

Epidemiological Study of COVID-19 among Healthcare Workers

Mahmoud Saif-Al-Islam*¹, Hamdy Saad Mohamed², Ahmad Mokhtar Abodahab³,
Doaa Gadallah Hassanin⁴, Magda Mohamed Ali⁵, Mustafa A Younis⁶, Safaa Khalaf¹.

Departments of Tropical Medicine and Gastroenterology¹, Internal Medicine², Radiology³,
Chest Diseases and Tuberculosis⁴, Community Medicine⁵, and Clinical and Chemical Pathology⁶,

Sohag University Hospitals, Sohag, Egypt.

*Corresponding author: Mahmoud Saif-Al-Islam, Mobile: 01091055908, E-mail: happyyear5000@yahoo.com

ABSTRACT

Background: Health care workers (HCWs) are crucial to maintaining healthcare services during COVID-19 pandemic. One of the greatest risks to healthcare system is the potentially high rate of infections due to COVID-19 among HCWs.

Objective: To summarize the epidemiologic characteristics, clinical features, radiologic findings, laboratory data, and outcomes of health care workers diagnosed with coronavirus disease 2019 (COVID-19) in Sohag University Hospitals.

Patients and methods: A retrospective study included 101 HCWs who were proved to have COVID-19. HCWs with COVID-19 were categorized to asymptomatic cases, mild cases which included patients with mild clinical symptoms and normal lung computed tomography (CT), and moderate cases which included patients with mild or moderate clinical features and abnormal lung CT.

Results: 89.11% of infected HCWs had no definite history of contact with a confirmed case of COVID-19. A considerable percent of the patients presented with non-respiratory symptoms such as GIT, and neurological symptoms. Patients who had a moderate respiratory illness were significantly older than those who had a mild respiratory illness and were more likely to have diabetes. Home isolation was recommended in most cases (n=73). Several cases (n=24) preferred isolation in university undergraduate houses, and 4 patients were treated at isolation hospital, 2 of them needed oxygen therapy.

Conclusion: COVID-19 in HCWs exhibited a wide spectrum of disease severity. Symptom-based screening for COVID-19 in HCWs may underestimate the affected number as there is a considerable percent of asymptomatic cases. For HCWs' safety, the use of protective personal equipment and adherence to proper hand-hygiene practice are important protective tools during this pandemic. Also, there is a growing need for educational and training programs for all levels of HCWs.

Keywords: COVID-19, Health care worker.

INTRODUCTION

COVID-19 is an emerging respiratory disease with high infectivity and mortality rates. The causative organism for COVID-19 is severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2). COVID-19 was firstly reported in Wuhan city in China at the end of 2019⁽¹⁾. The novel coronavirus rapidly spread outside China throughout the world causing pandemic crisis⁽²⁾.

SARS-CoV-2 can cause a spectrum of disease severity ranging from mild illness to severe symptoms especially in the elderly and patients with comorbidities^(3,4). The commonly reported symptoms included fever, fatigue, dry cough, myalgia, dyspnea, and sore throat⁽⁵⁾.

COVID-19 is considered an important HCWs occupational disease. Globally several thousand of HCWs have been reported to get the infection by SARS-CoV-2⁽⁶⁾. Hence HCWs are at the first lines of the COVID-19 outbreak response, they are exposed to the hazard of infection⁽⁷⁾.

Also, HCWs are vulnerable to get the infection through either household or community transmission. Besides, transmission might come from unrecognized sources, including asymptomatic or pre-symptomatic persons^(8,9). HCWs were understandably worried not only about becoming infected but also about

transmitting the infection to their co-workers, patients, and families⁽¹⁰⁾.

Early identification of COVID-19 cases with the determination of disease severity and prognosis is very important for the reduction of mortality risk. Egypt registered the first COVID-19 case on the 14th of February 2020⁽¹¹⁾. Egypt began a strategy to prevent the spread of infection. Nasopharyngeal swabs for real-time reverse transcriptase-polymerase chain reaction (rRT-PCR) were done for patients with suspicious symptoms, and the contacts of COVID-19 confirmed cases⁽¹²⁾.

The Egyptian studies that could be traced in the literature regarding COVID-19 in HCWs are scarce, so we performed a retrospective analysis of a cohort of HCWs proved to have COVID-19 from those who work in Sohag University Hospitals, Upper Egypt.

The aim of this study is to summarize the epidemiologic characteristics, clinical features, radiologic findings, laboratory data, and outcomes of HCWs diagnosed with COVID-19 in Sohag University Hospitals.

PATIENTS AND METHODS

This is a retrospective study that was carried out from the 2nd of May 2020 to the 12th of July 2020 at Sohag University Hospitals, Sohag city, Upper Egypt.



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Ethical approval:

The approval for the study was obtained from the Ethical Committee of Faculty of Medicine, Sohag University (date: 9/9/2020; IBR #S20-151). As the study design was retrospective, it did not require patients' informed written consent.

Data were collected from hospital medical records and databases created especially to register COVID-19 cases in HCWs. Outcomes were followed up through telemedicine practice. Baseline characteristics before implementation of any specific treatment, including demographic, clinical, radiological features, and laboratory data were reviewed.

