


Risk Factors Associated with COVID-19 Infected Healthcare Workers in Muscat Governorate, Oman

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Abstract

Introduction: Coronavirus disease 2019 (COVID-19) has spread rapidly worldwide, causing a global public health crisis. Healthcare workers (HCWs) are vulnerable due to their role in the management of COVID-19 infected patients. As of June 2020, a total of 847 HCWs in Oman had reportedly contracted COVID-19, with an incidence rate of 1.47%. This study therefore aimed to identify factors associated with COVID-19 infection among HCWs in Muscat Governorate, Oman, as well as to evaluate adherence to infection prevention and control (IPC) measures. **Methods:** This cross-sectional study involved cases of laboratory-confirmed COVID-19 infection among HCWs working under the Directorate General of Health Services of Muscat Governorate, Ministry of Health, between February and June 2020. Data regarding the participants' sociodemographic characteristics, risk factors, pre-existing medical conditions, and adherence to IPC measures were collected using a self-administered questionnaire distributed via a web-based mobile application. **Results:** A total of 126 HCWs with confirmed COVID-19 infection participated in the study. Of these, 72.2% were female, 53.2% worked in primary care facilities, and 61.1% were medical doctors or nurses. Only 18.1% were over 45 years of age and 30.2% had pre-existing medical conditions. While 29.4% had never received IPC training, the majority followed recommended hand hygiene practice (96.8%) and social distancing protocols (93.7%) and wore protective facemasks for routine patient care (96.9%). **Conclusion:** While the majority of HCWs followed crucial IPC measures, one-third had never received specific IPC training or faced restrictions on PPE use. HCWs, including those in housekeeping and administrative functions are recommended to undergo rigorous IPC training. In addition, high-risk HCWs could be assigned duties away from active COVID 19 cases. It is recommended to restructure health facilities for better adherence to IPC standards.

Keywords

healthcare workers, COVID-19, occupational risk, infection control and prevention, risk factors, adherence, Oman

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Introduction

Coronavirus disease 2019 (COVID-19) is an infectious disease caused by the severe acute respiratory syndrome (SARS) coronavirus 2 (CoV-2). It was first identified in December 2019 in Wuhan, China, and has since spread across the globe. As of the end of June 2020, around 10 185 374 cases had been reported worldwide, resulting in more than 503 862 deaths.¹ In Oman, the virus affected 40 070 people during the same period, with 23 425 recoveries and 176 deaths.² Common symptoms of COVID-19 infection include a fever, dry cough, shortness of breath, and pneumonia of varying severity with related complications.³

The incubation period of the SARS-CoV-2 virus is estimated to be 2 to 14 days, with symptoms usually appearing

within this period. Transmission occurs either via direct contact, airborne aerosol or by inhaling respiratory droplets from infected patients.² Data from China indicate that approximately 85% of cases of human-to-human transmission occur within family groups.⁴ In many instances, infected

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individuals act as asymptomatic carriers, as they do not show signs or symptoms.² As a result, the most critical measures for infection protection and control (IPC) are hand hygiene and social distancing.

Moreover, CDC recommends using additional infection prevention and control practices during the COVID-19 pandemic, along with standard practices recommended as a part of routine healthcare delivery to all patients. These practices are intended to apply to all patients, not just those with suspected or confirmed SARS-CoV-2 infection. These practices include but not limited to implementation of universal source control measures for everyone in a healthcare facility which include well-fitting cloth masks or facemasks to cover a person's mouth and nose all the time even in breakrooms.⁵

In addition, CDC recommend implementation of telehealth and nurse-directed triage protocols to determine if an appointment is necessary or if the patient can be managed from home. In health care facility, screening and triaging everyone entering a healthcare facility including HCWs for signs and symptoms of COVID-19 is mandatory.⁵

Healthcare workers (HCWs) are at the forefront of COVID-19 management. Unfortunately, due to their increased exposure to highly contagious patients, along with the relative novelty of the virus and the unpreparedness of the healthcare system to deal with the sudden influx of cases, HCWs represent a vulnerable target for infection. According to a previous report by the World Health Organization (WHO), 20% of those affected during the 2002 SARS outbreak were HCWs.⁶ The impact of this on the healthcare system is doubly concerning, given that health facilities are already overburdened by high numbers of patients, with infection among HCWs further aggravating the existing shortage of staff working to curb the spread of disease.

