Frequency and Risk Factors for COVID-19 Infection among Healthcare Workers in a Large-Scale University Teaching Hospital: A Case Control Study

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Abstract

Objective: This study aims to find out the frequency and risk factors responsible for COVID-19 infection among healthcare workers in a large-scale university teaching hospital.

Methods: This case-control study was conducted on 185 healthcare workers sampled from the database of 1309 participants maintained at Dr. Ruth K. M. Pfau Civil Hospital, Karachi. Both the cases and controls were derived from the hospital's database of COVID-19 Reverse Transcriptase-Polymerase Chain Reaction (RT-PCR) and COVID-19 antibody tests were performed on the said population. The participants included were physicians working in the hospital. They were grouped into cases and controls based on the positive diagnostic tests. We administered a simple structured questionnaire over the telephone and face to face for the interview. Statistical analyses were performed on IBM SPSS version 25.

Results: The mean age of the cases was significantly different than controls [cases (32.7±9.9) vs controls (38.8±10.6), [p-value=0.002]. More cases 29/37 (78.3%) were working at a single setting compared to controls 54/148 (36.5%) (p-value<0.001). The use of Personal Protective Equipment (PPE), exposure to COVID-19 patients and experiencing symptoms also had statistical significance with the odds of infection (p-value<0.05).

Conclusion: This study concludes that younger age, exposure to a known COVID-19 patient and longer duration of exposure among the hospital physicians is associated with positive COVID-19 results. Therefore, it is imperative that adequate measures be undertaken to limit the exposure to COVID-19 patients in this age group.

Keywords: SARS-CoV-2, COVID-19, healthcare personnel, Personal Protective Equipment, environmental exposure, occupational health

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Introduction

The world has never seen a pandemic as great as Coronavirus Disease 2019 (COVID-19) causing life at halt, leaving millions dead and disrupting global economic activities[1,2]. COVID-19 is an unprecedented pandemic with highly variable disease course in the affected individuals. The affected individual may have a range of sign and symptoms which could be a mild common cold to more severe respiratory tract illness which has a potential to affect other bodily systems especially in the presence of comorbidities and smoking history[3-5]. However, asymptomatic cases have been reported and assumed to play a role in community spread[6].

The surge of COVID-19 cases disrupted the health system even in the developed economies[7,8]. Undoubtedly the forefront of the anti-COVID-19 war is being fought by the healthcare staff. Working day and night with a heavy load of infection in the

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surrounding environment ultimately affected a number of doctors and paramedics and caused morbidity and mortality all over the world[9-12].

In Pakistan, the cases started rising in April 2020 with the first documented case, a pilgrim, in February 2020[13]. Up till October 24th, 2021, a total of 1,267,945 cases and 28,359 deaths have been reported with a COVID-19 mortality rate of 2.2% in Pakistan[14]. According to a report, up till De-cember 13th, 2020, 142 doctors and numerous par-amedics have lost lives or been affected due to COVID19[12]. Pakistan's healthcare system is fight-ing hard with its meager resources against this deadly pandemic[15].

Karachi, being the biggest cosmopolitan city of the country consistently reported the highest number of cases[14]. The city's Dr. Ruth K.M. Pfau Civil hospital is one of the biggest, 2000-bedded hospital, which caters thousands of COVID-19 patients, and its healthcare staff took the toll of this pandemic. A western study also demonstrates that the rate of infection among the healthcare professionals and staff was greater than the community COVID-19 rates[16].

This study is aimed to find out the frequency and risk factors responsible for COVID-19 infection among healthcare workers in a large-scale university teaching hospital. Since COVID19 is a variable disease, finding out the risk factors would help understand the disease pathology in local population. This study will also help to highlight the role of personal protective equipment use, gravity of exposure and subsequent COVID-19 in the selected population. Moreover, we aim to fill the gaps in the scientific literature present to-date regarding the occurrence or absence of signs and symptoms in laboratory-proven COVID-19 patients via this study.

Subjects and Methods

This study was based on the physician population of Dow University of Health Sciences and Dr. Ruth K. M. Pfau Civil Hospital, Karachi. We retrieved the results of COVID-19 Reverse transcriptase-Polymerase Chain Reaction (RT-PCR) and COVID-19 antibody tests performed during May 2021 to August 2021. The database comprised of 1309 RT-PCR tests and 292 antibody tests performed on a total of 1309 individuals. Only the physicians working in the hospital were sampled from the database and included postgraduate trainees, interns, and consultants working in the said university teaching hospital. The database results were first utilized to find out the frequency of COVID-19 positivity rate and were then used to draw the cases and controls for the subsequent comparison. Considering the cases and controls drawn from the same population, the chances of bias have been reduced.

