International Journal of INFECTION CONTROL

ORIGINAL ARTICLE

Risk factors for SARS-CoV-2 infection among healthcare workers in Rajasthan: A Case-Control Study aligned with WHO UNITY protocol

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Abstract

***Background*:** Understanding the risk factors for healthcare workers (HCWs) involved in COVID-19 care is essential for developing effective infection prevention strategies.

***Methodology*:** A case-control study, aligned with the World Health Organization UNITY protocol and using the WHO Go.Data template, was conducted in Rajasthan across three public hospitals to identify factors associated with COVID-19 infection among HCWs. Data were analyzed using SPSS v.23. Descriptive analysis included COVID-19 positivity rates, exposure frequency and duration, and Infection Prevention and Control (IPC) practice scores. Chi-square and Fisher's exact tests ($P < 0.05$) were used to assess associations.

***Results*:** A total of 196 participants (50 cases and 146 controls) were enrolled. Among the cases, 54% were doctors and 42% were specifically assigned to COVID-19 care, with an average exposure duration of 8.8 ± 4.9 days over the prior 2 weeks. Notably, 36% experienced long-term face-to-face exposure. Of all variables, only hand hygiene before and after patient material contact showed a significant association with infection ($P = 0.036$).

***Conclusion*:** These findings underscore the need for strengthened IPC adherence, particularly hand hygiene, among HCWs in high-exposure settings.

Keywords: *COVID-19; IPC; hand hygiene; patient care; risk factors; health personnel; hospital; India*

Received: 30 November 2022; Revised: 30 April 2025; Accepted: 15 July 2025; Published: 05 November 2025.

Since its inception, COVID-19 has become an unprecedented global threat. The second wave of COVID-19 moved at a breakneck pace when compared to the first, with variations in clinical representation. If more cases of shortness of breath are reported, there will be an enduring need for frontline healthcare workers (HCWs) in patient-facing roles (1). Consequently, this close personal exposure to COVID-19 patients puts HCWs at greater risk of infection, calling for greater safety parameters.

Due to repeated occupational exposure, evidence suggests that HCWs are especially vulnerable to COVID-19 infection (1). Infection prevention measures aimed at the general population included social isolation, the use of face masks, and frequent hand washing with alcohol rubs or soap. HCWs, on the other hand, were exposed to a higher quantum of risk and required additional intervention approaches for protection (2). Aprons, gowns, gloves, masks, face shields, and goggles were used to meet such requirements. It is crucial to understand the risks factors associated with HCWs in hospital settings. Risk prediction can help develop the guidelines for effective personal protective equipment (PPE) at the workplace or in the community (3).

Evidence from studies in developed countries suggested that HCWs dedicated to the care of COVID-19 patients are five times more likely to become infected, even with the use of adequate PPE (1), while another study of HCWs in a large healthcare system noticed a decrease in positive COVID-19 tests associated with a universal masking recommendation (4). This complex situation made it difficult for the HCWs to assess the actual risk of acquiring COVID-19 and the efficacy of various risk-reduction strategies in the hospital settings.

This study investigates the risk factors for COVID-19 infection in exposed HCWs as well as the effectiveness of IPC measures in hospital settings across the Rajasthan state.

Methodology

Study participants

As part of the World Health Organization (WHO) UNITY protocol (Ref: WHO/2019-nCoV/HCW_RF_CaseControlProtocol/2020.1/ Risk Factors for SARS-CoV-2 Infection among Health Care Workers in India A Case Control Study'), a multi-centric case-control study was conducted at All India Institute of Medical Sciences, Jodhpur, Rajasthan, after ethical clearance. To obtain a representative sample of HCWs in Rajasthan, we intend to conduct the study in three different hospitals that are actively involved in COVID-19 treatment and have a high patient load.

