Coronavirus Pandemic

Assessing COVID-19 outcomes among healthcare workers: a retrospective study

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Abstract

Introduction: The purpose of this research was to investigate the outcomes of coronavirus disease 2019 (COVID-19) infection in healthcare workers, assess the incidence of infection among them, and identify factors linked to the severity of the disease.

Methodology: This cross-sectional study was conducted retrospectively in Duhok city, Kurdistan Region of Iraq, from September 2021 to January 2023.

Results: The study included 1,958 participants, of whom 1,338 (68.33%) contracted the infection. Among them, 830 (62.03%) and 372 (27.81%) patients experienced mild and moderate infections, respectively, while 136 (10.1%) had severe infections. The results indicated that several factors, including maintaining a healthy lifestyle, avoiding obesity, having a chronic condition, working consecutive hours, and being in an overwhelmed work environment were significantly associated with a higher severity of infection ($p < 0.05$). However, factors such as smoking habits, adherence to preventive health guidelines, direct exposure to COVID-19 patients, work days and patterns, family members with COVID-19, and hand/glove sterilization did not appear to have a significant effect on the severity of infection ($p > 0.05$).

Conclusions: These findings may offer valuable insights for clinicians and public health officials, and aid in the development of effective strategies to manage COVID-19 patients based on their risk factors for infection severity.

Key words: COVID-19; healthcare workers; outcomes; Iraq.

Introduction

The coronavirus disease 2019 (COVID-19) pandemic has impacted the world since December 2019 [1]. It is caused by a highly infectious virus, known as severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), which was initially identified in Wuhan City, China [1]. The virus rapidly spread across the globe, leading to the first confirmed case of COVID-19 in the Kurdistan Region of Iraq on March 1, 2020. The gravity of the situation was further emphasized when the World Health Organization (WHO) declared COVID-19 a global pandemic on March 11, 2020. In the subsequent months, the region grappled with the challenges of navigating through four harrowing waves of the disease, each one taking a heavy toll on the lives of its people [2,3]. Healthcare workers (HCWs) are a high-risk group for infections and are especially vulnerable to SARS-CoV-2 infection [4]. As the first responders in the outbreak of COVID-19, HCWs are at the forefront of the response effort and, consequently, are most susceptible to contracting the virus due to their exposure to infectious materials [4–6]. A previous study identified critical risk factors for COVID-19 infection among HCWs, including the lack of adequate personal protective equipment (PPE), exposure to infected patients, excessive workload, poor

infection control practices, and pre-existing medical conditions [5]. HCWs were found to have a risk of severe COVID-19 that was more than seven times higher compared to the general population. Meanwhile, individuals employed in social care and transportation occupations had a risk that was twice as high [4]. A recent study conducted in Iraq, found that out of 743 participants, 62.58% tested positive for SARS-CoV-2 antibodies [6]. The aims of this paper were to determine the frequency of COVID-19 infections among HCWs, examine the factors increasing the risk of contracting the virus, and evaluate the medical outcomes for workers at the forefront of the pandemic.

Methodology

Study settings

This retrospective cross-sectional study was conducted from September 2021 to January 2023 in major healthcare facilities spanning five districts of Duhok Governorate in the Kurdistan Region of Iraq. These districts included Akre, Bardarash, Semmel, Zakho, Amedye, and the central district of Duhok. The target population comprised the entire Duhok province, estimated to have a population of 1.65 million. It is noteworthy that the study was conducted after the introduction of the COVID-19 vaccine in Iraq, as the first vaccination date in the country was 25 March 2021 [7].

Participants

We aimed to interview all HCWs assigned to morning shifts across various medical facilities. A total of 1,958 HCWs who worked during the morning shifts were included in the study, with participants ranging in age from 16 to 75 years old. Participants were classified as positive for COVID-19 infection based on the results of the real-time reverse transcriptase polymerase chain reaction (RT-PCR) test on nasal and oro-nasal swabs, following the local protocol [8]. RNA was extracted from swabs using a QIAamp Viral RNA Mini kit (Qiagen, Seoul, Korea) and eluted in 50 μL of RNase-free water following the manufacturer's instructions. Two RT-PCR reactions were conducted in this study. The first targeted a conserved 76 bp fragment from the *E* gene (LightMix®), and the second targeted a 100 bp fragment from a conserved region of the *RNA dependent RNA polymerase* (*RdRP*) gene (LightMix® Modular Wuhan CoV *RdRP*-gene by Roche Diagnostics, Berlin, Germany). A positive test required both the reactions to be positive; a negative test required both the reactions to be negative; and an indeterminate

result occurred if one reaction was positive and the other negative.

