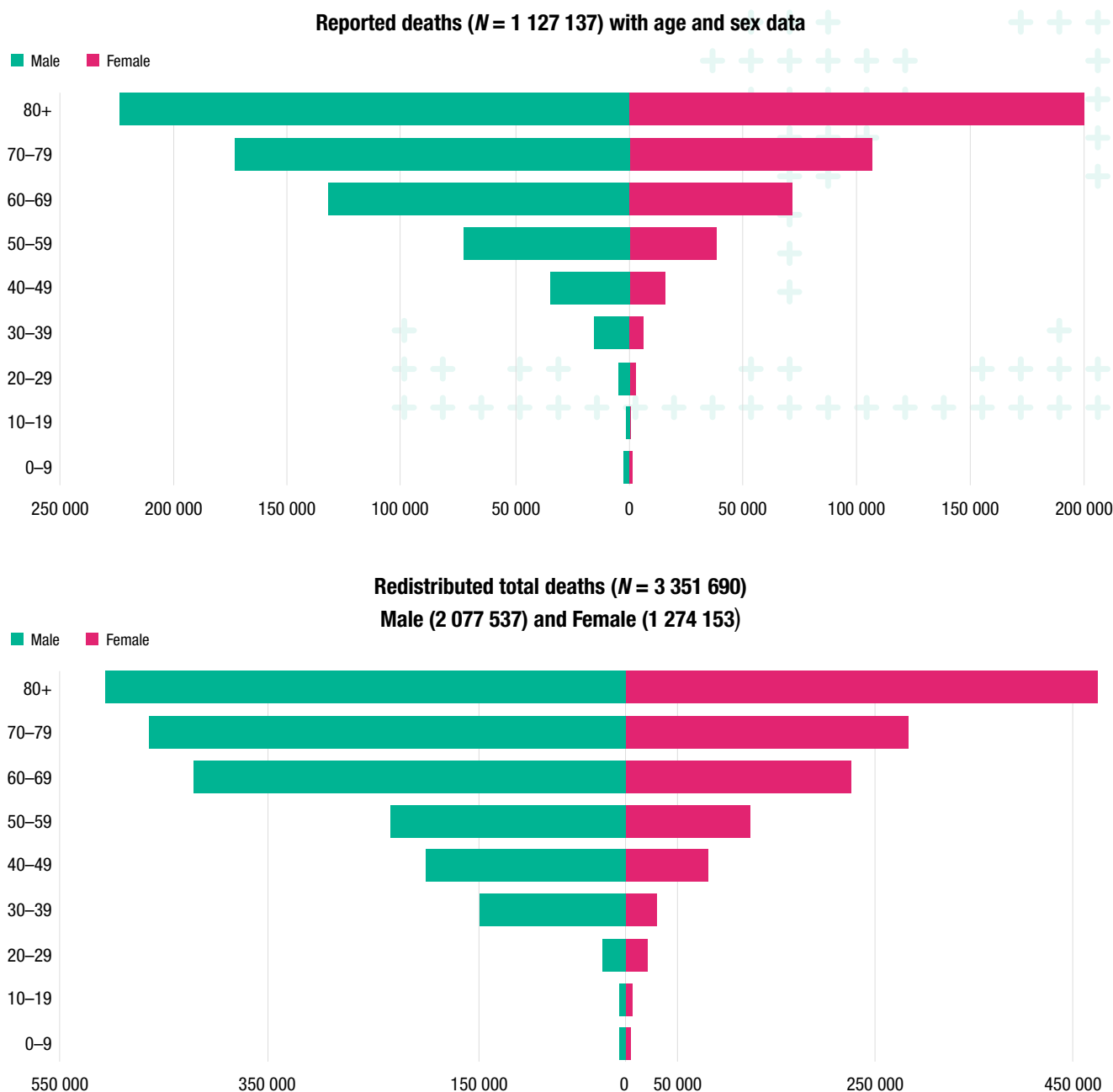
Annex 3: Three main steps to explain indirect standardization (by sex and age)

The three main steps for indirect standardization by age and sex are as follows:

- (1) use the known sex- and age-specific average regional distribution of deaths from COVID-19 reported to WHO (available for a third of reported deaths) to redistribute all deaths reported to WHO (Fig. 1);

ANNEX 3. FIG. 1.

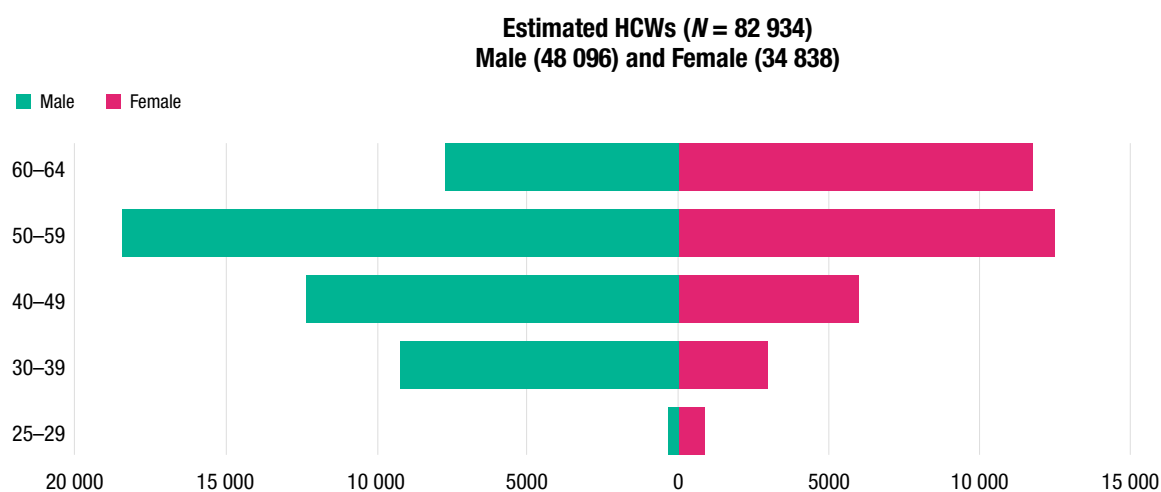
Redistributed COVID-19 deaths by age and sex



