



Clinical Characteristics and Risk Factors of COVID-19 Infection Among Healthcare Workers

Sağlık Çalışanlarında COVID-19 Klinik Özellikleri ve Risk Faktörleri

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ABSTRACT

Introduction: Understanding the pandemic characteristics and risk factors associated with COVID-19 infection among healthcare workers (HCWs) in hospitals is crucial for both preventing and controlling the spread of COVID-19 and safeguarding healthcare personnel. In our study, our objective was to examine the risk factors for SARS-CoV-2 infection among HCWs and to assess the disease's transmission characteristics and impact on the workforce.

Materials and Methods: Healthcare workers at Ankara Bilkent Şehir Hastanesi with positive (cases) and negative (control) results on SARS-CoV-2 reverse-transcriptase polymerase chain reaction (RT-PCR) tests were enrolled. Following the initial case in our country, follow-up forms were implemented for HCWs with a history of contact and COVID-19 infection at our hospital. Healthcare workers were subjected to active surveillance for follow-up. Demographic characteristics of HCWs, including occupation, the unit of employment, and risky contact status, were documented. Additionally, the duration of hospitalization for cases, administered treatments, and overall workforce loss were assessed. A comparison between the case and control groups was conducted regarding the aforementioned characteristics to explore factors influencing the onset of COVID-19 infection among HCWs. The SPSS 18.0 software was utilized for data analysis.

Results: One thousand five hundred fifty-nine cases were evaluated. The mean age of the patients was 31.3 ± 8.61 , and 75.1% were male. At the time of diagnosis, 50.9% of the HCWs were assigned to non-COVID-19 areas, 24.6% were working in the COVID-19 intensive care unit (ICU), and 24.5% were stationed in the COVID-19 ward. Fifty-one point three percent of the cases had a risky contact history. Risky contact was most frequently reported with patients (43.2%) and via close contact (99.3%). Of the cases, 84.2% exhibited symptoms, and 141 individuals were monitored through hospitalization. The hospitalization duration was 10.1 ± 13.9 days (1-150 days). The total workforce loss was 12.9 ± 7.1 days (median 10 days). Recovery was observed in 99.9% of cases. In a multivariate analysis of 742 individuals in the control group and 1559 in the case group, it was found that compared to individuals working in non-COVID-19 areas, those working in COVID-19 wards experienced a 70.2% lower risk of SARS-CoV-2 RT-PCR positivity. Similarly, those working in COVID-19 ICUs had a 57.8% lower risk (OR= 0.298, 95% CI= 0.225-0.394, $p < 0.001$, OR= 0.422, 95% CI= 0.308-0.577; $p < 0.001$, respectively).

Conclusion: During a pandemic, all healthcare workers need to exercise caution regardless of their work setting, not just those in high-risk areas.

Key Words: Healthcare workers; COVID-19; SARS-CoV-2; Clinical features; Risk factors

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ÖZ

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Giriş: Hastanelerde, sağlık çalışanları arasında COVID-19 enfeksiyonunun salgın özelliklerini ve risk faktörlerini anlamak, hem COVID-19'un önlenmesi ve kontrolü hem de sağlık çalışanı korumak adına büyük önem taşımaktadır. Çalışmamızda, sağlık çalışanlarında SARS-CoV-2 enfeksiyonu risk faktörlerini araştırmayı, hastalık, bulaş özelliklerini ve iş gücü kaybını değerlendirmeyi amaçladık.

Materyal ve Metod: Ankara Bilkent Şehir Hastanesinde çalışan, SARS-CoV-2 reverse-transcriptase polymerase chain reaction (RT-PCR) testi pozitif (vaka) ve negatif (kontrol) olan sağlık çalışanları çalışmaya dahil edildi. Ülkemizde ilk vakanın görülmesiyle birlikte temaslı ve COVID-19 olan sağlık çalışanları için takip formları oluşturuldu. Sağlık çalışanları aktif süreyans ile takip edildi. Sağlık çalışanlarının demografik özellikleri, meslekleri, çalıştıkları birim, riskli temas durumları kaydedildi. Hastanede kalış süresi, tedaviler ve toplam iş gücü kaybı hesaplandı. Sağlık çalışanlarında COVID-19 gelişimine etki eden faktörleri araştırmak için vaka ve kontrol grubu yukarıda belirtilen özellikler açısından karşılaştırıldı. Verilerin analizinde SPSS 18.0 programı kullanıldı.

