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Incidence and epidemiological characteristics of COVID-19 among health care workers in Saudi Arabia: A retrospective cohort study

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ABSTRACT

Introduction: Novel coronavirus (SARS-CoV-2) is a highly infectious serious acute respiratory syndrome that has emerged in Wuhan, China, and has spread rapidly throughout the world including Saudi Arabia. An important source of infection of 2019 novel coronavirus (2019-nCoV) is healthcare-associated infection (HAI). Healthcare workers (HCWs) have a greater risk of acquiring COVID-19 infection than the general population. Globally, thousands of HCWs have lost their lives due to COVID-19 infection.

Aim: Identify Incidence Rate and epidemiological characteristics of COVID-19 infection among health workers in Saudi Arabia.

Methodology: A retrospective cohort study carried from March to November 2020. HCWs selected by a Complete Enumeration Survey method. Data analyzed in frequencies and percentage tables. To test the differences, post hoc after chi-square- (χ^2) tests were used.

Results: As of November 30, 2020, a total of 57,159 HCWs tested positive with COVID-19. Their median age was 34 years, and 53% were male. Nurses were the most infected HCWs category (36%). The most common source of infection was from the community (78%). The majority of HCWs who acquired the infection from healthcare facilities got the infection from another HCW (63%). There was a significant difference between community and healthcare-acquired COVID-19 in relation to gender ($P < 0.001$) nationality ($P < 0.001$) job categories ($P < 0.001$) three age groups (<26 : $P = 0.012$, $26-35$ and $36-45$: $P < 0.001$), and among HCWs who worked in MOH and private healthcare facilities ($P < 0.001$). The total number of reported deaths among HCWs during the study period was 198, with a case fatality rate of (0.35%).

Conclusion: This study findings show that infected HCWs characteristics were similar to the previous studies and indicate incidence rates of 10% among COVID-19 infected HCWs in Saudi Arabia. Analysis of the infection status of HCWs is critical, to understand their needs and challenges, improve protective measures, and provide effective recommendations for policymakers.

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Introduction

Globally, lower respiratory tract infections have the highest mortality rates among communicable diseases [1]. In December 2019, a highly infectious serious acute respiratory syndrome caused by a novel coronavirus (SARS-CoV-2) emerged in Wuhan, China. On 11 March 2020, COVID-19 has declared as global pandemic by the World Health Organization (WHO) [2]. The infection has spread

rapidly throughout many countries around the world including Saudi Arabia as well [3].

COVID-19 pandemic has caused various global crises and concerns at different level, including healthcare sector [4]. By November 30, 2020, the coronavirus (COVID-19) pandemic had resulted in 62,787,929 cases and 1,460,179 deaths worldwide, including 357,360 cases and 5896 deaths in Saudi Arabia [5]. Before reporting the first case in the country on March 2, 2020, Saudi Arabia started its early unprecedented precaution to prevent COVID-19 introduction into the country or to mitigate its impact when it arrives [6].

An important source of infection of 2019 novel coronavirus (2019-nCoV) is healthcare-associated infection (HAI) [7]. Accord-

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Table 1
Summary of data-collection tools.

Purpose	Collecting from whom?
Tool 1: Saudi Health Electronic Surveillance Network System (HESN) Initial reporting (notifications of the positive laboratory result test of COVID-19)	All hospitals infection control departments
Tool 2: Ministry of Health's (MOH) electronic self-reporting. Epidemic investigation and follow up	Regional infection control departments of MOH

ing to WHO (2020), healthcare workers (HCWs) have a greater risk of acquiring COVID-19 infection than the general population. Even though HCWs only represent less than 3% of the general population in most countries and less than 2% in almost all low- and middle-income countries, around 14% of COVID-19 cases reported to the WHO are among HCWs. Globally, thousands of HCWs have lost their lives due to COVID-19 infection [8].

Moreover, evidence obtained from Wuhan in China proved that HCWs are not just at a high risk of getting the virus within medical facilities; on the other hand, they could catch the infection from the community or transmit it to others [9]. Another reported study from the CDC's COVID-19 response team proved that even though the majority of HCWs have reported catching the infection from healthcare facilities. However, some exposures occurred in households and the community, highlighting the chance for exposure in different settings. The study found that whether the infection has occurred at work or in the community, it is critically necessary to protect and ensure the health and safety of these essential national workforces [10].

This current study aims to identify the incidence rate and epidemiological information of COVID-19 infection among healthcare workers in Saudi Arabia. The findings of this study could help inform the ongoing public and health policy practices across the country and therefore provide better prevention measures.

