

# COVID-19 among health-care providers during the first and second wave of infection in India: A systematic review

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## Abstract

Health-care providers or health-care workers (HCWs) are at higher risk of severe acute respiratory syndrome coronavirus-2 (SARS-CoV-2) infection when compared to the general population. An early routine screening of both symptomatic and asymptomatic HCWs is essential to prevent transmission of infection and thus the nosocomial spread. The cumulative prevalence of SARS-CoV-2 infection among Indian HCWs is unknown. This systematic review was aimed to analyse the prevalence of SARS-CoV-2 disease (COVID-19) among Indian HCWs. Data were collected from a comprehensive computerised search in PubMed, Google Scholar, ScienceDirect, ResearchGate, Scopus and Web of Science using the terms 'Prevalence of COVID-19 among HCWs in India' and 'prevalence of SARS-CoV-2 among HCWs in India'. Results of original research papers and meta-analysis published were collected and data analysed. Results of seven studies on 31656 HCWs in India were pooled. Overall, average prevalence of COVID-19 among the HCWs was 12.3%. Majorities were frontline workers irrespective of the gender. Most of the cases were symptomatic, with cough and fever as major clinical presentations. Findings suggest that adequate organisation of clinical wards and personnel, appropriate personal protective equipment supply and training of all workers directly and repeatedly exposed to COVID-19 patients should be prioritised to decrease the risk of infection. Furthermore, the duty time of HCWs who works in COVID treating area should be minimised.

**Keywords:** COVID-19, diabetes mellitus, health-care workers, hypertension, reverse transcription polymerase chain reaction severe acute respiratory syndrome coronavirus-2 infection, seroprevalence

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**Submitted:** 15-Jul-2022    **Revised:** 29-Aug-2022    **Accepted:** 30-Aug-2022    **Published:** 16-Feb-2023

## INTRODUCTION

The World Health Organization (WHO) had named the disease caused by Severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) identified in 2019 as (COVID-19).<sup>[1,2]</sup> The common symptoms reported were coughs, fever, sore throat, myalgia and anosmia. Fever, cough or muscle soreness were also found in

several. Some patients had deteriorated suddenly in the later stages or in the process of recovery of the disease. Acute respiratory distress syndrome A higher mortality was found among individuals with critical illness.<sup>[3]</sup> Acute respiratory distress syndrome (ARDS) and multiple-organ failure were the factors resulting in death within a short time.<sup>[4-7]</sup>

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**How to cite this article:** Ajith TA, Remith PR. COVID-19 among health-care providers during the first and second wave of infection in India: A systematic review. *J Clin Sci Res* 2023;12:57-63.

### Access this article online

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#### DOI:

10.4103/jcsr.jcsr\_143\_22

A health-care worker (HCW) is one who provides care and services to the sick directly as doctors and nurses or indirectly as helpers, laboratory technicians or even medical waste handlers. HCWs are constantly exposed to a complex variety of health and safety hazards in the course of their work than the general population. The front-line HCWs who care patients have more risk to COVID-19 due to potential occupational exposures. The higher risk of infection can either be from directly patients or from other infected HCWs. An early diagnosis is needful to prevent transmission of infection and thus the nosocomial spread. Hence, an early routine screening of both symptomatic and asymptomatic HCWs is essential. A recent meta-analysis<sup>[8]</sup> estimated that the overall global seroprevalence of SARS-CoV-2 among the general population and HCWs was 8% and 17.1%, respectively. Data on the cumulative prevalence of SARS-CoV-2 infection among HCWs in India are not clearly documented. Further, a significant difference exists in the availability of SARS-CoV-2 infection among HCWs of different countries. Therefore, this systematic review aimed to evaluate the prevalence of COVID-19 among HCWs in India based on the available published reports in journals.

