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Evaluation and Screening of COVID-19, Contact and Risk Conditions in Healthcare Workers in a University Hospital

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ABSTRACT

Objectives: The aim of this study was to evaluate the management and risk conditions of healthcare workers (HCWs) having COVID-19 infection before and after the normalization process (NP).

Methods: The working group of this study consisted of 1881 HCWs who applied to the Occupational Health and Safety Unit. A form for determining the HCWs' sociodemographic characteristics and the Healthcare Worker COVID-19 Contact Case Follow-up Form were used using the Ministry of Health COVID-19 Guide.

Results: This study included 1881 HCWs. The polymerase chain reaction (PCR) test was assessed in 1373 (73.0%) of the HCWs, and 172 (12.5%) of the PCR tests were positive HCWs who underwent PCR testing. Before the NP, 13 (2.5%) of the HCWs had PCR positive, and after the NP, 159 (18.4%) of 862 HCWs were PCR positive. While 80 (46.5%) of PCR-positive HCWs were using personal protective equipment (PPE), 478 (39.8%) of PCR-negative HCWs were using PPE ($p<0.001$). While 5 (38.4%) PCR-positive and 262 (52.6) PCR-negative HCWs were using PPE before NP, 75 (47.1%) PCR-positive and 216 (30.7) PCR-negative HCWs were using PPE after NP ($p<0.001$ and $p<0.001$, respectively).

Conclusion: The study showed that the frequency of COVID-19 PCR positivity in the HCWs is similar to that given by World Health Organization.

Keywords: COVID-19, healthcare worker, hospital

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INTRODUCTION

COVID-19 first appeared in Wuhan, China, in December 2019. The epidemic, which is not yet clear on the cause of its occurrence, spread to the country in as little as 1 month.[1,2] The World Health Organization (WHO) announced this epidemic disease as a new type of coronavirus (COVID-19) on February 11, 2020. It was determined that two-thirds of the 41 people infected with this virus epidemic in China were linked to the live animal market in Wuhan, and it was stated that the source of the virus was here.[3,4] Furthermore, it was determined that some infected people never went to this market. In the first released reports, it was said that its spread among people was limited, but it was later revealed that it could spread from person to person and over large areas. More than 2 months after the epidemic, after the virus was seen and spread in countries other than China, it was declared a global outbreak (Pandemic) by the WHO on March 11, 2020. While the first case in Turkey was recorded on March 11, 2020,

the first death due to the disease was reported on March 16, 2020.[5] As of April 19, Turkey became the seventh most common country in terms of the number of cases, after France, leaving behind China, the country where the outbreak first began. In terms of the number of deaths, it rose to 13th place among 185 countries.

The Severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) virus that causes COVID-19 spreads between people, mainly when an infected person is in close contact with another person.[6] The virus can spread from an infected person's mouth or nose in small liquid particles when they cough, sneeze, talk, sing, or breathe heavily. These liquid particles are of different sizes, ranging from larger "respiratory droplets" to smaller "aerosols." Other people can catch COVID-19 when the virus gets into their mouth, nose or eyes, which is more likely to happen when people are in direct or close contact with an infected person. Current evidence suggests that the main way the virus spreads is by respiratory droplets among people who are in close contact with each other. Aerosol transmission can occur in specific settings, particularly in indoor, crowded places where the infected person(s) spend long periods of time with others, such as restaurants, choir practices, fitness classes, offices, and/or places of worship. More studies are underway to better understand the conditions in which aerosol transmission occurs outside of medical facilities where specific medical procedures, called aerosol-generating procedures, are conducted.

Those infected with COVID-19 may be asymptomatic or have symptoms such as fever, dry and wet cough, nasal congestion, fatigue, myalgia, sore throat, headache, diarrhea, dizziness, and loss of taste or smell.[7,8] The time to onset of symptoms is estimated by the WHO as 2–10 days. Severe cases of infection were strongly associated with acute kidney failure, respiratory failure, and in-hospital mortality.

Healthcare workers (HCWs) have provided a wide range of services during the pandemic process.[9] They have worked in clinics, wards, operating rooms and intensive care units, emergency departments, ambulances, family health centers, pharmacies, and adoption teams, whether during a pandemic or not.

Current evidence shows that COVID-19 is transmitted by close contact and droplets between humans.[10] Those at the greatest risk of acquiring this disease are those who come into contact with or care for the patient. Therefore, HCWs who care for these patients are considered to be at high risk in terms of this infection, and the protection of HCWs is considered one of the top priorities. Professor Dr Cemal Taşçıoğlu from Istanbul University Faculty of Medicine, one of the leading internists in Turkey and one of the first doctors to diagnose coronavirus cases, unfortunately, was the first HCW who died in Turkey due to coronavirus.[11] In late September 2020, the WHO reported that at least 10% of all cases (more than 1.4 million COVID-19 infections) were HCWs, and at least 7000 HCWs worldwide died from coronavirus.[12,13] In Turkey, the Minister of Health reported that 74248 (6.5%) of the total one million HCWs were infected in his statement about the employees' health affected by the outbreak in Turkey.

