Assessment of the Pattern and Risk Factors for COVID-19 among Infected Healthcare Workers

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Abstract:

Background: Treating COVID-19-infected individuals is the primary responsibility of healthcare workers (HCWs). Initial data revealed a rising rate of COVID-19 infection among HCWs**.**

The study aims to determine the risk factors for COVID-19 infection and analyze the disease pattern among HCWs at Assiut University hospitals. The current study was conducted.

Patients and Methods: This study was carried out in Assiut University Hospitals. After obtaining ethical committee approval, HCWs who were proven infected with the COVID-19 virus based on positive PCR testing. All participants were asked to fill out the study questionnaire.

Results: This questionnaire-based study included 165 participants (119 females and 46 males) with a mean age of 29.22 ± 4.75 years. Seventy-one cases (43.0%) received a special training course for infection control, and personal protective equipment(PPE) was fully used at work, which was reported by only 47 participants (28.5%), while 118 cases (71.5%) used personal protective equipment (PPE) at work partially. One hundred eighteen cases (71.5%) reused the PPE equipment. Concerning hospital admission, the studied participants were divided into two groups; 42.4% required hospitalization, while 57.6% were treated at home.

Conclusion: Vaccination against COVID-19 infection was the only significant protective factor against the need for hospitalization (P value=0.002). Females were more likely to cope with the disease faster and recover quicker without residual symptoms than males.

Keywords: Coronavirus disease 2019, healthcare workers, personal protective measures.

Introduction:

SARS-CoV-2 is a new coronavirus that is the cause of COVID-19, an infectious respiratory disease. In December 2019, the first group of COVID-19 patients was discovered in China (1). SARS-CoV-2 spreads quickly (3). It swiftly spread to most nations on Earth, becoming a global pandemic. As a result, researchers from throughout the globe gave it a lot of attention (4, 5). The primary means of transmission for COVID-19 are respiratory droplets and close contact (2). The most common clinical manifestations documented are fever, malaise, tachypnea, chest distress, and cough (6).

HCWs treat COVID-19-infected patients on the front lines of care. On the other hand, there is a dearth of information

regarding HCW infection rates. According to preliminary data, the percentage of HCWs with the novel infection is rising, ranging from 15% to 18%, and in some instances up to 20% of the infected population. The following are major risk factors for infection among HCWs: psychological stress, unclear diagnostic criteria, inadequate use and availability of personal protective equipment (PPE), and lack of understanding of the disease (7).

A key issue during the COVID-19 pandemic was the very large number of infected people, both symptomatic and asymptomatic, who were admitted to hospitals (7). Protection of HCWs who are vulnerable, such as those over 50, those with systemic diseases, smokers, and people with disabilities, was a crucial component (8).

Objectives:

The study aims to evaluate the pattern of COVID-19 disease among HCWs in Assiut University hospitals and assess the risk factors for such an infection.

Patients and Methods:

This study is a single-center, observational questionnaire-based study that was carried out in Assiut University Hospitals. HCWs who were proven to be infected with the COVID-19 virus from the first of March 2020 up to the end of February 2021 were assigned to the study, as shown in (**Figure A**). We included those proven to be infected with COVID-19 based on positive PCR testing. Eligible participants for the current study were not in contact with household COVID-19 patients within 14 days before getting infected. Apart from attending work, adherence to social isolation was an important requirement for participation. The study was approved by the ethics committee, Faculty of Medicine, Assiut University (**IRB no.:** 17101386).

Data Collection:

All participants who willingly agreed to contribute to this study were asked to fill out the study questionnaire. It included personal, anthropometric data, history of chronic disease, including obesity, DM, heart disease, hypertension, renal disease, hepatic disease, pulmonary disease, cancer, and/or other diseases. It also included questions about the protective measures: if the participant received infection control training course before dealing with patients, used personal protective equipment (PPE) at work; which type: full (wearing gloves, face shield, respirator mask, apron,gowen, eye goggles, shoes cover) or partial (lack of one or more of the previous mentioned equipment) and how often. Symptoms at the time of infection were documented, including fever, cough, fatigue, shortness of breath, loss of smell/taste, runny nose, chest pain or tightness, unusual abdominal pain, diarrhea, confusion, disorientation or drowsiness, headache, sore throat, strong muscle pains, and/or other symptoms. The participants were asked if they needed hospitalization at the time of the infection. In case of hospitalization, in which hospital zone (green, yellow, or red zone) were they admitted? The participants were also asked if they felt completely healthy when completing the questionnaire or if residual symptoms were still present. The questionnaire also asked about the patient's investigations during infection. For example: High resolution computed tomography, Polymerase Chain Reaction (PCR), Complete blood count (CBC), liver function tests (total protein, albumin, total bilirubin, direct bilirubin, alanine transaminase and aspartate transaminase), kidney function test, C-reactive protein (CRP), D-dimer test, serum ferritin, blood sugar test, blood gas analysis, serum electrolytes and others.