We included HCWs who were proved to have COVID-19 based on the positive results of quantitative rRT-PCR testing of combined nasopharyngeal and oropharyngeal swabs which were performed in collaboration with the Ministry of Health and Population, at a specialized laboratory, Akhmiem Hospital, Egypt. We excluded those who were tested negative for COVID-19. rRT-PCR was repeated 48 hours later for highly suspicious patients⁽¹²⁾. Also, senior faculty members were excluded as their medical files were unavailable.

HCWs with COVID-19 were categorized according to the latest guidelines provided by World Health Organization (WHO) and Chinese health authorities to asymptomatic cases who were defined as cases that tested positive for the nucleic acid of SARS-CoV-2 by RT-PCR, but did not have any clinical symptoms at any point of time, and had normal lung CT, mild cases which included patients with mild clinical symptoms and normal lung CT, and moderate cases which included patients with mild or moderate clinical features and abnormal lung CT^(5, 13).

Detection of SARS-CoV-2 by (RT-PCR):

A total of 101 specimens (combined nasopharyngeal and oropharyngeal swabs) were collected for SARS-CoV-2 RT-PCR testing using Daan novel coronavirus nucleic acid detection kit (Fluorescent PCR, Da An Gene Co., Ltd. Of Sun Yat-sen University, China). RNA was extracted by fully automated purification of nucleic acids using QIAGEN extraction Kit and The QIASymphony RGQ system (QIAGEN S.A.S., France). The purified nucleic acid was reverse transcribed into cDNA and amplified using the Daan novel COVID-19 RT-PCR Kit in one step

using Rotor-Gene 6000™ RT-PCR version 1.7 and its software (Corbett Research, Australia). It is a one-step RT-PCR technique. Coronavirus (2019-nCoV) open reading frame (ORF) and nucleocapsid (N) genes were selected as amplification target regions. Specific primers and fluorescent probes were designed for the detection of novel virus RNA in the specimens. This kit also included an endogenous internal standard detection system, which is used for monitoring over the processes of specimen collection, RNA, and PCR amplification, thereby reducing false-negative results. Negative and positive control samples were also included. All the previous requirements must be met at the same time in each experiment; otherwise, the experiment was considered invalid and carried out again.

Statistical analysis

Data were analyzed using SPSS version 23. Quantitative data were represented as mean ± standard deviation, median and interquartile range (IQR), and were analyzed using the Mann-Whitney test to compare the means of two groups. Qualitative data were presented as numbers and percentages. Comparisons of qualitative data were done by Chi-square test and Fisher's exact test when suitable. Graphs were produced by the SPSS program. P-value was considered significant if it was less than 0.05.

RESULTS

This study included 101 patients. Their ages ranged from 18 to 59 years with a mean of 30.78±7.53 years. Eighty (79.21%) were in the age group of 25-35 years old. Forty-eight were males and 53 were females. Patients were categorized according to disease severity into 38 asymptomatic patients, 11 patients with non-respiratory illness, 32 patients with mild respiratory illness, and 20 patients with moderate respiratory illness. The mean values of age for the asymptomatic group and patients with mild respiratory illness were close, and sex distributions were similar with non-significant differences between the two groups. Patients who had a moderate respiratory illness were significantly older than those who had a mild respiratory illness and were more likely to have diabetes. 89.11% of infected HCWs had no definite history of contact with a confirmed case of COVID-19, and in a minority of patients household transmission had been confirmed. Comorbid conditions were found in 7 patients (Table 1).

Table (1): Demographic characteristics of COVID-19 in HCWs with different types of disease severity

Variables	Total N=101	Asymptomatic N=38 (37.62%)	Symptomatic			P-value
			Non-respiratory symptoms	Mild illness N=32 (31.68%)	Moderate illness N=20 (19.80%)	

			N= 11 (10.89%)			
Age:						
Mean±SD	30.78±7.53	30.7±8.4	33.9±8.4	28.7±4.6	33.6±9.4	P1= >0.05 P2= 0.01
< 25 years	5 (4.95%)	4 (10.53%)	0	1 (3.13%)	0	
25-35 years	80 (79.21%)	30 (78.95%)	9 (81.82%)	28 (87.50%)	13 (65%)	
≥ 35 years	16 (15.84%)	4 (10.53%)	2 (18.18%)	3 (9.38%)	7 (35%)	
Sex:						
Males	48 (47.52%)	17 (44.74%)	6 (54.55%)	14 (43.75%)	12 (60%)	>0.05
Females	53 (52.48%)	21 (55.26%)	5 (45.45%)	18 (56.25%)	8 (40%)	
History of contact with COVID-19 confirmed case:						
Yes	11(10.89%)	1 (2.63%)	2 (18.18%)	2 (6.25%)	6 (30%)	>0.05
No	90 (89.11%)	37 (97.37%)	9 (81.82%)	30 (93.75%)	14 (70%)	
Household transmission						
Yes	14 (13.86%)	0	3 (27.27%)	10 (31.25%)	1 (5%)	>0.05
No	87 (86.14%)	38 (100%)	8 (72.73%)	22 (68.75%)	19 (95%)	
Comorbidity:	7 (6.93%)					
Diabetes mellitus	3 (2.97%)	0	0	0	3 (15%)	P3= 0.017
Hypertension	2 (1.98%)	0	1 (9.09%)	0	1 (5%)	
Smoking	2 (1.98%)	1 (2.63%)	1 (9.09%)	0	0	

N: number, P1: asymptomatic versus mild illness, P2: mild versus moderate illness, P3: value tested by Fisher’s Exact test.