Methodology

Study population

A retrospective cohort study carried out in Saudi Arabia, and a complete enumeration survey "Census Method" has performed to study a population of 57,159 HCWs, which approached through the Saudi Health Electronic Surveillance Network System (HESN). The study population includes all laboratory confirmed – positive COVID-19 staff in health care facilities (physicians, nurses, allied health workers, and support services workers), who worked during the period of 2 March to 30 November 2020. Whether they were providing health care to patients with a laboratory-confirmed COVID-19 test or not, and either the infection was healthcare-acquired infection "HAI" or community-acquired infection "CAI". HCWs in this study recruited from all different types of healthcare facilities including hospitals, primary healthcare centers, pharmacies, dialysis centers, rehabilitation centers, psychiatric clinics, and dental clinics.

Data collection tools and procedure

Besides the notifications from HESN (Data obtained from laboratory test results). The Ministry of Health's (MOH) electronic self-reporting system was used. It is an online designed multi-section self-administered system consisting of close and open-ended questions. It covers demographic information and exposure history. It is using by MOH regions directorate [Table 1].

Statistical analysis

Data were extracted from the system in a Microsoft Excel form and then SPSS version (27) was employed to analyze and code of data in frequencies and percentage (%) tables. To test the difference between HAI cases and CAI cases, chi-square (χ^2) test was used. Post hoc tests were conducted after statistically significant chi-square tests. P-value <0.05 had been considering statistical significance.

Ethical consideration

Approval from Institutional Review Board was obtained. This study considered all national laws on patient information, anonymity, and privacy. No identifiable private information about living individuals or any health institutions have provide.

Study definitions

Health care worker: are all individuals whose job is intend to protect and enhance the health of their communities including physicians, nurses, allied health workers, and administrative staff [11,12].

Allied health workers (Other HCWs): are people involved in giving healthcare services distinct from medicine or nursing [13].

Support services: people responsible for providing and maintaining a sanitary and therapeutic environment in which health care can be appropriately delivered to individuals [14].

Healthcare facility types: healthcare services in Saudi Arabia are provide by three main sectors: MOH, other governmental institutions, and the private sector [15].

- **Ministry of Health "MOH":** is a network of hospitals and primary healthcare centers that are finance, manage, and organize solely by the Ministry of Health in Saudi Arabia.
- **Governmental non-MOH:** are healthcare facilities that are finance, manage, and organize by different governmental institutions in Saudi Arabia, such as the Ministry of Defense and National Guard Health Affairs.
- **Private:** are healthcare facilities that are finance, manage, and organize by private profit or non-profit institutions.

Healthcare-acquired infections "HAIs": are infections that are acquire in a healthcare facility [16].

Community-acquired infections "CAIs": are infections that are acquire outside of a healthcare facility [17].

HESN: "Health Electronic Surveillance Network". It is a comprehensive web-based electronic health solution made by The Ministry of Health in Saudi Arabia to accommodate all Saudi public health programs, and integrate Public Health Information System (PHIS) [18].

Results

From the beginning of March until the end of November 2020, a total of 57,159 HCWs cases were confirmed positive for COVID-19. This is 10% of the total number of HCWs in Saudi Arabia (600,000) [19].

Among infected HCWs, with data available, the median age was 34 years (interquartile range = 30–41 years), and 51% were in the age group 26–35. Slightly over half of infected HCWs were male (53%) and 55% were expatriates. The most infected HCWs category, with data available, were nurses (36%), followed by support services category (28%) and the proportions were equal for the least infected two HCWs categories: allied health professions and doctors (18%) [Table 2].

Table 2
Characteristics among health care workers infected with COVID-19 (N = 57,159) – Saudi Arabia, March 5–November 30, 2020.

Characteristic (no. with available information)	No.	%
Gender (54,193)		
Male	28,480	53%
Female	25,713	47%
Age group (yrs) (55,694)		
<26	3499	6%
26–35	28,133	51%
36–45	15,687	28%
46–55	6395	11%
56–65	1767	3%
≥66	213	0%
Nationality (56,267)		
Saudi	25,467	45%
Non-Saudi	30,800	55%
HCWs category (57,080)		
Doctor	10,124	18%
Nurse	20,438	36%
Other HCWs	10,385	18%
Support services	16,133	28%
Type of healthcare facility (57,140)		
MOH	34,329	60%
Gov. non MOH	12,262	21%
Private	10,549	18%
Symptomatic at swab time (55,629)		
Yes	45,914	83%
No	9715	17%

The confirmed HCWs cases were distributed among the main three healthcare facility types in Saudi Arabia; roughly 60% were from the Ministry of Health (MOH), 21% were from other Governmental Institutions (Gov. non-MOH), and 18% were from the private sector. Furthermore, approximately 83% of infected HCWs reported having symptoms at swab time, while the remaining 17% were asymptomatic at swab time [Table 2].