Worldwide, it is clear that HCWs are being increasingly infected. Reports from Italy, one of the top 5 countries affected by COVID-19 globally, indicate that 20% of all HCWs dealing with COVID-19 patients were themselves infected.⁷ In Spain, 9400 HCWs had been infected by March 2020, representing nearly 15% of all cases.⁸ In the state of Ohio in the USA, 18% of HCWs were reported to have been infected.⁸ According to the Ministry of Health, the total number of HCWs in government and private institutions in Oman was 57340 in 2019.⁹ By the end of June 2020, 847 had contracted COVID-19, resulting in an incidence of 1.47%.¹⁰ In Muscat Governorate, one of 11 governorates in Oman comprising the capital city and surrounding region, 144 (2.8%) of 5097 HCWs working under the Directorate General of Health Services (DGHS) in Muscat Governorate were infected by June 2020.¹¹

As early as February 2020, researchers worldwide had established that COVID-19 transmission among HCWs was associated with overcrowding, the absence of isolation

room facilities, and environmental contamination; moreover, a lack of personal protective equipment (PPE), exposure to infected patients, work overload, poor IPC practices, and pre-existing medical conditions were identified as risk factors for infection in this group.¹² However, it is not clear whether these factors are associated with infection among HCWs in Oman.

Every country needs to tailor prevention and control programs to their specific national context. For this reason, understanding the risk factors for COVID-19 infection and evaluating adherence to IPC measures among HCWs in Oman is important not only for characterizing virus transmission patterns, but also for preventing the infection of future HCWs and those with whom they come into contact. As such, this study aimed to identify factors associated with infection and adherence to IPC measures among HCWs with confirmed COVID-19 infections in Muscat Governorate.

Methods

This cross-sectional study was carried out in Muscat Governorate under all health care institutions of the DGHS Muscat from February to June 2020. These health institutions included 30 primary healthcare centers, 2 polyclinics (Bawsher and Seeb Polyclinics), and 3 hospitals (Al Nahdha, Al Massarah, and Quriyat Hospitals). The target population of this study was all HCW with laboratory-confirmed COVID-19 infection. As per the central public health laboratory (CPHL), the total number of laboratory-confirmed COVID-19 infected HCW was 144 during the study period. Any person not willing to participate, not answering phone calls (3 calls on 3 different days), or whose identity was not identical to the one in the registry was excluded from the study. Each participant was contacted individually by one of the researchers to confirm their identity and invite them to participate in the study. Subsequently, the questionnaire was distributed to the participants electronically using a web-based mobile application (WhatsApp Messenger, Facebook Inc., Menlo Park, CA, USA).

Data were collected using a self-administered, valid, structured questionnaire with closed-ended questions designed by the WHO to assess potential risk factors for COVID-19 among HCWs.¹³ The questionnaire consisted of 3 main parts, of which the first determined the sociodemographic characteristics of the participants, including age, gender, nationality, place of work, occupation, and date of confirmation of COVID-19 infection. The second part explored risk factors and pre-existing medical conditions, while the third assessed participants' adherence to IPC measures and the availability of personal protective equipment (PPE). An additional open-ended question was included at the end to determine other factors which could increase the risk of COVID-19 infection at the participants'

health institutions. Following minor modifications, the original English-language questionnaire was translated into Arabic by an expert.

Results were presented in percentages and numbers and analyzed using the Statistical Package for the Social Sciences (SPSS), version 20 (IBM Corp., Armonk, NY, USA). A Chi-squared test was used to test associations between categorical variables. A *P*-value of $<.05$ was considered statistically significant. This study was approved by the Regional Research and Ethical Committee of the Ministry of Health in Muscat Governorate. Informed verbal consent was received from the participants following a brief explanation of the aims of the study. All subjects were assured that their participation was voluntary, and that all information would remain confidential. Confirmation of consent was also obtained electronically prior to the administration of the questionnaire.