According to hospital workforce records, HCWs who had been working in our hospital at the time of the study were 461 physicians, 40 pharmacists, 832 nurses, and assistant nurses, 130 technicians, and 350 workers. The study included 51 (11.06%) physicians, 36 (4.33%) nurses and assistant nurses, 4 (3.08%) technicians, 2 (0.57%) workers, 1 pharmacist, and other 7 patients (facility management personnel) (Figure 1). More than half of the infected HCWs work in internal medicine departments (55.45%), and a third of them work in surgical departments (31.68%) (Figure 2).

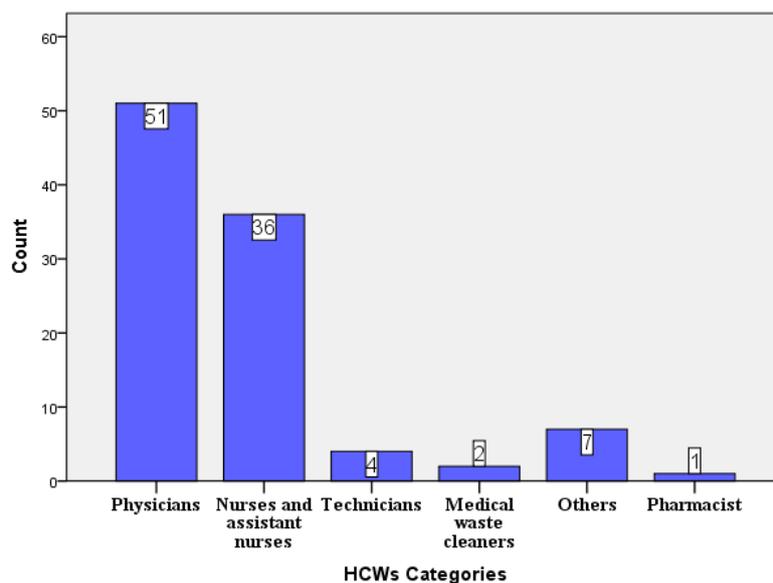


Figure (1): Categories of health care workers infected by COVID-19.

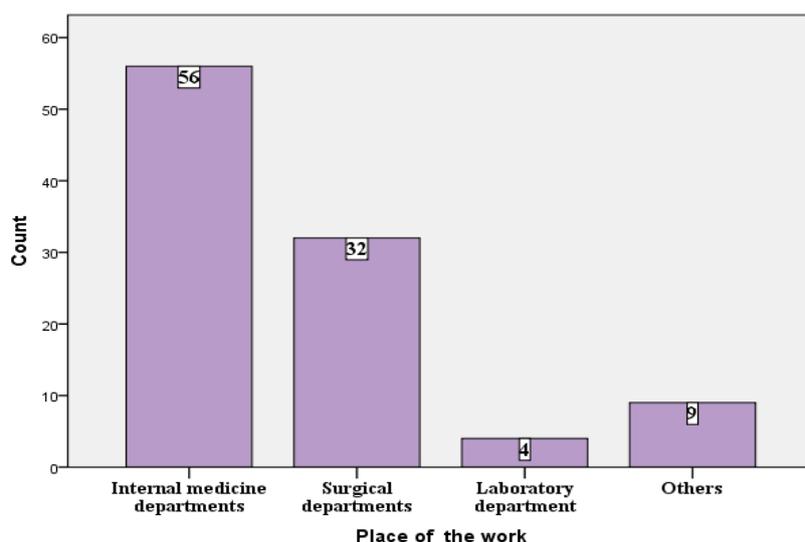


Figure (2): Distribution of infected HCWs according to different hospital departments.

Regarding COVID-19 clinical manifestations among HCWs, the most frequent symptoms were fever, cough, sore throat, malaise, and dyspnea. Patients with moderate respiratory illness had a significantly higher incidence of cough, dyspnea, and muscle ache than those with mild respiratory illness (Table 2).

