ORIGINAL ARTICLE

Risk of COVID-19 Outcomes among Healthcare Workers: Findings from the Philippine CORONA Retrospective Cohort Study

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ABSTRACT

Objectives. While many healthcare workers (HCWs) contracted COVID-19 during the pandemic, more information is needed to fully understand the potential for adverse health effects in this population segment. The aim of the present study is to examine the association between healthcare worker status and neurologic and clinical outcomes in COVID-19 infected inpatients.

Methods. Using the nationwide database provided by the retrospective cohort Philippine CORONA study, we extracted relevant data and performed a secondary analysis primarily focusing on the presentation and outcomes of healthcare workers. Propensity score matching in a 3:1 ratio was performed to match HCWs and non-HCWs. We performed multiple logistic and Cox regression analyses to determine the relationship between HCWs and COVID-19 clinical outcomes.

Results. We included 3,362 patients infected with COVID-19; of which, 854 were HCWs. Among the HCWs, a total of 31 (3.63%) and 45 (5.27%) had the primary outcomes of in-hospital mortality and respiratory failure, respectively. For both overall and 3:1 propensity-matched cohorts, being an HCW significantly decreased the odds of the following outcomes: severe/critical COVID-19 at nadir; in-hospital mortality; respiratory failure; intensive care unit admission; and hospital stay >14 days.

Conclusion. We found that being an HCW is not associated with worse neurologic and clinical outcomes among patients hospitalized for COVID-19.

Keywords: healthcare worker, COVID-19, SARS-CoV-2, outcomes, cohort study

INTRODUCTION

On December 31, 2019, the government in Wuhan, China reported that they had been treating an outbreak of pneumonia with an unknown cause. This disease was isolated and confirmed to be a new type of coronavirus on January 7 2020 and would eventually come to be known as the coronavirus disease 2019 (COVID-19). On January 13, 2020, reports of the first confirmed cases outside China started trickling in from Japan, South Korea, and Thailand.[1] Due to the rising number of cases and the high public health risk, the World Health Organization (WHO) pronounced

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COVID-19 as a global health emergency on January 30, 2020.[2] On that same day, the first case of COVID-19 was reported in the Philippines.[3] Less than a month and a half later, on March 11, 2020, COVID-19 was declared a global pandemic.[4]

As an emerging disease, knowledge on COVID-19 and its effects were yet to be established. Of particular interest were the neurological manifestations of COVID-19, which became the impetus for the Philippine CORONA study (COVID-19 outcomes: A retrospective study of neurological manifestations and associated symptoms), which included more than 10,000 patients.[5] This study and the information gleaned from it also allowed the researchers to look into other questions on COVID-19, such as how healthcare workers in the Philippines were affected by it, and their outcomes.

Healthcare workers (HCWs) are disproportionately affected by COVID-19,[6] and by pandemics in general.[7] As the frontline workers during these events, they are essential to the provision of care for those affected by illness, and in the course of such an effort, place themselves at higher risk. During the outbreak of Severe Acute Respiratory Syndrome (SARS) in the early 2000s, a large number of cases of secondary and tertiary spread occurred among HCWs.[8] This is quite similar with the current COVID-19 pandemic situation. While HCWs only make up two to three percent of a given country's population, reports show that 14 to 35% of all COVID-19 cases, especially in the early days of the pandemic, occurred among health personnel.[9]

In SARS, the increased infection rates among HCWs were indubitably attributed to increased exposure to respiratory secretions and aerosol-generating procedures, as well as contact with patients during the most contagious phase of their illness.[10] It would stand to reason that COVID-19, a similar respiratory pandemic, would have the same factors contributing to its spread among health workers, alongside lack of awareness of adequate protection of healthcare workers and the systems that govern them, and insufficient supply of protective devices.[11]

As there are multiple variables that affect infection of COVID-19 among HCWs, it stands to reason that clinical outcomes of these patients vary as well. With evidence showing that a high transmission setting of COVID-19 increases the risk of more severe courses of the illness,[12] it is important to investigate the impact of the disease on one of its most affected populations. Thus, this study aimed to determine the association of being an HCW to COVID 19–related outcomes [e.g., mortality, respiratory failure, intensive care unit (ICU) admission, and ICU length of hospital stay] in the Philippine setting.