Results

During the study period, a total of 144 HCWs with laboratory-confirmed COVID-19 were identified; however, 17 could not be reached due to a lack of ($n=6$) or incorrect contact details ($n=6$) or lack of response ($n=5$). In addition, 1 individual did not submit any answers to the electronic questionnaire. Two participants did not answer the occupation question. As such, a total of 126 HCWs were included in the final analysis (response rate: 87.5%). There was a greater number of female (72.2%) and Omani participants (81.0%). Nearly half of the HCWs (44.4%) were 25 to 35 years old and 36.5% were 36 to 45 years old. The majority worked in primary care centers (53.2%), followed by tertiary hospitals (25.4%), and secondary polyclinics (21.4%) (Table 1).

In terms of occupation, most of the participants were nurses (34.9%) followed by medical doctors (26.2%). The remaining HCWs were administrative personnel (10.3%), medical recorders (7.9%), pharmacists (5.6%), laboratory technicians (4.0%), cleaners (4.0%), ambulance drivers (2.4%), dieticians (1.6%), physiotherapists (0.8%), and watchmen (0.8%) (Table 1). Most of the participants reported having had contact with a positive COVID-19 case, either at work (62.7%) or at home (23.8%) (Table 2).

With regards to pre-existing medical conditions and risk factors for COVID-19 infection, 15 (11.9%) and 5 (4.0%) participants reported being obese and having diabetes mellitus, respectively. Asthma and chronic lung disease were reported by 3 (2.4%) and 2 (1.6%) HCWs, respectively. A total of 11 participants (8.7%) were pregnant. Four participants (3.2%) had heart disease, 7 (5.6%) had chronic neurological disease, and 2 (1.6%) had chronic hematological disease. None of the HCWs reported being smokers or having a history of chronic liver or kidney disease, human immunodeficiency virus infection, cancer, or immune deficiency.

Table 1. Sociodemographic Characteristics of the Participants.

Characteristic	n (%)
Gender	
Male	35 (27.8)
Female	91 (72.2)
Age group (years)	
25-35	56 (44.4)
36-45	46 (36.5)
46-55	23 (18.1)
>56	1 (0.8)
Nationality	
Omani	102 (81.0)
Non-Omani	24 (19.0)
Type of healthcare facility	
Primary care	67 (53.2)
Secondary care	27 (21.4)
Tertiary care	32 (25.4)
Occupation	
Medical doctor	33 (26.6)
Nurse staff	44 (34.9)
Administration personnel	13 (10.3)
Medical recorder	10 (7.9)
Pharmacy personnel	7 (5.6)
Laboratory technician	5 (4.0)
Cleaner	5 (4.0)
Ambulance driver	3 (2.4)
Dietitian/health educator	2 (1.6)
Physiotherapist	1 (0.8)
Watchman	1 (0.8)

Table 2. Preexisting Medical Conditions and Risk Factors Associated with COVID-19 Infection.

Risk factors	N (%)
Contact with COVID-19 positive case at work	
Yes	79 (62.7)
No	47 (37.3)
Contact with COVID-19 positive case at home	
Yes	30 (33.8)
No	96 (76.2)
Preexisting medical condition	
Obesity	15 (11.9)
Pregnancy	11 (8.7)
Chronic neurological impairment/ disease	7 (5.5)
Diabetic mellitus	5 (4)
Heart disease	4 (3.1)
Asthma	3 (2.4)
Chronic lung disease	2 (1.6)
Chronic hematological disorders	2 (1.6)
HIV and immunodeficiency	0 (0)
Smoking	0 (0)
Cancer	0 (0)
Chronic kidney disease	0 (0)
Chronic liver disease	0 (0)
Organ or bone marrow recipient	0 (0)

Table 3. Adherence to Infection Prevention and Control Measures among the Participants.