In this study, it was aimed to evaluate the management and risk conditions of HCWs having COVID-19 infection before and after the normalization process (NP).

METHOD

The study group of their search consists of 1881 health workers who applied to the Selcuk University Faculty of Medicine Occupational Health and Safety Unit between March 16, 2020, and August 16, 2020. This study was conducted to evaluate the HCWs' contact with COVID-19 patients, their risk conditions, laboratory algorithms, treatment, and isolation according to the risk categories, both in general and before and after the NP. In workers looking after COVID-19 patients, after their on-call periods, COVID-19 symptom questioning and evaluation of the contact status with COVID-19 patients were performed, and the exposure risk was determined. According to the COVID-19 guidelines of the Ministry of Health, laboratory algorithms and treatment were applied according to the risk categories for the contact HCW.[10] Isolation is proposed according to this algorithm. The same care and screening were performed for HCWs who did not work in COVID-19 wards and did not have any symptoms. In the Healthcare Worker COVID-19 Contact and Risk Assessment Form, the participants' age, profession, unit, contact status with Covid-19 patients, date of contact, symptom status, smoking status, chronic diseases, use of medicines, procedures requiring intense exposure, and use of personal protective equipment (PPE) were questioned.

HCWs in different departments were divided into two groups based on risk exposure. High-risk exposure was defined as the high-risk units with interventional medical or surgical procedures that generate respiratory aerosols, including the respiratory department, infectious disease department, intensive care unit, and surgical department. Other clinical departments were regarded as low-risk units.

In the diagnosis of SARS-CoV-2 infection, the polymerase chain reaction (PCR) method has been accepted as the

"gold standard" for detecting certain viruses, and it is a test with high sensitivity and specificity that gives rapid results and has been used in diagnosis.[14] PCR tests were applied to 1373 (73.0%) HCWs from 1881 health workers according to the Ministry's algorithm. The algorithm determined that PCR testing on 508 health-care personnel was not considered necessary and was not carried out.

Measures for disease prevention and control are implemented, and hygiene and cleaning advice is applied to the transportation vehicles such as public transportation and shuttle buses. Restrictions have been imposed on the number of passengers in public transport and on working hours in public as of March 21, 2020. Within the framework of the relationship between the risk of transmission and age, the curfew has been initiated for those over 65 years and those with chronic diseases as of March 22, 2020, and for the group under 20 as of April 4, 2020. Later on, as of April 11, 2020, curfews to cover all citizens in 30 metropolitan cities, including Konya (also in Zonguldak due to the high number of cases) were implemented on April 11–12, April 18–19, April 23–26, May 1–3, May 9–10, May 16–19, and May 23–26. The curfew was not implemented with the June 1 NP, but a partial ban was imposed on June 20–21 and June 27–28 due to exams.[10,15-17] In this study, PCR results were evaluated before the NP between March 16 and May 31 in Turkey and after the NP after June 1, 2020.

The data on the form, in which the recorded information of HCWs included in the study, were evaluated using IBM SPSS Version 22.0 package software. Normality of data was checked with Q-Q plots, the Shapiro–Wilk normality test. Categorical variables in the data were expressed in frequency and percentages. Descriptive statistics for the data are presented as median (minimum–maximum) for numerical variables. Chi-square and Binary logistic regression tests were used to compare categorical data between the groups. A p-value was taken as <0.05.

RESULTS

This study was performed on 1881 HCWs. The sociodemographic and occupational characteristics of HCWs are summarized in Table 1.

There was 172 (12.5%) PCR positivity among 1373 HCWs who underwent PCR testing. Twenty-six (15.1%) PCR positives were found to be at high risk, and 88 (7.3%) PCR negatives were found to be at high risk (p<0.001). Sociodemographics and occupational characteristics according to PCR results are summarized in Table 2.

Table 1. Sociodemographic and occupational characteristics of healthcare workers

	Median (min-max)
Age (years)	30.0 (20.0–64.0)
	n (%)
Gender	
Male	965 (51.3)
Female	916 (48.7)
Age groups	
20–29 years old	923 (49.1)
30–39 years old	666 (35.4)
40 years and over	292 (15.5)
Smoking status	
Yes	664 (35.3)
No	1201 (63.8)
Quit	16 (0.9)
Occupation	
Doctor	614 (32.6)
Nurse	604 (32.1)
Staff	352 (18.7)
Technician	150 (8.0)
Secretary	90 (4.8)
Other	71 (3.8)
Place of work	
Covid-19 high-risk units	850 (45.2)
Covid-19 low-risk units	1031 (54.8)
Work by profession	
Covid-19 high-risk units	
Doctor	286 (15.2)
Nurse	312 (16.6)
Personnel/technician/secretary	252 (13.3)
Covid-19 low-risk units	
Doctor	328 (17.4)
Nurse	292 (15.5)
Personnel/technician/secretary	339 (18.2)
Other employees	72 (3.8)
PCR test result	
Positive	172 (9.2)
Negative	1201 (63.8)
Not required	508 (27.0)

PCR: Polymerase chain reaction.

