

# Global Estimation of COVID-19 Infections among Healthcare Workers

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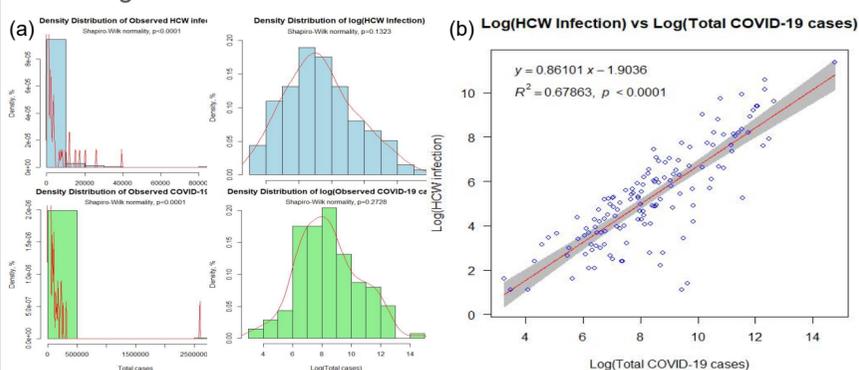
## Background

As of 30 July 2020, coronavirus disease 2019 (COVID-19) has caused over 17 million infections and resulted in 667,000 deaths worldwide<sup>1</sup>. Healthcare workers (HCW) as the frontliners face occupational health risk of becoming infected with the disease. HCW infection also negatively affect responses of national healthcare systems towards the pandemic.

Knowledge on the case infection rate (CIR) of HCW remains scarce. This study aims to assess the risk of HCW COVID-19 infection for each country and to estimate the current global HCW infection rate.

## Methods

More than 550 online news and literature up to 30 June 2020 were assessed to establish a model for observed HCW infection of COVID-19 globally. The respective total COVID-19 cases for those countries were cited based on the reporting date for HCW infection. Finally, the observed HCW infection and respective total COVID-19 cases from 137 countries were included in the final analysis and modelling.



**Figure 1:** (a) Density distribution of HCW infection and total COVID-19 cases before and after log-transformation

(b) Correlation between log-transformed HCW infection and total COVID-19 cases.

(c) Countries with higher and lower risk for HCW infection (only countries with PR values  $>\pm 1SD$  are presented).

The risk of HCW infection is assessed using a log-linear model. The log-transformed HCW infection and total COVID-19 cases shows highly significant linear correlation ( $R=0.823$ , 95% CI: 0.761, 0.871,  $R^2=0.679$ ,  $p<0.0001$ ) (Figure 1(b)).

Percent residual (PR) between observed and expected log-transformed cases were calculated for the estimation of risk for HCW infection (Figure 1(c)).

Assuming the correlation between log-transformed HCW infection and total COVID-19 cases was consistent across different pandemic phases, the log-linear model was then used to estimate the current HCW infection rate (as of 25 July 2020).

## Results

Variables	N	Case infection rate, %		p-value <sup>†</sup>	Log (HCW infection)		p-value <sup>†</sup>
		Median	Mean (SD)		Median	Mean (SD)	
Overall	137	5.9	7.9 (7.3)		5.2	5.3 (2.2)	
<b>Region</b>							
Africa	38	3.9	5.9 (5.0)	0.001	4.2	4.1 (1.4)	<0.001
Asia	29	3.6	5.5 (6.2)		5.8	5.7 (2.1)	
Europe	45	9.6	12.0 (8.4)		6.0	6.2 (2.1)	
America	22	4.2	6.4 (6.9)		5.0	5.5 (2.9)	
Oceania	3	7.0	6.7 (3.9)		5.0	4.8 (1.5)	
<b>Income group</b>							
High	51	7.0	9.1 (8.3)	0.157	5.3	5.7 (2.4)	0.013
Upper middle	36	6.5	7.5 (5.6)		5.9	5.8 (2.2)	
Lower middle	30	3.5	5.8 (6.0)		4.9	4.9 (2.1)	
Low	20	6.3	9.0 (8.8)		4.1	4.2 (1.2)	
<b>Severity rating</b>							
1	65	7.0	8.3 (6.9)	0.051	4.8	4.6 (1.7)	0.003
2	20	8.0	9.1 (6.4)		6.2	6.0 (2.1)	
3	13	5.3	7.6 (9.4)		6.0	6.1 (2.5)	
4	21	5.9	7.9 (8.1)		7.0	6.8 (2.8)	
5	12	2.0	4.2 (6.5)		5.4	5.4 (2.4)	

N=Effective sample size; SD=Standard deviation; GCI=Global COVID-19 Index.

