Since January 2020 Elsevier has created a COVID-19 resource centre with free information in English and Mandarin on the novel coronavirus COVID-19. The COVID-19 resource centre is hosted on Elsevier Connect, the company's public news and information website.

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Assessment of potential risk factors for coronavirus disease-19 (COVID-19) among health care workers

Rania M. Kishk[a,*], Nader Nemr[b], Hebatalla M. Aly[c], Nourhan H. Soliman[d], Abeer M. Hagras[e], Ali A.A. Ahmed[f], Safaa M. Kishk[g], Mona Mostafa Ahmed[h], Nageh Louis[b]

[a] Microbiology and Immunology Department, Faculty of Medicine, Suez Canal University, Ismailia 41522, Egypt
[b] Endemic and Infectious Diseases Department, Faculty of Medicine, Suez Canal University, Ismailia 41522, Egypt
[c] Public Health, Community, Occupational and Environmental Medicine Department, Faculty of Medicine, Suez Canal University, Ismailia 41522, Egypt
[d] Clinical Pathology Department, Faculty of Medicine, Suez Canal University, Ismailia 41522, Egypt
[e] Forensic Medicine & Clinical Toxicology Department, Faculty of Medicine, Suez Canal University, Ismailia 41522, Egypt
[f] Microbiology and Immunology Department, Faculty of Pharmacy, Suez Canal University, Ismailia 41522, Egypt
[g] Pharmaceutical Medicinal Chemistry Department, Faculty of Pharmacy, Suez Canal University, Ismailia 41522, Egypt
[h] Internal Medicine Department, Faculty of Medicine, Suez Canal University, Ismailia 41522, Egypt

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ABSTRACT

Background: Understanding COVID-19 infection among health workers and the risk factors for adverse outcomes is important not only for characterizing virus transmission patterns and risk factors for infection, but also for preventing the future infection of health workers and other patients and reducing secondary COVID-19 transmission within health care settings. Our aim was to identify risk factors for infection among health care workers to limit adverse events in health care facilities.
Subjects and Methods: A total of 336 HCWs from COVID-19 treatment hospitals took part in the study with varying COVID-19 exposure risk depending on job function and working site. All participants were asked about risk factors for COVID-19 infection.
Results: Among our participants, 42.6% were medical doctors, 28.6% nurses and 7.4% assistant nurses and 21.4% were others. Forty four percent of participants had work experience 5–10 years. More than half of participants received training in Infection Prevention and Control (IPC) (56.8%) about COVID 19; 91% have hand hygiene facilities and 69% admitted availability of PPE. More than half of participants admitted that they always follow IPC measures. Two thirds of participants (66.7%) had close contact with a patient since admission; 42.3% were present in aerosolizing procedures for patients. Forty two percent of participants had respiratory symptom; the most common was sore throat representing (32.4%). The highest frequency of respiratory symptoms was among of nurses and assistant nurses 51%. Frequency of respiratory symptoms was higher among those who contacted the patient directly or for prolonged period compared to those who do not admitted these contacts.
Conclusions: Risk factors for COVID-19 represented by those who were smokers, nurses and assistant nurses were more liable to catch COVID-19 than doctors as they contacted the patient directly for prolonged period or his/her body fluids, materials or surfaces around him.

Introduction

A novel pathogen emerged in December 2019 from Wuhan city in China was rapidly spreading all over the world. It was called first 2019 novel coronavirus (2019-nCoV) and then the World Health Organization (WHO) called the new emerging respiratory virus as severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) and the disease is now termed coronavirus disease 19 (COVID-19) [1,2].

The international response has been dramatic with global travel restrictions between countries to decrease the virus transmission and prevent associated illness and death. In 9th July 2020, WHO published a scientific brief discussing different possible modes of

* Corresponding author.
E-mail address: raniakishk@med.suez.edu.eg (R.M. Kishk).

