



FOREWORD

Healthcare workers (HCWs) are at the frontline of the COVID-19 pandemic, but little is known about the clinical course and risks for mortality amongst them in South Africa. A study designed to compare the characteristics of hospitalized HCWs against non-HCWs with COVID-19 and to assess those factors associated with COVID-19 mortality among HCWs in South Africa was therefore conducted. The study showed that the risk of in-hospital COVID-19 mortality among hospitalized HCWs was lower than that of non-HCWs, and in-hospital mortality amongst HCWs was associated with age, race, wave period, presence of comorbidities and health sector. It is therefore suggested that older HCWs with comorbidities be removed from direct patient care, even though COVID-19 cases and mortality among HCWs are expected to decline following the roll-out of vaccines to this group.

This is the tenth special issue of our COVID-19 series, and we trust that you will find this information useful as we grapple with the third COVID-19 wave in South Africa.

Prof Basil Brooke - Editor

NATIONAL COVID-19 HOSPITAL ADMISSIONS AND MORTALITY AMONG HEALTHCARE WORKERS IN SOUTH AFRICA, 2020-2021

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SUMMARY

Healthcare workers (HCWs) in close contact with SARS-CoV-2-infected patients have an increased risk of infection compared to non-HCWs, but little is known about the clinical course and risks for mortality amongst HCWs in South Africa. In this study, we compared the characteristics of hospitalised HCWs against non-HCWs with COVID-19 and assessed those factors associated with COVID-19 mortality among HCWs. Data from 5 March 2020 to 30 April 2021 were obtained from DATCOV, the national surveillance programme monitoring COVID-19 admissions in all private and public hospitals across South Africa. A logistic regression model was used to determine factors associated with COVID-19 HCW admissions and mortality. As of 30 April 2021, there was a total 169,678 confirmed COVID-19 admissions reported on DATCOV, of which 6,364 (3.8%) were HCWs. Compared to non-HCWs, HCWs were more likely to be younger, to be white or of non-black race, have pre-existing obesity and asthma, be admitted in the private sector and in the Eastern Cape, Gauteng, KwaZulu-Natal, Limpopo, Northern Cape and North West provinces, be admitted in pre-wave 1 [(aOR 3.0; 95%CI 2.4-3.7)], wave 1 [(aOR 2.1; 95%CI 1.8-2.5)] and post-wave 1 [(aOR 1.3; 95%CI 1.0-1.7)] compared to wave 2, were less likely to be male (aOR 0.3, 95%CI 0.3-0.4), and have HIV and chronic kidney diseases. There was an increased risk for in-hospital mortality in HCWs in the older age group (40-49 [aOR 3.8; 95%CI (1.6-8.80)]; 50-59 [(aOR 4.7; 95%CI 2.0-10.9)] and 60-65 years [(aOR 9.8; 95%CI (4.2-23.0))] compared to HCWs less than 40 years, with comorbidities such as hypertension, diabetes, chronic kidney diseases, malignancy and TB. Mortality was decreased for HCWs who were coloured [aOR 0.5; 95%CI (0.3-0.8)], and admitted in the public sector [aOR 0.7; 95%CI (0.5-0.9)] in pre-wave 1 [aOR 0.6; 95%CI (0.3-0.9)] compared to wave 1 period. It is concluded that in-hospital mortality in HCWs was associated with age, race, wave period, presence of comorbidities and health sector. Policies should be put in place to remove older HCWs with comorbidities from direct patient care. Acquired immunity from infections in the first wave could have led to a decline in HCW COVID-19 cases in the second wave. With the roll-out of vaccines amongst HCWs, we expect a further decrease in COVID-19 cases and mortality amongst this group, despite the fact that the country has entered a third wave of the COVID-19 pandemic.

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BACKGROUND

On the 30 January 2020, the World Health Organization (WHO) declared the coronavirus disease 2019 (COVID-19) outbreak a Public Health Emergency of International Concern and a pandemic on 11 March 2020.^{1,2} As at 30 April 2021, a total of 153 million COVID-19 cases was reported globally, with 3.2 million deaths.³ In South Africa, the number of cumulative COVID-19 cases by 30 April 2021 was 1,581,210, including 54,350 deaths.⁴

Health-care workers (HCWs) are the first to come into contact with infected patients and are at an increased risk of being exposed to infectious diseases compared to the general population. The WHO has estimated that up to 14% of COVID-19 cases globally are in HCWs.⁵ In South Africa, the estimated number of HCWs from both private and public sector is 1.25 million.⁶ Many factors can increase the risk of COVID-19 transmission among HCWs including lack of personnel protective equipment (PPE), inappropriate training on specimen or patient-handling and infection control, and infection control strategies not being properly implemented in some healthcare facilities.^{7,8} Nonetheless, even with clinical guidelines and protective measures in place for hospital staff to follow in terms of the management of patients with respiratory diseases, aerosol-generating procedures (AGPs) increase the risk of HCWs acquiring infections. AGPs are carried out on admitted patients presenting severe acute respiratory diseases and include positive-pressure ventilation, tracheal intubation, airway suction, tracheotomy and manual intubation, among others.⁹

