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*Observational Study*

**Demographic and Risk Characteristics of Healthcare Workers Infected with SARS-CoV-2 from Two Tertiary Care Hospitals in the United Arab Emirates**

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**Abstract**

BACKGROUND

Understanding the transmission dynamics of Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2) infection among Healthcare Workers (HCWs) and their social contacts is crucial to plan appropriate risk-reduction measures.

AIM

A retrospective cross-sectional analysis of HCWs infected with SARS-CoV-2 was performed to analyse the socio-demographic risk factors and transmission of SARS-CoV-2 infection.

METHODS

The data on the infected HCWs was extracted from the hospital records and cross-sectional survey. The cross-sectional survey was conducted in January-April 2022 among HCWs tested positive through Reverse Transcriptase Polymerase Chain Reaction of the nasopharyngeal swab for SARS-CoV-2 between March 2020 and August 2021 in two tertiary-level hospitals. The survey included questions on demographics, work profile, characteristics of Coronavirus Disease 2019 (COVID-19), and infection

among their household or co-workers. The survey also checked the knowledge and perception of participants on the infection prevention measures related to SARS-CoV-2.

## RESULTS

Out of a total of 346 HCWs infected with SARS-CoV-2, 286 (82.7%) HCWs, consented to participate in this study. From the sample population, 150 (52.5%) of participants were female, and a majority (230, 80.4%) were frontline HCWs, including 121 nurses (121, 42.4%). Only 48 (16.8%) participants were fully vaccinated, and most (225, 78.7%) were symptomatic at the time of testing. Nearly half of the participants (140, 49%) had co-infection among household, and nearly one-third (29.5%) had co-infection among three or more household. Another 108 (37.8%) participants reported cross-infection among co-workers. The frontline HCWs were significantly more infected (25.1% *vs* 8.6%,  $p<0.001$ ). Other significant risk factor for a high infection rate was male sex ( $p<0.001$ ). Among the infected frontline HCWs, a significantly higher proportion were male and staying in the shared accommodation with family ( $p<0.001$ ). COVID-19 vaccination was effective in reducing the infection rate (83.2% *vs* 16.8,  $p<0.001$ ). Most participants were aware about the appropriate use of PPEs (99.3%) and did not report any unprotected exposure (85%). However, only 70% agreed with the efficacy of the COVID-19 vaccination in preventing an infection and severe disease.

## CONCLUSION

The risk profiling of the HCWs infected with SARS-CoV-2 found that working at frontline and male sex, increases the rate of infection. COVID-19 vaccination can effectively reduce the rate of transmission of SARS-CoV-2 among the HCWs.

## INTRODUCTION

Coronavirus Disease 2019 (COVID-19) pandemic has overwhelmed the healthcare resources across the globe. Since the inception of the pandemic, there have been reports

published on the increased vulnerabilities of Healthcare Workers (HCWs) compared to the general community for <sup>1</sup>infection with Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2)<sup>[1,2]</sup>. A prospective cohort study conducted among 99,795 HCWs reported that the HCWs are at threefold high risk of acquiring COVID-19 compared to the general community. However, the risk of exposure is not uniform and it depends on multiple factors, like the nature of work (frontline), race or ethnicity (Black, Asian, and other ethnic minorities), and access to or reuse of the Personal Protective Equipment (PPE)<sup>[1]</sup>. Besides, the risk of illness, the HCWs are at considerable risk of adverse mental health during the COVID-19 pandemic<sup>[3]</sup>. Moreover, the social and household contacts of the HCWs are also potentially vulnerable to SARS-CoV-2 infection<sup>[4]</sup>. On the other hand, the absenteeism of HCWs from work is further detrimental to the already stretched healthcare services during the pandemic<sup>[5]</sup>.

From the start of COVID-19 pandemic, the experts strongly placed their concerns regarding the nosocomial transmission of SARS-CoV-2<sup>[6,7]</sup>. The HCWs were assumed to play a pivotal role in the transmission chain during a nosocomial outbreak of SARS-CoV-2. However, only a limited information exists on the transmission characteristics and dynamics of SARS-CoV-2 infection among the HCWs or their social contacts. In this scenario, it is crucial to explore the dynamics of SARS-CoV-2 transmission among the HCWs and their social contacts to develop and implement appropriate risk-reduction measures<sup>[6]</sup>.

In the current study, the authors performed a retrospective analysis of HCWs infected with SARS-CoV-2 to analyse the socio-demographic risk factors and the characteristics of SARS-CoV-2 infection among HCWs and their social contacts.

