

Safety of Healthcare Workers at the Commencement of COVID-19: A Systematic Review

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Abstract

Background: Infection prevention, control, and health workers' safety in the face of biological agents are among the vital issues in healthcare systems worldwide. Considering the high prevalence of COVID-19 infection and its high mortality rate, this epidemic can be tackled to some extent through infection control in the general population and promoting the safety of health centers.

Objectives: The aim of this study was to scrutinize the literature regarding measures adopted for infection control and safety of healthcare workers in health centers during the beginning of COVID-19.

Methods: A systematic review following the PRISMA guidelines was performed. Keywords related to the study namely, "prevention and control", "safety", "coronavirus", "COVID-19", and "health personnel" in PubMed, Web of Science, ScienceDirect, Scopus databases, and Google Scholar using AND/OR functions from February 2020 to July 2020 were searched. To select the documents, the titles of the retrieved studies were first evaluated for relevance; then, the abstracts and full texts of the papers with relevant titles were inspected.

Results: Out of 136 retrieved studies, 10 were relevant and their data were analyzed. Four articles highlighted the importance of prevention, three enunciated the importance of control, and three related to care providers' safety. The results showed that the COVID-19 epidemic has affected the healthcare providers' health; however, it is possible to prevent a catastrophe through strategic planning, prevention, and control measures.

Conclusion: Considering the importance of healthcare workers' health, it is necessary to implement COVID-19 prevention and control management principles based on scientific evidence.

Keywords: Delivery of Healthcare, Safety, Coronavirus, COVID-19, Health Personnel, Health Services

1. Background

An outbreak of a new virus (SARS-CoV-2) started in Wuhan, China in December 2019 and spread to the rest of the world very quickly. The new coronavirus, which belongs to the betacoronavirus family, caused COVID-19 characterized by fever, coughs, and shortness of breath.¹ The spread of the coronavirus in China followed by its global spread has affected health systems, economy, and human societies across the world.² Although many people in different professions are exposed to coronavirus, healthcare workers who care for COVID-19 patients are at higher risk of infection due to their close contact with the patients.³

The World Health Organization (WHO) has recommended that healthcare workers adopt certain control and prevention measures to minimize the risk of infection transmission; however, many of them have been infected

with COVID-19,⁴ which is due to a shortage of personal protection equipment and lack of training for infection prevention and control.¹ Moreover, it has been reported that nurses were infected with COVID-19 through respiratory droplets produced by coughs despite using protective equipment.² The situation even becomes worse with coinfection of COVID-19 with other infections and lack of respiratory symptoms in many patients at the time of referring to health centers.⁵ Furthermore, lack of personal protection equipment, high workload, ineffective infection control systems, and even direct verbal insults from patients like using offensive words or coughing deliberately on them, which may be due to high levels of stress, economic pressure, and the critical situation of the society, have increased the vulnerability of the healthcare providers. Therefore, it is necessary to provide extra support for healthcare personnel.⁶

While there is a high level of agreement amongst key agencies that masks and respirators play a role in the protection of health workers, there are currently discrepancies between these agencies regarding how and when they should be used. The WHO, the Centers for Disease Control and Prevention (CDC) and other leading health organizations have different recommendations for the selection of respiratory protection. For example, the WHO recommends using masks to protect health workers from COVID-19 during routine care and respirators during aerosol-generating procedures.⁶ In contrast, CDC⁷ and the European Center for Disease Prevention and Control (ECDC) recommend using respirators during both routine care of COVID-19 patients and high-risk situations.⁸ Evidence suggests that infections cannot neatly be separated into the dichotomy of droplet versus airborne transmission routes. Several studies of Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2) support aerosol transmission, and one study documented the virus at a distance of four meters from the patient. Out of 10 studies on horizontal droplet distance, eight showed droplets travel more than two meters, in some cases up to eight meters. Available

studies also show that SARS-CoV-2 can be detected in the air, and remain viable three hours after aerosolization. Therefore, the evidence supports airborne precautions for the occupational health and safety of health workers treating patients with COVID-19.⁹

2. Objectives

The objective of this study was to conduct a comprehensive review of the safety measures for healthcare workers during the development period of COVID-19. This review aims to identify and evaluate different preventive measures and management plans to effectively achieve infection prevention and control in health centers, considering the lack of definitive treatment for the disease and the risks of disease transmission.

