How to Cite:
Desai, D., Channe, P. P., Nayak, A. K., Mishra, J., Behera, N. K., & Shetty, A. (2022). Primary health care and hospital management during COVID-19: Systematic review & meta analysis. *International Journal of Health Sciences*, *6*(S5), 1075–1089. https://doi.org/10.53730/ijhs.v6nS5.8822

Primary health care and hospital management during COVID-19: Systematic review & meta analysis

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***Abstract*---**Introduction: The COVID-19 outbreak has brought to light the issues and risks that frontline healthcare professionals face (HCW). The goal of this study was to describe the clinical outcomes and risk variables in HCW infected with SARS-CoV-2 and thus evaluate the primary health care and hospital management. Methods: A total of 328 articles were found after searching three databases. Only 97 full-text articles were screened because 225 articles did not match the inclusion criteria. Finally, 30 articles were included in the

International Journal of Health Sciences ISSN 2550-6978 E-ISSN 2550-696X © 2022.
Manuscript submitted: 18 March 2022, Manuscript revised: 9 April 2022, Accepted for publication: 27 May 2022

systematic review and 28 were used in the meta-analysis following further revision. Results: Twenty-eight studies with a total of 119,883 patients were found. The patients' average age was 38.37 years (95 percent CI 36.72–40.03), and males made up 21.4 percent of the HCW population (95 percent CI 12.4–34.2). COVID-19 positivity was found in 51.7 percent of HCW (95 percent confidence interval: 34.7–68.2). In seven investigations, the overall prevalence of comorbidities was 18.4 percent (95 percent confidence interval 15.5–21.7). Fever and cough were the most common symptoms, with 27.5 percent (95 percent CI 17.6–40.3) and 26.1 percent (95 percent CI 18.1–36) respectively. In 13 studies, the prevalence of hospitalization was 15.1 percent (95 percent CI 5.6–35), while the frequency of death was 1.5 percent (95 percent CI 0.5–3.9). Personal protective equipment, job setting, occupation, exposure, contacts, and testing all demonstrated a higher relative risk for COVID-19 in HCW with and without infection. Conclusion: During the first six months of the COVID-19 pandemic, a significant number of HCW were reported to be infected with COVID-19, with a hospitalization rate of 15.1 percent and a mortality rate of 1.5 percent. As the pandemic progresses and health systems respond, more data is needed to track the ongoing hazards in HCW.

***Keywords*---**COVID-19 SARS-CoV2, Healthcare workers Meta-analysis Occupational health, Infectious disease transmission.

Introduction

A pneumonia-like outbreak with an unknown cause or origin was discovered on December 21, 2019 in Wuhan, Hubei Province, China. Patients' bronchoalveolar lavage samples were isolated and analyzed by 03 January 2020, due to the rapidly growing instances and unclear methodology surrounding medical care. The findings highlighted a novel coronavirus strain, initially dubbed 2019-nCoVs by the Chinese Center for Disease Control and Prevention (CDC) (Zhang, 2020), and later dubbed SARS-CoV-2 by the International Committee on Virus Taxonomy. The World Health Organization labeled the COVID-19 outbreak a pandemic on March 11, 2020, causing alarm among millions and prompting several federal governments to devise efforts to protect their citizens (World Health Organization).

Healthcare workers (HCW) were quickly identified as one of the groups with the highest risk of COVID-19 infection due to their low understanding of this novel coronavirus strain and their position on the front lines. COVID-19 was transmitted to 16 healthcare workers in late January 2020, according to CDC China, as a result of being in contact with patients from the outbreak (Li, 2020c). HCW infection was thought to have the potential to exacerbate the chain of transmission in hospitals and other health institutions, hence appropriate protection of HCW against COVID-19 by enforcing protective practices had to be prioritized (Black et al., 2020).

Along with focusing on COVID-19's influence on the general public, numerous papers have now been published in various regions of the world describing the virus's impact on healthcare systems, specifically the problems and hazards encountered by frontline and high-risk HCW. The scope of these research investigations has ranged from describing clinical characteristics of COVID-19-infected HCW to researching risk factors for infection, transmission dynamics among HCW, and stating the infection's sequelae and outcomes.

The goal of this study was to combine a systematic review of the published data with a meta-analysis to evaluate the risk of infection and clinical outcomes among HCWs who are on the front lines of diagnosing and caring for COVID-19 infected patients. Furthermore, as part of the qualitative discussion, it was intended to look into the risk variables that may have played a role in COVID-19 transmission to HCW.

Material and methods

Study Design

The Preferred Reporting Items for Systematic reviews and Meta-Analyses (PRISMA) criteria were used to conduct this systematic review. The PRISMA flow system was utilized to stratify the studies and provide a basis for evaluating studies.

Inclusion and Exclusion Criteria

All the published studies that report the clinical outcomes and risk variables in HCW infected with SARS-CoV-2 and thus evaluate the primary health care and hospital management, studies published in English, cross-sectional studies, longitudinal studies, randomized and Non- randomized control trials were included in this review. Studies performed in animal subjects, grey literature, including presented abstracts, letters to the editors, commentaries, systematic review, narrative reviews or meta-analysis articles and unavailability of the full text of the article were excluded from the current review.