Several studies have demonstrated poorer COVID-19 outcomes related to older age, male sex and a history of comorbidities such as hypertension, diabetes, malignancy, chronic cardiac diseases and asthma.¹⁰⁻¹² South Africa has a high prevalence of diseases such as diabetes (12.8%), hypertension (41.6 - 54%) and obesity (68% of females, 31% of males).¹³ In 2017, a national survey of HIV prevalence showed that about 14.6% of the South African population was living with HIV¹⁴; and 11-12% of HCWs in South Africa are HIV infected.¹⁵ The prevalence of tuberculosis (TB) in South Africa is 3.6%¹⁶ and high rates of TB infections have been recorded among South African HCWs, with an active TB disease incidence of 1.13% to 1.47%.^{15,17}

There is limited published information comparing hospitalised HCWs against non-HCWs due to COVID-19 infection in South Africa. The aim of this study was to describe the characteristics of hospitalised HCWs and assess the factors associated with in-hospital mortality among HCWs with COVID-19 in South Africa.

METHODS

Data Sources

The DATCOV national hospital surveillance system was established in March 2020 to monitor COVID-19 hospital admissions in South Africa.¹⁸ DATCOV contains data on all individuals that had a positive test for SARS-CoV-2 using real-time reverse transcription-polymerase chain reaction (rRT-PCR) assay or a positive SARS-CoV-2 antigen test, with a confirmed duration of stay in hospital of one full day or longer, regardless of age or reason for admission. The case-reporting tool contains variables on basic demographics such as age, sex, race, and potential risk factors such as comorbid disease(s). Data

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collection was either through direct entry onto the DATCOV online platform, or through import of electronic data from health information systems into the database. Data imports contained validation checks to identify data errors.

Study population

This study included SARS-CoV-2 positive patients who were admitted to public and private health facilities in South Africa from 5 March 2020 to 30 April 2021. Patients were further classified as health care workers (HCWs) and non-health care workers (non-HCWs). HCW status was ascertained by a clinician report and included administrators and porters, doctors, nurses, allied health care workers, laboratory staff and paramedics. Unknown HCW occupations were labelled as 'other'. The age for both HCW and non-HCWs was restricted to working age adults (20-65 years) to make the two groups comparable.

Data analysis

Descriptive analysis was used to summarise variables. Frequencies and percentages were used to summarise categorical variables. The outcome variable hospital mortality was generated from the variable 'discharge status', which included patients who were discharged alive or had died. All patients who died of non-COVID causes were excluded from the analysis. We implemented multivariable logistic regression models to (a) compare the characteristics of hospitalised COVID-19 HCWs and non-HCWs, and (b) assess risk factors for in-hospital mortality among HCWs. Covariates included were age, which was categorised into five groups (20-29 years, 30-39 years, 40-49 years, 50-59 years and 60-65 years), sex, race, and individual comorbidities (hypertension, diabetes, chronic renal diseases, chronic pulmonary asthma, chronic cardiovascular diseases, current and past tuberculosis (TB), HIV status and obesity). The study period was divided into five wave periods: pre-wave 1 ((weeks 10 – 23 (5 March – 6 June 2020)); wave 1 ((weeks 24 – 35 (7 June – 29 August 2020)); post-wave 1 ((weeks 36 – 47 (30 August – 21 November 2020)), wave 2 ((week 48 of 2020 – week 5 of 2021 (22 November 2020 – 6 February 2021)), and post-wave 2 ((week 6 of 2021- week 17 of 2021 (7 February 2021-30 April 2021)). Sector and province were adjusted for in the model to account for the differences in hospital admissions and in the quality of care received in the private and public sectors within provinces. The variable 'weekly COVID-19 admissions' consisting of three categories, was generated and used as a proxy to measure the burden of COVID-19 cases on hospital admission, where admissions <3500 were described as 'low admission', 3500-7999 were 'moderate admission' and >8000 were 'high admission'. For the final adjusted model, a maximum likelihood test was used to include variables at the 5% level. Variables that were statistically significant and those that are considered important based on the existing literature were included in the final model. The results were presented as unadjusted (OR) and adjusted odds ratios (AOR) and 95% confidence intervals. To investigate the effect of missing observation on the final model, a model with the variable containing more than 50% missing was fitted, which was compared to the model without the variable. Data analysis was conducted using STATA 15 (Stata Corp® College Station, Texas, USA).

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RESULTS

Characteristics of COVID-19 patient admissions

As of 30th April 2021, South Africa experienced two COVID-19 waves; the first peaked in week 28-29 of 2020 (July 11th –July 18th 2021) and the second peaked in week 1 of 2021 (December 26th 2020- January 2nd 2021) (Figure 1). The number of admissions in HCWs and non-HCWs in the first wave was 462 and 8,152, and in the second wave was 373 and 14,615 respectively.