One thousand and two (53.3%) of 1881 HCWs had symptoms at the time of application, and 879 (46.7%) had no symptoms. Of the patients with at least 1 symptom, 163 (94.8%) were PCR-positive, 773 (64.4%) were PCR-negative, and 66 (13.0%) did not require PCR for diagnosis (p<0.001).

Table 2. Sociodemographics and and occupational characteristics according to PCR results

	PCR Results		p
	Positive (n=172)	Negative (n=1201)	
Gender			
Female	81 (47.1)	594 (49.5)	0.618
Male	91 (52.9)	607 (50.5)	
Age groups			
20–29 years old	84 (48.8)	597 (49.7)	0.711
30–39 years old	61 (35.5)	443 (36.9)	
40 years and over	27 (15.7)	161 (13.4)	
Occupation			
Doctor	52 (30.2)	421 (35.1)	0.130
Nurse	50 (29.1)	400 (33.3)	
Staff	33 (19.2)	213 (17.7)	
Technician	18 (10.5)	76 (6.3)	
Secretary	9 (5.2)	50 (4.2)	
Other	10 (5.8)	41 (3.4)	
Place of work			
COVID-19 high-risk units	56 (32.6)	484 (40.3)	0.063
COVID-19 low-risk units	116 (67.4)	717 (59.7)	
Work by profession			0.113
COVID-19 high-risk units			
Doctor	14 (8.1)	170 (14.1)	
Nurse	21 (12.2)	189 (15.7)	
Personnel/technician/secretary	20 (11.6)	126 (10.5)	
COVID-19 low-risk units			
Doctor	38 (22.1)	253 (21.1)	
Nurse	29 (16.9)	209 (17.4)	
Personnel/technician/secretary	40 (23.3)	212 (17.7)	
Other employees	10 (5.8)	42 (3.5)	
Symptom status			
No	9 (5.2)	428 (35.6)	<0.001
Yes	163 (94.8)	773 (64.4)	
Risk status			
High risk	26 (15.1)	88 (7.3)	<0.001
Moderate risk	50 (29.1)	510 (42.5)	
Low risk	22 (12.8)	147 (12.2)	
No considerable risk	74 (43.0)	456 (38.0)	
Contact status			
Unknown contact	67 (39.0)	370 (30.8)	<0.001
With the HCW	48 (27.9)	398 (33.1)	
With the patient	15 (8.7)	313 (26.1)	
With both the patient and the HCW	3 (1.7)	42 (3.5)	
Family and external environment	39 (22.7)	78 (6.5)	

Table 2. CONT.

	PCR Results		p
	Positive (n=172)	Negative (n=1201)	
Personal protective equipment			
Not used	58 (33.7)	282 (23.5)	<0.001
Partially used	34 (19.8)	441 (36.7)	
Fully used	80 (46.5)	478 (39.8)	
Computed tomography			
COVID-19 compatible	54 (31.4)	33 (2.7)	<0.001
COVID-19 non-compatible or normal	100 (58.1)	199 (16.6)	
Not needed-refused	18 (10.5)	969 (80.7)	

HCWs: Healthcare workers; PCR: Polymerase chain reaction.
Data is presented as n (%).
Chi-square test.

The presence of symptoms according to PCR results is summarized in Table 3.

In PCR positives compared to PCR negatives, fever 6.399 times (OR=6.399, 95% CI=4.115–9.952, p<0.001), joint pain 4.709 times (OR=4.709, 95% CI=3.328–6.662, p<0.001), myalgia 4.295 times (OR=4.295, 95% CI=3.046–6.055, p<0.001), nasal congestion 3.397 times (OR=3.397, 95% CI=1.443–7.997, p=0.005), fatigue 3.162 times (OR=3.162, 95% CI=2.223–4.498, p<0.001), cough 2.718 times (OR=2.718, 95% CI=1.964–3.762, p<0.001), headache 2.452 times (OR=2.452, 95% CI=1.621–3.710, p<0.001) and sore throat was 1.685 times (OR=1.685, 95% CI=1.222–2.323, p=0.001) higher. On the other hand, no difference in dyspnea and diarrhea symptoms in PCR positives compared to PCR negatives (p=0.209 and p=0.572, respectively).

PCR results of 511 (37.2%) HCWs before the NP and 862 (62.8%) HCWs after normalization were evaluated. While 13 (2.5%) of the HCWs were PCR positive before the NP, 159 (18.4%) of the HCWs were PCR positive after the NP. Sociodemographic and occupational characteristics according to the PCR results before and after the NP summarized in Table 4.