Search Strategy

We conducted a manual and electronic search and identified literature published up to March 30th, 2022. Literature searches were carried out on databases such as Cochrane, PubMed (Medline), Google Scholar, and Scopus with the appropriate key terms (MeSH) and phrases. Different types of keywords were used for the search strategies such as “COVID-19 SARS-CoV2, Healthcare workers Meta-analysis Occupational health, Infectious disease transmission” etc. The bibliographic sources of the selected articles were also screened.

Article Screening

After applying the eligibility criteria, relevant articles were chosen for full-text screening. Two authors have independently performed articles screening process and eligibility assessment. In case of some contradictions between the authors,

the decision was made by an unbiased third party. The articles were initially screened based on their title, followed by the article's abstract. The case title and abstract of the articles were irrelevant to the present investigation; these were excluded from the secondary screening.

Data Extraction

Two investigators independently assessed search results and selected studies, and extracted data. Full papers were retrieved for further examination if the information in the abstract showed that the above inclusion criteria were met. To construct a customized Microsoft Excel spreadsheet, the following criteria were collected, and the following data was retrieved from the inclusion criteria: the name of the author and the year in which it was published, study design, Country, Number of patients, age, gender, disease, and outcomes.

Results

From May 1 to July 9, 2020, specified keywords and a search strategy were used to search three databases: PubMed, Scopus, and Google Scholar. Figure 1 depicts the literature retrieval flowchart. 328 articles were found during the initial phase of the search, with 33 duplicates deleted. Following the assessment of the abstracts, 198 articles were eliminated because they did not match the inclusion requirements. A total of 97 full-text papers were downloaded and evaluated. There were 67 items that were eliminated owing to a lack of sufficient data, remark, or viewpoint, as well as three pieces that were written in languages other than English and did not have an English translation accessible. The total number of publications for systematic review was 30, with 28 of them being used for meta-analysis and published between February and June 2020. (Figure 1 and Table 1).
Table 1 summarizes the features of the papers included. There were thirteen pieces from China, seven from the United States, three each from the Netherlands and Italy, two from Germany, and one from Spain. With the exception of one case-series publication, the most common research type among the papers was cross-sectional (n = 19), while the rest were a mix of retrospective and prospective cohort studies (Table 1).

The meta-analysis includes twenty-nine factors. The majority of the studies exhibited significant heterogeneity (I2 > 75%). Egger's test revealed that fewer studies had signs of bias (p > 0.05).
Features of the population:
A total of 119,883 patients were analyzed across the 28 studies. The patients' average age was 38.37 years (95 percent CI 36.72–40.03), and males made up 21.4 percent of the HCW population (95 percent CI 12.4–34.2).
Comorbidities:
In the seven studies included, the overall prevalence of comorbidities was 18.4 percent (95 percent CI 15.5–21.7), with hypertension accounting for 2.5 percent (95 percent CI 0.2–27.2), CVD 2.4 percent (95 percent CI 0.7–7.5), COPD 2.4 percent (95 percent CI 0.9–6.4), and diabetes 1.4 percent (95 percent CI 0.1–12.9).
Clinical signs and symptoms:

COVID-19 was found in 51.7 percent (95 percent CI 34.7–68.2) of HCW in 28 investigations. The most common COVID-19 symptom among HCW was fever (27.5 percent, 95 percent CI 17.6–40.3), followed by cough (26.1 percent, 95 percent CI 18.1–36), fatigue 23.4 percent (95 percent CI 12.7–39), sputum 17.6 percent (95 percent CI 10.1–28.8), headache 15.1 percent (95 percent CI 9.0–24.1), sore throat 13.3 percent (95 percent CI 8.2–20.9), nausea.
Investigations of the blood and imaging:
Leukopenia was the most common laboratory finding at 49.4% (95 percent CI 10.3–89.2), followed by lymphopenia at 29.1% (95 percent CI 12–55.1), high creatinine at 22.6 percent (95 percent CI 7.2–52.5), high CRP at 17.3 percent (95 percent CI 5.1–45), leukopenia at 13 percent (95 percent CI 5.5–27.8), and high LDH at 12.2% (95 Bilateral pneumonia was the most prevalent pneumonia finding on radiological imaging, with a frequency of 78.7% (95 percent CI 43.9–94.6). Ground-glass opacity was found to be prevalent in 67.5 percent of cases (95 percent CI 41.4–86) while unilateral pneumonia was found to be prevalent in 26.8 percent of cases (95 percent CI 19.4–35.8).
Illness progression, complications, and outcomes:
ARDS was found to be a complication of COVID-19 infection in two investigations, with a frequency of 12.2% (95 percent CI 0–97.8). The prevalence of HCW hospitalization was 15.1 percent (95 percent CI 5.6–35) across 13 studies, and the prevalence of release from the hospital was 47.5 percent (95 percent CI 10.9–87) across seven studies using the random-effect model to find the pooled prevalence and 95 percent CI. Death was found to be 1.5 percent of the time in 12 research (95 percent confidence interval 0.5–3.9). Figure 2 shows funnel plots of hospitalizations and deaths, which reveal that there is a low risk of bias in death rates but a higher risk of bias in reporting hospitalization rates.
Risk Factors:
Six independent researchers thoroughly reviewed thirty articles in search of risk variables for HCW COVID-19 infection. Seven articles out of 30 provided information on the relevant risk factors. In the individual articles, an overview of the important points about risk factors may be found in. Personal protective equipment (PPE), job setting, profession, exposure, contacts, and testing were the six categories of risk variables identified.

