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Physical and stressful psychological impacts of prolonged personal protective equipment use during the COVID-19 pandemic: A cross-sectional survey study

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ABSTRACT

Background: Healthcare workers (HCWs) caring for COVID-19 infected patients were exposed to stressful and traumatic events with potential for severe and sustained adverse mental and physical health consequences. Our aim was to assess the magnitude of physical and mental health outcomes of HCWs due to the prolonged use of personal protective equipment (PPE) treating COVID-19 patients.

Methods: This cross-sectional study of 727 HCW assessed the symptoms of stress, anxiety, insomnia, and psychological resilience using the Stress and Anxiety to Viral Epidemics (SAVE) scale, Insomnia Severity Index (ISI), and Resilience Scale (RS), respectively, in Italy between 1st February and 31st March 2022. The physical outcomes reported included vertigo, dyspnea, nausea, micturition desire, retroauricular pain, thirst, discomfort at work, physical fatigue, and thermal stress. The relationships between prolonged PPE use and psychological outcomes and physical discomforts were analyzed using Generalized Linear Models (GLMs). We calculated the factor mean scores and a binary outcome to measure study outcomes.

Findings: We found that 23% of the respondents reported stress related symptoms, 33% anxiety, 43% moderate to severe insomnia, and 67% reported moderate to very low resilience. The GLMs suggested that older people (> 55 years old) are less likely to suffer from stress compared to younger people (< 35 y.o); conversely, HCW aged more than 35 years are more inclined to suffer from insomnia than younger people (< 35 y.o). Female HCW reported a lower probability of resilience than males. University employed HCWs were less likely to report anxiety than those who worked in a community hospital. The odds of suffering from insomnia for social workers was significantly higher than for other HCWs. Female HCW > 35 years old, enrolled in training programs for nursing, social work, technical training and other healthcare professionals increased the probability of reported physical discomforts. HCW that worked on non COVID-19 wards and used PPE for low-medium exposure level, were at lower risks for lasting physical side effects as compared to the HCW who worked in high-risk PPE intense, COVID-19 environments.

Interpretation: The study suggests that frontline HCWs who had extensive PPE exposure while directly

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engaged in the diagnosis, treatment, and care for patients with COVID-19 are at significant risks for lasting physical and psychological harm and distress.

Research in context

Evidence before this study

A literature search of original articles performed in the MEDLINE and Nursing journals databases via PubMed, based on the chronological order of the publications up until April 2021. The search string used in the databases was: "Italian hospitals" or "Italian regions" or "Mental healthcare" or "Psychological distress" or "Healthcare workers" or "Italian healthcare workers" or "Stress factors" or "Impact on mental health "and" Covid-19 ". The literature search revealed significant levels of stress, burnout, anxiety, depression and subjective distress. There is a negative reported impact on professional quality of life and scores and poor mental well-being of HCWs, attributable to the pandemic. Future research should evaluate specific risk factors and psychological variables of HCW such as sleep quality and the individual differences in the modulation of emotions under conditions of high stress.

Added value of this study

This prospective cross-sectional study of 727 HCWs directly engaged in diagnosing, treating or providing care to patients with suspected or confirmed COVID-19, reported a considerable proportion of HCW experiencined symptoms of stress, anxiety, insomnia (moderate to severe), and resilience (moderate to very low). Adverse physical outcomes show a strong association between age, gender, professional role, and the use of PPE in relation to the level of exposure to SARS-CoV-2 (high, medium and low) and work on COVID-19 wards.

Implications of all the available evidence

Frontline HCWs directly engaged in the diagnosis, treatment, and care for patients with COVID-19 are at significant risks for lasting physical, psychological harm and distress during and after the COVID-19 pandemic. This is likely impacting ongoing HCW shortages. These findings should guide intervention wellness strategies including periodic screening to monitor and mitigate risks that can compromise HCWs' performance and wellness, patient safety, and population health.

1. Introduction

Abundant data demonstrates that the COVID-19 pandemic has had significant untoward effects on health care workers (HCWs) requiring significant changes in the working routines and conditions of HCWs in health systems worldwide [1]. HCWs are required to wear personal protective equipment (PPE) kit, including a respirator mask, gown, gloves, at all times, both to protect themselves and to preserve their patients from the virus [2]. The compulsory requirements to don PPE was a necessary protective measure to prevent the spread of the COVID-19 virus, but the long hours of PPE use remains highly uncomfortable [3], and the estimated average PPE use time is 6.8 h per shift [4]. HCWs choose the most appropriate PPE to use during their working activities based on the perceived risks of their clinical procedures [5–7].

There are three levels of recommended PPE protection depending on the level of risk exposure of infection (high, medium and low). HCWs that performed or directly assisted high-risk medical procedures that generated aerosols (AGMPs) used PPE with a level 3 protection [5–7]. The high workload and discomfort of wearing PPE and especially at level 3 for long periods of time placed significant physical and mental burdens on HCWs [8]. In many cases, HCWs were not adequately trained to use PPE correctly, the PPE was not fit for their body size or purpose of multi hour use, and many had to reuse PPE due to shortages of protective devices [9].