Questionnaire

In this study, a standardized questionnaire was employed to collect data through participant interviews. The questionnaire covered several key domains. The first section focused on socio-demographic characteristics, including age, gender, marital status, smoking habits, body mass index (BMI), preexisting comorbidities, type of comorbidities, and duration of COVID-19 infection. The second section delved into questions concerning participants' job roles in healthcare settings. The third and final section consisted of inquiries related to clinical data, encompassing COVID-19 infection, symptoms experienced by the participants, and details about the type of treatment regimen they underwent.

The RT-PCR-confirmed cases of COVID-19 were categorized according to the severity of infection into four categories: mild, moderate, severe and critical cases [9,10]. In this study, cases that did not exhibit any signs or symptoms and lacked radiological evidence of pneumonia were classified as mild cases. On the other hand, cases that presented with signs and symptoms of pneumonia, radiological evidence of pneumonia, normal respiratory rate, and oxygen saturation of $\geq 90\%$ at rest were categorized as moderate cases. Furthermore, cases that displayed radiological evidence of pneumonia, respiratory distress (characterized by difficulty in breathing), oxygen saturation of $< 90\%$ while resting, or arterial partial pressure of oxygen (PaO_2)/fraction of inspired oxygen (FiO_2) ≤ 300 mmHg (where 1 mmHg = 0.133 kPa) were deemed severe cases. [9,11]. Critical cases were characterized as those in which patients exhibited dyspnea, pneumonia, and varying levels of respiratory distress (i.e., respiratory rate exceeding 30 breaths per minute) in addition to other symptoms that necessitated intensive care unit (ICU) admission and mechanical ventilation [10].

Statistics

The statistical analysis of the data in this manuscript utilized SPSS version 25 (IBM Corp. Armonk, NY, USA) Logistic regression analysis was employed to explore potential variables contributing to the prevalence of long COVID-19. Additionally, multivariate logistic regression analysis was conducted to investigate associations between variables and different outcomes. The Chi square test was used to identify associations, considering *p* values ≤ 0.05 as statistically significant.

Ethical considerations

The project received approval from the Scientific Committee of the College of Medicine at the University of Zakho (UoZEC 22/11). Verbal consent was obtained from each participant prior to responding to the questionnaire. The questionnaires were confirmed and checked by the Ethics Committee of the College of Medicine, University of Zakho.

Results

Symptoms of infection

The most commonly reported symptoms were fever (86.2%), cough (67.2%), and tiredness and muscle pain (81.8% and 77.5%, respectively). A smaller proportion of infected HCWs reported symptoms such as hemoptysis (coughing up blood, 4.7%), shortness of breath (30.5%), and the need for hospitalization (5.2%) or oxygen therapy (4.9%). On average, HCWs took 12 ($\pm$ 7) days to recover from the infection (Table 1).

Association between variables and COVID-19 infection rate

We examined variables associated with COVID-19 infection in a sample of 1,958 individuals, with 1,338 (68.33%) testing positive and 620 testing negative. We identified significant associations between infection and several factors, including age (p = 0.02), maintaining a healthy lifestyle (p = 0.01), smoking cigarettes (p = 0.003), direct contact with COVID-19 patients (p = 0.0001), experiencing work overload (p = 0.000), receiving training for the strategic use of PPE ahead of time (p = 0.016), using a sterilizer (p = 0.01), and having a family member with a COVID-19 infection (p = 0.0001) (Table 2).

Severity of the infection

In this study, 830 patients had mild, 372 had moderate, and 136 had severe COVID-19 infections. The results indicated that maintaining a healthy

Table 1. COVID-19 infection outcomes among infected healthcare workers.