Discussion

The available clinical information and characteristics of HCW with COVID-19, as well as the risk factors that make them more susceptible to infection, were summarized in this systematic review and meta-analysis. The PRISMA requirements were followed, and 30 publications from three online databases were filtered (Shamseer et al., 2015). This study looked at 119,883 HCW and found that 51.7 percent of them tested positive for COVID-19 in the reports that were analyzed. It's worth noting that several of these publications only included HCW who had COVID-19 infections. The majority of the articles were from China, but there were also stories from the United States, the Netherlands, Italy, Germany, and Spain (Table 1).

There was a wide range of symptoms, comorbidities, and consequences among the HCW who were studied. HCWs were found to be a youthful working-age population (mean age 38.73 years), and their clinical characteristics were likely

similar to those of other people in this age range. Fever was reported to be the most common symptom in COVID-19-infected HCWs, followed by cough and weariness (Guan et al., 2020; Li et al., 2020b; Sun et al., 2020). Patients with comorbidities have a higher chance of symptomatic infection with COVID-19, as well as a worse prognosis, than those who do not (Sanyaolu et al., 2020). Pre-existing conditions were found in 18.4% of the infected healthcare professionals in this investigation. While hypertension was found to be the most common (2.5 percent), CVD and COPD were found to be the second most common (2.4 percent), and diabetes was found in 1.4 percent. These findings contrast with preliminary data on comorbidities in the general population of COVID-19 patients found in a meta-analysis of reports from China, where the prevalence of these comorbidities was higher: 15.8% for hypertension, 11.7 percent for CVD, 9.4% for diabetes, and 1.4 percent for COPD. The 'Healthy Worker Effect,' which has been described as "the reduction of mortality or morbidity of occupational cohorts when compared to the general population" by some, is likely to explain the typically lower prevalence rates of comorbidities in HCW compared to the general population (Shah, 2009).

This study looked at the key laboratory findings in COVID-19 infection, including leucocytosis, lymphopenia, and an increased CRP, in addition to comorbidities. Other studies have observed a drop in CD4+ and CD8+ cells, attributable to lymphocyte consumption throughout the infection phase, as well as an increase in cytokine release, both of which are linked to disease severity and death (Huang et al., 2020; Li et al., 2020a; Qin et al., 2020; Ruan et al., 2020). The most common imaging finding for HCW in the current study was bilateral pneumonia, followed by ground-glass opacity. The most prevalent finding among patients in the general population was ground-glass opacity, but consolidations were more frequently reported among individuals who were thought to be very ill (Li et al., 2020b). In the studies examined, no results regarding the presence of shock, anemia, or an elevated ESR were reported.

The results of COVID-19 in HCW remained significantly better than those reported in most general population investigations. Overall, 15% of HCW with COVID-19 required hospitalization, approximately 50% were discharged, and 1% of HCW with COVID-19 died. Previous comorbidities, particularly CVD, secondary infection, and high inflammatory markers on laboratory examination were all factors that favored unfavorable outcomes among COVID-19 patients (Ruan et al., 2020). This is in contrast to previous findings of HCW infection with SARS-CoV-1 and MERS. Between 2012 and 2018, the WHO received 415 MERS-CoV-positive HCW reports, with 24 (5.8%) of them dying as a direct result of the infection (Elkholy et al., 2020). HCWs with renal impairment were identified as having the highest risk of death at the time (Shalhoub et al., 2018). Comparisons with the current pandemic trend are difficult due to the limited available data on SARS until 2003, with a relatively low total number of cases reported by the WHO (8096 cases and 774 deaths) (WHO| Summary of probable SARS cases with onset of illness from 1 November 2002 to 31 July 2003, 2015). There was no evidence of a definitive mortality rate for HCW infected with Sars-CoV-1. Xiao et al. calculated that HCW deaths attributable to SARS-CoV-1 could account for up to 164 of the total 774 deaths (21%), while they cautioned that this figure could be overstated

due to factors such as the frontline HCWs' young age and high immunity (Xiao et al., 2020).

The largest reported series came from a study that reached out to HCW using a new smartphone application called "Covid Symptom Study," which was used by 2,035,395 people in the United Kingdom and the United States (Nguyen et al., 2020a). There were 99,795 people who identified themselves as HCWs and provided information on their symptoms and PPE use. There were 1922 (1.9 percent) positive Covid-19 tests among the identified HCWs, compared to 3623 (0.18 percent) positive Covid-19 tests among the general population. In this study, the reported rates of comorbidities in HCW were higher, particularly for the prevalence of pulmonary disease. Data on hospitalization and mortality were not given, and the procedures for acquiring this novel self-reported data will need to be verified further.

