Original Article

HEALTH SCIENCES
MEDICINE

DOI: 10.32322/jhsm.1180325
J Health Sci Med 2022; 5(6): 1725-1731

Determination of risk factors playing a role in the transmission of COVID-19 in healthcare professionals

Tuba Kuruoğlu, Aynur Atilla, Şeyma Betül Kayhan, Fatih Temocin, Esra Tanyel

Ondokuz Mayıs University Faculty of Medicine, Department of Clinical Microbiology and Infectious Disease, Samsun, Turkey

Cite this article as: Kuruoğlu T, Atilla A, Kayhan ŞB, Temocin F, Tanyel E. Determination of risk factors playing a role in the transmission of COVID-19 in healthcare professionals. J Health Sci Med 2022; 5(6): 1725-1731.

ABSTRACT

Introduction: Healthcare workers and professionals have the highest risk of transmission of novel coronavirus disease-2019 (COVID-19). The risks faced by healthcare professionals can vary according to their working conditions, knowledge, attitudes and behaviours. This study aimed to identify risk factors contributing to transmission among frontline healthcare providers in the pandemic period.

Material and Method: The healthcare workers working at the school of medicine hospital and referred to the COVID-19 clinics by the filiation team following risky exposure between March 15, 2020 and December 31, 2020 were included in the study. sociodemographic features, use of protective equipment, unprotected contact data, and severe acute respiratory syndrome coronavirus-2 (SARS-CoV-2) Real-time reverse transcription-polymerase chain reaction (RT-PCR) test results recorded on the contact healthcare follow-up form of the participants were taken from the hospital records and analyzed retrospectively.

Results: Of the healthcare workers included in the study, 790 (58%) were female, and 571 (42%) were male, with a mean age of 33,6±8,3 years. SARS-CoV2 PCR positivity was detected in 94 (6%) participants. According to the multivariate model results, the male gender was found as a risk factor in terms of transmission which increased the risk 1.633-fold [%95 Cl; (1,048-2,544), p=0,030], working in a laboratory unit increased the risk 2.89-fold [%95 Cl; (1,322-6,316), p=0,008], and contacting out of the hospital increased the risk 7.154-fold [%95 Cl; (4,085-12,529), p <0,001], and all these were determined as independent risk factors.

Conclusion: We think that indoor units such as laboratories that do not have direct contact the patient, which seems to be risk-free in terms of transmission, contribute to the cross-contamination of COVID-19 among healthcare workers.

Keywords: COVID-19, healthcare worker, personal protective equipment, contact, risk factors

The manuscript was presented as an oral presentation at HIKON Congress on December 16-19, 2021 Ankara, Turkey.

INTRODUCTION

In the novel coronavirus disease-2019 (COVID-19) pandemic, prevention is as important as treatment itself in limiting the disease. There were significant challenges at the beginning of the pandemic, such as insufficient protective equipment, failure to provide isolation conditions, difficulty in complying with protective measures, and disruption in health care due to infected healthcare workers. Healthcare workers have been at high risk due to exposure to infection and being a source of disease due to intense patient exposure before vaccination. According to the World Health Organization (WHO), 14% of COVID-19 cases are among healthcare workers (1). It has been reported that approximately 6% of COVID-19 cases in Turkey are among healthcare workers (2). This rate is vital in controlling pandemic for the health of healthcare providers, and the maintenance of public health service. The knowledge and attitude responses of healthcare professionals about COVID-19, the precautions they take to approach the patient are as critical to the spread and control of the disease as the use of personal protective equipment (PPE) (3-6).

It is known that unprotected contact is directly related to the transmission of COVID-19 (6-8). Besides, risk factors that play role in transmission need detailed search due to the prominence of number of patients whose possible transmission source yet to be identified among infected health care providers. In addition to these, we observed that more healthcare workers were infected in some units in our hospital compared to others. Therefore, we aimed to determine different risk factors as well as known factors that play a role in transmission among healthcare workers.