The number of COVID-19 incidences among HCWs in Saudi Arabia has increased gradually since March and reached its peak in July, after which the rate decreased gradually [Fig. 1]. More than three-quarters (78%, n = 44,647) of infected HCWs had CAI, while 22% of them had HAI (n = 12,512). Out of these HAI, 7840 (63%) acquired the infection from positive HCWs, whereas 4654 (37%) acquired the infection from exposure to a positive patient [Table 3].

In the bivariate analysis, CAI and HAI cases compared among the different variables and categories of HCWs. A statistically significant difference were found among gender, nationality, job categories, three age groups (<26, 26–35, and 36–45), and among HCWs who worked in MOH and private healthcare facilities. However, no significant difference was found between the three other age groups (46–55, 56–65, and ≥66), and HCWs who worked in

Table 3
Source of infection among health care workers infected with COVID-19 (N = 57,159) – Saudi Arabia, March 5–November 30, 2020.

Source of infection	No.	%
CAI	44,647	78%
HAI	12,512	22%
HAI exposed to		
HCWs	7840	63%
PT	4654	37%
Unidentified	18	0%

CAI, community acquired infection, HAI, hospital acquired infection.

Table 4
Bivariate analysis of the source of infection among health care workers infected with COVID-19 (N = 57,159) – Saudi Arabia, March 5–November 30, 2020.

Characteristic (no. with available information)	CAI, n (%)	HAI n (%)	P value
Gender (54,193)			
Male	23,179 (81)	5301 (19)	<0.001
Female	19,259 (75)	6454 (25)	<0.001
Age group (yrs) (55,694)			
<26	2789 (80)	710 (20)	0.012
26–35	21,730 (77)	6403 (23)	<0.001
36–45	12,426 (79)	3261 (21)	<0.001
46–55	4973 (78)	1422 (22)	0.617
56–65	1366 (77)	401 (23)	0.484
≥66	154 (72)	59 (28)	0.046
Nationality (56,267)			
Saudi	21,109 (83)	4358 (17)	<0.001
Non-Saudi	22,792 (74)	8008 (26)	<0.001
HCWs category (57,080)			
Doctor	7487 (74)	2637 (26)	<0.001
Nurse	14,404 (70)	6034 (30)	<0.001
Other HCWs	8713 (84)	1672 (16)	<0.001
Support services	13,992 (87)	2141 (13)	<0.001
Type of healthcare facility (57,140)			
MOH	27,053 (79)	7276 (21)	<0.001
Gov. non MOH	9606 (78)	2656 (22)	0.484
Private	7970 (76)	2579 (24)	<0.001

other governmental healthcare facilities. A quarter (25%) of infected females and 19% of males HCWs had HAI. Overall, for <26, 26–35 and 36–45 age groups, 20%, 23% and 21% had HAI, respectively. Moreover, 26% of non-Saudi HCWs and 17% of Saudi HCWs had HAI. Approximately, 21% of HCWs working in MOH and 24% in the private sector had HAI. Nurses reported the highest HAI with approximately 30% whereas support services staff had the lowest (13%) [Table 4].

The total number of reported deaths among positive COVID-19 HCWs cases during this period was 198 (case fatality rate = 0.35%), with a median age of 53 years (interquartile range = 46–61

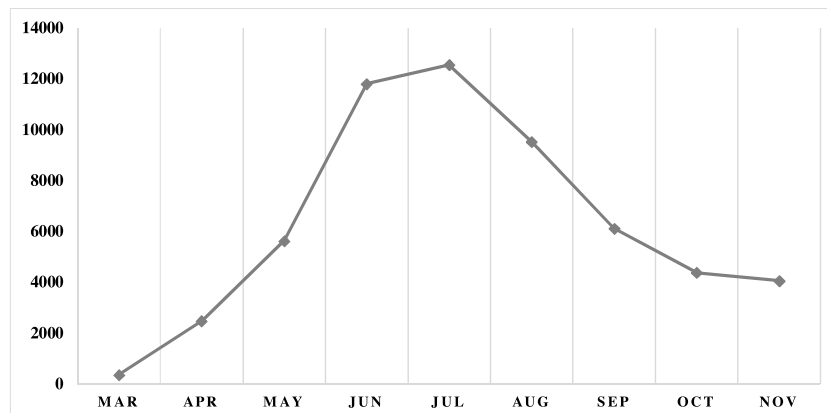


Fig. 1. Monthly trend of COVID-19 infected HCWs – Saudi Arabia, March 5–November 30, 2020.

years). Slightly less than two-thirds of reported deaths (64%, $n = 126$) were among HCWs aged 46–65. The mortality rate was highest in June accounting for 26% of the total number of HCWs deaths. Although only 213 (0.38%) of all infected HCWs were aged 66 and above, this age group accounted for nearly 14% of all deaths among infected HCWs. Mortality rate was the highest in the private healthcare facilities by 0.8%, followed by MOH and governmental non MOH healthcare facilities by 0.3% and 0.1% respectively.