Risk measurements were discovered for the following factors among HCW who tested positive for SARS-CoV-2 infection: PPE, working setting, profession, exposure, contacts, and testing in this analysis of risk factors among HCW who tested positive for SARS-CoV-2 infection (Table 7). Face masks have been demonstrated to protect against infection, and wearing one at all times reduced the chance of infection (Chen et al., 2020; Guo et al., 2020). PPE training has been reported to be a protective factor, however the lack of N95 masks, reused PPE, and poor hand hygiene techniques have all been linked to COVID-19 infection (Guo et al., 2020; Nguyen et al., 2020b; Ran et al., 2020). When compared to nurses and general service professionals, physicians exposed to COVID-19-positive patients had the highest risk. Physicians working in respiratory departments, infection control departments, intensive care units, and surgical departments were the ones who were most at risk (Ran et al., 2020). With positive individuals, there was no link between infection risk and exposure time or distance (Garzaro et al., 2020). In comparison to the general public, frontline HCW in all healthcare settings had a higher risk of infection, with HCW working in inpatient settings and nursing homes having a higher risk (Nguyen et al., 2020b). China has reported the most risk factor data, followed by Italy, the United States, the United Kingdom, and Germany. Guo et al. highlighted PPE training as a key risk factor in December–February, however articles released later in March–May reported insufficient PPE availability, work conditions, and contact exposure as the primary risk factors for HCW (Guo et al., 2020).

Conclusion

With the rapid global spread of this novel coronavirus strain, it became clear that much more study was needed to understand and contain the infection, particularly for frontline health care workers. The data in this paper covers the first 6 months after COVID-19 was officially declared a pandemic, as well as the early experience of the disease in HCW with a previously unknown virus. A survey of members of the ID-IRI (Infectious Diseases International Research Initiative) from 37 countries through August 15, 2020, recently documented the overall global amount of COVID-19 in HCWs (Erdem and Lucey, 2021). They found 2736 HCW deaths in the reporting nations, with a mortality rate of 0–0.90/100,000.

More information is needed to fully comprehend the pandemic's developing impact on the health and well-being of healthcare professionals.

References

1. Black JRM, Bailey C, Przewrocka J, Dijkstra KK, Swanton C. COVID-19: the case for health-care worker screening to prevent hospital transmission. Lancet 2020;395(10234)1418–20,doi:http://dx.doi.org/10.1016/S0140-6736(20)30917-X
2. Breazzano MP, Shen J, Abdelhakim AH, Dagi Glass L, Horowitz J, Xie SX, et al. New York City COVID-19 resident physician exposure during exponential phase of pandemic. J Clin Invest 2020;(May), doi:http://dx.doi.org/10.1172/JCI139587
3. CDC COVID-19 Response Team. Burrer SL, et al. Characteristics of health care personnel with COVID-19–United States, February 12–April 9, 2020. MMWR Morb Mortal Wkly Rep 2020;69(15):477–81.
4. Cabas P, di Bella S, Giuffrè M, Rizzo M, Trombetta C, Luzzati R, et al. Community pharmacists' exposure to COVID-19. Res Social Adm Pharm 2021;17(1):1882–7, doi:http://dx.doi.org/10.1016/j.sapharm.2020.05.020.
5. Canova V, Lederer Schläpfer H, Piso RJ, Droll A, Fenner L, Hoffmann T, et al. Transmission risk of SARS-CoV-2 to healthcare workers-observational results of a primary care hospital contact tracing. Swiss Med Wkly 2020;150:w20257, doi: http://dx.doi.org/10.4414/smw.2020.20257 PMID: 32333603.
6. Chen T, Wu D, Chen H, Yan W, Yang D, Chen G, et al. Clinical characteristics of 113 deceased patients with coronavirus disease 2019: retrospective study. BMJ 2020;368.
7. Chow EJ, Schwartz NG, Tobolowsky FA, Zacks RLT, Huntington-Frazier M, Reddy SC, et al. Symptom screening at illness onset of health care personnel with SARS- CoV-2 infection in King County, Washington. JAMA 2020;323(20):2087–9.
8. Chu Jiaojiao, et al. Clinical characteristics of 54 medical staff with COVID-19: a retrospective study in a single center in Wuhan, China. J Med Virol 2020;92 (7):807–13, doi:http://dx.doi.org/10.1002/jmv.25793.
9. Elkholy AA, Grant R, Assiri A, Elhakim M, Malik MR, Van Kerkhove MD. MERS-CoV infection among healthcare worker and risk factors for death: retrospective analysis of all laboratory-confirmed cases reported to WHO from 2012 to 2 June 2018. J Infect Public Health 2020;13(3), doi:http://dx.doi.org/10.1016/j. jiph.2019.04.011.
10. Erdem H, Lucey DR. Healthcare worker infections and deaths due to COVID-19: a survey from 37 nations and a call for WHO to post national data on their website. Int J Infect Dis 2021;102:239–41, doi:http://dx.doi.org/10.1016/j. ijid.2020.10.064.
11. Felice C, di Tanna GL, Zanus G, Grossi U. Impact of COVID-19 outbreak on healthcare workers in Italy: results from a national e-survey. J Community Health 2020;45:675–83, doi:http://dx.doi.org/10.1007/s10900-020-00845-5.
12. Garzaro G, Clari M, Ciocan C, Grillo E, Mansour I, Godono A, et al. COVID-19 infection and diffusion among the healthcare workforce in a large university-hospital in Northwest Italy. Med Lav 2020;111(3):184–94.