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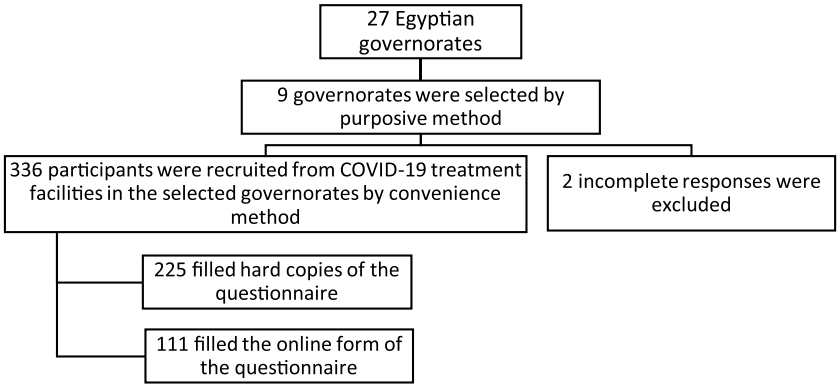

Fig. 1. Flowchart showing sampling technique.

transmission for SARS-CoV-2, including contact, droplet [3–7], airborne in aerosol generating procedures [8–13] and fomite [14–16].

Since the declaration of the first case of the SARS-CoV-2 case in Egypt, the government ongoing multidisciplinary national management between different ministries. In February, Egypt started to observe all tourists coming to Egypt for fever or respiratory symptoms, as cough, shortness of breath, after arrival. By the middle of March, the number of cases increased to be more than 100 cases. Egypt postponed schools and universities stimulated electronic distance learning and forced a curfew from 7 pm until 6 am [17].

In every governate, quarantine hospitals for COVID-19 patients were assigned with a special medical team of different specialties (Pulmonology, Internal Medicine, Tropical Medicine, Infectious Diseases, Intensive care, Radiology, Clinical Pathology, Clinical Pharmacy, and Infection control). This medical team stayed in the hospital for 14 days, then investigated for SARS-CoV-2 through nasopharyngeal swabs before release from the quarantine hospital [17].

Reports have said that until 5th June 2020, at least 90,000 health care workers was infected by COVID-19 and more than 260 nurses have lost their lives to the pandemic [18]. Currently, by mid-October 2020, it was estimated that 3576 COVID-19 cases (1.6%) and 188 deaths (5.3%) have occurred among 220 000 Egyptian physicians [19,20].The magnitude of COVID-19 in health care settings is not clear. Understanding the nature of this emerging infection, COVID-19, among health care workers is important in prevention of further infections to HCWs and community. So, this study investigated the extent of infection in health care settings and identified risk factors for infection among health care workers to limit adverse events in health care facilities.

Subjects and methods

Study design and setting

This study was a cross-sectional analytic study carried out in Egypt from June 2020 to December 2020. Healthcare facilities that dealt with COVID-19 patients in Ismailia, Cairo, upper and lower Egypt during the study period constituted our study settings.

Study population

All healthcare workers in the above-mentioned healthcare facilities represented our study population. Health care worker were defined as all staff within the health care facility involved within the provision of take care of a COVID-19 infected patient, including those that were present in the same area of the patient, also those who might not have provided direct care to the patient, but who have had contact with the patient's body fluids, potentially contaminated items, or environmental surfaces. They included physicians, nurses, assistant nurses, technicians, clerks, nutritionists, physiotherapists, catering staff, cleaners, etc.

Sampling

Sample size

We used the rule of thumb $N \geq 20^{*}m$.

Where m is the number of studied risk factors (independent variables in the regression model = 15).

So $N = 20 \times 15 = 300$.

We added 12 % for non-response to get a sample of 336 HCWs.

Sampling technique

Egypt includes 27 governorates; 9 governorates were chosen purposively to participate in the study which are (Ismailia, Suez, Portsaid, Cairo, sharkya, Dakahlya, Menofia, Kafr Elsheikh and Gharbia. COVID-19 treatment facilities in selected governorates were contacted and asked for participation. Participants from facilities that accept participation were selected by convenience sampling method. Participants who accepted to participate were asked to fill either a hard copy or an online form of the questionnaire. The online form was sent out to participants through online platforms, including WhatsApp, Facebook, and Messenger. We continued to enroll participants till completion of a sample of 336 complete responses. Two incomplete responses were excluded and replaced by another respondent from the same facility and occupation (Fig. 1).

Data collection tool

All study participants filled a self-administered questionnaire adopted from the protocol for assessment of potential risk factors for coronavirus disease 2019 (COVID-19) among health workers in a health care setting published by WHO [21].

