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COVID-19 among Amazonian indigenous in Peru: mortality, incidence, and clinical characteristics

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ABSTRACT

Background Few studies have described the clinical characteristics of patients with COVID-19 from ethnic minority groups. Our objective was to evaluate the mortality and incidence rates, clinical characteristics and factors associated with mortality in cases with COVID-19 belonging to the Amazonian indigenous ethnic group in Peru.

Methods We performed a retrospective cohort study including all cases from COVID-19 among Peruvian people identified as Amazonian indigenous from 07 March to 31 October 2020. We calculated the standardized mortality and incidence ratios using the indirect age-adjusted method to determine the differences between Amazonian Indigenous and the general population. In addition, we used multivariable logistic regression to determine the risk factors for death.

Results A total of 19 018 laboratory confirmed COVID-19 cases were analyzed. Indigenous people had 3.18 (95% CI, 3.13–3.23) times the risk of infection and 0.34 (0.31–0.37) times the mortality risk of the general Peruvian population. Males had 1.29 (1.04–1.61) times the odds of death compared with females and for each year of age, the odds of mortality increased 1.03 (1.03–1.04) times. Cases with respiratory distress had 2.47 (1.96–3.10) times more likely to die. Having an immunodeficiency was 18.7 (6.12–57.00) times more likely to die.

Discussion The Amazonian indigenous population in Peru was strongly affected by COVID-19 compared with the general Peruvian population.

Keywords COVID-19, indigenous people, mortality, Peru

Introduction

Coronavirus disease 2019 (COVID-19) has disproportionately affected certain vulnerable groups such as older adults, people with comorbidities and ethnic minorities.[1] In previous epidemics, Indigenous peoples had higher infectious and death rates than the non-indigenous population.[2] For example, during the 1918 Spanish Influenza pandemic, the Maori ethnic group, from New Zealand, had seven times more mortality than the European population.[3] Indigenous Australians during the H1N1 influenza pandemic in 2009 had ICU admission five times higher than non-indigenous.[4] Indian and Alaska Natives from the United States had four times more mortality than the other ethnic groups.[5]

Worldwide, there are >476 million indigenous people that represent 6.2% of the population.[6] In Peru, the 2017 Census revealed that the country has 210 612 adults who self-identified as Amazonian indigenous.[7] Most Peruvian Amazonian groups live in the north of the country but are unique for their small but dispersed population in all the east region, mainly from rural areas. This ethnic group presents several health disparities and living conditions that are likely to facilitate the spread of different infectious agents like the SARS-CoV-2. Usually, the indigenous populations endure the burden of infectious diseases typical of rural areas. However,

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during the previous years, these populations have also had to deal with an increase in non-communicable diseases.[8] In addition, this population lives in frequently isolated areas with poor communication and precarious health services access, suffering marginalization and higher rates of poverty.[7]

Despite COVID-19 knowledge increasing exponentially, there are limited data regarding the impact on Indigenous people in South America that have been neglected. This study aimed to[1]: compare the COVID-19 mortality and incidence rates between the Amazonian Indigenous Peruvians and the Peruvian general population[2]; describe the clinical characteristics of Amazonian indigenous COVID-19 cases[3]; and assess factors associated with mortality among this ethnic group.

Methods

Study design and population

We performed a retrospective cohort study using the Epidemiological Surveillance System data of the National Center for Epidemiology, Disease Prevention and Control, Ministry of Health of Peru (CDC-Peru). Healthcare facilities in the Peruvian territory have notified COVID-19 cases to the CDC-Peru throughout the Notiweb app since the beginning of the pandemic in 2020. The study population consisted of laboratory-confirmed cases with SARS-CoV-2 molecular or serological test[9] that belonged to Amazonian Indigenous ethnicity between 05 March and 31 October 2020 (first wave in the country). We limited the analysis to cases from regions with at least 100 Amazonian Indigenous COVID-19 cases and <25% of missing data in ethnicity into the Surveillance System that correspond to nine regions: Loreto, Amazonas, Ucayali, San Martín, Junín, Pasco, Madre de Dios, Huánuco, Cajamarca.

Data sources and variables

The analyzed database consisted of demographic and clinical data registered in the Epidemiological Form is filled at the COVID-19 case notification moment by a health professional. Demographic variables included age, gender and being a health worker. Age groups were defined as early childhood (0–5 years old), childhood (6–11 years), adolescence (12–17 years), young adults (18–29 years), middle adults (30–44 years), adults (45–59 years) and older adults (60 and older). Clinical data included symptoms, signs and risk conditions. Other variables included length of hospitalization, use of mechanical ventilation and admission to intensive care unit. Indigenous communities were identified using the Indigenous Peoples Database of the Culture Peruvian Ministry.[10] The COVID-19 incidence in general population was obtained from national data reported in Open COVID-19 data.[11]

Statistical analysis

We used indirect age-adjusted standardization to compare COVID-19 mortality and incidence rates between the Amazonian indigenous population and the general Peruvian population. First, we calculated the expected COVID-19 incidence and mortality among the Amazonian indigenous population by multiplying the mortality and incidence of the general population by the number of indigenous reported in the 2017 Census. Then, we calculated the standardized mortality ratio (SMR) and standardized incidence ratio (SIR) by dividing the observed number of cases and deaths in the Surveillance System by the expected, respectively, to determine the differences in rates between Indigenous population and general population. The calculation of the SIR was limited to the population older than 12 years since it was not assessed in population younger than that age in the 2017 Census. In addition, we calculated case fatality rates (CFRs) by dividing the number of deaths by the number of COVID-19 cases. We described numerical variables by median and interquartile range, and categorical variables by absolute and relative frequencies. Fisher's exact test and Student's *t*-test were used to compare categorical and numerical variables between survivors and deceased cases, respectively. Odd ratios (OR) and 95% confidence intervals (95% CI) were calculated using logistic regression to determine the risk factors associated with death. Statistical analyses were performed using R version 4 (www.r-project.org) and a *P*-value below the threshold of 0.05 was considered statistically significant.