3. Methods

This systematic review was guided by the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) statement on systematic reviews, and the steps involved are shown in a PRISMA flow diagram (Figure 1).^{9,10}

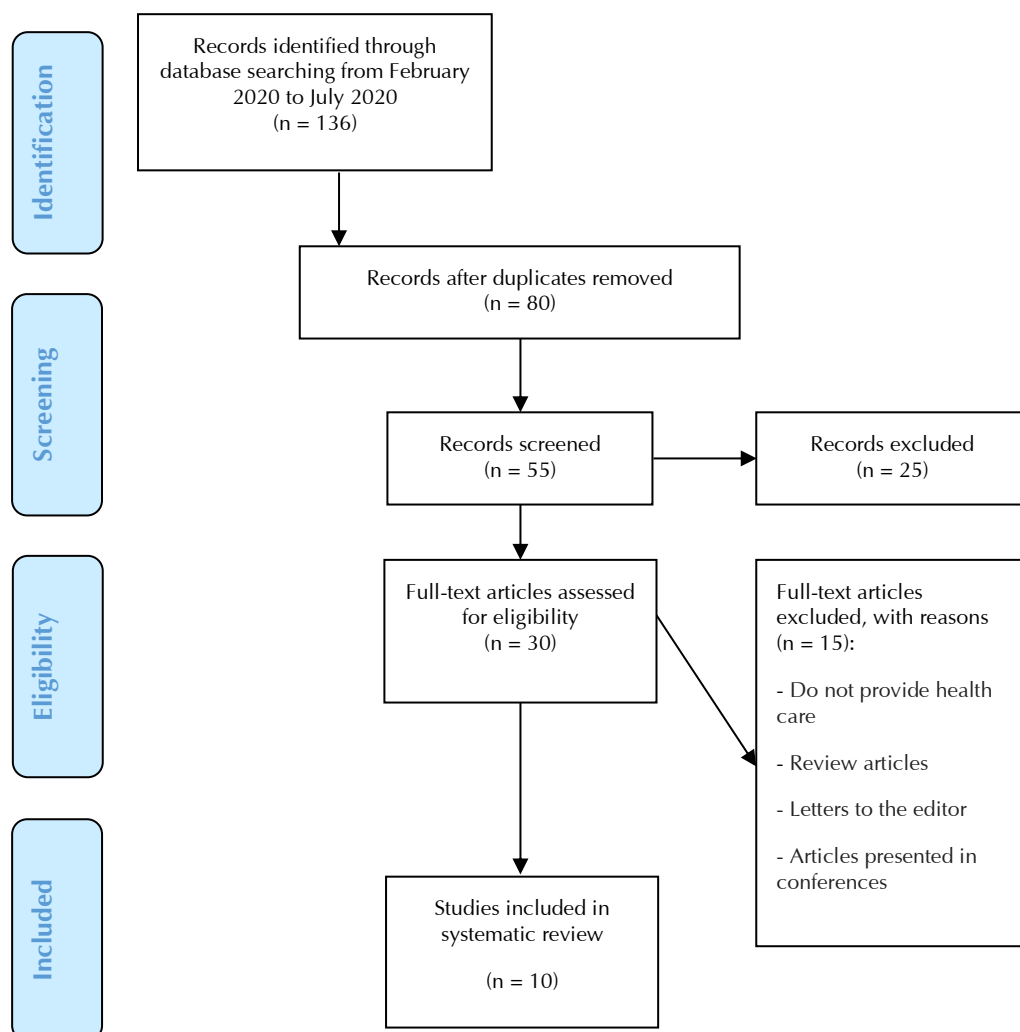


Figure 1. Flowchart for Study Selection Process based on PRISMA Statement.

3.1. Data Sources and Search Strategy

Databases were systematically searched about COVID-19 prevention, control, and healthcare workers' safety from February 2020 to July 2020 based on the objective of the study. We searched keywords related to the study namely, "prevention and control", "safety", "coronavirus", "COVID-19", and "health personnel" in PubMed, Web of Science, ScienceDirect, Scopus databases, and Google Scholar using AND/OR functions. Subsequently, we collected all articles relevant to the control and safety of health

workers and collected their full texts. Then, the full texts of the papers (excluding the authors' names to prevent any bias) were presented to two researchers who were experts in review studies. Both researchers independently reviewed each article and stated their reasons for accepting or rejecting the paper. Any disagreement was resolved through consultation with a third reviewer.

