

Clinical Characteristics and Mortality of Healthcare Workers with SARS-CoV-2 infection in
Mexico City

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Summary:

Among 125,665 patients with SARS-CoV-2 infection in Mexico City, 13.1% were healthcare workers
(HCW). Deaths in non-HCW were significantly higher than in HCW, and the risk of death after
adjusting for age, sex and comorbidities, remained higher in non-HCW.

ABSTRACT

Background: We evaluated the risk of death of healthcare workers (HCW) with SARS-CoV-2 infection in Mexico City during the COVID-19 pandemic and described the associated factors in hospitalized HCW compared with non-HCW.

Methods: We analyzed data from laboratory-confirmed SARS-CoV-2 cases registered from February 27-August 31, 2020 in Mexico City's public database. Individuals were classified as non-HCW and HCW (subcategorized as physicians, nurses and other HCW). In hospitalized individuals, a multivariate logistic regression model was used to analyze potential factors associated with death and compare mortality risk among groups.

Results: A total of 125,665 patients were included. Of these, 13.1% were HCW (28% physicians, 38% nurses and 34% other HCW). Compared with non-HCW, HCW were more frequently female, younger and free of comorbidities. Overall, 25,771 (20.5%) were treated as inpatients and 11,182 (8.9%) deaths were reported. Deaths in the total population and in hospitalized patients were significantly higher in non-HCW than in HCW (9.9% vs 1.9%, $P<.001$; and 39.6% vs 19.3%, $P<.001$, respectively). In hospitalized patients, using a multivariate model, the risk of death in HCW in general was lower (OR 0.53) compared to non-HCW, and by specific occupation, in physicians, nurses and other HCW risk was OR 0.60, 0.29, 0.61, respectively.

Conclusions: HCW represent an important proportion of individuals with SARS-CoV-2 infection in Mexico City. While the mortality risk in HCW is lower compared with non-HCW, a high mortality rate in hospitalized patients was observed in this study. Among HCW, nurses had lower risk of death compared to physicians and other HCW.

Keywords: Healthcare workers, SARS-CoV-2, COVID-19, mortality

INTRODUCTION

On December 31, 2019, a cluster of pneumonia cases was reported in Wuhan, China.[1] The cause was later identified as the novel severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), and the disease was named “coronavirus disease 2019” (COVID-19).[2,3] On January 20, 2020, the announcement of human-to-human transmission was made alongside of the first report of infections among healthcare workers.[4] The first imported case of COVID-19 in Mexico was reported on February 27, 2020. Then, on March 24, 2020, local transmission was confirmed, and lockdown measures were initiated.[5] As of August 30, 2020, with 585,738 confirmed cases and 63,146 deaths, Mexico is the third country with more deaths in the Americas, where the pandemic is most active currently, just behind the United States of America (USA) and Brazil.[6]

Globally, healthcare workers (HCW) are at high risk of SARS-CoV-2 infection.[7,8] Since the beginning of the outbreak, studies have reported different proportions of affected HCW, ranging from 3.8% in China and USA, to 10% in Italy, leading to further loss of workforce capacity to respond to this emergency.[4,8–12] Shortage of personal protective equipment (PPE) also exacerbated this crisis in cities like Lombardy (Italy), Madrid (Spain), New York City (USA), among others.[11] Although Mexico has the lowest testing rate per 1000 habitants in the region and one of the highest positivity rates in the world, of those tested until June 16, 2020, HCW represented 21% of all individuals with laboratory-confirmed SARS-CoV-2 in Mexico.[13–15] Moreover, according to an investigation report that used the Federal Government data, the death rate of confirmed SARS-CoV-2 cases in Mexican HCW was 26 per 1000 individuals, over 5 times the rate in US.[15]

A metanalysis of 15 studies addressing the burden of SARS-CoV-2 infection on HCW, and 3 studies addressing risk factors for infection revealed that HCW accounted for a significant proportion of

infections across studies and experienced high incidence of infection after unprotected exposure.[16] Based on 12 studies, no difference in risk of acquiring SARS-CoV-2 between nurses and physicians was found. Remarkably, illness severity was lower than in non-HCW, probably due to younger age and fewer comorbidities. However, authors conclude that evidence on SARS-CoV-2 infections in HCW is scarce and many studies have methodological limitations, suggesting that large cohort studies of infected HCW are still needed.[16]

This study evaluated risk of death of HCW with SARS-CoV-2 infection in Mexico City from February 27, 2020 to August 31, 2020 through a public database and described associated risk factors for death and mortality risk in hospitalized HCW (differentiating between physicians, nurses and other HCW) compared to non-HCW.

