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## Original article

## Epidemiological and clinical characteristics of COVID-19 mortality among healthcare workers in Saudi Arabia: A nationwide study



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## ABSTRACT

**Background:** Healthcare workers (HCWs) have been highly affected by COVID-19 due to their fundamental duties in diagnosing, caring, and treating the rapidly increasing number of infected patients. Thus, are facing the occupational risk of COVID-19 infection and mortality.

**Purpose:** To investigate the COVID-19 disease clinical characteristic and associated factors among HCWs in Saudi Arabia.

**Methods:** This was a nationwide, retrospective analytical study conducted from 5th of March 2020–21 st of August 2021. All deceased HCWs who were diagnosed with COVID-19 were included in this study.

**Results:** As of August 21, 2021, a total of 305 deaths were recorded due to COVID-19 infection among HCWs in all Saudi healthcare facilities. The case fatality rate was 0.35%. Deaths were highest among physicians (40.0%). Most of deceased HCWs acquired the infection from the community (80%). 71% of deceased HCWs had at least one chronic medical condition. Most of them were admitted to ICU before they passed away (83.6%). Three significant variables predicting ICU admission were presence of one or more comorbidities, hypertension, and chronic respiratory diseases

**Conclusion:** HCWs are at higher risk for exposure to COVID-19 due to their occupational risk. Our study encourages future research to provide more comprehensive information regarding COVID-19 morbidity and mortality among HCWs.

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## 1. Background

The coronavirus disease-2019 (COVID-19) pandemic has affected many people globally through mortality and morbidity. Over 500 million cases and 6 million deaths have been registered worldwide, including over 750 hundred cases and more than 9 thousand deaths in Saudi Arabia [1]. Throughout the pandemic, healthcare workers (HCWs) all over the world have been on the frontline trying to put an end to the disease. World Health Organisation (WHO) defines HCWs as “all people engaged in actions whose primary duty is to enhance health” [2]. These people include doctors, nurses, allied health professions, hospital administrators, and support services providers. At the frontlines, many HCWs have been reportedly infected with

COVID-19 and have lost their lives [3]. In Saudi Arabia, HCWs' infection from COVID-19 was about 16% of all COVID-19 cases in the country [4]. This proportion is big enough to demonstrate a need for intervention. It is, therefore, important to ensure adequate protection of all frontline HCWs particularly when there is a need to increase healthcare capacity to meet the growing demand for patients requiring urgent care and emergency services [5].

In February 2021, WHO issued a document regarding occupational health and safety for health workers in the context of the COVID-19 pandemic [6]. Protecting HCWs remains a challenge for many countries, where the lack of adequate personal protective equipment (PPE) is a frequent concern. Limited testing capacity is another challenge that hinders early detection and isolation of infected cases [7]. These challenges increase occupational exposure for HCWs given the significantly many asymptomatic COVID-19 cases [8]. Since HCWs are a valuable resource of any nation and hard to replace, protecting them should be a priority for all nations.

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Therefore, the aim of this study was to retrospectively paint a picture on the COVID-19 disease clinical characteristic and associated factors among HCWs in Saudi Arabia with the aim of strengthening the HCWs' protection from the disease. This study was guided by three main objectives: (1) to identify the demographic and clinical characteristics of COVID-19 related HCWs deaths, (2) to determine the COVID-19 mortality rate among HCWs, and (3) to assess the risk factors associated with ICU admission among deaths of HCWs.

## 2. Methods and materials

### 2.1. Study setting and population

This is a nationwide, retrospective analytical study conducted from 5 March 2020–21 August 2021. All deceased HCWs diagnosed by positive polymerase chain reaction (PCR) for COVID-19 were included in this study.

### 3. Data collection and management

These deceased participants data were obtained from Health Electronic Surveillance System (HESN) and the Ministry of Health's (MOH) death notification forms. HESN is a web-based surveillance system in Saudi Arabia that is connected to all health facilities for reporting different health related data. HESN is the main health facility data tracking platform for Ministry of Health in Saudi Arabia [9]. The MOH death notification forms are collected from the hospitals' infection control departments by the regions directorates who notify the General Directorate of Infection Prevention and Control (GDIPC) in MOH. These notification forms include socio-demographic information, chronic comorbidities, and clinical characteristics of COVID-19 death cases among the HCWs. All data from HESN and the death notification forms pertaining the included cases were entered in excel software, cleaned, and transferred to IBM SPSS 27 and Stata 17 for analysis.