13. Guan W, Ni Z, Hu Y, Liang W, Ou C, He J, et al. Clinical characteristics of coronavirus disease 2019 in China. N Engl J Med 2020;382(18):1708–20.
14. Guo X, Wang J, Hu D, Wu L, Gu L, Wang Y, et al. Survey of COVID-19 disease among orthopaedic surgeons in Wuhan, People's Republic of China. J Bone Joint Surg Am 2020;102(10):847–54, doi:http://dx.doi.org/10.2106/JBJS.20.00417.
15. Heinzerling A, Stuckey MJ, Scheuer T, Xu K, Perkins KM, Resseger H, et al. Transmission of COVID-19 to health care personnel during exposures to a hospitalized patient–Solano County, California, February 2020. Morb Mortal Wkly Rep 2020;69(15)472–6.
16. Huang C, Wang Y, Li X, Ren L, Zhao J, Hu Y, et al. Clinical features of patients infected with 2019 novel coronavirus in Wuhan, China. Lancet 2020;395 (10223):497–506.
17. Jin Y-H, Huang Q, Wang Y-Y, Zeng X-T, Luo L-S, Pan Z-Y, et al. Perceived infection transmission routes, infection control practices, psychosocial changes, and management of COVID-19 infected healthcare workers in a tertiary acute care hospital in Wuhan: a cross-sectional survey. Mil Med Res 2020;7(1)24.
18. Kimball A, Hatfield KM, Arons M, James A, Taylor J, Spicer K, et al. Asymptomatic and presymptomatic SARS-COV-2 infections in residents of a long-term Care Skilled Nursing Facility—King County, Washington, March 2020. Morb Mortal Wkly Rep 2020;69:377–81 DOI: https://doi.org/10.15585/mmwr.mm6913e1external icon.
19. Korth J, Wilde B, Dolff S, Anastasiou OE, Krawczyk A, Jahn M, et al. SARS-CoV-2- specific antibody detection in healthcare workers in Germany with direct contact to COVID-19 patients. J Clin Virol 2020;128:104437, doi:http://dx.doi. org/10.1016/j.jcv.2020.104437.
20. Lai X, Wang M, Qin C, Tan L, Ran L, Chen D, et al. Coronavirus disease 2019 (COVID- 2019) infection among health care workers and implications for prevention measures in a tertiary hospital in Wuhan, China. JAMA Netw Open 2020;3(5) e209666.
21. Li G, Fan Y, Lai Y, Han T, Li Z, Zhou P, et al. Coronavirus infections and immune responses. J Med Virol 2020a;92(4):424–32.
22. Li K, Wu J, Wu F, Guo D, Chen L, Fang Z, et al. The clinical and chest CT features associated with severe and critical COVID-19 pneumonia. Invest Radiol 2020b;55(6):327–31.
23. Li Q. An outbreak of NCIP (2019-nCoV) infection in China—Wuhan, Hubei Province, 2019–2020. China CDC Wkly 2020c;2(5):79–80.
24. Li YK, Peng S, Li L-Q, Wang Q, Ping W, Zhang N, et al. Clinical and transmission characteristics of Covid-19–a retrospective study of 25 cases from a single thoracic surgery department. Curr Med Sci 2020;40(2):295–300.
25. Marjolein FQ, et al. Prevalence and clinical presentation of health care workers with symptoms of coronavirus disease 2019 in 2 Dutch hospitals during an early phase of the pandemic. JAMA Netw Open 2020;3(5)e209673.
26. McMichael TM, et al. Epidemiology of Covid-19 in a long-term care facility in King County, Washington. N Engl J Med 2020;382(21)2005–11, doi:http://dx.doi.org/ 10.1056/NEJMoa2005412
27. Nguyen LH, Drew DA, Graham MS, Joshi AD, Guo CG, Ma W, et al. Risk of COVID-19 among front-line health-care workers and the general community: a prospective cohort study. Lancet Pub Health 2020a;5(9):e475–83.