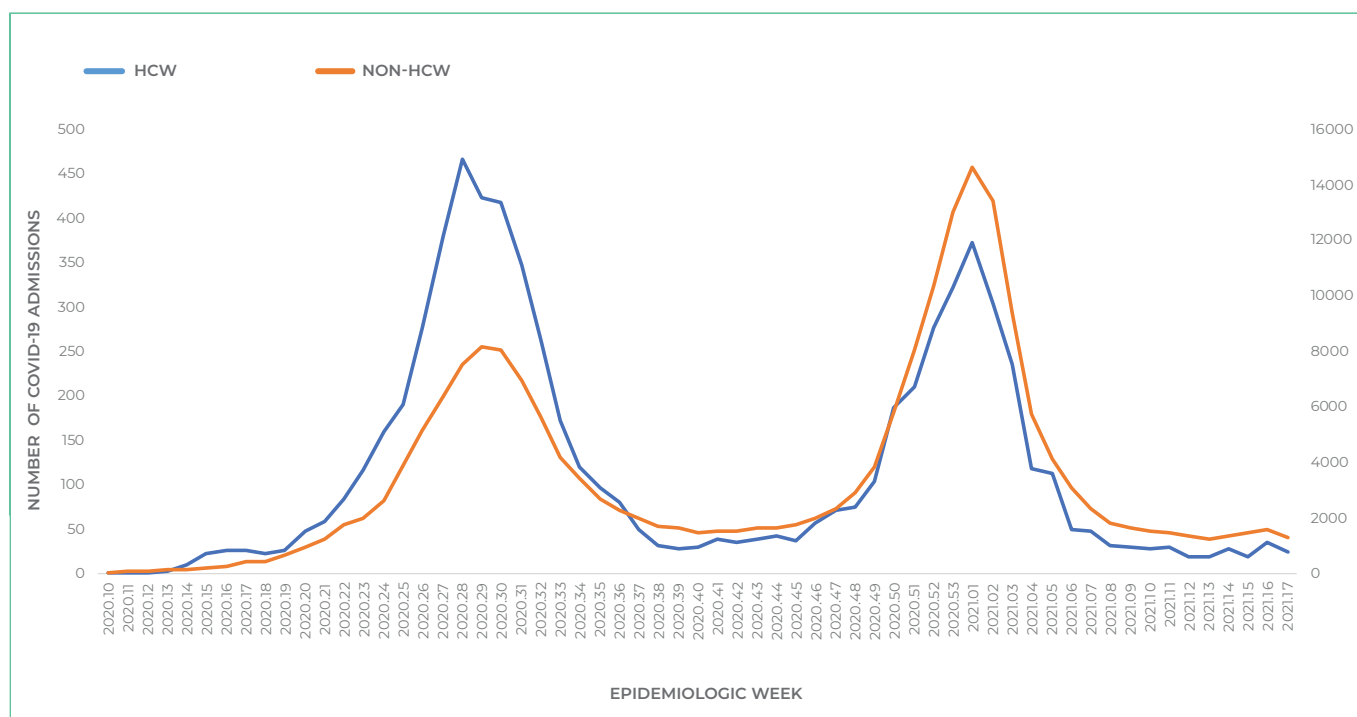


Figure 1. Number of COVID-19 admissions reported in healthcare workers (HCW) and non-healthcare workers (non-HCW) by epidemiologic week, 5 March 2020-30 April 2021, South Africa, n=169,678.

A total of 169,678 admissions related to COVID-19 was reported across 625 hospitals (375 from the public sector and 250 from the private sector) in South Africa, with 6,364 (3.8%) patients reported as HCWs. Table 1 gives the demographic and clinical characteristics of HCWs and non-HCWs. There were 30,191 (17.8%) deaths recorded, with a CFR of 9.5% for HCWs and 18.1% for non-HCWs. A multivariable analysis comparing characteristics of HCWs to non-HCWs showed that HCWs admitted with COVID-19 were less likely to be males [aOR 0.3, 95%CI (0.3-0.4)] and to have mortality as an outcome [aOR 0.6; 95% CI (0.5-0.7)]. HCWs were more likely to be admitted in the private sector [aOR 1.3; 95%CI (1.1-1.5)], in the Eastern Cape [aOR 1.9;95%CI (1.5-2.4)], Gauteng [aOR 2.1; 95%CI (1.6-2.6)], KwaZulu-Natal [aOR 2.4; 95%CI (1.9-2.6)], Limpopo [aOR 1.7; 95%CI (1.2-2.6)] and North West [aOR 1.8; 95%CI (2.1-3.8)] provinces. HCW hospital admissions were more likely to occur in the age group 30-39 years [aOR 1.4; 95%CI (1.1-1.9)], 40-49 years [aOR 1.6; 95%CI (1.2-2.0)] and 50-59 years [aOR 1.4; 95%CI (1.1-1.8)] compared to 20-29 years; and in pre-wave 1 [aOR 3.0; 95%CI (2.4-3.7)] and the first wave [aOR 2.1; 95%CI (1.8-2.5)] compared to the second wave. HCWs were more likely to have obesity (aOR 1.8; 95%CI 1.5-2.1) and asthma [aOR 1.3; 95%CI (1.0-1.5)] as existing comorbidities, and less likely to have HIV [aOR 0.7; 95%CI (0.6-0.9)] and chronic kidney diseases [aOR 0.2; 95%CI (0.1-0.4)].