## **MATERIALS AND METHODS**

The deidentified data for the current study was collected from the hospital records and a cross-sectional survey. The survey was conducted between January and April 2022 among the HCWs who tested positive for reverse transcriptase polymerase chain reaction (RT-PCR) for SARS-CoV-2 between March 2020 and August 2021 in two multi-

speciality tertiary-level hospitals located in Dubai. The cross-sectional survey was conducted to extract further information from the infected HCWs on their social contacts, including household. The survey included Multiple-Choice Questions (MCQs) and questions with 5-point Likert scale. The survey questionnaire, attached in the Supplementary material, has a total of three sections s; 1) Demographic details of the participants, including age, gender, department, nature of work, and COVID-19 vaccination status 2) Details about SARS-CoV-2 infection, the reason for RT-PCR testing, severity and duration of the symptoms, and infection among their household contacts and co-workers; and 3) Knowledge and perception among the participants on PPE and infection prevention measures related to SARS-CoV-2. The human resource department, who were not part of the data analysis, sent the survey questionnaire through e-mail. The identity of the participants was kept confidential. As per the local health regulatory requirements, the HCWs were tested with RT-PCR only in case of symptomatic infections, contact tracing, or pre-travel screening during this period. The study considered only the first SARS-CoV-2 infection for further analysis. In the United Arab Emirates (UAE), seven COVID-19 vaccines were approved for use and are made available to the public for free of cost. The data on the average number of new cases in the community was extracted from the website of National Emergency Crisis and Disaster Management Authority, UAE (<https://covid19.ncema.gov.ae/en>). The study was approved by the scientific and ethical committee of the hospital and Dubai Scientific Research Ethics Committee (DSREC/09/2020\_32).

#### *Statistical analysis*

Descriptive statistical analysis was conducted for frequencies, percentages, medians, and ranges. Continuous data was presented as mean [standard deviation (SD)] or median with Interquartile Range (IQR). Two groups were compared in this study using the 2-sample test for equality of proportions with continuity correction (Chi-square). A comparison was made between the categorical paired data with McNemar Test. The authors used Fisher exact test to compare less than five-count cells. All the tests were 2-tailed, and  $p < 0.05$  was considered to be significant. The statistical analyses were

conducted using R version 3.4.2 from the Comprehensive R Archive Network (R Core Team, 2020).

## **RESULTS**

Out of the total 1,568 HCWs working in both the hospitals, 346 (22.1%) tested positive for SARS-CoV-2 RT-PCR for the study period. Amongst this study population, 16 (4.6%) HCWs were found to be re-infected with SARS-CoV-2. However, as mentioned earlier, only the first infection was considered for the analysis. From the 346 infected HCWs, 286 (82.7%) HCWs agreed to participate in the cross-sectional survey. Amongst the participants, 150 (52.5%) were females whereas a majority of the participants (230, 80.4%) were frontline HCWs, including 121 nurses (121, 42.4%). Only 48 (16.8%) participants were fully vaccinated at the time of infection.

Most of the participants (225, 78.7%) were symptomatic at the time of RT-PCR testing. Among the asymptomatic HCWs, 35 (12.2%) were tested for close contact tracing. Nearly half of the participants (140, 49%) had co-infection with their household contacts. Moreover, half (48, 51.6%) of the infection in the households occurred in a single person, while nearly one-third (29.5%) got infection among three or more households. Further, 108 (37.8%) participants reported cross-infection among their co-workers (table 1).

When compared between the infected and the uninfected HCWs, frontline HCWs (25.1% *vs* 8.6%,  $p<0.001$ ) who were males (54% *vs* 46%,  $p<0.001$ ) recorded a significantly high infection rate. The infection rate among the unvaccinated HCWs (83.2% *vs* 16.8%,  $p<0.001$ ) was nearly five times higher than those HCWs who were vaccinated against COVID-19. The study found that the type of accommodation (self-owned *vs* hospital sponsored) showed no significance effect on the infection rate (table 2). A significantly high proportion of the infected frontline HCWs were males, who stayed in a rented accommodation with family ( $p<0.001$ ) (table 3). Finally, the trend chart of a month-wise comparison of the infected HCWs and average new cases in UAE showed three peaks.