The effects of changes to the working routines of HCWs on their mental and physical health have not been definitively highlighted especially with regard to their long term effects on HCWs [10,11]. HCWs with repeated exposure to COVID-19 patient load reported significant physical and mental health problems [12]. Changes in the working routines of HCWs (especially the use and reuse of PPE) may have impacted their physical health [2–4]. HCWs reported multiple physical disorders including respiratory, nervous, musculoskeletal, and urinary related to the use of PPE, with skin problems the most frequently reported physical complaints [3].

The work-related stress associated with modified work procedures, together with the exposure to traumatic events during the pandemic, have been shown to cause an acute and chronic deterioration in the mental health of HCW [13]. Health care workers on the front line who were directly involved in the diagnosis, treatment, and care of patients with COVID-19 were at a significant risk of developing psychological distress, insomnia and other lasting mental health symptoms [14] with an estimated prevalence among HCWs ranging from 36.36% [15] to 38.9% [16]. Some studies suggest these changes are likely to have a lasting negative psychological resilience impact on HCWs [11,17]. Psychological resilience is defined as the ability to tolerate difficulties such as stressful phenomena or negative emotional events often associated with symptoms of depression and anxiety. High levels of resilience are associated with good quality sleep [18].

Studies have found that during the COVID-19 pandemic nurses generally reported moderate resilience scores. Specifically, nurses working in US hospitals reported low levels of resilience, while Chinese nurses reported a higher level of resilience than in the pre-pandemic period [19]. In other studies [18], physicians reported the lowest levels of psychological resilience among HCWs with a 23% prevalence of anxiety and depression [16]. Preliminary data from Italy show that HCWs working on COVID-19 wards reported higher levels of depressive symptoms and post-traumatic stress symptoms (PTSS) with gender and marital status significant predictors for depressive symptoms, while gender and age significantly predicting PTSS levels [20]. The objective of this study was to assess the impacts of prolonged PPE usage on physical and mental well-being of HCWs and specifically the prevalence of stress, anxiety, insomnia and resilience.

2. Methods

2.1. Study design and participants

We conducted a cross-sectional, analysis using an online validated questionnaire given to a group of risk managers. The distribution of the questionnaire was carried out in different ways. In some hospitals, the HCWs received an email containing the description of the project and the link to answer the survey, while in others the research protocol and the link was disseminated through the hospital's website. The study was conducted from 1st February

to 31st March 2022, during the fourth pandemic wave in Italy, in which 1988 cases per 100,000 inhabitants were reported nationwide [21] (as compared to the same period in 2021 where the incidence was of 368.75 cases per 100,000 inhabitants [22]). Participants were allowed to terminate the survey at any time and were not compensated in any manner. A detailed file containing the invitation e-mail and the survey psychometric details is available in the Supplementary Materials in their original Italian and English versions. The study was approved by the Ethics Committee of the Guglielmo Marconi University of Rome on 3/11/2021. The respondents gave their verbal and written consent to participate and the questionnaires were collected using a Google® Forms Platform. The survey was anonymous, and the confidentiality of the information was ensured.

2.2. Procedures

The psychological outcomes reported included i) stress and anxiety, assessed using the Italian version of the Stress and Anxiety to Viral Epidemics-9 items (SAVE-9) [23]; ii) insomnia, evaluated using the Insomnia Severity Index (ISI) [24], and, III) psychological resilience, evaluated using the Resilience Scale-14 items (RS-14) [25]. The physical outcomes reported were vertigo, dyspnea, nausea, micturition desire, retroauricular pain, thirst, discomfort at work, physical fatigue, and thermal stress.

The online survey included three main sections and required about 10 min to complete as follows:

i) The first section explored demographic and work-related characteristics of the respondents and were self-reported by the participants and included age, gender, work placement, professional role, clinical area of reference, and questions regarding working in an ICU ward, on a ward with COVID-19 patients, and what PPE level of equipment was used with respect to HCW perceived risk of exposure.

ii) The second section evaluated the physical discomforts of the respondents and HCWs were asked to declare whether they suffered from physical discomforts that were likely to be associated with prolonged usage of PPE such as vertigo, dyspnea, nausea, micturition desire, retroauricular pain, thirst, discomfort at work, physical fatigue, and thermal stress.

iii) The third section focused on the psychological symptoms of the respondents. HCWs were asked to provide details on their psychological wellness. The psychological outcomes that were included in the analysis were: i) anxiety and stress, ii) insomnia and iii) perceived level of resilience. These outcomes were evaluated through specific and validated sub-questionnaires, that helped to diagnose the presence of ongoing psychological difficulties including:

a) The SAVE-9 scale for anxiety and stress. The SAVE-9 scale includes nine items and uses a 5-point Likert scale ranging from 0 (never) to 4 (always). The SAVE-9 scale explores two distinct factors: (1) anxiety about viral epidemics (items: 1–2–3–4–5–8) and (2) work-related stress associated with viral epidemics (items: 6–7–9). The Italian version of the SAVE-9 scale has been validated for investigating anxious mental distress and stress during viral epidemics in HCWs [23]. The SAVE-9 has a satisfactory internal consistency (Cronbach's 0.795) and the cut-off values relating to the SAVE-9 scale and its subcategory of anxiety are 22 and 15, respectively [23,26].