Bulgular: Çalışmamıza 1559 SARS-CoV-2 RT-PCR pozitif sağlık çalışanları dahil edildi. Vakaların yaş ortalaması 31.3 ± 8.61 , %75.1'i erkekti. COVID-19 tanısı alındığında sağlık çalışanlarının %50.9'u COVID-19 dışı alanlarda, %24.6'sı COVID-19 yoğun bakım ünitesinde (YBÜ), %24.5'i COVID-19 servisinde çalışmaktaydı. Vakaların %51.3'ünün riskli teması mevcuttu. Riskli temas en sık hasta (%43.2) ile ve yakın temas (%99.3) şeklinde gerçekleşmişti. Vakaların %84.2'si semptomatik ve 141'i hastaneye yatırılarak izlendi. Hospitalizasyon süresi 10.1 ± 13.9 gündü (1-150). Toplam iş gücü kaybı 12.9 ± 7.1 gündü (medyan 10). Vakaların %99.9'u iyileşti. Kontrol (n= 742) ve vaka (n= 1559) gruplarının çok değişkenli analizi sonucunda, SARS-CoV-2 RT-PCR pozitifliği, pandemi dışı alanlarda çalışan sağlık çalışanlarına göre, pandemi servisinde çalışan sağlık çalışanlarında %70.2, pandemi YBÜ'de çalışan sağlık çalışanlarında ise %57.8 daha düşük bulundu (sırasıyla; OR= 0.298, %95 GA= 0.225-0.394; p< 0.001, OR= 0.422, %95 GA= 0.308-0.577; p< 0.001).

Sonuç: Salgın durumlarında sadece riskli alanlardaki sağlık çalışanları değil, tüm personel her alanda dikkatli olmalıdır.

Anahtar Kelimeler: Sağlık personeli; COVID-19; SARS-CoV-2; Klinik özellikler; Risk faktörleri

INTRODUCTION

The COVID-19 pandemic posed huge challenges to healthcare workers (HCWs). The increased risk of SARS-CoV-2 virus transmission is one of these challenges. In addition, the increasing number of cases with the pandemic implied working in overcrowded units, long working hours for the compensation of ill or quarantined colleagues, additional administrative duties, notification obligations, a heightened workload such as tracking contacts, prolonged use of personal protective equipment (PPE), limited contact with colleagues, and fear of transmission of the disease to their own families^[1-4]. Under all these negativities and stress, HCWs continued to work enthusiastically. The increasing number of cases demonstrated the importance of a functioning health system and the need for HCWs.

The prevalence of SARS-CoV-2 infection among HCWs was 3.46-28.9% in China, 12.9% in Massachusetts (USA), 38% in Madrid (Spain), 14% as per the Spanish Ministry of Health, and 14.5% in the United Kingdom^[5-8]. Until May 8, 2020, it was stated that 152.888 HCWs were infected worldwide^[9]. In Türkiye, it was reported that the number of infected HCWs exceeded 120.000 until December 9, 2020, as more than 10% of HCWs were infected and 216 HCWs died^[10].

Infected healthcare workers and patients in the hospital setting can play a critical role in facilitating transmission and increasing spread^[11,12]. Understanding the epidemic characteristics and risk factors of COVID-19 infection in hospitals, especially among healthcare workers, is indispensable for preventing and controlling COVID-19. Healthcare workers

represent a wide diversity, not only in the spectrum of occupations but also in demographic and socio-economic conditions^[13].

The present study aimed to investigate the risk factors for SARS-CoV-2 infection and evaluate the clinical course of the disease, the risk of exposure, and the loss of labor among our hospital staff.

MATERIALS and METHODS

Our study was carried out in Ankara Bilkent City Hospital. In our hospital, follow-up forms were created for the follow-ups of contact history and COVID-19 infection status of HCWs per the Turkish Ministry of Health's COVID-19 guidelines^[14]. Healthcare workers were monitored by the Infection Control Committee (ICC) through the use of pre-prepared forms for active surveillance. Between March 17, 2020, and February 28, 2021, HCWs (cases) with positive nasopharyngeal SARS-CoV-2 reverse-transcriptase polymerase chain reaction (RT-PCR) test results were included in the study. The control group consisted of HCWs (controls) whose SARS-CoV-2 RT-PCR test results were negative during this period. This prospective observational cohort study was approved by the Turkish Ministry of Health and Ankara Bilkent City Hospital Ethics Committee 1 (approval number: E1-22-2416). Written consent was not obtained from the participants due to the nature of the data collection, which involved epidemiological surveillance data.

The study recorded demographic characteristics such as age, gender, comorbid diseases, smoking habits, occupation, involvement in direct patient care, the specific unit where HCWs worked when they were diagnosed with COVID-19, and their status regarding receiving training on COVID-19 infection control measures. Additionally, the study documented whether there were risky contacts, specifying the index case (whether it was a colleague, patient, or household member), the type of contact (intense or close contact), the personal protective equipment (PPE) used by the healthcare worker during risky contact, and the mask-wearing status of the index case. Hospitalization status and duration of the cases, treatments received, and total labor loss were

evaluated. The case and control groups were compared in terms of the aforementioned characteristics to investigate the factors affecting the development of COVID-19 infection in HCWs.