<sup>†</sup> Kruskal-Wallis rank sum test

**Table 1: COVID-19 CIR of HCW and log(HCW infection).** Mean CIR for HCW was found to be 7.9%. Significantly higher CIR was seen in the Europe region ( $p=0.001$ ). Log-transformed HCW infection was significantly associated with region, income group<sup>2</sup> and COVID-19 severity rating<sup>3</sup> ( $p<0.05$ ).

Variables	HCW infection, N (%)		p-value
	Higher risk	Lower risk	
<b>Region</b>			
Africa	15 (18.3)	23 (41.8)	< 0.001 <sup>1</sup>
Asia	13 (15.9)	16 (29.1)	
Europe	39 (47.5)	6 (10.9)	
America	13 (15.9)	9 (16.4)	
Oceania	2 (2.4)	1 (1.8)	
<b>Income group</b>			
High	35 (42.7)	16 (29.1)	0.033 <sup>2</sup>
Upper middle	25 (30.5)	11 (20.0)	
Lower middle	12 (14.6)	18 (32.7)	
Low	10 (12.2)	10 (18.2)	
<b>Severity rating</b>			
1	38 (48.1)	27 (51.9)	0.110 <sup>1</sup>
2	16 (20.2)	4 (7.7)	
3	7 (8.9)	6 (11.5)	
4	14 (17.7)	7 (13.5)	
5	4 (5.1)	8 (15.4)	

<sup>1</sup> Fisher's exact test; <sup>2</sup> Chi-square test

**Table 2: Risk of HCW infection according to region, income status and severity rating.** Higher risk of HCW infection were observed in most European countries ( $p<0.001$ ); as well as high and upper middle income countries ( $p=0.033$ ). Majority of the countries with lower risk for HCW infection are from Africa (29%) (Figure 1(c)).

Parameter estimate	Regression coefficients	SE	p-value
<b>Unadjusted Model</b>			
Intercept	-1.904	0.442	<0.001
Log (Total COVID-19 cases)	0.861	0.051	<0.001
<b>Adjusted Model</b>			
Intercept	-2.321	0.443	<0.001
Log (Total COVID-19 cases)	0.876	0.056	<0.001
<b>Region</b>			
- Africa	Reference		
- America	0.130	0.356	0.714
- Asia	0.152	0.316	0.631
- Europe	1.059	0.278	<0.001
- Oceania	0.865	0.851	0.312
<b>Severity rating</b>			
- 1	Reference		
- 2	0.107	0.311	0.731
- 3	-0.366	0.375	0.331
- 4	-0.080	0.336	0.812
- 5	-1.006	0.402	0.014

SE = Standard error

**Table 3: Parameter estimates for unadjusted and adjusted log-linear models to estimate the current global HCW infection rate (based on total COVID-19 cases from 209 countries).** Income group was excluded as most European countries are high income countries. The unadjusted model estimated the global HCW infection rate to be 5.2% (95% CI: 1.8%, 12.8%). The adjusted model for regional and severity estimated the global HCW infection rate to be 5.7% (95% CI: 0.7%, 20.8%).

## Discussion/Conclusion

Our estimation of HCW infection rate appears to be much lower than the 10% reported by the World Health Organization<sup>4</sup>. It is also much lower than the infection rate of HCW of Severe Acute Respiratory Syndrome (SARS) back in 2003, which was 20%<sup>5</sup>.

This is the first study that estimates the global HCW infection rate of COVID-19 based on reported figures from 137 countries. Discrepancy with real figure may occur as official statistics are not available for certain countries. Definition of healthcare workers also differs from country to country.

HCW are essential in COVID-19 pandemic preparedness and response. Stringent measures must be taken to prevent HCW infections and to enhance coordination of public health response.

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