Table (2): Clinical manifestations of COVID-19 in HCWs with different types of disease severity

Variables	Total N=101	Non- respiratory symptoms N= 11	Mild illness N=32	Moderate illness N=20	P-value (Mild versus moderate illness)
Fever	46 (45.54%)	5 (45.45%)	23 (71.88%)	18 (90%)	> 0.05
Cough	41 (40.59%)	0	22 (68.75%)	19 (95%)	<0.001
Sore throat	32 (31.68%)	0	21 (65.63%)	11 (55%)	> 0.05
Malaise	28 (27.72%)	3 (27.27%)	14 (43.75%)	11 (55%)	> 0.05
Dyspnea	20 (19.80%)	0	7 (21.88%)	13 (65%)	<0.001
Diarrhea and abdominal pain	8 (7.92%)	5 (45.45%)	1 (3.13%)	2 (10%)	> 0.05
Muscle ache/bone pain	8 (7.92%)	1 (9.09%)	1 (3.13%)	6 (30%)	0.018
Anosmia	7 (6.93%)	2 (18.18%)	3 (9.38%)	2 (10%)	> 0.05
Headache	6 (5.94%)	1 (9.09%)	1 (3.13%)	4 (20%)	> 0.05
GIT upset	5 (4.95%)	2 (18.18%)	1 (3.13%)	2 (10%)	> 0.05
Nausea/Vomiting	5 (4.95%)	3 (27.27%)	1 (3.13%)	1 (5%)	> 0.05
Loss of taste	3 (2.97%)	2 (18.18%)	1 (3.13%)	0	> 0.05
Numbness	3 (2.97%)	1 (9.09%)	0	2 (10%)	> 0.05

N: number, GIT: gastrointestinal tract.

Chest CT was performed for 79 cases, of them, 59 cases had normal CT chest, and 20 cases had abnormal CT findings. The most common findings were bilateral lower posterior faint ground-glass opacities (GGO), bilateral diffuse peripheral patches of faint GGO, and bilateral multiple faint subpleural patches (Table 3). CT chest of two patients with moderate respiratory illness are provided (Figures 3, 4).

White blood cells (WBCs) with differential counts were examined in 101 cases. Normal WBCs counts were found in 45.54% of the cases. Third of the cases (36.63%) showed leukocytosis with lymphopenia in 22.77%, normal lymphocytic count in 10.89%, and absolute neutrophilia in 2.97% of them. Few percent of cases showed leukopenia (13.86%) either with lymphocytosis (10.89%) or lymphopenia (2.97%). Lymphopenia was found totally in 25.74% of cases. Also, normal leukocytic count with relative neutrophilia was found in 3.96% (Table 3).

Table (3): Chest CT and laboratory features of COVID-19

Variable	Statistical summary
Chest CT	N= 79
Normal finding	59 (74.68%)
Bilateral multiple upper, middle & lower GGO	2 (2.53%)
Bilateral Diffuse peripheral patches of faint GGO	5 (6.33%)
Bilateral lower posterior faint GGO	6 (7.59%)
Bilateral multiple faint subpleural patches	4 (5.06%)
Unilateral peripheral patches	3 (3.79%)
Laboratory	N=101
Normal leukocytes- normal lymphocytes	46 (45.54%)
Normal leukocytes -relative neutrophilia - normal lymphocytes	4 (3.96%)
Leukocytosis - absolute neutrophilia	3 (2.97%)
Leukocytosis - normal lymphocytic count	11 (10.89%)
Leukocytosis- lymphopenia	23 (22.77%)
Leukopenia- lymphocytosis	11 (10.89%)
Leukopenia- lymphopenia	3 (2.97%)

N: number, GGO: ground-glass opacities

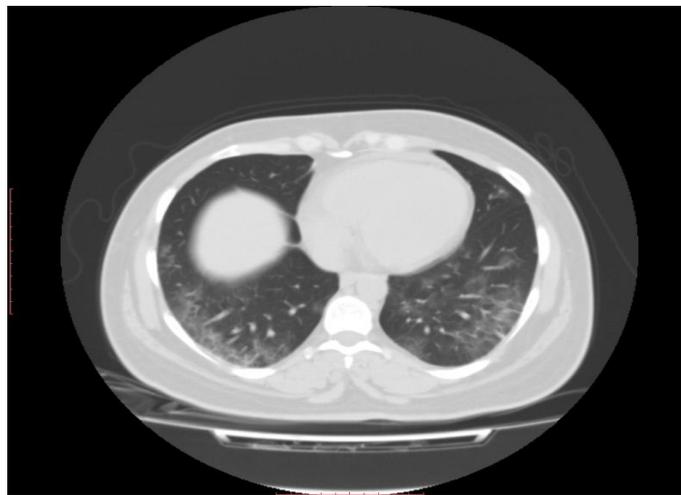
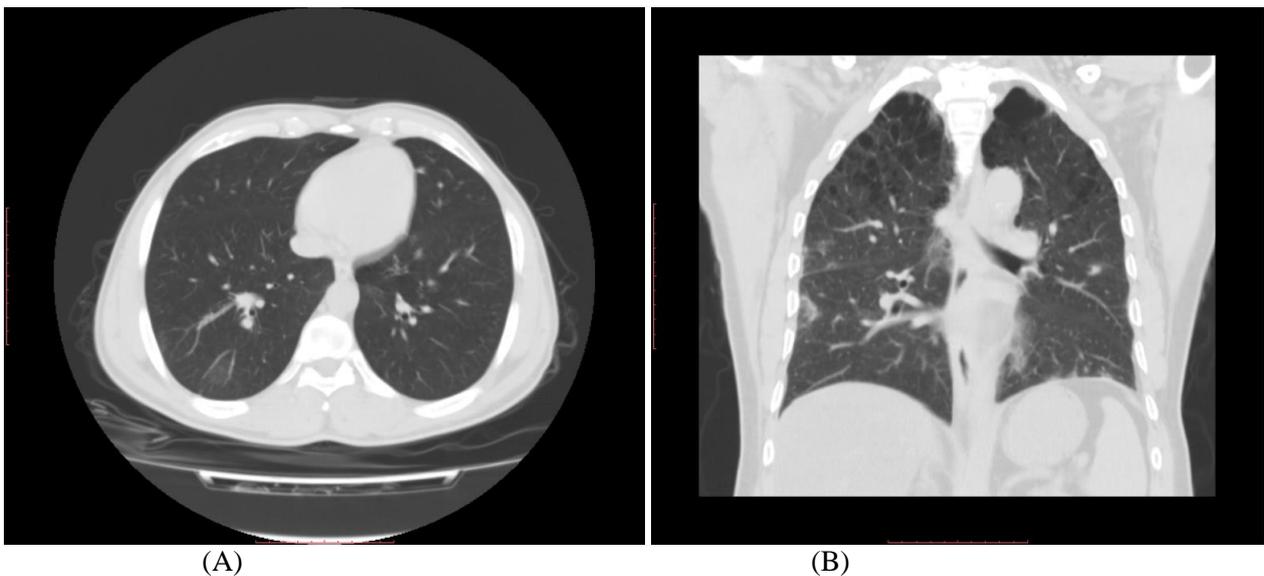