Definitions

Healthcare workers was defined as all personnel working in healthcare facilities. Occupational groups were recorded as doctors, nurses, auxiliary health personnel, other auxiliary health personnel, supportive personnel, and administrative staff. Auxiliary health personnel included radiology, portable X-ray, laboratory, anesthesia, physical therapy technicians, biologists, physiotherapists, audiometrists, and psychologists. Other auxiliary health personnel included the staff working in the cafeteria, security, waste services, and hospital drivers. The group defined as supportive personnel was the people who assisted the nurses and doctors in patient care, cleaning the patient room, and taking/transporting the patient to any place. The unit they worked in was classified as non-COVID-19 patient areas, COVID-19 ward, and COVID-19 intensive care unit (ICU).

"Index case" refers to the patient who has tested positive for SARS-CoV-2 via RT-PCR. The index case was classified into three groups: patient, household, and colleague. Intense contact was defined as performing aerosol-generating procedures (AGP) on a COVID-19 patient or assisting in this procedure. Close contact was defined as being within a one meter distance of a COVID-19 patient for 15 minutes or more within the last 3-4 days, engaging in face-to-face interaction for 15 minutes or more, direct physical contact (e.g., handshake) with a person diagnosed with COVID-19, or direct exposure to their secretions (e.g., through coughing or touching used tissues). Healthcare workers were considered risky contact for SARS-CoV-2 virus transmission if they were exposed to any of the indicated contact patterns without the use of appropriate PPE^[15,16].

Statistical Analysis

Kolmogorov-Smirnov test was used to assess the assumption of normality. Normally distributed continuous variables were expressed as mean

± standard deviation while the continuous variables that do not have normal distribution were expressed as median (minimum-maximum). Categorical variables were summarized as counts (percentages).

For non-normally distributed continuous variables, differences between groups were tested using Mann-Whitney U test. Associations between categorical variables were determined by Pearson Chi-square/Fisher Exact test analysis.

Univariate logistic regression analysis was used to analyze the factors leading to the risk of SARS-CoV-2 RT-PCR positivity. A two-sided p-value <0.05 was considered statistically

significant. A multivariable logistic regression model was employed to predict potential risk factors associated with the risk of SARS-CoV-2 RT-PCR positivity. The variables which had a significance level of $p < 0.20$ from the univariate analysis were identified as candidate variables for the multivariable model. The multivariable logistic regression model was created using the Forward LR method.

RESULTS

Our hospital diagnosed 1559 cases between March 17, 2020, and February 28, 2021. The demographic and clinical characteristics of the cases are presented in Table 1. The mean

Table 1. Demographic characteristics of cases

	Cases (n= 1559, %)
Gender	
Male	1171 (75.1)
Female	388 (24.9)
Age, years, mean ± SD	31.3 ± 8.6
Comorbid diseases	219 (14)
Chronic respiratory diseases	59 (26)
Chronic cardiovascular diseases	45 (24)
Thyroid disease	40 (18)
Chronic rheumatological diseases	26 (11)
Diabetes mellitus	21 (9)
Other	28 (12)
Smoker	229 (14.7)
Profession	
Nurse	941 (60.4)
Doctor	255 (16.4)
Supportive personnel	161 (10.3)
Auxiliary health personnel	90 (5.7)
Administrative staff	69 (4.4)
Other auxiliary health personnel	43 (2.8)
Taking part in direct patient care	1427 (91.5)
Unit worked	
Non-COVID-19 patient areas	794 (50.9)
COVID-19 ICU	383 (24.6)
COVID-19 ward	382 (24.5)
Being trained in the prevention of COVID-19 infection prior to the pandemic	1556 (99.8)

SD: Standard deviation, ICU: Intensive care unit.

age of the cases was 31.3 ± 8.61 years, and 75.1% were male. 14% of the cases had at least one chronic disease and had smoked. The most common comorbid diseases were chronic respiratory diseases (26%), chronic cardiovascular diseases (24%), and thyroid disease (18%). The positive test results were detected most frequently in nurses (60.4%) and secondly in doctors (16.4%). 91.5% of HCWs were directly involved in patient care. At the time of the SARS-CoV-2 RT-PCR test positivity, 50.9% of the HCWs had been working in non-COVID-19 areas, 24.6% in the COVID-19 ICU, and 24.5% in the COVID-19 wards. The majority of HCWs had received training in the prevention of COVID-19 infection.

Contact characteristics of the cases are summarized in Table 2. Risky contact was most common with patient contact (43.2%) and close contact (99.3%). Mask use was present in the index case in 87.1% of risky contacts. The rate of mask usage during contact with healthcare workers was recorded at 53.5%.