The survey also tried to assess the knowledge and perception of the participants about safety precaution, vaccination, and the disease. Most of the participants were aware about the appropriate usage of PPE (99.3%) and did not agree to unprotected exposure to a patient with COVID-19 (85%). Around 74% of the participants agreed the importance of social precautions like face mask, social distancing, and hand hygiene in preventing the SARS-CoV-2 infection. Only 70% agreed to the efficacy of COVID-19 vaccination in preventing the infection or progression to the severe disease. The deficiency of PPE at the workplace was reported by 23.4% of the participants, whereas 29.7% participants wanted an improvement in the quality and availability of the PPE (table 4).

## **DISCUSSION**

This cross-sectional analysis of RT-PCR-positive HCWs from two tertiary care hospitals showed that the frontline HCWs had a significantly higher infection rate. The study infers that being a male is one of the significant risk factors for getting infected with COVID-19. Among the infected frontline staff, a significantly higher proportion was male who shared their accommodation with family members. COVID-19 vaccination was effective in reducing the rate of infection among the HCWs.

From the start of COVID-19 pandemic, various studies recorded a higher infection rate among the frontline HCWs. The risk was higher due to the reuse or inadequate availability of the PPEs and due to which the studies advocated strategies like access to high-quality PPEs and early COVID-19 vaccination to curb the spread of the virus<sup>[2,8]</sup>. Nearly one-fourth of the participants in this study reported insufficient access to the PPEs, while most were unaware of any unprotected exposure with COVID-19 patients. Limited access to adequate PPE has been linked with higher odds of infection<sup>[9-11]</sup>. Hence, ensuring access to high-quality PPEs for HCWs is an important workplace risk-reduction measure. The rate of infection was significantly higher among the male HCWs as found in other studies as well<sup>[2,12]</sup>.

Around 13% of the study participants had asymptomatic infection. The number of asymptomatic infections could have been higher, if the hospitals had routine surveillance testing for the HCWs. However, the impact of the routine surveillance testing of asymptomatic HCWs in preventing nosocomial transmission of SARS-CoV-2 is unknown<sup>[13]</sup>. A consensus experts' panel recommended testing the HCWs to get tested for SARS-CoV-2 only when they are symptomatic or when they encountered unprotected exposure over routine testing<sup>[14]</sup>.

Around 38% of the infected participants agreed to infection among their co-workers within 14 days of their own infection, and nearly one-fifth of them agreed to have three or more infected co-workers. Moreover, sharing accommodation with family or friends was significantly higher among the infected frontline HCWs. In the absence of epidemiological investigation and genomic sequencing, these infections cannot be segregated as an outbreak. However, the absenteeism of multiple HCWs from the same department can disrupt the services of already overwhelmed frontline departments, during the pandemic. Despite, various published reports on a nosocomial outbreak of SARS-CoV-2, ambiguity exists on the role of HCWs in initiating or amplifying the nosocomial outbreaks<sup>[6,15]</sup>.

Most epidemiological research works on SARS-CoV-2 infection among the HCWs have focused on transmission dynamism within the hospital setting. However, the research on the impact of social-cultural and demographic factors on the transmission of SARS-CoV-2 among the HCWs is lacking. Recently, a large prospective study conducted in the United Kingdom found the effect of socio-demographic characteristics on the risk of infection among the vulnerable HCWs. The study found that amongst the demographic and household risk factors, young age, living with a co-worker, and high religiosity are associated with high infection odds among the HCWs<sup>[9]</sup>. In another study, high odds of infection were observed among the HCWs from community contact with a suspected or a confirmed COVID-19 individual, instead of the workplace<sup>[16]</sup>. The socio-demographic risk factors may differ based on the culture and geographical differences, and the availability of resources. The cross-transmission of SARS-CoV-2 among the household,



is well-established concept and persists even during the low-community transmission<sup>[17]</sup>.

The current study also found a significantly higher proportion of the infected frontline HCWs were staying in shared accommodation. When comparing infected HCWs per month with average new cases in the community, an agreement was observed in the peaks of two trend charts (figure 1). This pattern reveals a synchronization in the infection rate among the HCWs and the transmission rate of SARS-CoV-2 infection in the community. Hence, the HCWs are vulnerable to contract the infection from their households and social contacts, especially with a higher rate of SARS-CoV-2 transmission in the community. The hospital leadership can utilize this valuable insight to ensure workforce management and develop strategies to mitigate the risk of exposure to HCWs. Theoretically, the public transport can be another risk factor for transmission. However, as reported in the literature, the current study authors did not find any increased transmission risk with public transport<sup>[18]</sup>.

