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Occupational Exposure to COVID-19 among Healthcare Workers: Risk Patterns and Mental Health Implications

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Abstract

Background: Healthcare workers (HCWs) were among the most vulnerable groups during the COVID-19 pandemic due to direct exposure to infected patients and prolonged work in high-risk environments. In addition to infection risk, HCWs experienced considerable psychological stress. This study aimed to assess the occupational exposure patterns to COVID-19 among HCWs and evaluate the mental health implications and quality of life outcomes. **Methodology:** A mixed retrospective and prospective descriptive study was conducted from March 2020 to January 2022 at the Government Medical College and Hospital (GMCH), Chandigarh. A total of 241 HCWs exposed to COVID-19 were included. Data on demographic characteristics, exposure type and frequency, PPE use, and mental health outcomes were collected. Depression, anxiety, stress, PTSD, and quality of life were assessed using validated scales. Statistical analysis was performed using SPSS v26.0. **Results:** Of the 241 HCWs, 60.6% were female and 41.9% were aged 26–34 years. Most participants (87.6%) reported a single exposure. Common exposure settings included non-COVID wards (38.6%), emergency areas (25.9%), and operation theatres (14.1%). Only 39.3% of HCWs used full PPE during exposures. Mental health issues were significantly more prevalent in the high-risk group: PTSD (6.7%), depression (23.4%), anxiety (30%), and stress (33.3%) compared to the low-risk group. A statistically significant difference was observed in physical health-related quality of life between high- and low-risk HCWs (p = 0.014). Overall dissatisfaction with health was also higher in the high-risk group (10% vs. 2.2%). However, even low-risk workers reported psychological symptoms, indicating the widespread mental impact of the pandemic. **Conclusion:** The study highlights the dual burden of infection risk and psychological distress among HCWs. Inadequate PPE use and repeated exposures worsened mental health outcomes. Findings emphasize the urgent need for targeted occupational safety measures and mental health support systems for HCWs, especially during

Keywords: COVID-19, healthcare workers, personal protective equipment, quality of life

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Introduction

On December 21, 2019, an outbreak of pneumonia with an unknown cause emerged in Wuhan, Hubei Province, China. This outbreak was identified as a new strain of coronavirus, initially designated 2019-nCoV by the Chinese Center for Disease Control and Prevention and later renamed severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) by the International Committee on Taxonomy of Viruses.[1] COVID-19 is a disease that mainly affects the respiratory system and most infected people recover without requiring specific treatment. People above the age of 60 years and who have underlying medical conditions are at higher risk.[2]

The highly contagious illness caused by SARS-CoV-2 had a catastrophic impact on global demographics. The World Health Organization (WHO) declared COVID-19 a Public Health Emergency of International Concern on January 30, 2020.[3]

The spread of COVID-19 in India raised significant concerns due to its dense population, widespread poverty, high migration rates, prevalent chronic health conditions, and inadequate healthcare infrastructure. With over 2.5 million confirmed cases, India has one of the highest infection rates globally. The first case was reported on January 30, 2020, in Kerala, involving a student returning from Wuhan, China.[4] Since March 2020, COVID-19 infections surged in India. To mitigate viral transmission, the government implemented various measures, including a nationwide lockdown on March 23, 2020, alongside strategies such as social distancing, self-isolation, and shielding at-risk individuals.[5]

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Medical health workers (MHWs) face the highest burden of contracting COVID-19, with 14-35% of COVID-19 cases reported to WHO being among health workers.[5] Healthcare workers (HCWs) are among the highest at risk of COVID-19 exposure. The ongoing demand for frontline HCWs in patient-facing roles necessitates close personal contact with infected individuals, placing them at a significant risk of infection.