Table 3. Presence of symptoms according to PCR results

	PCR Result			p
	Positive (n=172)	Negative (n=1201)	Not required (n=508)	
Symptoms				
Sore throat	93 (54.1)	494 (41.1)	25 (4.9)	<0.001
Myalgia	118 (68.6)	405 (33.7)	25 (4.9)	<0.001
Joint pain	120 (69.8)	395 (32.9)	27 (5.3)	<0.001
Cough	86 (50.0)	323 (26.9)	26 (5.1)	<0.001
Fatigue	60 (34.9)	174 (14.5)	8 (1.6)	<0.001
Dyspnea	29 (16.9)	160 (13.3)	4 (0.8)	<0.001
Headache	36 (20.9)	117 (9.7)	7 (1.4)	<0.001
Diarrhea	15 (8.7)	90 (7.5)	5 (1.0)	<0.001
Fever	41 (23.8)	56 (4.7)	4 (0.8)	<0.001
Nasal congestion	8 (4.7)	17 (1.4)	2 (0.4)	<0.001

PCR: Polymerase chain reaction.
Data are presented as n (%).
Chi-square test.

Table 4. Socio-demographic and occupational characteristics according to the PCR results before and after the normalization process

	Before the May 31 normalization process			After the June 1 normalization process		
	Positive (n=13)	Negative (n=498)	p	Positive (n=159)	Negative (n=703)	p
Gender						
Female	5 (38.5)	235 (47.2)	0.534	76 (47.8)	359 (51.1)	0.457
Male	8 (61.5)	263 (52.8)		83 (52.2)	344 (48.9)	
Age groups						
20–29 years old	4 (30.8)	240 (48.2)	0.051	80 (50.4)	357 (50.8)	0.940
30–39 years old	4 (30.8)	187 (37.6)		57 (35.8)	256 (36.4)	
40 years and over	5 (38.4)	71 (14.2)		22 (13.8)	90 (12.8)	
Occupation						
Doctor	3 (23.1)	161 (32.3)	0.906	49 (30.8)	262 (37.3)	0.506
Nurse	6 (46.2)	196 (39.4)		44 (27.7)	202 (28.7)	
Staff	3 (23.1)	100 (20.1)		30 (18.9)	113 (16.1)	
Technician	1 (7.6)	19 (3.8)		17 (10.7)	57 (8.1)	
Secretary	0 (0.0)	11 (2.2)		9 (5.7)	39 (5.5)	
Other	0 (0.0)	11 (2.2)		10 (6.2)	30 (4.3)	
Place of work						
COVID-19 high-risk units	10 (76.9)	287 (57.6)	0.268	46 (28.9)	197 (28.0)	0.895
COVID-19 low-risk units	3 (23.1)	211 (42.4)		113 (71.1)	506 (72.0)	
Work by profession						
COVID-19 high-risk units						
Doctor	2 (15.4)	100 (20.1)	0.552	12 (7.5)	70 (10.0)	0.640
Nurse	4 (30.8)	117 (23.5)		17 (10.7)	72 (10.2)	
Personnel/technician/secretary	4 (30.8)	70 (14.1)		16 (10.1)	56 (7.9)	
COVID-19 low-risk units						
Doctor	1 (7.7)	61 (12.2)		37 (23.3)	192 (27.3)	
Nurse	2 (15.3)	79 (15.9)		27 (17.0)	130 (18.5)	
Personnel/technician/secretary	0 (0.0)	59 (11.8)		40 (25.1)	153 (21.8)	
Other employees	0 (0.0)	12 (2.4)		10 (6.3)	30 (4.3)	
Symptom status						
No	4 (30.8)	297 (59.6)	0.037	5 (3.1)	1311 (18.6)	<0.001
Yes	9 (69.2)	201 (40.4)		154 (96.9)	572 (81.4)	
Risk status						
High risk	4 (30.8)	35 (7.1)	<0.001	22 (13.8)	53 (7.5)	<0.001
Moderate risk	1 (7.7)	181 (36.3)		49 (30.8)	329 (46.8)	
Low risk	5 (38.4)	36 (7.2)		17 (10.7)	111 (15.8)	
No considerable risk	3 (23.1)	246 (49.4)		71 (44.7)	210 (39.9)	
Contact status						
Unknown contact	3 (23.1)	186 (37.3)	<0.001	64 (40.2)	184 (26.2)	<0.001
With the HCW	1 (7.7)	79 (15.9)		47 (29.6)	319 (45.4)	
With the patient	5 (38.4)	220 (44.2)		10 (6.3)	93 (13.2)	
With both the patient and the HCW	0 (0.0)	12 (2.4)		3 (1.9)	30 (4.2)	
Domestic and external environment	4 (30.8)	1 (0.2)		35 (22.0)	77 (11.0)	

Table 4. CONT.