### 4. Data management and analysis

Descriptive data analysis was performed to describe all categorical variables (e.g., HCWs demographic data, work data, speciality, and medical history) and were reported as frequencies (counts and percentages). Continuous variables were reported as medians (with interquartile ranges). Trend analysis was done to illustrate the number of deaths among HCWs by year and month. Two groups were compared (ICU admitted versus not admitted) using Pearson Chi-square ( $\chi^2$ ) test and Fisher's exact test for small frequency distributions. Multiple exact logistic regression model was done to find the adjusted effect of different risk factors and to identify the most significant factors associated with ICU admission. All statistical analysis was done using two tailed tests. The statistical significance was set to a P-value of < 0.05.

### 5. Ethical consideration

Institutional Review Board (IRB) approval of this research have been obtained. Principles of research ethics have been taken into consideration including anonymity and privacy of individuals and organizations.

### 6. Results

During the period from March 5, 2020 until August 21, 2021, a total of 305 deaths were recorded due to COVID-19 among HCWs in all Saudi healthcare facilities. During the same period, the number of COVID-19 infected HCWs was 88,091. The case fatality rate among

**Table 1**

Bio-demographic characteristics of HCWs that died of COVID-19 infection in Saudi Arabia.

Bio-demographic data		No.	%
Median interval from infection to death, days (IQR)			15 (7–25)
Age in years	≤ 60	230	75.41%
	> 60	75	24.59%
Age in years, Median (IQR)			52 (45–60)
Gender	Male	231	75.74%
	Female	74	24.26%
Nationality	Saudi	70	22.95%
	Non-Saudi	235	77.05%
Job title	Physician	122	40.00%
	Nurse	62	20.33%
	Paramedical	52	17.05%
	Support Workers	69	22.62%
Work setting	Hospital	245	80.33%
	PHC	19	6.23%
	Poly clinic	28	9.18%
	Others	13	4.26%
Type of work settings	MOH	168	55.08%
	Gov non MOH	26	8.52%
	Private	111	36.39%
Number of medical comorbidities	No underlying comorbidity	89	29.20%
	≥ 1 underlying comorbidity	216	70.82%
	≥ 2 underlying comorbidity	120	39.34%
Chronic health problem	Diabetes	134	43.93%
	Hypertension	127	41.64%
	Chronic respiratory diseases	43	14.10%
	Cardiac diseases	32	10.49%
	Other	14	4.59%
	Chronic kidney disease	7	2.30%
	Blood Disorders	6	1.97%
	Cancer/	5	1.64%
	Immunodeficiency		
	Obesity	4	1.31%
	neurological	4	1.31%
	Chronic liver disease	1	0.33%
	Source of infection	Community Acquired	243
Hospital Acquired		62	20.33%
Vaccinated	Yes, one dose	14	4.59%
	Yes, two doses	1	0.33%
	No	290	95.08%
Median interval from vaccination to infection, days (IQR)			51 (14–92)

infected HCWs was 0.35%. All cases had confirmatory positive results for COVID-19.

Deceased HCWs ages ranged from 26 to 83 years old with a median age of 52 years (interquartile range [IQR]: 45–60 years). Median interval for living with the disease post infection was 15 days (IQR: 7–25 days). The majority of the deceased HCWs were 60 years or below (75.4%), males (75.7%), and non-Saudi nationals (77.1%). Mortality was highest among physicians (40%) followed by support workers (22.6%), nurses (20.3%), and paramedical staff (17.1%). In terms of work setting, deaths among HCWs who worked in hospitals was the highest (80.33%) compared to primary healthcare facilities, polyclinics, and other work settings. Most of the deaths were recorded in MOH health facilities (55.1%) followed by private health facilities (36.4%), then governmental non-MOH health facilities (8.5%) (Table 1).