MATERIALS AND METHODS

From July to December 2022, we performed a secondary analysis of data from the nationwide, multicenter, observational (retrospective cohort) Philippine CORONA study, which involved adult patients with reverse transcription polymerase chain reaction-confirmed COVID-19 infection admitted to one of 37 participating hospitals across the country between February to December 2020.[5] The majority of the hospitals are located in the National Capital Region being the epicenter of the pandemic in the Philippines.[13] Approval from different study sites was obtained prior to data collection, as described in the published protocol (https://pubmed.ncbi.nlm.nih.gov/33257488/).[13]

The following independent variables were extracted and analyzed: HCW status, age, sex, smoking history, comorbidities, presenting symptoms, and inpatient treatments received. HCW was defined as healthcare personnel directly involved in patient care including doctors, nurses, and allied health professionals. We identified the primary outcomes as in-hospital mortality and respiratory failure (patients who experienced clinical symptoms and signs of respiratory insufficiency), and the secondary outcomes as COVID-19 severity at nadir, ICU admission, length of hospital stay (includes length of stay in the emergency room, ICU, and ward), and neurologic outcome on discharge. Neurologic outcome pertains to full or partial recovery from new-onset neurological disorders or complications during admission.

Data analysis was done using Stata version 17.1. Baseline characteristics and clinical outcomes were summarized using descriptive statistics. Numerical variables were described as mean and standard deviation (SD) for normally distributed data based on Shapiro-Wilk test for normality, and as median and IQR for the rest. Categorical variables were described as count and proportion. All independent and dependent variables were compared between HCW and non-HCW. Standardized differences between the two groups were computed using the method of Yange and Dalton, with the following formulae and an absolute standardized difference of >0.1000 considered as significant:

$$d = \frac{(\bar{X}_1 - \bar{X}_2)}{\sqrt{[(S_1^2 + S_2^2)/2]}}$$

for continuous variables, where $\bar{X}_1$ and $\bar{X}_2$ denote the sample mean in each group, and S_1^2 and S_2^2 denote the sample variances, and

$$d = \frac{(\hat{P}_1 - \hat{P}_2)}{\sqrt{\{[\hat{P}_1(1-\hat{P}_1) - \hat{P}_2(1-\hat{P}_2)]/2\}}}$$

for categorical variables, where $\hat{P}_1$ and $\hat{P}_2$ denote sample proportion in each group.[14]

The associations between being an HCW and the different individual dichotomous outcome variables of interest were determined through multivariable binary logistic regression. Survival analysis was also done for time-to-event data on mortality, respiratory failure, and admission to ICU. The time-to-event was right-censored on

time-to-discharge as the exit from the time-at-risk among those who have not experienced the event (i.e., mortality or respiratory failure, admission to ICU, length of hospital stay). The associations between being an HCW and the different time-to-event outcome variables of interest were determined through multivariable Cox proportional hazards regression. The logistic and Cox proportional hazards regression models were adjusted for the following pre-determined confounders: age group, sex, smoking status, hypertension, chronic cardiac disease, chronic respiratory disease, chronic kidney disease, and chronic neurologic disease. A cutoff of p-value <0.05 identifies history of diabetes as significant predictor of the different outcomes of interest.

Another round of analysis was performed on the propensity score-matched cohort. Propensity scores were estimated using a logit model for HCW status with the following covariates: age, sex, smoking status, hypertension, diabetes, chronic cardiac disease, chronic respiratory disease, chronic kidney disease, chronic liver disease, chronic neurologic disease, presenting symptoms, and treatment, dropping all those with missing values for these co-variates of interest (n dropped = 2; for two subjects with missing information on sex). Propensity score matching in a 3:1 ratio was then performed to match patients with confirmed non-HCW status and those with confirmed HCW status, excluding patients with unknown HCW status. Caliper matching without replacement was used, with an a priori caliper width set at 0.25 times the SD of the propensity score.