3.2. Inclusion and Exclusion Criteria

The inclusion criteria included all research published in

Table 1. Characteristics of the Studies Included in the Analysis

Study	Setting	Quality assessment	Focus	Healthcare workers	Outcomes
J. Tao (2020)	China	Moderate	Prevention	Dermatology departments	Although their hospital is in an infected center, no infected patients have been detected in their departments, owing to heightened surveillance.
Xiuqing Ma (2020)	West China Hospital, Wenjiang Hospital	High	Prevention	All departments and personnel	The control of epidemic prevention in the subdivision area was effective and effective emergency plans should be formulated from the very beginning. Safety control measures should be taken decisively. Only in this way can the infection be controlled to the minimum.
Yang CJ (2020)	Kaohsiung Municipal Ta-Tung hospital (KMTTH) in Kaohsiung, Taiwan	High	Prevention	All hospital staffs, included doctors, nurses, pharmacists, radiologists, cleaners etc.	Community hospitals play an important role in the health system in Taiwan, which provide the basic medical needs for general population with limited human and equipment resources compared to medical centers.
WHO (2020)	Worldwide	Moderate	Prevention	Healthcare workers, health care managers	Infection prevention and control during healthcare for probable cases of Middle East respiratory syndrome.
Kilic AU (2020)	An operation center in Ankara within the General Directorate of Public Health.		Control	Healthcare workers	Many factors may be contributed to the emergence and spread of previous outbreaks.
Zixing Huang (2020)	People suspected or confirmed to be infected with COVID-19	High	Control	Radiology department	Strategic planning and adequate protections can help protect patients and staff against a highly infectious disease while maintaining function at a high-volume capacity.
Bloomer MJ (2020)	Australian survey	High	Control	Nurses working in the intensive care unit	ICU nurses play a key role in managing end-of-life care. This not only includes ongoing clinical care for the dying patient, but caring for and supporting families
Anup Agarwal (2020)	An evidence-based plan according to the needs and infrastructure	High	Safety	Infectious disease department, engineering and nursing department, and departments of microbiology and virology	High-quality clinical care not only helps in limiting the loss of lives from the onslaught of the contagions, but also interrupts the transmission by excluding the infective patients from the general population.
Dabholkar YG (2020)	a cross-sectional hospital-based survey	High	Safety	40 healthcare workers	When infected, healthcare workers need to be taken out of work force to prevent infection to colleagues and patients, which puts a severe strain on their teams.
Chekol W (2020)	A systematic review	Moderate	Safety	All personnel working in the operating room	All healthcare personnel should wear personal protective equipment based on the class of patients during surgery. Elective procedures should be postponed to save and mobilize resources for the protection and management of the pandemic disease.

English and Persian that addressed the prevention, control, and health workers' safety from February 2020 to July 2020. Studies that did not provide healthcare and only

examined mortality and damage from emergencies were excluded. Furthermore, review articles, protocols, comments, letters to the editor and articles presented at conferences

(conference summary) were excluded from the study.

3.3. Study Selection

Two reviewers independently searched the databases systematically to identify relevant articles. Relevant results were entered into a reference management tool (Endnote) and duplicates were removed. Eligibility screening of articles was done independently by the reviewers. Additionally, articles that met the inclusion criteria were screened for further eligible studies. Conference abstracts as well as those where full text was not available were removed. Two reviewers compared studies for inclusion and exclusion. A third reviewer resolved discrepancies in decision-making. No language restrictions were applied to the search; however, all search results were written in English.

Overall, after an initial abstract and title screening by two independent reviewers, 55 articles were deemed relevant and eligible out of 136. All 55 full-text articles were subjected to the inclusion and exclusion criteria.

4. Results

To identify and evaluate different preventive measures and management plans to effectively achieve infection prevention and control in health centers, prevention, and control strategies are reported at three levels. These include case isolation, identification, and follow-up of contacts, environmental disinfection, and use of personal protective equipment.¹¹ Four of the articles highlighted the importance of prevention,^{8,12-14} three enunciated the importance of control,¹⁵⁻¹⁷ and three of them were related to care providers' safety¹⁸⁻²⁰ (Table 1).

