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Compliance of healthcare workers to the proper use of personal protective equipment during the first wave of COVID-19 pandemic



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ABSTRACT

Background: In limited resource settings, compliance to proper personal protective equipment (PPE) use is challenging. This study aims to characterize the pattern of PPE use among healthcare workers (HCWs) during the first wave of coronavirus diseases-2019 (COVID-19) in Egypt and to determine the factors associated with compliance to the proper use of PPE.

Methods: A cross-sectional study was conducted among Egyptian HCWs using an online self-administered questionnaire. Participants were classified as “Compliant” or “Non-compliant” according to their score.

Results: A total of 404 responses were analyzed, with a mean age of 36.6 ± 8.4 years, and 56.4% were females. Non-compliant HCWs represented 53.2% of participants. The majority reported shortage in N95 respirators (91.3%) and practiced extended PPE use (88.1%). Better compliance to proper PPE use was reported: females (51.3%, $p = 0.05$), Physicians (54.2%, $p = 0.005$), medical specialties (34.7%, $p < 0.001$), <10 years’ work experience (42.9%, $p = 0.05$) and working > eight hours/day (71.3%, $p < 0.001$). The significant predictors for compliance were; receiving prior training on the proper use of PPE (OR: 4.59, CI: 2.22–9.47, $p \leq 0.001$), exposure to COVID-19 patients (OR: 2.75, CI: 1.19–6.35, $p = 0.02$) and performing procedures that pose HCWs at a high risk of exposure to Severe Acute Respiratory Syndrome Coronavirus 2 (OR: 2.21, CI: 1.04–4.71, $p = 0.04$). The high percentage of non-compliant HCWs turns on a warning signal. Increase the availability of PPE, prioritize their use, provide more focus on training of HCWs and monitor their compliance is highly recommended.

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Introduction

The corona virus disease-2019 (COVID-19) pandemic has forced healthcare systems to face an unprecedented challenge and put

healthcare workers (HCWs) at substantial risk of exposure to Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2). Protecting HCWs, who can in turn transmit the infection to patients, coworkers and household contacts, is a cornerstone in sustaining safe healthcare delivery.

In the hierarchy of control measures for pandemics, personal protective equipment (PPE) comes as the last resort [1]. In Egypt, shortage of PPE, was reported as a reason for the increased risk

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perception among HCWs [2]. The understaffing, and shortage of supplies, commonly witnessed in resource-limited settings, aggravate the situation even more and hamper HCWs compliance to infection prevention and control (IPC) best practices [3].

Although several agencies issued recommendations regarding the extended use or reuse of some types of PPE [4], there were concerns among HCWs about the safety and effectiveness of these practices. Moreover, the inconsistencies among these recommendations remain confusing for HCWs and IPC policy makers [5].

As a part of the administrative control measures during the pandemic, the World Health Organization (WHO) has also addressed the rational use of PPE [6] and the monitoring of HCWs' compliance with standard precautions [7].

This study aims to characterize the pattern of PPE use among HCWs during the first wave of COVID-19 in Egypt and to determine the factors associated with compliance to the proper use of PPE.

Materials and methods

Study setting and participants

This descriptive cross-sectional study included HCWs from different healthcare sectors in Egypt; a low-middle income country in the Middle East region.

The study is questionnaire-based survey and was conducted according to the international guidelines of Strengthening the Reporting of Observational Studies in Epidemiology; STROBE [8]. It was conducted during the first wave of COVID-19 [9], between June and July 2020. Inclusion criteria for participation comprised complete responses from HCWs who worked in Egypt during the first wave of COVID-19 pandemic. Screening questions were formulated to ensure that only eligible participants were included.

Based on a 80% degree of precision at 95% confidence interval (CI), the estimated representative sample size for the study was (385), calculated using an online sample size calculator. To avoid missed responses, 454 responses were collected. A snowball and purposive sampling technique were used [10].

Based on the analysis of their responses, the participants were classified into two groups: "Non-compliant," and "Compliant."

Data collection tool

An online self-administered questionnaire was designed using Google Forms by experts in IPC and biostatistics, in accordance with the most recent international guidelines that address PPE use in healthcare facilities [1,11–17]. It was initially designed in English and translated into Arabic. The question appeared in both languages for the participants.