## MATERIAL AND METHODS

### Search strategy, inclusion and exclusion criteria

A thorough literature search in PubMed, Google Scholar, ScienceDirect, ResearchGate, Scopus and Web of Science was done on the prevalence of COVID-19 among the HCWs till June 2021 to obtain relevant documents published as original research article, systematic reviews and meta-analysis. 'Prevalence of COVID-19 and HCWs in India' and 'prevalence of SARS-CoV-2, HCWs in India' and 'COVID-19 and HCWs in India' were used for the literature search. Only articles such as original research, systematic review and meta-analysis published in the English language or ahead of print were included in the study. Non-scientific articles, letter to editor, case report and case series or article in books were excluded from the study. Furthermore, the reverse transcription-polymerase chain reaction confirmed cases of HCWs such as doctors, nurses and other allied health workers such as technician, sanitation worker and administrative staff were included in this study. Studies with incomplete data and seroprevalence/seropositive data based on results of SARS-CoV-2 immunoglobulin (Ig) M or SARS-CoV-2 IgG were excluded from the study. The reporting of this review is as per the guidelines of the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA): The PRISMA statement, 2009.<sup>[9]</sup>

### Statistical analysis

Only papers with data on the inclusion criteria were pooled and average prevalence of COVID-19 among HCWs was calculated and expressed in percentage.

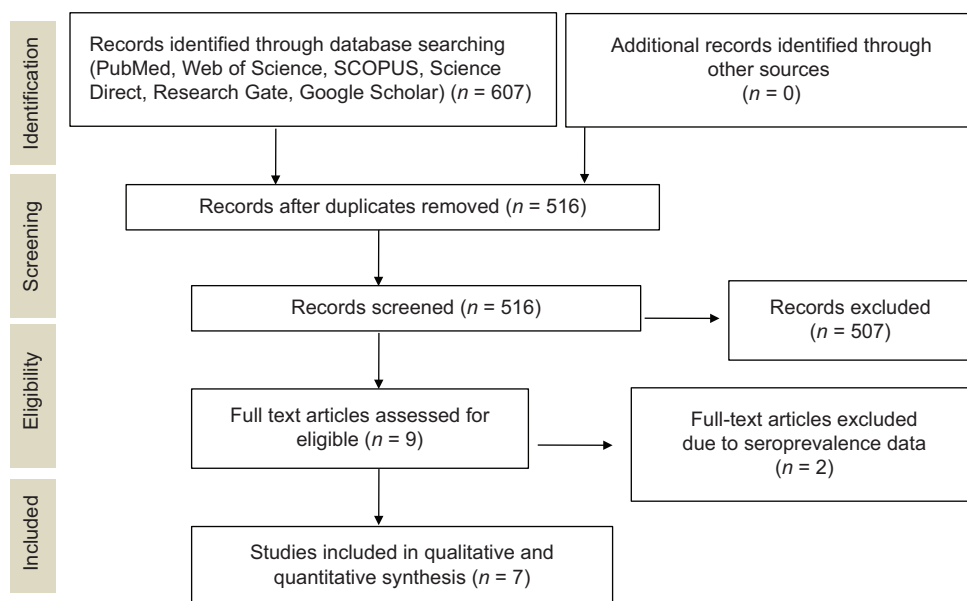
## RESULTS

A flowchart of the literature search is summarised in PRISMA 2009 format (Figure 1). Initially, 206 records were identified through PubMed, 250 records from ScienceDirect, 50 records from ResearchGate and 101 records in Google Scholar. After the removal of duplicates and screening of the titles and abstracts, nine studies were identified. Since the seroprevalence/seropositive data available in two studies, they were excluded. Finally, a total of seven scientific studies that met the inclusion criteria were analysed. A summary of the studies selected for the analysis is given in Table 1.<sup>[10-16]</sup> In this analysis, we included a total of 31,543 HCWs. The trend in prevalence rate was found to be decreased while going from April to December.

A study<sup>[17]</sup> reported the predominance of SARS-CoV2 infection in male HCWs (57%) than female HCWs (43%) in a COVID-treating hospital, Kolkata. Majorities (44%) were frontline male workers. Thirty-one per cent were asymptomatic with a history of direct contact with COVID-19-positive cases. Symptoms found were fever, sore throat, body ache, loss of sensation of smell and coughs.

A study<sup>[10]</sup> done in Mumbai found an 11% prevalence of SARS-CoV-2 infection among 3711 HCWs (frontline, 74.32% and non-frontline, 25.68%). Majority (85%) of the infected HCWs were symptomatic. Comorbidities were reported in 19% of HCWs with COVID-19. Diabetes mellitus and hypertension were the most common comorbidities.