In addition to physical health risks, high-demand settings have placed large levels of psychological stress on health workers, working incredibly long hours, and living in constant fear of

disease exposure while separated from family and facing social stigmatization.[6] A recent systematic review and meta-analysis revealed one in four healthcare professionals reporting depression and anxiety during COVID-19 and one in three suffering from insomnia.[7] Contributing factors to the same include physical exhaustion, increased susceptibility of infection, increased workload, inadequate personal equipment, and the need to make ethically difficult decisions on the rationing of care. The resilience to these stressors can be further compromised by factors such as isolation and loss of social support, risk of infecting family or friends, stigmatization and violence, and drastic changes in the ways of working. All these factors contribute to the increased vulnerability of MHWs toward mental and physiological health problems. It is imperative to ensure the safety of HCWs not only to safeguard continuous patient care but also to ensure they do not transmit the virus.[8]

In India, the Ministry of Health and Family Welfare's Directorate General of Health Services has issued an advisory for managing HCWs in both COVID-19 and non-COVID areas of hospitals. The advisory calls for healthcare facilities to activate their Hospital Infection Control Committees, which are responsible for implementing infection prevention and control measures and organizing regular training for staff. Each hospital is also required to appoint a Nodal Officer (Infection Control Officer) to oversee all matters related to Healthcare-Associated Infections.[9]

Provisions have been established for regular thermal screening of all hospital staff. HCWs managing COVID-19 receive chemo-prophylaxis under medical supervision. There are protocols for promptly reporting breaches of personal protective equipment (PPE) and implementing follow-up actions. Guidelines emphasize preventive measures at the institutional level and for HCWs, including frequent hand washing, use of alcohol-based hand sanitizers, respiratory etiquette, and consistent use of appropriate PPE while on duty.[9]

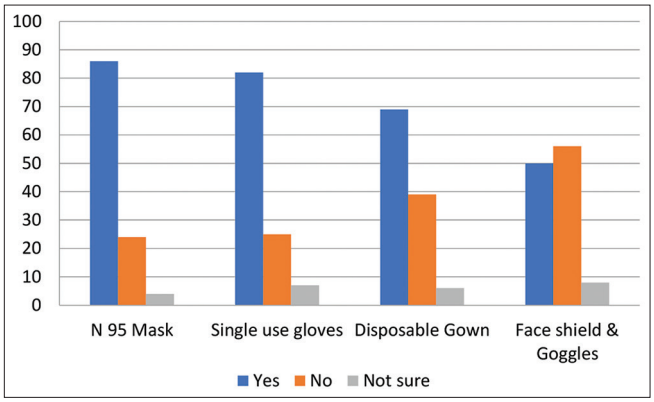
The present study aimed to examine the pattern of exposure of HCWs to COVID-19 infection and assess the outcomes of these infections.

Aims and Objectives

- To investigate the nature and type of exposure associated with COVID-19 infection among HCWs
- To evaluate the morbidities and quarantine patterns of exposed HCWs
- To assess the outcomes of exposure among HCWs who tested positive for COVID-19.

Materials and Methods

The study was conducted in the Department of Community Medicine in collaboration with the Department of Obstetrics and Gynaecology at GMCH, Chandigarh. Prospective data were collected after obtaining written informed consent, while retrospective data were gathered from the start of the lockdown on March 25, 2020. Updates from the Government of India regarding the management of HCWs in COVID-19 and non-COVID areas, as well as guidelines for PPE, were adhered to throughout the study.[9]



Graph 1: Personal protective equipment usage

Table 1: Age, gender, and type of healthcare worker distribution of the study populations

Parameter	*Number of subjects (n=241)*	*Percentage*
Age in years		
18–21	2	0.8
22–25	49	20.3
26–34	101	41.9
35–49	71	29.5
50–59	15	6.2
60–65	3	1.2
Gender distribution		
Male	95	39.4
Female	146	60.6
Type of HCW		
Doctor	91	37.8
Nurse	68	28.2
Ward attendant	22	9.1
Safai karamchari	11	4.6
Security guard	11	4.6
Technician	11	4.6
Clerical staff	9	3.7
Pharmacist	9	3.7
M.Phil. trainee	6	2.5
Pantry worker	3	1.2
Number of exposures		
1	211	87.6
2	20	8.3
3	4	1.7
4	4	1.7
5	2	0.8

HCW: Healthcare workers

Study Design

A mixed retrospective and prospective study design was adopted for the present descriptive study. Retrospective study data were collected for workers exposed to COVID-19 from 25th March 2020 to 11th February 2021 (Date of sanction of project). Prospective study data were collected thereafter till the third wave of COVID-19 pandemic, i.e., January 2022.