After translation, the questionnaire was pilot tested on 30 HCWs to determine the acceptability and clarity of the questions, and to confirm its face validity. The questionnaire was modified accordingly, and the responses obtained in the pilot study were excluded from the study analysis.

The questionnaire (Supplementary file) covered demographic and work-place characteristics, included questions addressing PPE use and comprised items measuring risk of exposure among HCWs who interacted with COVID-19 patients. They were subsequently classified as having a high or a low risk of exposure according to Centers of Disease Control and Prevention's (CDC) guidelines [18].

Data collection procedure

The research team members disseminated the survey to other colleagues and HCWs within and outside their practice network.

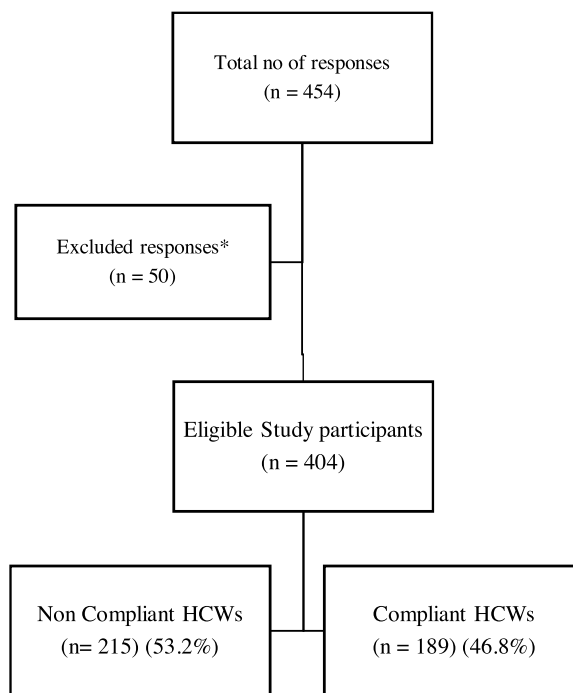


Fig. 1. Flow chart of the study participants.

*Reasons for exclusion: not on duty during COVID-19 first wave (n = 21), or working outside Egypt at that time (n = 29).

Other dissemination strategies involved some widely used social network channel with particular focus on professional groups.

Ethics approval and consent to participate

Ethical approval was obtained from the institutional review board, Faculty of Medicine, Zagazig University. The study followed the principles of the Helsinki Declaration. Participation was voluntary and anonymity of the participants was ensured with no identifiable information was collected. The completion of the questionnaire by participants was considered an informed consent for participation in the study.

Statistical analysis

Data were analyzed using the Statistical Package for the Social Sciences (SPSS) version 20.0 (SPSS, Chicago, IL, USA). Descriptive analysis was performed by means, standard deviations for quantitative data and frequencies, percentages for qualitative data as applicable using frequency analysis for clinical and epidemiological features. Logistic regression analysis was performed to predict potentially significant predictors of infection. *p* Value of ≤ 0.05 was considered statistically significant.

The responses to the section of the questionnaire, assessing the use of PPE were either: yes, or no. A score of one was assigned to "yes" and a score of 0 to "no".

The responses to the section of the questionnaire were calculated. One (yes/no) item assessing N95 respirator reprocessing; A score of one was assigned to "yes" and a score of 0 was assigned to "no." The frequency of using and extended using the various types of PPE, were assessed on a 4-point scale (1–4) for four items and on a 5-point scale (1–5) for one item. Total scores ranged from five to twenty-two. Then, the total score was dichotomized using the median as a cutoff point of 12 with those whose scores were equal or above the median were classified as "Compliant" and those with scores below median were classified as "Non-compliant" [19]