Figure (3): 52 years old patient with moderate respiratory illness. CT chest showing bilateral multiple large patches of ground-glass opacities in a posterior subpleural position.



(A)

(B)

Figure (4): 31 years old patient with moderate respiratory illness. CT chest axial scan (A), and coronal reformat imaging (B) showing unilateral faint small subpleural patches of ground-glass opacities in the right lower lobe.

Regarding management of HCWs with COVID-19, home isolation was recommended in most cases (n=73). Several cases (n=24) preferred isolation in university undergraduate houses, and 4 patients were treated at isolation hospital, 2 of them needed oxygen therapy, clinical recovery occurred after 5 days, and all were discharged after 14 days of admission. In the symptomatic patients (n=63) the median count of days from the first presentation to recovery date was 9.5 days with IQR 7-16 days, while the SARS-CoV-2 nucleic acid test turned negative after 21 days as a median value with IQR 14-28 days (Table 4).

Table (4): Management and outcome of COVID-19 infected cases

Variables	Statistical summary
Place of management	
Isolation in home	73 (72.28%)
Isolation in university undergraduate houses	24 (23.76%)
Isolation hospital admission	4 (3.96%)
Treatment	
Medical treatment	62 (61.39%)
Need oxygen therapy	2 (1.98%)
Days to clinical recovery: median (IQR)	9.5 (7-16)
Days to viral clearance: median (IQR)	21 (14-28)

IQR: interquartile range.

Infrequent hand washing after contact with surfaces or patients was found in 88 infected HCWs. Prolonged working hours of more than 12 hours/day were reported in all infected physicians (Table 5).

Table (5): Training courses, behavioral, and working conditions in COVID-19 infected HCWs

		Physicians N= 51	Other HCWs N=50	Total N=101
Attending training courses about infection control measures and occupational safety	Yes:	51	14	65
	No:	0	36	36
Frequent hand washing after contact with surfaces or patients	Yes:	10	3	13
	No:	41	47	88
Adherence to usage of personal protective equipment	Yes:	32	28	60
	No:	19	22	41
Working hours	>12 hours	51	0	51
	<12 hours	0	50	50

DISCUSSION

Infection with SARS-CoV-2 represents an occupational health problem with an unexpected risk of morbidity and mortality for HCWs⁽⁶⁾. HCWs are exposed to multiple sources of infection through contact with COVID-19 positive patients in the workplace, household, and community⁽¹⁴⁾. Currently, little is known about the transmission of SARS-CoV-2 in health care settings. Several reports described that there were HCWs exposed to confirmed cases of COVID-19 without any documented transmission of infection to them^(15, 16).

In the current pandemic, all ages had been affected from younger than 14 years old to those older than 65 years old with males slightly more affected than females⁽¹⁷⁾. Our study showed that the mean age of confirmed COVID-19 cases in HCWs was less than that reported by another Egyptian epidemiological study conducted on a sample of non-HCWs patients in a quarantine hospital⁽¹⁸⁾. Also, we found a preponderance of the female gender in infected HCWs. In agreement with our study, **Burrer et al.**⁽¹⁴⁾ reported that infected

HCWs were younger with a higher percentage of affected females, and this probably reflects age and gender distribution in the workplace.

