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Original Research

COVID-19 fatality in Mexico's indigenous populations

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ABSTRACT

Objective: The aim of the study was to explore the factors that could explain the differences in fatality rates among indigenous groups with COVID-19 diagnosis compared with the rest of the population in Mexico.
Study design: We analyzed the public data of COVID-19 surveillance, of the Mexican Ministry of Health, to estimate COVID-19 fatality rates by ethnicity.
Methods: We explored associated factors using Cox proportional hazards models stratified by outpatient and hospital management at diagnosis; analysis was conducted in three scenarios: national level, states with 89% of the indigenous population, and South Pacific region.
Results: A total of 412,017 COVID-19 cases were included, with 1.1% of the indigenous population. The crude fatality rate per 1000 person-weeks was 64.8% higher among indigenous than among non-indigenous people (29.97 vs. 18.18, respectively), and it increased more than twice within outpatients (5.99 vs. 2.64, respectively). Cox analysis revealed that indigenous people who received outpatient management had higher fatality rate than non-indigenous outpatients, at the national level (hazard ratio [HR] = 1.63; 95% confidence interval [CI] = 1.34–1.98), within the subgroup of 13 states (HR = 1.66; 95% CI = 1.33–2.07), and in the South Pacific region (HR = 2.35; 95% CI = 1.49–3.69). Factors associated with higher fatality rates among non-indigenous and indigenous outpatients were age, sex, and comorbidities.
Conclusions: COVID-19 fatality is higher among indigenous populations, particularly within cases managed as outpatients.

Introduction

The severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) pandemic has more serious repercussions in vulnerable groups: older people with comorbidities, homeless people, pregnant women, and ethnic minority groups.[1–3] There are more than 476 million indigenous people in the world, which represent around 6% of the worldwide population,[4,5] and in Mexico, it is 10% of the total population.[6,7]

Indigenous populations are frequently affected by various crises owing to the economic and social conditions they live in. Their communities are usually isolated or poorly communicated, with poor access to health services. In many cases, such health services have little capacity and limited coverage, which may delay seeking medical attention, complicating early management and, therefore, leading to greater risks of complications and mortality. Health disparities have been documented among ethnic minority groups that have a higher prevalence of metabolic disorders, such as diabetes.[8]

The living conditions of indigenous populations in Mexico could place them in a higher impact of the SARS-CoV-2 epidemic. The number of deaths can be used as a key indicator of the trajectory of COVID-19 in our country.[9–11] Various studies have identified factors associated with lower survival in patients with COVID-19: men, more than 65 years old, and the presence of chronic comorbidities.[12–14] Among indigenous populations, the COVID-19 fatality of 18.8% was reported, compared with 11.8% in the general population. Nevertheless, the causes and risk factors that may be associated with mortality were not analyzed.[15] It is necessary to investigate in more detail how the epidemic is differentially affecting indigenous populations owing to socio-demographic differences, comorbidities, and the type of management received.

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We aim to explore those factors that could explain the fatality differences between indigenous people with COVID-19 diagnosis compared with the non-indigenous Mexican population.

Methods

Study design, setting, and participants

We performed a longitudinal analysis using the public data of the COVID-19 information derived from the Epidemiological Surveillance System of Viral Respiratory Diseases of suspected cases identified by the healthcare system in Mexico.[16] The study population included those cases with a positive diagnosis for SARS-CoV-2 infection certified by the Institute of Epidemiological Diagnosis and Reference (InDRE), from February 27, 2020, when the first case in the country was officially reported, until July 30, 2020 (n = 424,637).

Definitions of suspected and confirmed COVID-19 cases

A suspected case was defined as a 'person of any age who had at least two of the following signs and symptoms in the last 7 days: cough, fever, or headache accompanied by either dyspnea, arthralgias, myalgias, sore throat, rhinorrhea, conjunctivitis, or chest pain,' and the confirmed case was the suspected case with a diagnosis confirmed by the InDRE.[17]

Outcome of interest

Fatality rate was defined as the ratio of the number of deaths, occurred within the cohort study of confirmed COVID-19 cases, and the person-time at risk.