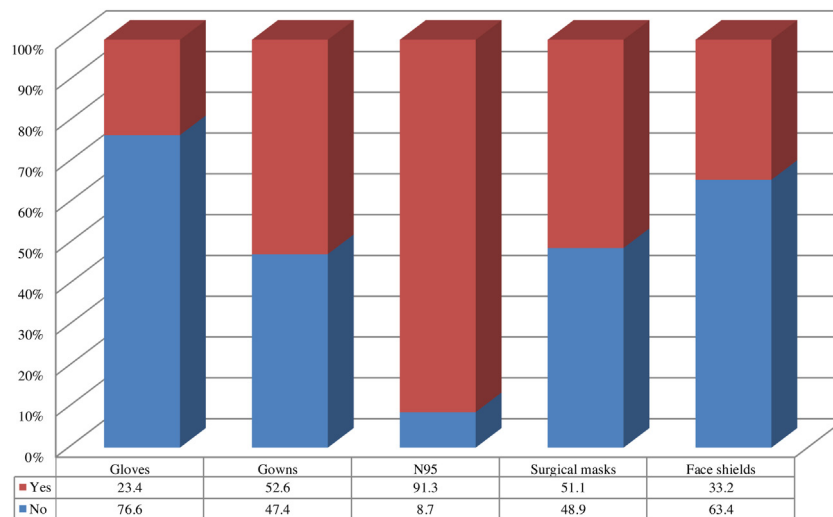


Fig. 2. Perception of shortage in PPE supplies by study respondents (n = 333).

Table 1
Pattern of PPE use during COVID-19 pandemic among respondent HCWs (N = 404).

PPE	Responses*	No.	%
Compliance to PPE use	Rarely	45	11.1
	Occasionally	46	11.4
Gloves	Mostly	88	21.8
	Always	225	55.7
	Rarely	5	1.2
Medical/surgical mask	Occasionally	15	3.7
	Mostly	117	29.0
	Always	267	66.1
Goggles/face shield	Rarely	160	39.6
	Occasionally	70	17.3
	Mostly	68	16.8
Extended PPE use	Always	106	26.2
	Rarely	150	37.1
Disposable gowns	For 1–3 days	2	.5
	For 24 h	31	7.7
	For 12 h	140	34.7
	Always, for one patient	81	20.0
	Rarely	84	20.8
Coverall	For 1–3 days	30	7.4
	For 12 h	10	2.5
	Always, for one patient	280	69.3
Re-processing of N95 respirator	Yes	119	29.5
	No	285	70.5
Total		404	100.0

PPE: personal protective equipment.
*According to published guidelines.

Results

A total of 404 HCWs (out of 454 respondents to the questionnaire) were eligible for inclusion in the study. Their age range was 36.6 ± 8.4 years. They were 176 (43.6%) males and 228 (56.4%) females. Non-Compliant HCWs counted for 53.2% of participants (Fig. 1). The data show that 66.1% and 55.7% of the study participants complied to the proper use of medical/surgical masks and disposable gloves respectively. While only 29.5% of participants were compliant to the proper use of goggles and face-shields (Table 1).

Most of the responding HCWs (82.4%) complained of shortage in PPE supply. Shortage in respirators came in the first place (91.3%), followed by disposable gowns (52.6%) and surgical masks (51.1%) (Fig. 2). Also, most of the participants (88.1%) practiced the extended use of PPE, particularly N95 respirators (91%) (Fig. 3).

We found statistically significant difference between compliant and non-compliant HCWs as regards gender, work experience and occupation; where better compliance to proper PPE use was noted between females, physicians with medical specialties, and HCWs with less than 10 years' work experience. Also, those working more than eight hours/day, in isolation hospitals or exposed to patients with COVID-19 were found more compliant to proper PPE use to a level that reached statistical significance. HCWs who faced shortage of PPE supplies were less compliant. Statistically significant difference was found between both groups regarding COVID-19 acquisition status. (Table 2).

Regression analysis shows that significant predictive factors for compliance to the proper use of PPE are prior training on the proper use of PPE, exposure to patients with COVID-19 and performing procedures that pose HCWs at a high risk of exposure to SARS-CoV-2 (Table 3).

Discussion

This self-administered questionnaire was set, while Egypt was struggling the first wave of COVID-19 pandemic [9]. The main striking finding was that more than half of the participants (53.2%) admitted their noncompliance to the proper use of PPE. One study in Egypt, assessed the application of recommended PPE in a tertiary care facility based on a questionnaire, in which, authors reported only 31.8% of SARS-CoV-2 infected HCWs as compliant [20]. In Brazil, researchers observed the compliance rate of HCWs to proper PPE use – in a special unit for suspected and confirmed COVID-19 cases – and found it to be 31.5% [21]. Also, low rate of consistent PPE use was reported in Congo [22].