A study<sup>[12]</sup> done in the gastroenterology department at hospitals in West Bengal found the highest prevalence for COVID-19 among endoscopy technicians (39.2%), followed by nurses (35.78%). Among the HCWs who tested positive, 67% were symptomatic. The main symptoms reported were cough (63.7%), fever (52.4%), tiredness/fatigue (13%), sore throat (12.4%), shortness of breath (11.2%), new loss of smell (4.2%) and taste (3.5%). A study<sup>[4]</sup> on 1113 participants in New Delhi, India, from 23 March to 30 April 2020, found that HCWs posted in the high-risk zones had more symptoms than those working in low-risk zones. Symptomatic HCWs had higher positivity than the asymptomatic ones. Cross-sectional<sup>[16]</sup> study among



**Figure 1:** PRISMA-2009 flow diagram  
PRISMA = Preferred Reporting Items for Systematic Reviews and Meta-Analyses

**Table 1:** The overall findings of the study on the prevalence of COVID-19 among health-care workers in India

| Study                                    | Place of study and period                         | Study design and sample size | Prevalence based on RT-PCR test (%) | Remarks  |
|--|---|------------------------------|-------------------------------------|--|
| Mahajan <i>et al.</i> <sup>[10]</sup>    | Mumbai<br>April–August 2020                       | Retrospective<br>3711        | 11                                  | 85% HCWs were symptomatic; duration of virus clearance 12 days in symptomatic and 8 days in asymptomatic cases |
| Mahajan <i>et al.</i> <sup>[11]</sup>    | Mumbai<br>April–October 2020                      | Retrospective<br>491         | 13                                  | Infection was higher among security guards   |
| Goenka <i>et al.</i> <sup>[12]</sup>     | Gastroenterology Hospital, Kolkata<br>August 2020 | Cross-sectional<br>117       | 23.9                                | 67% HCWs were symptomatic  |
| Chatterjee <i>et al.</i> <sup>[13]</sup> | Across India<br>May 2020                          | Case–control<br>21,402       | 5                                   | HCWs performing endotracheal intubation had higher odds (4.3) of SARS-CoV-2 infection                          |
| Jha <i>et al.</i> <sup>[14]</sup>        | New Delhi<br>March–April 2020                     | Prevalence<br>1113           | 1.8                                 | HCWs posted in the high-risk zones had more symptoms than those working in low-risk zones                      |
| Murhekar <i>et al.</i> <sup>[15]</sup>   | Across India<br>December 2020–January 2021        | Prevalence<br>4700           | 14.1                                | More female HCW  |
| Tyagi <i>et al.</i> <sup>[16]</sup>      | Delhi<br>January–June 2021                        | Cross-sectional<br>113       | 13.3                                | Mild disease was found 14 days after full vaccination  |

HCWs= Health-care workers; SARS-CoV-2=Severe acute respiratory syndrome coronavirus 2; RT-PCR=Reverse transcription-polymerase chain reaction

113 HCWs in Delhi found a 13.3% prevalence of disease 14 days after full vaccination. Analysing the total studies reported from India, the overall prevalence of COVID-19 among the HCWs was 12.3%. Major symptoms were cough and fever. No gender-wise difference was found. Most of the patients who tested positive were symptomatic.

**DISCUSSION**

Analysis of results found the prevalence of SARS-CoV-2 infection among the HCWs was 12.3%. Most of the HCWs were frontline and presented with symptoms of the infection such as cough and fever. A comparison of the prevalence of COVID-19 in India with other countries revealed almost consistent results. A hospital-based retrospective cross-sectional study<sup>[18]</sup> done in one of the

Iran’s fourth most populated provinces (Fars province) showed the lowest prevalence of 5.62%, with female dominance during a short period of 3 months. The study<sup>[18]</sup> also found that the frontline workers, nurses were more infected with SARS-CoV-2 and the rate of infection was highest in the emergency rooms. A study<sup>[18]</sup> reported 74.5% of the HCW patients were symptomatic which is consistent with the results from India. Myalgia and cough were reported as the common symptoms, whereas cough and fever were the common symptoms found in Indian HCWs.

From September 2000 to December 2000, the reported number of cases had declined in most of the Indian states. It was >90,000/day in September 2020 and <20,000 cases/day in December 2020.<sup>[19]</sup> Most of the studies found that the prevalence has no gender difference among HCWs.

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However, several studies concluded that male sex as a risk factor for COVID-19 adverse outcomes (in multivariate analyses after adjusting for potential confounders).<sup>[20-23]</sup> According to data from the Global Health 50/50 initiative, 63/75 countries revealed a male: female ratio of mortality over 1.<sup>[24]</sup> The exact reason for male dominance is not yet scientifically proven.