Measure	Frequency, n (%)				
	Never	Rarely	Occasionally	Most of the time	Always
Follow recommended hand hygiene practices	2 (1.6)	1 (0.8)	1 (0.8)	30 (23.8)	92 (73.0)
Use an alcohol-based hand rub or soap and water before touching patients	3 (2.4)	0 (0.0)	4 (3.2)	22 (17.5)	97 (77.0)
Use an alcohol-based hand rub or soap and water after touching patients	2 (1.6)	1 (0.8)	3 (2.4)	10 (7.9)	110 (87.3)
Use an alcohol-based hand rub or soap and water after touching a patient's surrounding	3 (2.4)	0 (0.0)	6 (4.8)	25 (19.8)	92 (73.0)
Follow social distancing protocols	3 (2.4)	0 (0.0)	5 (4.0)	51 (40.5)	67 (53.2)
Wear a protective mask for routine patient care	3 (2.4)	1 (0.8)	0 (0.0)	21 (16.7)	101 (80.2)
Wear PPE when indicated	10 (7.9)	2 (1.6)	0 (0.0)	35 (27.8)	79 (62.7)
Feel confident in making risk assessments to identify the need for PPE	4 (3.2)	0 (0.0)	11 (8.7)	54 (42.9)	57 (45.2)
Availability of PPE in the healthcare facility	4 (3.2)	6 (4.8)	25 (19.8)	50 (39.7)	41 (32.5)
Face restrictions in using PPE	36 (28.6)	26 (20.6)	24 (19.0)	23 (18.3)	17 (13.5)

Abbreviation: PPE, personal protective equipment.

In terms of training, 37 participants (29.4%) claimed that they had never received IPC training in their healthcare institutions, whereas other HCWs reported receiving training at least once (22.2%), twice (11.9%), or 3 or more times (36.5%). Only 55 HCWs (43.7%) had received IPC training during the preceding 6-month period from January to June 2020, whereas 12 (9.5%) had received training in the past year between July and December 2019, and 22 (17.1%) had no memory of their recent IPC training. All the pharmacists, 30.3% of the medical doctors, 23.1% of the administrative clerks, and 13.6% of the nurses had received no IPC training whatsoever.

The level of adherence to specific IPC measures among the HCWs is shown in Table 3. The vast majority (96.8%) followed recommended hand hygiene practices to some extent, with only 2 participants (1.6%) reporting that they never did so. Moreover, the majority either always or mostly used an alcohol-based hand rub or soap and water, both before (94.4%) and after (95.2%) touching patients and after touching their surroundings (92.9%). In addition, most participants always or mostly followed social distancing recommendations (93.7%) and wore protective masks for routine patient care (96.8%). Many HCWs (90.5%) mostly or always used PPE when indicated and 88.1% felt confident in making risk assessments to identify the need for PPE. However, 7.9% and 3.2%, respectively, never used PPE or felt confident in making risk assessments.

There was no statistically significant correlation between the timing of IPC training and level of confidence in making PPE risk assessments ($P > .05$). On the other hand, there was a significant correlation between number of IPC training sessions and level of confidence in risk assessment ($P < .05$). More than half of the participants who had

undergone IPC training at least once reported always being confident in making risk assessments to identify PPE need, with the level of confidence increasing with the number of training sessions; furthermore, among those who reported never being confident in making risk assessments, none had received IPC training. Among those who reported occasional or no confidence in making PPE risk assessments, 61% wore PPE all the time. In contrast, 78.9% of those who always felt confident making such risk assessments always wore PPE when indicated ($P < .05$).

In terms of availability, most HCWs reported that PPE was available either always (32.5%) or most of the time (39.7%) at their specific healthcare institutions. However, 19.8%, 4.8%, and 3.2%, respectively, stated that such equipment was only occasionally, rarely, or never available. Furthermore, 31.7% always or mostly faced restrictions in using PPE in their healthcare institutions. Additionally, 69 participants (54.8%) believed that certain risk factors increased their risk of contracting COVID-19 at their healthcare facility, including the availability of N95 masks, reuse of PPE, restrictions imposed on the use of PPE, and the use of a single facemask per shift. Other factors included the lack of availability of proper isolation rooms, inadequate cleaning and sanitization of surfaces, inadequate disinfection of medical equipment, lack of training and education for cleaners, the inability to maintain social distancing due to the small size of the facility, patient overcrowding, and poor ventilation.

