



## Case-control Study

# Case-Control Study to Identify Risk Factors Associated with COVID-19 Infection outbreak Among ICU Nurses in A Teaching Hospital

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**Citation:** Al-Abdullah NA, Almalki SH, Alharbi AR, Alkatheri A, Zaylaee S (2022) Identify Risk Factors Associated with COVID-19 Infection Among Nurses in A Teaching Hospital. Rep Glob Health Res 5: 10141. DOI: 10.29011/2574-710X.10141

**Received Date:** 09 June, 2022; **Accepted Date:** 14 June, 2022; **Published Date:** 17 June, 2022

### Abstract

Coronavirus disease, also known as COVID-19, is caused by the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) that first appeared in China in December 2019 and has since spread to most countries around the world. Nurses are on the front lines of this global crisis, with the significant challenges of diagnosing and treating progressive increasing number of acutely ill patients. Therefore, COVID-19 has infected a significant number of HCWs around the world, and some have even died. The study aimed to assess factors that associated with COVID-19 infection among nurses while providing patient care. According to the aim, researchers will identify many factors that influence the acquiring of disease to some staff rather than other staff who exposed to the same infected patient and provided the same care in the same sitting. As result of this study, researchers have identified risk factors that contribute to the transmission of COVID-19 infection to nurses as follow; less adherence in using single-use gloves when handling infected patients with COVID-19, no complain to use face shield or goggles/ protective glasses when providing care to infected patients, and less compliance in the use of disposable gown while deliver care to the infected patients.

**Keywords:** COVID-19; PPE; Nurses; Health care worker; Risk; infection prevention and control IPC procedures; Mask; Gloves; Goggles

**Abbreviations:** COVID-19: Coronavirus Disease; HCWs: Health Care Workers; PPE: Personal Protective Equipment's; WHO: World Health Organisation; IPC: Infection Prevention and Control; KAUH: King Abdulaziz University Hospital

### Introduction

Coronavirus disease, also known as COVID-19, is caused by the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) that first appeared in China in December 2019 and has since spread to most countries around the world. The virus spreads through respiratory droplets, which are created when an infected person coughs or sneezes, or by touching contaminated surfaces

or items and then touching their mouth, nose, or eyes [1]. Because COVID-19 has demonstrated a higher transmission rate and rapid development over a short period as compared to previous coronavirus infections such as SARS and Middle East Respiratory Syndrome (MERS). By February 2021, the number of people worldwide infected with COVID-19 is more than 111 million with more than 2 million deaths. However, In Saudi Arabia the first case of COVID-19 was recorded in March 2020 in the eastern region, a Saudi citizen came from Iran to Qatif city, which was the first city in Saudi Arabia to undergo mass quarantine with no one allowed leaving or entering the city. Furthermore, the disease spread rapidly, 375,333 cases were confirmed and 6,466 deaths had been recorded by February 2021 [2].

Nurses are on the front lines of this global crisis, with the significant challenges of diagnosing and treating progressive increasing number of acutely ill patients. Therefore, COVID-19 has

infected a significant number of HCWs around the world, and some have even died. The COVID-19 pandemic had a major effect on nurses' physical and mental health. So, protecting nurses is critical component of any country's strategic response to the COVID-19 crisis, particularly as governments scramble to expand healthcare capacity to cope with the influx of patients in need of immediate attention. Because of that, WHO has provided guidelines for the effective use of personal protective equipment (PPE) in hospital and community settings, also many of universities and specialty societies have established techniques and guidelines to minimize the risk of COVID-19 transmission in their respective fields [3].

Also, nurses are expected to follow approved infection prevention methods in order to mitigate risk. Aside from hand hygiene, wearing a facemask on a daily basis is an infection prevention measure. The use of adequate PPE is one of the most important ways to reduce the spread of the virus. The WHO suggests in their COVID-19 recommendations to wear a surgical mask, goggles or face shield, gown and gloves as PPE [4]. In addition, lack of understanding of the disease, insufficient use and availability of PPE, unclear diagnostic requirements, unavailability of rapid diagnostic tests, and psychological stress are all major risk factors for infection among nurses [4].