	Before the May 31 normalization process			After the June 1 normalization process		
	Positive (n=13)	Negative (n=498)	p	Positive (n=159)	Negative (n=703)	p
Personal protective equipment						
Not used	4 (30.8)	16 (3.2)	<0.001	54 (34.0)	266 (37.8)	<0.001
Partially used	4 (30.8)	220 (44.2)		30 (18.9)	221 (31.5)	
Fully used	5 (38.4)	262 (52.6)		75 (47.1)	216 (30.7)	
Computed tomography						
COVID-19 compatible	6 (46.2)	12 (2.4)	<0.001	48 (30.2)	21 (3.0)	<0.001
COVID-19 non-compatible or normal	7 (53.8)	92 (18.5)		93 (58.5)	107 (15.2)	
Not needed-refused	0 (0.0)	394 (79.1)		18 (11.3)	575 (81.8)	

HCWs: Healthcare workers, PCR: Polymerase chain reaction.
Data are presented as n(%).
Chi-square test.

When looking at PCR-positive HCWs' risk conditions before and after the NP, before the NP, 5 (38.4%) were not considered as low risk, and 71 (44.7%) after the NP were not considered as high risk (p=0.005). The risk factors of PCR-positive HCWs before and after the NP are summarized in Table 5.

DISCUSSION

In the direction of the Ministry of Health COVID-19 Guide, generally, 9.2% of the HCWs had a positive PCR test. While 2.5% were PCR positive before the NP, 18.4% were PCR positive after the NP. In a retrospective study conducted with 1407 HCWs, Zhao et al. investigated asymptomatic SARS-CoV-2 infection in HCWs at Wuhan University Renmin Hospital in China on January 14–February 21, 2020; all of the employees were scanned with computed tomography (CT) and PCR tests.[18] 235 out of 1407 HCWs reported symptoms. In this study, all employees were scanned with CT, abnormal CT findings were detected in 13.6%, PCR test was performed on 1060 employees, and PCR positivity was found in 15.1%. In the study conducted by Lahner et al. in Italy on the prevalence of SARS-CoV-2 in HCWs at the University of Rome between March 18 and April 27, 2020, the prevalence of PCR positivity of 2057 HCWs working in a high-risk unit for COVID-19 was found to be higher than those working in a low-risk unit for COVID-19.[19] Amongst the PCR-positive HCWs, 67.3% had associated symptoms, most frequently fever, ageusia, anosmia, cough, asthenia, arthralgia/myalgia, diarrhea, dyspnea, conjunctivitis, and headache. In another study conducted by García-Sierra et al., on February 17–May 3, 2020, with 1418 HCWs in a primary care unit in Spain, they found the frequency of PCR positivity to be 30.8%.[20] At the University of Verona Hospital in Veneto, which ranks fourth among the Italian regions for COVID-19 confirmed cases, Porru et al. evaluated the health surveillance data in terms of SARS-CoV-2 infection in 6092 HCWs in the Occupational Health Unit.[21] In this evaluation, 2.5% of the HCWs could not be reached for various reasons, and 97.5% were contacted. The PCR test was taken from all of the available HCWs, 4% of the 5942 HCWs screened for SARS-CoV-2 were found to be PCR positive, and 89% of the PCR-positive HCWs were reported to be in close contact with COVID-19 cases. Accordingly, the frequency of positive cases was <1% in people not exposed to COVID-19 cases and 10% in exposed people.[21] Within the scope of the personnel hotline system implemented by Lan et al. between March 9 and April 15, 2020, to ensure the continuity of the health workforce during the pandemic of the occupational health service of a Massachusetts community health-care system; by calling HCWs who underwent the SARS-CoV-2 test, symptoms were scanned during this process.[22] HCWs with negative tests but progressive symptoms were retested for SARS-CoV-2. Among the 592 HCWs retested, 14% were positive for the SARS-CoV-2 test. In the study conducted by Stock et al. in New York, between April 4 and 20, 2020, with serology and swab tests in HCWs infected with COVID-19, it was found that 4.1% of the employees were PCR positive, 4.1% were PCR and serology positive, 11.2% of them were serology positive, 19.4% of them were SARS-CoV-2 positive, and 80.6% were negative in total.[23] Martin et al. conducted a study at Saint-Pierre Hospital, a tertiary referral hospital for infectious diseases

Table 5. Risk factors of PCR-positive healthcare workers before and after the normalization process

	Normalization Process		p
	Before (n=13)	After (n=159)	
Risk status			
No considerable risk	3 (23.1)	71 (44.7)	0.005
Low risk	5 (38.4)	17 (10.7)	
Moderate risk	1 (7.7)	49 (30.8)	
High risk	4 (30.8)	22 (13.8)	
Contact status			
Contact unknown	3 (23.1)	64 (40.2)	0.001
With the HCW	1 (7.7)	47 (29.6)	
With the patient	5 (38.4)	10 (6.3)	
With both the patient and the HCW	0 (0.0)	3 (1.9)	
Domestic and external environment	4 (30.8)	35 (22.0)	
Personal protective equipment			
Not used	4 (30.8)	54 (34.0)	0.579
Partially used	4 (30.8)	30 (18.9)	
Fully used	5 (38.4)	75 (47.1)	
Place of work			
COVID-19 high-risk units	10 (76.9)	46 (28.9)	0.001
COVID-19 low-risk units	3 (23.1)	113 (71.1)	

HCWs: Healthcare workers, PCR: Polymerase chain reaction.