Corresponding Author: Tuba Kuruoglu, tuba.kuruoglu@omu.edu.tr
Received: 26.09.2022 **Accepted:** 19.10.2022

MATERIAL AND METHOD

The study was carried out with the permission of the university clinical research ethics committee (Date: 03.11.2021, Decision No: KAEK 448/2021). All study processes were conducted under the principles of the Declaration of Helsinki and ethical rules.

Study Design

The study included 1361 healthcare professionals working at the school of medicine hospital and referred to the COVID-19 clinics by the filiation team following risky exposure between March 15, 2020 and December 31, 2020. Sociodemographic data, contact risk, duration of contact, area of contact, personal protective equipment (PPE) use during contact, SARS-CoV2 PCR test results and clinical results were obtained from the contact tracking form recorded in the hospital automation system by the filiation teams. Healthcare providers who did not work in our hospital were excluded the study.

COVID-19 cases definitions were confirmed according to the definitions of the WHO (9). The confirmed cases with positive SARS-CoV2 PCR test post-exposure were considered as transmission. SARS-CoV2 viral RNA was tested using BioSpeedy COVID-19 RT-PCR (Bioeksen, Turkey) from nasopharyngeal and oropharyngeal swabs taken at admission in symptomatic participants and five or seven days after exposure from high and intermediate-risk participants.

The exposure risk of the participants was defined as low, medium and high according to the COVID-19 Filiation and contact follow-up guide of the ministry of health general directorate of public health. Healthcare workers who have come into contact with an unmasked COVID-19 patient without using PPE or a surgical mask constituted the high-risk group. Those who performed aerosol-generating procedures on a COVID-19 patient without using goggles or using a surgical mask, and healthcare workers who came into contact with a COVID-19 patient with a surgical mask without using PPE constituted the intermediate risk group. Those who came into contact with a COVID-19 patient without isolation gowns and gloves were in the low risk group. Healthcare workers caring for a COVID-19 patient using full PPE were not included in a risk group (10).

Statistical Analysis

Data were analyzed with IBM SPSS V23 (IBM SPSS, Chicago, IL, USA). Conformity to normal distribution was evaluated with the Kolmogrov-Smirnov test. The Mann-Whitney U test was used to compare the non-normally distributed age according to the groups. Chi-square and Fisher's Exact tests were used to compare categorical data according to groups. Binary logistic regression analysis was used to examine the risk factors affecting the positivity of the post-exposure SARS-CoV2 PCR result. Analysis results were presented as mean±standard deviation and median (minimum-maximum) for quantitative data, and frequency (percent) for categorical data. Significance level was taken as $p<0.05$.

RESULTS

Sociodemographic Features

A total of 1361 healthcare workers, 790 (58%) women and 571 (42%) men, were included in the study, and the mean age was 33,6±8,3 years. The healthcare workers consisted of 323 (23.7%) residents, 31 (2.3%) specialist doctors, 38 (2.8%) intern doctors, 504 (37%) nurses, 176 (12.9%) other healthcare staff, 126 (9.3%) secretaries, 114 (8.4%) healthcare technicians, 40 (2.9%) technicians providing non-health services and 9 (0.7%) security staff.

SARS-CoV2 PCR was positive in 94 (6.9%) of the participants due to exposure to patients. The ratio of male gender was significantly higher in those with positive SARS-CoV2 PCR results than those with negative results (54.3% vs 41%; p=0.012). Groups with positive and negative SARS-CoV2 PCR results were similar in terms of the mean age, presence of pregnancy, presence of comorbidity, occupational distribution, and the distribution of work units in the hospital ($p>0.05$ for each) (**Table 1**). Mortality was observed in one (1%) healthcare worker who was working as technician.

In univariate logistic regression analysis, the risk of transmission of COVID-19 was 1.704-fold higher in men (p=0.013) and 2,437-fold higher in those working in laboratory units (p=0.021). In the multivariate model analysis, being a male healthcare worker (1.633-fold; p=0.03) and working in laboratory units (2.89-fold; p=0.008) were independent risk factors for transmission (**Table 2**).