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Table 1. Characteristics of COVID-19 admissions in healthcare workers (HCW) and non-healthcare workers (non-HCW) aged 20-65 years in South Africa; 5 March 2020-30 April 2021 (N=169,678). OR=odds ratio, aOR=adjusted odds ratio.

Characteristic	HCWs (N, %) N=6,364	Non-HCWs (N, %) N=163,314	OR	p	aOR	p
Sex						
Female	4,571 (71.9)	90,295 (55.4)	Ref (1.00)		Ref (1.00)	
Male	1,791 (28.2)	72,760 (44.6)	0.5 (0.4-0.5)	<0.001	0.3 (0.3-0.4)	<0.001
Age group (years)						
20-29	464 (7.3)	15,540 (9.5)	Ref (1.00)		Ref (1.00)	
30-39	1,341 (21.1)	31,129 (19.1)	1.4 (1.3-1.6)	<0.001	1.4 (1.1-1.9)	0.005
40-49	1,769 (27.8)	38,715 (23.7)	1.5 (1.4-1.7)	<0.001	1.6 (1.2-2.0)	<0.001
50-59	2,103 (33.1)	49,927 (30.6)	1.4 (1.3-1.6)	<0.001	1.4 (1.1-1.8)	0.005
60-65	687 (10.8)	28,003 (17.2)	0.8 (0.7-0.9)	<0.001	0.8 (0.6-1.0)	0.139
Race (n/N, %)						
Black	3,865/6,273 (61.6)	89,298/162,518 (55.0)	Ref (1.00)		Ref (1.00)	
Coloured	387/6,273 (6.2)	7,562/162,518 (4.7)	1.2 (1.1-1.3)	0.002	1.0 (0.8-1.3)	0.799
Indian	457/6,273 (7.3)	6,043/162,518 (3.7)	1.7 (1.6-1.9)	<0.001	0.9 (0.7-1.1)	0.296
White	648/6,273 (10.3)	7,054/162,518 (4.3)	0.4 (0.3-0.4)	<0.001	1.4 (1.0-1.7)	0.014
Other	916/6,273 (14.6)	52,561/162,518 (32.3)	2.1 (1.9-2.3)	<0.001	0.4 (0.3-0.5)	<0.001
Sector						
Private	4,030 (63.3)	78,998 (48.4)	1.8 (1.7-1.9)	<0.001	1.3 (1.1-1.5)	<0.001
Public	2,334 (36.7)	84,316 (51.6)	Ref (1.00)		Ref (1.00)	
Province						
Western Cape	721 (11.3)	32,140 (19.7)	Ref (1.00)		Ref (1.00)	
Eastern Cape	891 (14.0)	19,601 (12.0)	2.0 (1.8-2.2)	<0.001	1.8 (1.5-2.4)	<0.001
Free State	276 (4.3)	9,646 (5.9)	1.3 (1.1-1.5)	0.001	1.0 (0.7-1.4)	0.784
Gauteng	2,045 (32.1)	44,504 (27.3)	2.0 (1.9-2.2)	<0.001	2.1 (1.6-2.6)	<0.001
KwaZulu-Natal	1,658 (26.1)	31,612 (19.4)	2.3 (2.1-2.6)	<0.001	2.3 (1.9-2.9)	<0.001
Limpopo	138 (2.2)	6,207 (3.8)	1.0 (0.8-1.1)	0.924	1.7 (1.2-2.6)	0.002
Mpumalanga	144 (2.3)	6,753 (4.1)	1.0 (0.8-1.1)	0.583	0.6 (0.4-1.2)	0.178
North West	424 (6.7)	9,683 (5.9)	2.0 (1.7-2.1)	<0.001	2.8 (2.1-3.6)	<0.001
Northern Cape	67 (1.1)	3,168 (1.9)	0.9 (0.7-1.2)	0.648	1.5 (1.0-2.6)	0.073
Wave						
Pre-wave 1	418 (6.6)	7,068 (4.3)	2.0 (1.8-2.2)	<0.001	3.0 (2.4-3.7)	<0.001
Wave 1	3,095 (48.6)	52,707 (32.3)	2.0 (1.9-2.1)	<0.001	2.1 (1.8-2.5)	<0.001
Post-wave 1	500 (7.9)	17,530 (10.7)	1.0 (0.9-1.1)	0.725	1.3 (1.0-1.7)	0.040
Wave 2	2,036 (32.0)	70,124 (42.9)	Ref (1.00)		Ref (1.00)	