b) The ISI scale for insomnia. The ISI is a 7-item self-reported questionnaire that assesses the nature, severity and impact of insomnia. The dimensions are: the severity of insomnia problems (difficulty falling asleep, maintenance of sleep and problems with early daytime awakening), satisfaction or dissatisfaction with sleep, the interference of sleep difficulties with functioning daytime, evidence of sleep problems from others and worry or distress caused by sleep difficulties [24,27,28]. A 5-point Likert scale is used to evaluate each element and a total score between 0 and 28 can be obtained and is interpretated as follows: absence of insomnia (0–7); subthreshold insomnia (8–14); moderate insomnia (15–21); and severe insomnia (22–28) [24,28].

c) The RS-14 scale for resilience. We defined resilience for this study as the ability of a HCW to face and overcome a stressful phenomenon or negative emotional events. This scale is characterized by intrinsic properties that highlight the positive psychological attributes of individuals, rather than their deficiencies. It includes 14 items with a seven-point Likert response scale rank ordered from strongly disagree (one) to strongly agreement (seven). The minimum score on the scale is 14 and the maximum score is 98. A score < 56 indicates very low resilience level, 57–64 indicates low resilience level, 65–73 low-end resilience level, 74–81 level of moderate resilience, 82–90 moderately high resilience level, and a score > 91 indicates a high level of resilience. The Italian version of the Resilience Scale has a high internal coherence with a Cronbach alpha (α) of 0.88 [25].

2.3. Statistical analysis

The descriptive data were expressed as absolute values (percentages), while numeric variables were expressed as a mean value ± standard deviation (SD) (Tables 1 and 2).

Different Generalized Linear Models (GLMs) were modelled to investigate the relationships between the outcomes and selected characteristics of the respondents (i.e., age, gender, work placement, professional role, clinical area of reference, working (or not) in the ICU wards, working (or not) on a ward with COVID-19 patients, type of employed PPE). Specifically, we implemented binary logistic regression models for the dichotomous dependent variable "Stress", "Anxiety" (Table 3), and for each of the "Physical Discomforts"

Table 1
Descriptive statistics of demographical and professional variables (N = 727).

Characteristics		N	%
Gender	Male	202	28
	Female	525	72
Age range	< 35	177	24
	35–55	368	51
	> 55	182	25
Work placement	Hospital Agency	269	37
	University Hospital	313	43
	Local Health Authority	122	17
	Territorial Services	23	3
Professional role	Physician	182	25
	Nurse	330	45
	Operator social health	47	6
	Technician	42	6
	Researcher/ Student	66	9
	Other	60	8
Clinical area of reference	Emergency-Urgency	188	26
	Medical	213	29
	Surgical	92	13
	Other	234	32
Do you work in the ICU ward?	Yes	123	17
	No	604	83
Do you work in a ward with COVID-19 patients?	Yes	231	32
	No	496	68
With respect to the risk of exposure to COVID-19, which PPE do you use as a priority?	High risk	174	24
	Medium risk	310	43
	Low risk	243	33
Was psychological support provided during the COVID-19 pandemic?	Yes	138	19
	No	589	81
Do you think psychological support is necessary?	Yes	643	88
	No	84	12

Table 2
Psychological Discomforts Reported by Healthcare Workers.

Primary outcomes	ICU Ward	No ICU Ward	COVID-19 Ward	No COVID-19 Ward	PPE used by exposure risk			Total sample
					High risk	Medium risk	Low risk	
SAVE-9 - Stress Mean (SD)	0.236 (0.426)	0.224 (0.417)	0.242 (0.429)	0.218 (0.413)	0.247 (0.433)	0.226 (0.419)	0.21 (0.408)	0.226 (0.418)
HCWs with a stress score above the cut-off. N (%)	29 (24%)	135 (22%)	56 (24%)	108 (22%)	43 (25%)	70 (23%)	51 (21%)	164 (23%)
SAVE-9 - Anxiety (subscale) Mean (SD)	0.325 (0.47)	0.336 (0.473)	0.329 (0.471)	0.337 (0.473)	0.322 (0.469)	0.348 (0.477)	0.325 (0.469)	0.334 (0.472)
HCWs with anxiety scores above the cut-off. N (%)	40 (33%)	203 (34%)	76 (33%)	167 (34%)	56 (32%)	108 (35%)	79 (33%)	243 (33%)
ISI Mean (SD)	0.447 (0.499)	0.429 (0.495)	0.45 (0.499)	0.423 (0.495)	0.437 (0.497)	0.458 (0.499)	0.395 (0.49)	0.432 (0.496)
HCWs with moderate to severe insomnia. N (%)	55 (45%)	259 (43%)	104 (45%)	210 (42%)	76 (44%)	142 (46%)	96 (40%)	314 (43%)
RS-14 Mean (SD)	0.602 (0.492)	0.679 (0.467)	0.615 (0.488)	0.69 (0.463)	0.621 (0.487)	0.668 (0.472)	0.695 (0.461)	0.666 (0.472)
HCWs with moderate to very low resilience. N (%)	74 (60%)	410 (68%)	142 (61%)	342 (69%)	108 (62%)	207 (67%)	169 (70%)	484 (67%)

(Vertigo, Dyspnea, Nausea, Micturition desire, Retroauricular pain, Thirst, Discomfort at work, Physical fatigue, and Thermal stress, Table 5), separately.