Discussion

In nearly 600,000 healthcare workers, the incidence rate of COVID-19 was 9527 per 100,000 (10%) healthcare workers during the study period [19]. Healthcare workers cases accounted for 16% of all COVID-19 cases in Saudi Arabia [5].

COVID-19 among the middle age group (26–45) was very high (79%). This high level could be relate to the differences in contact patterns in different age groups, or to the differences in the age distribution of the population, which could affect the rate in each age group [20].

The present findings point out that male HCWs reported positive COVID-19 result tests more than the female HCWs. This could be explained by the fact demonstrated by Dr. Kyle Sue In a 2017 BMJ article where it shows that there is an effect of sex hormones, estrogen, and testosterone, on the respond and engagement of the immune system [21].

Behavioral and cultural characteristics could also play a role in the incidence of COVID-19 among males or females. For instance, smoking is considered as a significant contributor to the severity of COVID-19. The smoking rate in many countries like China, Italy, and the US is much higher in men than in women. Similar gender-specific trends also present in Saudi Arabia show men are more likely to smoke than women, where 16% of smokers are men as compared to 2% of women [21,22].

Most of the infected HCWs were non-Saudi (55%). This is due to the number of non-Saudi health care workers in Saudi Arabia whereby the year 2019 has accounted for more than half of the total health care workforce (52%) [11].

Nurses were the most infected HCWs category (36%). This is similar to the earlier finding from other studies regarding HCWs infection in the United States and Mexico, where nurses were also the most commonly reported job category, representing around 38% and 39% of all infected HCWs, respectively [23,24]. This could be due to the fact that nurses have more patient contact time compared to other HCWs professionals [25].

Most HCWs cases were from MOH healthcare facilities (60%). This could be because of the larger number of MOH healthcare facilities compared to the number of governmental and private healthcare facilities. Based on recent statistics, MOH hospitals accounted for 57% of all hospitals in Saudi Arabia [26]. However, the most healthcare facility type that had the highest HAI rate was the private (24%) [Table 4].

The highest numbers of infected HCWs were reported in MOH and governmental non MOH healthcare facilities, whilst the lowest number was reported in Private healthcare facilities. However, highest mortality rate among infected HCWs was in Private healthcare facilities. That is in contrast to what is expected and observed in other countries, which is due to the excessive demand on governmental hospitals, the quality of care would be lower [27,28].

It was notable that there was an increase in the number of cases within 1–2 weeks after the holidays for Eid Al-Fitr and Eid Al-Adha. These are religious festivals celebrated by Muslims characterized by family visits and social gatherings.

Furthermore, most HCWs who had HAI (63%) were a result of direct contact with another infected HCW [Table 3]. Therefore, applying measures to increase protection of HCWs is highly recommended. Such measures include requiring employees to daily confirm that they are free from any symptoms of COVID-19 before starting their shift, as well as applying physical distancing between workers in all settings (including possibly ignored settings such as hospital shuttle buses, lifts, staff rooms, and clinical ward rounds), and increasing the accuracy and frequency of hand hygiene [29].

This study has two major strengths. First, we used a nationwide population-based dataset that provides a sufficient sample size and statistical power to a better understatement of the situation. Second, our information was collected on a wide range of evidence of the HCWs infected with COVID-19 (e.g., Source of infection), which are mostly not available in existing registries or population-scale surveillance activities.

Nevertheless, three limitations in this study should be consider. First, among cases reported in HCWs, there were some missing data across demographic information, exposures, symptoms, and health outcomes; and this could affect interpreting the results. Second, unknown potential occupational exposures, including whether the HCWs had protected or not. Therefore, additional information needed to confirm the association of important factors. Third, regardless there is a newer statistic in 2019 of the total health care workers in Saudi Arabia but still, we used the last statistic at the end of the year 2014, since it is the one constituted of all healthcare professionals, management, and support staff [5,19]. Despite these limitations, our findings provide valuable information regarding Saudi Arabia's situation of COVID-19 among HCWs during a peak period of the pandemic.

Conclusion

In conclusion, our retrospective cohort study provide timely and comprehensive evidence highlighting incidence rates (10%) among COVID-19 infected HCWs in Saudi Arabia. The study findings regarding infected HCWs characteristics were relatively similar to the previous findings from other studies. Findings support governments, healthcare leaders and health policy makers to look at the best precaution to protect healthcare workers on the assumption of a re-rising of the pandemic. This is necessary to decrease the spread into the community, and to ensure both a healthy functioning society and healthcare system.

Further clarification and intervention studies investigating COVID-19 risk factors among HCWs in Saudi Arabia are necessary to support our observational findings and help to improve our understanding of the measures needed to reduce COVID-19 transmission among HCWs, especially the kind of transmission “from HCWs to another”.

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Competing interests

None declared.

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