USE OF PROTECTIVE EQUIPMENT

The rate of those who did not wear surgical masks and gloves in the SARS-CoV2 positive group was significantly higher than those in the negative group (67% vs 51.9%; p=0.004 and 84% vs 71.5%; p=0.009, respectively). Positive and negative groups were similar in terms of N95 mask, goggles, face shield and isolation gowns usage rates ($p>0.05$ for each) (**Table 1**). In univariate logistic regression analysis, the healthcare workers who did not use surgical masks had a 1.887-fold higher risk of transmission than those who used, and it was found as an independent risk factor for transmission (p=0.005) (**Table 2**).

Table 1. Comparison of categorical variables according to post-exposure PCR results.

Variables	Mean±SD	Median	Min.-max.	Test statistics	p
Age				U=58028,5	0,679
Negative	33,6±8,3	32,0	18,0-63,0		
Positive	34,0±8,8	31,0	18,0-58,0		
Total	33,6±8,3	32,0	18,0-63,0		
Post-exposure COVID-19 PCR result	Negative (n=1267)	Positive (n=94)	Total (n=1361)	Test statistics	p
Gender				x^2=6,274	0,012
Female	747 (59)	43 (45,7)	790 (58)		
Male	520 (41)	51 (54,3)	571 (42)		
Pregnancy				---	1,000F
No	821 (99,5)	39 (100)	860 (99,5)		
Yes	4 (0,5)	0 (0)	4 (0,5)		
Comorbidity				---	0,251F
No	1207 (96,2)	93 (98,9)	1300 (96,4)		
Yes	48 (3,8)	1 (1,1)	49 (3,6)		
Profession				x^2=11,072	0,198
Residents	300 (23,7)	23 (24,5)	323 (23,7)		
Specialist doctor	29 (2,3)	2 (2,1)	31 (2,3)		
Nurse	481 (38)	23 (24,5)	504 (37)		
Healthcare technician	104 (8,2)	10 (10,6)	114 (8,4)		
Other healthcare staff	162 (12,8)	14 (14,9)	176 (12,9)		
Security	8 (0,6)	1 (1,1)	9 (0,7)		
Secretary	112 (8,8)	14 (14,9)	126 (9,3)		
Non-health service technician	35 (2,8)	5 (5,3)	40 (2,9)		
Intern doctor	36 (2,8)	2 (2,1)	38 (2,8)		
General Department				x^2=9,425	0,151
Clinic	801 (63,2)	58 (61,7)	859 (63,1)		
Emergency room	33 (2,6)	3 (3,2)	36 (2,6)		
Laboratory	51 (4)	9 (9,6)	60 (4,4)		
COVID-19 service	58 (4,6)	3 (3,2)	61 (4,5)		
Hospital management	79 (6,2)	7 (7,4)	86 (6,3)		
Supporting units	35 (2,8)	4 (4,3)	39 (2,9)		
ICU	210 (16,6)	10 (10,6)	220 (16,2)		
Surgical mask				x^2=8,079	0,004
No	657 (51,9)	63 (67)	720 (52,9)		
Yes	610 (48,1)	31 (33)	641 (47,1)		
N95 mask				x^2=1,086	0,297
No	1144 (90,4)	88 (93,6)	1232 (90,6)		
Yes	122 (9,6)	6 (6,4)	128 (9,4)		
Protective glasses				x^2=3,773	0,052
No	1133 (89,5)	90 (95,7)	1223 (89,9)		
Yes	133 (10,5)	4 (4,3)	137 (10,1)		
Face shield				x^2=0,775	0,379
No	1167 (92,2)	89 (94,7)	1256 (92,4)		
Yes	99 (7,8)	5 (5,3)	104 (7,6)		
Protective gown				x^2=1,826	0,177
No	1019 (80,5)	81 (86,2)	1100 (80,9)		
Yes	247 (19,5)	13 (13,8)	260 (19,1)		
Gloves				x^2=6,844	0,009
No	905 (71,5)	79 (84)	984 (72,4)		
Yes	360 (28,5)	15 (16)	375 (27,6)		