There are many studies done to identify risk factors associated with COVID-19 infection among health care workers in general. The study conducted by Kim [5] from 17 July to 25 September 2020 in six countries (the UK, Germany, France, Italy, Spain and USA) in a case-control study among 2884 exposed HCWs were 94% medical doctors and 6% nurses or physician assistants to determine the risk, seriousness, and period of COVID-19 in at-risk healthcare workers in relation to PPE access. All participants in the sample were adult HCWs in medical specialties with regular and near interaction with COVID-19 patients. In this study, HCWs who had been exposed filled out a comprehensive questionnaire that included demographics, medical, social, and lifestyle questions. COVID-19 cases were identified as those with COVID-19 symptoms such as fever, cough, fatigue, and loss of taste or smell, as well as those who tested positive for COVID-19 but had no symptoms. In six nations, frontline HCWs who had less access to PPE had a higher risk of disclosing COVID-19 illness as well as a longer and more serious disease path [5].

Another study conducted by Thomas Key [6] in San Mateo, California, USA. 315 staff took part in this study were invited to participate via an email with a link to an online survey to determine whether staff are aware of PPE guidelines, their views of PPE interventions, and their questions about PPE use when caring for COVID-19 patients. While 84.4% of employees were aware of PPE guidelines, only 52.4% reported having sufficient PPE provision. Despite high levels of anxiety about contracting COVID-19, 67.9% were still eager to come to work. In contrast to other staff classes, doctors scored substantially higher on questions about PPE comprehension. When it came to PPE and contracting

COVID-19, nursing workers had substantially higher levels of anxiety than doctors did [6].

F.Huang [7] study was conducted in France throughout the COVID-19 pandemic, this study used an automated hand hygiene recording system to assess HCW hand hygiene on entry and exit from patient rooms whether it decreased or increased over time. On room entry, HCWs had a decreased hygiene rate over time; on room exit, it increased by 13.73% during the first wave of COVID-19, dropped by 9.87% during the post-lockdown period, and then increased by 2.82% during the second wave of the epidemic. HCWs altered their actions in response to the pandemic's risk potential. However, reducing uncertainty between the hand hygiene and glove recommendations may be important to improve poor compliance at room entry; disinfection of gloving hands may solve this problem [7].

The other study carried out by Saqib Ali [8] that aimed to investigate the causes of COVID-19 infection in HCWs and potential solutions in most viral affected countries (Italy, China, United States, Spain, and France). Early evidence indicated that HCWs are becoming increasingly infected with the novel virus, with rates ranging from 15% to 18%, and up to 20% of the incidence rate. This study identified these risk factors as a major causes of infection; less understanding of the illness, poor use and accessibility of PPE, unfamiliar diagnostic requirement, no available diagnostic test, and psychological stress [8].

Kumar [1] conducted a cross-sectional study in Pakistan, the aim of this study was to look at HCWs awareness, attitudes, and practices about wearing a surgical face mask to prevent the spread of the new coronavirus disease. Therefore, total of 392 participants answered questionnaire consisting of the basic demographic characteristics, and the knowledge, attitude, and practices regarding the use of surgical facemask. Overall, 138 (35.2%) of the results were strong, 178 (45.4%) were moderate, and 76 were bad. Around 43.6% of participants were aware of the proper way to put on the masks, 68.9% were aware that there are three layers, 53% were aware that the middle layer serves as a filter media buffer, and 75.5% were aware of the recommended maximum wear time. The majority of respondents (88.2%) were aware that a cloth facemask is ineffective, that discarded face masks cannot be re-used, and that 44.8% were aware of the yellow-coded bag for disposal [1].