Discussion

Difficulties in increasing the detection and reducing the spread of a highly transmissible and virulent novel respiratory pathogen like the SARS-CoV-2 virus is compounded

by our lack of knowledge of its key epidemiological, clinical, and virological characteristics. According to local data, the incidence rate of COVID-19 infection among HCWs in Oman is considerably lower compared to rates recorded in many developed countries, including Italy, Spain, and the USA (1.47% vs 15%-20%).^{7,8} In particular, the incidence among HCWs in DGHS-Muscat Governorate is double than that of the whole of Oman, likely because this region is the most populated and has the highest number of confirmed cases.⁹⁻¹¹

In the current study, most infected HCWs were female; this was to be expected, as women represent the majority of healthcare workers in Oman.⁹ In addition, the majority were between 25 and 45 years old, with few being over 45 years of age. Only 38 participants (30.2%) had high-risk medical conditions, including obesity, diabetes mellitus, asthma, and chronic heart, respiratory, hematological, and neurological diseases, while 11 (8.7%) were pregnant. Previous studies have indicated that old age and pre-existing health conditions are important COVID-19 risk factors.^{12,14} Moreover, while the overall risk of COVID-19 infection to pregnant women is low, such individuals are at an increased risk of more severe illness compared to non-pregnant women.^{15,16} Healthcare institutions therefore often implement precautionary measures to keep older HCWs, those who are pregnant, and those with pre-existing medical conditions away from the frontline. Such measures are likely the reason why so few of the participants fell into these categories in the present study.

The majority of infected HCWs in the current study reported having had contact with a confirmed COVID-19 case at work. In addition, most were either medical doctors or nurses. One of the most important secondary routes of COVID-19 transmission is in a hospital setting.⁸ In particular, those who work at the frontline are highly exposed due to their role in the management and treatment of infected patients. Previous researchers have proved that HCWs with greater or more risky levels of exposure to COVID-19 cases have a higher susceptibility of respiratory infection compared to those with less or low-risk exposure.¹⁷ In particular, the use of aerosol-generating procedures like endotracheal intubation as well as electrocardiography and other procedures involving direct patient contact are associated with an increased risk COVID-19 infection in HCWs.¹⁸ For nurses, certain activities such as assisting during intubation, suctioning, and even manipulating oxygen face masks are particularly risky.¹⁹

Overall, the vast majority of participants in the present study followed recommended hand hygiene practices, both before and after touching patients or after touching their surroundings. Only <7.1% reported suboptimal hand hygiene practices. A study conducted in Wuhan found that 3.1% of infected HCWs reported suboptimal hand hygiene as a possible risk factor for COVID-19

infection.¹⁷ Transmission of the virus usually follows contamination of the hands after touching either an affected individual or fomites; as such, hand hygiene is considered one of the most important prevention measures for health-care-associated infections.¹⁷ When questioned about the use of a surgical facemask for routine patient care, almost all of the participants gave positive responses. Given the highly contagious nature of the SARS-CoV-2 virus, and the lack of universal testing to detect asymptomatic individuals, respiratory precautions such as the use of face-masks are critical to protect HCWs from infection and to prevent further transmission to others.²⁰

Education and training regarding IPC protocols are one of the most important methods of monitoring preparedness and response during a pandemic. Such training should be mandatory for all HCWs regardless of level, role, or position, including in-depth training for new employees as well as continuing education opportunities for existing staff.²¹ In the current study, while the majority of participants had undergone IPC training at least once, 29.4% claimed that they had never received such training. In particular, nurses (86.4%) appeared to have more frequently received IPC training compared to other types of practitioners, such as pharmacists (0%), medical doctors (69.7%), and administrative clerks (76.9%). Although 43.7% of HCWs in the current study had recently received IPC training within the preceding 6-month period, 88.1% claimed that they felt confident making risk assessments to identify the need for PPE, with no significant correlation between the timing of IPC training and level of confidence. Although the majority of HCWs were trained and felt confident in making risk assessments to identify the need for PPE, they were still infected. This is might be related to degree of quality and adherence to practice of IPC measures in workplace and community settings. It can be also be attributed to transmission in home or community settings even if the participants did not recall any contact as there is a possibility of transmission from asymptomatic COVID positive individuals.

