

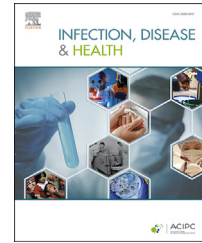


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Research paper

Adverse effects of personnel protective equipment among first line COVID-19 healthcare professionals: A survey in Southern Tunisia

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Received 6 May 2022; received in revised form 24 June 2022; accepted 26 June 2022

KEYWORDS

Adverse effects;
Health care professionals;
Personal protective equipment;
Prevalence;
Predictive factors

Abstract *Background:* Health care professionals (HCP) were obliged to wear personal protective equipment (PPE) during pandemic in order to minimize the risk of transmission of the emerging virus. The objective of the study was to estimate the prevalence of adverse effects related to the wear of PPE among HCP and to determinate their predictive factors.

Methods: This was a cross-sectional study including a representative sample of 300 randomized HCP at Hedi Chaker University Hospital Sfax, Tunisia, during the period August-September 2021. Data collection was carried out by an anonymous self-administered questionnaire.

Results: PPE related adverse effects were noted among 87 HCP with a prevalence of 57.2%. Multivariate analysis showed that factors independently associated with PPE adverse effects were female gender (Adjusted Odds Ratio (AOR) = 1.8; $p = 0.048$), chronic diseases (AOR = 0.29; $p = 0.001$) and previous infection with COVID-19 (AOR = 0.46; $p = 0.004$). Frequent use of bleach or other disinfection product without protection and use of hot water at work were independently associated with a high risk of adverse effects ((AOR = 2.22; $p = 0.003$) and (AOR = 2.83; $p = 0.005$), respectively). Similarly, a duration of use of PPE >4 h per day (AOR = 1.98; $p = 0.039$), as well as use of visors and/or glasses (AOR = 1.84; $p = 0.045$) were independently associated with PPE related adverse effects. *Conclusion:* The prevalence of adverse effects related to the wear of PPE was alarmingly high among HCP. Multiple risk factors were highlighted, notably professional aspects.

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Adequate and repetitive training for caregivers on the correct use of PPE remain essential to manage this problem.

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Highlights

- A relatively high prevalence of PPE related adverse effects among HCP.
 - Higher susceptibility to females, users of concomitant chemical and irritant materials.
 - Urgent need to training programs at work about adequate use of PPE.
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Introduction

COVID-19 was first discovered in China, in December 2019, before spreading to the whole world countries and becoming a global pandemic for more than 2 years [1]. Since the initial outbreak, this highly contagious virus poses a significant risk to healthcare professionals (HCP) that have faced the COVID-19 transmission not only through contact with tested positive patients, but also by touching contaminated materials and surfaces in the hospital units. In some areas, HCP have comprised up to 11% of all confirmed COVID-19 cases with an increasing number of occupationally attributed deaths being reported [2]. In fact, while waiting for the development of a new vaccine against this emerging virus, and in order to reduce the risk of transmission, HCP had recourse in addition to barrier procedures, to the use of personal protective equipment (PPE) such as masks, gloves, glasses and gowns, more than previously, especially in the case of tacking care for tested positive patients. The use of PPE can markedly reduce the infection risk associated with caring for COVID-19 patients by creating a physical barrier that prevented HCP from large particles inhalation as well as contact with biological fluids [3,4], infectious microorganisms and transmission through droplets in the air [5]. Because of the strong transmission of COVID-19 and the uncertainty of the infection status of patients, HCP find themselves forced to work for long hours wearing PPE, and many times with their complete materials at COVID-19 care units. Like all medical equipment, the use of PPE must be used according to standards guidelines and following the guides of use including duration, method of wear and way of undressing for maximum of effectiveness and protection. In spite of the adequate use according to the standards of PPE, working with PPE during long hours and successive days during more than 2 years of pandemic cannot be devoid of physical and psychological side effects on HCP and can have bad repercussions on the quality of care provided to their patients. Studying eventual adverse effects of PPE use among HCP was important because it can consequently suggest possible solutions for more comfortable and safe use of this materials by HCP at work. According to previous studies, adverse effects related to PPE use among HCP were variables and multiples among with the most importantly noted was dermatitis [6–8]. This effect could be majored by prolonged time of use [9], it could be also more pronounced among female HCP [10], among HCP Working at departments dedicated to COVID-19 patients [11] and in case of wearing half-face

