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
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Acronyms

<table>
<thead>
<tr>
<th>Acronym</th>
<th>Description</th>
</tr>
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<tbody>
<tr>
<td>COVID-19</td>
<td>The coronavirus disease 2019</td>
</tr>
<tr>
<td>HCW</td>
<td>Health and care worker</td>
</tr>
<tr>
<td>IHME</td>
<td>Institute for Health Metrics and Evaluation</td>
</tr>
<tr>
<td>ILO</td>
<td>International Labour Organization</td>
</tr>
<tr>
<td>SARS-CoV-2</td>
<td>The virus that causes COVID-19</td>
</tr>
<tr>
<td>WHO</td>
<td>World Health Organization</td>
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</table>
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.

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

- Shortage and vacancies
- Repurposing
- Surge capacity
- SARS-CoV-2-related absence

- Infections
- Deaths
- Stress
- Burnout
- Other mental disorders

- Lack of personal protective equipment
- Labour strikes
- Quarantine and self-isolation
- Temporary staff contracts
- Lack of incentives and insurance
- Violence and harassment
- Lack of psychological support
- Lack of COVID-19 vaccination

- Stigmatization and discrimination
- Care for family members
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...
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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 healthcare 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)).

### TABLE 1

<table>
<thead>
<tr>
<th>Scope</th>
<th>Reported to WHO COVID-19 surveillance</th>
<th>A summary of estimates derived from different sources*</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Source (reference)</td>
</tr>
<tr>
<td>Global (general population)</td>
<td>3.45 million COVID-19 deaths (reported until 16 May 2021)</td>
<td>WHO (18)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Financial Times (19)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>IHME (20)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>The Economist (21)</td>
</tr>
</tbody>
</table>

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

* 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).
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 estimates 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 healthier\(^2\) 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).

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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)

<table>
<thead>
<tr>
<th></th>
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<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>All deaths</td>
<td>HCW deaths</td>
<td>HCW deaths (all)</td>
<td>HCW deaths (males)</td>
<td>HCW deaths (males)</td>
<td>HCW deaths (females)</td>
<td>HCW deaths (females)</td>
</tr>
<tr>
<td>African</td>
<td>84 376</td>
<td>0</td>
<td>1134</td>
<td>2003</td>
<td>1173</td>
<td>830</td>
<td></td>
</tr>
<tr>
<td>Americas</td>
<td>1 575 005</td>
<td>4858</td>
<td>60 380</td>
<td>56 977</td>
<td>33 860</td>
<td>23 117</td>
<td></td>
</tr>
<tr>
<td>South-East Asia</td>
<td>335 603</td>
<td>0</td>
<td>1512</td>
<td>2717</td>
<td>1788</td>
<td>929</td>
<td></td>
</tr>
<tr>
<td>European</td>
<td>1 116 828</td>
<td>1395</td>
<td>49 374</td>
<td>17 805</td>
<td>8968</td>
<td>8387</td>
<td></td>
</tr>
<tr>
<td>Eastern Mediterranean</td>
<td>189 532</td>
<td>302</td>
<td>1804</td>
<td>2424</td>
<td>1792</td>
<td>632</td>
<td></td>
</tr>
<tr>
<td>Western Pacific</td>
<td>40 393</td>
<td>78</td>
<td>1289</td>
<td>1008</td>
<td>515</td>
<td>493</td>
<td></td>
</tr>
<tr>
<td>Global</td>
<td>3 341 737</td>
<td>6633</td>
<td>115 493</td>
<td>82 934</td>
<td>46 096</td>
<td>34 838</td>
<td></td>
</tr>
</tbody>
</table>


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 HCW 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).

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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)

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


Indicates a prevalence of deaths among infected HCWs of 0.8% (confidence interval 0.4%, 1.6%).
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 80 000–160 000) 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 renumeration 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.

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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


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-

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).


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)

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¹ With the exception of Belarus, Cuba, Czechia, Hungary, Latvia, Lithuania, Maldives, Russian Federation and Uruguay.
Annex 2: 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 See separate references at the end of the annex.


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

### Reported deaths \((N = 1\,127\,137)\) with age and sex data

- **0–9**: Male 550 000, Female 350 000
- **10–19**: Male 200 000, Female 100 000
- **20–29**: Male 150 000, Female 75 000
- **30–39**: Male 50 000, Female 50 000
- **40–49**: Male 50 000, Female 50 000
- **50–59**: Male 100 000, Female 50 000
- **60–69**: Male 250 000, Female 150 000
- **70–79**: Male 450 000, Female 350 000
- **80+**: Male 1 000 000, Female 700 000

### Redistributed total deaths \((N = 3\,351\,690)\)

- **0–9**: Male 250 000, Female 150 000
- **10–19**: Male 200 000, Female 100 000
- **20–29**: Male 150 000, Female 75 000
- **30–39**: Male 50 000, Female 50 000
- **40–49**: Male 50 000, Female 50 000
- **50–59**: Male 100 000, Female 50 000
- **60–69**: Male 250 000, Female 150 000
- **70–79**: Male 450 000, Female 350 000
- **80+**: Male 1 000 000, Female 700 000
The impact of COVID-19 on health and care workers: a closer look at deaths

(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 Accounts);

(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)

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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)

<table>
<thead>
<tr>
<th>Country</th>
<th>WHO Rank</th>
<th>IHME Rank</th>
<th>WHO COVID-19 Surveillance</th>
<th>Population-based estimated HCW deaths</th>
<th>Population-based indirect standardization (by sex and age)</th>
<th>Triangulation B Meta-analysis based on PCR testing (at 6.2% infection)</th>
<th>Based on IHME estimated overall deaths</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>All deaths</td>
<td>Share of all deaths (%)</td>
<td>HCW deaths</td>
<td>HCW deaths (all)</td>
<td>HCW deaths (males)</td>
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<td>578 984</td>
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<td>37 633</td>
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<td>4</td>
<td>430 417</td>
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<td>9769</td>
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<tr>
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<td><strong>73 636</strong></td>
<td><strong>42 748</strong></td>
<td><strong>30 888</strong></td>
<td><strong>64 263</strong></td>
</tr>
</tbody>
</table>
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