Epidemic diseases after the initial outbreak in hospitals may lead to outbreaks among patients and healthcare workers. It may even spread to the local community if visitors become infected, leading to increased patient mortality and medical costs in the community which could be prevented by protection measures.²¹

The study by Tao et al. aimed to highlight the need for protective measures and recommend proper emergency management programs to prevent and control nosocomial infections (COVID-19) in China. They realized that at the Union Hospital, the amount of knowledge and information among healthcare providers about protective equipment in various medical departments, including dermatology, was very low. Therefore, management protocols were set up to prevent and control the disease, including the establishment of multilayer triage from the entrance of the hospital to the entrance of the wards. In addition, measures were taken for dermatologists and hair specialists to work with nurses at dermatology triage stations to evaluate patients if necessary. Moreover, the use of online counseling for patients with mild and non-emergency symptoms to prevent unnecessary referrals

was prescribed.⁸

The second prevention study was conducted in Wenjiang Hospital in China to ensure the effective implementation of new coronavirus prevention and control measures. A three-layer control and prevention system was implemented: (A) prevention and primary control at the main entrance of the hospital, (B) monitoring and evaluation at the emergency entrance and (C) supervision at the entrance of each ward. At each entrance, professional nurses and security staff were responsible for closely monitoring the temperature, biographies of possible sources of the virus, identifying staff, and recording staff at the entry and exit. In other words, at each entrance, suspicious patients were carefully examined and in case of infection, the necessary isolation and treatment measures were performed. In addition, each unit was inspected at least three times a week for the effectiveness of the protective measures of different employees in the workplace.¹²

In the same vein, the study by Chin et al. in Taiwan stressed the need for protection and preventive measures for healthcare workers during COVID-19 pandemic. During this period, healthcare workers demanded to receive more equipment, which means that it is important to protect healthcare workers. This is because of the fact that healthcare providers interact closely with vulnerable patients which may lead to anxiety and a lack of willingness to work. The results of the study showed that psychological support of health care providers, availability of equipment, facilities to break the community-hospital infection cycle, and use of public health standards are of great importance.¹³

The study by Muh et al., which examined the consequences of prevention and control concluded that protecting healthcare providers from patients in hospitals should be of prime importance. This is because many patients have unusual manifestations of the disease or are waiting for a definite diagnosis, which can be dangerous for healthcare providers. Therefore, the use of disinfectants and protection equipment to control the transfer cycle of the disease in hospitals is very important.¹⁴ In a nutshell, they highlight three urgent actions: distribution of Infection Prevention and Control (IPC) policies and guidelines to all health facilities, manufacturing and distribution of IPC supplies to health facilities, and mass media hand hygiene behavior change campaigns for health workers and the general population.²² To control epidemics, some priorities should be considered such as controlling an epidemic in its early stages, strengthening knowledge about prevention and control, and ensuring full attention to the implementation of prevention and control strategies.²³

In a study by Kilic et al. in Turkey, results showed hand hygiene and proper use of personal protective equipment by healthcare providers are very important. In

so doing, relevant instructions, including the definition of suspected and definite cases and preventive and control measures for the transmission of the disease in all medical centers were immediately developed and notified to healthcare professionals.¹⁵ In the same line, Huang et al.'s study in the radiology department of West Hospital in China revealed that more than 3,000 patients with suspected or definite COVID-19 were referred for imaging procedures in less than 50 days. In the end, none of the radiology staff were infected with the virus following engineering measures (triage and zoning, low-dose chest CT protocol, and standard precautions in radiology). Therefore, strategic planning and adequate protection and control measures can help protect patients and staff against highly infectious diseases while maintaining high performance.¹⁶ The same results were also reported in Melissa et al.'s study of infection control in healthcare providers. They concluded that by providing infection prevention and control measures for emergency care workers, they can take care of the patients as best as they can although the implementation of these guidelines requires a unified approach.¹⁷ Government agencies should quickly incorporate recent scientific findings into public policies at the community, regional, and national levels to slow down and/or prevent the further spread of COVID-19.¹¹ Thus, dealing with COVID-19 and its outbreak requires fully equipped and dedicated health facilities for patient management. Meanwhile, health and environmental care workers must have the necessary safety to provide services to patients.¹¹