Data are presented as n (%).

Chi-square test.

in Brussels, Belgium, between April 15 and May 18, with HCWs to determine the dynamics of SARS-CoV-2 reverse transcription-PCR (RT-PCR) positivity and seroprevalence among high-risk HCWs.[24] They followed their HCWs for 6 months, and according to the results obtained from day 1 and day 15 visits, the overall infection rate among 326 HCWs was found to be 12.6%. According to the results of a comprehensive literature study conducted and published by Calò et al. between January 1 and May 22, 2020, to identify studies analyzing the infection burden, risk assessment, surveillance, and management of HCWs exposed to SARS-CoV-2, COVID-19 rate in HCWs was found between 3% and 38%.[25] The study conducted by Kassem et al. using PCR and rapid serological IgM/IgG tests (RST) in 138 HCWs in the gastroenterology service of Al-Manial University Hospital, the main hospital of the largest tertiary university hospitals complex in Egypt, aimed to evaluate the SARS-CoV-19 infection.[26] Seventy-four HCWs participated in the screening program, and 13.5% of them tested positive for RT-PCR; in 12.2% HCWs, antibodies were detected by RST. The frequency of positive tests was higher among workers with mild symptoms than completely asymptomatic HCWs. In a study done by Eyre et al. between April 23 and June 8, 2020, 73% of 13800 HCWs working in four training hospitals in a county in England participated in the evaluation of COVID-19; 11.2% of the 10034 HCWs tested positive for COVID-19.[27] Polat et al. evaluated 208 HCWs with a history of contact with COVID-19 patients between March 25 and April 25, 2020, in the Employee Health Unit of Bakırköy Sadi Konuk Training and Research Hospital.[28] While the PCR test of 12.5% of all HCWs was positive, the PCR test of 87.5% was negative. When looking at PCR positivity by risk groups, the frequency of PCR positivity was 8.7% in the high-risk group, 22.4% in the moderate-risk group, and 14.3% in the low-risk group, and PCR positivity in the moderate-risk group was found to be higher than the low and high-risk group. When HCWs' contact statuses were evaluated, the frequency of positivity resulting from contact with the patients was found to be higher than the frequency determined according to the HCWs' contact statuses between themselves. In the study conducted by Tostmann et al. in the Netherlands in April 2020 on "Strong Associations and Moderate Predic-

tive Value of Early Symptoms for SARS-Cov-2 Test Positivity Among HCWs," a total of 803 HCWs, including 627 in the initial cohort and 176 in the second, were questioned in terms of symptoms.[29] In the HCWs, 11.2% of participants were found to be SARS-CoV-2 positive by the PCR test. In this study, the frequency of COVID-19 positivity in HCWs, in general, was found to be 9.2%: This frequency is lower than the PCR positivity detected in HCWs in other countries and is similar to some other study results. The PCR testing rate before the NP was 2.5% in Turkey, reaching as high as 18.4% after the NP. As seen in the above studies, the frequency of COVID-19 PCR positivity in the HCWs varies between 3% and 38%. Although this study's frequency is in this range, the frequency of COVID-19 positivity in HCWs is higher than in other individuals due to occupation.[30] As a matter of fact, the Minister of Health announced on December 9, 2020, that more than 120,000 health-care employees, a total of 1 million in Turkey, tested positive for PCR, and the frequency of total cases is close to 10%. They also stated that 216 HCWs in Turkey have died from COVID-19 so far.[31]