Ordinal logistic regression models were implemented to understand the determinants for the polytomous dependent variables "Insomnia" and "Resilience" (Table 3).

The results of these models are expressed as odds ratios (OR) using a 95% confidence interval (95% CI). We measured associations between a numeric variable representing the total number of reported discomforts and the predictors using a linear regression model (Table 5). A $P < 0.05$ was considered statistically significant and all tests were two-tailed. The 95% CIs are presented below and the data analyses were conducted using R software. Data analysis was performed from April 15 to June 15, 2022.

3. Results

3.1. Demographic, professional and stressful life characteristics

The demographic characterizing data are summarized in Table 1 with 731 HCWs responding to the online survey. Four HCW questionnaires were excluded due to participants providing answers that were not in line with the questions or consent was not given to participate in the study. The final sample consists of 727 responses.

The respondents were mainly women (72%), aged between 35 and 55 (51%) and included nurses (45%), physicians (25%), researchers / students (9%, including researchers in the Faculty of Medicine and Surgery, PhD students, trainee students or post-graduates), social health workers (6%), technicians (6%), others (8%) as shown in Table 1. 17% of participants said they worked on ICU wards, 32% worked on general COVID-19 medical wards, and 43% reported they mainly used PPE for the medium risk level.

3.2. Severity of measurements and associated factors

A considerable proportion of HCW participants reported psychological symptoms (Table 2). These data were evaluated both in the whole sample and on specific sub-populations of respondents: (1) working (or not working) on ICU wards, (2) working (or not working) on COVID-19 wards, (3) using PPE associated to with low, medium and high exposure risks. Overall, the respondents reported stress scores of 23% and anxiety scores of 33% (we considered for the stress calculation all the items of the SAVE-9 scale with a cut-off ≥ 22, while for the anxiety calculation we considered the items belonging to the subcategory with a cut-off ≥ 15 [23,26]); in addition, moderate to severe insomnia values of 43% reflects percentage of sample suffering from moderate and severe insomnia (considering scores cut-off higher than 14 on the ISI [24,28]),and moderate to very low resilience equaled to 67% of the total sample as demonstrated in Table 2 (considering scores lower or equal to 81 on the RS-14 scale [25]). Table 2 suggests that, on average, the percentage of HCWs with anxiety and stress scores above the cut-off level is generally low. Higher levels of resilience, compared to the total sample, were reported in HCWs who used high-risk PPE (62%), who worked on ICU wards (60%) and on the COVID-19 wards (61%). Finally, HCW who used PPE for the medium risk (level 2) reported moderate to severe insomnia values of 46%.

3.3. Risk factors for mental health outcomes

The generalized linear model regression analysis was performed to estimate the associations between each of the psychological variables investigated and the potential risk predictors (Table 3). The adjusted Odds Ratios indicated that being older than 55 years (OR 0.54, CI 0.29–0.99, $p < 0.05$) decreased the likelihood of stress compared to being under the age of 35; HCW aged between 35 and 55 years (OR 1.52, CI 1.04–2.22, $p < 0.05$) and over the age of 55 years (OR 1.78, CI 1.14–2.77, $p < 0.05$) reported a greater likelihood of insomnia than those younger than 35.

Women (OR 0.73, CI 0.53–1.00, $p < 0.05$) reported a lower probability of being resilient than male HCW. HCWs who worked in a university hospital (OR 0.62, CI 0.42–0.92, $p < 0.05$) were less likely to report anxiety than those who worked in a community hospital. Social workers (OR 2.37, CI 1.29–4.40, $p < 0.01$) reported a higher risk of insomnia than physicians.

3.4. Physical outcomes

The physical discomforts reported by HCW (Table 4) included: discomfort at work such as difficulty communicating with colleagues or patients (62%), retroauricular pain (58%), thirst (54%), physical fatigue (50%), thermal stress (44%), dyspnea (39%), nausea (17%), micturition desire (14%) and vertigo (11%).

The most relevant results from the binary logistic regression models are reported below, considering each physical discomfort separately (Table 5). Female HCWs reported a higher probability of retroauricular pain, thirst, discomfort at work and physical fatigue, and reported a lower probability of urinary discomfort with respect to male HCW. Nurses had an increased likelihood of reporting vertigo, dyspnea, nausea, micturition desire, thirst and physical fatigue with respect to physicians. HCWs who did not work on wards with COVID-19 patients were less likely to report discomfort such as nausea, micturition desire, retroauricular pain, thirst, discomforts at work, physical fatigue and thermal stress compared to HCWs that

Table 3
Risk Factors for Mental Health Outcomes Identified by GLM Regression Analysis