The sample size of the study (n=185) was calculated using OpenEpi based on a study by Al-Qahtani et al[17]. We kept the percentage of cases exposed at 48.9%, percent of controls exposed at 23.4%, the ratio of controls to cases as 4:1 and confidence interval at 95% using unm-atched case-control study sample size. The num-ber of required cases was 37 while the number of controls was 148. The case definition of cases included individuals who had positive COVID-19 RT-PCR tests or antibody tests while the rest were grouped together as controls.

From the total number of 1309 tested individuals in the database, 230 physicians were approached for interview. Of the 230 consecutive physicians approached from the database, 185 gave consent for interview.

For measuring the frequency of COVID-19, we included all physicians who were tested for COVID-19 during the study period. Those who had substantial incomplete information or where the test reports could not be validated were excluded.

We categorized the age group of the study participants using a cutoff of 32 years age. The younger age group included mostly junior doctors i.e., postgraduate trainees and interns, while the older group comprised of senior ones i.e., registrars and consultants. This categorization conforms

to the age structure of physician trainees who spend more time and have more exposure to infections at their place of posting. We presented the specialty-wise results as Medicine and Allied, and Surgery and Allied. The former included general medicine, pediatric, neurology, psychiatry, radiology and COVID-19 isolation units. The latter comprised of general surgery, gynecology and obstetrics, neurosurgery, vascular surgery, dental surgery, ophthalmology, and otolaryngology departments. The categorization was done so as to segregate the healthcare professionals who work under operating room conditions, i.e Surgery and Allied and those who do not, that is, Medicine and Allied. Ethical approval was obtained from Institutional Review Board (IRB), Dow University of Health Sciences.

All available cases in the COVID-19 database were sampled after written informed consent while the controls who had negative RT-PCRs and antibody tests were sampled from the same database using random sampling. The source of data was the COVID-19 database and the study questionnaires filled in by the participants. Those healthcare workers were approached through questionnaires and inquired about exposure to risk factors for COVID-19, use of Personal Protective Equipment (PPE), signs and symptoms experienced prior to testing, remedies taken for prevention or control of the infection, departments they were working in, vaccination status, underlying medical conditions as well as their smoking status. The frequency of exposure to risk factors for COVID-19 was compared between the cases and controls.

We used IBM Statistical Package for the Social Sciences (IBM SPSS) version 25 for the purpose of data analyses. Categorical variables were reported as frequencies and percentages, while the quantitative variables were reported as mean ± standard deviation. Descriptive analyses were conducted for the assessment of qualitative variables. The Pearson chi-square test was used to determine the relationship between categorical variables. Independent sample t-test was used to compare the mean age among cases and controls. Multivariate regression analyses was conducted to predict the role of each risk factor, identified as significant in the univariate analyses. A *p*-value of $\leq$ 0.05 was considered significant for each test. We followed the STROBE® guidelines for case-control study to present our findings.

Results

Of the total database of 1309 participants, 37 had COVID-19 with a proportion of 2.8% (95% C.I 2.1, 3.9). A total of 230 physicians were approached and the data was collected from 185 participants with 80.4% response rate. The overall sample of 185 physicians comprised of 60% participants from Medicine and Allied departments while the rest were from Surgery and Allied (Table 1). A total of 19 healthcare workers (10.3%) repo-rted the use of conventional or herbal medication for the prevention of cure of COVID-19. Of most of the healthcare workers (95%) were fully vaccinated at the time of their testing and an equal proportion of the study population consisted of non-smokers. The mean age of the overall sample was 37.6 SD 10.7 with a median of 35 years and range was 40 years. The skewness for variable age was 0.523. Most of the healthcare workers, 106 (57.3%), were 32 years of age or less and included mostly postgraduate trainees and interns. There was a significant difference in the mean age of COVID-19 positive and negative participants (p-value =0.002). The mean age of those infected was 32.7 ± 9.86 which comprised mostly of junior doctors as described above, while the mean age of controls was 38.79 ± 10.63. The univariate analyses showed that compared to controls, the cases had 4 times the odds of being younger (OR =4.23, 95% C.I: 1.94, 9.25, p-value =0.01).