28. Nguyen LH, Drew DA, Joshi AD, Guo C-G, Ma W, Mehta RS, et al. Risk of COVID-19 among frontline healthcare workers and the general community: a prospective cohort study. medRxiv 2020b;5(9):E475–83.
29. Qin C, Zhou L, Hu Z, Zhang S, Yang S, Tao Y, et al. Dysregulation of immune response in patients with coronavirus 2019 (COVID-19) in Wuhan, China. Clin Infect Dis 2020;71(15):762–8.
30. Ran L, Chen X, Wang Y, Wu W, Zhang L, Tan X. Risk factors of healthcare workers with corona virus disease 2019: a retrospective cohort study in a designated hospital of Wuhan in China. Clin Infect Dis 2020;71(16)2218–21, doi:http://dx. doi.org/10.1093/cid/ciaa287 PMID: 32179890; PMCID: PMC7184482.
31. Reusken CB, Buiting A, Bleeker-Rovers C, Diederen B, Hooiveld M, Friesema I, et al. Rapid assessment of regional SARS-CoV-2 community transmission through a convenience sample of healthcare workers, the Netherlands, March 2020. Euro Surveill 2020;25(12)2000334, doi:http://dx.doi.org/10.2807/1560-7917. ES.2020.25.12.2000334 PMID: 32234115; PMCID: PMC7118342.
32. Rivera-Izquierdo M, Valero-Ubierna MDC, Martínez-Diz S, Fernández-García MÁ, Martín-Romero DT, Maldonado-Rodríguez F, et al. Clinical factors, preventive behaviours and temporal outcomes associated with COVID-19 infection in health professionals at a Spanish hospital. Int J Environ Res Public Health 2020;17(12):1–13.
33. Ruan Q, Yang K, Wang W, Jiang L, Song J. Clinical predictors of mortality due to COVID-19 based on an analysis of data of 150 patients from Wuhan, China. Intensive Care Med 2020;46(5)846–8, doi:http://dx.doi.org/10.1007/s00134- 020-05991-x [Internet].
34. Sanyaolu A, Okorie C, Marinkovic A, Patidar R, Younis K, Desai P, et al. Comorbidity and its impact on patients with COVID-19. SN Compr Clin Med 2020;2(8):1069–76.
35. Schwierzeck V, König JC, Kühn J, Mellmann A, Correa-Martínez CL, Omran H, et al. First reported nosocomial outbreak of severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) in a pediatric dialysis unit. Clin Infect Dis 2020 (April), doi:http://dx.doi.org/10.1093/cid/ciaa491 ciaa491, Epub ahead of print. PMID: 32337584; PMCID: PMC7197625.
36. Shah D. HWE-phenomenon. Indian J Occup Environ Med 2009;13(2):77–9, doi: http://dx.doi.org/10.4103/0019-5278.55123.
37. Shalhoub S, Al-Hameed F, Mandourah Y, Balkhy HH, Al-Omari A, al Mekhlafi GA, et al. Critically ill healthcare workers with the middle east respiratory syndrome (MERS): a multicenter study. PLoS One 2018;13(11):1–12.
38. Shamseer L, Moher D, Clarke M, Ghersi D, Liberati A, Petticrew M, et al. Preferred reporting items for systematic review and meta-analysis protocols (PRISMA-P) 2015: elaboration and explanation. BMJ 2015;350:g7647, doi:http://dx.doi.org/ 10.1136/bmj.g7647 Erratum in: BMJ. 2016 Jul 21;354:i4086. PMID: 25555855.
39. Sun P, Qie S, Liu Z, Ren J, Li K, Xi J. Clinical characteristics of hospitalized patients with SARS-CoV-2 infection: a single arm meta-analysis. J Med Virol 2020;92 (6):612–7.
40. Tostmann A, Bradley J, Bousema T, Yiek W-K, Holwerda M, Bleeker-Rovers C, et al. Strong associations and moderate predictive value of early symptoms for SARS- CoV-2 test positivity among healthcare workers, the Netherlands,

March 2020. Euro Surveill. 2020;25(16)2000508, doi:http://dx.doi.org/10.2807/1560-7917. ES.2020.25.16.2000508 PMID: 32347200; PMCID: PMC7189649.
41. Wang D, Hu B, Hu C, Zhu F, Liu X, Zhang J, et al. Clinical characteristics of 138 hospitalized patients with 2019 novel coronavirus-infected pneumonia in Wuhan, China. JAMA 2020;323(11):1061–9.
42. Wei X-S, Wang X-R, Zhang J-C, Yang W-B, Ma W-L, Yang B-H, et al. A cluster of health care workers with COVID-19 pneumonia caused by SARS-CoV-2. J Microbiol Immunol Infect 2020;(April), doi:http://dx.doi.org/10.1016/j.jmii.2020.04.013
43. S1684-1182(20)30107-9 Epub ahead of print. PMID: 32359943; PMCID: PMC7185000.
44. WHO. Summary of Probable SARS Cases with Onset of Illness from 1 November 2002 to 31 July 2003. [Internet] Available from:. Geneva: World Health Organization;2015.
45. Xiao J, Fang M, Chen Q, He B. SARS, MERS and COVID-19 among healthcare workers: a narrative review. J Infect Public Health 2020;13(6)843–8, doi:http://dx.doi. org/10.1016/j.jiph.2020.05.019 Epub 2020 May 27. PMID: 32493671; PMCID: PMC7250777.
46. Xing Y, Mo P, Xiao Y, Zhao O, Zhang Y, Wang F. Post-discharge surveillance and positive virus detection in two medical staff recovered from coronavirus disease 2019 (COVID-19), China, January to February 2020. Euro Surveill 2020;25(March (10)). . [Internet] Available from: https://www.eurosurveillance.org/content/ 10.2807/1560-7917.ES.2020.25.10.2000191.
47. Zhan M, et al. Death from Covid-19 of 23 health care workers in China. N Engl J Med 2020;382(23):2267–8, doi:http://dx.doi.org/10.1056/NEJMc2005696.
48. Zhang Y. The epidemiological characteristics of an outbreak of 2019 novel coronavirus diseases (COVID-19)-China, 2020. CCDC Weekly 2020;41 (2):113–22.
49. Zheng L, Wang X, Zhou C, Liu Q, Li S, Sun Q, et al. Analysis of the infection status of the health care workers in Wuhan during the COVID-19 outbreak: a cross- sectional study. Clin Infect Dis 2020;71(16)2109–13, doi:http://dx.doi.org/ 10.1093/cid/ciaa588 PMID: 32409825; PMCID: PMC7239233