METHODS

We extracted data from Mexico City's Government database of suspected and confirmed SARS-CoV-2 cases in Mexico City, which is an open-source dataset, daily updated by the National Epidemiological Surveillance System (SINAVE, for its acronym in Spanish).[17] This database was downloaded on September 9, 2020.

All laboratory-confirmed SARS-CoV-2 cases from February 27 to August 31, 2020 were included in this analysis. A laboratory-confirmed SARS-CoV-2 case, according to the Ministry of Health's definition, is an individual who in the last 7 days has presented at least two of the following: fever, cough or headache, accompanied by any of the following: chest pain, rhinorrhea, dyspnea, arthralgias, myalgias, sore throat or conjunctivitis, and has a positive result of a SARS-CoV-2 polymerase chain reaction test on a nasopharyngeal and oropharyngeal swab, bronchoalveolar lavage fluid or tracheal aspirate specimens from a certified laboratory by the National Institute for Diagnosis and Epidemiological Referral.[18]

The public database includes clinical and demographic information on admission for all registered cases. For the present study, we included relevant variables such as age, sex, occupation, type of institution of care (facilities of the Ministry of Health, facilities of the Social Security system [IMSS] or [ISSSTE], other public institutions and private institutions), municipality of residency (options available were Mexico City, the state of Mexico and other states), date of symptom onset, date of first evaluation, comorbidities (diabetes, chronic obstructive pulmonary disease [COPD], asthma, immunosuppression, hypertension, cardiovascular disease, obesity, chronic kidney disease [CKD]), current smoking, treatment setting (outpatient or hospitalized), diagnosis of pneumonia, outcomes (ICU admission, invasive mechanical ventilation and death), and date of death. Outcomes in the database are updated upon report capacity from each medical institution to the SINAVE.

We classified positive SARS-CoV-2 individuals from the original dataset, as HCW and non-HCW and compared both groups in terms of age, sex, treatment setting, number of comorbidities, current smoking, state of residency, and type of medical institution of care. HCW were further categorized in three groups: 1) medical doctors or physicians, 2) nurses, 3) other healthcare workers (including dentists, laboratory's workers and other HCW). We documented the number and percentage of deaths by occupation. According to previous reports, diabetes, obesity and hypertension have been associated to severity of the disease and lethality.[8,19,20] Therefore, obesity, diabetes and hypertension were considered "key comorbidities" and were tallied together as "One" or "Two or more" depending on the number of these comorbidities present on each patient. All other comorbidities, such as immunosuppression, HIV, cancer, COPD, asthma, cardiovascular disease and CKD, were grouped as "Others". Descriptive statistics were performed on demographic and clinical variables. Continuous variables were reported as medians and interquartile range (IQR) according to distribution. Categorical variables were reported as numbers and percentages. Group comparisons were performed using Kruskal-Wallis test for continuous variables and the Fisher test of X^2 when

appropriate for categorical variables. A two-sided P value $<.05$ was considered statistically significant.

To avoid bias of better access to testing and health services in HCW that would translate in more registered cases of mild severity in this group, only hospitalized patients were further analyzed. To compare the risk of death among groups, we analyzed the potential factors associated to death using a multivariable logistic regression model in the hospitalized group (non-HCW vs HCW and then non-HCW vs HCW by specific occupation: physicians, nurses and other HCW). We used splines with 4 knots for age and time from symptom onset to first evaluation variables. Subsequently, to compare hospitalized HCW and non-HCW using similar groups in terms of their sociodemographic and clinical characteristics, we selected a sample of the non-HCW matching age, sex, comorbidities, current smoking, state of residence and time from symptom onset to first evaluation, with those on the HCW, and repeated the logistic regression model analysis. This type of analysis fits the data to reduce the relation among the treatment group (in this case the occupation) and the independent variables (age, sex, comorbidities), and eliminates the dependence of the response (death) with the model selected.[21,22] For this analysis, we used the MatchIt package in R in the optimal matching option.[22] Results are expressed as odds ratios (OR) and 95% confidence intervals (CI). Data analyses were performed in R version 3.6.1 (2019-07-05). Our Institutional Board Review does not require formal review for analysis of public use data.