Study Population

HCWs from the Government Medical College and Hospital, including doctors, interns, nursing staff, ministerial staff, hospital

attendants, and Safai Karamcharis, who were willing to participate and had exposure to COVID-19, were enrolled.

Inclusion Criteria

Healthcare workers belonging to different categories were exposed to COVID-19 infection irrespective of age and gender and were willing to participate in the study.

Table 2: Place, distance, and duration of exposure to COVID-19 infection

Parameter	*Number of exposures n=290*	*Percentage*
Place of exposure		
Non COVID-19 ward	112	38.6
Emergency	75	25.9
Operation theater	41	14.1
Department	39	13.4
COVID-19 area	16	5.6
OPD	7	2.4
Approximate distance from patient (feet)		
<6 feet	272	93.8
More than 6 feet	18	6.2
Duration of contact (minute)		
<15 min	154	53.1
More than 15 min	132	46.9
Exposure to body fluids		
Yes	25	8.6
No	252	86.9
Not sure	13	4.5

OPD: Outpatient department

Exclusion Criteria

Healthcare workers not exposed to COVID-19 infection and not willing to participate in the study.

All data regarding the type of exposure, duration of exposure, use of PPE, morbidities associated, and quarantine pattern in relation to COVID-19 patient exposure was recorded. Health-related outcomes such as mental stress, quality of life (QoL), physical health, and health of family members were assessed for HCWs was studied prospectively.

Statistical Analysis

Discrete categorical data were presented as *n* (%), whereas continuous data (scores of mental stress, anxiety, and QoL) were either presented as mean ± SD along with the range or as median and interquartile range, as per the requirement. The normality of quantitative data was checked using measures of Kolmogorov–Smirnov tests of Normality. For normally distributed data, *t*-test was applied for statistical analysis for the risk categorization of the HCWs: High risk/low risk. For skewed data or scores, non-parametric Mann–Whitney U-test will be used for the statistical analysis of the 2 groups. Group comparisons of values of skewed data will be done via Kruskal Wallis test for type of HCW groups. Analysis of variance followed by *post hoc* multiple comparisons test was carried out if data were found normally distributed. Chi-square test was used. For categorical data (Type of HCW groups), comparisons were made using the Pearson Chi-square test, or Fisher's exact test, as found appropriate. Logistic regression

Table 3: Mental health status of healthcare workers

Domain	*Category*	*Total n=241*		*High risk n=60*		*Low risk n=181*		*Chi-square significance level*
		Frequency (%)		*Frequency (%)*		*Frequency (%)*		
PTSD	Present	5 (2.1)		4 (6.7)		1 (0.6)		0.014*
	Absent	236 (97.1)		56 (93.3)		180 (99.4)		
Depression	Normal	203 (84.2)		46 (76.7)		157 (86.7)		0.158
	Mild	15 (6.2)	15.8	4 (6.7)	23.4	11 (6.1)	13.3	
	Moderate	17 (7.1)		7 (11.7)		10 (5.5)		
	Severe	1 (.4)		1 (1.7)		0 (0)		
	Extreme Severe	5 (2.1)		2 (3.3)		3 (1.7)		
Anxiety	Normal	189 (78.4)		42 (70.0)		147 (81.2)		0.135
	Mild	14 (5.8)	21.6	6 (10.0)	30	8 (4.4)	18.7	
	Moderate	24 (10.0)		6 (10.0)		18 (9.9)		
	Severe	0 (0)		0 (0)		0 (0)		
	Extreme Severe	14 (5.8)		6 (10.0)		8 (4.4)		
Stress	Normal	198 (82.2)		40 (66.7)		158 (87.3)		0.004**
	Mild	27 (11.2)	17.8	11 (18.3)	33.3	16 (8.8)	12.7	
	Moderate	10 (4.1)		5 (8.3)		5 (2.8)		
	Severe	1 (0.4)		1 (1.7)		0 (0)		
	Extreme Severe	5 (2.1)		3 (5.0)		2 (1.1)		
Overall QoL	Very Good	45 (18.7)		9 (15.0)		36 (19.9)		0.067
	Good	163 (67.6)		37 (61.7)		126 (69.6)		
	Neither Good nor Poor	29 (12.0)		13 (21.7)		16 (8.8)		
	Poor	4 (1.7)	1.7	1 (1.7)	1.7	3 (1.7)	1.7	
	Very Poor	0 (0)		0 (0)		0 (0)		
Overall satisfaction over health	Very satisfied	22 (9.1)		3 (5.0)		19 (10.5)		0.042*
	Satisfied	182 (75.5)		45 (75.0)		137 (75.7)		
	Neither satisfied nor dissatisfied	27 (11.2)		6 (10.0)		21 (11.6)		
	Dissatisfied	10 (4.1)	4.1	6 (10.0)	10	04 (2.2)	2.2	
	Very dissatisfied	0 (0)		0 (0.0)		0 (0.0)		