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Post-wave 2	315 (4.9)	15,885 (9.7)	0.7 (0.6-0.8)	<0.001	1.0 (0.7-1.4)	0.976
Chronic diseases (n/N, %)						
Obesity						
No	1,398 (81.1)	36,412 (88.2)	Ref (1.00)		Ref (1.00)	
Yes	325 (18.9)	4,857 (11.8)	1.7 (1.5-1.9)	<0.001	1.8 (1.5-2.1)	<0.001
Hypertension						
No	3,318/50,49 (65.7)	79,728/118,636 (67.2)	Ref (1.00)			
Yes	1,731/5,049 (34.3)	38,908/118,636 (32.8)	1.1 (1.0-1.1)	0.028		
Diabetes						
No	3,852/4,993 (77.2)	86,727/116,665 (74.3)	Ref (1.00)			
Yes	1,141/4,993 (22.9)	29,938/116,665 (25.7)	0.9 (0.8-0.9)	<0.001		
Asthma						
No	4,543/4,880 (93.1)	104,936/111,741 (93.9)	Ref (1.00)		Ref (1.00)	
Yes	337/4,880 (6.9)	6,805/111,741 (6.1)	1.1 (1.0-1.3)	0.020	1.3 (1.0-1.5)	0.014
HIV						
No	4,492/4,807 (93.5)	98,308/111,731 (88.0)	Ref (1.00)		Ref (1.00)	
Yes	315/4,807 (6.6)	13,423/111,731 (12.0)	0.5 (0.5-0.6)	<0.001	0.7 (0.6-0.9)	<0.001
TB (current/past)						
No	4,751/4,842 (98.1)	105,661/110,877 (95.3)	Ref (1.00)			
Yes	91/4,842 (1.9)	5,216/110,877 (4.7)	0.4 (0.3-0.5)	<0.001		
Chronic kidney disease						
No	4,778/4,807 (99.4)	106,527/108,836 (97.9)	Ref (1.00)		Ref (1.00)	
Yes	29/4,807 (0.6)	2,309/108,836 (2.1)	0.3 (0.2-0.4)	<0.001	0.2 (0.1-0.5)	<0.001
Pregnancy (n/N, %)						
No	6,234/6,364 (98.0)	157,608/157,608 (96.1)	Ref (1.00)		Ref (1.00)	
Yes	130/6364 (2.0)	5,706/16,314 (3.5)	0.6 (0.5-0.7)	<0.001	0.3 (0.2-0.4)	<0.001
Admission Outcomes						
Discharged alive	5,761 (90.3)	128,238 (81.3)	Ref (1.00)		Ref (1.00)	
Died	603 (9.7)	29,588 (18.7)	0.5 (0.4-0.5)	<0.001	0.6 (0.5-0.7)	<0.001

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Comorbidities reported for COVID-19 deaths

Comorbidities reported among HCWs who died of COVID-19 across all age groups are shown in Figure 2. Most COVID-19 related deaths were reported in the 50-59 and 40-49 year age groups. Malignancy and chronic cardiac diseases were the most commonly reported comorbidities in the age group 50-59 years, and TB and obesity the most commonly reported comorbidities in the age group 40-49 years.