In this study, 94.8% of PCR-positive HCWs reported symptoms at the time of admission, while 5.2% did not report any symptoms. In the study of Lahner and his colleagues in Italy, 67.3% of PCR-positive HCWs were symptomatic.[19] Symptoms in order of frequency were determined as; 34.7% fever, 34.7% ageusia, 26.5% anosmia, 22.4% cough, 20.4% asthenia, 20.4% arthralgia and myalgia, 14.3% diarrhea, 10.2% dyspnea, 8.2% conjunctivitis, and 8.2% as headache. In the study conducted by García-Sierra and his colleagues in Spain, 73.6% of 1050 HCWs who underwent a PCR test had various symptoms; 89.7% of 323 PCR-positive people were symptomatic, and 66.4% of 727 HCWs who had a negative PCR test were symptomatic.[20] Symptom statuses in PCR positives were as follows: myalgia in 24.1%, anosmia in 20.4%, asthenia in 18%, arthralgia in 14.2%, ageusia in 7.4%, fatigue in 6.8%, odynophagia in 7.1%, nasal congestion in 4%, nausea-vomiting in 1.9%, and retro-orbital pain was detected in 0.6%. In the study conducted by Tostmann et al. in the Netherlands between March 10 and 29, 2020, 21.1% of PCR positives were male, and 78.9% were female.[29] About 1.2% were 20 years and younger, 26.9% were between 21 and 30 years old, 28.8% were between 31 and 40 years old, 21.5% were between 41 and 50 years old, 16.6% were between 51 and 60 years old, and 5% were 60 years old and over. The most frequently reported symptoms among test-negative HCWs were cough, sore throat, and flu-like symptoms. The most commonly reported symptoms among test positives were headache, general malaise, and myalgia. Univariate associations were evaluated by calculating probability ratios. General non-respiratory symptoms (myalgia, eye pain, general malaise, headache, and extreme tiredness) have been associated with test positivity. Anosmia was reported by 47% of test positives and was strongly associated with SARS-CoV-2 positivity. PCR-positive HCWs had anosmia 23 times, myalgia 6.9 times, eye pain 4.5 times, malaise 4.2 times, headache 3.5 times, extreme tiredness 2.8 times, and fever 2.7 times more. In contrast to this study, fever, myalgia, and headache were higher in PCR positives than in PCR negatives.

In the report titled "Characteristics of Health Care Personnel with COVID-19" published by the CDC Department, 55% of the 1423 COVID-19 HCWs who reported exposure to COVID-19 patients were in contact only in a health-care settings within the hospital 14 days before the onset of the disease, 27% reported contact only in a household setting, 13% reported contact only in a community setting, and 5% reported contact in more than one setting.[32] In the study conducted by Polat et al. with 208 HCWs in Turkey, 20.7% of the HCWs were found to have contact with patients and 79.3% with HCWs.[28] About 25.6% of the HCWs who had contact with the patient were PCR positive, and 74.4% were PCR negative. About 9.1% of the HCWs who had contact with another HCW were PCR positive, and 90.9% were found to be PCR negative. As can be seen in the just mentioned study and this study, it was found that contact with the patient was important in terms of PCR positivity, and it made a significant difference. In this study, HCWs had more contact with patients before the NP, while contact with patients after the NP decreased, and those with unknown contact increased. This makes us think and show that there is more external contact among the HCWs after the NP. As a matter of fact, the increase in personal protective use within the hospital after the NP supports this situation.

Ran et al. conducted a retrospective study to analyze the risk factors of 72 HCWs who developed the acute respiratory disease in a tertiary hospital in Wuhan, China.[33] In the high-risk unit, longer working hours and poor hand hygiene after contact with patients have been linked to COVID-19. HCWs in different departments are divided into two categories based on risk exposure. Aerosol-generating interventional medical or procedural areas, including intensive care, surgical, infection, and respiratory departments with high-risk exposure, have been accepted as "high-risk departments." Other low-risk clinical departments were accepted as "general departments." The follow-up ended on January 28th. HCWs filled out a questionnaire detailing sociodemographic characteristics, time to symptomatic progression, contact history, medical practice, hand hygiene, and the use of appropriate PPE. Seventy-two of 83 of the

surveys were considered valid. Of the 72 people, 39 were in the general department, and 33 were in the high-risk department. Their ages were between 21 and 66, and they worked for an average of 8 h. Of the 28 HCWs diagnosed with COVID19, 85.71% had fever, 60.71% had cough, 7.14% had bradypnea, 7.14% had chest tightness, 7.14% had headache, 7.14% had diarrhea, and 7.14% had hemoptysis. It was reported that infection in the HCWs had associations with COVID-19 diagnosed family members 2.76 times, COVID-19 patients 0.36 times, and patients with suspected COVID-19 0.49 times. Inadequate handwashing was found to increase the risk of COVID-19 by 2.64 times, suboptimal hand hygiene before and after contact with the patients by 3.10 and 2.43 times, and inadequate use of PPE by 2.82 times. It was found that the infection rate decreased with the decrease in daily working hours in the high-risk department. The risk of COVID-19 was high in those who worked in a high-risk department and had suboptimal hand hygiene after contact with the patients. It was found that the risk increases with the increase in working hours in the high-risk department. The risk of developing COVID-19 in the high-risk department was found to be 2.13 times higher than in the general department. In this study, 1881 HCWs were divided into two groups according to their work, high-risk and low-risk units for COVID-19. Eight hundred and fifty people were working in the COVID-19 high-risk units, and 1031 people were working in the low-risk units. In this study, PCR positivity was found to be higher in those working in high-risk units before the NP compared to those working in low-risk units. PCR positivity was lower in those working in high-risk units after the NP than in those working in low-risk units. This situation suggests contact based on socialization.