RESULTS

Out of the overall cohort of 10,881 patients in the Philippine CORONA Study, 876 (8.1%) were HCW. Meanwhile, there were 854 HCWs out of the 3,362 patients included in the 3:1 propensity-matched cohort. No patient had unknown HCW status. The baseline characteristics of both cohorts stratified according to HCW status are presented in Table 1. Regardless of HCW status, most of the patients in the propensity-matched cohort were less than 60 years of age (802, 91.55%), females (476, 54.34%), and non-smokers (823, 93.95%). Hypertension (192, 21.92%) was the most common comorbid condition among HCW and non-HCW. Across all cohorts, cough (398, 45.43%) was the most common non-neurologic presenting symptom, while olfactory or taste dysfunction (128, 14.61%) was the most common neurologic presentation.

All covariates included in the propensity score estimation had absolute standardized difference of <10%. After 3:1 propensity score matching, the following neurologic presentation/acute diagnosis on admission had standardized difference of >10%: more HCW presented with headache than non-HCW; more HCW presented with olfactory and taste dysfunction than non-HCW; and more non-HCW were acutely diagnosed with stroke/CVD during admission than HCW.

After 3:1 propensity score matching, the following outcomes showed standardized difference of >10%: more non-HCW died compared to HCW; time to in-hospital mortality was longer among non-HCW; more non-HCW had respiratory failure; intermittent mandatory ventilation (IMV) dependence was longer among non-HCW (as count variable, but not categorically); more non-HCW had severe/critical COVID-19; hospital stay was longer among non-HCW (both as count and categorical variables); and more HCW had full/partial neurologic recovery (Table 2). On the other hand, all ICU outcomes had standardized difference of <10%.

Our results appeared to be similar in the full cohort and in the 3:1 propensity-matched cohort (Tables 3 and 4). The odds of having the following outcomes were notably decreased among HCW after propensity score matching: severe/critical COVID-19 at nadir (decreased by 32%, p <0.001, 95% CI 0.55—0.84), in-hospital mortality (by 57%, p <0.001, 95% CI 0.29—0.63), respiratory failure (by 46%, p <0.001, 95% CI 0.39—0.75), ICU admission (by 26%, p = 0.03, 95% CI 0.56—0.97), and hospital stay >14 days (by 75%, p <0.001, 95% CI 0.21—0.31) (Table 3). On the other hand, HCW status significantly increased the odds of having a neurologic presentation/complication by 44% (p <0.001, 95% CI 1.21—1.73) and full/partial neurologic improvement by 211% (p = 0.011, 95% CI 1.29—7.48). There was no sufficient evidence to conclude that being an HCW was associated with IMV dependence ≥14 days (p = 0.933, 95% CI 0.51—1.84) and ICU stay >7 days (p = 0.527, 95% CI 0.59—2.77). After performing Cox proportional hazard regression analysis (Table 4), it was found that being an HCW significantly decreased the hazard risk of the following outcomes in the propensity score-matched cohort: in-hospital mortality by 66% (p <0.001, 95% CI 0.24—0.49), respiratory failure by 68% (p <0.001, 95% CI 0.24—0.43), and ICU admission by 53% (p <0.001, 95% CI 0.37—0.60).

DISCUSSION

In this study involving 3,362 inpatients with COVID-19, we found that being an HCW does not seem to be associated with worse neurologic and clinical outcomes. Based on our results, being an HCW significantly decreased the odds of experiencing severe/critical COVID-19 at nadir, respiratory failure, intensive care unit admission, prolonged hospital stay (>14 days), and in-hospital death.