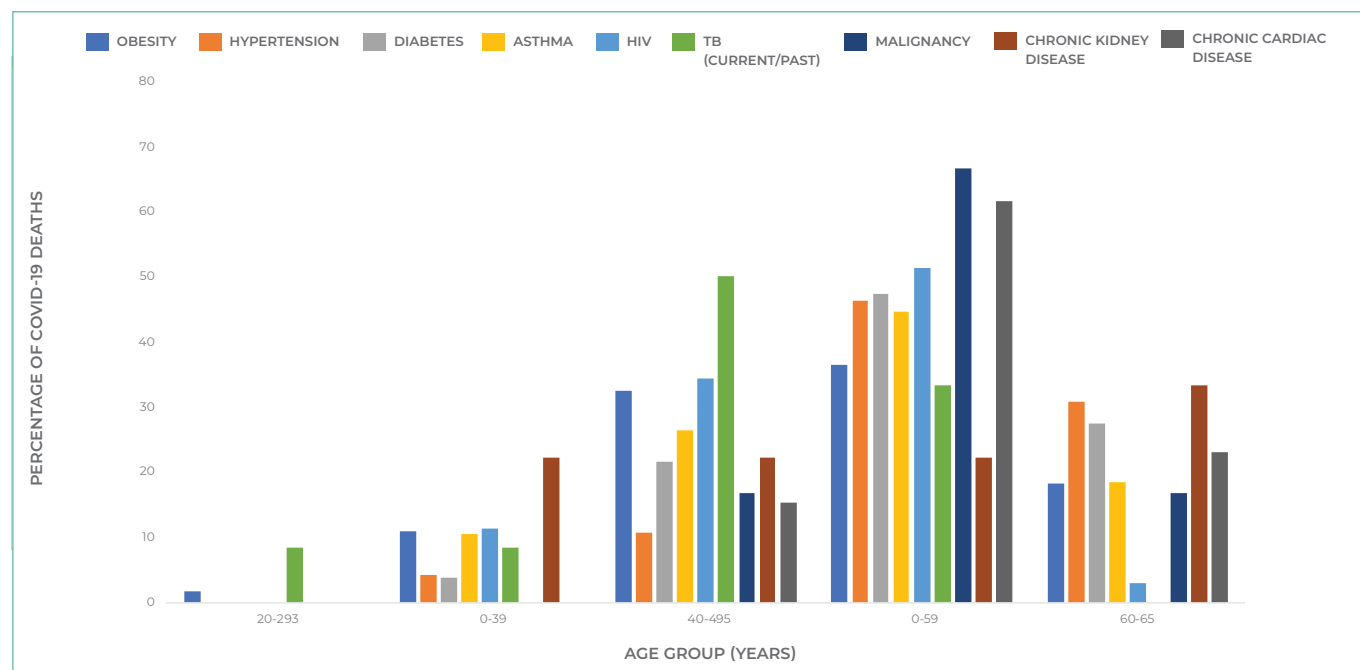


Figure 2. Percentages of reported comorbid diseases among healthcare workers (HCWs) who died from COVID-19, stratified by age-group between from 5 March 2020 through 30 April 2021, South Africa, n=603.

Factors associated with COVID-19 hospital mortality among HCWs

On multivariable analysis, risk factors associated with in-hospital mortality among HCWs were older age, high weekly load of hospital admissions, province and history of comorbidities. The odds of HCW mortality increased with age, with HCWs in the age groups 40-49 years [aOR 3.8; 95%CI 1.6-8.8], 50-59 years [aOR 4.7; 95%CI 2.0-10.9] and 60-65 years [aOR 9.8; 95%CI 4.2-22.9] having increased odds of mortality compared to HCWs in the 20-29 years age group. The risk of mortality was increased among HCWs admitted in Limpopo (aOR 2.5; 95%CI 1.3-5.2) and the Eastern Cape [aOR 1.9; 95%CI (1.3-2.9)] provinces compared to those in the Western Cape Province. Weekly hospital admissions of more than 8000 increased the risk of hospital mortality among HCWs compared to low admission numbers [aOR 1.5; 95%CI 1.1-2.3]. HCWs with hypertension [aOR 1.3, 95% CI 1.0-1.6], diabetes [aOR 1.8, 95% CI 1.4-2.2], chronic renal diseases [aOR 3.7, 95% CI 1.6-10.0], malignancy [aOR 3.7; 95%CI 1.1-7.2] and TB [aOR 2.2; 95%CI 1.1-4.4] were more likely to have died than those without comorbidities.

There was a lower risk of mortality among HCWs who were coloured [aOR 0.5; 95%CI 0.3-0.8] compared to black HCWs in the public health sector [aOR 0.7; 95%CI 0.5-0.9] and in pre-wave 1 [aOR 0.6; 95%CI 0.3-0.9] as compared to the wave 1 period. There was no statistically significant difference in mortality in wave 1 and wave 2 [aOR 1.1; 95%CI 0.9-1.5] (Table 2).

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Table 2. Factors associated with COVID-19 in-hospital mortality among hospitalized healthcare workers (HCWs) aged 20-65 years in South Africa, 5 March 2020 – 30 April 2021.