HCWs were informed about the study objectives and enrolled after obtaining consent. HCWs with positive COVID-19 test were recruited as **cases**, and those tested negative were recruited as **controls** in same hospital settings. For an expected odds ratio of 2.5, 63% exposed cases and 3 controls per case. Therefore, at least 50 cases and 150 controls (total of 200 study participants) are required in order to get a statistical power of 80% with a confidence interval of 95%. So, we were able to recruit 196 HCWs who were enrolled in the All India Institute of Medical Sciences-Jodhpur (n = 97), Dr. S N Medical College-Jodhpur (n = 45), and Mahatma Gandhi Institute of Medical Sciences-Jaipur (n = 54). The study's key objective includes the assessment of risk factors for HCWs exposed to COVID-19 patients in a healthcare setting from January 2020 to November 2021. Second, adherence to Infection Practice Control (IPC) was also assessed using a standardized interviewer-administered questionnaire.

For this study, a ***healthcare worker*** *was defined as any member or staff in the healthcare facility involved in the care for a COVID-19 patient directly or indirectly having contact with the patient's body fluids, potentially contaminated items, or environmental surfaces. This included healthcare professionals, allied health workers, and auxiliary health workers* (WHO/2019-nCoV/HCW_RF_CaseControlProtocol/2020.1).

Exposure to COVID-19 patients *is defined as close contact* (*within 1 meter and for more than 15 min*) *with a suspected/probable/confirmed COVID-19 patient(s) or Indirect contact with fomites (for example, clothes, linen, utensils, and so on) or with medical devices or equipment linked to a suspected/probable/confirmed COVID-19 patient(s)* (WHO/2019-nCoV/HCW_RF_CaseControlProtocol/2020.1).

A case *is defined as a HCW who has been exposed to a COVID-19 patient in a healthcare setting within the last 14 days prior to their COVID-19 confirmation test* (WHO/2019-nCoV/HCW_RF_CaseControlProtocol/2020.1).

A control *is defined as a HCW who was exposed to a COVID-19 patient in a healthcare setting within 14 days of recruitment and is not classified as a suspected, probable, or confirmed COVID-19 case* (WHO/2019-nCoV/HCW_RF_CaseControlProtocol/2020.1).

Exclusion criterion

- HCWs having a confirmed COVID-19 case among their close contacts, including members of their household, within the previous 14 days (except the COVID-19 patient(s) to whom they were exposed) (WHO/2019-nCoV/ HCW_RF_CaseControlProtocol/2020.1)
- HCWs having a positive serology test for severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) (WHO/2019-nCoV/HCW_RF_CaseControlProtocol/2020.1)

Data collection

Data on demographic information, past medical history, clinical symptoms, adherence to IPC measures, and

Citation: Int J Infect Control 2025, **21**: 23283 – http://dx.doi.org/10.3396/ijic.v21.23283

exposure to COVID-19 patients were obtained by an interviewer-administered questionnaire. Furthermore, after 21–28 days, a follow-up form was filled to collect data on their health status and symptom severity.

Data analysis

The WHO Go.data tool for the Global Outbreak Alert and Response Network (GOARN) was used (*Go.data (2019), World Health Organization*). Data were analyzed using SPSS v. 23. The total number of HCWs infected with COVID-19, the duration and frequency of COVID-19 exposure, and adherence to IPC practices were all interpreted using a descriptive analysis. Furthermore, the Chi-square and Fisher's Exact tests were used to determine the relationship of independent variables in the case and control groups. A *P*-value of less than 0.05 was considered statistically significant.

Results

A total of 196 HCWs were recruited for this study with the mean age of 32.05 ± 8.34 years, of which 60.2% were males. There were 50 HCWs in the case group and 146 HCWs in the control group. Among the HCWs, 56.63% were doctors, 28.06% were registered nurses, and remaining were auxiliary health staff.

History of potential exposure outside workplace

11 (22.0%) out of 50 HCWs from the case group used public transport in last 14 days. Almost equal number of HCWs from both groups had social interaction with individuals outside of work, home, or transport [cases = 25 (50%) and controls = 74 (50.7%)].

History of exposure to COVID-19 patients

Forty two per cent (n = 21) of the HCWs in the case group were specifically trained to care for COVID-19 patients. During the previous 14 days, the average number of days dedicated to COVID-19 patients was 8.8 days. A total of 118 HCWs had exposure to COVID-19. A total of 64 HCWs were exposed to COVID-19 patients more than 10 times.