Covariates

Variables of interest were age, sex, state of residence, presence of chronic obstructive pulmonary disease (COPD), asthma, immunosuppression, cardiovascular disease, chronic kidney disease, smoking, metabolic comorbidities (joint effect of diabetes, hypertension, and obesity), date of admission in the cohort study, number of days from the symptom onset to seeking care, and severity of the patient's condition at the time of seeking care. This variable was defined based on the type of management at diagnosis: (a) outpatient management (OM), (b) hospital management (HM), and (c) management in the intensive care unit (ICU) and/or with intubation and assisted ventilation.

Indigenous population was defined as all individuals who declared to speak an indigenous language.

Statistical analysis

We conducted a descriptive analysis of indigenous and non-indigenous populations based on their survival condition. The person-time of the fatality rate was expressed in person-weeks based on the date from the symptom onset until death. Statistical differences between non-survivor indigenous people vs. non-survivor non-indigenous people were tested using the immediate two-sample proportion test for categorical variables and the non-parametric Mann-Whitney U test for numerical variables.

To investigate risk factors of COVID-19 fatality, the hazard ratio (HR) and 95% confidence interval (CI) were calculated using the multivariable Cox proportional hazards regression models stratified by management at diagnosis. For variables that did not meet the proportional risk assumption, an interaction with time was performed.[18,19] From this multivariable model, we explored the statistical significance of three-way interaction terms (indigenous × sex × time, indigenous × age-groups × time, and indigenous × comorbid conditions × time).

To improve comparability among the population groups, associations of interest were evaluated in three scenarios: considering the entire national population in Mexico, considering the population within the 13 states that concentrate 89% of the indigenous population in Mexico as per the National Population Council (Oaxaca, Chiapas, Veracruz, Estado de México, Puebla, Yucatán, Guerrero, Hidalgo, Quintana Roo, San Luis Potosí, Ciudad de México, Michoacán, and Campeche), and considering only three states of the South Pacific where the largest proportion of indigenous people is concentrated (34% in Oaxaca, Chiapas, and Guerrero). We excluded 12,610 cases without indigenous language information. There were no statistically significant differences in age (60.6 vs. 61.7, respectively), sex (men 66.1% vs. 64.9%), and comorbidities conditions such as diabetes (37.7% and 38%, respectively), hypertension (42.5% vs. 43.8%), or COPD (4.6% vs. 4.8%) between excluded and included individuals. All analyses were performed using Stata 14.1 and GraphPad Prism 8.2. All *P*-values were two tailed, and a *P*-value <0.05 was considered statistically significant.

Results

Characteristics of test-positive cases for COVID-19

The average age of non-survivors in the non-indigenous population with COVID-19 was 61.7 years (standard deviation [SD] = 14.2), more than half were in the 35- to 64-year age range, compared with 63.3 years of age (SD = 13.4), and almost half of them were 65 years or older, in the indigenous population. In both groups, the majority were men. Most comorbidities were more frequent in non-survivors in both the non-indigenous and indigenous population: hypertension (43.9% vs. 39.1%, respectively), diabetes (38.1% vs. 36.5%), obesity (24.7% vs. 25.6%, respectively), COPD (4.8% vs. 7.6%), immunosuppression (2.7% vs. 2.6%), cardiovascular disease (5.3% vs. 4.6%), chronic kidney disease (6.9% vs. 5.5%), and smoking (8.3% vs. 7.1%), except for obesity (24.7% vs. 25.6%, respectively) and asthma (with higher prevalence in indigenous non-survivors) (Table 1). Considering all comorbidities, 64.4% of the indigenous people who died had one metabolic comorbidity at least, compared with 66.6% of the non-indigenous people who died; the most prevalent ones in both groups were diabetes + hypertension, hypertension, and diabetes (Table 1). Regarding initial medical management, the majority of survivors received OM (80.5% of non-indigenous vs. 69.5% of indigenous people). A lower percentage of non-indigenous patients required hospitalization than indigenous (17.9% and 27.7%, respectively), as well as management in the ICU and/or with intubation (1.6% vs. 2.8%, respectively).