Characteristics	Case fatality ratio n/N (%)	OR (95% CI)	p	aOR (95% CI)	p
Sex					
Female	390/4462 (8.7)	1.00 (ref)			
Male	213/1,756(12.1)	1.4 (1.2-1.7)	<0.001		
Age group (years)					
20-29	8/453 (1.8)	1.00 (ref)		1.00 (ref)	
30-39	47/1,318(3.6)	2.1 (1.0-4.4)	0.062	1.7 (0.7-4.1)	0.229
40-49	142/1,730 (8.2)	4.9 (2.4-10.2)	<0.001	3.8 (1.6-8.8)	0.002
50-59	249/2,047 (12.2)	7.7 (3.8-15.6)	<0.001	4.7 (2.0-10.9)	<0.001
60-65	157/672 (23.4)	16.9 (8.2-34.7)	<0.001	9.8 (4.2-23.0)	<0.001
Race					
Black	391/3,758 (10.4)	1.00 (ref)		1.00 (ref)	
Coloured	28/75 (37.3)	0.7 (0.5-1.0)	0.074	0.5 (0.3-0.8)	0.008
Indian	59/454 (13.0)	1.3 (0.9-1.7)	0.092	1.2 (0.8-1.7)	0.329
White	68/635 (10.7)	1.0 (0.8-1.4)	0.817	0.8 (0.6-1.0)	0.081
Other	48/911 (5.3)	0.5 (0.4-0.7)	<0.001	1.0 (0.6-1.5)	0.911
Wave					
Pre-wave 1	19/412 (4.6)	0.5 (0.3-0.9)	0.015	0.6 (0.3-0.9)	0.041
Wave 1	274/3,044 (9.0)	1.00 (ref)		1.00 (ref)	
Post-wave 1	33/489 (6.7)	0.8 (0.67-1.2)	0.322	0.8 (0.4-1.3)	0.386
Wave 2	277/1,999 (13.9)	1.8 (1.5-2.2)	<0.001	1.1 (0.9-1.5)	0.373
Post-wave 2	29/276 (10.5)	1.3 (0.9-2.0)	0.157	1.0 (0.6-1.8)	0.905
Weekly national number of admitted COVID-19 cases					
Low <3500	166/1,949 (8.5)	1.00 (ref)		1.00 (ref)	
Medium 3500-7999	270/2,998 (9.0)	1.2 (0.9-1.4)	0.142	1.1 (0.8-1.5)	0.385
High 8000-12499	167/1,110(15.0)	2.1 (1.6-2.6)	<0.001	1.5 (1.1-2.3)	0.025
Health sector					
Private	440/3,967 (11.1)	1.00 (ref)		1.00 (ref)	
Public	163/2,253 (7.2)	0.6 (0.5-0.8)	<0.001	0.7 (0.5-0.9)	0.011
Province					
Western Cape	65/710 (9.2)	1.00 (ref)		1.00 (ref)	
Eastern Cape	134/872(15.4)	1.8 (1.3-2.5)	<0.001	1.9 (1.3-2.9)	0.003
Free State	19/251 (7.6)	0.8 (0.5-1.4)	0.445	0.8 (0.4-1.6)	0.516
Gauteng	142/2,016 (7.0)	0.8 (0.6-1.0)	0.069	0.9 (0.6-1.5)	0.861
KwaZulu-Natal	176/1,639 (10.7)	1.2 (0.9-1.6)	0.246	1.0 (0.6-1.6)	0.895
Limpopo	19/130 (14.6)	1.7 (0.9-2.9)	0.059	2.5 (1.3-5.2)	0.009
Mpumalanga	18/136 (13.2)	1.5 (0.9-2.6)	0.145	1.8 (0.8-3.7)	0.117

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North West	25/404(6.2)	0.7 (0.4-1.1)	0.089	0.7 (0.3-1.2)	0.209
Northern Cape	5/62 (8.1)	0.9 (0.3-2.4)	0.774	1.3 (0.3-4.6)	0.658
Hypertension					
No	276/3,259 (8.5)	1.00 (ref)		1.00 (ref)	
Yes	283/1,686 (16.8)	2.2 (1.8-2.6)	<0.001	1.3 (1.0-1.6)	0.027
Diabetes mellitus					
No	329/3,779 (8.7)	1.00 (ref)		1.00 (ref)	
Yes	218/1,111 (19.6)	2.6 (2.1-3.1)	<0.001	1.8 (1.4-2.2)	<0.001
Chronic kidney disease					
No	516/4,690 (11.0)	1.00 (ref)		1.00 (ref)	
Yes	9/28 (32.1)	3.8 (1.7-8.5)	0.001	4.1 (1.6-10.0)	0.002
Malignancy					
No	518/4,674 (11.1)	1.00 (ref)		1.00 (ref)	
Yes	6/23 (26.1)	2.8 (1.1-6.9)	0.029	3.7 (1.1-7.2)	0.014
TB (current /past)					
No	514/4,665 (11.0)	1.00 (ref)		1.00 (ref)	
Yes	12/87 (13.8)	1.3 (0.7-2.3)	0.473	2.2 (1.1-4.4)	0.019

DISCUSSION

As of 30 April 2021, a total of 6,364 COVID-19 admissions (2.7% of all hospital admissions) was reported amongst HCWs across South Africa. Compared to other countries, South Africa reached its first and second COVID-19 waves a few months later.¹⁹⁻²¹ The implementation of the four-week hard lockdown period following identification of the first case in the country likely slowed transmission of SARS-CoV-2 in the general population.²¹ Early studies on COVID-19 reported that a large proportion of early cases was amongst HCWs.^{21,22} In this study, a high number of HCW admissions was seen in the pre-wave 1, wave 1 and post-wave 1 periods, compared to the second wave. The decrease in admissions of HCWs in the second wave may be due to better safety protocols being implemented in health facilities to manage transmission of the virus, such as appropriate PPE and improved handling of admitted patients. In pre-wave 1, the spread of the virus was new in South Africa, and facilities and frontline workers were comparatively ill-prepared for rising COVID-19 cases. Work overload, lack of PPE and poor infection control, which resulted in outbreaks in hospitals and limited training on handling of the new disease, were among the reported risk factors of HCW infections in the first wave.⁷ Improved competency in handling infected patients as well as better preparedness in facilities may have resulted in subsequent decreased HCW admissions.^{18,19} In addition, HCW exposure to COVID-19 during the first wave may have increased their antibody levels, thus producing subsequent improved immunity against infections in the second wave.^{23,24} It was expected that hospital admissions among non-HCWs would decrease in the second wave due to the introduction of several interventions and therapeutic agents administered to admitted patients, such as high flow oxygen (HFNO)²⁵, remdesivir²⁶, dexamethasone²⁷ and thromboprophylaxis.²⁸