Risk Predictors	MODEL	Stress		Anxiety		Insomnia		Resilience	
		Binary logit model		Binary logit model		Ordinal logit model		Ordinal logit model	
		Odds Ratios	*CI*	*Odds Ratios*	*CI*	*Odds Ratios*	*CI*	*Odds Ratios*	*CI*
	(Intercept)	0.09***	0.03 – 0.20	0.14***	0.06 – 0.30				
Age range (ref < 35)	35–55	0.87	0.54 – 1.43	0.86	0.55 – 1.35	1.52*	1.04 – 2.22	1.10	0.77 – 1.59
	> 55	0.54*	0.29 – 0.99	0.68	0.40 – 1.16	1.78*	1.14 – 2.77	1.26	0.83 – 1.93
Gender (ref: male)	Female	0.89	0.57 – 1.40	1.26	0.85 – 1.88	1.11	0.80 – 1.53	0.73*	0.53 – 1.00
Work placement (ref: Hospital agency)	University hospital	0.80	0.52 – 1.22	0.62*	0.42 – 0.92	0.74	0.54 – 1.02	0.92	0.67 – 1.26
	Local health company	0.59	0.32 – 1.05	0.63	0.38 – 1.03	0.74	0.49 – 1.12	1.27	0.85 – 1.89
	Territorial services	0.71	0.16 – 2.32	0.60	0.19 – 1.67	1.12	0.49 – 2.52	0.60	0.26 – 1.34
Professional role (ref: Physician)	Nurse	1.33	0.80 – 2.24	1.55	0.99 – 2.44	1.21	0.84 – 1.74	1.11	0.78 – 1.59
	Operator social health	1.17	0.50 – 2.63	1.08	0.50 – 2.24	2.37**	1.29 – 4.40	1.43	0.80 – 2.57
	Technician	1.18	0.47 – 2.80	0.91	0.40 – 2.02	0.96	0.50 – 1.84	0.57	0.31 – 1.04
	Researcher / Student	0.96	0.41 – 2.16	1.90	0.93 – 3.87	1.55	0.87 – 2.78	1.47	0.83 – 2.59
	Other	1.06	0.45 – 2.40	1.00	0.48 – 2.03	1.50	0.84 – 2.66	0.69	0.40 – 1.19
Clinical area (ref: Emergency-urgency)	Medical	0.89	0.50 – 1.61	0.95	0.56 – 1.60	1.30	0.85 – 2.00	0.68	0.44 – 1.03
	Surgical	1.39	0.72 – 2.65	1.31	0.72 – 2.37	1.53	0.92 – 2.54	0.84	0.51 – 1.40
	Other	0.93	0.51 – 1.69	1.16	0.68 – 1.97	1.08	0.69 – 1.68	1.09	0.70 – 1.67
ICU Ward (ref: yes)	ICU Ward	1.31	0.73 – 2.38	1.20	0.70 – 2.05	1.09	0.70 – 1.69	0.88	0.57 – 1.36
COVID-19 Ward (ref: yes)	COVID-19 Ward	1.21	0.71 – 2.08	1.11	0.69 – 1.78	1.12	0.76 – 1.66	0.77	0.53 – 1.13
PPE used (ref: High risk)	Medium risk	1.03	0.59 – 1.81	1.26	0.77 – 2.10	1.17	0.77 – 1.78	1.13	0.75 – 1.70
	Low risk	1.24	0.64 – 2.43	1.43	0.79 – 2.60	1.04	0.64 – 1.71	1.11	0.69 – 1.80
	TOT Outcomes	1.35***	1.21 – 1.50	1.25***	1.14 – 1.38	1.41***	1.30 – 1.52	0.95	0.89 – 1.03
Intercepts	0|1					2.72**	1.41 – 5.21	0.07***	0.03 – 0.13
	1|2					10.37***	5.30 – 20.29	0.16***	0.08 – 0.31
	2|3					64.57***	31.45 – 132.58	0.41**	0.21 – 0.77
	3|4							1.17	0.62 – 2.20
	4|5							5.26***	2.73 – 10.13
Observations		727		727		727		727	
R^2 Tjur		0.077		0.074		0.152		0.046	
AIC		760.431		910.401		1.880.086		2.526.315	

* p < 0.05 * * p < 0.01 * ** p < 0.001

Table 4
Physical Discomforts found after Prolonged use of PPE

Physical discomforts	Physical outcomes (%)
Vertigo	11
Dyspnea	39
Nausea	17
Micturition desire	14
Retroauricular pain	58
Thirst	54
Discomfort at work	62
Physical fatigue	50
Thermal stress	44

worked on wards with COVID-19 patients. The linear model's analysis suggests that being older than 35 years old, female and enrolled as nurses, social workers, technicians and other healthcare professionals increased the probability of suffering from a higher number of physical discomforts, while keeping the levels of the other covariates fixed. Furthermore, not working on an COVID-19 ward and using PPE for the low-medium risk levels of exposure led to a significant reduction in the number of total physical discomfort symptoms reported by HCWs. The independent variables (1) work location, and (2) work on the ICU wards did not produce statistically significant results in the binary logistic regression models or in the linear models (Table 5).