Table 1. Comparison of categorical variables according to post-exposure PCR results (continued)					
Post-exposure COVID-19 PCR result	**Negative (n=1267)**	**Positive (n=94)**	**Total (n=1361)**	**Test istatistics**	**p**
Contact duration					
<15 minutes	353 (27,9)	13 (13,8)	366 (26,9)	x^2=8,763	0,003
≥15 minutes	914 (72,1)	81 (86,2)	995 (73,1)		
Contact risk					
High	456 (36)a	69 (73,4)b	525 (38,6)	x^2=56,502	<0,001
Intermediate	523 (41,3)a	24 (25,5)b	547 (40,2)		
Low	278 (21,9)a	1 (1,1)b	279 (20,5)		
Non-applicable	10 (0,8)	0 (0)	10 (0,7)		
Contact area					
Hospital	1204 (95)	69 (73,4)	1273 (93,5)	x^2=67,655	<0,001
Out of the hospital	63 (5)	25 (26,6)	88 (6,5)		
Contact area: hospital					
Working	706 (58,6)	46 (66,7)	752 (59,1)	x^2=1,740	0,187
Social	498 (41,4)	23 (33,3)	521 (40,9)		
Patient contact					
Aerosol-forming procedures	36 (12,6)	0 (0)	36 (12)	---	0,389F
Nonaerosol-forming procedures	250 (87,4)	14 (100)	264 (88)		
Contact area: out of the hospital					
Home	34 (54)	20 (80)	54 (61,4)	x^2=5,465	0,065
Hospital service vehicle	3 (4,8)	0 (0)	3 (3,4)		
Restaurant, public transport	26 (41,3)	5 (20)	31 (35,2)		

Table 2. Examination of the risk factors affecting the positivity of post-exposure PCR results.				
	Univariate		**Multivariate***	
	OR (%95 CI)	**p**	**OR (%95 CI)**	**p**
Age	1,005 (0,98-1,031)	0,683		
Gender (male)	1,704 (1,118-2,596)	0,013	1,633 (1,048-2,544)	0,030
Comorbidity (Yes)	0,27 (0,037-1,981)	0,198		
Profession	1,077 (0,988-1,174)	0,092		
General Department (Clinics)				
Emergency room	1,255 (0,374-4,217)	0,713	1,445 (0,423-4,935)	0,557
Laboratory	2,437 (1,143-5,196)	0,021	2,89 (1,322-6,316)	0,008
COVID-19	0,714 (0,217-2,35)	0,580	0,662 (0,193-2,271)	0,511
Hospital management	1,224 (0,54-2,772)	0,628	1,303 (0,564-3,01)	0,536
Supporting units	1,578 (0,542-4,593)	0,402	0,75 (0,237-2,372)	0,624
ICU	0,658 (0,33-1,309)	0,233	0,529 (0,257-1,088)	0,083
Surgical mask (no)	1,887 (1,211-2,941)	0,005		
N95 (no)	0,639 (0,274-1,493)	0,301		
Protective glasses / face shield (no)	0,456 (0,182-1,141)	0,093		
Protective uniform (no)	0,662 (0,363-1,209)	0,179		
Gloves (no)	2,096 (1,19-3,69)	0,010		
Contact duration (<15 minutes)	2,406 (1,323-4,377)	0,004	1,762 (0,949-3,273)	0,073
Contact risk				
High	42,066 (5,809-304,593)	<0,001		
Intermediate	12,757 (1,717-94,799)	0,013		
Contact area (out of hospital)	6,924 (4,104-11,682)	<0,001	7,154 (4,085-12,529)	<0,001
Contact area: hospital (working)	0,709 (0,424-1,185)	0,189		
Contact area: out of hospital (home)	3,058 (1,013-9,259)	0,047		

Contact

In group with positive SARS-CoV2 PCR, the rate of those with a contact duration of 15 minutes or longer, high-risk contacts, out-of-hospital contact were significantly higher than the negative group (86.2% vs 72.1%; p=0.003 and 73.4% vs 36%; p<0.001 and 73.4% vs 95%; p<0.001 respectively) (**Table 1**).