Among non-survivors, the majority were hospitalized (69.2% of non-indigenous vs. 63.7% of indigenous people), followed by management in the ICU and/or with intubation (19.6% vs. 23%, respectively), and a lower percentage received OM (11.2% vs. 13.3%, respectively).

The time from the symptom onset to seeking medical attention, as well as death, was similar in indigenous and non-indigenous people. Finally, non-survivor indigenous people had an average time of 6.5 days (SD = 7.2) from the beginning of hospitalization to death, compared with 7.7 days (SD = 7.5) in non-indigenous people (Table 1).

Table 1
Characteristics of test-positive cases for COVID-19 and fatality in Mexico.

Characteristics	Non-indigenous population			Indigenous population			*P*-value
	Total	Survivors	Non-survivors	Total	Survivors	Non-survivors	
	407,548 (98.9)	362,562 (89.0)	44,986 (11.0)	4469 (1.1)	3701 (82.8)	768 (17.2)	
Age (years), mean (SD)	45.2 (16.4)	43.1 (15.5)	61.7 (14.2)	50.4 (17.4)	47.7 (16.9)	63.3 (13.4)	
<35	117,173 (28.8)	31.9	3.4	905 (20.2)	23.9	2.7	0.288
35–64*	236,051 (57.9)	58.6	52.7	2537 (56.8)	58.7	47.4	0.004
≥65*	54,324 (13.3)	9.5	43.9	1027 (23.0)	17.4	49.9	0.009
Sex, N (%)							
Women	191,078 (46.9)	48.3	35.1	1813 (40.6)	42.0	33.5	0.357
Men	216,470 (53.1)	51.7	64.9	2656 (59.4)	58.0	66.5	0.357
Diabetes, N (%)	65,047 (16.0)	13.3	38.1	974 (21.9)	18.9	36.5	0.365
COPD,* N (%)	6354 (1.6)	1.2	4.8	161 (3.6)	2.8	7.6	0.000
Asthma,* N (%)	10,926 (2.7)	2.8	2.0	125 (2.8)	2.6	3.8	0.001
Immunosuppression, N (%)	4897 (1.2)	1.0	2.7	58 (1.3)	1.0	2.6	0.865
Hypertension,* N (%)	80,723 (19.9)	16.9	43.9	976 (21.9)	18.4	39.1	0.008
Cardiovascular disease, N (%)	8676 (2.1)	1.7	5.3	100 (2.3)	1.8	4.6	0.390
Chronic kidney disease, N (%)	8165 (2.0)	1.4	6.9	97 (2.2)	1.5	5.5	0.128
Obesity, N (%)	76,674 (18.9)	18.1	24.7	892 (20.0)	18.9	25.6	0.566
Smoking, N (%)	29,590 (7.3)	7.2	8.3	274 (6.2)	6.0	7.1	0.232
Metabolic comorbidities,[a] N (%)							
None	250,667 (61.7)	65.2	33.4	2438 (54.8)	58.8	35.6	0.200
Hypertension*	32,045 (7.9)	7.1	14.3	369 (8.3)	7.5	12.0	0.071
Obesity	44,645 (11.0)	11.3	8.6	529 (11.9)	12.1	11.0	0.019
Diabetes	23,054 (5.7)	5.0	11.0	416 (9.4)	8.9	11.3	0.792
Obesity + hypertension	13,674 (3.4)	3.1	5.7	140 (3.2)	2.8	5.0	0.406
Diabetes + hypertension	23.669 (5.8)	4.5	16.6	335 (7.5)	5.9	15.6	0.460
Diabetes + obesity	7007 (1.7)	1.6	3.2	91 (2.1)	1.8	3.0	0.755
Diabetes + obesity + hypertension	11,216 (2.8)	2.2	7.2	130 (2.9)	2.2	6.5	0.341
Initial management, N (%)							
Outpatients*	296,675 (72.8)	80.5	11.2	2674 (59.9)	69.5	13.3	0.068
Hospitalization *	96,041 (23.6)	17.9	69.2	1513 (33.9)	27.7	63.7	0.001
Hospitalization and/or ICU and/or intubation*	14,728 (3.6)	1.6	19.6	279 (6.3)	2.8	23.0	0.019
[b]Time from symptom onset to seeking care (days)*	4.3 (3.3)	4.3 (3.3)	4.4 (3.5)	4.3 (3.2)	4.2 (3.0)	4.7 (3.8)	0.012
[b]Time from symptom onset to death (days)*	12.1 (8.0)	–	12.1 (8.0)	11.2 (7.2)	–	11.2 (7.2)	0.002
[b]Time from seeking care to death (days)*	7.7 (7.5)	–	7.7 (7.5)	6.5 (7.2)	–	6.5 (7.2)	<0.001