4. Discussion

We found that hospital staff who treated patients with COVID-19 reported a high prevalence of emotional distress and serious physical discomforts due to prolonged PPE usage. Studies assessing psychological impacts of the pandemic in HCWs are relevant since this population is especially vulnerable and continues to suffer increased mental health morbidity. Our study results point to a general physical and psychological burden on HCWs with (see Table 2) in line with or higher than those obtained in studies from Italian [29], Chinese [30,31] and American [32] studies, who evaluated the effects of the COVID-19 pandemic on HCWs. We foundhigher reported scores for anxiety (33% of respondents compared to 19.8%) and severe insomnia (13% of the total sample as compared to 8.27%), in comparison with the study by Rossi et al. [29] on psychological outcomes, considering an ISI cut-off ≥ 22 and stress results consistent with "high perceived stress" as shown by the Italian study [29]. The assessment of insomnia has been explored by several Chinese studies with a prevalence ranging from 34.0% [30] to 36.1% [31] using the ISI scale, considering different threshold scores (Lai et al. [30] and using a cutoff score of 14, while Zhang et al. [31] considered a total cut off score ≥8). Surveys conducted in US hospitals reported moderate insomnia values of 39.72% and severe insomnia values of 5.67% [32]. The results of our survey on the detection of insomnia symptoms appear to be greater than the Chinese samples [30,31], perhaps due to the COVID wave period in which the survey was conducted, and a similar prevalence compared to the American studies [32]. Our results are partially consistent with the results from a previous Italian study by Lisi et al. [33]. The levels of resilience (moderate to very low) reported by the respondents is higher than in the previous work [33]. Both the studies do not show statistically significant correlations between professional roles and the dependent variable "resilience". In addition, our results suggest that HCW age, the clinical area of reference, working in ICU and the use of PPE in relation to the risk exposure are not associated with lower resilience. Our logistic regression models (Table 3) suggest that females are less likely to be resilient than males, while Lisi et al. [33] found some association in females between lower resilience and working in a Covid-free setting. While gender is an independent variable, this likely indicates a robust relationship between the socio-cultural differences between genders and the variables of psychological distress.

The survey reporting the total physical discomfort reported by HCWs (Table 5) provided marked differences, with respect to:

(1) *gender*: females report greater discomfort than males;.

(2) *professional role*: nurses present more inconvenience than physicians;.

(3) *work environment*: HCWs who worked on non-COVID-19 wards and were less exposed to the risks reported less inconvenience than HCWs who worked on COVID-19 wards; and,

(4) *PPE adoption*: HCWs using PPE for the medium to low risk levels have a reduced likelihood of reporting inconvenience as compared to HCWs who reported wearing PPE for high-risk patient exposures.

The study results, stratified by gender and profession, confirm the existence of marked gender differences related to HCW female staff (compared to men) who reported a worse mental health state and higher level of discomforts. The existing literature [29,30,32] regarding female gender, nursing profession and work on COVID-19 wards suggest significant risk factors for the onset of severe psychological symptoms for HCW. Gender differences =are attributable to multiple factors: differences in the type of work assigned to male and female health workers, limited size design variation of PPE, gender differences in reporting distress, physical strength and different psychological coping mechanisms [8]. Finally, the respondents reported that they did not receive psychological support during the pandemic (81%) and that they considered this prevention measure necessary (88%) (Table 1). This rate seems higher when compared with an international pandemic management survey in which only 50% of health workers indicated they needed ongoing psychological support [9].

A variety of limitations of this study should be noted. First, there is likely a selection bias toward those HCW who responded because the participants were recruited mostly from university hospital settings. We asked risk managers to disseminate the survey link among their HCW in a non-probabilistic nature, using a snowball sampling procedure which might have undermined the generalizability of our findings. Second, some recall bias is inherent to a survey that requires self-reporting of behaviors occurring in the past. Third, generalizability of the results might be limited because all of the participants were Italian HCW working in university hospitals. Fourth, a response bias may still exist if the nonrespondents were either too stressed to respond or not at all stressed and therefore not interested in this survey. Fifth, the cross-sectional design of the study is a potential limitation, especially if we consider the constantly changing contexts of the pandemic situation, leading to diverse impacts on the psychological and mental health of the HCW=. Sixth, the sample size was unbalanced by gender, as women represented the majority, even if this distribution appears to be representative of the gender differences among Italian HCWs where women represent the majority of HCW [34]. Seventh, the study results reflect the Italian health system, which may not be generalized to other countries with their distinct health delivery systems, comprising unique staffing and population characteristics, and within different clinical settings. Finally, the nature of the study does not allow to determine causal relationships.

Protecting health care workers is an essential component of public health measures for addressing the COVID-19 epidemic. We aimed to develop a deeper understanding about the links between work and mental health by investigating the possible associations between the psychological variables investigated and the inconvenience and ongoing harms caused by the prolonged use of PPE. This study provides valuable and novel insights into the psychological distress and physical discomforts related to the extended use of PPE during the COVID-19 pandemic. The prolonged and continuous use of PPE likely had a negative impact over time on the ongoing mental and physical health of HCWs. The results support the need

Table 5
Physical Discomforts due to Prolonged use of PPE.