The questionnaire was in English form, so we performed bidirectional translation into Arabic. We used the most appropriate and understandable terms. A pilot study was then conducted to test the questionnaire on a group of study participants to determine all the language amendments and ease of use, as well as determining the feasibility of the survey. We tested the response to different items of the questionnaire. Validity was estimated by deciding whether the questions were comprehensive. Acceptability was evaluated by asking the prescribers how they found answering the questionnaire and if they wanted to omit or add questions. Their suggestions and comments were addressed in a timely manner. Pilot study results showed the most important risk factors which was used later to calculate our full study sample size. The results of the pilot study were notincluded within the final analysis.

Table 1
Frequency of infection and prevention control (IPC) training, hand hygiene facilities and personal protective equipment (PPE) among health care workers included.

		Frequency	Percent
Did you receive IPC training about COVID-19?	Yes	191	56.8
	No	145	43.2
How much cumulative IPC training have you had at the healthcare facility?	Did not receive	6	1.8
	<2 h	200	59.5
	2–5 h	100	29.8
	>5 h	30	8.9
Do you have hand hygiene facilities (washing/ rubbing)?	Yes	306	91.1
	No	25	7.4
	Do not know	5	1.5
Are PPE available in sufficient quantity in the health care facility?	Yes	232	69
	No	72	21.4
	Do not know	32	9.5

The precautions that were taken to assure that all are participants (specifically from online survey) were HCWs in Egypt's COVID-19 treatment hospitals, the online survey was not open to everyone, but it targeted the medical sector only through communication with the medical institutions, hospitals affiliated with the Ministry of Health, and educational hospitals in Egyptian universities. This survey was also available through the authority in each institution concerned with them, and therefore they are aware of the participants from their medical sector.

Statistical analysis

Data collected were coded and entered to SPSS version 23 to be analyzed. Data were presented in tables, figures or numbers accordingly. Mean and standard deviation were used to express quantitative variables. Absolute frequencies (number) and relative frequencies (percentage) were used to express categorical qualitative variables (percentage). The Chi-square test (χ^2 test) was used to compare categorical data. Odds ratios were used to assess the strength of association between different risk factors and COVID-19 infection among HCWs. Binary logistic regression analysis was done to find out the best predictor for COVID-19 infection among HCWs. A p-value of >0.05 was considered statistically significant.

Ethical considerations

- Approval was obtained from the ethics committee of Suez Canal University Faculty of Medicine (Reference: Research#4286).
- The procedures utilized in this study adhere to the tenets of the Declaration of Helsinki.
- Written or oral consents were obtained from all participants before participating in the study.
- Participants knew that participation is voluntary, and they can withdraw from the study at any time.
- Data confidentiality was ensured, and data collected will not be used for any purposes other than the study.

Results

Three hundred and thirty-six participants were enrolled in the study. The mean age of participants was 32 ± 7.9 years with the great majority (89.6%) between 18 and 40 years. Males represent 56% and females represent 44 % of our sample. About half of participants (50.3 %) were married and 28 % were smokers

Regarding distribution health care workers participated in the study among different Egyptian governorates, the study showed that, more than 45 % were from Ismailia governorate, nearly 42% were from Suez, 3.9% were from Sharkya. Regarding medical history 18.5% of participants were obese; 7 % had heart diseases; other chronic diseases showed low frequencies, 6% of participants were diabetics, 2.1% had chronic lung disease and 2.1% of participating females were pregnant.

Among our participants 42.6% were medical doctors, 28.6% nurses and 7.4% assistant nurses; the rest were represented but with less numbers. Forty-four percent of participants had work experience 5–10 years, and 37.5% work at emergency department, nearly 22% work at outpatient clinic, and 19% work at ICU (Table 1).

More than half of participants received training in IPC (56.8%) about COVID 19; 59.2% received <2 h cumulative IPC training (standard precautions, additional precautions); 91% have hand hygiene facilities and 69 % admitted availability of PPE (Table 1).

Availability of health care resources, as regarded by study participants is shown in Table 2. Answer of no or do not know was given a score 0 and yes was given 1 and the total score was calculated and arbitrary having a total score of 14 out of 21 was considered satisfactorily available resources and supplies. Mean score percent as regarded by participants was 71.4 ± 28.6 with about 65.5% of participants thought that supplies availability was satisfactory (>60%).

Adherence to IPC measures by study participants is shown in Table 3. Each question was given a score from 0 to 4 where 0 for I do not know and 4 for always. A total score percent >60% was considered satisfactory adherence to IPC measures. Mean total score percent was 84.2 ± 15.9 with 91.4% stated that they satisfactorily adhere to IPC measures.