Some earlier studies (before COVID-19 era), recorded low compliance rates among HCWs. This was the case in a systematic review done in Pakistan [3]. Katanami et al. [23] also found poor adherence (34%) to correct PPE use by HCWs dealing with patients under contact isolation in Japan precautions. However, in the aforementioned study, the researchers employed video cameras to fulfill the assessment objectively.

Though self-reporting of compliance rates tends to overestimate the actual rates [24,25], we are convinced that the anonymity of the questionnaire gave the participants freedom to describe their pattern of PPE use and increased the study credibility. Nevertheless, in such critical timing, this low compliance rate should be carefully studied and analyzed, especially with the resonating increase in number of deaths among Egyptian physicians [26].

Table 2
Relation between participants' compliance to proper PPE use and their personal, work-related characteristics and exposure to SARS-CoV-2 (n = 404).

Characteristics	Proper PPE use		Total No. (%)	X ² Test	p Value
	Non-compliant No. (%)	Compliant No. (%)			
Personal characteristics					
Age (years)					
20–29	31(16.4)	34(15.8)	65(16.1)	1.61	.66
30–39	89(47.1)	104(48.4)	193(47.8)		
40–49	36(19.0)	48(22.3)	84(20.8)		
50+	33(17.5)	29(13.5)	62(15.3)		
Mean ± SD	36.6 ± 8.4				
Gender					
Males	84 (39.1)	92 (48.7)	176 (43.6)	3.8	0.05*
Females	131 (60.9)	97 (51.3)	228 (56.4)		
Chronic health problems					
No	152 (70.7)	127 (67.2)	279 (69.1)	0.56	0.45
Yes	63 (29.3)	62 (32.8)	125 (30.9)		
Work characteristics					
Work experience (years)					
≤10	101 (47.0)	81 (42.9)	182 (45.0)	5.9	0.05*
11–20	85 (39.5)	65 (34.4)	150 (37.1)		
> 20	29 (13.5)	43 (22.8)	72 (17.8)		
Occupation					
Physician	111 (51.6)	108 (57.1)	219 (54.2)	20.3	0.005*
Pharmacist	38 (17.7)	9 (4.8)	47 (11.6)		
Dentist	6 (2.8)	8 (4.2)	14 (3.5)		
Nurse	3 (1.4)	2 (1.1)	5 (1.2)		
Ancillary staff	29 (13.5)	40 (21.2)	69 (17.1)		
Technician	8 (3.7)	4 (2.1)	12 (3.0)		
Others ^a	2 (0.9)	1 (0.5)	3 (0.7)		
Medical Specialty					
Surgical	21 (18.1)	11 (8.9)	32 (13.4)	13.2	<0.001*
ICU & anesthesia	18 (15.5)	34 (27.6)	52 (21.8)		
Medical	40 (34.5)	43 (35.0)	83 (34.7)		
Diagnostics	24 (20.7)	25 (20.3)	49 (20.5)		
Others ^b	13 (11.2)	10 (8.1)	23 (9.6)		
Type of facility					
Hospital	175 (81.4)	160 (84.7)	335 (82.9)	0.76	0.39
Non-Hospital	40 (18.6)	29 (15.3)	69 (17.1)		
Nature of work					
Full time	176 (81.9)	163 (86.2)	339 (83.9)	1.43	0.23
Part time	39 (18.1)	26 (13.8)	65 (16.1)		
Work duration (hours/day)					
<8	77 (35.8)	39 (20.6)	116 (28.7)	11.3	0.001*
≥8	138 (64.2)	150 (79.4)	288 (71.3)		
Work in isolation hospital					
No	126 (58.6)	80 (42.3)	206 (51.0)	10.7	0.001*
Yes	89 (41.4)	109 (57.7)	198 (49.0)		
Exposure to COVID-19 patient(s)					
No	92 (42.8)	43 (22.8)	135 (33.4)	18.2	<0.001*
Yes	123 (57.2)	146 (77.2)	269 (66.6)		
Risk of exposure to SARS-CoV-2					
Low	34 (27.6)	58 (39.7)	92 (34.2)	4.3	0.04*
High	89 (72.4)	88 (60.3)	177 (65.8)		
COVID-19 acquisition status					
No	178 (82.8)	135 (71.4)	313 (77.5)	7.4	0.006*
Yes	37 (17.2)	54 (28.6)	91 (22.5)		
Shortage in PPE					
No	26 (12.1)	45 (23.8)	71 (17.6)	9.5	0.002*
Yes	189 (87.9)	144 (76.2)	333 (82.4)		
Extended PPE use					
No	20 (9.3)	28 (14.8)	48 (11.9)	2.9	0.09
Yes	195 (90.7)	161 (85.2)	356 (88.1)		
Total	215 (53.2)	189 (46.8)	404 (100.0)		