Yogesh et al. conducted a cross-sectional and hospital-based survey from April 2020 to June 2020 to examine workplace safety and mental health of healthcare workers. They concluded that healthcare workers who are at the forefront of dealing with Coronavirus disease are at increased risk of developing COVID-19 infections. When contaminated, health workers and patients need to rest to prevent infection, which puts pressure on their health systems. Thus, paying attention to the safety of the mental health workplace is very important for health care providers.²⁴ By the same token, Tongji at Wuhan Hospital in China conducted a study on effective safety management measures in the field of nursing during the COVID-19 disease epidemic. They concluded by formulating solutions for nurses' safety: (A) forming an epidemic leadership team as a responsible system for designing emergency plans, (B) selecting experienced nurses as head nurses in different wards, (C) rotating nursing staff and observing the arrangement and composition of new and old staff inwards, (D) highlighting the role of nurse managers in the front line as a model and instructor to create a sense of responsibility and improve the nurses' morale and (E) providing adequate materials and equipment for nurses at the forefront of exposure to coronavirus.¹⁴ Likewise,

Chekol et al.'s study was designed to assess the safety of operating room staff that is part of the service personnel. They concluded that all healthcare personnel should use personal protective equipment based on the type of patient's surgery. Besides, selective operations should be delayed and emergency procedures like burns, cesarean operation, malignant neoplasia, and traumatic injury should be performed using personal protective equipment.²⁵

To conclude, studies have shown that a highly skilled healthcare workforce is a top priority for communities and healthcare systems. Based on the experience of health care systems in Asia and Europe, the risk of exposure and infection among healthcare workers could be greatly reduced through strict safety guidelines.²⁶ Overall, the results highlight the importance of protective measures, emergency management programs, and strict safety guidelines to prevent and control the spread of infectious diseases, protect healthcare workers, and ensure the safety of patients.

5. Discussion

The COVID-19 manifests with a range of mild to severe symptoms; a major problem is that similar to the common cold, patients with mild symptoms may not seek treatment, which may result in a lack of diagnosis, increased chance of infection, and virus cycle expansion.² On the other hand, virus transmission is possible during the incubation period, which may last up to 14 days.⁸ Tao et al. showed that since the COVID-19 outbreak, the governments have implemented strict prevention and control measures; however, infected patients may still be missed in the asymptomatic incubation period. The study in China showed that 77.5% of the infected health professionals worked in general wards, indicating the high transmissibility of the disease even in general wards. Furthermore, the coinfection of COVID-19 disease with other infections may even intensify the problem.⁵ In the same line, Lotfinejad et al. found that healthcare providers are at the forefront of the fight against coronavirus. The growing rate of coronavirus transmission in hospitals has increased global demand for more effective prevention and control across healthcare settings. Experienced nurses can avoid infections with appropriate hand hygiene compliance and the use of protective equipment. However, it is crucial to have adequate numbers of nursing staff and access to protective equipment to ensure the safety and quality of care.^{2,27} To this end, experienced nurses can prevent infection by maintaining proper hygiene and using protective equipment. To ensure the safety and quality of care, it is essential to have a sufficient number of nursing staff and access to equipment.^{1,13} In the study by Liu, they also mentioned that one of the most important challenges in responding to the coronavirus is human resource management and personal protective equipment.²⁷

A key step in controlling the coronavirus is hand washing, which has been repeatedly recommended by the WHO. The WHO has also advised health workers to cover their noses and mouths with a cloth or elbow when coughing or sneezing, and to provide masks for patients with suspected infections.¹ The CDC and the WHO have also published lessons from China that protect healthcare providers and the proper use of masks according to protocols to protect healthcare providers from the coronavirus.²⁸ Intriguingly, a study by Gibson et al. in the United States found that the pre-hospital emergency staff received no benefits in connection with COVID-19 disease. More importantly, 60% of mission staff do emergency work without an N95 mask, and 18% use only one N95 mask for a week or more on emergency missions. However, according to the WHO, it is important to maintain appropriate preventive measures not only when caring for patients but also in close contact with colleagues. The results of the study illustrated that the United States, as a leading country in the field of Emergency Medical Services (EMS), is facing a serious problem and crisis. At present, treating coronavirus patients in the emergency centers is in accordance with the instructions of the CDC.^{3,29}