SD = standard deviation; ICU = intensive care unit.
**P*-value <0.05 when comparing between non-survivors in the indigenous and non-indigenous population. For categorical variables, the immediate two-sample proportion test was used, and for continuous variables, we used the Mann-Whitney U test.
[a] None = without obesity, diabetes, hypertension. Obesity, diabetes, and hypertension categories do not exclude other types of comorbidities.
[b] Mean (SD).

COVID-19 crude fatality

The COVID-19 crude fatality rate per 1000 person-weeks was 64.8% higher in the indigenous population than in the non-indigenous population. In the indigenous population, 768 deaths were identified in 25,621 person-weeks (crude fatality: 29.97; 95% CI = 27.82–32.17), whereas in the non-indigenous population, 44,986 deaths were identified in 2,474,472 person-weeks (crude fatality: 18.18; 95% CI = 18.01–18.34).

When stratifying the analysis by type of management at diagnosis, we observed that the indigenous population had a higher crude fatality rate in both outpatients and hospitalized patients, than among non-indigenous people. Furthermore, we observed a significant difference in outpatients, wherein the indigenous population had a crude fatality rate more than twice the rate among non-indigenous patients (6.0 vs. 2.6, respectively). These results were similar in the subgroup of the 13 states containing 89% of the total indigenous population (2.4 vs. 6.1, respectively) and in the South Pacific region (2.6 vs. 7.6, respectively). In addition, we observed differences in time from the symptom onset to seeking care (days) among non-indigenous outpatients and indigenous outpatients for the different regions, and at the national level and in the 13 states, we observed an average time of 4.2 days in the non-indigenous population and 3.9 in the indigenous population ($P < 0.01$); however, in the South Pacific region, we observed that indigenous people have a longer time seeking care than non-indigenous people (4.5 vs. 4.2, $P < 0.001$, respectively). Within the outpatient group, the men were the most affected ones, wherein indigenous people had a crude fatality rate of 132% more than non-indigenous people; when assessing age, indigenous people in the 35- to 64-year age range had a crude fatality rate 119% higher than non-indigenous people of the same age-group (Table 2).

COVID-19 fatality risk

The results from the Cox proportional hazards analysis showed that sex, age, and the presence of comorbidities (COPD, hypertension, obesity, diabetes, and chronic kidney disease) are associated with a higher COVID-19 fatality rate, both in outpatients and in hospitalized patients.

Ethnicity was associated with a higher COVID-19 fatality rate in individuals who received OM, but not in individuals who received HM, regardless of age, sex, and comorbidities. In outpatients, we found that being indigenous increases the COVID-19 fatality rate by 63% compared with being non-indigenous (HR = 1.63; 95% CI = 1.34–1.98). We also observed that age ≥65 years had the highest risk when compared with age less than <35 years (HR = 30.68; 95% CI = 26.41–35.63), and the risk fatality in men increases by 97% compared with women (HR = 1.97; 95% CI = 1.86–2.09).

When evaluating metabolic comorbidities, we found that the risk was higher in people with diabetes (HR = 3.15; 95% CI = 2.63–3.77). The risk increases in people with diabetes and

Table 2
COVID-19 crude fatality rate in initial outpatient and hospitalized managements.