- (2) apportion the ILO's estimated number of HCWs (by sex), for each country, between the country's population for age 25 to 64 years (to reflect the working ages of HCWs as reported in the National Health Workforce Accounts¹);
- (3) then, estimate the number of deaths of HCWs from COVID-19 as a share of the redistributed reported deaths for each specific age group (from step (1) above), as shown in Fig. 2.

ANNEX 3. FIG. 2.

Indirect standardization method (by age and sex)



¹ WHO. National Health Workforce Accounts Data Portal [website]. Geneva: World Health Organization (<https://apps.who.int/nhwportal/>, accessed 14 September 2021).

Annex 4: Estimated deaths in HCWs using the Institute for Health Metrics and Evaluation’s estimated number of COVID-19 deaths globally

The Institute for Health Metrics and Evaluation (IHME) published the results of its analysis using excess all-cause mortality methods ^(20¹) at the same time as WHO completed its analysis included in this working paper. The time period of comparison is almost the same. Table 1 provides a comparative view of the population-based estimates of deaths of HCWs related to COVID-19 in the top-ranking 20 countries (which constitute 80% of the global COVID-19 deaths reported to WHO), and using as denominator the IHME’s estimate of total deaths related to COVID-19. Strikingly, the estimated HCWs deaths are likely to be higher than 179 500 considering the high burden countries studied by IHME.

¹ Reference in main body of text.

ANNEX 4. TABLE 1

Comparison of the population-based deaths in HCWs related to COVID-19 using surveillance data reported to WHO and IHME's total deaths – top-ranking countries (January 2020–May 2021)

Country	WHO Rank	IHME Rank	WHO COVID-19 Surveillance		Population-based estimated HCW deaths	Triangulation A Indirect standardization (by sex and age)			Triangulation B Meta-analysis based on PCR testing (at 6.2% infection)			Based on IHME estimated overall deaths
			All deaths	Share of all deaths (%)		HCW deaths	HCW deaths (all)	HCW deaths (males)	HCW deaths (females)	HCW deaths (at 0.8%)	HCW deaths (at 1.6%)	
United States of America	1	1	578 984	17.3	59	37 633	21 950	15 683	16 137	32 274	62 426	
Brazil	2	4	430 417	12.8	684	8966	5430	3536	7655	15 311	13 525	
India	3	2	266 207	7.9	0	2053	1378	675	12 089	24 178	2775	
Mexico	4	3	219 901	6.6	3214	2870	1899	971	1178	2356	7625	
United Kingdom of Great Britain and Northern Ireland	5	6	127 668	3.8	0	3177	1586	1591	2206	4411	14 061	
Italy	6	7	123 927	3.7	269	1462	810	652	2057	4114	5633	
Russian Federation	7	5	115 480	3.4	0	1532	803	729	2446	4892	22 546	
France	8	14	106 666	3.2	4	2545	1282	1263	2854	5708	8344	
Germany	9	16	86 025	2.6	0	2112	1056	1056	1778	3556	8152	
Colombia	10		79 760	2.4	0	1506	891	615	1522	3043		
Spain	11	15	79 095	2.4	148	998	503	495	1778	3556	4453	
Islamic Republic of Iran	12	8	76 433	2.3	0	877	639	238	1355	2710	1679	
Poland	13	11	71 609	2.1	5	676	318	358	1415	2829	4213	
Argentina	14		69 254	2.1	534	1883	1209	674	1608	3216		
Peru	15	12	65 316	1.9	0	877	550	327	929	1858	2027	
South Africa	16	10	55 124	1.6	0	1620	905	715	798	1596	2812	
Ukraine	17	13	47 942	1.4	615	448	229	219	1067	2133	3877	
Indonesia	18	17	47 823	1.4	0	534	321	213	860	1720	760	
Turkey	19		44 301	1.3	0	318	178	140	2527	5055		
Czech Republic	20		29 712	0.9	87	367	177	190	816	1632		
Romania	21	19	29 413	0.9	12	214	100	114	531	1062	1943	
Egypt	34	9	14 206	0.4	181	177	121	56	121	241	1544	
Japan	39	18	11 365	0.3	0	745	389	356	333	666	8978	
Kazakhstan	59	20	4760	0.1	0	46	24	22	203	406	2042	
Sub-total						73 636	42 748	30 888	64 263	128 523	179 415	



Contact

Health Workforce Department
World Health Organization (WHO)
Avenue Appia 20
1211 Geneva 27
Switzerland
hrhstatistics@who.int