elastomeric respirator [12] and gloves [6]. In Tunisia, there were no published studies estimating the prevalence of different adverse effects related to PPE use that may had significant or occupational health problems among HCP. In light of this, the aim of this study was to estimate the prevalence of adverse effects of wearing PPE at work among HCP in Southern Tunisia and to study their associated factors.

Methods

Study design and settings

This was a cross-sectional study using an anonymous self-administered questionnaire, including a randomized sample of HCP at Hedi Chaker University Hospital (HCUH) of Sfax, Southern Tunisia, during the fourth wave of COVID-19, from August, 1st, to September, 30th, 2021. The study was conducted concomitantly with the 4th wave of COVID-19 pandemic in our country. At this time, PPE were available to ensure maximum of HCP protection, who were at well trained in the use of each type of equipment during the survey period, as they have been using them for over a year and a half.

Inclusion criteria and sampling procedures

All medical and paramedical HCP aged 18 years or older and those who were active during the COVID-19 outbreak were eligible for the study. The Anonymity and confidentiality of HCP identity were guaranteed and maintained. In order to have a representative sample, HCP were randomly selected proportionally to the number of each professional category working at HCUH. Excluded cases were those who provided incomplete responses. The minimum required number of participants was 327, with a 5% margin of error, a PPE use related adverse effects rate of 30.7% reported in a previous study [13], a 95% confidence interval (CI) and a 10% loss or incomplete response rate.

Data collection

The data were collected via two methods simultaneously: the electronic method using an online self-administered questionnaire sent to the participants created via Google Forms application and distributed through official platforms as well as individual emails, and the traditional method using the same version printed and distributed to the recruited participants anonymously. HCP were benefited by multiple training

sessions about adequate use of PPE at work which were done similarly for all HCP working at different hospitals of Southern Tunisia by the same team and with the same materials. The questionnaire was developed by the investigators after an exhaustive review of the literature and previous published studies in the same subject. The questionnaire was tested before in a pilot study by different investigators, and then we calculated the alpha Cronbach coefficient to measure the internal reliability, which was of 0.84.

The questionnaire was composed of three major parts. The first one contained questions about the personal and sociodemographic characteristics of HCP such as age, gender, and seniority at work. The second part, focused on the working conditions during pandemic circumstances and detailed the use of different PPE by HCP in the workplace: For masks, we have specified two types that were authorized and available, which were surgical masks and the FFP2 (or N95) masks. For gloves, our hospital delivered 2 types of gloves for HCP during care, which were sterile gloves and clean gloves, and there was no difference between the two types in terms of adverse effects because both had the same components including Latex. Visors were also standardized and same prototypes were used at the whole hospital (plastic support part fixed to the front of HCP with hooks, which were adjusted to the holes of a transparent plastic sheet covering face). Similarly, Jumpsuits and/or gowns were the same for all staff in the hospital made in disposable woven material. The third part included the eventual self-reported adverse effects or problems related to using each type of PPE asked as yes/no. The use of PPE by HCP is certainly old, but at the time of the pandemic, the frequency and duration of wearing this equipment was extremely more pronounced than ever. Moreover, while distributing the questionnaire to the study participants, we underlined that the objective of the study was to illustrate the eventual adverse effects of PPE use that occurred during the pandemic and not before.

Statistical analysis

Data were entered into the SPSS.26 version. The results of continuous variables were presented as mean \pm standard deviation or median and interquartile range (IQR), according to the normality of the variable distribution. Categorical variables were presented as frequencies and percentages. Univariate logistic regression was used to compare two categorical variables in independent samples [Crude Odds Ratio (COR); (95% CI), p]. Then, all variables significant at $p < 0.05$ in the univariate analysis were entered into a multivariate model using a logistic binary regression [adjusted Odds Ratio (AOR); 95% CI, p], in order to determine the independent factors associated with the occurrence of adverse effects related to PPE use among HCP. P values lower than 0.05 were considered statistically significant.