There was no significant difference in transmission between the working and the social areas in the hospital, as well as among home, hospital service vehicle, restaurant and public transportation outside the hospital. In addition, no difference was noted between the procedures of aerosol-forming and not-forming. (p>0.05 for each) (**Table 1**).

In univariate logistic regression analysis, the risk of transmission was 2,406-fold higher in those with a contact duration of 15 minutes or longer (p=0.004). The risk was 42,066-fold higher in those with high-contact risk (p<0.001), and it was 6,924-fold higher in those whose contact area was out of hospital (p<0.001). The risk was 3.058-fold higher in those whose contact area was home (p=0.047). In the multivariate model analysis, those with contact area was out of the hospital had a 7,154-fold higher risk of transmission, and this was an independent risk factor (p<0.001) (**Table 2**).

We observed that the number of contacts increased as the pandemic prolonged (**Figure 1**). In addition, in daily analysis, we found that it decreased towards the weekend (**Figure 2**).

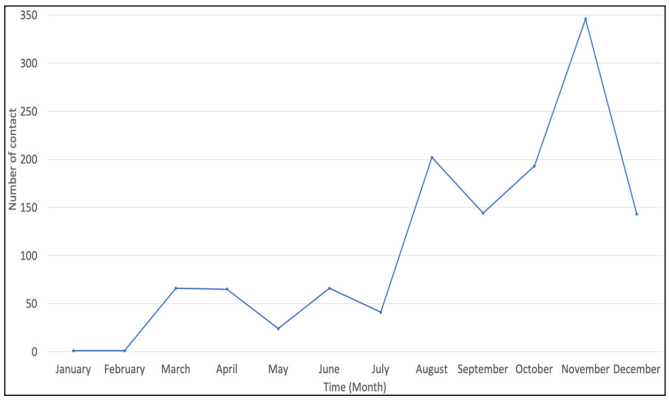

Figure 1. The number of risky contacts in 2020.

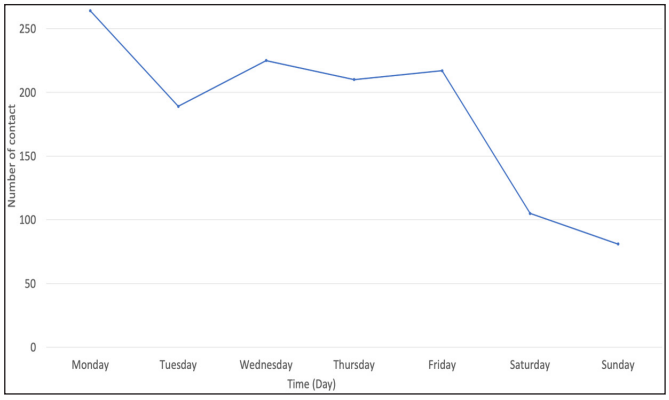

Figure 2. The number of risky contacts on daily.

DISCUSSION

The healthcare professionals' knowledge, attitudes, and behaviours about COVID-19 can affect patient management and pandemic control. The deficiencies of the healthcare workers in taking precautions against COVID-19 may make pandemic control more difficult (5, 11, 12).

While some studies reported no relationship between the transmission of COVID-19 and gender (13, 14). Another study reported that male gender was an independent risk factor for transmission (15). Authors explained the higher incidence of disease in males by behavioural factors such as low handwashing rates and non-compliance with rules (16, 17). In this study, the ratio of male gender was significantly higher in those with positive group than those with negative group (54.3% vs 41%; p=0.012). We found that male gender was an independent risk factor for transmission. The risk of transmission of COVID-19 was 1.704-fold higher in men (p=0.013). Since we obtained the participants' data mainly from declarations, we were not able to evaluate handwashing compliance adequately. The risk of transmission can be reduced by close observation following education of male healthcare workers who have high risk.