Reszke [9] conducted in Poland, the study's aim was to see if various HCWs used face masks in accordance with WHO guidelines for 2020. The participants in this cross-sectional analysis were 1156 people who took part in an online survey about mask-related behaviors. The survey also contained seven questions focused on WHO recommendations for the proper use of facemasks. The results of the study, all the participants were 1156 (60.6%) their primary workplace is hospital, whereas 39.4% work in outpatient settings. Furthermore, other results regarding the correct use of

face mask as follow; 90.8% strictly cover the nose and mouth with the face mask, 49% wash/disinfect hands after mask removal or touching, 43.4% take off the mask properly without touching the anterior surface, 35.4% use disposal of single-use face masks after one use, 33.7% have not reuse single-use masks, 6.8% avoid touching the mask with hands. In conclusion, the Polish HCW fail the exam of strict compliance to 2020 WHO guidance criteria for safe use of face masks, where they adhere strongly to some criteria [9].

Kassie [10] conducted a cross-sectional study in Ethiopia, the purpose of this study was to evaluate COVID-19 preventive measures and factors for healthcare workers. Researchers in this study selected 630 health care staff to participated in institution-based study from March to April 2020 by using self-administered questionnaire. The results show that respondents' knowledge of COVID-19 and their attitudes toward it was generally good and well-informed, with nearly 64.1% of those polled having excellent knowledge of the causes, associated symptoms, and preventive measures. In term of preventive practice, 36.3% of healthcare providers did not use a face mask in the office, and 84% washed their hands regularly with sanitizers before and after treating patients and entering their homes. The overall good COVID-19 preventive practice among HCWs was found to be 38.7%. It is likely that this is linked to the country's financial condition, which has expanded the capacity and distribution of protective equipment in the healthcare sector. Only 36.1% reported wearing face masks at work on a regular basis, greatly increasing the risk of contracting and transmitting the disease. Some HCWs find it hard to use masks as well as other items because they make patients feel alone, afraid, and that some HCWs find masks unpleasant to wear. Therefore, HCWs should have access to a wide range of education and training programs, including an emphasis on COVID-19 preventative measures [10].

Another study is a case-control study done by Celebi [11] in Turkey, the goal of this study was to investigate the particular risk factors for COVID-19 transmission among HCWs in a tertiary care university hospital. Between March 20 and May 20, 2020, 703 HCWs were examined, with 50 (7.1%) testing positive. HCWs who worked in COVID-19 units had an infection rate of 8.3%, whereas those who did not work in COVID-19 units had an infection rate of 3.4%. Also The presence of a SARS-CoV-2 positive person in the household ( $P = .003$ ), improper use of PPE when caring for patients with COVID-19 infection ( $P = .003$ ), and spending more than 15 minutes in the same personnel break room with an HCW without a medical mask ( $P = .000$ ). Infection risk variables were failing to keep a safe social distance from an HCW ( $P = .003$ ) and failing to keep a safe social distance from an HCW ( $P = .003$ ). While caring for COVID-19 patients, HCWs are at a significant risk of transmitting infection. However, transmission can also happen when speaking or eating in non-medical sections of the hospital [11].

Ghassan [12] conducted a cross-sectional study in Oman. The aim of this study was to find out factors that are linked to COVID-19 infection in HCWs. A total of 126 HCWs were included with confirmed COVID-19 infection. In this study 72.2% of the participants were female, and 61.1% were medical professionals or nurses. Only 18.1% were over 45 years old, and 30.2% had pre-existing medical issues and 53.2% worked in primary care facilities. 29.4% had never undergone IPC training. However, the majority adhered to recommended hand cleanliness (96.8%) and social distancing measures (93.7%), and wore protective facemasks for normal patient care (96.9%) [12].

### **Study aim**

The study aimed to assess factors that associated with COVID-19 infection among nurses while providing patient care. According to the aim, researchers will identify many factors that influence the acquiring of disease to some staff rather than other staff who exposed to the same infected patient and provided the same care in the same sitting.

### **Methodology**

This research design quantitative retrospective case-control study to identify risk factors that associated acquiring the COVID-19 infection.