While 15.8% of the cases were asymptomatic, 84.2% had at least one symptom (Table 3). The

most common symptom was sore throat (77.2%). Ninety-six point two percent of the cases received treatment, and 141 were hospitalized and followed up. Mean hospitalization time was 10.1 ± 13.9 days, and total labor loss was 12.9 ± 7.1 (median 10) days. Out of the 1559 cases that were monitored, 99.9% recovered from the disease.

Case (n= 1559) and control (n= 742) groups were compared to investigate the factors affecting SARS-CoV-2 RT-PCR positivity. There was no difference between the two groups in terms of gender, age, involvement in patient care, and comorbidities ($p= 0.230, 0.196, 0.280, 0.153$, respectively). As a result of multivariate analysis, the risk of SARS-CoV-2 RT-PCR positivity among those working in the COVID-19 wards was 70.2% lower than those working in the non-COVID-19 areas (OR= 0.298, 95% CI= 0.225-0.394; $p< 0.001$). Furthermore, the risk of SARS-CoV-2 RT-PCR positivity in COVID-19 ICU workers was 57.8% lower than in those working in non-COVID-19 areas (OR= 0.422, 95% CI= 0.308-0.577; $p< 0.001$) (Table 4).

Table 2. Contact patterns and contact characteristics

	Cases (n= 1559, %)
Non-risky exposed (non-contact)	759 (48.7)
Risky exposed	800 (51.3)
Index case (n= 800)	
Patient	346 (43.2)
Household	248 (31)
Colleague	206 (25.8)
Contact type	
Close contact	795 (99.3)
Intense contact	26 (3.2)
Presence of mask in the index case (n= 800)	697 (87.1)
Cases' use of PPE (n= 800)	
Surgical/FFP2 mask	428 (53.5)
Eye protection	133 (16.6)
Glove	294 (36.8)
Apron	240 (30)

PPE: Personal protective equipment.

Table 3. Clinical course and treatment features of the cases

	Cases (n= 1559, %)
Asymptomatic	247 (15.8)
Symptomatic	1312 (84.2)
Sore throat	1013 (77.2)
Cough	509 (38.8)
Fever	508 (38.7)
Inability to taste/smell	278 (21.2)
Runny/stuffy nose	244 (18.5)
Shortness of breath	172 (13.1)
Diarrhea	146 (11.1)
Status of receiving treatment	1500 (96.2)
Favipiravir	790 (52.7)
Favipiravir + HQ	377 (25.1)
HQ	306 (20.4)
HQ + Azithromycin	27 (1.8)
Hospitalization duration, days, (mean ± SD) (n= 141)	10.1 ± 13.9
Total labor loss, days (mean ± SD)	12.9 ± 7.1
Outcome	
Recovery	1558 (99.9)
Death	1 (0.1)

HQ: Hydroxychloroquine, SD: Standard deviation.

Table 4. Factors affecting SARS-CoV-2 RT-PCR positivity

Factors	Univariate logistic regression analysis			Multivariable logistic regression analysis		
	Crude OR	95% CI	p	Adjusted OR	95% CI	p
Unit worked (reference non-COVID-19 areas)						
COVID-19 wards	1.335	1.081-1.648	0.007	0.298	0.225-0.394	<0.001
COVID-19 ICU	3.244	2.466-4.269	0.001	0.422	0.308-0.577	<0.001

DISCUSSION

The COVID-19 pandemic has had a significant impact on the entire world, with the health sector being among the most profoundly affected. In our hospital, as the number of patients increased, bed capacities increased, and many HCWs were assigned to COVID-19 patient care outside their unit. This study was performed to evaluate the potential risk factors, clinical status, and effectiveness of infection prevention and control measures for COVID-19 among healthcare professionals working in our hospital.

In our study, we found that nurses had the highest rate of COVID-19 infection at 60.4%, followed by doctors at 16.4%, and auxiliary personnel at 10.3%. These findings are consistent with the literature^[17-19]. While the lowest rates were determined in clerical workers and technicians (3.6%) in the Italian study, our study concluded that the lowest rates occurred in personnel who were classified as administrative staff (4.4%) and other auxiliary health personnel (2.8%), who were not involved in primary patient care. The elevated infection rates among

doctors and nurses could be attributed to their prolonged exposure to patients and procedures that potentially expose them to higher viral loads^[20,21].