Compared to controls, the cases had higher odds of working only in public hospital setting throughout the day (OR =6.32, 95% C.I: 2.7, 14.8, p-value < 0.001). However, there was no significant difference in the proportion of specialty/department between cases and controls (p-value=0.134).

The use of Personal Protective Equipment (PPE) by the healthcare workers was significantly associated with COVID-19 infectivity. A significant number of individuals who used N-95 respirators (OR: 2.1, 95% C.I: 1.03, 4.43, p-value=0.04), face shield (OR: 3.1, 95% C.I: 1.21, 7.81, p-value =0. 014) and gloves (OR: 5.1, 95% C.I: 2.31, 11.44, p-value < 0.001) were tested positive for COVID-19. The COVID-19 positive cases had higher odds of using PPE as compared to controls.

High body temperature or fever was the most common symptom experienced by both the cases and controls. The association between experiencing symptoms and positivity for COVID-19 achieved statistical significance (OR: 0.07, 95% C.I: 0.03, 0.177, p-value<0.001). Compared to controls, the controls had higher odds of showing symptoms (OR =15.384). Fever (OR: 8.2, 95% C.I: 3.7 , 18.2, p-value<0.001), cough (OR: 4.5, 95% C.I: 1.91, 10.5, p-value<0.001), body aches (OR: 12.82, 95% C.I: 4.4 , 36.9, p-value<0.001) and new loss of smell or taste (OR: 5.6, 95% C.I: 1.9 , 16.5, p-value =0.001) were the symptoms that were significantly associated with COVID-19 infection. It was also reported that among those healthcare workers who experienced any symptoms prior to their RT-PCR or antibody testing, the majority (55%) eventually tested negative. Exposure to a known or suspected COVID-19 patient up to 2 weeks prior to testing was also significantly associated with acquiring the infection (OR: 8.8, 95% C.I: 3.7, 20.9, p-value<0.001).

None of the participants had underlying lung disease, chronic kidney disease or cardiac disease. However, diabetes was the most common reported co-morbidity among the healthcare workers. The COVID-19 positive individuals were found to have higher odds of being diabetics (OR=1.36), but statistical significance was not achieved.

A multivariate regression analysis was performed using the Wald test for quantifying the role of each risk factor in the infectivity rate of COVID-19 among healthcare workers. The logistic regression analyses showed the explanatory factors for COVID-19 infection (Table 2). Individuals who were infected with COVID-19 as compared to those who did not were 32 years of age or younger (Adjusted odds ratio [AOR] =9.94, 95% CI 2.46, 40.07) and had experienced fever (AOR= 12.98, 95% CI 2.54, 66.10) and body aches (AOR= 18.38, 95% CI 3.36, 100.39). The most strongly associated factor with COVID-19 infectivity was exposure to a known or suspected COVID-19 patient, and odds of having past exposure to COVID-19 patients were 18.6 in cases as compared to the control group. Cough which was found to be a significant risk factor by crude analyses, however, was shown as non-significant in the adjusted model. The model explained 67.3% (Nagelkerke R^2) of the variance in COVID-19 infectivity and correctly classified 80% of the sample.

Fig. 1 shows a box plot displaying distribution of ages of COVID-19 positive cases and COVID-19 negative controls with respect to exposure to a known or suspected COVID-19 patient.

Table 1. Socio-demographic characteristics and signs and symptoms in the study participants (*n*=185)

Characteristics	Cases (n=37)	Controls (n=148)
Socio-demographics:		
Mean age (years)	32.7 ± 9.86	38.79 ± 10.63
Gender:		
Male	13 (35.1%)	60 (40.5%)
Female	24 (64.9%)	88 (59.5%)
Place(s) of work:		
Only Civil Hospital	29 (78.37%)	54 (36.5%)
Civil Hospital and private settings	08 (21.62%)	94 (63.5%)
Department/specialty:		
Medicine and Allied	18 (48.64%)	92 (62.2%)
Surgery and Allied	19 (51.35%)	56 (37.8%)
Exposure within last 2 weeks:		
Yes	29 (78.37%)	43 (29.1%)
No	08 (21.62%)	105 (70.9%)
Symptoms:		
*(multi-response variable)		
Fever	25 (67.6%)	30 (20.3%)
Cough	13 (35.1%)	16 (10.8%)
Body aches	13 (35.1%)	06 (4.1 %)
New loss of smell or taste	08 (21.6%)	07 (4.7%)
Sore throat	14 (37.8%)	12 (8.1%)
Shortness of breath	06 (16.2%)	none