In most respects, the HCW population in the Philippines mirrors that of the rest of the world,[15,16] showing a tendency for admissions among female HCWs aged between 30 to 40 years old. To fully understand the implications of these findings, they must be framed within the specific demographic composition of the healthcare workforce in the Philippines. The majority of the nation's healthcare workers are women (75%) according to statistics collected in 2018. It was also noted that 65% of HCWs

Table 1. Baseline Characteristics Stratified by Healthcare versus Non-healthcare Worker

	Overall Cohort (n = 10881)			3:1 Propensity-matched Cohort† (n = 3362)		
	HCW (n = 876)	Non-HCW (n = 10,005)	Std. Diff.	HCW (n = 854)	Non-HCW (n = 2,508)	Std. Diff.
Socio-demographic data						
Age, median (IQR)	33 (17)	54 (27)	0.9303	35 (21)	34 (18)	0.0500
Age group						
18 – 59 y, n (%)	802 (91.55%)	6245 (62.42%)	0.7376	780 (91.33%)	2235 (89.11%)	0.0748
≥60 y, n (%)	74 (8.45%)	3760 (37.58%)		74 (8.67%)	273 (10.89%)	
Female, n (%), [n=10,879]	476 (54.34%)	4623 (46.22%)	-0.1629	460 (53.86%)	1294 (51.59%)	-0.0455
Ever-smoker (past/current), n (%)	53 (6.05%)	973 (9.73%)	0.1366	53 (6.21%)	167 (6.66%)	0.0184
Clinical characteristics						
Non-neurologic comorbidities						
Hypertension, n (%)	192 (21.92%)	3455 (34.53%)	0.2830	192 (22.48%)	596 (23.76%)	0.0304
Diabetes, n (%)	100 (11.42%)	2091 (20.90%)	0.2598	100 (11.71%)	295 (11.76%)	0.0016
Chronic cardiac disease‡, n (%)	17 (1.94%)	495 (4.95%)	0.1654	17 (1.99%)	48 (1.91%)	-0.0056
Chronic respiratory disease§, n (%)	76 (8.68%)	540 (5.40%)	-0.1284	72 (8.43%)	191 (7.62%)	-0.0300
Chronic kidney disease, n (%)	16 (1.83%)	595 (5.95%)	0.2144	16 (1.87%)	40 (1.59%)	-0.0213
Chronic liver disease, n (%)	2 (0.23%)	58 (0.58%)	0.0554	2 (0.23%)	10 (0.40%)	0.0293
Malignancy, n (%)	6 (0.68%)	238 (2.38%)	0.1382	6 (0.70%)	18 (0.72%)	0.0018
HIV/AIDS, n (%)	3 (0.34%)	34 (0.34%)	-0.0005	3 (0.35%)	6 (0.24%)	-0.0206
Number of non-neurologic comorbidities, median (IQR)	0 (1)	1 (2)	0.3060	0 (1)	0 (1)	-0.0245
Non-neurologic presenting symptom						
Fever, n (%)	376 (42.92%)	3551 (35.49%)	-0.1526	363 (42.51%)	1056 (42.11%)	-0.0081
Cough, n (%)	398 (45.43%)	4013 (40.11%)	-0.1077	386 (45.20%)	1107 (44.14%)	-0.0213
Dyspnea, n (%)	151 (17.24%)	2552 (25.51%)	0.2027	149 (17.45%)	437 (17.42%)	-0.0006
Rhinorrhea, n (%)	135 (15.41%)	472 (4.72%)	-0.3610	119 (13.93%)	282 (11.24%)	-0.0811
Sputum production, n (%)	58 (6.62%)	579 (5.79%)	-0.0346	56 (6.56%)	156 (6.22%)	-0.0138
Sore throat, n (%)	142 (16.21%)	609 (6.09%)	-0.0326	134 (15.69%)	350 (13.96%)	-0.0488
Diarrhea, n (%)	72 (8.22%)	525 (5.25%)	-0.1188	69 (8.08%)	207 (8.25%)	0.0064
Fatigue, n (%)	89 (10.16%)	624 (6.24%)	-0.1433	82 (9.60%)	245 (9.77%)	0.0056
Others, n (%)	127 (14.50%)	1547 (15.46%)	0.0270	123 (14.40%)	332 (13.24%)	-0.0338
Neurologic history or chronic neurologic disease						
Stroke/cerebrovascular, n (%)	13 (1.48%)	308 (3.08%)	0.1069	13 (1.52%)	16 (0.64%)	-0.0856
Epilepsy, n (%)	3 (0.34%)	24 (0.24%)	-0.0190	3 (0.35%)	2 (0.08%)	-0.0586
Degenerative, n (%)	1 (0.11%)	43 (0.43%)	0.0606	1 (0.12%)	2 (0.08%)	-0.0119
Headache syndrome, n (%)	2 (0.23%)	3 (0.03%)	-0.0552	2 (0.23%)	2 (0.08%)	-0.0390
Demyelinating disorder, n (%)	-	2 (0.02%)	0.0200	-	-	-
CNS infection, n (%)	-	5 (0.05%)	0.0316	-	1 (0.04%)	0.0282
PNS disorders, n (%)	1 (0.11%)	14 (0.14%)	0.0072	1 (0.12%)	1 (0.04%)	-0.2757
Neurologic presenting symptom						
Headache, n (%)	101 (11.53%)	506 (5.06%)	-0.2362	99 (11.59%)	174 (6.94%)	-0.1610
Nausea or vomiting, n (%)	9 (1.03%)	149 (1.49%)	0.0414	9 (1.05%)	42 (1.67%)	0.0535
Seizure, n (%)	6 (7.7%)	90 (0.90%)	0.0242	6 (0.70%)	19 (0.76%)	0.0065
Altered mental state, n (%)	13 (41.7%)	505 (5.05%)	0.2015	13 (1.52%)	67 (2.67%)	0.0802
Olfactory or taste dysfunction, n (%)	128 (14.61%)	535 (5.35%)	-0.3127	124 (14.52%)	191 (7.62%)	-0.2213
Dysfunctions of other senses, n (%)	7 (0.80%)	159 (1.59%)	0.0728	6 (0.70%)	48 (1.91%)	0.1067
Bulbar symptoms, n (%)	3 (0.34%)	119 (1.19%)	0.0972	3 (0.35%)	18 (0.72%)	0.0503
Motor symptoms, n (%)	6 (0.68%)	240 (2.40%)	0.1394	6 (0.70%)	40 (1.59%)	0.0838
Sensory symptoms, n (%)	2 (0.23%)	51 (0.51%)	0.0464	2 (0.23%)	9 (0.36%)	0.0229
Myalgia, n (%)	40 (4.57%)	216 (2.16%)	-0.1338	40 (4.68%)	69 (2.75%)	-0.1022
Others, n (%)	2 (0.23%)	31 (0.31%)	0.0157	2 (0.23%)	10 (0.40%)	0.0293