Risk Predictors	MODEL	Vertigo		Dyspnea		Nausea		Micturition Desire		Retroauricular Pain		Thirst		Discomfort at work		Physical Fatigue		Thermal Stress		Total outcomes	
		Binary logit model		Binary logit model		Binary logit model		Binary logit model		Binary logit model		Binary logit model		Binary logit model		Binary logit model		Binary logit model		**Linear model**	
	Predictors	*Odds Ratios*	*CI*	*Odds Ratios*	*CI*	*Odds Ratios*	*CI*	*Odds Ratios*	*CI*	*Odds Ratios*	*CI*	*Odds Ratios*	*CI*	*Odds Ratios*	*CI*	*Odds Ratios*	*CI*	*Odds Ratios*	*CI*	*Estimates*	*CI*
	(Intercept)	0.07***	0.02 – 0.18	0.33***	0.17 – 0.62	0.26***	0.11 – 0.57	0.99	0.41 – 2.34	1.79	0.95 – 3.40	2.14*	1.10 – 4.23	1.64	0.86 – 3.15	0.99	0.52 – 1.88	2.32*	1.22 – 4.50	4.14***	3.60 – 4.68
Age (ref: < 35)	35–55	1.18	0.61 – 2.44	0.67	0.44 – 1.04	0.53*	0.32 – 0.87	0.60	0.33 – 1.08	0.70	0.45 – 1.07	0.68	0.43 – 1.07	1.04	0.67 – 1.61	1.09	0.70 – 1.68	0.77	0.49 – 1.19	-0.44*	-0.80 – – 0.07
	> 55	1.22	0.54 – 2.84	0.84	0.51 – 1.39	0.21***	0.10 – 0.42	0.55	0.25 – 1.20	0.77	0.47 – 1.25	0.61	0.36 – 1.02	0.91	0.55 – 1.50	0.98	0.59 – 1.63	0.65	0.39 – 1.09	-0.57**	-0.99 – – 0.15
Gender (ref: male)	Female	0.97	0.55 – 1.76	1.00	0.69 – 1.47	1.51	0.90 – 2.61	0.48**	0.28 – 0.82	1.51*	1.05 – 2.17	1.47*	1.00 – 2.15	1.65**	1.15 – 2.39	1.50*	1.04 – 2.19	1.08	0.74 – 1.58	0.37*	0.06 – 0.68
Work placement (ref: Hospital agency)	University hospital	1.12	0.65 – 1.95	1.12	0.77 – 1.63	1.23	0.77 – 1.99	0.80	0.44 – 1.45	1.27	0.89 – 1.83	1.12	0.77 – 1.62	1.40	0.96 – 2.04	1.40	0.97 – 2.03	0.87	0.60 – 1.26	0.25	-0.06 – 0.56
	Local health company	0.44	0.18 – 0.98	0.67	0.41 – 1.08	1.01	0.53 – 1.86	1.24	0.63 – 2.40	0.81	0.51 – 1.27	1.20	0.74 – 1.95	0.72	0.45 – 1.15	1.22	0.76 – 1.96	0.92	0.57 – 1.49	-0.18	-0.57 – 0.22
	Territorial services	0.35	0.02 – 1.93	0.48	0.15 – 1.32	0.77	0.11 – 3.05	0.73	0.10 – 3.21	0.77	0.31 – 1.92	0.41	0.13 – 1.13	0.45	0.17 – 1.13	1.56	0.61 – 3.97	0.52	0.17 – 1.42	-0.69	-1.47 – 0.09
Professional role (ref: Physician)	Nurse	2.86**	1.39 – 6.44	2.79***	1.81 – 4.38	1.89*	1.09 – 3.38	2.97**	1.52 – 6.10	1.27	0.85 – 1.89	2.05***	1.35 – 3.10	1.28	0.85 – 1.92	1.65*	1.10 – 2.49	1.41	0.93 – 2.15	0.96***	0.61 – 1.30
	Operator social health	5.19***	1.96 – 13.95	5.12***	2.56 – 10.49	1.24	0.47 – 3.04	2.72	0.92 – 7.71	1.28	0.65 – 2.57	2.53*	1.25 – 5.24	0.79	0.40 – 1.58	1.38	0.69 – 2.78	2.30*	1.14 – 4.71	1.12***	0.53 – 1.70
	Technician	2.25	0.64 – 7.14	2.17*	1.01 – 4.59	0.76	0.21 – 2.29	1.83	0.43 – 6.53	1.38	0.67 – 2.86	2.23*	1.07 – 4.69	1.31	0.63 – 2.80	2.42*	1.16 – 5.09	2.59*	1.24 – 5.45	0.99**	0.37 – 1.62
	Researcher / Student	2.19	0.67 – 6.98	1.70	0.85 – 3.40	0.29*	0.09 – 0.82	1.68	0.53 – 5.07	1.34	0.68 – 2.69	1.24	0.62 – 2.47	1.05	0.53 – 2.11	1.02	0.51 – 2.04	0.81	0.40 – 1.65	0.12	-0.46 – 0.70
	Other	1.09	0.28 – 3.61	2.04*	1.04 – 3.98	1.29	0.49 – 3.19	1.51	0.37 – 5.07	0.78	0.42 – 1.48	1.81	0.94 – 3.50	1.05	0.55 – 2.02	2.11*	1.10 – 4.08	1.46	0.74 – 2.85	0.56*	0.01 – 1.11
Clinical area (ref: Emergency-urgency)	Medical	0.54	0.24 – 1.19	1.27	0.77 – 2.12	1.61	0.85 – 3.11	0.87	0.43 – 1.77	1.08	0.66 – 1.76	0.69	0.41 – 1.15	1.03	0.62 – 1.70	1.03	0.62 – 1.69	1.03	0.63 – 1.69	0.00	-0.42 – 0.42
	Surgical	1.16	0.50 – 2.62	2.02*	1.13 – 3.64	1.27	0.58 – 2.72	0.64	0.24 – 1.55	1.24	0.70 – 2.22	0.63	0.35 – 1.14	0.99	0.55 – 1.79	0.99	0.55 – 1.78	1.04	0.58 – 1.86	0.10	-0.39 – 0.59
	Other	0.97	0.45 – 2.08	1.36	0.81 – 2.28	1.15	0.57 – 2.33	0.67	0.31 – 1.44	1.20	0.73 – 1.98	0.52*	0.31 – 0.87	0.97	0.58 – 1.62	0.69	0.41 – 1.15	0.79	0.48 – 1.32	-0.21	-0.64 – 0.22
ICU Ward (ref: yes)	ICU Ward	1.24	0.60 – 2.66	0.95	0.57 – 1.60	0.59	0.32 – 1.11	0.74	0.38 – 1.45	0.90	0.54 – 1.49	1.04	0.61 – 1.77	1.07	0.63 – 1.81	1.13	0.68 – 1.89	0.79	0.47 – 1.32	-0.16	-0.59 – 0.27