In our study, 60% of cases (n = 30) and 60.2% of controls (n = 88) reported a history of direct exposure to confirmed COVID-19 patients during duty (P = 0.9). When specifically asked about exposure outside of duty-related settings, none of the cases (n = 0) and only 2% of controls (n = 3) reported such exposure (P = 1.04).

In the case group, 36% (n = 18) of the HCWs had prolonged face-to-face exposure. After prolonged exposure to COVID-19 patients, 22% (n = 11) of HCWs in the case group and 26.7% (n = 39) of HCWs in the control group did not always wear PPE when indicated (P = 0.50).

Aerosolizing procedures were performed on the patient by 28.0% (14 HCWs from the case group) and 30.82% (45 HCWs from the control group). 15 (30%) HCWs from the case group and 39 (26.71%) from the control group came into contact with the patient's bodily fluid. Ten HCWs from the case group reported coming into contact with the patient's bodily fluids via the patient's materials. 29 of the 50 HCWs (58%) in the case group and 64 of the 146 HCWs (43.8%) in the control group had direct contact with the patient's surroundings. Only four HCWs from the case group came into contact with the patient's bodily fluids through surfaces such as the bed, patient table, corridor, bedside table, bathroom, and others.

Lacunae in infection prevention and control practices

COVID-19-specific training was reportedly received by 60% of HCWs in both groups. A total of 79 HCWs received no COVID-19-specific training. A total of 42 HCWs from the case group were trained in theoretical, online, and practical modes. In the healthcare facility, 23 out of 50 HCWs from the case group received less than 2 h of cumulative IPC training.

Thirteen out of fifty HCWs in the case group (26%) did not know all of the recommended moments for hand hygiene in healthcare settings, while 21 out of 146 HCWs in the control group (14.4%) did not know all of the recommended moments for hand hygiene. 7 HCWs in the case group and 22 HCWs in the control group did not adhere to the recommended hand hygiene practices. Between the cases and the control group, there was a significant difference (P = 0.036) in hand hygiene practices performed after coming into contact with the patient's material. When in contact with any patient, 9 HCWs from the case group (18.0%) and 18 HCWs from the control group (12.3%) did not follow recommended IPC measures (Table 1).

A total of 11 HCWs (22.0%) from case the group did not wear PPE when indicated. Overall, no significant difference was observed while comparing mean of practice score between case and control group (Table 2).

Most of the HCWs used PPE like Medical Mask, Respirator, Face shield, Glove, Gown, Head cover, and Shoe cover as a protective shield against COVID-19. 21.93% HCWs preferred an N-95 mask as their choice of a respirator.

Discussion

The majority of the HCWs in the case group (60%) had prior exposure to COVID-19 patients. There was no significant difference in baseline information between HCWs tested positive and negative for COVID-19 in the present study. This may increase their likelihood of contracting COVID-19 infection. However, being a HCW was found to be a protective factor against SARS-CoV-2 infection in a Brazilian study due to detailed access and awareness to preventive measures (5).

Table 1. Sociodemographic variables and risk factors for healthcare workers

	Case (*n* = 50)	Control (*n* = 146)	*P*
Age (in mean ±SD)	33.72±10.89	31.47±7.24	0.101[c]
Sex (%)			
Male	38 (76.0)	80 (54.8)	0.008[a]
Female	12 (24.0)	66 (45.2)	
Healthcare worker category (%)			
Medical Doctor	27 (54.0)	84 (57.5)	0.663[a]
Registered Nurse & Supporting Staff	23 (46.0)	62 (42.5)	
History of potential exposure outside the workplace (%)			
In the last 14 days, used public transport	11 (22.0)	27 (18.5)	0.678[b]
In the last 14 days, had social interactions outside of work	25 (50.0)	74 (50.7)	0.933[a]
History of Exposure to COVID-19 patients (%)			
HCWs dedicated to caring for COVID-19 patients	21 (42.0)	64 (43.8)	0.821[a]
Exposure to COVID-19 patients >10 times	19 (38.0)	45 (30.82)	0.350[a]
Exposure to COVID-19 patients >15 min	13 (26.0)	35 (23.9)	0.770[a]
Prolonged face-to-face exposure >15 min	18 (36.0)	39 (26.71)	0.211[a]
Exposure to aerosolizing procedures	14 (28.0)	45 (30.82)	0.707[a]
Exposure to patient's body fluids	15 (30.0)	39 (26.71)	0.653[a]
Direct contact with the surfaces around the patient	29 (58.0)	64 (43.8)	0.083[a]
Lacunae in Infection Prevention and Control (%)			
Didn't know all recommended moments for hand hygiene	13 (26.0)	21 (14.4)	0.061[a]
Cumulative IPC training received at healthcare facility (<2 h)	23 (46.0)	72 (49.3)	0.685[a]