Statistical Analysis:

Data were collected and analyzed using SPSS (Statistical Package for the Social Sciences, version 20, IBM, Armonk, New York). Data were statistically described in terms of mean ± standard deviation (±SD),

or median and range when not normally distributed, frequencies (number of cases), and relative frequencies (percentages) when appropriate. Comparison of quantitative variables was done using Student's t-test for normally distributed data and the Mann-Whitney U test for non-normally distributed data. For comparing categorical data, the Chi-square ($\chi 2$) test was performed. An exact test was used when the expected frequency was less than 5. Correlation between various variables was done using Spearman's rho correlation test. P-value set at a significant level of 0.05.

Results:

This study included 165 participants. The mean age of the studied cases was 29.22 ± 4.75 years and ranged from 21 to 50 years. One hundred nineteen cases (72.1%) were females, and 46 (27.9%) were males. Among the studied participants, 73.3% were medical doctors, 23.6% nurses, and 3.0% workers. Their duty hours were as follows: 73 (44.2%) worked up to 12 hours daily, 46 (27.9%) worked more than 12 up to 24h/day, and another 46 (27.9%) worked more than 24h. Seventy-one participants (43.0%) received a special training course for infection control. Only 47 participants (28.5%) reported the full use of PPE, while 118 (71.5%) used PPE only partially. One hundred eighteen of the studied population (71.5%) reused the PPE equipment, as shown in (**Table 1)**. Regarding the exposure risk for infection, it was found that direct contact with COVID-19 patients was documented in 144 cases (87.3%), and caring for COVID-19 patients in an isolation unit was documented in 111 cases (67.3%). Regarding the symptoms, the most frequently reported symptoms by the contributing HCWs were fatigue (91.3%), headache (86.1%), fever (80.6%), loss of smell/taste (72.7%), and respiratory symptoms. Among the reported respiratory symptoms, 89.1% had cough, 72.7% had sore throat and shortness of breath, 35.8% had chest pain or tightness, and 40.6% had a runny nose. Gastrointestinal manifestations were also reported; diarrhea was documented in 50.9%, abdominal pain in 32.7% and loss of appetite in 61.8% of the studied participants. Additionally, muscle pain was reported in 53.3%, confusion in 3.6% and depression was reported only in one case, as shown in (**Figure B**). Regarding vaccination, only 41 cases (24.8%) received vaccination against COVID-19 infection. The other 124 cases (76.2%) didn't receive vaccination against COVID-19 infection (23 cases refused to receive the vaccination, and 101 got infected before the availability of the vaccine (**Table 2**). The studied participants were divided into two groups according to the requirement for hospital admission; 42.4% required hospitalization, while 57.6% were treated at home (**Table 2**). The current study tried to analyze the risk factors for hospitalization by using hospitalization as an indicator for the severity of COVID-19 infection. It was observed that vaccination against COVID-19 infection was the only significant protective factor against the need for hospitalization (P value = 0.002) **(Table 3)**. Other personal and clinical risk factors were comparable between hospitalized and non-hospitalized groups, with no significant difference. Finally, comparing the personal and clinical data between those who still have residual symptoms and those who don't, it was found that females were more likely to cope with the disease faster and recover quicker than males **(Table 4)**.

Figures and Tables:

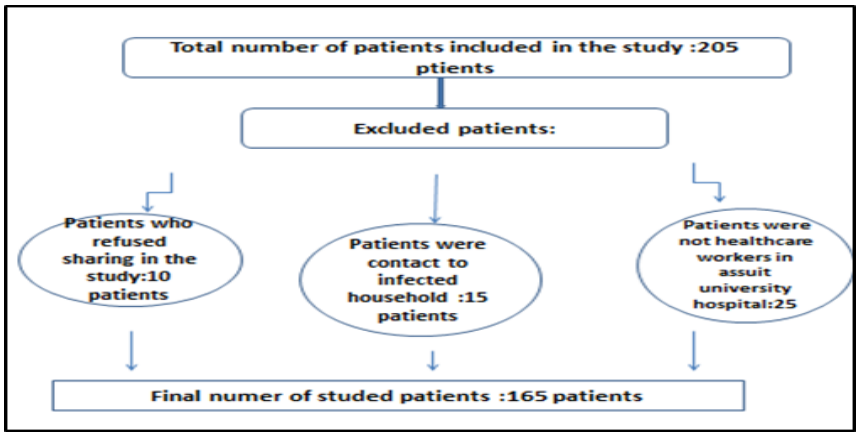

Figure a: Selection process of patients.