On the other hand, there was a significant correlation between number of IPC training sessions and level of confidence. Even a single IPC session appeared to dramatically increase confidence in making risk assessments. Critically, none of those who reported never feeling confident in making PPE risk assessments had previously received IPC training.

Preventive measures against COVID-19 infection in HCWs require the use of specialized PPE, including respirators, N95 masks, gowns, and visors or face shields.²² Lack of availability and improper use of PPE is a critical contributing factor to infection in HCWs.⁸ In the current study, 90.5% reported mostly or always wearing PPE when indicated. However, 31.7% reported that they often faced restrictions on PPE use in their workplace. It is worth

mentioning that there were no significant differences in the availability or restriction of PPE between primary, secondary, or tertiary facilities. Interestingly, only 78.9% of those who always felt confident in making PPE risk assessments reported always wearing PPE when indicated ($P < .05$). Although the availability of PPE and restrictions imposed on their use might be thought to play a role in this finding, there was no correlation between these factors and level of confidence.

In contrast, 61% of those who reported a lack of confidence when making PPE risk assessments wore PPE all of the time ($P < .05$). This might reflect panic, uncertainty, and a lack of elementary knowledge regarding the clinical and epidemiological characteristics of COVID-19, thereby resulting in the irrational use of PPE and wasted resources. Unfortunately, due to the largescale nature of the pandemic, many healthcare facilities are currently facing shortages in the supply of such equipment, a situation exacerbated by the fact that most PPE should be discarded after a single use. Indeed, the reuse of PPE may comparably increase the risk of infection, likely due to either self-contamination during repeated application and removal, the breakdown of materials with extended use, or lack of appropriate disinfection protocols prior to reuse.²³ Thus, there is a need to strike a balance between safeguarding HCWs against infection and ensuring the strategic use of increasingly scarce resources.

Nevertheless, even when wearing PPE, HCWs who care for COVID-19 patients remain at increased risk of infection themselves, as demonstrated in the current study. These findings highlight the importance of not only ensuring PPE quality and availability, but also other aspects of appropriate use, such as correct methods of donning and removing this type of equipment. Participants in the study also mentioned other factors which they believed to increase their risk of infection, including inadequate cleaning and sanitization of surfaces and disinfection of medical equipment, and a lack of training for cleaners. Similar findings have been reported in previous research.⁸ In addition, several concerns were voiced with regards to the structure and protocols of healthcare facilities, including the overcrowding of suspected patients in areas without proper ventilation, and the lack of isolation rooms. According to the WHO, isolation capacity is an important indicator of strategic preparedness and response to the COVID-19 pandemic.²¹

Limitations

Several limitations to this study need to be acknowledged. First, the study focused only on HCWs working in healthcare institutes under the DGHS-Muscat Governorate; as such, the results cannot be generalized to the whole country.

Second, information regarding the degree of exposure, type of procedures performed, and knowledge of IPC practices was not explored. Further research is recommended to assess these aspects and their impact on COVID-19 infection rates among HCWs. Third, as data were collected using a self-reported questionnaire, the results may have been affected by recall bias, as well as social desirability bias, and demand characteristics. Moreover, potential psychological and emotional stressors related to COVID-19 could represent further potential for bias in the results.

Conclusions

This study found that approximately one-third of HCWs under the DGHS in Muscat Governorate with confirmed COVID-19 infection had never received IPC training. However, the majority followed recommended hand hygiene practices, social distancing protocols, and used PPE when indicated. HCWs at risk for worse outcomes of COVID-19 due to age, pregnancy, or preexisting conditions could be assigned duties away from active COVID-19 cases. In addition, strategies to enhance IPC education, training, and emergency preparedness among all HCWs, including housekeeping staff could be implemented. Finally, existing healthcare facilities can be restructured for better adherence to international standards, including the designation of well-ventilated isolation rooms for suspected cases.

Appendix I. Questionnaire Section to Determine Sociodemographic Characteristics.