Study conducted at the largest teaching hospital affiliated to medical and nursing college at king Abdulaziz University, King Abdulaziz University Hospital (KAUH). The sample of the study nurses who got infected with COVID-19 during care of suspected or confirmed patients between March 2020 to April 2021. Cases in the study are nurses who got infected from the infected patient during the care hours and their number is 13. In the other hand, controls are nurses who take care of infected patients but did not get infected and their number is 17. Regarding tool used in this research, researchers developed a structured interview questionnaire that is consisting of three sections. The first section contains sociodemographic data of the participants. The second section is about nurses' activities performed on infected patients in a health care facility. The third section is about adherence to infection prevention control IPC procedures during health care interaction. Data were analyzed using IBM® SPSS Statistics software version 16 used to analyze the data.

### **Ethical consideration**

Ethical approval obtained from KAUH medical ethics committee and they reviewed and approved the study protocols and interview questionnaire. The confidentiality was obtained for all participants in the study by using coding system and the questionnaire was anonymous.

## Results

The sample of the study consists of 30 nurses, 13 (43.4%) case and 17 (56.7%) control. The average age for case group is 33.3 years old compared to the average age for control group which is 34 years old. 13 of the sample are men and 17 are women. There are three different nationalities, 24 Indians, 5 Philippines and 1 Saudi. The average years of experience for case group is 5.5 year, which has slight difference from control group 5.1 year (See Table 1).

Variables	Case (N%)	Control(N%)	OR	P-value	CI 95%
<b>Age</b> Mean(±SD)	13(43.3%) ±4	17(56.7%) ±2		0.09	
<b>Gender</b> Male Female	4 (13.3%) 9(30%)	9(30%) 8(26.7%)	0.4	0.2	0.9-1.8
<b>Nationality</b> Saudi Non Saudi	1 (3.3%)	1 (3.3%) 16(53.3%)	1.1	0.56	0.94-1.2
<b>Unit</b> ICU Non ICU	3(10%) 10(33.3%)	7 (23.3%) 10(33.3%)	0.42	0.25	0.1-2.1
<b>Years of experience From 1-5 years 6 years or more</b>	8(26.6%) 5(16.6%)	9(30%) 8(26.6%)		0.96	0.9-1.7

**Table 1:** Sociodemographic Characteristics of the Participants. (N=30).

When data analyzed based on nurses' activities performed on COVID-19 patient in health care facility, researchers asked specific yes/no questions. The first question is whether the nurse has provided direct care to a confirmed COVID-19 patient. The answers for case group 12 (40%) yes compared with 13 (43.3%) yes in control group. The P-value is  $\geq$  than 0.05 which indicates that there is no statistically significant correlation between providing direct care to a confirmed COVID-19 patient and getting the infection, the rational for this result is because that all nurses were exposed to the same risk factors during caring of COVID-19 patients.

With regard to other procedures, survey questions include different procedures provided by nurses to examine the risk associated with each procedure. Researchers asked yes/no questions to determine if any of these procedures were performed; bed making, suctioning, oral hygiene, wound care, turning of patient, emptying of urine bag, and assisting in other procedures. Results of All P-values for these procedures are greater than 0.05 (P-value  $\geq$ 0.05) which indicates that there is no statistically significant correlation between providing any of these procedures and getting infected with COVID-19. Moreover, the odd ratio in most of variables close to 1 or less, which indicate that the exposure is not associate with the infection. Except emptying urine bag that has OR grater that 1, however 1.69 means that there is an association but not that strong. (See Table 2)

Variables	Case (N%)	Control (N%)	OR	p-value	CI 95%
<b>provide direct care to a confirmed COVID-19 patient</b> Yes No	12 (40%) 1(3.3%)	13(43.3%) 4 (13.3%)	3.69	0.24	0.36-37.8
<b>Aerosol-generating procedures</b> Yes No	10(33.3%) 3 (10%)	11(36.7%) 6 (20%)	1.81	0.46	0.35-9.27