Two thirds of participants (66.7%) had close contact with a patient since admission; 63.7% have direct contact with surfaces around the patient; 48.5% contacted patient's materials; 42.3 % were present in aerosolizing procedures performed to the patient; 42 % came in contact with patient's body fluids and 7% had prolonged face to face exposure (>15 min) with the patient (Table 4).

Regarding symptoms which represented on healthcare workers during processing the study, Forty-two percent of participants had respiratory symptom; the most common was sore throat representing (32.4%), 26.2% of healthcare workers were suffering from cough, nearly 23% had running nose and nearly 14 % had shortness of breath. Concerning other symptoms, nearly 30% had headache, 28.6% had fever, 25.3% had fatigue, nearly 23% had bone aches, 24.1% had diarrhea, 21.4% lost the taste and nearly 21% lost the smell.

Study participants were divided into 2 groups according to presence or absence of chest symptoms and compared regarding risk factors of catching infection and results are shown in Table 5.

Binary logistic regression analysis was performed to find out the association between different independent risk factors and possibility of having COVID-19 infection (clinically by presence of respiratory symptoms) among participating healthcare workers (Table 6).

Discussion

Frontline HCWs are more likely to become infected with SARS-COV-2 virus, as they provide direct care to COVID-19 patients [22].

Table 2
Availability of resources and supplies in the healthcare facility as regarded by participating HCWs.

	Yes	No	I do not know
Does the health care facility have an appropriate WASH services and materials?	292 (86.9%)	31 (9.2%)	13 (3.9%)
Does the health care facility have an infection prevention and control (IPC) program and team?	259 (77.1%)	42 (12.5%)	35 (10.4%)
Does the health care facility have infection prevention and control (IPC) guidelines for health care workers?	245 (72.9%)	43 (12.8%)	48 (14.3%)
Does the health care facility have IPC guidelines for standard and additional (transmission-based precautions)?	229 (68.2%)	48 (14.3%)	59 (17.6%)
Does the health care facility have regular IPC training for health care workers (at least once a year)?	209 (62.2%)	76 (22.6%)	51 (15.2)
Does the health care facility have personal protective equipment (PPE)?	276 (82.1%)	37 (11%)	23 (6.8%)
Is PPE available in sufficient quantity in the health care facility?	227 (67.6%)	70 (20.8%)	39 (11.6%)
Are the PPE available of good quality and fit for purposes?	210 (62.5%)	69 (20.5%)	57 (17%)
Is alcohol-based hand rub easily available (i.e. at the point of care%) for hand hygiene within the health care facility?	279 (83%)	43 (12.8%)	14 (4.2
Are soap and water available for hand hygiene within the health care facility?	294 (87.5%)	34 (10.1%)	8 (2.4%)
Does the health care facility conduct regular (at least once a year%) hand hygiene audits and feedback to health care workers?	217 (64.6%)	57 (17%)	62 (18.5%)
Does the health care facility conduct other IPC audits?	198 (58.9%)	66 (19.6%)	72 (21.4%)
Does the health care facility have a surveillance system for nosocomial infections in patients?	185 (55.1%)	80 (23.8%)	71 (21.1%)
Does the health care facility have a surveillance system for nosocomial infections in health care workers?	183 (54.5%)	79 (23.5%)	74 (22%)
Does the health care facility screen staff on arrival for symptoms of infection?	205 (61%)	96 (28.6%)	35 (10.4%)
Does the health care facility alert all health care workers if a 2019-nCoV infected patient is being cared for within the health care facility?	272 (81%)	41 (12.2%)	23 (6.8%)
Does the health care facility have a well-equipped triage station at the entrance, supported by trained staff?	261 (77.7%)	53 (15.8%)	22 (6.5%)
Are patients with suspected 2019-nCoV infection isolated upon arrival in the health care facility?	276 (82.1%)	46 (13.7%)	14 (4.2%)
Is a medical mask systemically fitted to the patients with suspected 2019-nCoV infection upon arrival in the health care facility?	262 (78%)	45 (13.4%)	29 (8.6%)
Are health care worker staffing levels adequately assigned according to patient workload?	237 (70.5%)	64 (19%)	35 (10.4%)
Does bed occupancy exceed standard capacity of the health care facility?	228 (67.9%)	66 (19.6%)	42 (12.5%)
Total score (mean ± SD)	15 ± 6		
Total percent (mean ± SD)	71.4 ± 28.6		
• **Satisfactory (>** 60%**): No. (%)**	220 (65.5%)		
• **Non-satisfactory (≤** 60%**): No. (%)**	116 (34.5%)		

In Egypt, little is known about how HCW exposure to the COVID-19 virus translates into infection risk [23].