Table 1. Baseline Characteristics Stratified by Healthcare versus Non-healthcare Worker *(continued)*

	Overall Cohort (n = 10881)			3:1 Propensity-matched Cohort† (n = 3362)		
	HCW (n = 876)	Non-HCW (n = 10,005)	Std. Diff.	HCW (n = 854)	Non-HCW (n = 2,508)	Std. Diff.
Concomitant acute neurologic diagnosis or disorder on admission						
Encephalopathy, n (%)	15 (1.71%)	629 (6.29%)	0.2350	15 (1.76%)	83 (3.31%)	0.0989
Symptomatic seizure/ status epilepticus, n (%)	6 (0.68%)	119 (1.19%)	0.0524	6 (0.70%)	21 (0.84%)	0.0154
Stroke/cerebrovascular, n (%)	7 (0.80%)	360 (3.60%)	0.1917	7 (0.82%)	65 (2.59%)	0.1371
CNS infection, n (%)	1 (0.11%)	6 (0.06%)	-0.0184	1 (0.12%)	3 (0.12%)	0.0007
Others, n (%)	2 (0.23%)	12 (0.12%)	-0.0260	2 (0.23%)	3 (0.12%)	-0.0273
Treatment/s received						
Glucocorticoids, n (%)	139 (15.87%)	2705 (27.04%)	0.2746	139 (16.28%)	439 (17.50%)	0.0328
Tocilizumab, n (%)	60 (6.85%)	969 (9.69%)	0.1031	60 (7.03%)	191 (7.62%)	0.0226
Antiviral¶, n (%)	115 (13.13%)	1787 (17.86%)	0.1311	113 (13.23%)	353 (14.07%)	0.0246
Antibacterial, n (%)	503 (57.42%)	8511 (85.07%)	0.6412	498 (58.31%)	1480 (59.01%)	0.0142
Others#, n (%)	349 (39.84%)	3556 (35.54%)	-0.0888	339 (39.70%)	935 (37.28%)	-0.0496