<b>Other Procedures: Bed Making</b> Yes No	11(36.7%) 2 (6.7%)	17(56.7%)	1	0.09	0.67-1.06
<b>Suctioning</b> Yes No	10(33.3%) 3 (10%)	13(43.3%) 4 (13.3%)	1.02	0.97	0.18-5.66
<b>Oral Hygiene</b> Yes No	10(33.3%) 3 (10%)	14(46.7%) 3 (10%)	0.71	0.73	0.11-4.29
<b>Wound care</b> Yes No	7 (23.3%) 6 (20%)	13(43.3%) 4 (13.3%)	0.35	0.19	0.07-1.71
<b>Turning of patient</b> Yes No	12 (40%) 1 (3.3%)	16(53.3%) 1 (3.3%)	0.75	0.84	0.04-13.24
<b>Emptying of urine bag</b> Yes No	11(36.7%) 2 (6.7%)	13 (43.3%) 4 (13.3%)	1.69	0.58	0.25-11.06
<b>Assisting other procedures</b> Yes No	7 (23.3%) 6 (20%)	14 (46.7%) 3 (10%)	0.25	0.09	0.04-1.31

**Table 2:** Nurses activities performed on COVID-19 patient in health care facility. (N=30).

One of the important aspects that have been included in the study is the adherence to infection prevention and control IPC procedures during health care interactions. The P-value of single use gloves is 0.037 (P-value  $\leq 0.05$ ) which means that there is a significant correlation between single use gloves and getting infected with COVID-19. Obviously, control group were more complain in using single-use gloves compared to case group which decrease their risk of becoming infected. (See table 3).

Variables	Case (%)	Control (%)	OR	CI 95%	P-value
<b>Times Entering Room</b> Two to Four Times Five or More Time	13(43.3%)	2 (6.6%) 15 (50%)			0.44
<b>Single Use Gloves (N=30)</b>					
<b>Single Use Gloves</b> All the time Most of time	10(33.3%) 3 (10%)	17(56.7%)		1.7-1.8	0.03
<b>Surgical mask or N95 mask. (N=30)</b>					
<b>Surgical mask or N95 mask</b> Always Most of time Rarely	12 (40%) 1 (3.3%)	15 (50%) 2(6.7%)			0.24
<b>Face shield or goggles/protective glasses. (N=30)</b>					

<b>Face shield or goggles/protective glasses</b> Always Occasionally Rarely	3 (10%) 2(6.7%) 8 (26.7%)	12 (40%) 3(10%) 2(6.7%)			0.01
<b>Disposable gown. (N=30)</b>					
<b>Disposable gown</b> Always Most of the time Occasionally Rarely	5 (16.7%) 5 (16.7%) 2 (6.7%) 1 (3.3%)	16 (53.3%) 1 (3.3%)			0.01
<b>Remove and replace PPE according to protocol. (N=30)</b>					
<b>Remove and replace PPE according to protocol</b> Always Most of the time Occasionally Rarely	8 (26.7%) 5(16.7%)	11(36.7%) 4(13.3) 1(3.3%) 1(3.3%)			0.55
<b>Frequency of decontaminate high-touch surface.(N=30).</b>					
<b>Frequency of decontamination of high-touch surfaces</b> Always Most of the time	5 (16.7%) 8 (26.7%)	12(40%) 5 (16.7%)	0.2	0.05-1.20	0.07

**Table 3:** Times of entry to patient room (N=30).

The use of face shield or goggles/protective glasses has P-value 0.012 ( $P \leq 0.05$ ) so there is a significant correlation between the use of face shield or goggles/protective glasses and getting infected with COVID-19.

Results for disposable gown for P-value is 0.01 ( $P \leq 0.05$ ). Therefore, there is a significant correlation between the use of disposable gown and getting infected with COVID-19. In other words, nurses in control group have more compliance in wearing disposable gown than case group which increased the risk in cases of acquiring the infection.

## Discussion

There's a fewer published study explore the possible risk factors for COVID-19 in health care workers. Beside, Kim [5] conduct study in six countries of among 2884 exposed HCWs, the risk of get infected associated with close contact with infected patient, long number of working hours, and limited access to and shortage of PPE [5]. The adherence to infection prevention and control IPC procedures during the nurse interaction with infected patient

divide into many aspects, while the using of single-use gloves has significant correlation to get COVID-19 infection. fewer participant in case group reported that they are most of the time use the single-use gloves, so that may indicate one of the factors that contribute to acquiring the COVID-19 infection. In addition, Ashinyo [13] reported that high compliance to use single-use gloves and high adequate compliance to use PPE protocols among health professional workers than nonclinical staff [13]. Furthermore, Wong [14] have found that the SARS-CoV2 transmission can prevented by using the infection control measures [14].