Our study assessed the role of age in determining the risk of SARS-CoV-2 infection in the HCWs. The great majority (89.6%) between 18 and 40 years. Being older than 40 years had a lower prevalence in our population. Similar results were suggested by Piccoli et al. study, in which being older than 50 years was associated with a lower seroprevalence in population [24]. This could be explained by older employees' greater awareness of the dangers of severe COVID-19 and, as a result, their willingness to adhere to personal protective measures more strictly than younger employees. Furthermore, when compared to younger HCWs, 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. Also, declined humoral immunity with age cannot be ruled out [25,26].

Our findings revealed a high level of exposure to the COVID-19 virus in our population. This is similar to a study conducted in a Guinean Ebola treatment center, which found a high rate of occupational exposure among health-care workers [27]. Previous research has shown that, contact of HCW to COVID-19 patients results in more possibly to catch COVID-19 [28,29]. The high COVID-19 virus exposure in this study was expected because the study sites were designated COVID-19 treatment hospitals.

Table 3
Adherence to infection prevention and control (IPC) measures information by participating HCWs.

	Always	Most of the time	Occasionally	Rarely	I don't know
Do you follow recommended hand hygiene practices?	178 (53%)	129 (38.4%)	21 (6.3%)	8 (2.4%)	0 (0%)
Do you use alcohol-based hand rub or soap and water before touching a patient?	159 (47.3%)	96 (28.6%)	55 (16.4%)	23 (6.8%)	3 (0.9%)
Do you use alcohol-based hand rub or soap and water before cleaning/aseptic procedures?	179 (53.3%)	93 (27.7%)	39 (11.6%)	24 (7.1%)	1 (0.3%)
Do you use alcohol-based hand rub or soap and water after (risk of%) body fluid exposure?	219 (65.2%)	85 (25.3%)	21 (6.3%)[;7 QE	11 (3.3%)	0 (0%)
Do you use alcohol-based hand rub or soap and water after touching a patient?	217 (64.6%)	80 (23.8%)	26 (7.7%)	13 (3.9%)	0 (0%)
Do you use alcohol-based hand rub or soap and water after touching a patient's surroundings?	180 (53.6%)	102 (30.4%)	37 (11%)	14 (4.2%)	3 (0.9%)
Do you follow IPC standard precautions when in contact with any patient?	175 (52.1%)	110 (32.7%)	39 (11.6%)	9 (2.7%)	3 (0.9%)
Do you wear PPE when indicated?	218 (64.9%)	76 (22.6%)	28 (8.3%)	13 (3.9%)	1 (0.3%)
Total score (mean ± SD)	26.9 ± 5.1				
Total percent (mean ± SD)	84.2 ± 15.9				
• **Satisfactory (>**60%)	307 (91.4%)				
• **Non-satisfactory (**≤60%)	29 (8.6%)				

Table 4
Distribution of health care workers regarding exposure to confirmed case infected with COVID19.

	Yes	No	I don't know
Have you had close contact (within 1 m%) with the patient since his/her admission?	224 (66.7%)	103 (30.7%)	9 (2.7%)
Did you have prolonged face-to-face exposure (>15 min)?	141 (42%)	178 (53%)	17 (5.1 %)
Were you present for any aerosolizing procedures performed on the patient?	142 (42.3%)	182 (54.2%)	12 (3.6%)
Did you come into contact with the patient's body fluids?	141 (42%)	189 (56.3%)	6 (1.8%)
Have you had direct contact with the patient's materials since his/her admission?	163 (48.5%)	168 (50%)	5 (1.5%)
Have you had direct contact with the surfaces around the patient?	214 (63.7%)	117 (34.8%)	5 (1.5%)

Table 5
Comparison between health care workers with respiratory symptoms and those without regarding risk factors of COVID-19 infection.