(*continued on next page*)

Table 5 (*continued*)

Risk Predictors	MODEL	Vertigo		Dyspnea		Nausea		Micturition Desire		Retroauricular Pain		Thirst		Discomfort at work		Physical Fatigue		Thermal Stress		Total outcomes	
COVID-19 Ward (ref: yes)	COVID-19 Ward	0.59	0.30 – 1.18	1.04	0.67 – 1.63	0.57*	0.32 – 1.00	0.29***	0.15 – 0.54	0.59*	0.38 – 0.91	0.62*	0.40 – 0.97	0.57*	0.36 – 0.90	0.51**	0.33 – 0.80	0.52**	0.34 – 0.80	-0.92***	-1.29 – − 0.55
PPE used (ref: High risk)	Medium risk	0.92	0.44 – 1.91	1.02	0.63 – 1.66	1.54	0.84 – 2.87	0.49*	0.27 – 0.90	0.81	0.50 – 1.31	0.67	0.41 – 1.09	0.76	0.46 – 1.25	0.68	0.42 – 1.10	0.72	0.45 – 1.15	-0.42*	-0.83 – − 0.02
	Low risk	1.38	0.59 – 3.34	0.79	0.45 – 1.41	1.39	0.65 – 3.02	0.31*	0.12 – 0.76	0.79	0.45 – 1.38	0.47**	0.26 – 0.83	0.80	0.45 – 1.42	0.45**	0.26 – 0.79	0.44**	0.25 – 0.78	-0.74**	-1.22 – − 0.27
	Observations	727		727		727		727		727		727		727		727		727		727	
	AIC	512.064		958.715		638.493		495.523		997.003		947.279		964.084		970.413		946.724		2.916.228	
	R^2 Tjur	0.043		0.066		0.082		0.219		0.043		0.122		0.052		0.099		0.117		R^2 / R^2 adjusted	0.216 / 0.196

* $p < 0.05$ * * $p < 0.01$ * ** $p < 0.001$

for periodic monitoring, screening and specific interventions to prevent adverse events related to HCW long-term mental wellness. Immediate interventions are necessary to increase the levels of psychological support and resilience of HCWs aimed at restoring individual agency and well-being despite the conditions of high stress and the improvement of their work performance. Clinical protocols for mental health related to sleep, resilience, anxiety, should be implemented in order to support the work resilience and wellness of health care professionals.

5. Contributors

GC, PC, RT and CB conceptualized the study, the methodology and contributed to Ethics protocol. CT and CS were responsible for data analysis, interpretation, and reporting. All authors (GC, CT, CB, CS, IMR, MLR, SS, MU, CP, PC, PB and RT) have directly accessed and verified the underlying data reported in the manuscript. IMR, MLR, SS, and MU as Risk Management, contributed to the design of the study and the dissemination of the questionnaire in the health facilities in which they operate. GC is the first author, collected and managed the data, and took care of the initial drafting of the manuscript. PB, CS, CB and RT reviewed and edited the manuscript. PC, RT, and CB contributed to study supervision. All authors read and approved the final version of the manuscript, and accept responsibility for the decision to submit for publication.

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Declaration of Competing Interest

We declare no competing interests.

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Data sharing

All data relevant to the study are included in the article or uploaded as supplementary information. The data consist of deidentified participant data. The data are available from Giuseppe Candido upon request.

Appendix A. Supporting information

Supplementary data associated with this article can be found in the online version at doi:10.1016/j.jiph.2023.05.039.

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