According to a study conducted earlier, the vaccination of the HCWs effectively reduces the risk of severe disease and the transmission of SARS-CoV-2<sup>[19]</sup>. Advanced age ( $\geq 65$  years), male sex, and other co-morbidities like diabetes mellitus, **chronic respiratory disease, hypertension, chronic kidney disease, and cardiovascular disease are risk factors for severe illness and mortality**<sup>[20]</sup>. **COVID-19** vaccination **is** highly effective in reducing the progression and the severity of disease and ICU or hospital admission, especially in the elderly population and patients with co-morbidities<sup>[21]</sup>. Vaccination is an essential intervention for the HCWs to protect them from getting infected and severe illness that may require hospital or ICU admission. However, the effectiveness of the vaccine in reducing the risk of disease reduces considerably after six months of the last dose. So, a booster dose is recommended for the vulnerable population, including HCWs<sup>[19]</sup>. Vaccine hesitancy among the HCWs is a major issue in the successful implementation of the COVID-19 vaccination programme. Only 70.2% of the participants have agreed upon the efficacy of the COVID-19 vaccines. Other studies also found more vaccination hesitation among the previously infected people<sup>[22]</sup>. The

hospital leadership and infection preventionist should address the issue of vaccine hesitancy strategically and through collaboration.

#### *Strength and Limitations*

This is the first study to the best of the author's knowledge from the UAE or the countries in the Gulf Cooperation Council on risk profiling of RT-PCR-positive HCWs with COVID-19 using socio-demographic factors. The study also evaluated the impact of COVID-19 vaccination on cross-transmission among the HCWs. The current study has a few limitations that are listed herewith. Firstly, the information on social contacts and households was collected through a cross-sectional survey. Hence, there exists a potential recall bias because of the time-gap between period of infection and data collection. However, to avoid this bias, the data collected from the cross-sectional survey was validated through the human resource records maintained by the hospital. There is missing data for about 17% of the eligible HCWs who did not participate in the cross-sectional survey due to reasons like resignation and immigration to other countries. Secondly, genomic sequencing was not used to confirm the phylogenetic linkage in infection among the co-workers or the household. Thirdly, the small cohort size could have missed to portray the complete statistical correlation of various socio-demographic factors. Finally, the impact of the COVID-19 vaccination booster on transmission dynamics was not assessed.

#### **CONCLUSION**

The risk profiling of the HCWs, infected with SARS-CoV-2 from two tertiary care hospitals, showed that the frontline HCWs had a significantly higher infection rate. Other significant risk factor was male sex. COVID-19 vaccination can effectively reduce the rate of SARS-CoV-2 transmission among the HCWs.

#### **ARTICLE HIGHLIGHTS**

##### *Research background*

There is paucity of the research on the transmission dynamics of Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2) among the Healthcare Workers (HCWs) and their co-workers and household. The current study conducted a retrospective analysis of the infected HCWs to analyse the socio-demographic risk factors and the characteristics of SARS-CoV-2 transmission among HCWs and their social contacts.

### ***Research motivation***

The HCWs are vulnerable to SARS-CoV-2 infection during their work. The potential risk of transmission of SARS-CoV-2 infection from the household and co-workers of HCWs is unclear. The current study will help to provide a valuable insight for workforce management and to formulate strategies to mitigate the risk of exposure to the HCWs.

### ***Research objectives***

The current study evaluated the risk factors of SARS-CoV-2 infection among the HCWs. The study also explored the potential of transmission of SARS-CoV-2 among the household and co-workers of the infected HCWs.

### ***Research methods***

The health records of all infected HCWs between March 2020 and August 2021 were analysed. The information on the COVID-19 vaccination, household and co-workers of the infected HCWs was collected through a cross-sectional survey

### ***Research results***

The cross-sectional analysis of health records of 346 reverse transcriptase polymerase chain reaction (RT-PCR)-positive HCWs showed that the risk of infection was significantly higher among the frontline HCWs. Being a male is one of the significant risk factors for SARS-CoV-2 infection. Among the infected frontline staff, a significantly

higher proportion was male, who were staying with their families in rented accommodation. COVID-19 vaccination was effective in reducing the rate of infection among the HCWs.

### ***Research conclusions***

Working at the frontline and being male are the significant risk factors for SARS-CoV-2 infection among the HCWs. COVID-19 vaccination is effective in reducing the infection rate among the HCWs.

### ***Research perspectives***

The future research should explore the role of the community transmission of SARS-CoV-2 in the infection of the HCWs

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