Table 2. Multivariate logistic regression analyses showing risk factors for COVID-19 infection among healthcare workers (*n*=185)

Risk factors for COVID-19	B	Wald	Sig.	Adjusted OR with 95% Confidence Intervals		
					Lower	Upper
Use of N-95 respirator	-1.38	4.47	0.035	0.25	0.07	0.90
Use of gloves	-2.16	8.74	0.003	0.11	0.02	0.48
Fever	2.56	9.52	0.002	12.98	2.54	66.10
Cough	-1.00	0.02	0.891	0.90	0.21	3.80
Body aches	2.91	11.30	0.001	18.38	3.36	100.39
Exposure to a COVID-19 patient	2.92	18.81	0.000	18.59	4.96	69.68
Age 32 years or younger	2.29	10.43	0.001	9.94	2.46	40.07

*OR=odds ratio

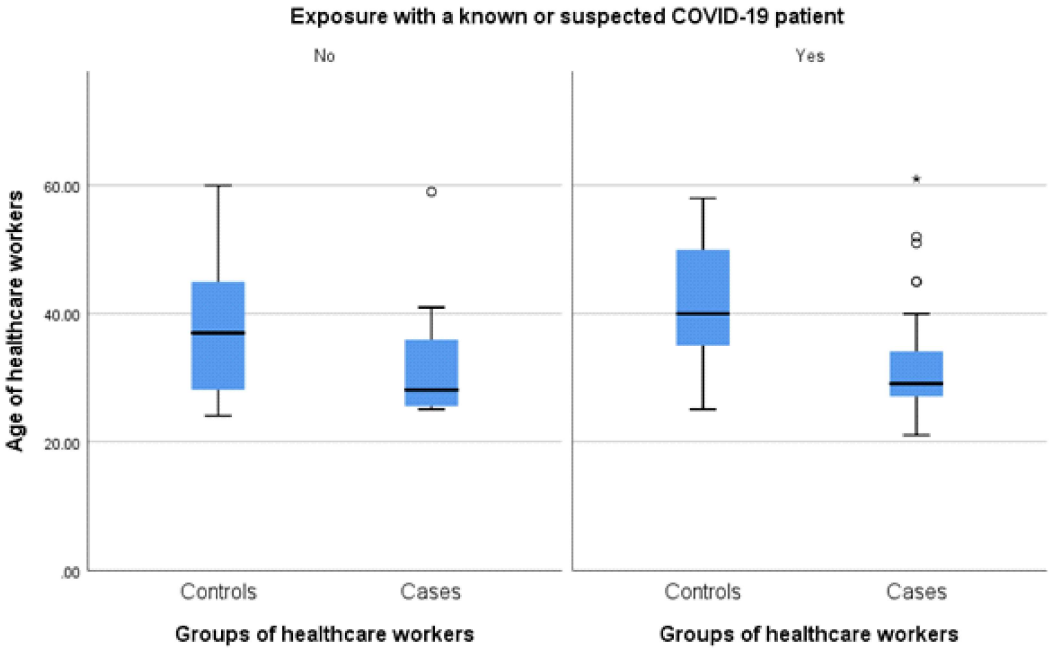

Fig 1. Boxplot demonstrating significant difference in mean age between cases and controls with respect to exposure to a known or suspected COVID-19 patient

Discussion

In this study, the risk factors associated with COVID-19 infection in the healthcare workers of Dr. Ruth K. M. Pfau Civil Hospital, Karachi were assessed. Age was found to be a significant risk factor for COVID-19 infection. Healthcare workers of younger ages i.e., 32 years of age or less were found to be affected more than senior healthcare workers. This finding, however, was in contrast to previous studies where higher age was found to be associated with severe COVID-19 infection[18] and the median age of COVID-19 affected individuals was also found to be higher[19]. This can be supported by the fact that the younger age group in our clinical setting included mostly postgraduate trainees and interns, who work round the clock, have extended exposure time to COVID-19 patients, and have higher odds of getting infected, as compared to senior doctors or consultants whose extent of exposure is at a modest level. Consistent with this finding, it was also observed that doctors who worked only in Dr. Ruth K. M. Pfau Civil Hospital, Karachi, had higher infection rates than their counterparts who practiced at multiple setting for smaller hours. As the duty hours of the latter are of shorter duration and many of the consultants are visiting professionals, it is contemplated that the exposure to potential sources of COVID-19 in these settings is redu-

ced to minimum, thus explaining the lower infection rates in senior doctors.