† *Propensity-matched to age, sex, smoking status, hypertension, diabetes, chronic cardiac disease, chronic respiratory disease, chronic kidney disease, chronic liver disease, chronic neurologic disease, presenting symptoms, and treatment.*
‡ *Includes heart failure, coronary artery disease, prior history of myocardial infarction, and other cardiac conditions.*
§ *Includes bronchial asthma, chronic obstructive pulmonary disease (COPD), restrictive lung disease, and other pulmonary conditions.*
¶ *Includes remdesivir, lopinavir, ritonavir.*
# *Includes chloroquine, hydroxychloroquine, convalescent plasma, and other therapies.*

CNS: Central nervous system, HCW: Healthcare worker, HIV/AIDS: Human immunodeficiency virus/ acquired immunodeficiency syndrome, IQR: Interquartile range, PNS: Peripheral nervous system, Std. Diff: Standard difference.

Table 2. Clinical Outcomes of COVID-19 Patients Stratified by Healthcare versus Non-healthcare Worker

Outcomes	Overall Cohort (n = 10,881)			3:1 Propensity-matched Cohort† (n = 3,362)		
	HCW (n = 876)	Non-HCW (n = 10,005)	Std. Diff.	HCW (n = 854)	Non-HCW (n = 2,508)	Std. Diff.
Final outcome						
In-hospital mortality, n (%)	31 (3.54%)	1671 (16.70%)	0.4472	31 (3.63%)	202 (8.05%)	0.1894
Discharged, n (%)	845 (96.46%)	8334 (83.30%)		823 (96.37%)	2306 (91.95%)	
Time to in-hospital mortality in days, median (IQR)	15 (10)	15 (14)	0.4068	15 (10)	16 (12)	0.4416
Respiratory failure, n (%), [n=1,606]	45 (5.14%)	1563 (15.62%)	0.3489	45 (5.27%)	235 (9.37%)	0.1579
Duration of IMV in days, median (IQR)	13 (10)	13 (12)	0.1391	13 (10)	13 (11)	0.1476
IMV dependence <14 days, n (%)	23 (51.11%)	821 (52.59%)	-0.0295	23 (51.11%)	118 (50.43%)	0.0136
IMV dependence ≥14 days, n (%),	22 (48.89%)	740 (47.41%)		22 (48.89%)	116 (49.57%)	
COVID-19 severity at nadir, [n=10,751]						
Mild/moderate, n (%)	735 (84.78%)	5955 (60.25%)	0.5712	714 (84.50%)	1949 (78.68%)	0.1504
Severe/critical, n (%)	132 (15.22%)	3929 (39.75%)		131 (15.50%)	528 (21.32%)	
Admitted to ICU, n (%), [n=1,740]	71 (8.11%)	1669 (16.68%)	0.2625	71 (8.31%)	274 (10.93%)	0.0886
Length of ICU stay in days, median (IQR)	16 (12)	15 (11)	0.1061	16 (12)	15 (11)	0.0436
ICU stay ≤7 days, n (%)	9 (12.68%)	263 (15.76%)	-0.0880	9 (12.68%)	43 (15.69%)	-0.0862
ICU stay >7 days, n (%)	62 (87.32%)	1406 (84.24%)		62 (87.32%)	231 (84.31%)	
Length of hospital stay‡ in days, median (IQR)	11 (5)	13 (9)	0.0413	11 (5)	14 (10)	0.4458
Hospital stay ≤14 days, n (%)	735 (83.90%)	5842 (58.39%)	0.5867	714 (83.61%)	1409 (56.18%)	0.6263
Hospital stay >14 days, n (%)	141 (16.10%)	4163 (41.61%)		140 (16.39%)	1099 (43.82%)	
Neurologic outcome on discharge§, [n=1,905]						
Full/partial neurologic recovery, n (%)	227 (97.42%)	1412 (84.45%)	-0.4637	222 (97.37%)	440 (92.24%)	-0.2322
No recovery, n (%),	6 (2.58%)	260 (15.55%)		6 (2.63%)	37 (7.76%)	