PTSD: Post-traumatic stress disorder, QoL: Quality of life, * $p < 0.05$, considered statistically significant.

Table 4: Test findings between the groups on QoL domains

WHO QoL BREF domains	*Risk categorization of HCW*	*n*	*Mean*	*Standard deviation*	*Mean difference*	*t-test significance*
Physical health (transform scores 0–100)	High risk	60	73.73	18.002	−5.184	0.014*
	Low risk	181	78.92	12.537		
Psychological (transform scores 0–100)	High risk	60	71.62	18.470	−2.803	0.169
	Low risk	181	74.42	11.627		
Social relationships (transform scores 0–100)	High risk	60	77.63	19.120	1.904	0.513
	Low risk	181	75.73	19.617		
Environment (transform scores 0–100)	High risk	60	74.53	19.105	−4.063	0.053
	Low risk	181	78.60	11.920		

HCW: Healthcare workers, QoL: Quality of life, * $p < 0.05$, considered statistically significant.

analysis was carried out to assess the independent contribution of different factors on COVID-19 risk status. IBM Statistical Packages for the Social Sciences STATISTICS (version 26.0) was used for data analysis.

Results

A mixed retrospective and prospective study was conducted to assess the occupational exposure of HCWs to COVID-19. Retrospective data were gathered from March 25, 2020, to February 11, 2021, while prospective data collection continued through the third wave of the pandemic, ending in January 2022. During the 2-year study period, a total of 241 HCWs were exposed to COVID-19, with 290 instances of exposure recorded, accounting for multiple exposures among some individuals.

As shown in Table 1, the majority of HCWs exposed to the virus were between 26 and 34 years old, making up approximately 42% of the study population. Female HCWs were disproportionately affected, representing 60.6% of those exposed. Most participants (87.6%) experienced only a single exposure, whereas a few had up to five exposures to COVID-19. These findings highlight the significant risk faced by frontline HCWs, particularly among younger professionals and women, throughout the pandemic. The majority of HCWs exposed to COVID-19 were doctors, followed by nurses, ward attendants, Safai Karamcharis, and security guards.

Exposure locations were categorized as COVID ward, non-COVID ward, operation theater, emergency area, outpatient department, and department exposure (from colleagues). Table 2 shows that the most common exposure sites were non-COVID wards (38.6%), emergency areas (25.9%), operation theaters (14.1%), and departments (13.4%). The majority (93.8%) of HCWs were exposed to COVID-19 at a distance of <6 feet, and 46.9% had contact lasting more than 15 min.

About 10% of HCWs performed aerosol-generating procedures, with 65.5% of those workers using protection during the procedures. The most common procedures were intubation (55.2%), followed by airway suctioning (24.1%), nebulization (10.3%), and normal delivery (10.3%). The remaining 90% of exposures did not involve aerosol-generating procedures.

As shown in Graph 1, only 39.3% of healthcare workers reported using complete PPE during exposure events, underscoring the need for stricter adherence to infection control protocols. 75.4% of workers used N95 masks, while 21.1% did not, and 3.5% were unsure. For single-use gloves, 71.9% of workers used them, 21.9% did not, and 6.1% were uncertain. 60.5% of workers wore disposable gowns, whereas 34.2% did not, and 5.3% were unsure. Finally, 43.9% of workers used face shields or goggles, 49.1% did not, and 7% were uncertain about their usage.