COVID-19: Coronavirus Disease 2019, ICU: Intensive Care Unit, PPE: Personal Protective Equipment, SARS-CoV-2: Severe Acute Respiratory Syndrome Coronavirus 2.

^a health inspector, hospital administrators.^b General physicians, family medicine, dermatology.

* p ≤ 0.05 is significance.

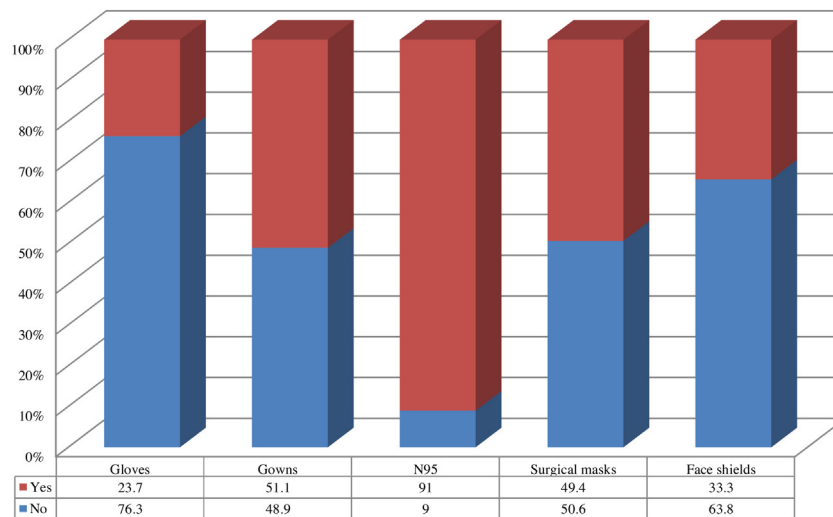


Fig. 3. The extended use of PPE by study respondents (n = 356).

Table 3

Regression analysis for predicting factors of compliance to proper use of PPE among participating HCWs.

Variable	B	Wald	p Value	OR	95% C.I.	
					Lower	Upper
Gender	-0.44	1.81	0.18	0.64	0.34	1.22
Work experience	0.09	0.18	0.67	1.09	0.72	1.68
Occupation	-0.11	2.53	0.11	0.89	0.79	1.03
Medical specialty	0.05	0.58	0.45	1.05	0.93	1.19
Work duration	0.52	1.76	0.19	1.68	0.78	3.60
Work in isolation hospitals	0.16	0.21	0.65	1.17	0.59	2.29
Exposure to patients with COVID-19	1.01	5.59	0.02*	2.75	1.19	6.35
Risky exposure to SARS-CoV-2	0.79	4.22	0.04*	2.21	1.04	4.71
COVID-19 infected	0.21	0.32	0.57	1.23	0.59	2.53
Shortage in PPE	-0.36	0.82	0.37	0.68	0.29	1.57
Prior training on the proper use of PPE	1.5	17.05	<.001*	4.59	2.22	9.47
Constant	-2.2	3.92	0.048	0.12		

B = unstandardized β" regression coefficient." β = standardized β. OR = odds ratio.

* p ≤ 0.05 is significant.

Many factors can contribute to the inappropriate use of PPE, such as unavailability [27], negligence, lack of knowledge and personal discomfort [3]. Surgeons from Pakistan, for instance, believed that PPE required while working on patients with COVID-19 have negative impact on their performance [28].