Among the registered deaths, the majority (70.8%) had at least one underlying comorbidity, while 39.3% had two or more underlying comorbidity and 29.2% had no comorbidity. The most reported underlying comorbidity were diabetes mellitus (43.93%), hypertension (41.64%), chronic respiratory diseases (14.10%), and cardiac diseases (10.49%). The majority (95.1%) of deaths occurred among unvaccinated HCWs. The few (4.9%) vaccinated HCWs who got infected with the disease had a median of 51 days between vaccination to getting infected. Most of the infections (79.7%) were acquired

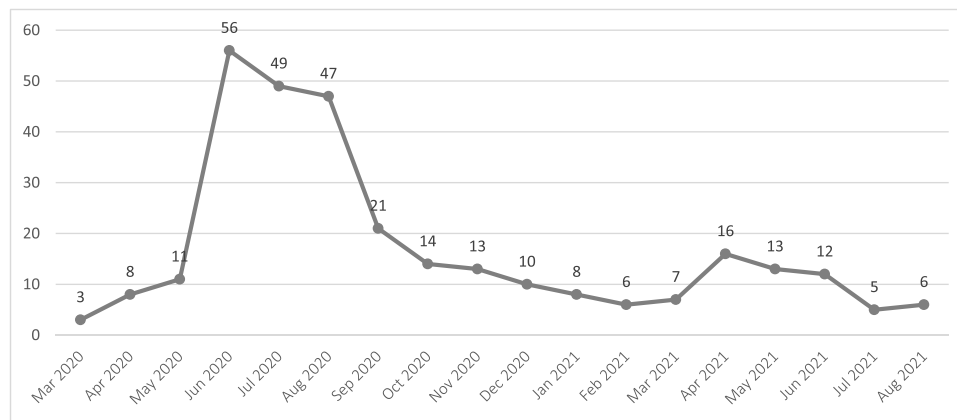


Fig. 1. Monthly trend of HCWs mortality due to COVID-19 infection, Saudi Arabia.

from the community while the rest of infections (20.3%) were acquired in healthcare facilities (Table 1).

The number of COVID-19 mortality among HCWs in Saudi Arabia increased gradually from March to May 2020, then increased dramatically and reached its peak in June 2020. From June 2020, the deaths decreased gradually to August 2021 with a slight increase in April 2021 (Fig. 1).

As indicated in Table 2 below, most (83.6%) deceased HCWs were admitted to the ICU before they passed away. The median interval from ICU admission until death was 13 days (IQR = 5–23 days). Among those who were admitted to the ICU, 92.94% were in a critical state and needed intubation.

The bivariate analysis compares ICU and non-ICU COVID-19 cases among different characteristics. COVID-19 infected cases who had one comorbidity or more ( $X^2 =$ ,  $p < 0.001$ ) or chronic respiratory conditions ( $X^2 =$ ,  $p = 0.025$ ) were more likely to be admitted in ICU than those who had not (Table 3).

The logistic regression model identifies the ICU admission predictors among deceased HCWs infected with COVID-19. The infected cases who had either one or more comorbidities ( $OR=7.1$ ,  $P=0.002$ ,  $CI=1.99–25.25$ ), hypertension ( $OR=3.6$ ,  $P=0.034$ ,  $CI=1.1–11.9$ ), or a respiratory disease ( $OR=8.1$ ,  $P=0.014$ ,  $CI= 1.5–42.8$ ) had statistically higher chances of getting admitted in ICU (Table 4).

## 7. Discussion

Healthcare workers are at a very high risk of contracting COVID-19 compared to the general population through their occupational exposure in healthcare facilities [10]. It is crucial to mention that most of the deaths among HCWs in our study was prior to the establishment of COVID-19 vaccines. This is the reason why most of deceased HCWs were unvaccinated. This rate has been on the decline with the increasing vaccination coverage across the country.

Approximately half of the deceased HCWs were from MOH healthcare facilities (55%). This could be due to the larger number of MOH healthcare facilities compared to other sectors' healthcare facilities. MOH hospitals account for approximately 60% of all hospitals in Saudi Arabia with an overall higher number of bed capacities [11].