Study population characteristics	National level				States with 89% of the indigenous population				Oaxaca, Chiapas, Guerrero			
	Non-indigenous population		Indigenous population		Non-indigenous population		Indigenous population		Non-indigenous population		Indigenous population	
	Outpatients	Hospitalized	Outpatients	Hospitalized	Outpatients	Hospitalized	Outpatients	Hospitalized	Outpatients	Hospitalized	Outpatients	Hospitalized
Total, n	296,675	110,873	2674	1795	163,485	67,166	2183	1533	18,921	6866	414	367
Deaths	5008	39,978	102	666	2691	24,498	82	576	320	2795	21	134
Person-week	1,896,871	577,600	17,019	8603	1,109,718	369,473	13,407	7138	121,741	33,101	2746	1964
Fatality rate (95% CI)[d]	2.6 (2.6–2.7)	69.2 (68.5–69.9)	6.0 (4.9–7.3)	77.4 (71.8–83.5)	2.4 (2.3–2.5)	66.3 (65.5–67.1)	6.1 (4.9–7.6)	80.7 (74.5–87.6)	2.6 (2.4–2.9)	84.4 (81.4–87.6)	7.6 (5.0–11.7)	68.2 (57.6–80.8)
[a]Time SSC (days)[e]	4.2 (3.3)	4.4 (3.5)	3.9 (2.9)	4.7 (3.5)	4.3 (3.4)	4.5 (3.5)	3.9 (2.9)	4.8 (3.5)	4.2 (2.6)	4.3 (3.1)	4.5 (2.8)	4.6 (3.1)
[b]Time SD (days)[e]	12.8 (8.7)	12.0 (7.9)	10.9 (7.7)	11.2 (7.1)	12.8 (8.9)	12.2 (8.01)	10.8 (6.6)	11.1 (7.0)	11.3 (7.2)	11.4 (7.6)	10.0 (6.5)	10.8 (6.7)
[c]Time SCD (days)[e]	7.7 (8.2)	7.7 (7.4)	6.3 (7.4)	6.5 (7.2)	7.6 (8.3)	7.8 (7.5)	6.3 (6.4)	6.5 (7.1)	6.1 (6.6)	7.0 (7.2)	5.0 (5.4)	6.1 (6.0)
Women, n	148,222	42,856	1159	654	81,266	25,075	927	554	9057	2482	181	104
Deaths	1702	14,104	25	232	879	8117	20	205	110	926	3	39
Person-week	937,202	224,884	7408	3112	546,022	140,028	5685	2483	57,353	12,014	1186	526
Fatality rate (95% CI)[d]	1.8 (1.7–1.9)	62.7 (61.7–63.8)	3.4 (2.3–5.0)	74.6 (65.6–84.8)	1.6 (1.5–1.7)	58.0 (56.7–59.2)	3.5 (2.3–5.5)	82.6 (72.0–94.7)	1.9 (1.6–2.3)	77.1 (72.3–82.2)	2.5 (0.8–7.8)	74.2 (54.2–101.6)
Men, n	148,453	68,017	1515	1141	82,219	42,091	1256	979	9864	4384	233	263
Deaths	3306	25,874	77	434	1812	16,381	62	371	210	1869	18	95
Person-week	959,669	352,717	9611	5491	563,696	229,445	7723	4655	64,388	21,087	1560	1438
Fatality rate (95% CI)[d]	3.4 (3.3–3.6)	73.4 (72.5–74.2)	8.0 (6.4–10.0)	79.0 (71.9–86.8)	3.2 (3.1–3.6)	71.4 (70.3–72.5)	8.0 (6.3–10.3)	79.7 (72.0–88.2)	3.3 (2.9–3.7)	88.6 (84.7–92.7)	11.5 (7.3–18.3)	66.0 (54.0–80.8)
Age <35 years, n	106,480	10,693	776	129	57,027	6664	620	93	6229	759	108	44
Deaths	205	1328	4	17	108	807	3	14	8	86	2	6
Person-week	672,857	72,612	4983	856	379,561	47,547	3891	592	39,774	4718	729	308
Fatality rate (95% CI)[d]	0.3 (0.3–0.3)	18.3 (17.3–19.3)	0.80 (0.30–2.13)	19.9 (12.3–31.9)	0.3 (0.2–0.3)	16.9 (15.8–18.2)	0.8 (0.2–2.4)	23.6 (14.0–39.9)	0.2 (0.1–0.4)	18.2 (14.8–22.5)	2.7 (0.7–11.0)	19.5 (8.7–43.4)
Age 35–64 years, n	170,255	65,796	1558	979	95,165	40,726	1267	845	11,159	3778	254	208
Deaths	2751	20,968	55	309	1522	13,221	41	268	162	1334	8	68
Person-week	1,108,272	369,875	10,124	5128	658,945	240,710	7919	4302	72,990	19,957	1695	1113
Fatality rate (95% CI)[d]	2.5 (2.4–2.6)	56.7 (55.9–57.5)	5.43 (4.17–7.07)	60.3 (53.9–67.4)	2.3 (2.2–2.4)	54.9 (54.0–55.9)	5.2 (3.8–7.0)	62.3 (55.3–70.2)	2.2 (1.9–2.6)	66.8 (63.3–70.5)	4.7 (2.4–9.4)	61.1 (48.2–77.5)
Age ≥65 years, n	19,940	34,384	340	687	11,293	19,776	296	595	1533	2329	52	115
Deaths	2052	17,682	43	340	1061	10,470	38	294	150	1375	11	60
Person-week	115,742	135,114	1912	2619	71,213	81,216	1598	2243	8977	8427	322	543
Fatality rate (95% CI)[d]	17.7 (17.0–18.5)	130.9 (128.9–132.8)	22.5 (16.7–30.3)	129.8 (116.7–144.4)	14.9 (14.0–15.8)	128.9 (126.5–131.4)	23.8 (17.3–32.7)	131.1 (116.9–146.9)	16.7 (14.2–19.6)	163.2 (154.7–172.0)	34.1 (18.9–61.6)	110.5 (85.8–142.3)