RESULTS

A total of 125,665 confirmed SARS-CoV-2 cases were registered in Mexico City from February 27 to August 31, 2020. As shown in Table 1, 16,446 (13.1%) were HCW and 109,219 (86.9%) were non-HCW. At the time of analysis, a total of 11,182 (8.9%) individuals had died, 321 HCW and 10,861 non-HCW, representing 1.9% (321 of 16,446) deaths in HCW and 9.9% (10,861 of 109,219) in non-HCW, $P < 0.001$. Among deceased HCW, 148 (46.1%) were physicians, 42 (13.1%) were nurses and 131 (40.8%) were other HCW. Of those who died, 9,951 (88.9%) were hospitalized and 1,231 (11.1%) were outpatients.

Compared with non-HCW, HCW were mostly females (61.1% vs 46.6%, $P < 0.001$), younger (median [IQR] age, 38 [31-47] years vs 45 [32-57] years, $P < 0.001$), and were more frequently free of underlying conditions (66.5% vs 60.6%, $P < 0.001$). Overall, 48,578 (38.7%) had at least one comorbidity. The most frequently reported were obesity (17.7%) and hypertension (16.3%), followed by diabetes (13.5%). Diabetes and hypertension were more frequent in non-HCW compared with HCW (14.5% vs 6.9%, $P < 0.01$; and 17.2% vs 10.4%, $P < 0.01$, respectively). A total of 99,894 (79.5%) patients were treated as outpatients and 25,771 (20.5%) as inpatients. The median time from symptom onset to first evaluation was 4 (IQR 2-7) days overall but differed among groups: 3 (IQR 2-6) days in HCW, and 4 (IQR 2-7) days in non-HCW, $P < 0.001$.

Clinical and demographic characteristics among inpatients

To avoid bias due to a better access to testing and healthcare services in HCW that would traduce in a higher proportion of mild cases in the HCW group, only hospitalized patients were further analyzed. Of the 25,771 patients treated as inpatients, 24,461 (94.9%) were non-HCW and 1,310 (5.1%) HCW. A total of 9,951 deaths occurred among the hospitalized group. Of these, 253 were

HCW and 9,698 were non-HCW, representing 19.3% (253 of 1310) deaths in HCW and 39.6% (9,698 of 24,461) deaths in non-HCW, $P < .001$.

Patients in the HCW group were more frequently female (44.4% vs 36.4%, $P < .001$), younger (median [IQR] age, 46 [37-56] years vs 58 [47-68] years; $P < .001$), and had a higher proportion of individuals without comorbidities (48.5% vs 38.7%, $P < .001$), compared with non-HCW (Table 2). Non-HCW had a higher proportion of two or more comorbidities than patients from the HCW group (24.4% vs 16.5%, $P < .001$). The median time from symptom onset to first evaluation was significantly shorter among HCW compared to non-HCW (median [IQR] days, 4 [1-7] vs 5 [1-7], $P < .01$).

Factors associated to death and mortality risk among inpatients

Among inpatients with COVID-19 in the multivariate model of HCW vs non-HCW, HCW had a lower risk of death OR 0.53 [95% CI: 0.46-0.61], $P < .001$, independently of age, sex, number of comorbidities and type of institution of care (Supplementary Table 1).