Participants in our study have high adherence in wearing surgical mask or N95 mask in both groups. Furthermore, Reszke [9] reported that Polish health-care worker rarely adheres to criteria of using face mask according to 2020 WHO guidance [9]. Also, Kumar [1] founded that inadequate knowledge, attitude, and practice of HCWs regarding the use of face mask [1]. Moreover, Kassie [10] reported only 36.1% of the whole sample consistently use face mask at workplace, which contribute to transmit the disease because most of the health-care professionals find the use of

face mask difficult and uncomfortable [10].

Even though all the nurses have adhered to wear face mask, some of them got infected from infected patients. Furthermore, Lancet [15] have found the transmission of COVID-19 through the airborne is possible, the growing evidence emphasize that the microdroplet are small enough to remain in the air and reach to beyond 2 meters. So, COVID-19 transmutation through airborne could be one of the reasons behind acquiring the infection to nurses [15]. The use of face shield or goggles/protective glasses is used always only by 10% of cases compared to 40% of control, that is one of the risk factors that contribute to transmission of the infection to nurses. Additionally, Jackson [16] reported that the compliance to IPC measures were low. Also, Ashinyo [13] found the compliance to faces yield or goggles/protective glasses were high when the health care workers interact with COVID-19 patient. However, the SARS-CoV-2 is transmitting through droplet that may contact the eyes, nose, or mouth according to WHO, and that predict the reason behind the transmission of the infection to the nurses who did not always use the eyes protective equipment.

Furthermore, controls group have more compliance in wearing disposable gown comparing to case group, and that indicate one of the factors of acquiring the infection. Additionally, Atnafie [17] reported that only 15.1% of HCW had always use gown, also low compliance to PPE use and aseptic practice while interact with infected patient. Moreover, Ahmad S Farhat [18] reported that the use of cotton surgical gown protected the HCW against COVID-19

## Conclusion

The study aimed to assess risk factors that contributed to COVID-19 infection among nurses while providing health care to infected patient with COVID-19. Overall, in the research we found that the most significant findings are the relationship between single use gloves, face shield or goggles/ protective glasses, and disposable gown and getting infected with COVID-19. According to the results, there is a negative relationship between single use gloves, face shield or goggles/ protective glasses, and disposable gown and acquiring COVID-19 infection.

In the study researchers have identified the risk factors that contribute to the transmission of the COVID-19 infection to nurses as follow; less adherence in using single-use gloves when handling infected patients with COVID-19, no complain to use face shield or goggles/ protective glasses when providing care to infected patients, and less compliance in the use of disposable gown while deliver care to the infected patients.

In conclusion, nurses are the backbone of health care system and they are in the frontline in facing the COVID-19 disease. Because of that, they should be aware of the risk factors that associated with the transmission of the infection while providing care.

Further, nurses should use effective strategies to face the pandemic and receive adequate knowledge about the appropriate use of PPE and follow IPC measures. Lastly, further studies should be done on COVID-19 to ensure the exact way of transmission and take the appropriate measures in providing care which emphasis on the evidence-based practice.

## Limitations

Numerous limitations in this study need to be recognized. Firstly, the study limited to nurses based on exposure event in governmental teaching hospital, because of small sample size, results cannot be generalized to other hospitals in Saudi Arabia. Secondly, the exact time spent while providing care for infected patients is not included in the study. Thirdly, the study was conducted in specific area in the hospital based on exposure event, only two units from KAUH hospital were examined and different results that may appear in other setting.

## Recommendations

Regardless of using the data collected from nurses, researchers recommend further studies to assess the risk factor of acquiring COVID-19 infection on other Health care professionals to generalize the study in other health settings. Moreover, researchers recommend performing another study to assess the exact time spent with COVID-19 patients, which could be one of the risk factors of acquiring COVID-19 infection among healthcare workers.

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