CI = confidence interval.
[a] Time SSC: time from the symptom onset to seeking care (days).
[b] Time SD: time from the symptom onset to death (days).
[c] Time SCD: time from seeking care to death (days).
[d] Crude fatality rate per 1,000 person-weeks.
[e] Mean (SD).

hypertension (HR = 3.58; 95% CI = 3.05–4.22), obesity (HR = 4.69; 95% CI = 3.53–6.23), and hypertension + obesity (HR = 5.57; 95% CI = 4.54–6.84) (Fig. 1) (Table 3). We found an interaction effect with time in most of comorbidities in outpatients; in all cases, the risk of mortality decreased eventually, for example, the risk in people with chronic kidney disease during the first week is 3.58, and every week, the risk decreased by 17%, that is, in the second week, the risk decreased to 2.97 (95% CI = 2.60–3.40), and in the third week, it was 2.47 (95% CI = 2.17–2.81).

Furthermore, we did not observe statistically significant differences among outpatients between non-indigenous and indigenous people in variables such as sex (HR = 1.96 vs. 2.18), age (35–64 years, HR = 6.32 vs. 5.8, and >65 years, HR = 30.26 vs. 18.75), obesity + hypertension (HR = 2.61 vs. 2.3), diabetes + obesity + hypertension (HR = 4.03 vs. 3.37), and time from the symptom onset to seeking care (HR = 1.04 vs. 1.03).

In contrast to outpatients, in hospitalized patients, the COVID-19 fatality rate in indigenous and non-indigenous populations was similar (HR = 1.01; 95% CI = 0.94–1.09). We observed a positive interaction with time and sex, age, and hypertension, higher being in the following age-groups: ≥65 years and 35–64 years, wherein the risk increased by 26% and 21%, respectively.

Excess fatality in the indigenous population that received OM was observed in the following three scenarios: HR = 1.63 at the national level (95% CI = 1.34–1.98), HR = 1.66 in the subgroup of the 13 states containing 89% of the total indigenous population (95% CI = 1.33–2.07), and HR = 2.35 in the South Pacific region (95% CI = 1.49–3.69) (Fig. 2). The three-way interactions for indigenous × demographic (sex, age-groups) × time and indigenous × comorbid conditions × time were not statistically significant (*P* value >0.05).