By specific occupation within HCW and compared to non-HCW, the odds ratios for death were lower in physicians (OR 0.60 [95% CI: 0.48-0.75], nurses (OR 0.29 [95% CI: 0.20-0.42] and other HCW (OR 0.61 [95% CI: 0.49-0.77]), $P < .001$. Males had higher risk of death (OR 1.60 [95% CI: 1.51-1.69], $P < .001$) compared to females. Older age was also associated to higher risk of death (50 vs 30 years OR 2.31 [95% CI: 2.10-2.54]; 60 vs 30 years OR 3.65 [95% CI: 3.31-4.01], $P < .001$). The number of comorbidities present conferred a higher risk of death (one OR 1.26 [95% CI: 1.18-1.34], two or more OR 1.47 [95% CI: 1.37-1.58], and others OR 1.24 [95% CI: 1.08-1.41], $P < .001$) compared with not having any comorbidity. Current smoking and state of residence were not significantly associated to death; whereas, the risk of death was significantly lower in certain institutions (Supplementary Table 2). Adjusted probability of death by age and specific occupation is shown in Figure 1A.

Since there were important differences in the baseline characteristics of HCW and non-HCW regarding factors known to influence risk of death, we matched the 1,310 HCW with the same number of randomly selected individuals in non-HCW by age, sex and comorbidities, current smoking, state of residence and time from symptom onset to first evaluation. We provide details of the characteristics of original and matched samples among HCW and non-HCW in the Supplementary Table 3. In this analysis, the risk factors for death were similar to those in the multivariate analysis presented above (Supplementary Table 2). In particular, by specific occupation and compared to non-HCW, the odds ratios for death in HCW were lower in physicians (OR 0.59 [95% CI: 0.45-0.78]), nurses (OR 0.32 [95% CI: 0.22-0.48]) and other HCW (OR 0.62 [95% CI: 0.47-0.81]), $P < .001$. Adjusted probability of death by age and specific occupation for the matched sample is shown in Figure 1B.

DISCUSSION

In this study of confirmed SARS-CoV-2 cases in Mexico City, up to 13% of all infected individuals were HCW, one of the highest proportions of infection reported in HCW globally [4,8,9,11]. Overall, HCW in this study were mostly young, females, with no underlying diseases, as previously described in other reports. [9,16] Using the publicly available database from the Mexico City government that registers all confirmed cases of COVID-19 since the beginning of the epidemic, we found lower mortality in HCW compared to non-HCW. This finding was significant both overall and for hospitalized patients. Available data from other countries report rates of death among HCW with SARS-CoV-2 infection of 0.3%, 0.3-0.6% and 0.2-0.5% in China, USA and Germany, respectively. In contrast, this analysis showed a fatality rate in Mexican HCW of 1.9% for all HCW and 19.3% for inpatients. [9,12,23]

As reported previously, the usually described factors such as being male, older age and having comorbidities were clearly associated with higher rates of mortality in this study. [12,24] Adjusting for these factors, in the multivariate model, the risk of death for all HCW was lower than in non-HCW. Among the HCW, the nurses had a lower risk compared to physicians and other HCW. Nurses

were younger, more commonly female, had lower frequency of diabetes and had a slight but higher frequency of obesity. In a separate analysis HCW and non-HCW were matched by age, sex and comorbidities, and the lower risk of death in HCW overall and nurses, in particular, persisted.

Explanations for lower risk of death in HCW in general probably derive from a better access to testing and health services and to lower prevalence of associated risk factors. Even in the hospitalized population a lower threshold to admit HCW with mild disease may account for the lower mortality. Information on disease severity on admission was not available in the database, therefore we did not analyze this aspect. If this were the case, this may be due to low testing among the general population with access to testing mostly in the context of symptomatic disease and selection of more severe cases in those with confirmed COVID-19. The fact that non-HCW had a small, but significantly higher median of days from symptoms to diagnosis, could support the former assumption. The lower risk of death observed in nurses compared to physicians and other HCW is not easily explained. A recent study on German HCW with SARS-CoV-2 found a 2-fold rate of severe illness on physicians compared to other HCW.[23] The authors suggest that testing and reporting behavior could differ among occupational groups, proposing an underreport of non-severe disease in physicians. Furthermore, SARS-CoV-2 high viral load has been associated with severe clinical outcomes, higher risk of intubation and mortality.[25,26] Specific activities in which physicians may be exposed to higher inoculum needs to be explored in appropriately conducted studies.