Results

Baseline characteristics of the study population

Valid responses were received from 300 out of 327 frontline HCP who were selected for the study, giving a response rate

of 91.7%. The mean age of the participants was 25.6 ± 3.49 years. In total, 218 subjects were females (72.7%) and 198 subjects were single (66%). There were 202 (67.3%) doctors and 26 HCP (8.7%) with more than 10 years' seniority at work. Overall, 185 participants (61.7%) were working at medical department and 19 HCP (6.3%) worked at COVID-19 hospitalization units. The prevalence of one or more adverse effects related to the wear of PPE was 52.3% (157 participants), among whom 45 HCP (78.9%) needed to consult a doctor to have a specialist opinion (Table 1).

Table 1 Baseline characteristics of the study population.

Characteristics	Number	Percentage (%)
Gender		
Male	82	27.3
Female	218	72.7
Age category (years)		
≤ 45	287	95.7
> 45	13	4.3
Educational level		
Secondary	5	1.7
University	295	98.3
Marital status		
Single	198	66
Married	102	34
Profession		
Medical	202	67.3
Paramedical	98	32.7
Work seniority (years)		
≤ 10	274	91.3
> 10	26	8.7
Department or unit		
Medical	185	61.7
Surgical	59	19.7
Intensive care unit	37	12.3
COVID-19 unit	19	6.3
Chronic diseases		
Dermatological disease	15	5
Others diseases	39	13
Types of PPE used		
Mask		
Surgical	278	92.7
FFP2 or N95	161	53.7
Gloves	132	44
Visors and/or glasses	93	31
Jumpsuits and/or gowns	137	45.6
Full PPE	158	52.7
Duration of PPE use per day (hours)		
≤ 4	60	20
> 4	240	80
Duration of PPE use per week (days)		
≤ 4	50	16.7
> 4	250	83.3
Side effects related to PPE	157	52.3
Need for a specialist opinion for those side effects	45	78.9

*PPE=Personal Protective Equipment.

Main adverse effects of PE use mentioned by HCP during COVID-19 pandemic

Principals adverse effects of masks were excessive heat (160 HCP; (63.3%)), excessive sweating (156 HCP; (52%)), discomfort (156 HCP (52%)) and appearance or worsening of acne or papules or changes in skin characteristics (126 HCP (74%)). Principal adverse effects of gloves were dry hands (75 HCP (25%)) and itching (53 HCP (17.7%)). Discomfort was the major adverse effect of wearing Visors

and jumpsuits ((61 HCP (20.3%) and (70 HCP (23.3%)), respectively) (Table 2).

Factors associated with adverse effects related to the wear of PE among HCP

Univariate analysis

Socio-demographic factors statistically associated with PPE related adverse effects among HCP were age group ≤ 45 years (COR = 5.26; $p = 0.03$) and female gender (COR = 1.74;

Table 2 Main adverse effects related to the wear of personal protective equipment among healthcare professionals.