As COVID-19 surged throughout the world and was declared a global pandemic, PPE was considered a major requirement for battling this pandemic and minimizing the risk of viral transmission[20-22]. The appropriate use of PPE holds the status of a very important strategy in the protection of healthcare workers and patients from transmissible infectious agents. The PPE utilized by most healthcare workers includes gloves, waterproof disposable gowns, surgical face masks, hair protection and face shields in combination with good hand hygiene to diminish the exposure to infectious agents[23-24]. The use of properly fitted respirators such as N-95 respirators is also highly recommended[24]. If properly utilized, PPE significantly reduces the transmission of COVID-19 which helps to minimize the burden on the healthcare sector of any country. In this study, however, it was found that the use of PPE such as N-95 respirators, face shield, and gloves was significantly associated with COVID-19 positivity in healthcare workers. This can be explained to a large extent by the fact that since there was global shortage of PPE, only those healthcare workers who worked in high-exposure areas such as COVID-19 isolation wards and Intensive Care Units were provided with this indispensable need. These healthcare workers were already at higher risk of being infected, and due to the shortage of supply, were also more likely to reuse their PPE intended for single-use or wear them for periods longer than recommended. The latter was evident in a United States-based study[25] and could be the reason for higher positivity rates in our setting.

The symptoms of COVID-19 are diverse. Affected individual may well be asymptomatic and a source of community spread or suffer from a range of mild to severe symptoms like fever and cough to new loss of smell or taste or even shortness of breath[4]. Previous studies reported fever, cough, and weakness as the commoner symptoms of COVID-19 among affected individuals[3,26]. Multiple studies have reported fever as the predominant symptom[3,27-29]. This is consistent with our study where fever was the most common symptom experienced by both cases and controls prior to their testing. A recent observational study concluded that taste and smell disorders, and diarrhea were significant markers in COVID-19 infection[26]. However, our study showed that the most important symptoms linked to the infection were fever, loss of smell and taste, and body aches. This study showed that cases tend to be asymptomatic. Hence, in settings like ours, any healthcare provider who is asymptomatic for COVID-19 is not necessarily free of infection.

Many of the strategies for battling the COVID-19 infection aim at limiting the exposure to affected patients by social distancing, use of PPE or other means. This is because exposure is a significant risk factor for acquiring the infection as evidenced in many studies[30-32]. This study also demonstrated that exposure to a known or suspected COVID-19 patient significantly increased the risk for infection among healthcare workers.

The risk of severe disease is increased in the affected patient in the presence of any co-morbidity[33]. Diabetes was found to be the most common reported co-morbidity in our data and there were higher odds of diabetics being tested positive for the disease. However, it is vital that suspected or confirmed COVID-19 cases should be thoroughly assessed for underlying conditions and treatment be tailored to the individual patient.

The primary limitation of this study is that it was conducted on postgraduate trainees, interns, and consultants of Dr. Ruth K. M. Pfau Civil Hospital, Karachi, all being clinicians. Paramedical, technical, or janitorial staff was not interviewed despite the fact that they are also exposed to the novel coronavirus. Though the total strength of healthcare workers in Dr. Ruth K. M. Pfau Civil Hospital is around 5000, but the reported positivity rate in the clinical setting was just under 3% and there were multiple challenges in fulfilling the sample size of this study. With limited sample size, certain results of the study could not achieve statistical significance. Another limitation relates to recall bias as retrospective details were inquired from the partici-

pants and this could have been a potential source of bias.

The strengths of our study include the completion of a pilot study prior to actual data collection. The changes deemed necessary after the pilot study were incorporated in the main study.

Conclusion

This study concludes that younger age, exposure to a known COVID-19 patient and longer duration of exposure among the hospital physicians is associated with positive COVID-19 results. Therefore, it is imperative that adequate measures be undertaken to limit the exposure to COVID-19 patients in this age group.

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Conflict of Interest

Authors have no conflict of interest and no grant/funding from any organization.

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