In this study, lung CT findings were compatible with Covid-19 in 31.4% of PCR-positive HCWs and 2.7% of PCR-negative HCWs. In the study conducted by Zhao et al. between January 14 and February 21, 2020, in Wuhan, China, lung CT was performed on all 1407 HCWs. CT findings were detected in 13.6% of all HCWs.[18] While 56% of those with CT findings had symptoms, 44% had no symptoms. In the study conducted by Lahner et al. in Italy between March 18 and April 27, 2020, in Rome, they detected lung CT findings in 16.7% of PCR-positive HCWs.[19] Studies show that the frequency of lung CT involvement varies in PCR positives and negatives.

In a case–control study by Chatterjee et al. with 751 HCWs in India, PPE use was independently associated with a reduction in the likelihood of being infected with SARS-CoV-2.[34] Participants who reported never using PPEs were at higher risk. On the other hand, when participants were asked about the individual components of PPE, usage of masks, caps, gowns, and gloves was associated with reduced odds of acquiring SARS-CoV-2 infection. The PCR positivity, which is the rate of cases of those who never used PPE, was 3.72 times more when the full and partial PPE users were taken as references. In the study conducted by Kassem et al. with 138 HCWs in the gastroenterology service of Al-Manial University Hospital in Egypt, 95.5% reported proper hand hygiene practice in evaluating infection control measures, whereas 31.8% reported insufficient use of PPEs.[26] In the study conducted by Lai et al. with 1386 HCWs on January 15–17, 2020, in two tertiary hospitals in China to determine the risk of COVID-19 and the infection prevention and control behaviors of HCWs; after the COVID-19 outbreak, the use of equipment was higher than before.[35] Before and after touching the patient's environment, hand hygiene was relatively lower than others, even after the COVID-19 outbreak. Hand hygiene of the high-risk unit workers before contact with the patient, after the contact, after contamination with body secretions, after exposure to the patient's environment, general hand hygiene, wearing glasses, wearing an apron, and using PPE were found to be higher. 19.28% of the HCWs worked in the high-risk unit, and the use of PPE after the COVID-19 outbreak was higher than before. General PPE use by those working in the high-risk unit was found to be higher. In the study conducted by Ran et al., the use of insufficient PPE was found to be 2.82 times higher.[33] In this study, the frequency of full PPE use before the NP was 52.3% and 38.4% for PCR positives, while the overall frequency of PPE use after the NP was 33.8% and increased by 47.2% for PCR positives. This situation suggests that PCR-positive HCWs' use of PPE increased after the NP, but the PCR positivity after the NP increased approximately nine times compared to before, post-study socialization, and PCR positivity due to external contact.

In the study conducted by Polat et al., 8.7% of high-risk workers, 22.4% of moderate-risk workers, and 14.3% of low-risk workers were found to be PCR positive.[28] In this study, it was observed that 76.9% of PCR-positive HCWs before the NP were working in high-risk units for COVID-19, while 71.1% of PCR-positive HCWs after the NP were working in units with low risk for COVID-19. After the NP, the frequency of those with the low and moderate risk increased compared to before, and the frequency of those who were not considered at risk decreased. The frequency of PCR positives is increased in moderate-risk and non-risky individuals. This situation suggests that HCWs got COVID-19 infection after the NP due to risky contacts in their domestic and social life rather than in-hospital exposure. Since no

study was conducted on the NP-specific to Turkey in the literature, there is not enough data regarding this subject.

As a limitation, in this study, PCR test was performed on HCWs who looked after COVID-19 patients, HCWs who had symptoms after being questioned about COVID-19 symptoms after on-call periods, HCWs who were at risk of contacting a COVID-19 patient, or HCWs who did not work in the high-risk department and had no contact but still had symptoms according to the risk categories and laboratory algorithm and treatment guides for the contacted healthcare worker in accordance with the "Ministry of Health COVID-19 Guidelines." HCWs with no symptoms and/or no risk of COVID-19 were not subjected to PCR tests according to the risk categories and laboratory algorithm and treatment guides for the contacted HCWs according to the "Ministry of Health COVID-19 Guidelines." Therefore, COVID-19 disease status could not be determined in HCWs without symptoms and with no risk.

CONCLUSION

In this study, although it is observed that the frequency of COVID-19 PCR positivity in HCWs is similar to the frequency given by the WHO, it is lower than the frequency of PCR positivity in HCWs in some other countries. Specifically for Turkey, COVID-19 PCR positivity increased approximately 9 times in HCWs with normal life and socialization after the NP. It is seen that it is important to comply with the Mask, Distance and Hygiene rule, both for the general population and HCWs, in protection against the COVID-19 pandemic. Especially in recent months, it is thought that the implementation of partial and weekend curfews will decrease the increase of SARS-CoV-2 infection in Turkey.

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