The use of face protection equipment is of great importance in preventing transmission (6-8). Exposure to the aerosols of infected patients without protective equipment has increased the risk of transmission (6,18). Lammers et al. (19) recommend taking precautions against airborne transmission, especially during the aerosol-generating processes. Bartoszko et al. (20) reported that the use of high-quality surgical masks could be as reliable as N95 masks in healthcare workers. The groups in our study were similar in terms of aerosol-generating procedures rates. This may be due to undetailed recording and explanations of procedures by healthcare providers and may suggest that a surgical mask may be sufficient in aerosol-generating procedures.

Other studies reported that the transmission of COVID-19 was significantly higher in healthcare workers who do not use PPE and led to increase in risk 3.8-5.9-fold (14, 21). It has thus shown that many healthcare workers were protected from transmission by using PPE before the vaccine (6). We found that the risk for contagion was 1.887-fold higher in those who did not use a surgical mask but not wearing an N95 mask did not increase the risk (p=0,005). We think surgical masks could be as reliable as N95 masks in healthcare workers. Bartoszko et al. (20) support this. We determined that not wearing gloves was a risk factor; the risk was 2,096-fold higher in participants without gloves but not using equipment such as face shields and safety glasses did not increase the risk (p=0.010). A contaminated environment is one of the major risk factors for healthcare-associated infections, The risk of transmission is high even when touching the mouth, nose, eyes and face skin through hands. Some studies have suggested that viral inoculum of SARS-CoV-2 could be transmission of disease (18). Our findings support that there is more virus inoculum with hand contact. The findings of our study show that healthcare workers who do not use surgical masks or gloves have a much more significant risk of transmission than those who do not use other PPE. Groups were similar in terms of other PPE use ratios.

Only one out of 94 healthcare workers in our hospital died of COVID-19. SARS-CoV2 can also be transmitted through the air, indoor and this contributes to the persistence of SARS-CoV2 in crowded areas (22,23). We found that the working area distributions between the positive and negative groups were similar. However, healthcare providers working in laboratory units had a 2,437-fold higher risk of transmission. These findings may explain why there is more transmission among healthcare workers in these areas. These units pose a risk for susceptible healthcare workers. We think that indoor units such as laboratories that direct patient contact considered unexpected which seems to be risk-free in terms of transmission, contribute to the cross-contamination of COVID-19 among healthcare workers.

Celebi et al. (24) reported that being in contact without a mask for 15 minutes or longer in the same room during the staff break increases the risk of transmission 7.42-fold. In the positive group, the risk rate of those with a contact duration of 15 minutes or longer was significantly higher than the negative group (86.2% vs 72.1%). We found that longer contact duration increased the risk of transmission by 2,406-fold. Another study showed that high-risk contact increased the risk of transmission 1.7 (25). The rate of high-risk contact in the positive group was significantly higher than that in the negative group (73.4% vs 36%). We showed that high-risk contact had 42,066-fold higher risk. These findings show that healthcare workers have an expected increased risk of transmission if they have high-risk contact.

Some studies have shown that the rate of household or community-acquired COVID-19 transmission is higher than that of hospital-acquired transmission (15, 26). In the positive group, the rate of those with out-of-hospital contact was significantly higher than the negative group (95% vs 73.4%). In this study, contact outside the hospital was found as an independent risk factor that caused the transmission 7,154-fold higher than in-hospital contact. In addition, if the contact was at home, the risk of transmission was 3,058-fold higher. These results showed that especially household contact played a role in increasing the transmission of COVID-19 in healthcare workers. Therefore, it is essential to comply with protective contact measures at home as in the hospital.

Galán et al. (13) reported that the risk of transmission in healthcare workers working in the COVID-19 unit was 1.7-fold higher. Madran et al. (14) reported that it was 2.7-fold higher. Celebi et al. (24) reported the infection rate as 8.3% in the COVID-19 unit, while it was 3.4% in other units. Working in the COVID-19 unit was not found as a risk factor for the transmission in our study. This can be explained by the careful compliance of the staff to the protective contact precautions in these units.