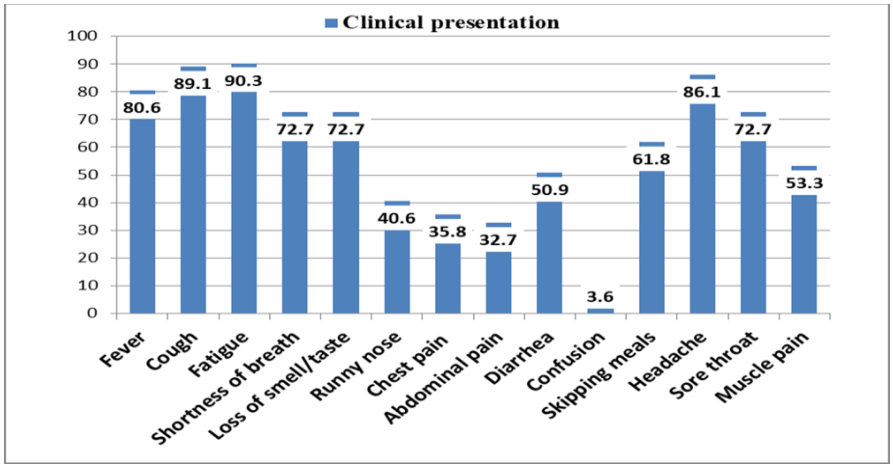

Figure b: Bar graph showing the distribution of clinical presentation of COVID-19 infection among the studied HCWs.

Table 1: Protective measures used against COVID-19 infection among the studied HCWs (n=165)

PPE	**N**	**(%)**
Received a special training course for infection control		
I. No	94	(57.0)
II. Yes	71	(43.0)
PPE used at work		
III. Full	47	(28.5)
IV. Partial	118	(71.5)
PPE frequency		
V. Always	73	(44.2)
VI. Sometimes	87	(52.7)
VII. Never	5	(3.0)
Reuse any PPE		
VIII. No	47	(28.5)
IX. Yes	118	(71.5)
Hand hygiene		
X. Median times of hand hygiene	3 (1 – 10)	
XI. Disinfectant		
▪ No	41	(24.8)
▪ Yes	124	(75.2)

Table 2: Vaccination and the need for hospitalization among the studied HCWs (n=165)

Variable name	**N**	**(%)**
Vaccination		
a. Yes	41	(24.8)
b. No	124	(76.2)
Hospitalization		
c. No	95	(57.6)
d. Yes	70	(42.4)
Hospitalization zone (n=70)		
- Green	66	(40.0)
- Yellow	4	(2.4)
- Red	0	(0.0)

Qualitative data are presented as a number (percentage).

Table 3: Exposure hazard and effect of COVID-19 infection among the studied HCWs

	Hospitalization				
COVID-19 infection	**No (n=95)**		**Yes (n=70)**		**P-value***
Feel right now					
e. I feel as healthy as normal	83	(87.4)	60	(85.7)	0.757
f. I'm not feeling quite right	12	(12.6)	10	(14.3)	
Exposed to aerosol-generating procedures					
g. No	16	(16.8)	10	(14.3)	0.656
h. Yes	79	(83.2)	60	(85.7)	
Come into contact with the patient's body fluids or patient's material					
i. No	21	(22.1)	19	(27.1)	0.456
j. Yes	74	(77.9)	51	(72.9)	
k. Protection					
▪ Without protection	30	(31.6)	21	(30.0)	0.282
▪ With protection	65	(68.4)	49	(70.0)	
Vaccination					
l. Yes	32	(33.7)	9	(12.9)	**0.002**
m. No	63	(66.3)	61	(87.1)	

***** Chi-square test was used

Table 4 Comparison of the demographic and clinical data of the studied COVID-19 infected HCWs according to feeling better or not (n=165)