† *Propensity-matched to age, sex, smoking status, hypertension, diabetes, chronic cardiac disease, chronic respiratory disease, chronic kidney disease, chronic liver disease, chronic neurologic disease, presenting symptoms, and treatment.*
‡ *Derived from overall length of stay for patients who were never admitted to ICU; excludes ICU length of stay for those who were admitted in the ICU.*
§ *Patients who had a neurologic presentation or concomitant acute neurologic diagnosis on admission (n = 2291).*

HCW: Healthcare worker, ICU: Intensive care unit, IMV: Intermittent mandatory ventilation, IQR: Interquartile range, Std. Diff: Standard difference

are under the age of 35, and less than five percent of health workers in the Philippines are at or above 60 years of age.[17]

Overall, we found that the probability of in-hospital death, respiratory failure, and ICU admission was considerably lower among hospitalized HCW patients compared to non-HCWs. These findings are similar to those found in investigations performed in other countries,[15,16,18] although most were performed in unmatched populations. In a propensity score-matched study performed in North America, HCWs were also significantly less likely to require admission into an ICU, and also had a shorter length of hospitalization.[19]

One of the prevailing explanations why HCWs seem to have better outcomes in most studies on COVID-19 than their non-HCW counterparts is the *Healthy Worker Effect*, where the actively employed is shown to have a tendency towards a more favorable mortality outcome than the population at large since those who are not considered "healthy," such as the elderly or persons with illnesses, are less likely to be employed.[20] This is exemplified by the base data taken from the Philippine CORONA study, where there were fewer patients with comorbidities among health workers hospitalized. However, through propensity score matching, the effect and ultimately the risk for selection bias are mitigated, and as such it seems that there are other fundamental differences between the HCW and non-HCW population than what is immediately apparent. Some postulate that health personnel have better access to healthcare, leading to a more timely diagnosis and initiation of intervention, thus preventing their decline in health status or death.[21] Other possibilities may include HCWs being generally better informed than the rest of the population on the illness, and may have better adherence to the proper usage of protective personal equipment (PPE) and safety protocols,[19] although there is still a paucity of literature to support these claims. Furthermore, hospitals may have reassigned HCWs potentially at greater risk of contracting COVID-19, such as older employees and those with comorbidities, to jobs that were less "risky," such as support or administrative work, telemedicine, or responsibilities in non-COVID wards.

Regarding the strengths of our study, our data can contribute to the limited literature on the impact of

Table 3. Association of being a Healthcare Worker to the Different Outcomes of Interest

Outcomes†	Overall Cohort (n = 10,881)			3:1 Propensity-matched Cohort§ (n = 3,362)		
	Adj. OR‡	95% CI	p-value	OR	95% CI	p-value
Severe/critical COVID-19 at nadir	0.45	0.37, 0.56	<0.001	0.68	0.55, 0.84	<0.001
Full/partial neurological improvement	4.59	1.99, 10.6	<0.001	3.11	1.29, 7.48	0.011
In-hospital mortality	0.30	0.21, 0.43	<0.001	0.43	0.29, 0.63	<0.001
Respiratory failure	0.40	0.29, 0.54	<0.001	0.54	0.39, 0.75	<0.001
IMV dependence ≥14 days	1.02	0.56, 1.85	0.960	0.97	0.51, 1.84	0.933
ICU admission	0.59	0.45, 0.76	<0.001	0.74	0.56, 0.97	0.030
ICU stay >7 days	1.24	0.61, 2.55	0.552	1.28	0.59, 2.77	0.527
Hospital stay >14 days	0.27	0.22, 0.32	<0.001	0.25	0.21, 0.31	<0.001