We adopted a comprehensive approach in designing the survey that allowed us to explore some personal and work characteristics related to the noncompliance among HCWs.

According to our results, receiving prior training on the proper use of PPE exposure to patients with COVID-19, and performing procedures that pose HCWs at high risk of exposure to SARS-CoV-2 represented the most significant predicting factors for compliance to PPE use. This finding was not astonishing; bearing in mind HCWs substantial fear and anxiety, that led to unnecessary overuse of some items [21,29]. It is also worth noting that in Egypt the steady rise in cases had not started until June 2020. This gave the health authorities and local IPC teams some time to provide trainings on choosing, donning and doffing different types of PPE and prepare HCWs regarding risky encounters and the required precautions.

Initially, the Egyptian authorities dedicated over 350 hospitals across the country for the management and isolation of all COVID-19 confirmed cases-even those with mild symptoms-.

But, after the surging rise in cases, hospitalization was kept exclusive for moderate and severe cases. The staff working in these facilities were the main targeted group for training on isolation

precautions. PPE was made available in such settings. In fact, 198 (49%) of the current study participants had worked these isolation hospitals.

As the case in many other countries-even with higher socio-economic status [3,21,29–32], most of our participants (82.4%) complained of shortage in PPE supplies (which showed statistical correlation with noncompliance). During the first wave, Egypt witnessed a serious shortage in gloves and mask [33] which caused wide-scale discussions in both; the medical community and the media. The Egyptian market depends mainly on imported medical supplies (especially masks and respirators). The interruption of importation during the peak of the pandemic led to severe shortage and rocket increase in the prices of authentic respirators [34]. Besides, fake masks and respirators had flooded the market [35]. Monitoring the quality of PPE that reached points of care in different healthcare settings can be achievable in large hospitals of different healthcare sectors (governmental, private and university). Yet, it is not the case in small hospitals in rural areas and private clinics. Consequently, local IPC teams had to compromise and apply many strategies for the reuse of authentic face masks and respirators rather than purchasing unaffordable counterfeit alternatives.

Since the start of the outbreak in Wuhan, China [36], IPC recommendations, and guidelines have displayed inconsistencies between countries and international agencies regarding the virus's mode of transmission and necessary PPE for each situation. Based

on interim recommendations published by WHO and CDC, the Ministry of Health and Population issued several circulars on hospital preparedness and IPC measures. At the timing of disseminating this questionnaire, there was an agreement that airborne precautions are only required when performing AGP for patients with COVID-19 [11,37,38].

When IPC practitioners and employers attempted to optimize the use of respirators, they faced the HCWs' lack of trust and tendency to demand respirators for every encounter. The same issue had also been highlighted in literature [21,39,40]. However, the consumption of authentic imported respirators and intensive awareness campaigns organized by all relevant authorities have eventually led to an increase in HCWs' awareness. Our data show that about 66% of the participating HCWs complied to the proper use of medical (surgical) masks of all other PPE types, reflecting the basic understanding of the viral transmission among participants.

The Arabic translation of the questionnaire increased the spectrum of participation among different sectors of healthcare workforce, including ancillary staff (49 participants). This cohort of HCWs should never be overlooked. In addition, their perception of, and compliance to, the basic IPC measures should be monitored carefully.

Study limitations

The subjectivity of a self-reported questionnaire remains the main limitation to the study. Despite the survey being launched nationally using different on-line channels, we still believe that we missed a considerable proportion of HCWs who do not have /not accustomed to using on-line communication channels. We also relied on the participants' knowledge and perception of the local IPC guidelines in their facilities. Factors of poor compliance to PPE use were not explored in this study.

Conclusion

The high percentage of non-compliant HCWs turns on a warning signal. We should apply strict measures to increase the availability of PPE, prioritize their use, provide more focused training to HCWs and monitor their compliance to the proper use of PPE.

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Competing interests

None declared.

Ethical approval

Not required.

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Appendix A. Supplementary data

Supplementary material related to this article can be found, in the online version, at doi:<https://doi.org/10.1016/j.jiph.2021.07.017>.

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