Another important issue that should be mentioned is the use of experienced trained staff in COVID-19 to form a team to develop disease prevention and control programs, integrate processes, and continually improve management principles in disease prevention and control based on scientific evidence. Based on Huang et al.'s study, this group should provide a daily report on the updated status of suspected and definitively infected patients and analyze their condition and inform the specialists in the intensive care unit and radiology to assess whether the patient needs further examination and treatment. These medical communications can be web-based. Moreover, isolation, reporting and transfer of suspected patients should be done following policies and processes to control local infection and involve the general public. The above measures of the management group will stabilize the order in the wards and greatly reduce the duration of exposure to the patient and the risk of infection.^{8,16} The main difference in masks and respirators is their intended use. Masks were originally designed to prevent the spread of infections from wearers to other people around them, referred to as "source control". Masks are also used to protect from infections transmitted through the droplet mode and splashes or sprays of blood or body fluids. In contrast to this, respirators are designed for respiratory protection. A medical or surgical mask may be enough to prevent droplet transfer, while a respirator is required for airborne infection.³⁰

Finally, the study conducted by Belingheri et al. concluded that there is no recommendation and protective

equipment for personal protective equipment for people in unhygienic environments. Nevertheless, to prevent the spread of droplets, they should use masks, observe social distancing, clean and disinfect dirty surfaces, and prevent overcrowding at work.²³

In the case of serious emerging infections, like COVID-19, the precautionary principle should be used for frontline health workers and a properly fitted respirator should be used. If respirators are not available, masks should be used. Extended use and reuse are high-risk practices and may lead to self-contamination to the wearer and should be avoided. In case of shortage, extended use should be balanced against the risk of infections and the wearer should not remove masks between patient encounters. There should be a uniform policy around the use of personal protective equipment to avoid confusion which places occupational health and safety of health workers as a high priority.²⁷

The findings emphasize the need for governments and healthcare institutions to develop and implement evidence-based policies and protocols for infection prevention and control. Future research should focus on evaluating the effectiveness of preventive measures and safety protocols, exploring innovative approaches to protect healthcare workers, and identifying strategies to improve overall pandemic response in healthcare settings. It is important to consider the limitations of the evidence, such as the specific context of the studies and the potential biases or limitations in the data collection methods. The findings may not be directly applicable to all healthcare settings or regions, and local factors should be considered when implementing preventive measures and safety protocols.

6. Conclusion

In conclusion, the results from these studies reinforce the importance of preventive measures, safety protocols, and adequate support for healthcare workers in the fight against COVID-19. These findings have implications for practice, policy, and future research, highlighting the need for effective collaboration, evidence-based policies, and ongoing research to improve infection prevention and control in healthcare settings.

Personal protective equipment for healthcare workers will improve services and improve the quality of staff care for patients. Thus, prominent protective measures and appropriate emergency management plans are recommended to prevent and control infection and the safety of healthcare workers.

It should be noted that most of the current studies investigated the prevention and emergency control of hospital pediatrics and the evaluation of patients with COVID-19 in the radiology department and unsanitary environments. Therefore, future studies should inclusively focus on the safety of healthcare providers in a hospital environment.

Research Highlights

What Is Already Known?

- Healthcare workers who care for COVID-19 patients are at higher risk of infection due to their close contact with the patients.
- It is necessary to provide extra support for healthcare personnel.
- Health organizations have different recommendations for the selection of respiratory protection

What Does This Study Add?

- The studies highlight the importance of implementing and adhering to preventive measures and safety protocols such as hand hygiene, proper use of masks, and appropriate use of Personal Protective Equipment (PPE) to protect healthcare workers from infection.
- The studies underscore the importance of ensuring the safety and well-being of healthcare workers who are at the forefront of the fight against COVID-19.
- It is crucial to provide an adequate number of healthcare staff, access to appropriate PPE, and training on infection prevention and control to protect healthcare workers and provide quality care.
- The mental health and well-being of healthcare workers also need to be prioritized, as they face increased stress and risk of infection during the pandemic.
- A multidisciplinary approach involving medical, nursing, and support staff is crucial for effective prevention and control of the disease.

Author Contributions

MHE and FBS contributed to designing the study, data collection, interpreting the results, and writing the manuscript. MR contributed to providing intellectual feedback and reviewing, editing, and finalizing the original draft. All authors read and confirmed the final draft.

Conflict of Interest Disclosures

All authors declared that they have no conflict of interest.

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