	Health care workers with respiratory symptoms (n = 141%)	Health care workers without respiratory symptoms (n = 195%)	*OR (95% CI)*	*p*-Value
Smoking status				
Smoker	29 (30.9%)	65 (69.1%)	0.52 (0.31–0.86)	0.010[1]*
Non smoker	112 (46.3%)	130 (53.7%)		
Occupation				
Medical doctor (ref.)	48 (33.6%)	95 (66.4%)	1	
Nurse/ assistant nurse	62 (51.2%)	59 (48.8%)	2.08 (1.26–3.42)	0.015[1]*
Others	31 (43.1 %)	41 (56.9%)	1.5 (0.84–2.68)	
Have you had close contact (within 1 m%) with the patient since his/her admission?				
Yes	118 (52.7%)	106 (47.3%)	4.62 (2.65–8.04)	
No (ref.)	20 (19.4%)	83 (80.6%)	1	<0.001[2]*
I do not know	3 (33.3%)	6 (66.7%)	2.08 (0.48–9.02)	
Did you have prolonged face-to-face exposure (>15 min**%)?**				
Yes	80 (56.7%)	61 (43.3%)	2.93 (1.85–4.65)	
No (ref.)	55 (30.9%)	123 (69.1%)	1	<0,001[1]*
I do not know	6 (35.3%)	11 (64.7%)	1.22 (0.43–3.47)	
Were you present for any aerosolizing procedures performed on the patient?				
Yes	69 (48.6%)	73 (51.4%)	1.79 (1.14–2.8)	
No (ref.)	63 (34.6%)	119 (65.4%)	1	0.003[1]*
I do not know	9 (75%)	3 (25%)	5.67 (1.48–21.68)	
Have you had direct contact with the patient's materials since his/her admission?				
Yes	80 (49.1%)	83 (50.9%)	1.73 (1.12–2.69)	
No (ref.)	60 (35.7%)	108 (64.3%)	1	0.029[2]*
I do not know	1 (20%)	4 (80%)	0.45 (0.05–4.12)	
Have you had direct contact with the surfaces around the patient?				
Yes	105 (49.1%)	109 (50.9%)	2.35 (1.45–3.8)	
No (ref.)	34 (29.1%)	83 (70.9%)	1	0.002[2]*
I do not know	2 (40%)	3 (60%)	1.63 (0.26–10.18)	

1. Chi square test; 2. Fisher's exact test.
* Statistically significant at $p < 0.05$.

In this study, HCW-reported symptoms indicative to virus exposure was the most among nurses and assistant nurses and least among medical doctors, also was higher among those who contacted the patient directly compared to those who do not, which is consistent with the New York study [30]. Ashinyo et al. reported that registered nurses were less likely to be at high risk of COVID-19 virus infection compared to assistant nurses [31]. Also, a study

Table 6
Binary logistic regression model for risk factors of COVID-19 possible infection.

Covariates	β	*p*-Value	OR (95% CI)
Smoking status	0.696	0.021*	2.007 (1.113–3.619)
Occupation (reference doctors)		0.040*	
• Nurses	−0.711	0.056	0.491 (0.236–1.019)
• Others	0.027	0.942	1.027 (0.501–2.108)
Receiving training about COVID-19 IPC measures (no/ yes)	0.304	0.267	1.355 (0.793–2.315)
Availability of resources and supplies total score	−0.051	0.050	0.950 (0.903–1)
Adherence to IPC measures	0.070	0.025*	1.073 (1.009–1.141)
Close contact with COVID-19 confirmed case within 1 m (no/yes)	1.201	0.020*	3.322 (1.204–9.167)
Frequency of close contact with the patients	0.024	0.904	1.024 (0.698–1.502)
Prolonged contact with COVID-19 confirmed case > 15 min (no/ yes)	1.295	0.005*	3.651 (1.475–9.038)
Wearing PPE during prolonged contact (no/ yes)	−0.839	0.074	0.432 (0.173–1.083)
Presence during aerosolizing procedure performed to COVID-19 confirmed case (no/ yes)	−1.126	0.067	0.324 (0.097–1.081)
Wearing PPE during aerosolizing procedure (no/ yes)	0.885	0.141	2.422 (0.747–7.854)
Contact with COVID-19 confirmed case body fluids (no/ yes)	0.783	0.218	2.187 (0.630–7.592)
Wearing PPE during contact with patients' body fluids (no/ yes)	−1.110	0.090	0.329 (0.091–1.187)
Contact with COVID-19 confirmed case materials (no/ yes)	0.229	0.498	1.257 (0.649–2.437)
Contact with COVID-19 confirmed case surrounding surfaces	0.401	0.230	1.494 (0.776–2.877)
Constant	−4.133	<0.001*	0.016
Model $\varkappa^2$ = 70.306		<0.001*	

* Statistically significant at $p < 0.05$.

which carried on southwest Iran reported that highest infection rate was among nurses (51.3%) [32].