Characteristics	Days to recover	Presence/Intensity	N	%
Fever		Yes	1153	86.2
		No	185	13.8
Cough		Yes	899	67.2
		No	439	32.8
Sputum		Yes	407	30.4
		No	931	69.6
Cough up blood (hemoptysis)		Yes	63	4.7
		No	1275	95.3
Sore throat		Yes	895	66.9
		No	443	33.1
Headache		Yes	1071	80.0
		No	267	20.0
Tiredness and being out of energy		Yes	1095	81.8
		No	243	18.2
Pain in the muscles (myalgia)		Yes	1037	77.5
		No	301	22.5
Abdominal pain		Yes	310	23.2
		No	1028	76.8
Having the desire to eat		Yes	501	37.4
		No	837	62.6
Could you smell and taste		Yes	512	38.3
		No	826	61.7
Nausea		Yes	291	21.7
		No	1047	78.3
Vomiting		Yes	137	10.2
		No	1201	89.8
FBM (diarrhoea)		Yes	324	24.2
		No	1014	75.8
Shortness of breath (dyspnea)		Yes	408	30.5
		No	930	69.5
Tightness or pressure on the chest		Yes	450	33.6
		No	888	66.4
How was your condition?		Mild	830	62.0
		Moderate	372	27.8
		severe	136	10.2
Did you require hospitalization?		Yes	70	5.2
		No	1268	94.8
Did you require oxygen therapy?		Yes	65	4.9
		No	1273	95.1
How many days did it take to recover from COVID-19 infection? Mean ($\pm$ SD)	12 ($\pm$ 7)			

COVID-19: coronavirus disease 2019; FBM: Frequent bowel motion.

lifestyle, avoiding obesity, having a chronic condition, working consecutive hours, and being in an overwhelmed work environment were significantly associated with higher infection severity *(p < 0.05)*. Conversely, factors such as smoking habits, adherence to preventive health guidelines, direct exposure to COVID-19 patients, work days and patterns, family members with COVID-19, and hand/glove sterilization

did not appear to significantly affect infection severity (*p* > 0.05) (Table 3).

Discussion

Protecting HCWs is a critical aspect of any nation's strategy for dealing with the COVID-19 pandemic, especially as governments work to increase healthcare capacity to accommodate the growing number of patients in need of urgent care. WHO has provided

Table 2. Demographic information and infection associated factors among infected and non-infected healthcare workers.

Characteristics		Infected (N = 1338)			Not infected (N = 620)			
		Mean (± SD)	N	%	Mean (± SD)	N	%	*p* value
Age		35.45(± 9.60)			34.27(± 10.25)			0.02
Age group	< 15		0	0.0		2	0.3	0.02
	16–25		202	15.1		133	21.5	
	26–35		555	41.5		218	35.2	
	36–45		369	27.6		173	27.9	
	46–66		163	12.2		76	12.3	
	56–66		44	3.3		18	2.9	
	66–75		5	4		0	0.0	
Gender	Male		672	50.2		313	50.5	0.915
	Female		666	49.8		307	49.5	
Marital status	Single		462	34.5		241	38.9	0.062
	Married		876	65.5		379	61.1	
Do you maintain a healthy lifestyle?	Yes		816	61.0		340	54.8	0.01
	No		522	39.0		280	45.2	
Are you obese (BMI > 30)	Yes		315	23.5		129	20.8	0.179
	No		1023	76.5		491	79.2	
Do you smoke cigarettes?	Yes		217	16.2		135	21.8	0.003
	No		1121	83.8		485	78.2	
Do you smoke hookah?	Yes		139	10.4		77	12.4	0.182
	No		1199	89.6		543	87.6	
In daily life, do you often stick to required preventive health guidelines?	Yes		889	66.4		399	64.4	0.365
	No		449	33.6		221	35.6	
Do you have any chronic conditions?	Yes		204	15.2		76	12.3	0.79
	No		1134	84.8		544	87.7	
Did you have direct contact with COVID-19 patients?	Yes		1171	87.5		481	77.6	0.000
	No		167	12.5		139	22.4	
How many hours a day did you have to work?	≤ 1		1	.1		0	0	0.085
	2–9		1032	77.1		461	34.5	
	10–17		253	18.9		131	9.8	
	18–23		51	3.8		27	2.0	
	24		1	1		0	0.0	
Did you work for consecutive hours?	1		1060	79.2		468	75.5	0.063
	2		278	20.8		152	24.5	
How many days of the week did you have to work?	1		18	1.3		7	1.1	0.729
	2		57	4.3		25	4.0	
	3		97	7.2		49	7.9	
	4		133	9.9		55	8.9	
	5		258	19.3		131	21.1	
	6		637	47.6		278	44.8	
	7		138	10.3		75	12.1	
Did you work for consecutive days?	Yes		1087	81.2		506	81.6	0.844
	No		251	18.8		114	18.4	
Did you get immersed in an overwhelmed work (work overload)?	Yes		815	60.9		324	52.3	0.000
	No		523	39.1		296	47.7	
Did you have training for strategic use of PPE ahead of time?	Yes		569	42.5		228	36.8	0.016
	No		769	57.5		392	63.2	
Were there adequate PPE available in the hospital?	Yes		633	47.3		274	44.2	0.198
	No		705	52.7		346	55.8	
Have you ever reused secondhand PPE due to its shortage in the hospital	Yes		260	19.4		128	20.6	0.531
	No		1078	80.6		492	79.4	
Do you often sterilize your hands/ gloves in the hospital?	Yes		1255	93.8		554	89.4	0.01
	No		83	6.2		66	10.6	
Did a family member contract the infection?	Yes		1152	86.1		4	.6	0.000
	No		185	13.8		616	99.4	