During the study period, we reported that 101 HCWs had confirmed infection with SARS-CoV-2, most of them were physicians and nurses. This increased vulnerability could be attributed to that physicians and nurses spent much more time in direct contact with the patients. Also, we found more than half of the infected HCWs work in internal medicine departments, a third of them work in surgical departments, and the remaining numbers work in the laboratory, the pharmacy, other hospital facilities, and administrative services. **Jary et al.**⁽¹⁹⁾ also reported that the largest number of affected HCWs were in internal medicine departments followed by surgical departments. However, they found that most of the cases tested positive for COVID-19 were nurses (27%), and assistant nurses (25%). This variation may be attributed to differences in the type of hospitals whether general, university, or quarantine hospitals as well as different sample sizes and population demographics.

In the current study, we found that the majority of HCWs in our institute had no history of contact with a confirmed case of COVID-19 except in 10.89% of the cases. Similarly, **Jary et al.** ⁽¹⁹⁾ found no history of contact with a case of COVID-19 in 65.9% of infected HCWs. On the other hand, **Burrer et al.** ⁽¹⁴⁾ reported that more than half of SARS-CoV-2 infected HCWs had a history of contact with COVID-19 positive patients in healthcare settings.

In our study, we found more than a third (37.62%) of the COVID-19 confirmed cases were asymptomatic; and another 10.89% of the patients presented with non-respiratory symptoms such as GIT, and neurological symptoms. We reported 3 (2.97%) patients presented only by numbness of the face, hands, and lower limbs with fatigue, but without any other constitutional or respiratory symptoms. In the context of the SARS-CoV-2 pandemic, our study reinforces the evidence from other studies that, asymptomatic cases and those with atypical presentation may increase the risk of infection among HCWs, and this atypical presentation should be considered as many cases may be missed if the surveillance case definition focused on feverish patient⁽²⁰⁻²²⁾.

In our study, we found the most frequently reported symptoms were fever followed by cough, sore throat, malaise, and dyspnea. In agreement with our study, several studies reported that fever, cough, and myalgia were the most prevalent presenting symptoms^(19,23). Also, we found that COVID-19 patients with moderate illness were significantly older, more likely to have diabetes, cough, dyspnea, and muscle ache than those with mild respiratory illness. Considering the disease severity and mortality among the affected HCWs, this was extremely lower than non-HCWs positive COVID-19 patients. The explanation for this difference could be that HCWs were younger with a lesser prevalence of chronic comorbid conditions than non-HCWs positive COVID-19 patients⁽²⁴⁾.

In the present study, normal WBCs counts were found in 45.54% of the cases. In agreement with our results, many authors reported that WBCs counts were normal in 45%, 56.6%, and 58% of the cases^(23,25,26). On the contrary, **Liu et al.** ⁽²⁷⁾ and **Wu et al.** ⁽²⁸⁾ reported a higher percentage of normal WBCs counts than our results where normal WBCs counts were found in 92% and 81% of cases respectively. Also, **Fan et al.** ⁽²⁹⁾ found that even in mild to moderate cases normal WBCs counts were found in a high percentage of cases (73%). In our study, we found that about a third of cases (36.63%) showed leukocytosis. Similarly, **Huang et al.** ⁽²³⁾ and **Shi et al.** ⁽³⁰⁾ reported that leukocytosis was found in 30%, and 32% respectively. Also, we found leukopenia in 13.86% of the studied cases. A similar finding was reported by several previous studies^(31,32). On the contrary, **Chen et al.** ⁽²⁶⁾ reported leucopenia in only 9% of cases. Many other studies reported a higher percentage of leukopenia than our study that ranged from 29.2% to 33.7% of cases^(23,25,29).

In our study lymphopenia was found only in 25.74% of cases. Similarly, many studies found lymphopenia in 33% to 35.5 % of patients^(26,30). Other studies found lymphopenia in 63% to 75% of cases^(23,25,31). **Cao et al.** ⁽³²⁾ reported that absolute lymphopenia was present in only 8.9% of cases.

All the confirmed COVID-19 patients in our study underwent quarantine measures irrespective of presence or absence of symptoms. Most cases (n=73, 72.28%) were subjected to home isolation, and 24 (23.76%) cases preferred isolation in university undergraduate housing, which was prepared for this purpose at the time of the pandemic. In general, COVID-19 asymptomatic cases should be quarantined in their homes and followed up strictly as SAR-CoV-2 infections in asymptomatic cases had the same infectivity as symptomatic infections^(20,33). Patients with mild illness also might not require hospital admission and can be managed at home⁽³³⁾. Only 4 (3.96%) patients were referred to isolation hospital and received treatment, 2 of them needed oxygen therapy, in them, clinical recovery occurred after 5 days, and all were discharged after 14 days of hospital admission. The outcome was favorable in all the symptomatic patients, where recovery occurred after 9.5 days as a median value with IQR 7-16 days, and turned negative for SARS-CoV-2 after 21 days as a median value with IQR 14-28 days. Our results showed a longer period for viral clearance than that reported by **Pan et al.** ⁽³⁴⁾ who found a median period of 7.5 days from the diagnosis to negative nucleic acid test with IQR of 2-20 days. This may be due to different patients' selection where they conducted their study on asymptomatic carriers.