† *Individual univariate logistic regression analysis with independent variable healthcare worker.*
‡ *Adjusted for age group, sex, smoking history, hypertension, diabetes, chronic cardiac disease, chronic kidney disease, chronic respiratory disease, and chronic neurologic disease.*
§ *Propensity-matched to age, sex, smoking status, hypertension, diabetes, chronic cardiac disease, chronic respiratory disease, chronic kidney disease, chronic liver disease, chronic neurologic disease, presenting symptoms, and treatment*

CI: Confidence interval, ICU: Intensive care unit, IMV: Intermittent mandatory ventilation, OR: Odds ratio.

Table 4. Association of being a Healthcare Worker to the Different Outcomes of Interest (time-to-event analysis)

Outcomes†	Overall Cohort (n = 10,881)			3:1 Propensity-matched Cohort§ (n = 3,362)		
	Adj. HR‡	95% CI	*p*-value	HR	95% CI	*p*-value
Mortality	0.48	0.34, 0.69	<0.001	0.34	0.24, 0.49	<0.001
Respiratory failure	0.44	0.32, 0.59	<0.001	0.32	0.24, 0.43	<0.001
ICU admission	0.63	0.49, 0.80	<0.001	0.47	0.37, 0.60	<0.001

† *Individual univariate Cox proportional hazard regression analysis with independent variable healthcare worker.*
‡ *Adjusted for age group, sex, smoking history, hypertension, diabetes, chronic cardiac disease, chronic kidney disease, chronic respiratory disease, and chronic neurologic disease.*
§ *Propensity-matched to age, sex, smoking status, hypertension, diabetes, chronic cardiac disease, chronic respiratory disease, chronic kidney disease, chronic liver disease, chronic neurologic disease, presenting symptoms, and treatment.*

CI: Confidence interval, HR: Hazard ratio, ICU: Intensive care unit.

COVID-19 on clinical outcomes of hospitalized HCWs versus non-HCWs in the Philippines, taking into consideration multiple factors including age, sex, smoking status, comorbidities, presenting status, and treatment. To date, our study is one of the largest studies in the literature comparing the outcomes of the two populations. After an extensive search in PubMed performed in July 2023, it is also the first study performed of the sort in an Asian country.

Some limitations of this study include a few missing data, and the lack of information under the label of a HCW, as different risks are involved across specific work-related roles (i.e., if one is patient-facing or not).[22] The degree of patient exposure is also a consideration; although the highest risk of severe COVID-19 was faced by healthcare professionals, a study in the United Kingdom showed that the highest affected sub-category within this group is medical support staff, which includes nursing assistants and porters, followed by nurses, paramedics, doctors, and pharmacists.[23] This study was also unable to take into consideration HCWs and non-HCWs who were not hospitalized. This may be particularly important, as many individuals were forced to recover at home or elsewhere due to the massive burden on hospitals and healthcare system in general.[24] Another limitation would be the period this study was performed and the evolving nature of COVID-19. Since this investigation's data collection period in 2020, there have been multiple developments in the fight against this disease, with the discovery of the COVID-19 variants, the changing restrictions on social engagements, breakthroughs in COVID-19 management, and the distribution of vaccines.

CONCLUSION

In summary, our results show that being an HCW in the Philippines is not associated with an increased risk of various poor COVID-19 outcomes, and is instead linked to lower risk of mortality, respiratory failure, and ICU admission. The variations in healthcare access between HCWs and non-HCWs and the knowledge gaps that may have contributed to better outcomes in healthcare personnel warrant further research.

Statement of Authorship

All authors certified fulfillment of ICMJE authorship criteria.

Author Disclosure

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