Table 2  
Hospitalization data for HCWs who died due to COVID-19 infection, Saudi Arabia.

Hospitalization data		No	%
ICU admission	Yes	255	83.61%
	No	50	16.39%
Median interval from ICU admission to death, days (IQR)		13 (5–23)	
Need for intubation	Yes	237	92.94%
	No	18	7.06%
Median interval from intubation to death, days (IQR)		8 (3–18)	

Table 3  
Factors associated with ICU admission among the participants.

Risk factors		ICU admission		p-value		
		No	Yes			
		No.	%			
Age in years	≤ 60	37	16.1%	193	83.9%	0.800
	> 60	13	17.3%	62	82.7%	
Gender	Male	39	16.9%	192	83.1%	0.683
	Female	11	14.9%	63	85.1%	
Nationality	Saudi	15	21.4%	55	78.6%	0.195
	Non-Saudi	35	14.9%	200	85.1%	
Job title	Physician	22	18.0%	100	82.0%	0.840
	Nurse	10	16.1%	52	83.9%	
	Paramedical	9	17.3%	43	82.7%	
	Support Workers	9	13.0%	60	87.0%	
Work setting	Hospital	40	16.3%	205	83.7%	0.603#
	PHC	5	26.3%	14	73.7%	
	Poly clinic	3	10.7%	25	89.3%	
	Others	2	15.4%	11	84.6%	
Type of work settings	MOH	32	19.0%	136	81.0%	0.270
	Gov	2	7.7%	24	92.3%	
	non MOH					
Having one or more comorbidities	Private	16	14.4%	95	85.6%	< 0.001*
	No	26	29.2%	63	70.8%	
Diabetes	Yes	24	11.1%	192	88.9%	0.063
	No	34	19.9%	137	80.1%	
Hypertension	Yes	16	11.9%	118	88.1%	0.068
	No	35	19.7%	143	80.3%	
Chronic respiratory diseases	Yes	15	11.8%	112	88.2%	0.025*
	No	48	18.3%	214	81.7%	
Cardiac diseases	Yes	2	4.7%	41	95.3%	0.257
	No	47	17.2%	226	82.8%	
Infection source	Yes	3	9.4%	29	90.6%	0.224
	No	43	17.7%	200	82.3%	
Vaccinated	Community	7	11.3%	55	88.7%	0.565#
	Acquired					
	Acquired					
	Acquired					
Vaccinated	Yes, one dose	1	7.1%	13	92.9%	0.565#
	Yes, two doses	0	0.0%	1	100.0%	
	No	49	16.9%	241	83.1%	
	No					

P: Pearson  $X^2$  test, \*  $P < 0.05$  (significant), #: Exact probability test.

Three quarters (75.74%) of deaths among HCWs in our study occurred among males and most (40%) of the deaths were amongst physicians. These findings agree with the findings of a recent systematic review conducted on COVID-19 infections and deaths in HCWs worldwide that indicated that most of the deceased HCWs were males (70.8%) and doctors (51.4%) [5]. A study investigating HCWs deaths due to COVID-19 in The United States found that males

**Table 4**  
Logistic regression model for predicting ICU admission among participants.

Predictor	p-value	OR <sub>A</sub>	95% C.I for OR <sub>A</sub>	
			Lower	Upper
Age	0.071	0.97	0.94	1
Female	0.919	1.04	0.47	2.31
Non-Saudi	0.328	1.45	0.69	3.06
Having one or more comorbidities	0.002*	7.1	1.99	25.25
Hypertension	0.034*	3.62	1.1	11.89
Diabetes	0.098	2.51	0.84	7.45
Respiratory diseases	0.014*	8.1	1.53	42.83
Cardiac diseases	0.075	3.78	0.88	16.35

OR<sub>A</sub>: Adjusted Odds Ratio, C.I: Confidence interval.

\* P < 0.05 (significant).