Discussion

Our data suggest that management of treatment is the main factor associated with the differences in the COVID-19 fatality rates between the indigenous and non-indigenous population in the three scenarios (at the national level, in the subgroup of 13 states with 89% of the indigenous population, and in the South Pacific region). We observed that the indigenous population had a 64.8% higher crude fatality rate than non-indigenous people. Similar findings have been recorded in various countries, where it has been observed that ethnic minorities have a higher risk of dying from COVID-19. In Brazil, for example, the Pardo indigenous group was the second most important risk factor (after age) for death.[20]

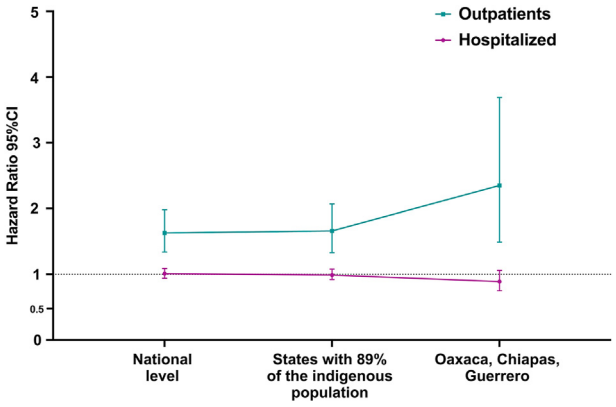

Fig. 1. COVID-19 fatality hazard ratios based on the type of management and the presence of comorbidities (multivariate model). HR reference: none (hypertension, obesity, diabetes). HR = hazard ratio; CI = confidence interval.

Similarly, the mortality rate in the United States of America is higher among Black people, Hispanics, or Asians, than in the white population.[21] In addition, in England and in Wales, ethnic disparities with regard to COVID-19 mortality have been observed: Black people, Indians, Pakistanis, Bangladeshis, and other ethnic groups had significantly higher risk of dying than the white population.[22]

In our data, after adjusting for sex, age, and metabolic comorbidities, the fatality rate is particularly higher among indigenous outpatients than among non-indigenous outpatients, whereas the fatality rates in hospitalized patients (indigenous and non-indigenous) are the same, in the three regions in Mexico (national, 13 states, and South Pacific region). Similar results were found in Georgia, USA, where the fatality rate during hospitalization was similar between African-Americans and other ethnic groups.[23]

When analyzing the differences in the prevalence of various comorbidities, it was found that non-survivor indigenous people had a higher frequency of comorbidities, being most affected by chronic and metabolic diseases, corresponding to the elevated prevalence of metabolic syndrome, central obesity, and hypertension in indigenous communities in Mexico.[24]

Historically, the indigenous population has shown poor health indicators in high rates of morbidity, disability, and early mortality, which are related to their own social, environmental, geographic, and cultural conditions. Access barriers are well-known factors that affect health results of these communities.[9,10,25] Unfortunately, the data set we used for this analysis is only a public administrative information, we acknowledge the data set lacks variables that measure access to care precisely, so we used time from the beginning of symptoms and seeking medical attention as the proxy variable. Nonetheless, in our study, we did not observe differences between non-indigenous and indigenous populations (4.3 vs. 4.3 h) regarding the chance to access medical attention. Furthermore, non-relevant differences were observed between time from the symptom onset and death in non-survivor indigenous and non-indigenous people (4.7 vs. 4.4, approximately 7 h).

Previous studies in different populations have documented that the person's perception of risk is important and is associated with the uptake of preventive and/or avoidant behaviors, which reported moderate risk perceptions in American, Australian, and UK individuals.[26–28] Among French individuals with high risk of severe COVID-19 (e.g., age >70 years and presence of chronic diseases), about 20% of them did not feel at risk and could therefore adopt avoidant behaviors.[29] We were unable to evaluate these factors in our analysis, but we consider this should be evaluated in further studies.

Despite the large volume of research on the pandemic, studies aimed at analyzing the association between ethnicity and COVID-19 are limited.[30] According to our knowledge, this is the first study in Mexico that analyzes COVID-19 fatality risk in the indigenous population. Although the number of national indigenous individuals screened for SARS-CoV-2 is small (n = 8835), it was possible to establish that they have higher COVID-19 fatality rates. These results, however, should be interpreted with caution as the nature of the data does not allow full understanding of the phenomenon that occurred in the indigenous population with COVID-19 and because of the observed underrepresentation as well.