Estimates of the incidence of asymptomatic infections will clarify an understanding of the epidemiological potential of COVID-19 transmission and the true universality of the disease^[22,23]. The asymptomatic infection mostly develops in children and young adults aged 18-29 years, and the incidence rate varies between 1.6-56.5% in various studies^[24]. Asymptomatic infection rates in HCWs have been reported to be 1.6-44%^[17-19,25]. In these studies, the reported high rates were attributed to healthcare worker screening being conducted as a result of contact exposure. In our study, 1559 HCWs were diagnosed with COVID-19 in our hospital in less than a year. Asymptomatic infection developed in 15.8% of HCWs. In another study performed in our country, the rate of asymptomatic infection was reported as 18%^[26]. Healthcare workers may have participated more in patient care during this process, being more cautious about infecting others, including loved ones, and accessing tests more readily due to their profession. This screening approach can reduce cross-contamination among healthcare workers, ensuring a safer hospital environment and optimal hospital functioning during the crisis. Additionally, it can reduce staff anxiety about being infected by a colleague by contributing to the staff's sense of trust. For asymptomatic HCWs, however, running such a program requires a large laboratory capacity not available at every institution. Besides, SARS-CoV-2 RT-PCR-based screening results are only valid for the day of the test, which can lead to a false sense of confidence.

When the literature is examined, dry cough, fever, and shortness of breath are the most common symptoms^[27]. Studies conducted with HCWs show a wide spectrum of symptoms^[28,29]. Fever (OR= 4.86, 95% CI= 2.38-8.37; I²= 84%), anosmia (OR= 28.37; 95% CI 9.45-85.16; I²= 79%), and myalgia (OR= 3.06; 95% CI= 1.24-7.56; I²= 86%) were associated with higher rates of COVID-19 for symptomatic healthcare

workers^[19,30]. Relying on these specific but non-sensitive symptoms to define symptom-by-symptom screening criteria may result in missing a significant proportion of COVID-19-positive cases, so being cautious is emphasized. In their study, Chow et al. stated that screening of HCWs solely based on fever, cough, shortness of breath, and sore throat may have missed 17% of symptomatic healthcare workers at the onset of the disease. The authors also reported that expanding the symptom screening criteria to include chills and myalgia may still miss 10% of cases^[29]. Specifically, screening for these symptoms may benefit low- and middle-income countries with limited testing capacity. When the results are considered, it is necessary to increase the symptom diversity in the screening criteria for HCWs^[31].

In the review of Gymez-Ochoa et al., the severe COVID-19 infection rate was 5%, and mortality was 0.5% among HCWs^[19]. The mortality rate among healthcare workers was lower than the general population reported in the literature^[28]. This condition may be due to factors such as better overall health and care in healthcare workers, different age demographics, and chronic illness relative to the general population. However, while caring for large numbers of infected patients, HCWs are more likely to be infected with a higher viral load, which is associated with poor clinical outcomes, although the results show a lower mortality rate. This is strong evidence that current PPE practices are protective and reduce healthcare workers' anxiety and psychological distress^[32,33]. In our study, similar to others, only one HCW who was followed up due to COVID-19 died.

SARS-CoV-2 RT-PCR positivity rate was lower in patients working in the COVID-19 ICU and COVID-19 wards compared to HCWs working in non-COVID-19 areas (57.8%, OR= 0.298, 95% CI= 0.225-0.394, $p < 0.001$; and 70.2%, OR= 0.298, 95% CI= 0.225-0.394, $p < 0.001$, respectively) in the present study. These results are consistent with other studies in the literature^[18,21,34,35]. This condition may be attributed to HCWs being more diligent in adhering to infection control measures when

interacting with suspected and confirmed cases, along with the frequent implementation of cleaning and disinfection protocols in these areas. The study by Grant et al. concluded that seroprevalence was lower among COVID-19 ICU workers, possibly due to several factors. These include the use of specialized personal protective equipment designed for healthcare workers in intensive care units, closed-circuit ventilation systems for intubated patients, and COVID-19 patients requiring intensive care admission typically present around the 10th day of illness, potentially resulting in decreased viral loads^[36]. However, a study involving 3477 symptomatic HCWs in the USA found no difference in disease prevalence between COVID-19 and non-COVID-19 areas [5.2% (95% CI, 4.33-6.15) vs. 5.5% (95% CI, 4.17-6.78), respectively]. As a result of this study, the authors concluded that they initially believed community transmission played a significant role in healthcare worker infections at the onset of the pandemic^[28].

Inappropriate PPE use, suboptimal hand hygiene, working in the emergency room, long working hours, and removing masks during breaks with colleagues were risk factors for COVID-19 transmission among HCWs^[9,19,37-39]. Studies prove that improper removal of PPE causes contamination^[40,41]. In our study, we examined the use of PPE. However, we did not assess additional factors such as the correct wearing and removal of PPE, contamination rates during these procedures, and compliance with hand hygiene protocols.

Our study contributes to the existing literature by further elucidating the risk factors associated with SARS-CoV-2 infections among healthcare workers when compared with their uninfected counterparts. We also collected information from healthcare professionals with active surveillance regardless of their symptoms, allowing us to assess risk factors with minimal recall bias.