Personal Protective equipment	Main related adverse effects	Number		Percentage (%)	
		Surgical masks	FFP2 or N95 masks	Surgical masks	FFP2 or N95 masks
Masks	Discomfort	156	113	52	37.7
	Excessive sweating	156	100	52	33.3
	Excessive heat	160	113	53.3	37.7
	Nose pain	82	88	27.3	29.3
	Redness, scar, erosion or ulceration of nasal bridge	109	94	36.3	31.3
	Redness or scarring at ears	90	61	30	20.3
	Interference with speech	105	99	35	33
	Pathway disorders	74	72	24.7	24
	Appearance or worsening of acne or papules or changes in skin characteristics	126	74	42	24.7
	Dry mouth or bad taste	66	41	22	13.7
	Discomfort or difficulty in breathing	115	90	38.3	30
	Dyspnea	62	87	20.7	29
	Headache	91	69	30.3	23
	Pain in pressure areas	68	48	22.7	16
	Gloves	Dry hands	75		25
Erythema or dermatitis		31		10.3	
Itching (pruritus)		53		17.7	
Hand eczema		42		14	
Visors and/or glasses	Urticaria, dermatitis	33		11	
	Discomfort	61		20.3	
	Pain in pressure areas facial and/or suborbital friction or maceration	38		12.7	
	62		20.7		
Jumpsuits and/or gowns	Visibility restriction	93		31	
	Discomfort	70		23.3	
	Excessive sweating	100		33.3	
	Excessive heat	104		34.7	
	Discomfort when walking and/or moving	67		22.3	
	Inability to use bathroom for a long time (retention problems)	53		17.7	
	Increased thirst	63		21	
	Palpitation	52		17.3	
Full PPE	Continuous embarrassment	107		35.7	
	Exhaustion and fatigue	111		37	
	Made work more difficult with extra effort	136		45.3	
	Difficulty in establishing	108		36	

Table 2 (continued)

Personal Protective equipment	Main related adverse effects	Number		Percentage (%)	
		Surgical masks	FFP2 or N95 masks	Surgical masks	FFP2 or N95 masks
	good contact and adequate communication				
	Fear or anxiety	74		24.7	
	Lack of concentration and motivation	105		35	
	Inability to perform simple diagnostic procedures	111		24.7	
	Decreased the quality of care	209		35	

*PPE = Personal Protective Equipment.

$p = 0.03$). Individual factors were history of chronic diseases ($COR = 0.35$; $p = 0.002$) and previous infection by COVID-19 at work ($COR = 0.56$; $p = 0.01$). Professional factors were work seniority ≤ 10 years ($COR = 3.3$; $p = 0.01$), working at medical departments ($COR = 2.55$; $p = 0.004$), dealing with COVID-19 positive patients ($COR = 2.24$; $p = 0.001$), number of night shifts at COVID-19 unit > 1 per month ($COR = 2.01$; $p = 0.04$) and number of hours at the night shift at COVID-19 unit > 10 ($COR = 1.59$; $p = 0.04$). The frequent use of bleach or other product of disinfection without protection and hot water were statistically associated with PPE related adverse effects ($COR = 3.14$; $p < 0.001$) and ($COR = 2.01$; $p = 0.03$),

respectively). According to PPE specificities, adverse effects were statistically associate with FFP2 or N95 masks ($COR = 3.27$; $p = 0.04$), visors and/or mirror ($COR = 2.51$; $p < 0.001$) and wearing full PE ($COR = 2.1$; $p = 0.02$) as well as PPE use more than 4 h per day and more than 4 days per week (($COR = 1.99$; $p = 0.02$) and ($COR = 1.97$; $p = 0.03$), respectively) (Table 3).

Multivariate analysis

Binary logistic multivariate analysis showed that factors independently associated with PPE related adverse effects were female gender (AOR = 1.8; $p = 0.048$), having

Table 3 Factors associated with adverse effects related to the wear of personal protective equipment among healthcare professionals: results of univariate analysis.

Variables	Adverse effects related to PPE		Crude Odds Ratio	95% CI	p
	Yes (N (%))	No (N (%))			
Age groups (years)					
≤ 45	141 (49.1)	146 (50.9)	1		
> 45	2 (15.4)	11 (84.6)	0.19	[0.04–0.86]	0.03
Gender					
Male	31 (37.8)	51 (62.2)	1		
Female	112 (51.4)	106 (48.6)	1.74	[1.1–2.92]	0.03
Educational level					
Secondary	2 (40)	3 (60)	1		
University	141 (47.8)	154 (52.2)	1.37	[0.22–8.34]	0.73
Matrimonial status					
Single	44 (44.9)	54 (55.1)	1		
Married	99 (49)	103 (51)	1.18	[0.72–1.91]	0.50
Number of family members					
< 4	87 (48.6)	92 (51.4)	1		
≥ 4	56 (46.3)	65 (53.7)	0.91	[0.57–1.45]	0.69
Professional category					
Paramedical	28 (40.6)	41 (59.4)	1		0.16
Medical	104 (51.5)	98 (48.5)	1.55	[0.89–2.70]	0.12
Other categories	11 (37.9)	18 (62.1)	0.89	[0.37–2.18]	0.80
Work seniority (years)					
> 10	6 (23.1)	20 (76.9)	1		
≤ 10	137 (50)	137 (50)	3.33	[1.30–8.33]	0.01