[a]Chi-Square test; [b]Fischer's Exact Test; [c]*t*-test.

Table 2. Practice score among healthcare workers in cases and controls groups

Practice Variables	Group	Always as recommended (%)	Most of the time (%)	Occasionally (%)	Rarely (%)	Never (%)
Follow the recommended Hand Hygiene Practices	Cases	43 (86.0)	6 (12.0)	0 (0.0)	1 (2.0)	0 (0.0)
	Controls	124 (84.9)	20 (13.7)	2 (1.4)	0 (0.0)	0 (0.0)
Follow IPC standard measures during contact with any COVID-19 patients	Cases	41 (82.0)	9 (18.0)	0 (0.0)	0 (0.0)	0 (0.0)
	Controls	128 (87.7)	18 (12.3)	0 (0.0)	0 (0.0%)	0 (0.0)
Wear PPE when indicated	Cases	39 (78.0)	8 (16.0)	1 (2.0)	0 (0.0)	2 (4.0)
	Controls	107 (73.3)	29 (19.9)	5 (3.4)	1 (0.7)	4 (2.7)
Use an alcohol-based hand rub or soap and water before touching any COVID-19 patient	Cases	43 (86.0)	6 (12.0)	1 (2.0)	0 (0.0)	0 (0.0)
	Controls	126 (86.3)	15 (10.3)	5 (3.4)	0 (0.0)	0 (0.0)
Use an alcohol-based hand rub or soap and water after touching any COVID-19 patient	Cases	44 (88.0)	5 (10.0)	1 (2.0)	0 (0.0)	0 (0.0)
	Controls	131 (89.7)	14 (9.6)	1 (0.7)	0 (0.0)	0 (0.0)
Use an alcohol-based hand rub or soap and water before any aseptic procedures	Cases	44 (88.0)	5 (10.0)	1 (2.0)	0(0.0)	0 (0.0)
	Controls	125 (85.6)	19 (13.0)	2 (1.4)	0(0.0)	0 (0.0)
Use an alcohol-based rub or soap and water after body fluid exposure	Cases	46 (92.0)	4 (8.0)	0 (0.0)	0(0.0)	0 (0.0)
	Controls	133 (91.1)	13 (8.9)	0 (0.0)	0(0.0)	0 (0.0)
Use an alcohol-based hand rub or soap and water after touching any COVID-19 patient's surrounding	Cases	42 (84.0)	6 (12.0)	2 (4.0)	0 (0.0)	0 (0.0)
	Controls	133 (91.1)	11 (7.5)	2 (1.4)	0 (0.0)	0 (0.0)
Perform hand hygiene before coming into contact with patient's material	Cases	44 (88.0)	4 (8.0)	2 (4.0)	0 (0.0)	0 (0.0)
	Controls	130 (89.0)	10 (6.8)	6 (4.1)	0 (0.0)	0 (0.0)
Perform hand hygiene after coming into contact with patient's material	Cases	46 (92.0)	4 (8.0)	0 (0.0)	0 (0.0)	0 (0.0)
	Controls	144 (98.6)	2 (1.4)	0 (0.0)	0 (0.0)	0 (0.0)

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In our study, the majority of participants (54%) were doctors involved in the care of COVID-19 patients. In our study findings, HCWs using public transportation or social interaction with individuals outside of the workplace was found to be an insignificant risk factor.