Fever, dry cough and fatigue are the most common symptoms among COVID-19 patients. Nasal congestion, headache, loss of taste or smell, conjunctivitis, sore throat, joint/muscle pain, skin rashes, diarrhoea, dizziness, nausea, vomiting or chills were also reported to a lesser extent. In addition, some other less common symptoms were irritability, confusion, reduced consciousness (sometimes associated with seizures) and anxiety, depression and sleep disorders. More severe and rare neurological complications such as strokes, brain inflammation, delirium and nerve damage were found to be associated with the infection.<sup>[25]</sup> A systematic analysis<sup>[26]</sup> of 97 studies, found an prevalence of COVID-19 among HCWs in the UK to be 11%. The most frequently affected personnel were nurses (48%). Anosmia, fever and myalgia were the only symptoms associated with HCW with SARS-CoV-2 positivity, while 40% of positive cases were asymptomatic.

In the present systematic review, we included a total of 31543 HCWs and found a decreasing trend in prevalence rate while going from April to December. A nationwide serosurvey<sup>[27]</sup> in India found nearly 1/4 of individuals from the general population, as well as HCWs of age  $\geq 10$  years, had been exposed to SARS-CoV-2 by December 2020. Seroprevalence was increased between August and December 2020. The data on seroprevalence are not included in this study.

Variation in the prevalence of COVID-19 among HCWs was evident while analysing studies from various countries. A recent study<sup>[28]</sup> among the individuals of the Lombardy region in Italy found 2.2% (95% confidence interval, 12%–12.4%) positive results with more women HCW (72.2%). Statistically significant higher odds of infection were found among health assistants and nurses. The infection rates among HCWs were found very high in countries such as China and Ethiopia. A cross-sectional study<sup>[29]</sup> in Wuhan, China, showed a prevalence of 79% COVID-19 cases among the HCW. Infection among nurses was found to be the highest.<sup>[30]</sup> A high prevalence (76%) was reported recently from a COVID-19 treatment centre in Ethiopia from September to October 2020.<sup>[31]</sup> This was associated with the inadequate supply of personal protective equipment (PPE), lack of access to alcohol-based hand

rub, long working hours, providing care within 1 m of COVID-19 patients, proper use of PPE and direct contact with an environment where COVID-19 patient received care. A 2-month survey<sup>[32]</sup> conducted among front-line HCWs in the UK and the USA, found a high-risk ratio of 11.6%.

The risk of infection was found high among HCWs involved in nasopharyngeal swab collection, endotracheal intubation or respiratory suction in suspected or confirmed patients of COVID-19. All these procedures have potential risks for generating aerosols from the respiratory tract. After a restriction of endoscopy activity to only urgent procedures in both public and private hospitals, a study<sup>[12]</sup> among endoscopy technicians of gastroenterology departments in North India showed a 23.93% prevalence which is found to be high when compared to a similar report from Brazil. A nationwide survey<sup>[33]</sup> in Brazil showed only 1% COVID-19 infection among the HCW involved in endoscopic procedures. The difference may probably be due to the small sample size used in the survey (375 in India vs. 1155 in Brazil). Most of the centres doing endoscopic procedures may have limited resources to follow current international guidelines, availability of negative pressure rooms and PPE.

In our study, we found most of the infected HCWs were symptomatic. The result is consistent with previous reports from various countries. A study<sup>[34]</sup> report from the UK revealed 57% HCWs were truly asymptomatic and 40% had experienced symptoms before testing SARS-CoV-2. A study<sup>[35]</sup> done in Milan, Italy, among the 1573 HCWs showed a significant difference between asymptomatic (1.6%) and symptomatic (24.2%) cases. The highest frequency of positive tests (10.5%) was for physicians, whereas clerical workers and technicians had the lowest frequency (3.6%). Further study on this group of HCWs found that the most frequently associated symptoms were alterations of taste and smell (odds ratio [OR] 4.62) and fever (OR 4.37).<sup>[36]</sup>

The overall seroprevalence among HCWs across India was reported as 25.6%.<sup>[15]</sup> However, it is found to be varying among different states in India. A study done among HCWs in Kashmir, India, found 2.5% seroprevalence (SARS-CoV-2-specific immunoglobulin G [IgG] antibodies).<sup>[37]</sup> A multicentre study among 3253 HCWs reported a seroprevalence of 19.7%.<sup>[38]</sup> In general, the seroprevalence was found to be double among the HCWs. A meta-analysis<sup>[8]</sup> estimated that the overall global seroprevalence of SARS-CoV-2 was 8% in the general population and 17.1% among HCWs.