Overall, our findings suggest that COVID-19 fatality is adversely affecting the indigenous population, particularly patients who received initial outpatient care. In addition, comorbidity mainly affects the indigenous population. Further analysis of the factors that could better explain the differential impact of COVID-19 in the indigenous population is warranted. In the meantime, an alternative may be to promote hospitalized management among indigenous populations. This may reduce disparities without increasing

Table 3
COVID-19 fatality hazard ratios with regard to initial outpatient and hospitalized management at the national level.

Study variables	Outpatients	Hospitalized
	HR (95% CI)	HR (95% CI)
Indigenous (reference: no)		
Yes	1.63 (1.34–1.98)	1.01 (0.94–1.09)
Sex (reference: women)		
Men	1.97 (1.86–2.09)	1.13 (1.09–1.18)[a]
Age (reference: <35 years)		
35–64 years	6.41 (5.55–7.40)	1.86 (1.68–2.07)[a]
≥65 years	30.68 (26.41–35.63)	3.16 (2.84–3.52)[a]
COPD (reference: no)		
Yes	2.19 (1.73–2.77)[a]	1.26 (1.16–1.37)[a]
Metabolic comorbidities (reference: none)		
Hypertension	2.20 (1.88–2.59)[a]	1.13 (1.06–1.20)[a]
Obesity	2.10 (1.74–2.53)[a]	1.13 (1.05–1.21)
Diabetes	3.15 (2.63–3.77)[a]	1.33 (1.25–1.41)
Obesity + hypertension	2.84 (2.29–3.51)	1.31 (1.21–1.42)
Diabetes + hypertension	3.58 (3.05–4.22)[a]	1.51 (1.43–1.59)[a]
Diabetes + obesity	4.69 (3.53–6.23)[a]	1.32 (1.18–1.46)
Diabetes + obesity + hypertension	5.57 (4.54–6.84)[a]	1.66 (1.54–1.79)[a]
Chronic kidney disease (reference: no)		
Yes	3.58 (2.88–4.44)[a]	1.93 (1.79–2.08)[a]

COPD = chronic obstructive pulmonary disease; HR = hazard ratio; CI = confidence interval.
[a] Interaction with time.

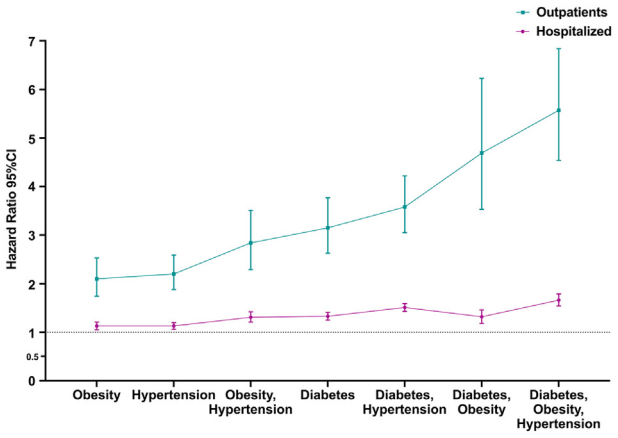

Fig. 2. COVID-19 fatality hazard ratios among indigenous people vs. non-indigenous people based on the type of management, in different regions in Mexico (multivariate model). HR reference: non-indigenous. States with 89% of the indigenous population: Campeche, Chiapas, Mexico City, Guerrero, Hidalgo, Estado de México, Michoacán, Oaxaca, Puebla, Quintana Roo, San Luis Potosí, Veracruz, and Yucatán. Three states in the South Pacific with the highest proportion of indigenous people: Oaxaca, Chiapas, and Guerrero. HR = hazard ratio; CI = confidence interval.

the healthcare service capacity overload, given the relatively small number of indigenous cases. Besides, health authorities mostly implement special care protocols for indigenous patients to reduce their fatality rates.

Author statements

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Ethical approval

No ethical approval was required as all the data analyzed were publicly available.

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Competing interests

Nothing to disclose.

Author contributions

A.D.A.-P., K.R.-R., B.R.-P., and J.S. contributed to conception, design, data analysis, data interpretation, and manuscript writing. All authors reviewed the manuscript, had primary responsibility for final content, and read and approved the final manuscript.

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