Twenty-one of the fifty HCWs in the case group were specifically involved in the care for COVID-19 patients admitted to the hospital. A retrospective study conducted in Brazil, on the other hand, discovered that nurses were the most affected among healthcare professionals due to their long exposure with COVID-19-confirmed patients (5). Health and social work activities, according to the proposed risk assessment classification, resulted in a higher average risk than other types of employment (6).

Furthermore, HCW's susceptibility to infection was found to be increased with prolonged face-to-face exposure of more than 15 min with any COVID-19 confirmed case (36% HCWs from the case group). Furthermore, 14 of the 50 HCWs in the case group had been exposed to the aerolizing procedure. HCWs who perform aerosol-generating procedures such as noninvasive ventilation (NIV), high flow nasal cannula (HFNC), and endotracheal intubation are at a higher risk (7). [AQ2]

HCWs who are not using PPE effectively were at the greatest risk compared to those who strictly followed adequate PPE. Only 78% of HCWs in the case group reported using PPE as indicated. Similarly, a prospective study in the United States found that frontline HCWs working in inpatient settings with inadequate PPE faced a 31% increase in risk (1).

Following recommended hand hygiene practices and the use of proper PPE may reduce the spread of COVID-19 infection in healthcare settings and communities. Hands should be washed with water and soap for 40–60 s, if alcohol-based sanitizer is not available (8). The recommended hand hygiene practices were followed by 86% of the HCWs in the case group. Hand hygiene practices of HCWs before and after touching the COVID-19 patients did not differ significantly. Before performing any aseptic procedures, the majority of HCWs (80%) in the case group used an alcohol-based hand rub or soap and water.

However, there was significant difference in hand hygiene practices before and after coming into contact with patient's material ($P = 0.036$). Health professionals who do not decontaminate high touch areas are 2.5 times more likely to become infected with COVID-19 than health professionals who disinfect high touch areas on a regular basis (9). As a result, periodic training and sensitization of HCWs on hand hygiene practices are required to prevent cross-contamination in health facilities.

There were only minor differences in both groups' adherence to IPC practices. Furthermore, only 46% of HCWs from the case group attended the cumulative training to improve IPC practices. A significant impact of training was observed in a Wuhan study, and no one reported infection with COVID-19 (10). This finding emphasizes the critical importance of proper PPE use in preventing infections among physicians.

There were some limitations to the study as well. Because the HCWs had to recall their events while completing the form, there is a chance of recall bias. Besides this, study findings were limited to COVID-19 infection, which may not be generalized to all other acute respiratory infections. The probability that HCWs acquired COVID-19 infection through community transmission or confounding factors cannot be ruled out in this study.

Conclusion

The current study attempted to shed light on the current challenges that healthcare providers in the developing world face in the fight against COVID-19 infection. Risk factors like prolonged face-to-face exposure, inadequate PPE use, poor hand hygiene practices, and lack of adherence to IPC protocols are few to mention. Therefore, policymakers must strictly implement periodic IPC training and sensitization for healthcare providers to prevent cross-contamination and enhance patient safety at hospital settings.

Disclaimers

The views expressed in the submitted article are authors own views and not an official position of the institution or funder.

Ethics approval and consent to participate

Approval obtained from Ethics Committee (Ref: AIIMS/IEC/2020-21/3074).

Availability of data and materials

Available from the corresponding author upon reasonable request.

Conflict of interest and funding

By World Health Organization, India.

Authors' contributions

- Conception and design: PB, LSG
- Acquisition of data: J, VJ, SS, GKB, NKC, MV, AK, SB, NG, AP, RV, CT
- Analysis and interpretation of data: ADG, NM, MKG, NKJ, PB
- Drafting of the manuscript: PB, LSG, MKG, ADG, NKJ, NM, NK
- Critical revision/review of the manuscript PB, LSG, MKG, ADG, NKJ, NM, CT, NK, J, VJ, SS, GKB, NKC, MV, AK, SB, NG, AP, RV, VLN, MKG, SM
- Statistical analysis: ADG, NM, MKG, NKJ, PB
- Administrative, technical, or material support: LSG, VLN, MKG, SM

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