The current study showed that although all HCWs were aware of the importance of infection control measures and about two-thirds of infected HCWs had previously attended training courses about infection control measures and occupational safety, there were gaps in their knowledge and practice. The majority of HCWs showed infrequent hand washing after contact with surfaces or examining their patients, and more than a third of them did not show adequate adherence to the usage of personal protective equipment.

In a health care setting, the lack of efficacious infection control measures, the presence of inadequate personal protective equipment, and work overload put HCWs at risk for nosocomial COVID-19 infection⁽⁶⁾. Hand hygiene is a cost-effective intervention to prevent nosocomial infections. It disrupts and reduces the chance of transmission of the microbes from one individual to another⁽³⁵⁾.

The persistence of the COVID-19 pandemic has grave consequences and no satisfactory vaccine is available so far. HCWs will be at great risk if special precautions will not be taken to check its transmission in a hospital setting. Therefore, the use of preventive precautions and the provision of educational training programs to all levels of HCWs are important tools for

protection from this growing occupational hazard. The occupational groups that are at a high risk of COVID-19 transmission should be identified and the risk factors should be carefully analyzed and used to design preventive strategies for them.

CONCLUSION

COVID-19 in HCWs exhibited a wide spectrum of disease severity ranging from asymptomatic cases to moderate respiratory illness. No severe cases had been reported. Also, a considerable percent of the patients presented with non-respiratory symptoms such as GIT, and neurological symptoms.

Novel symptoms as numbness of face, hands, and lower limbs were reported as the only presentation in some HCWs. Symptom-based screening for COVID-19 in HCWs may underestimate the affected number as there is a considerable percent of asymptomatic cases which may also imply a risk of infection to their colleagues, and patients. For HCWs' safety, the use of protective personal equipment and adherence to proper hand-hygiene practice are important protective tools during this pandemic. Also, there is a growing need for educational and training programs for all levels of HCWs.

Authors' contributions:

Contributions:

(I) Conception and design: All authors;
(II) Administrative support: Hamdy SM. and Ahmad MA.; (III) Provision of study materials and patients follow up: Hamdy SM. and Mahmoud Saif-Al-Islam and Doaa GH.; (IV) Collection and assembly of data: Safaa K., Hamdy SM., Mustafa AY. and Ahmad MA.; (V) Data analysis and interpretation: Safaa K. and Magda MA.; (VI) Manuscript writing: All authors; (VII) Final approval of manuscript: All authors.

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Competing interests:

There are no conflicts of interest.

REFERENCES

1. **Li Q (2020):** An outbreak of NCIP (2019-nCoV) infection in China — Wuhan, Hubei Province, 2019–2020. *China CDC Weekly*, 2:79-80.
2. **Zhu N, Zhang D, Wang W et al. (2020):** A novel coronavirus from patients with pneumonia in China, 2019. *N Engl J Med.*, 382(8):727-33.
3. **Cascella M, Rajnik M, Cuomo A et al. (2021):** Features, evaluation, and treatment of coronavirus (COVID-19). In: *StatPearls [Internet]*. Treasure Island (FL): StatPearls Publishing. <https://pubmed.ncbi.nlm.nih.gov/32150360/>
4. **Guo Y, Cao Q, Hong Z et al. (2020):** The origin, transmission, and clinical therapies on coronavirus disease 2019 (COVID-19) outbreak - an update on the status. *Mil Med Res.*, 7(1):11-15.
5. **National Health Commission of People's Republic of China (2020):** Diagnostic and treatment plan of Coronavirus disease 2019 (7th ed.) (2020) tentative. http://www.nhc.gov.cn/zycgjs/7653p/202003/46c9_294a7dfe4cef80dc7f5912eb1989.shtml
6. **Mhango M, Dzobo M, Chitungo I et al. (2020):** COVID-19 risk factors among health workers: a rapid review. *Safety and Health at Work*, 11(3):262-5.
7. **WHO (2020):** Health Workers exposure risk assessment and management in the context of COVID-19 virus: Interim guidance. <https://apps.who.int/iris/handle/10665/331340>.
8. **Kimball A, Hatfield K, Arons M et al. (2020):** Public Health – Seattle & King County; CDC COVID-19 Investigation Team. Asymptomatic and presymptomatic SARS-CoV-2 infections in residents of a long-term care skilled nursing facility—King County, Washington, March 2020. *Morbidity and Mortality Weekly Report*, 69(13):377-81.
9. **Wei W, Li Z, Chiew C et al. (2020):** Presymptomatic transmission of SARS-CoV-2-Singapore, January 23–March 16, 2020. *MMWR Morb Mortal Wkly Rep.*, 69(14):411-5.
10. **Li X, Cai W, Huang L et al. (2020):** Comparison of epidemic characteristics between SARS in 2003 and COVID-19 in 2020 in Guangzhou. *Chinese Journal of Epidemiology*, 41(5):634-7.
11. **WHO (2020):** COVID-2019 situation report—26. 2020. https://www.who.int/docs/default-source/coronaviruse/situation-reports/20200215-sitrep-26-covid-19.pdf?sfvrsn=a4cc6787_2.
12. **Hassany M, Abdel-Razek W, Asem N et al. (2020):** Estimation of COVID-19 burden in Egypt. *Lancet Infect Dis.*, 20(8):896-7.
13. **World Health Organization (2020):** Coronavirus disease (COVID-19) technical guidance: Laboratory testing for 2019-nCoV in humans. <https://www.who.int/emergencies/diseases/novel-coronavirus-2019/technical-guidance/laboratory-guidance>.
14. **Burrer S, De Perio M, Hughes M et al. (2020):** CDC COVID-19 Response Team. Characteristics of health care personnel with COVID-19 – United States, February 12–April 9, 2020. *MMWR Morb Mort Wkly Rep.*, 69(15):477-81.
15. **Ghinai I, McPherson T, Hunter J et al. (2020):** First known person-to-person transmission of severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) in the USA. *Lancet*, 395(10230): 1137-44.
16. **Ng K, Poon B, Puar T et al. (2020):** COVID-19 and the risk to health care workers: a case report. *Ann Intern Med.*, 172(11):766-7.
17. **Alsofayan Y, Althunayyan S, Khan A et al. (2020):** Clinical characteristics of COVID-19 in Saudi Arabia: A national retrospective study. *Journal of Infection and Public Health*, 13(7):920-5.
18. **Ghweil A, Hassan M, Khodeary A et al. (2020):** Characteristics, outcomes and indicators of severity for COVID-19 among sample of ESNA Quarantine Hospital's Patients, Egypt: a retrospective study. *Infection and Drug Resistance*, 13(17): 2375-83.
19. **Jary A, Flandre P, Chabouis A et al. (2020):** Clinical presentation of Covid-19 in health care workers from a French University Hospital. *Journal of Infection*, 81(3): 61-3.