Item	Response
Serial #	
Gender	1-Male 2-Female
Age	
Nationality	1-Omani 2-Non-Omani
Healthcare facility	
Occupation in healthcare facility	Administration personnel Cleaner Dentist Dental surgical assistant Dietitian/health educator Laboratory technician Medical doctor Medical recorder Medical orderly Nursing staff Radiologist/X-ray technician Watchman
Date of diagnosis (DD/MM/YYYY)	

Appendix 2. Questionnaire Section to Determine Pre-Existing Conditions/Risk Factors.

Item	Response
Contact with a positive case at work	1-Yes 2-No
Contact with a positive case at home	1-Yes 2-No
Obesity	1-Yes 2-No
Diabetes	1-Yes 2-No
Asthma	1-Yes 2-No
Chronic lung disease	1-Yes 2-No
HIV/immunodeficiency	1-Yes 2-No
Pregnancy	1-Yes 2-No
Smoking	1-Yes 2-No
Cancer	1-Yes 2-No
Heart disease	1-Yes 2-No
Chronic kidney disease	1-Yes 2-No
Chronic liver disease	1-Yes 2-No
Chronic hematological disorders	1-Yes 2-No
Chronic neurological impairment/disease	1-Yes 2-No
Organ or bone marrow recipient	1-Yes 2-No
Other, please specify	

Abbreviation: HIV, human immunodeficiency virus.

Appendix 3. Questionnaire Section to Determine Adherence to Infection Prevention and Control Measures.

Item	Response
How many times have you received IPC training at your healthcare facility?	1-Never 2-Once 3-Twice 4-Three times or more
When was your most recent IPC training within your healthcare facility?	1-Cannot recall/none undertaken 2-Jul to Sep 2019 3-Oct to Dec 2019 4-Jan to Mar 2020 5-Apr to Jun 2020
Do you follow recommended hand hygiene practices?	1-Always (as recommended) 2-Most of the time 3-Occasionally 4-Rarely 5-Never

(continued)

Appendix 3. (continued)

Item	Response
Do you use an alcohol-based hand rub or soap and water before touching a patient?	1-Always (as recommended) 2-Most of the time 3-Occasionally 4-Rarely 5-Never
Do you use an alcohol-based hand rub or soap and water after touching a patient?	1-Always (as recommended) 2-Most of the time 3-Occasionally 4-Rarely 5-Never
Do you use an alcohol-based hand rub or soap and water after touching a patient's surroundings?	1-Always (as recommended) 2-Most of the time 3-Occasionally 4-Rarely 5-Never
Do you follow social distancing recommendations?	1-Always (as recommended) 2-Most of the time 3-Occasionally 4-Rarely 5-Never
Do you wear a protective mask for routine patient care?	1-Always (as recommended) 2-Most of the time 3-Occasionally 4-Rarely 5-Never
Do you wear PPE when indicated?	1-Always (according to risk assessment) 2-Most of the time (according to risk assessment) 3-Occasionally 4-Rarely 5-Never
Do you feel confident in making a risk assessment to identify the need for PPE?	1-Always 2-Most of the time 3-Occasionally 4-Rarely 5-Never
Is PPE available in sufficient quantity in your health care facility?	1-Always 2-Most of the time 3-Occasionally 4-Rarely 5-Never
Do you face restrictions in using PPE in your healthcare facility?	1-Always 2-Most of the time 3-Occasionally 4-Rarely 5-Never
Do you think there are factors which may increase the risk of getting COVID-19 infection in your health institution?	1-Yes 2-No
If yes, please specify	

Abbreviations: IPC, infection prevention and control; PPE, personal protective equipment; COVID-19, coronavirus disease 2019.

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Authors' Contributions

ZA and MZ are the principal investigators in charge of the project. AL is a co-author. AL and MZ construct the electronic questionnaire. TG, AL, and ZB were involved in study design. Data collection was assisted by ZB, TZ, SW, IR, IM, NZ, and NM. ZA and MZ prepared the initial draft of the manuscript and TG, AL, and ZB have reviewed and approved the final version of the manuscript.

Declaration of Conflicting Interests

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