The majority of HCW and non-HCW admissions were female (71.9% for HCWs and 55.4% for non-HCWs) in the age group 50-59 years (33.1% and 30.6%). HCWs in this study were less likely to be male, and more likely to be in the age group 30-59 years and admitted in the private health sector. In addition, we found that HCWs were less likely to have mortality as an outcome [aOR 0.6; 95%CI (0.5-0.7)]. A study comparing COVID-19 infections among HCWs and non-HCWs reported that being a HCW was not associated with increased risk of mortality. Furthermore, the risk of mortality in HCWs was high in the older age group (≥ 60 years).²²

We assessed COVID-19 hospital mortality among HCWs. After restricting the age to that of the working population, multivariable analysis showed that risk of mortality increased with age, with the older age group (60-65 years) having higher risk of mortality compared to the young age group (20-29 years). In many countries, COVID-19 mortality was seen among the older age group, especially those aged ≥ 60 years.^{28,29} Previous studies have shown that males were twice as likely to be at high risk of mortality than females across age groups.³⁰⁻³³ Our study however did not find an association of male sex with mortality. Comorbidities have been identified as a significant factor for mortality in both older and young COVID-19 patients.³⁴⁻³⁶ A meta-analysis of 55 independent studies reporting clinical data of patients with COVID-19 reported that pre-existing hypertension, diabetes, respiratory diseases, malignancy and severe chronic kidney diseases were risk factors for severe COVID-19 infection and mortality.¹⁰ Our study showed that HCWs who had hypertension, diabetes, chronic renal diseases, malignancy and current and past TB history were more likely to die compared to those without these comorbidities.^{10,35,37} Even though obesity has been shown to increase COVID-19 mortality^{38,39}, this study did not find obesity to be a significant factor of mortality amongst HCWs. Although it has previously been reported by that HIV and TB increases the risk of hospital mortality in the general population⁴⁰, we found that HIV infection

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in HCWs was not associated with COVID-19 mortality. Antiretroviral (ART) drugs such as tenofovir (TDF) and lopinavir-ritonavir have been found to reduce the risk of severe COVID-19 in people living with HIV.^{35,41} The lack of association in this study could be that HIV-infected HCWs may be receiving ART. A recent study conducted in Western Cape Province reported that patients with HIV and TB are at an increased risk of COVID-19 mortality, whereas those who received TDF as ART treatment had a lower risk of COVID-19 mortality.³³ In a poorly-resourced country such as South Africa, TB infection prevention and control (IPC) measures are frequently suboptimally implemented. There have been reports that show that HCWs who care directly and indirectly for TB patients irregularly use appropriate respiratory protection, resulting in high prevalences of TB among HCWs.⁴² In this study, we found that current and past TB history was associated with HCW mortality.

This study shows that HCWs admitted to hospital for COVID-19 were more likely to be white. White and coloured HCWs were however less likely than black HCWs to have mortality as an outcome. HCWs were more likely to be admitted to the private health sector compared to the public health sector, and the public sector had decreased odds of hospital mortality among HCWs compared to the private sector. This may be expected as most HCWs access the private healthcare sector to seek treatment. Differences in HCW hospitalisation between provinces may indicate differences in health systems and testing, health-seeking behaviour and clinical practice.¹⁸

STRENGTHS AND LIMITATIONS

The main strength of this study is that we used real-time data from an ongoing hospital surveillance system (DATCOV) that covers a large number of public and private health facilities across provinces in South Africa, thus maximizing generalisability of the data. Nonetheless, there are limitations in the use of these data to assess mortality, such as the under-reporting of risk factors such as comorbidities, race, obesity and specific job categories of HCWs, which may indicate which job category of HCWs had increased mortality.

CONCLUSION

We found that the risk of in-hospital COVID-19 mortality among hospitalised healthcare workers was lower when compared to non-HCWs. HCW admission decreased in the second COVID-19 wave due to improvement of resources in health facilities and improved preparedness for the disease within the country. In addition, acquired immunity from infections in the first wave could have led to a decline in HCW COVID-19 cases in the second wave. With the roll-out of vaccines amongst HCW underway since February 2021 in South Africa, we expect further decreases in COVID-19 cases and mortality among HCWs, despite the fact that the country has entered the third wave of the pandemic.

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