BMI: body mass index; PPE: personal protective equipment; SD: standard deviation.

guidelines for the appropriate use of PPE in both hospital and community settings. Various medical organizations and specialty societies have developed protocols and recommendations to reduce the transmission of COVID-19 in their respective fields. Despite these efforts, protecting HCWs continues to be a challenge for many countries, The objective of this study was to determine the frequency of COVID-19 infection among HCWs, identify the risk factors related to their infection, and evaluate the occurrence of

COVID-19 infection in HCWs on the front line, where the lack of sufficient PPE remains a daily issue.

In the studied population, 1,338 (68.33%) HCWs contracted the infection. The findings of the study indicate that the largest proportion of HCWs who tested positive for COVID-19 were within the age group of 26 to 35 years. This is consistent with a similar study conducted in Turkey, which found that the majority of infected HCWs were within the same age range [12]. This could be due to the fact that young adults are

Table 3. Severity of COVID-19 infection according to the factors among infected participants.

Characteristics		Severity of infection			
		Mild	Moderate	Severe	*p* value
Age (years)	16–25	141	49	12	
	26–35	346	153	56	
	36–45	214	115	40	0.063
	46–55	105	36	22	
	56–65	21	17	6	
	66–75	3	2	0	
Gender	female	422	188	56	0.106
	male	408	184	80	
Marital Status	single	301	123	38	0.131
	married	529	249	98	
Do you maintain a healthy lifestyle?	Yes	482	235	99	0.003
	No	348	137	37	
Are you obese (BMI > 30)	Yes	152	105	58	0.000
	No	678	267	78	
Do you smoke cigarettes?	Yes	135	60	22	0.998
	No	695	312	114	
Do you smoke hookah?	Yes	78	48	13	0.174
	No	752	324	123	
In daily life, do you often stick to required preventive health guidelines?	Yes	551	253	85	0.507
	No	279	119	51	
Do you have any chronic conditions?	Yes	108	61	35	0.001
	No	722	311	101	
Did you have direct contact with covid-19 patients?	Yes	733	324	114	0.326
	No	97	48	22	
How many hours a day did you have to work? (Binned)	≤ 1	1	0	0	
	2–9	665	272	95	
	10–17	128	87	38	0.009
	18–23	35	13	3	
	24	1	0	0	
Did you work for consecutive hours?	Yes	679	279	101	0.012
	No	151	93	34	
How many days of the week did you have to work?	1	10	4	4	
	2	34	18	5	
	3	59	28	10	
	4	77	35	21	0.457
	5	158	71	29	
	6	401	183	53	
	7	91	33	14	
Did you work for consecutive days?	Yes	679	300	108	0.756
	No	151	72	28	
Did you get immersed in an overwhelmed work (work overload)?	Yes	474	237	104	0.000
	No	356	135	32	
Did you have training for strategic use of PPE ahead of time?	Yes	311	184	74	0.000
	No	519	187	62	
Were there adequate PPE available in the hospital?	Yes	374	184	75	0.057
	No	456	187	61	
Have you ever reused secondhand PPE due to its shortage in the hospital	Yes	160	78	22	0.474
	No	670	294	114	
Do you often sterilize your hands/ gloves in the hospital?	Yes	781	348	126	0.788
	No	49	24	10	
Did a family member contract the infection?	Yes	711	325	116	0.724
	No	118	47	20	

BMI: body mass index; COVID-19: coronavirus disease 2019; PPE: personal protective equipment.

frequently employed in essential sectors, increasing their risk of exposure to the virus. Additionally, this age group may be less likely to adhere to recommended health practices such as wearing masks, frequent hand washing, and maintaining physical distance. Our study found that the rate of COVID-19 infection was the same among male and female HCWs, which is in contrast to previous research that reported a higher rate of infection among female HCWs [12,13]. This disparity in results may be attributed to the fact that in our region, the majority of HCWs, particularly those on the front line, were male. Furthermore, the study found a significant relationship between maintaining a healthy lifestyle and the risk of COVID-19 infection. This correlation may be because individuals who lead healthy lifestyles are more likely to engage in activities that put them at a higher risk of exposure to the virus, such as going to public places or participating in social activities. Our study aligns with previous research in finding an inverse relationship between smoking and COVID-19 [14].