The present study has some limitations. In our study, we examined the use of PPE. However, we did not assess additional factors such as the correct wearing and removal of PPE, contamination rates during these procedures,

and compliance with hand hygiene protocols. A more robust case-control study would offer more comprehensive guidance for identifying predictors and risk factors associated with SARS-CoV-2 infection among healthcare workers. Healthcare workers face significant risks in the event of a pandemic. As a result of our study, it was found that the risk of infection was high in those working in areas other than COVID-19. It is equally important for HCWs in other departments to be alert to COVID-19 and adhere to infection control measures. Additional measures should be implemented to mitigate this risk among HCWs, including ensuring adequate nutrition, implementing work rotation schedules, and providing psychological support.

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ETHICS COMMITTEE APPROVAL

This study was approved by the Ankara City Hospital Clinical Research Ethics Committee 1 (Decision no: E1-22-2416, Date: 23.02.2022).

CONFLICT of INTEREST

The authors have no conflicts of interest to declare that are relevant to the content of this article.

AUTHORSHIP CONTRIBUTIONS

Concept and Design: RG, AKK

Analysis/Interpretation: RG, AKK, BK

Data Collection or Processing: AKK, İH, AAS, FE, BK

Writing: AKK, RG, BK, FE, İH, AD

Review and Correction: All of authors

Final Approval: All of authors

REFERENCES

1. TC Sağlık Bakanlığı. COVID-19 durum raporları. Available from: https://covid19.saglik.gov.tr/Eklenti/39229/0/covid-19-haftalik-durum-raporu---43pdf.pdf?_tag1=70F7CD-89B8F7191D8FAD3ACF29EF550190C31B61.
2. World Health Organization (WHO). Summary of probable SARS cases with onset of illness from 1 November 2002 to 31 July 2003. Available from: https://www.who.int/csr/sars/country/table2004_04_21/en/ (Accessed date: 05.05.2020).
3. Schwartz J, King CC, Yen MY. Protecting healthcare workers during the coronavirus disease 2019 (COVID-19) outbreak: Lessons from Taiwan's severe acute respiratory syndrome response. *Clin Infect Dis* 2020;71:858-60. <https://doi.org/10.1093/cid/ciaa255>
4. Yen MY, Lin YE, Lee CH, Ho MS, Huang FY, Chang SC, et al. Taiwan's traffic control bundle and the elimination of nosocomial severe acute respiratory syndrome among healthcare workers. *J Hosp Infect* 2011;77:332-7. <https://doi.org/10.1016/j.jhin.2010.12.002>
5. The Lancet. COVID-19: Protecting health-care workers. *Lancet* 2020;395:922. [https://doi.org/10.1016/S0140-6736\(20\)30644-9](https://doi.org/10.1016/S0140-6736(20)30644-9)
6. Wang D, Hu B, Hu C, Zhu F, Liu X, Zhang J, et al. Clinical characteristics of 138 hospitalized patients with 2019 novel coronavirus-infected pneumonia in Wuhan, China. *Jama* 2020;323:1061-9. <https://doi.org/10.1001/jama.2020.1585>
7. Wang X, Ferro EG, Zhou G, Hashimoto D, Bhatt DL. Association between universal masking in a health care system and SARS-CoV-2 positivity among health care workers. *JAMA* 2020;324:703-4. <https://doi.org/10.1001/jama.2020.12897>
8. Hunter E, Price DA, Murphy E, van der Loeff IS, Baker KF, Lendrem D, et al. First experience of COVID-19 screening of health-care workers in England. *Lancet* 2020;395:e77-8. [https://doi.org/10.1016/S0140-6736\(20\)30970-3](https://doi.org/10.1016/S0140-6736(20)30970-3)
9. Bandyopadhyay S, Baticulon RE, Kadhum M, Alser M, Ojuka DK, Badereddin Y, et al. Infection and mortality of healthcare workers worldwide from COVID-19: A systematic review. *BMJ Glob Health* 2020;5:e003097. <https://doi.org/10.1136/bmjgh-2020-003097>