Tables and figures

FIGURE 1 Flowchart: Selection of the studies

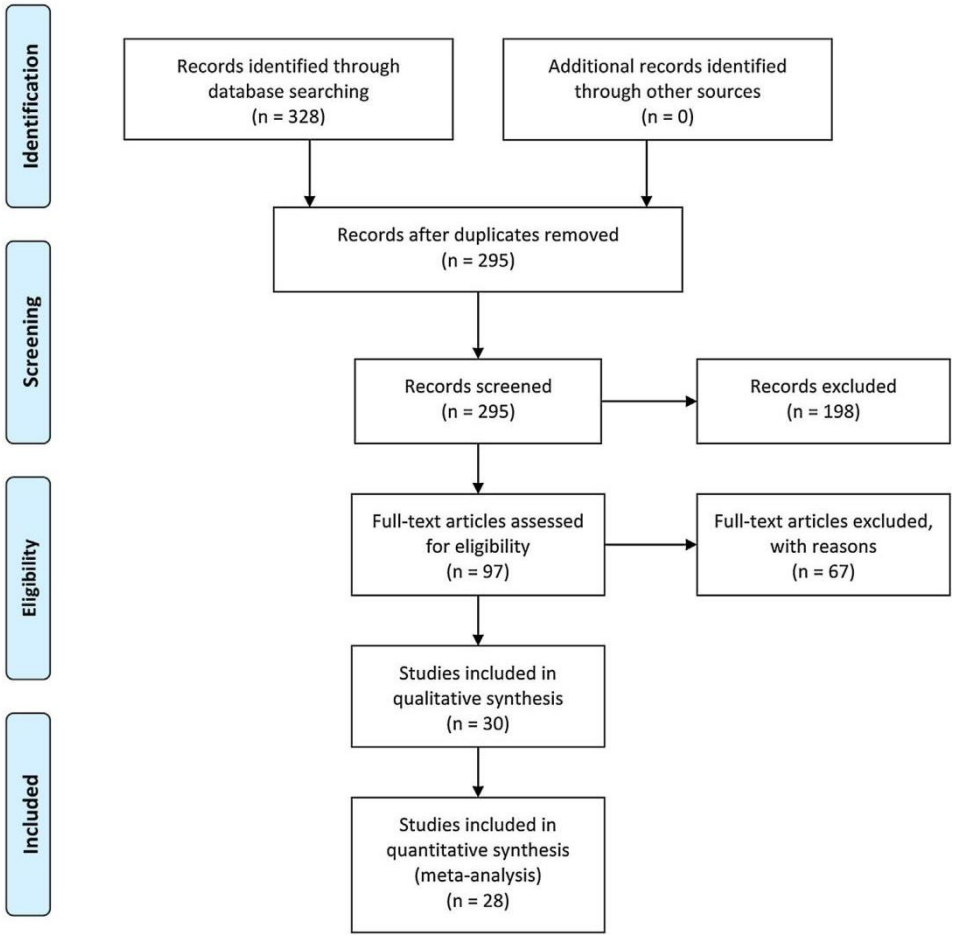
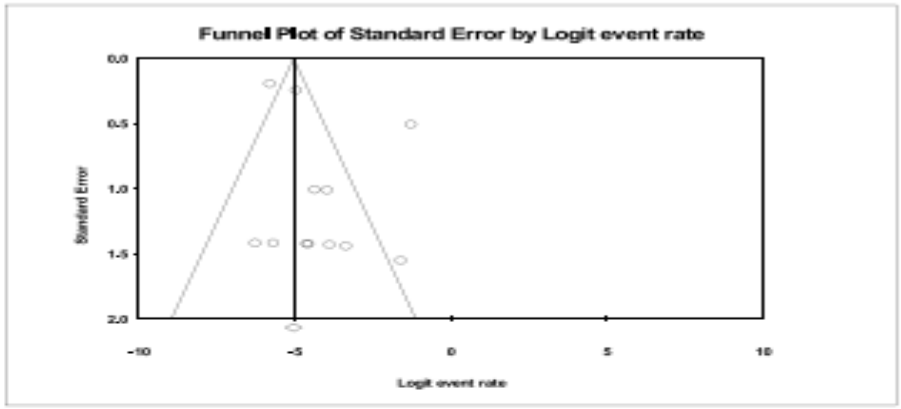