It is important to note that our study was a cross-sectional study, which is considered the weakest form of observational study. Cross-sectional studies can only demonstrate a correlation between two variables but cannot establish a causal relationship. To determine the causal relationship between smoking and SARS-CoV-2 infection, a larger cohort study that follows a group of patients over an extended period of time would be required. It is crucial that any misconceptions regarding smoking and COVID-19 among the general population are dispelled, particularly given the growing body of evidence that smokers tend to experience worse outcomes when infected with the virus. Our study found that direct contact with COVID-19 patients and being overwhelmed with work were associated with an increased risk of COVID-19 infection, which aligns with the results of a previous study conducted in China [15]. In contrast to previous findings [16], our study revealed that advance training on the use of PPE and the use of hand sanitizers were linked to a higher risk of infection. This result is difficult to interpret and more research is necessary to investigate any other contributing factors to the increased risk of infection. Furthermore, in agreement with previous studies [16], we found a significant association between the history of infection within the family and COVID-19 infection.

The most frequently reported symptoms associated with COVID-19 infection include fever, dry cough, shortness of breath, runny nose, and coughing up blood [17]. In a previous study conducted in Iraq, the most commonly observed symptoms were fever, dry cough,

and mild shortness of breath [18]. This is consistent with the findings of our study, with fever being the most prevalent symptom, followed by tiredness and muscle pain. There have been growing reports indicating an increased incidence of olfactory and taste dysfunction (OTD) among individuals who have been infected with COVID-19. According to Tong *et al.*, there was a combined prevalence of 52.73% for olfactory dysfunction and 43.93% for taste dysfunction among those who tested positive for COVID-19 [17]. In our study, the incidence of OTD was 38%. Despite a recent meta-analysis suggesting that a significant proportion of COVID-19 patients experience gastrointestinal symptoms [19], such symptoms were rare in our study. The disparity in the results for gastrointestinal symptoms may be attributed to differences in the variants of the virus and the sampling methods used in each study.

Previous research showed that there is a significant association between physical inactivity and the severity of COVID-19, with patients who engage in lower levels of physical activity generally experiencing more severe symptoms and longer-lasting illness [20]. However, in our study, we found that maintaining a healthy lifestyle and avoiding obesity was associated with a higher severity of infection. The reasons for this difference between studies are not easily explainable. It should be noted that it was previously observed in our region that people who pursue a healthy lifestyle by going to the gym, exercising without taking precautions to prevent the spread of infection, and not wearing masks have an increased risk of catching the virus [21].

Previously, it was found that individuals who had both COVID-19 and chronic illnesses were more prone to experiencing severe symptoms, being admitted to the ICU, and facing a higher risk of mortality [22]. Our research supports this notion, as we discovered that HCWs who have chronic illnesses are more susceptible to having a severe infection.

A study carried out in Egypt revealed that working in the hospital for a long duration was linked to a more severe COVID-19 infection [23]. Our research supports this finding, as we observed that working for extended hours and being exposed to a heavily burdened work environment were significantly associated with a higher likelihood of experiencing a more severe infection. These results emphasize the importance of ensuring that HCWs are not overburdened and have access to necessary resources to prevent the spread of the virus and protect their own health. It is essential to prioritize the safety and well-being of frontline workers to effectively combat the COVID-19 pandemic.

On the other hand, factors such as smoking habits, adherence to preventive health guidelines, direct exposure to COVID-19 patients, work days and pattern, family members with COVID-19, and hand/glove sterilization did not appear to have a significant effect on the severity of infection.

Conclusions

Protecting HCWs is crucial for dealing with the COVID-19 pandemic. The study highlights the risk factors associated with COVID-19 infection among HCWs, including young age, direct contact with infected patients, being overwhelmed with work, and having chronic illnesses. The study found that maintaining a healthy lifestyle and avoiding obesity was associated with a higher severity of infection, while physical inactivity was not found to be a significant risk factor. The most common symptoms reported among infected HCWs were fever, tiredness, and muscle pain. It is important to note that the study was a cross-sectional study, and further research is needed to investigate the impact of different factors on COVID-19 infection outcome among healthcare workers.

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