Our study has several limitations. First, the source of the information is a public database with not well-established quality control or validation procedures, registry delays and lack of some information that may influence risk of death such as severity of illness on admission. Second, this database had several missing data regarding mechanical intubation and admission to the intensive care unit (ICU), thus these variables were not analyzed. Information regarding the need and access to mechanical intubation among groups would help to elucidate if differences in mortality could be partially explained by a prioritization of allocation of this limited resource to HCW, as has been

recommended.[27] Third, information about HCW's exposure (nosocomial, household, community or multiple exposures) is not reported. Up to 25% of HCW in the Mexico City Hospitals were on paid leave due to presidential order that included people with high risk factors for severe COVID-19 (unpublished data). Fourth, details of specific occupation, place of work and the availability of EPP are also unknown and could explain differences within the groups of study. Fifth, although HCW are considered essential workers, due to a presidential order released on March 23, 2020, all employees on high risk of severe illness from COVID-19 (age >65 years, pregnant women, people with comorbidities or disabilities) were able to request a paid leave.[28] Therefore, younger individuals with fewer comorbidities could be overrepresented among the HCW evaluated in this study. Nevertheless, the robust size of the sample and the analysis through various statistical techniques may balance some of the potential confounders and bias in the present study.

CONCLUSION

HCW in Mexico have been severely affected by the COVID-19 pandemic, with a high proportion of infection among the total number of cases and with a high fatality rate. The increasing number of ill and quarantined HCW could endanger functioning of the already overburdened healthcare system. In this study in Mexico City, we found a high mortality rate in hospitalized patients, with a lower mortality risk in HCW compared with non-HCW. This could reflect earlier testing, easier access to care and lower frequency of comorbidities in this group. Differences in mortality risk within HCW groups, raise important questions which may provide the bases for further research.

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TABLES

Table 1. Characteristics of all HCW and non-HCW with SARS-CoV-2 infection.

Characteristic	Patients, No. (%)			P Value
	All (N=125665)	HCW (n =16446)	Non-HCW (n=109219)	
Age, median (IQR), y	44 (32 – 56)	38 (31 – 47)	45 (32 – 57)	< .001
Sex				
Female	60890 (48.4)	10042 (61.1)	50848 (46.6)	< .001
Male	64775 (51.6)	6404 (38.9)	58371 (53.4)	
Occupation				
Physicians	4609 (3.7)	4609 (28.0)	-	< .001
Nurses	6240 (5.0)	6240 (38.0)	-	
Other HCW	5597 (4.4)	5597 (34.0)	-	
Non-HCW	109219 (86.9)	-	109219 (100)	
Number of comorbidities*				
None	77087 (61.3)	10931 (66.5)	66156 (60.6)	< .001
One	29417 (23.4)	3524 (21.4)	25893 (23.7)	
Two or more	13889 (11.1)	1033 (6.3)	12856 (11.8)	
Others	5272 (4.2)	958 (5.8)	4314 (3.9)	
Key comorbidities				
Obesity	22272 (17.7)	2915 (17.7)	19357 (17.7)	1
Hypertension	20553 (16.3)	1706 (10.4)	18847 (17.2)	< .01
Diabetes	16922 (13.5)	1128 (6.9)	15794 (14.5)	< .01
Current smoking	13439 (10.7)	1534 (9.3)	11905 (10.9)	< .001
Treatment setting				
Outpatient	99894 (79.5)	15136 (92.0)	84758 (77.6)	< .001
Inpatient	25771 (20.5)	1310 (8.0)	24461 (22.4)	
State of residence				
Mexico City	102216 (81.3)	7123 (76.3)	31961 (81.2)	< .001
State of Mexico	21781 (17.3)	2143 (22.9)	6975 (17.7)	
Other states	1667 (1.3)	72 (0.8)	449 (1.1)	
Type of Institution of care				
Ministry of Health	84468 (67.2)	7610 (46.3)	76858 (70.4)	< .001
IMSS	29441 (23.4)	7344 (44.6)	22097 (20.2)	
ISSSTE	3516 (2.8)	718 (4.4)	2798 (2.6)	
Other public	4636 (3.7)	461 (2.8)	4175 (3.8)	
Private	3604 (2.9)	313 (1.9)	3291 (3.0)	
Onset of symptom to first evaluation, median (IQR), d	4 (2 – 7)	3 (2 – 6)	4 (2 – 7)	< .001
Deaths	11182 (8.9)	321 (1.9)	10861 (9.9)	< .001

*Key comorbidities (obesity, diabetes and hypertension) were tallied together as “One” or “Two or more” depending on the number of conditions present on each patient. Comorbidities such as immunosuppression, HIV, cancer, COPD, asthma, cardiovascular disease and CKD, were grouped as “Others”. The P values were obtained from X² tests for distribution differences among groups.