Table 1: Summary of characteristics of articles included in the study

No.	Author	Journal	Date (MM/YY)	Country	Study type	N (total population)	N HCW with COVID-19	Quality score	Reference
1	Zhan et al.	N Engl J Med	02/20	China	Cross-	23	23	8	Zhan (2020)
2	Chu et al.	J Med Virol	03/20	China	Retrospective cohort	54	38	10	Chu (2020)
3	Xing et al.	Euro Surveill	03/20	China	Case series	2	2	8	Xing et al. (2020)
4	Marjolein et al.	JAMA Netw Open	03/20	Netherlands	Cross-sectional	1353	86	8	Marjolein (2020)
5	Zheng et al.	Clin Infect Dis	03/20	China	Cross-sectional	2457	2457	8	Zheng et al. (2020)
6	Li YK et al.	Curr Med Sci	03/20	China	Retrospective cohort	148	12	10	Li et al. (2020)
7	Reusken et al.	Euro Surveill	03/20	Netherlands	Cross-sectional	1097	45	10	Reusken et al. (2020)
8	Ran et al.	Clin Infect Dis	03/20	China	Retrospective cohort	72	28	11	Ran et al. (2020)
9	McMichael	N Engl J Med	03/20	USA	Retrospective cohort	50	50	9	McMichael (2020)
10	Sun et al.	J Infect	03/20	China	Cross-sectional	32	32	7	Sun et al. (2020)
11	Burrer et al.	MMWR Morb Mortal Wkly Rep	04/20	USA	Cross-sectional	8945	8495	10	Burrer (2020)
12	Wei et al.	J Microbiol Immunol Infect	04/20	China	Prospective Cohort	14	12	10	Wei et al. (2020)
13	Kimball et al.	MMWR Morb Mortal Wkly Rep	04/20	USA	Cross-sectional	–	1	9	Kimball et al. (2020)
14	Wang et al.	J Hosp Infect	04/20	China	Cross-sectional	80	80	8	Wang et al. (2020)
15	Schwierzeck	Dtsch Arztebl Int	04/20	Germany	Cross-sectional	957	52	9	Schwierzeck et al.

16	Canova et al.	Swiss Med Wkly	04/20	Switzerland	Cross-sectional	21	0	8	Canova et al. (2020)
17	Tostmann et al.	Euro Surveill	04/20	Netherlands	Cross-sectional	803	90	9	Tostmann et al.
18	Heinzerling	MMWR Morb Mortal Wkly Rep	04/20	USA	Cross-sectional	43	43	8	Heinzerling et al.
19	Breazzano et al.	J Clin Invest	04/20	USA	Cross-sectional	264	101	9	Breazzano et al.
20	Nguyen et al.	Lancet Public Health	05/20	USA	Prospective	99,795	1922	11	Nguyen et al. (2020b)
21	Lai et al.	JAMA Netw Open	05/20	China	Case-series	110	110	9	Lai et al. (2020)
22	Chow et al.	JAMA Netw Open	05/20	USA	Cross-sectional	48	48	8	Chow et al. (2020)
23	Korth et al.	J Clin Virol	05/20	Germany	Cross-sectional	316	5	9	Korth et al. (2020)
24	Felice et al.	J Community Health	05/20	Italy	Cross-sectional	388	18	9	Felice et al. (2020)
25	Jin et al.	Mil Med Res	05/20	China	Cross-sectional	103	84	8	Jin et al. (2020)
26	Cabas et al.	Res Social Adm Pharm	05/20	Italy	Cross-sectional	1632	15	9	Cabas et al. (2021)
27	Chen et al.	J Infect	05/20	China	Prospective	105	18	11	Chen et al. (2020)
28	Garzaro et al.	Med Lav	05/20	Italy	Cross-sectional	830	80	9	Garzaro et al. (2020)
29	Guo et al.	J Bone Joint Surg Am	05/20	China	Cross-sectional	24	24	10	Guo et al. (2020)
30	Rivera-Izquierdo et al.	Int J Environ Res Public Health	06/20	Spain	Prospective cohort	76	76	11	Rivera-Izquierdo et al. (2020)

A.



B.

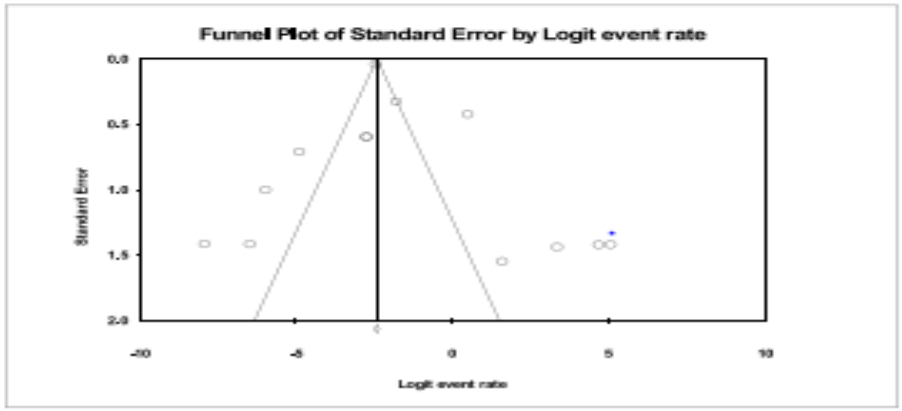


Figure 2. (A) Funnel plot showing death among healthcare workers. The standard errors are well distributed showing minimal bias. (B) Funnel plot showing hospitalisation among HCW with COVID-19. The standard errors are widely distributed and demonstrates more potential bias.