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Table 3 (continued)

Variables	Adverse effects related to PPE		Crude Odds Ratio	95% CI	p
	Yes (N (%))	No (N (%))			
Department or unit					
Surgical	94 (50.8)	91 (49.2)	1		0.008
Medical	17 (28.8)	42 (71.2)	2.55	[1.35–4.80]	0.004
Intensive care unit	23 (62.6)	14 (37.8)	4.06	[1.69–9.69]	0.002
COVID-19 unit	9 (47.4)	10 (52.6)	2.22	[0.76–6.43]	0.14
Tobacco					
No	117 (49.4)	120 (50.6)	1		
Yes	26 (41.3)	37 (58.7)	0.27	[0.41–1.26]	0.25
Chronic disease					
No	128 (52)	118 (48)	1		
Yes	15 (27.8)	39 (72.2)	0.35	[0.19–0.68]	0.002
Previously infected by COVID-19					
No	91 (53.8)	78 (46.2)	1		
Yes	52 (39.7)	79 (60.3)	0.56	[0.35–0.89]	0.01
Frequent use of moisturizers cream					
No	76 (44.2)	96 (55.8)	1		
Yes	67 (52.3)	61 (47.7)	1.38	[0.87–2.19]	0.16
Frequent use of bleach or other product of disinfection without protection					
No	50 (33.6)	99 (66.4)	1		
Yes	92 (61.3)	58 (38.7)	3.14	[1.95–5.04]	<0.001
Frequent use of hot water					
No	112 (44.8)	138 (55.2)	1		
Yes	31 (62)	19 (38)	2.01	[1.08–3.75]	0.03
Frequency of hydro alcoholic gel use					
≤once an hour	63 (49.2)	65 (50.8)	1		
>once an hour	80 (46.5)	92 (53.5)	0.89	[0.57–1.42]	0.64
Hands wash frequency					
<10 times per day	50 (48.1)	54 (51.9)	1		
≥10 times per day	93 (47.4)	103 (52.6)	0.97	[0.61–1.57]	0.92
Dealing with COVID-19 positive patients					
No	51 (37)	87 (63)	1		
Yes	92 (56.8)	70 (43.2)	2.24	[1.41–3.57]	0.001
Number of night shift at COVID-19 unit per month					
≤1 per month	118 (45.4)	25 (62.5)	1		
>1 per month	142 (54.6)	15 (37.5)	2.01	[1.01–3.97]	0.04
Number of hours at the night shift at COVID-19 unit					
≤10	72 (42.6)	97 (57.4)	1		
>10	71 (54.2)	60 (45.8)	1.59	[1.01–2.52]	0.04
PPE availability and accessibility					
No	76 (48.4)	81 (51.6)	1		
Yes	67 (46.9)	76 (53.1)	0.94	[0.59–1.4]	0.78
Confidence in PPE protection					
No	69 (46.9)	78 (53.1)	1		
Yes	74 (48.4)	79 (51.9)	1.06	[0.67–1.66]	0.80
Adequate training for the proper use of PPE					
No	30 (42.3)	41 (57.7)	1		
Yes	113 (49.3)	116 (50.7)	1.33	[0.78–2.28]	0.29
Type of PPE					
Masks					
Cloth face mask	4 (26.7)	11 (73.3)	1		0.02
Surgical mask	45 (40.2)	67 (59.8)	1.85	[0.55–6.16]	0.32
FFP2 or N95 mask	94 (54.3)	79 (45.7)	3.27	[1.1–10.68]	0.04
Gloves					
No	68 (43.6)	88 (56.4)	1		
Yes	75 (52.1)	69 (47.9)	1.41	[0.89–2.21]	0.14