10. Haberler. Salgın süresince 216 sağlık personeli koronavirüs nedeniyle hayatını kaybetti - Haberler [Internet]. [cited 2021 May 1]. Available from: <https://www.haberler.com/salgin-suresince-216-saglik-personeli-koronavirus-13790214-haber/>.
11. Chou R, Dana T, Buckley DI, Selph S, Fu R, Totten AM. Update Alert: Epidemiology of and risk factors for Coronavirus infection in health care workers. *Ann Intern Med* 2020;173:w46-7. <https://doi.org/10.7326/L20-0768>
12. Kaya Kalem A, Kayaaslan B, Eser F, Hasanoglu İ, Ayhan M, Coskun B, et al. Investigation of the relation between risk assessment of exposure and nosocomial SARS-CoV-2 transmission in healthcare workers: A prospective single-centre study. *BMJ Open* 2022;12:e056858. <https://doi.org/10.1136/bmjopen-2021-056858>
13. Çelebi G, Pişkin N, Çelik Bekleviç A, Altunay Y, Salcı Keleş A, Tüz MA, 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. <https://doi.org/10.1016/j.ajic.2020.07.039>
14. T.C. Sağlık Bakanlığı Halk Sağlığı Genel Müdürlüğü. COVID-19 (SARS-CoV-2 Enfeksiyonu) Rehberi (Bilim Kurulu Çalışması) [Internet]. Ankara: Sağlık Bakanlığı Available from: <https://covid19.saglik.gov.tr/TR-66301/covid-19-rehberi.html> Accessed date: 14.04.2020).
15. Centers for Disease Control and Prevention (CDC). Interim U.S. guidance for risk assessment and work restrictions for healthcare personnel with potential exposure to COVID-19. Available from: <https://www.cdc.gov/coronavirus/2019-ncov/hcp/guidance-risk-assesmenthcp.html> (Accessed date: 27.05.2020).
16. World Health Organization (WHO). Health workers exposure risk assessment and management in the context of COVID-19 virus: Interim guidance, 4 March 2020. Available from: <https://apps.who.int/iris/handle/10665/331340>
17. Lombardi A, Consonni D, Carugno M, Bozzi G, Mangioni D, Muscatello A, et al. Characteristics of 1573 healthcare workers who underwent nasopharyngeal swab testing for SARS-CoV-2 in Milan, Lombardy, Italy. *Clin Microbiol Infect* 2020;26:1413.e9-e13. <https://doi.org/10.1016/j.cmi.2020.06.013>
18. Dev N, Meena RC, Gupta DK, Gupta N, Sankar J. Risk factors and frequency of COVID-19 among healthcare workers at a tertiary care centre in India: a case-control study. *Trans R Soc Trop Med Hyg* 2021;115:551-6. <https://doi.org/10.1093/trstmh/traab047>
19. Gómez-Ochoa SA, Franco OH, Rojas LZ, Raguidin PF, Roa-Díaz ZM, Wyssmann BM, et al. COVID-19 in healthcare workers: a living systematic review and meta-analysis of prevalence, risk factors, clinical characteristics, and outcomes. *Am J Epidemiol* 2021;190:161-75. <https://doi.org/10.1093/aje/kwaa191>
20. Zheng L, Wang X, Zhou C, Liu Q, Li S, Sun Q, et al. Analysis of the infection status of healthcare workers in Wuhan during the COVID-19 outbreak: a cross-sectional study. *Clin Infect Dis* 2020;71:2109-13. <https://doi.org/10.1093/cid/ciaa588>
21. Marwah S, Arora R, Sivajyothi BM, Dhama V, Gupta N. SARS COV 2 positive healthcare workers in obstetrics and gynaecology Save the saviour study. *J Family Med Prim Care* 2021;10:4410-7. https://doi.org/10.4103/jfmpc.jfmpc_2541_20
22. Chams N, Chams S, Badran R, Shams A, Araj A, Raad M, et al. COVID-19: A multidisciplinary review. *Front Public Health* 2020;8:383. <https://doi.org/10.3389/fpubh.2020.00383>
23. Pan X, Chen D, Xia Y, Wu X, Li T, Ou X, Zhou L, Liu J. Asymptomatic cases in a family cluster with SARS-CoV-2 infection. *Lancet Infect Dis* 2020;20:410-1. [https://doi.org/10.1016/S1473-3099\(20\)30114-6](https://doi.org/10.1016/S1473-3099(20)30114-6)
24. The Novel Coronavirus Pneumonia Emergency Response Epidemiology Team The epidemiological characteristics of an outbreak of 2019 novel coronavirus diseases (COVID-19) - China, 2020. *China CDC Wkly* 2020;2:113-22. <https://doi.org/10.46234/ccdcw2020.032>