Some studies revealed that doctors or nurses had a higher risk of the transmission of COVID-19 (13, 27). However, Erol et al. (15) revealed that healthcare workers other than doctors had a higher risk. We found no significant relationship between the transmission of COVID-19 and the profession. More detailed and extensive studies are needed to clarify this situation.

We observed that the number of contacts increased as the pandemic prolonged. This may be due to increasing number of patients. Furthermore, the observation that decrease towards the end of the week may be due to decrease in the workload towards that time period, and fewer healthcare workers working at the weekend. Workload may cause a decrease in compliance with infection control measures. Healthcare workers should be trained on this subject frequently.

The participant data obtained without any objective evaluation may include the limitations of our study. Provided data were created by health workers' responses. However, the number of participants was kept high in order to reduce the margin of error. In addition, due to the mutations, the contagiousness of the disease has increased gradually. Therefore, the results of our study, which included patients in 2020, may not fully reflect current risk factors for contagion.

CONCLUSION

In addition to the known risk factors that play a role in the transmission to healthcare workers, we would like to draw attention to the indoor areas in which direct patient contact considered unexpected in the hospital. These areas, which seem risk-free in terms of transmission, are at high risk and contribute to the cross-contamination of COVID-19 among healthcare workers. We want to emphasize again that we must comply with infection control measures at indoor hospital areas that direct patient contact seemed unexpected.

ETHICAL DECLARATIONS

Ethics Committee Approval: The study was conducted with the permission of the Ondokuz Mayıs University Clinical Research Ethics Committee (Date: 03.11.2021, Decision No: KAEK 448/2021).

Informed Consent: All patients signed the free and informed consent form.

Referee Evaluation Process: Externally peer-reviewed.

Conflict of Interest Statement: The authors have no conflicts of interest to declare.

Financial Disclosure: The authors declared that this study has received no financial support.

Author Contributions: All of the authors declare that they have all participated in the design, execution, and analysis of the paper, and that they have approved the final version.