Our study represented that the most of HCW follow recommended hand hygiene practices, by using alcohol-based hand rub and soap and water before and after touching the patients, also, the most of HCW follow IPC standard precaution and the most of them wear PPE when indicated. These results are disagree with the results of a study carried on southwest Iran [32] which reported that, out of total number 273 hospital staff about 1.5% of HCWs did not use masks, 18.7% did not use gloves, 65.9% did not use protective goggles and 58.2% did not use face shields. Also a study regarding the knowledge, attitude, and practice towards COVID-19 in Iran [33], demonstrated that personnel with healthcare-related occupations, although with higher knowledge, had significantly lower practice towards the diseases.

The importance of appropriate PPE when dealing with COVID-19 patients, including full PEE when in the isolated chamber or performing airways procedures generating aerosol, has been highlighted early [34,35]. In a multinational study, the incidence of laboratory-confirmed COVID-19 in HCWs after a tracheal intubation episode performed with PPE conforming to standards was reported to be 10.7% [36], which is comparable to the incidence of seropositivity [24]. It is equally possible and inevitable that the exposure will pass from the HCW to a household member and vice versa.

In our study the majority of health care workers exposed directly to confirmed cases infected with COVID19 through various ways including close contact (within 1 m) with the patients since their admission, direct contact with the surfaces around the patients, direct contact with the patient's materials, present for any aerosolizing procedures performed on the patients and come into contact with the patient's body fluids. These results are in agreement with the results of study which was carried out in the early phase of the COVID-19 outbreak, in which the number of HCWs and personal protective equipment (PPE) were insufficient, and the continuous working hours of HCWs were relatively longer [37]. The high possibility of caching COVID-19 among HCWs may be due to that, they were exhausted physically and mentally, with decreased immunity this situation which may lead to increase chance of infection among HCWs.

Regarding risk factors of catching COVID-19, our study represented that, a significant result with the highest frequency of respiratory symptoms was among smokers, nurses and assistant nurses. A significant result of having respiratory symptoms was higher among those who contacted the patients directly or for prolonged period or the body fluids of the patients, materials or surfaces around them compared to those who do not admitted these contacts. These results are in agreement with the results of a study which carried out on Sohag 2020 [38] which reported that, coronavirus disease 2019 (SARS-CoV-2) is caused by severe acute Respiratory syndrome- and is highly contagious. Transmission is believed to be predominantly through droplet spread and direct patient contact rather than 'airborne spread.

Our results are supported by evidence from past infectious disease outbreaks. During the Ebola virus outbreak, health-care staff accounted for 39% of all cases, which was 21–32 times higher than the general population [39]. Health-care staff accounted for 20–40% of cases during the extreme acute respiratory syndrome epidemic, 24–26 and insufficient PPE was linked to an increased risk [40].

Conclusion and recommendation

The first line of defense against COVID-19 infection in communities are healthcare workers. Lack of understanding of COVID 19 infection among HCWs, as well as insufficient use and availability of PPE, uncertain diagnosis criteria and the absence of a diagnostic test; as well as psychological stress are major factors. It is, therefore, recommended that authorities should provide protection to HCWs through education and training, staff preparation, rewards, and PPE availability as well as psychological support.

Limitation of the study

- Study design: a cross sectional study design was used in this study with the advantages of assessment of risk factors and outcome at the same time point, it can yield prevalence and it is relatively quick and inexpensive. From its' disadvantages that it provides only a snapshot in time and does not yield incidence. We can not also confirm temporal relationship between exposure and outcome or know the best predictor for the outcome.
- Sampling technique: we used non probability sampling methods which was more feasible to our study and we tried to take sample from different COVID-19 treatment facilities in 9 Egyptian governorates (which represent third of Egyptian governorates) to improve representativeness of the study population.

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Competing interests

None declared.

Ethical approval

Not required.

Author contributions

All Authors have equal contribution to all of the following: (1) the conception and design of the study, or acquisition of data, or analysis and interpretation of data, (2) drafting the article or revising it critically for important intellectual content, (3) final approval of the version to be submitted.

Availability of data and materials

All authors claim that all data and materials as well as software application or custom code support our published claims and comply with field standards.

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