A systematic review and meta-analysis<sup>[39]</sup> reported that working as a frontline HCW was inconsistent in its association with higher seroprevalence. The analysis of seroprevalence in various countries showed a lower value. A cohort screening study<sup>[40]</sup> among the HCWs in the Capital Region of Denmark showed seropositivity of 4.04%. A seroprevalence of SARS-CoV-2 in the greater New York area and state was 13.7% and 14%, respectively.<sup>[41]</sup> Adjusted SARS-CoV-2 seropositivity in the metropolitan area of Atlanta, Georgia, was estimated to be 3.8% among the HCWs of a large academic health-care system.<sup>[42]</sup> Seropositivity among younger female nurses who had workplace contact in the inpatient setting at four large health-care systems in three US states was 4.4%.<sup>[43]</sup> However, a high seroprevalence of 24% was found among 446 front-line HCWs in a tertiary care hospital in Chile (from April to July 2020). Among the total, no prior symptoms were reported in majorities (43%).<sup>[44]</sup>

A study<sup>[45]</sup> conducted among Illinois- and Wisconsin-based adult HCWs found a significant disparity in positivity rate by age, race, ethnicity and clinical role. Participants aged 32–82 had lower adjusted odds ratio (ORs) of positive IgG than participants aged 18–31 years. The primary source of SARS-CoV-2 transmission is respiratory droplets and physical contact. The other possible aspects of virus transmission must not be ignored, which include spread through conjunctival secretions, asymptomatic carriers, faecal-oral routes, vertical transmission as well as sexual transmission.<sup>[46]</sup>

With respect to the risk analysed among HCWs who are being exposed to a higher quantum of risk, additional intervention is needed for protection. This includes using gowns, aprons, gloves, masks and goggles/face shields. These protective gears serve useful purposes in settings where risk procedures are performed.<sup>[47-50]</sup> Lack of PPE, poor infection prevention and control practices, work overload and pre-existing health condition, close contact with a SARS-CoV-2 patient has been identified as the leading risk factors among thousands of HCWs infected with SARS-CoV-2 globally.<sup>[51,52]</sup>

Demographic (age, sex, race and ethnicity) and community risk factors are also strongly associated with SARS-CoV-2 infection among HCWs. Frontline HCWs should receive sufficient rest time to avoid overwork, ensure adequate sleep and consume a nutritious diet and supplements to maintain the body's immunity to reduce the likelihood of infection.<sup>[30]</sup> It is unclear whether the humoral immune response after SARS-CoV-2 infection offers durable

protection against reinfection. A prospective cohort study in HCWs with SARS-CoV-2 IgG antibodies showed no protection against COVID-19 recurrence. This was evident from the observation that a 51% increased risk of COVID-19 infection was found among the IgG-positive participants.<sup>[53]</sup> A recent study in the UK also found that IgG-positive HCWs with certain risk factors for severe COVID-19 illness, such as older age, African American or Asian ethnicity and hypertension, showed greater persistence over time than IgG-positive participants without the risk factors.<sup>[54]</sup> This emphasizes the significance of selecting appropriate preventive measures by HCWs while working in high-risk environments.

Literature survey in databases found only few studies as per the inclusion criteria selected. No comparative studies were reported in HCWs working in urban and rural COVID-19 treating centres. Furthermore, studies from various states are not available to derive a conclusion on the overall prevalence of infection among the HCWs and planning necessary preventive programmes. This warrants future studies in individual states with respect to urban and rural centres.

Adequate organisation of hospital COVID-19 treating areas, supply of appropriate PPEs, including N95 masks, protective clothing and goggles, hand hygiene and training of all workers who are directly and indirectly exposed to patients with the clinical or subclinical presentation of disease should be prioritised to decrease the risk of infection among HCWs. Furthermore, HCWs should avoid overwork, ensure adequate sleep and consume a nutritious diet to ensure the body's immunity. Despite higher knowledge, proper training to the area concerned, protocol revision and strict supervision are additional measures to limit exposure risk to COVID-19 among HCWs.

#### Financial support and sponsorship

Nil.

#### Conflicts of interest

There are no conflicts of interest.

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