20. **Chen Y, Wang A, Yi B *et al.* (2020):** The epidemiological characteristics of infection in close contacts of COVID-19 in Ningbo city. *Chin J Epidemiol.*, 41(5):667-671.
21. **Chu J, Yang N, Wei Y *et al.* (2020):** Clinical characteristics of 54 medical staff with COVID-19: A retrospective study in a single center in Wuhan, China. *J Med Virol.*, 92(7):807-13.
22. **World Health Organization (2020):** Clinical management of severe acute respiratory infection when novel coronavirus (2019-nCoV) infection is suspected: interim guidance. <https://www.who.int/docs/default-source/coronavirus/clinical-management-of-novel-cov.pdf>.
23. **Huang C, Wang Y, Li X *et al.* (2020):** Clinical features of patients infected with 2019 novel coronavirus in Wuhan, China. *Lancet*, 395(10223):497-506.
24. **McMichael T, Currie D, Clark S *et al.* (2020):** Epidemiology of COVID-19 in a Long-Term Care Facility in King County, Washington. *N Engl J Med.*, 382(21):2005-11.
25. **Zhang G, Hu C, Luo L *et al.* (2020):** Clinical features and short-term outcomes of 221 patients with COVID-19 in Wuhan, China (2020). *J Clin Virol.*, 127:364-69.
26. **Chen N, Zhou M, Dong X *et al.* (2020):** Epidemiological and clinical characteristics of 99 cases of 2019 novel coronavirus pneumonia in Wuhan, China: a descriptive study. *The Lancet*, 395 (10223):507-13.
27. **Liu Y, Yang Y, Zhang C *et al.* (2020):** Clinical and biochemical indexes from 2019-nCoV infected patients linked to viral loads and lung injury. *Sci China Life Sci.*, 63(3):364-74.
28. **Wu J, Wu X, Zeng W *et al.* (2020):** Chest CT findings in patients with coronavirus disease 2019 and its relationship with clinical features. *Invest. Radiol.*, 55(5):257-61.
29. **Fan B, Chong V, Chan S *et al.* (2020):** Hematologic parameters in patients with COVID-19 infection. *Am J Hematol.*, 95(6): 131-134.
30. **Shi H, Han X, Jiang N *et al.* (2020):** Radiological findings from 81 patients with COVID-19 pneumonia in Wuhan, China: a descriptive study. *Lancet Infect Dis.*, 20(4):425-434.
31. **Zhang J, Dong X, Cao Y *et al.* (2020):** Clinical characteristics of 140 patients infected with SARS-CoV-2 in Wuhan, China. *Allergy*, 75(7):1730-1741.
32. **Cao M, Zhang D, Wang Y *et al.* (2020):** Clinical features of patients infected with the 2019 novel coronavirus (COVID-19) in Shanghai, China. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7255784/>
33. **Almutairi A, Al-Shamrani A (2020):** Overview of COVID 19 in children with the current situation in Saudi Arabia. *The Egyptian Journal of Hospital Medicine*, 80:704-14.
34. **Pan Y, Yu X, Du X *et al.* (2020):** Epidemiological and clinical characteristics of 26 asymptomatic severe acute respiratory syndrome coronavirus 2 carriers. *J Infect Dis.*, 221(12):1940-7.
35. **McLaws M (2015):** The relationship between hand hygiene and health care-associated infection: It's complicated. *Infect Drug Resist.*, 8:7-18.