25. Oster Y, Wolf DG, Olshatkin-Pops K, Rotstein Z, Schwartz C, Benenson S. Proactive screening approach for SARS-CoV-2 among healthcare workers. *Clin Microbiol Infect* 2021;27:155-6. <https://doi.org/10.1016/j.cmi.2020.08.009>
26. Eren E, Çelik İ, Yıldız M, Topaloğlu US, Kılınç Toker A, Arman Fırat Emine, et al. Evaluation of health care workers with COVID-19. *Klinik Derg* 2020;33:230-4. <https://doi.org/10.5152/kd.2020.48>
27. Seyed Hosseini E, Riahi Kashani N, Nikzad H, Azadbakht J, Hassani Bafrani H, Haddad Kashani H. The novel Coronavirus Disease-2019 (COVID-19): Mechanism of action, detection and recent therapeutic strategies. *Virology* 2020;551:1-9. <https://doi.org/10.1016/j.virol.2020.08.011>
28. Mani NS, Budak JZ, Lan KF, Bryson-Cahn C, Zelikoff A, Barker GEC, et al. Prevalence of Coronavirus Disease 2019 Infection and outcomes among symptomatic healthcare workers in seattle, Washington. *Clin Infect Dis* 2020;71:2702-7. <https://doi.org/10.1093/cid/ciaa761>
29. Chow EJ, Schwartz NG, Tobolowsky FA, Zacks RLT, Huntington-Frazier M, Reddy SC, et al. Symptom screening at illness onset of health care personnel with SARS-CoV-2 infection in King County, Washington. *JAMA* 2020;323:2087-9. <https://doi.org/10.1001/jama.2020.6637>
30. Chas J, Nadal M, Siguier M, Fajac A, Denis M, Morand-Joubert L, et al. Broad-based SARS-CoV-2 testing program for healthcare workers in a primary care hospital in France. *Infect Dis Now* 2021;51:556-9. <https://doi.org/10.1016/j.idnow.2020.11.016>
31. Lee Y, Min P, Lee S, Kim SW. Prevalence and duration of acute loss of smell or taste in COVID-19 patients. *J Korean Med Sci* 2020;35:e174. <https://doi.org/10.3346/jkms.2020.35.e174>
32. Liu Y, Yan LM, Wan L, Xiang TX, Le A, Liu JM, et al. Viral dynamics in mild and severe cases of COVID-19. *Lancet Infect Dis* 2020;20:656-7. [https://doi.org/10.1016/S1473-3099\(20\)30232-2](https://doi.org/10.1016/S1473-3099(20)30232-2)
33. Jeremias A, Nguyen J, Levine J, Pollack S, Engellenner W, Thakore A, et al. Prevalence of SARS-CoV-2 Infection among health care workers in a tertiary community hospital. *JAMA Intern Med* 2020;180:1707-9. <https://doi.org/10.1001/jamainternmed.2020.4214>
34. Zabarsky TF, Bhullar D, Silva SY, Mana TSC, Ertle MT, Navas ME, et al. What are the sources of exposure in healthcare personnel with coronavirus disease 2019 infection? *Am J Infect Control* 2021;49:392-5. <https://doi.org/10.1016/j.ajic.2020.08.004>
35. Fusco FM, Pisaturo M, Iodice V, Bellopede R, Tambaro O, Parrella G, et al. COVID-19 among healthcare workers in a specialist infectious diseases setting in Naples, Southern Italy: Results of a cross-sectional surveillance study. *J Hosp Infect* 2020;105:596-600. <https://doi.org/10.1016/j.jhin.2020.06.021>
36. Grant JJ, Wilmore S, McCann NS, Donnelly O, Lai R, Kinsella MJ, et al. Seroprevalence of SARS-CoV-2 antibodies in healthcare workers at a London NHS trust. *Infect Control Hosp Epidemiol* 2020;4:1-3. <https://doi.org/10.1017/ice.2020.402>
37. Hoernke K, Djellouli N, Andrews L, Lewis-Jackson S, Manby L, Martin S, et al. Frontline healthcare worker's experiences with personal protective equipment during the COVID-19 pandemic in the UK: A rapid qualitative appraisal. *BMJ Open*. 2021;11:e046199. <https://doi.org/10.1136/bmjopen-2020-046199>
38. Kim H, Hegde S, LaFiura C, Raghavan M, Sun N, Cheng S, 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 Glob Health* 2021;6:e004611. <https://doi.org/10.1136/bmjgh-2020-004611>
39. 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. <https://doi.org/10.3390/ijerph17197149>
40. Sharma S, Mohindra R, Rana K, Suri V, Bhalla A, Biswal M, et al. Assessment of potential risk factors for 2019-Nov-el Coronavirus (2019-nCov) infection among health care workers in a tertiary care hospital, North India. *J Prim Care Community Health* 2021;12:21501327211002099. <https://doi.org/10.1177/21501327211002099>
41. Mumma JM, Durso FT, Ferguson AN, Gipson CL, Casanova L, Erukunakpor K, et al. Centers for Disease Control and Prevention Epicenters Program, Division of Healthcare Quality Promotion. Human factors risk analyses of a doffing protocol for ebola-level personal protective equipment: Mapping errors to contamination. *Clin Infect Dis* 2018;66:950-9. <https://doi.org/10.1093/cid/cix957>

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