Table 3 (continued)

Variables	Adverse effects related to PPE		Crude Odds Ratio	95% CI	p
	Yes (N (%))	No (N (%))			
Visors and/or mirror					
No	87 (41)	125 (59)	1		
Yes	56 (63.6)	32 (36.4)	2.51	[1.50–4.2]	<0.001
Jumpsuits and/or gowns					
No	74 (46)	87 (54)	1		
Yes	69 (49.6)	70 (50.4)	1.16	[0.74–1.83]	0.52
Full PPE					
No	54 (38)	88 (62)	1		
Yes	89 (56.3)	69 (43.7)	2.1	[1.32–3.34]	0.002
Duration of PPE use per day (hours)					
≤4	20 (33.3)	40 (66.7)	1		
>4	123 (51.2)	117 (48.8)	1.99	[1.11–3.57]	0.02
Duration of PPE use per week (days)					
≤4	17 (34)	33 (66)	1		
>4	126 (50.4)	124 (49.6)	1.97	[1.1–3.72]	0.03

*PPE= Personal Protective equipment; CI= Confidence interval; % = Percentage; N= Number.

chronic diseases (AOR = 0.29; p = 0.001) and previous infection by COVID-19 (AOR = 0.46; p = 0.004). The frequent use of bleach or other product of disinfection without protection and hot water were independently associated with high risk of adverse effects ((AOR = 2.22; p = 0.003) and (AOR = 2.83; p = 0.005), respectively). The independent factors related to the PPE were duration of use more than 4 h per day (AOR = 1.98; p = 0.039), as well as using visors and/or mirror at work (AOR = 1.84; p = 0.045) (Table 4).

Discussion

In times of pandemic and given the highly contagious character of COVID-19 virus, HCP across the world are required to wear PPE at work in addition to other infection control measures. In spite of its large benefits, such as decreasing the risk of infection, the use of PPE in hospitals among frontline HCP, can also have adverse effects. In the current study, we noted a prevalence of 52.3% of PPE related adverse effects among HCP, which was lower than previous similar studies conducted in other countries (80%, 78% and 75%) [2,14–16]. This can be explained by the difference in the methodology adopted across studies. In fact, in this study, all HCP categories were enrolled, so that there were some participants who were not working in contact with COVID-19 positive patients and consequently, they used only masks at workplace.

Moreover, this study showed that female gender was independently associated with high prevalence of adverse effects among HCP. This gender discrepancy was also illustrated in previous studies [13,17]. This fact may be related to the less attention given by men compared to women to skin reactions related to PPE wear, and also to the difference at norms on perception, expressing and reporting discomfort or any other adverse effects among the two genders. Another interesting finding highlighted in this study was that HCP with chronic diseases had less PPE

related adverse effects, which was in line with literature [15,18]. Possible explanation for this was the fragility of the ground of those HCP, so that they were exempted from entering to the COVID-19 units and then they wear PPE so rarely.

Table 4 Predictors of adverse effects related to personal protective equipment among health-care professionals: Results of Multivariate Logistic Regression Model.

Independent factors	AOR	95% CI	p
Gender			
Male	1		
Female	1.80	[1.10–3.25]	0.048
Chronic disease			
No	1		
Yes	0.29	[0.14–0.61]	0.001
Previously infected by COVID-19			
No	1		
Yes	0.46	[0.27–0.78]	0.004
Frequent use of bleach or other product of disinfection without protection			
No	1		
Yes	2.22	[1.31–3.74]	0.003
Frequent use of hot water			
No	1		
Yes	2.83	[1.36–5.88]	0.005
Duration of PPE use per day (hours)			
≤4	1		
>4	1.98	[1.1–3.37]	0.039
The use of visors and/or mirror			
No	1		
Yes	1.84	[1.1–3.37]	0.045
The use of full PPE			
No	1		
Yes	1.58	[0.92–2.74]	0.099

*PPE = Personal Protective Equipment/AOR = Adjusted Odds Ratio/CI = confidence interval.