REFERENCES

1. Prevention, identification and management of health worker infection in the context of COVID-19 [Internet]. World Health Organization. [cited 2020 Oct 30]. Available from: https://www.who.int/publications/i/item/10665-336265
2. COVID-19 Pandemisi İki Aylık Değerlendirme Raporu [Internet]. Türk Tabipler Birliği COVID-19 Danışma ve İzleme Kurulu. [cited 2020 Aug 19]. Available from: https://www.ttb.org.tr/userfiles/files/covid19-rapor.pdf
3. Gómez-Ochoa SA, Franco OH, Rojas LZ, et al. COVID-19 in health-care workers: a living systematic review and meta-analysis of prevalence, risk factors, clinical characteristics, and outcomes. Am J Epidemiol 2021; 190: 161-75.
4. Shreffler J, Petrey J, Huecker M. The Impact of COVID-19 on Healthcare Worker Wellness: A Scoping Review. West J Emerg Med 2020; 21: 1059-66.
5. Sahu AK, Amrithanand V, Mathew R, Aggarwal P, Nayer J, Bhoi S. COVID-19 in health care workers-A systematic review and meta-analysis. Am J Emerg Med 2020; 38: 1727-31.
6. Gholami M, Fawad I, Shadan S, et al. COVID-19 and healthcare workers: A systematic review and meta-analysis. Int J Infect Dis 2021; 104: 335-46.
7. Ha JF. The COVID-19 pandemic, personal protective equipment and respirator: A narrative review. Int J Clin Pract 2020; 74: e13578.
8. Li DT, Samaranayake LP, Leung YY, Neelakantan P. Facial protection in the era of COVID-19: A narrative review. Oral Dis 2021; 27: 665-73.
9. WHO COVID-19 Case definition [Internet]. World Health Organization. [cited 2020 Aug 8]. Available from: https://www.who.int/publications/i/item/WHO-2019-nCoV Surveillance_Case_Definition-2020.1
10. Temaslı Takibi, Salgın Yönetimi, Evde Hasta İzlemi ve Filyasyon [Internet]. T.C. Sağlık Bakanlığı COVID-19 Bilgilendirme Platformu. [cited 2020 Mar 11]. Available from: https://covid19.saglik.gov.tr/TR-66339/temasli-takibi-salgin-yonetimi-evde-hasta-izlemi-ve-filyasyon.html
11. Wei JT, Liu ZD, Fan ZW, Zhao L, Cao WC. Epidemiology of and risk factors for COVID-19 infection among health care workers: a multi-centre comparative study. Int J Environ Res Public Health 2020; 17: 7149.
12. Zheng C, Hafezi-Bakhtiari N, Cooper V, et al. Characteristics and transmission dynamics of COVID-19 in healthcare workers at a London teaching hospital. J Hosp Infect 2020; 106: 325-9.
13. Galán MI, Velasco M, Casas ML, et al. Hospital-Wide SARS-CoV-2 seroprevalence in health care workers in a Spanish teaching hospital. Enferm Infecc Microbiol Clin 2020; 40: 302-309.
14. Madran B, Keske S, Beşli Y, Bozkurt İ, Ergönül Ö. The risk of SARS-CoV-2 infection among healthcare workers. Infect Dis Clin Microbiol 2020; 2: 54-60.
15. Erol Ç, Yanık-Yalçın T, Sarı N, Azap Ö, Arslan H. Predictors of COVID-19 among Healthcare Workers who were Exposed to COVID-19. Infect Dis Clin Microbiol 2021; 3: 87-96.
16. Acharya Y, Pant S, Gyanwali P, et al. Gender disaggregation in COVID-19 and increased male susceptibility. J Nepal Health Res Counc 2020; 18: 345-50.
17. Bwire GM. Coronavirus: Why Men are More Vulnerable to Covid-19 Than Women? SN Compr Clin Med 2020: 1-3.
18. Kim H, Hegde S, LaFiura C, et al. Access to personal protective equipment in exposed healthcare workers and COVID-19 illness, severity, symptoms and duration: a population-based case-control study in six countries. BMJ Global Health 2021; 6: e004611.
19. Lammers MJ, Lea J, Westerberg BD. Guidance for otolaryngology health care workers performing aerosol generating medical procedures during the COVID-19 pandemic. J Otolaryngol Head Neck Surg 2020; 49: 1-8.
20. Bartoszko JJ, Farooqi MAM, Alhazzani W, Loeb M. Medical masks vs N95 respirators for preventing COVID-19 in healthcare workers: A systematic review and meta-analysis of randomized trials. Influenza Other Respir Viruses 2020; 14: 365-73.
21. Contejean A, Leporrier J, Canouï E, et al. Transmission routes of severe acute respiratory syndrome coronavirus 2 among healthcare workers of a French university hospital in Paris, France. Open Forum Infect Dis 2021; 8: ofab054.
22. Centers for Disease Control and Prevention (CDC). Last accessed date: 2021 August 20. Available from: https://www.cdc.gov/infectioncontrol/pdf/guidelines/environmental-guidelines-P.pdf
23. Azuma K, Yanagi U, Kagi N, Kim H, Ogata M, Hayashi M. Environmental factors involved in SARS-CoV-2 transmission: effect and role of indoor environmental quality in the strategy for COVID-19 infection control. Environ Health Prev Med 2020; 25: 1-16.
24. Çelebi G, Pişkin N, Bekleviç AÇ, et al. Specific risk factors for SARS-CoV-2 transmission among health care workers in a university hospital. Am J Infect Control 2020; 48: 1225-30.
25. Varona JF, Madurga R, Peñalver F, et al. Seroprevalence of SARS-CoV-2 antibodies in over 6000 healthcare workers in Spain. Int J Epidemiol 2021; 50: 400-9.
26. Canova V, Lederer Schläpfer H, Piso RJ, 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
27. Bandyopadhyay S, Baticulon RE, Kadhum M, et al. Infection and mortality of healthcare workers worldwide from COVID-19: a systematic review. BMJ Glob Health 2020; 5: e003097.