	Feeling better				
Variables	**Feeling right (n=143)**		**Not feeling right (n=22)**		**P-value**
Age (years)					
• Mean ± SD	29.07 ± 4.71		28.78 ± 4.96		0.341**
• Median (range)	28 (21 – 50)		29 (24 – 43)		
Sex, n (%)					
XII. Male	33	(23.1)	13	(59.1)	**<0.001***
XIII. Female	110	(76.9)	9	(40.9)	
BMI (kg/m^2)					
XIV. Median (range)	25.7 (16.9 – 40.0)		27.3 (20.8 – 37.8)		0.094**
XV. Underweight "< 18.5"	1	(0.7)	0	(0.0)	0.332*
XVI. Healthy weight "18.5 - <25"	52	(36.4)	4	(18.2)	
XVII. Overweight "25 - <30"	64	(44.8)	13	(59.1)	
XVIII. Obese "≥ 30"	26	(18.2)	5	(22.7)	
Occupation, n (%)					
XIX. Doctor	107	(74.8)	14	(63.6)	0.135*
XX. Nurse	33	(23.1)	6	(27.3)	
XXI. Worker	3	(2.1)	2	(9.1)	

Table 4 Comparison of the demographic and clinical data of the studied COVID-19 infected HCWs according to feeling better or not (n=165) *(Cont.)*

	Feeling better				
Variables	**Feeling right (n=143)**		**Not feeling right (n=22)**		**P-value**
Duty hours level					
XXII. Up to 12 h.	63	(44.1)	10	(45.5)	0.822*****
XXIII. More than 12 up to 24 h.	39	(27.3)	7	(31.8)	
XXIV. More than 24h.	41	(28.7)	5	(22.7)	
Smoking, n (%)					
XXV. Smoker "cigarette"	9	(6.3)	2	(9.1)	0.691*****
XXVI. Non-smoker	133	(93.0)	20	(90.9)	
XXVII. Ex-smoker	1	(0.7)	0	(0.0)	
Pregnancy, n (%)					
XXVIII. No	137	(95.8)	19	(86.4)	0.102*****
XXIX. Yes	6	(4.2)	3	(13.6)	
Chronic disease, n (%)					
XXX. No	112	(78.3)	17	(77.3)	1.000*****
XXXI. Yes	31	(21.7)	5	(22.7)	
Diabetes mellitus, n (%)					
XXXII. No	132	(92.3)	20	(90.9)	0.685*****
XXXIII. Yes	11	(7.7)	2	(9.1)	
Hypertension, n (%)					
XXXIV. No	135	(94.4)	22	(100.0)	0.599*****
XXXV. Yes	8	(5.6)	0	(0.0)	

***** Chi-square test was used ** Mann-Whitney test was used

Discussion:

The current study included 165 HCWs who were infected with COVID-19. The great majority of the included participants (95.7%) were between 21 and 40 years old. The explanation that most of the participants are young could be that older HCWs were less likely to be assigned to high-risk sites and wards and were more likely to be reassigned to duties that did not expose them to infectious patients. Kishk et al. observed similar findings, showing that 89.6% of the study participants were in the 18—40 age range (9). 72.1 % of the HCWs under study were female. According to Ran et al.'s 2020 report, female HCWs in the ICU had the highest infection rates. This was to be expected because women make up the bulk of the nursing staff at our institution (10).

In the current study, the majority of HCWs were exposed directly to confirmed cases infected with COVID-19 through various ways, including close contact with the patients, direct contact with the contaminated surfaces or patients' materials, and/or attending aerosol-generating procedures performed on the patients. It was observed that direct contact with COVID-19 patients was documented in 87.3%. Of them, 67.3% cared for COVID-19 patients in an isolation unit.

Similar results were reported by Kishk et al., who discovered that 42.3% of study participants came into contact with patient bodily fluids, 7% had a prolonged face-to-face exposure (>15 min) with the patients, 66.7% of participants had close contact with patients since admission, 63.7% had direct

contact with surfaces surrounding the patient, 48.5% had contacted patient materials, and 42.3% attended aerosolizing procedures performed on the patient (9). Furthermore, in line with the New York study, the same author revealed that individuals who made direct contact with the patients had a higher probability of contracting COVID-19 infection than those who did not (12).

Since infection control practices are thought to be the most effective defence against COVID-19 for ICU HCWs(13), the current study tried to investigate different methods of infection control by HCWs. Unfortunately, only 28.5% reported using full PPE compared to 71.5% used PPE partially, and five cases (3.0%) never used PPE. Out of the studied population, 71.5% were reusing the PPE equipment. This was further explained by the PPE shortage or its shortage avoidance.