(64.1%) and physicians (54.8%) represented most reported deaths among a sample of 1004 HCWs COVID-19 deaths [12]. It has been suggested in another study conducted in Iran that a possible reason more COVID-19 deaths are being observed among physicians could be due to the careless use of PPE by physicians and the better discipline to follow safety procedures by nurses [13]. Although gender and job title category contribution to COVID-19 infection has not been well studied, it is assumed that males are in general more risk takers compared to females and that majority of the physicians are males, thus, justifying the observed difference [14]. Furthermore, this could also be due to the differences in the level of exposure, equipment and training provided or qualification age [5,14]. Generally, majority of the studies investigating COVID-19 infection and mortality report that nurses comprise most of the infected cases and mortality rates are found to be higher among physicians [5,13,14].

In our study it was found that the majority (79.3%) of the cases acquired the infection from the community, while approximately fifth of the cases (20.3%) acquired the infection from healthcare facilities. These findings agree with the findings of a study conducted in Oman, where 61.3% of HCWs COVID-19 cases acquired the infection from the community and 25.5% acquired the infection from the healthcare sitting [15].

Our study indicates that most COVID-19 deceased HCWs had one or more underlying comorbidity (70.8%), with diabetes mellitus (43.9%) and hypertension (41.6%) being the most prevalent underlying medical conditions. This is similar to the findings of a study conducted in Saudi Arabia regarding clinical and epidemiological characteristics of COVID-19 mortality in the general population, where comorbidities were present in most of the cases (96.9%) [15]. Likewise, this study has found that the most prevalent comorbidities were diabetes mellitus (73.7%) followed by hypertension (69.6%) [15]. Another study done in Saudi Arabia assessing the comorbidities and risk factors for severe outcomes in COVID-19 patients, found that mortality rate of COVID-19 was significantly higher among patients with respiratory, cardiovascular, neurological, and renal comorbidities [16].

Our study further asserts that given the presence of either one comorbidity or more, hypertension, or a chronic respiratory condition; one can predict that a HCW infected with COVID-19 will end up admitted in ICU. Two studies, one conducted in Saudi Arabia and one in Egypt, asserted that on addition to these three factors, renal impairment is also a significant predictor of ICU admission among COVID-19 patients [16,17].

The case fatality rate among COVID-19 infected HCWs in our study was 0.35%. This case fatality rate is lower to what was calculated in Saudi Arabia among the general population (1.09%) [18]. Another study done in Saudi Arabia comparing clinical characteristics and outcomes among hospitalized COVID-19 patients, found that the mortality rate among HCWs was lower by almost three folds than that of the general population (4.6% vs 13.5%) [19]. This is likely

due to the better, and more informed medical self-care of HCWs [20].

Our study had several limitations that motivate future work. Firstly, data in this study were retrieved from electronic records, therefore, it might have information and documentation bias. Secondly, due to unavailability of data regarding demographic and clinical characteristics in survived HCWs, no relationship between different variables and the risk of death have been established. Thirdly, variables and factors related to PPE proper use as well as infection control training and education among HCWs were not covered in this study. Despite the limitations, this study is unique in its kind since there is no other previous research that discussed COVID-19 mortality among HCWs in Saudi Arabia according to our knowledge. However, more extended longitudinal follow-up studies are needed to study the correlation between important variables and the risk of death among HCWs.

## 8. Conclusion

Health care workers are at risk of acquiring COVID-19 infection because they are frontline workers. As of August 21st, 2021, 305 deaths among HCWs were reported in Saudi Arabia, with a 0.35% case fatality rate. The majority of deceased HCWs were males, 122 were physicians, 69 were support workers, 62 were nurses, and 52 were paramedical workers. Most of the deceased HCWs had at least one comorbidity and were admitted to ICU before they passed away.

It is suggested that more effort is required to minimize the risk of infection in the work setting. Training and education should be implemented for all healthcare workers on infection prevention and control techniques. As well, more actions should be done to minimize the infection rate in the community as the majority of deceased HCWs acquired the infection from the community. Delivering quality health services including availability of rapid COVID-19 tests and vaccinations is essential to maintain a safe work environment. Data on COVID-19 morbidity and mortality among HCWs should be collected, analyzed, and published in a systematic manner. Our study provides valuable findings and encourages future research to provide more comprehensive information.

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## Conflict of interests

None declared.

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