Mental Health

As shown in Tables 3 and 4, post-traumatic stress disorder (PTSD) was observed in 6.7% of HCWs in the high-risk group compared to only 0.6% in the low-risk group. Depression, ranging from mild to extreme severity, affected 23.4% of high-risk workers and 13.3% of low-risk workers. Anxiety, ranging from mild to extreme severity, was present in 30% of the high-risk group and 18.7% of the low-risk group. Stress, from mild to extreme, was noted in 33.3% of high-risk participants versus 12.7% in the low-risk group. QoL findings indicated that 1.7% of participants in both high- and low-risk groups reported poor QoL, while most fell into the categories of neither good nor poor, good, or very good. However, 10% of high-risk workers reported dissatisfaction with their health, compared to 2.2% in the low-risk group.

While comparing the physical, psychological, social, and environmental domains of WHO BREF QoL, it was found that there statistically significant difference ($P < 0.05$) between the high-risk and low-risk group in the domain of physical health indicating the impact of COVID-19 on the physical health domain of the QoL of the HCW in the high-risk group. Other domains of QoL among HCWs were not significantly different in respect to their risk categorization. Overall findings suggest that PTSD was present in more participants in high-risk group as compared to the low-risk group, also symptoms of anxiety (21.6%), stress (17.8%), and depression (15.8%) were reported by healthcare workers due to COVID-19 pandemic and exposure in a total study sample of 241 participants.

Overall, the study revealed that high-risk HCWs experienced higher rates of PTSD, anxiety, stress, and depression due to COVID-19 exposure. However, even those in low-risk groups reported mental health challenges, highlighting the broader psychological impact of the pandemic. These findings underscore the need for strategies to address mental health issues among HCWs during future pandemics.

Discussion

HCWs globally faced significant risks of contracting COVID-19 while treating patients during the pandemic. A multicenter cross-sectional study by Wei *et al*. examined all confirmed COVID-19 cases in Wuhan, comparing the epidemic characteristics between HCWs and non-HCWs and identifying risk factors for infection and deterioration among HCWs based on hospital settings. Similarly, the United Kingdom Research Study into Ethnicity and Coronavirus Disease 2019 (UK-REACH), using data from questionnaires administered between December 2020 and March 2021, investigated demographic, household, and occupational risk factors for SARS-CoV-2 infection among HCWs in the UK.

At Government Medical College and Hospital, Chandigarh, a 2-year study observed 241 HCWs, with a total of 290 exposures to COVID-19, accounting for multiple exposures per worker. Occupational exposure was more common among female HCWs (60.6%), which is consistent with the demographic findings of Wei *et al*., where 71.5% of cases were female, and the UK-REACH study, where 75.1% of exposed workers were women. In Chandigarh, doctors, followed by nurses, ward attendants, Safai Karamcharis, security guards, and technicians, experienced the highest rates of exposure. Similarly, the UK-REACH study found that nursing and midwifery workers were more likely to be infected than doctors (1.30, 1.11–1.53, $P = 0.001$).

The most common places of exposure in Chandigarh were non-COVID-19 wards (38.6%), emergency areas (25.9%), operation theaters (14.1%), and departments (13.4%). The UK-REACH study highlighted that working in ambulances (2.00, 1.56–2.58, $P < 0.001$) or inpatient settings (1.55, 1.38–1.75, $P < 0.001$) increased infection risk while working in intensive care units was associated with lower odds of infection (0.76, 0.64–0.92, $P = 0.003$).

Overall, our findings suggest that PTSD was more prevalent in the high-risk group compared to the low-risk group. In addition, symptoms of anxiety (21.6%), stress (17.8%), and depression (15.8%) were reported among HCWs due to COVID-19 exposure. Notably, even HCWs in the low-risk group, including those who tested negative, experienced mental health issues. To the best of our knowledge, there is no comparative data available that specifically examines the mental health impact based on risk categorization among HCWs.

Conclusion

The study underscores the heightened risk of COVID-19 exposure among healthcare workers, particularly in non-COVID wards and emergency areas. Mental health challenges, including PTSD, anxiety, depression, and stress, were more pronounced in high-risk HCWs, although low-risk individuals also exhibited psychological distress. These findings emphasize the importance of ensuring both physical safety through adequate protective measures and psychological support mechanisms for HCWs in future public health emergencies.

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