Table 2. Characteristics of HCW and non-HCW hospitalized for SARS-CoV-2 infection.

Characteristic	Patients, No. (%)					P value
	Non-HCW (n=24461)	All HCW (n=1310)	Physicians (n=498)	Nurses (n=364)	Other HCW (n=448)	
Age, median (IQR)	58 (47 – 68)	46 (37 – 56)	48 (37 – 60)	43 (34 – 50)	48 (39 – 56)	< .001
Sex						< .001
Female	8914 (36.4)	582 (44.4)	134 (26.9)	264 (72.5)	184 (41.1)	
Male	15547 (63.6)	728 (55.6)	364 (73.1)	100 (27.5)	264 (58.9)	
Number of comorbidities*						< .001
None	9471 (38.7)	636 (48.5)	241 (48.4)	179 (49.2)	216 (48.2)	
One	7739 (31.7)	378 (28.9)	131 (26.3)	120 (33.0)	127 (28.4)	
Two or more	5975 (24.4)	216 (16.5)	94 (18.9)	43 (11.8)	79 (17.6)	
Others	1276 (5.2)	80 (6.1)	32 (6.4)	22 (6.0)	26 (5.8)	
Key comorbidities						
Obesity	5584 (22.8)	336 (25.6)	121 (24.3)	103 (28.3)	112 (25.0)	0.05
Diabetes	7253 (29.6)	235 (17.9)	101 (20.3)	45 (12.4)	89 (19.9)	< .001
Hypertension	8028 (32.8)	286 (21.8)	123 (24.7)	64 (17.6)	99 (22.1)	< .001
Current smoking	2541 (10.4)	116 (8.8)	43 (8.6)	31 (8.5)	42 (9.4)	0.34
State of residence						0.19
Mexico City	18258 (74.6)	962 (73.4)	370 (74.3)	265 (72.8)	327 (73.0)	
State of Mexico	5496 (22.5)	315 (24.0)	109 (21.9)	93 (25.6)	113 (25.2)	
Other states	707 (2.9)	33 (2.6)	19 (3.8)	6 (1.6)	8 (1.8)	
Type of Institution of care						< .001

Ministry of Health	7146 (29.2)	346 (26.4)	160 (32.1)	85 (23.3)	101 (22.5)	
IMSS	11968 (48.9)	575 (43.9)	170 (34.1)	170 (46.7)	235 (52.4)	
ISSSTE	2501 (10.2)	276 (21.1)	110 (22.1)	81 (22.2)	85 (18.9)	
Other public	1911 (7.8)	76 (5.8)	36 (7.2)	23 (6.3)	17 (3.8)	
Private	935 (3.8)	37 (2.8)	22 (4.4)	5 (1.4)	10 (2.2)	
Onset of symptom to first evaluation, median (IQR), d	5 (1 – 7)	4 (1 – 7)	5 (1 – 7)	3 (1 – 7)	4 (1 – 8)	0.001
Deaths	9698 (39.6)	253 (19.3)	116 (23.3)	33 (9.1)	104 (23.2)	< .001
*Key comorbidities (obesity, diabetes and hypertension) were tallied together as “One” or “Two or more” depending on the number of conditions present on each patient. Comorbidities such as immunosuppression, HIV, cancer, COPD, asthma, cardiovascular disease and CKD, were grouped as “Others”. The <i>P</i> values were obtained from X^2 tests for distribution differences of non-HCW vs each group of HCW.						

FIGURE LEGENDS

Figure 1. Adjusted Probability of Death by Age and Occupation. *Adjusted for sex (male), number of comorbidities (two or more), state of residence (Mexico City), type of institution of care (IMSS) and time from symptom initiation to evaluation (4 days).

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Figure 1