Among the most reported important hygiene measures is hand hygiene. In the present study, the median frequency of hand hygiene practices was three times/day and ranged from once/day up to ten times/day. This low frequency of hand hygiene could be an important cause of the increased risk of COVID-19 infection; however, further studies are still required. This conclusion was also reported by Kishk et al. (9) and Aly Mohammed et al. (11).

Different findings were reported in a different study conducted in southwest Iran. Approximately 65.9% of the 273 HCWs did not wear safety goggles, 58.2% did not use face shields, 18.7% did not wear gloves, and 1.5% did not wear masks (14).

The different results among studies from different populations and institutes could be explained by different awareness, education, and adherence to hygiene rules. Other reasons could be the availability of PPE and Infection Prevention and Control (IPC) standard education in different hospitals.

Among the studied HCWs, fatigue (91.3%), headache (86.1%), fever (80.6%), loss of smell/taste (72.7%), and respiratory symptoms were the most frequently reported symptoms. Among the reported respiratory symptoms, 89.1% had cough, 72.7% had sore throat and shortness of breath, 35.8% had chest pain or tightness, and 40.6% had a runny nose. Similar symptom frequencies were reported by Aly Mohammed et al. (11).

Conversely, Kishk et al. found that just 42.0% of the HCWs in their study experienced respiratory symptoms. Regarding additional symptoms, nearly 30% experienced headaches, 24% experienced fevers, 23% had bone aches, 24.1% had diarrhoea, and 21.4% and 21% lost their sense of taste and smell, respectively (9).

In the investigated participants, vaccination against COVID-19 was documented in only 24.8%. A similar finding was reported by Maraqa et al. (15). However, like in the case of any other vaccine, there has been vaccination hesitancy among the HCWs regarding the COVID-19 vaccine. Additionally, the vaccine was insufficient at the time of the study to vaccinate all HCWs despite their priority to get the vaccine.

Concerning hospital admission, 42.4% of the studied HCWs required hospitalization. Taking hospitalization as an indicator for the severity of COVID-19 infection, it was found that vaccination against COVID-19 infection was the only significant protective factor against the need for hospitalization. This result emphasizes the importance of vaccination and highlights its role in minimizing the severity of the disease. Other demographic and clinical risk factors studied were comparable between hospitalized and non-hospitalized groups, with no significant protective or harmful effect.

Surprisingly, using PPE did not significantly prevent hospitalization among the infected HCWs. The results of a pan-

African survey, which included six nations and sought to determine the effect of COVID-19 on HCWs across the continent, found no statistically significant correlation between having access to personal protective equipment (PPE) and possible SARS-CoV-2 exposure (RR, 0.81; CI, 0.64—1.03; P = 0.10) (16).

Another recent study result is that the number of female gender participants was significantly less among those with residual symptoms when filling out the questionnaire. The ability of females to cope faster with the disease compared to males was confirmed in other studies. For example, a consistent observation across diverse countries and cultures is that severe COVID-19 is more likely to occur in males than females (17-18). Furthermore, sex differences in outcomes of viral infections are not limited to SARS-CoV-2.There is evidence from numerous clinical and epidemiological studies that biological sex broadly impacts immunity to viral infection (19, 20). Furthermore, other studies have demonstrated that females generally exhibit stronger innate and adaptive immune responses across various species than males (21,22). This could support the present finding.

Limitations of the Study:

The study's findings were subject to some limitations. First, that is a single-center study. The second includes different HCWs with different work responsibilities. This still could be considered a limitation of the study; however, the study's main aim was to improve the representation of the studied population. This is because different work responsibilities can result in different degrees of exposure. Thirdly, the majority of the included participants were between 21 and 40 years old. This limited the study of COVID-19 infection among older HCWs. Finally, the present study provided only a snapshot in time. Therefore, a temporal relationship between the exposure and the outcome, or identifying the best predictor, could not be confirmed.

Conclusion:

HCWs are at high risk for severe COVID-19 infection, showing different presenting symptoms and severity levels. Vaccination against COVID-19 is still highlighted and considered the most important protective tool against COVID-19. Further studies evaluating the precise use of PPE and other infection control measures in preventing COVID-19 are still recommended. The female sex showed the ability to cope faster with the disease and to get well without further residual symptoms earlier than the male sex.

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