It was not surprising that we found an independent association between PPE related adverse effects and high duration of use. Similarly, previous studies indicated that prolonged use of PPE can lead to an increased risk of adverse effects [5,19–21]. In the same point of view, wearing PPE for long hours caused skin friction and irritation; on the other hand, excessive sweating and the warm atmosphere created by wearing PPE continually promoted skin microbial proliferation. These two conditions were favorable for the occurrence of adverse effects among HCP if they used PPE for much time. Moreover, this study showed that using visors and/or mirror at work was independently associated with high risk of adverse effects among HCP. This finding was also reported by other studies [14,22]. Indeed, these PPE were more likely to have adverse effects because they were used with extreme contact with HCP skin. In addition, prolonged wear and excessive tightening of visors and/or mirrors would be likely more associated with adverse effects.

The frequent use of bleach or other product of disinfection and hot water without protection by HCP were independently associated with high risk of adverse effects among the study population. Likewise, these findings were demonstrated by previous studies, with an AOR of 2.9 [14,16]. These chemical products therefore would be a source of an added toxicity and more adverse effects would appear. Paradoxically, this study showed that HCP previously infected with COVID-19 developed less adverse effects related to PPE wear. A probable explanation for this result is that being infected by COVID-19 at the workplace could have led to some psychological disorders on HCP mental health, namely anxiety and fear. These feelings might be responsible for avoidance behaviors of positive patients and COVID-19 units; therefore, HCP would wear PPE less frequently, and then will develop less adverse effects.

This original study was the first research highlighting the prevalence and the predictive factors of adverse effects related to the wear of PPE among HCP in Tunisia. A notable strength point was the exhaustibility of the questionnaire since the participants were asked about all the adverse effects of any type of PPE used at time of COVID-19 pandemic and it was not limited on studying one PPE. In addition, these findings could be used as a referent document by extrapolating the reported rates at larger scales, since it was carried out on a representative randomized sample of HCP. Nevertheless, it had some limitations: firstly, the cross-sectional design of the study is prone to certain biases, notably the temporal link, since this is a one-time measurement of the phenomenon and its predictive factors, so it was not easy to determinate causal relationships. Secondly, this study was addressed to HCP from only one University Hospital Center in Southern Tunisia, because of the material resources constraint. Finally, the adverse effects on HCP were evaluated subjectively and self-reported because of the use of a self-administered questionnaire.

This research demonstrated that the prevalence of PPE related adverse effects among HCP was relatively high in South Tunisian Hospital. Various individual, sociodemographic and professional predictive factors were noted. Quantification of those adverse effects was of a great interest in order to be able to treat and to prevent the

occurrence of such problems among caregivers. Promoting training programs at work continually for HCP on the adequate use of PPE and explaining effective procedures or means to prevent adverse effects of PPE wear would be of a great benefit. In the same way, increasing the number of workers involved at pandemic era in order to reduce working hours remains essential to protect HCP from the adverse effects of PPE prolonged wear while carrying out their noble work.

Ethical approval

The study was approved by the “Ethical Research Committee” with number 0420/2022 on 24/06/2022.

Author contribution

Baklouti Mouna, Ben Ayed Houda, Maamri Hanen, Ketata Nouha: Substantial contribution to conception and design of the study, to data acquisition, or to data analysis and interpretation.

Baklouti Mouna, Ben Ayed Houda, wrote the article and/or revised the article for important intellectual content.

Baklouti Mouna, Ben Ayed Houda, Maamri Hanen, Ketata Nouha, Mejdoub Yosra, Karray Raouf, Jdidi Jihene, Yaich Sourour, kassis Mondher, Feki Habib, Dammak Jmel, read and approved the final version of the submitted manuscript.

All Authors revised the manuscript and gave their contribution to improve the paper.

All authors read and approved the final manuscript.

Funding

None.

Provenance and peer review

Not commissioned; externally peer reviewed.

Declaration of competing interest

None.

Acknowledgements

None.

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