Results

A total of 19 018 cases of COVID-19 were identified as Amazonian indigenous during the study period.

The first Indigenous case was diagnosed on 12 March 2020, and the peak of the wave in this population was slightly before the largest peak of infections at the national level. The Awajun and Kichwaruna communities reported higher incidence among Indigenous Amazonian. The indirect-adjusted incidence rate for indigenous people was 102 per 1000. Indigenous people had 3.18 (95% CI, 3.13–3.23) times the risk of infection of the general Peruvian population. Those aged 60 or more had the highest associated risk of infection compared with the younger population (Supplementary Material, Table S1). On the other hand, the indirectly adjusted mortality rate for indigenous people was 24.0 per 1000, and indigenous persons had 0.34 (95%

CI, 0.31–0.37) times the mortality risk of the general Peruvian population. This lower risk of death in Amazonian indigenous people than in the general population remained constant among age groups, except in the young adult group (18–29 years). These had 1.85 times the mortality risk of the general Peruvian population. The CFR was 1.9%. The people aged older 60 years had the higher CFR (5.5%) (Supplementary Material, Table S2).

Female sex predominated (57.3%); the median age was 34 years (Interquartile range, 22–48). Most cases were middle adults, and 16.6% were children or adolescents. Most participants presented three to four symptoms at the reported moment. Headache, cough and general malaise were the most frequent symptoms, present in more than half. Irritability, abdominal pain and nausea were the less common, present in <10%. About 3.7% had at least one risk condition, being pregnant (1.8%) and cardiovascular disease (0.8%) being the most frequent (Table 1). More than half (57.1%) of the cases with immunodeficiencies were observed among the young adult group (18–29 years), but we did not observe differences between communities.

Cases who died were on average 12 years older ($P < 0.001$) compared with survivors. Male cases had 1.58 times higher mortality than female cases. Mortality was similar in cases younger than 59 years (0.4–2.0%), but was significantly higher in older adults (5.5%, $P < 0.001$). Persons with more than four symptoms (2.5%) had 1.76 and 1.27 times the risk of mortality than persons with three to four symptoms and less than three symptoms, respectively. Participants with respiratory distress, general malaise, cough or irritability had a higher mortality than those without these symptoms ($P < 0.05$). In contrast, those with headaches had less mortality than those without this symptom. Participants with coma, abnormal auscultation or abnormal chest X-ray had higher mortality than participants who did not present these signs ($P < 0.05$) (Table 2). Participants with risk conditions had 1.85 times the risk of mortality than participants with no conditions. Indeed, those with two risk conditions had 1.70 and 4.51 times the risk of mortality than those with one or zero risks conditions, respectively. Cases with diabetes, cardiovascular disease, immunodeficiency and cancer had higher odds of mortality than those without these diseases. Mortality was higher among cases that were hospitalized (25% versus 1.7%, $P < 0.001$) or used mechanical ventilation (12% versus 1.9%, $P = 0.009$) (Table 3).

Multivariable analyses showed that males had 1.29 (95% CI 1.04–1.61) times the odds of mortality compared with females. For each year of age, the odds of mortality increased by 0.3 (95% CI 0.3–0.4). Cases that presented respiratory distress had 2.47 times the odds of death. Immunodeficiency was the only risk condition that was associated with death and involved 19 higher odds of dying (Table 4).

Table 1 Characteristics of Amazonian indigenous Peruvians with confirmed COVID-19 during 2020

Characteristic	*N* = 19 018
Female, *n* (%)	10 897 (57.3%)
Age, Median (IQR)	34 (22, 48)
Age group, *n* (%)	
Early childhood	803 (4.2%)
Childhood	1015 (5.3%)
Adolescence	1356 (7.1%)
Young adults	4350 (22.9%)
Middle adults	9308 (48.9%)
Older adults	2186 (11.5%)
Health worker, *n* (%)	322 (1.7%)
Number of symptoms, *n* (%)	
0	550 (2.9%)
1–2	4993 (26.3%)
3–4	7532 (39.6%)
>4	5943 (31.2%)
Symptoms, *n* (%)	
Headache	12 555 (66.0%)
Cough	11 617 (61.1%)
General malaise	9822 (51.6%)
Sore throat	8851 (46.5%)
Fever	8424 (44.3%)
Nasal congestion	4960 (26.1%)
Muscle pain	4093 (21.5%)
Respiratory distress	3026 (15.9%)
Diarrhea	2948 (15.5%)
Chest pain	2481 (13.0%)
Nausea	1588 (8.3%)
Joint pain	1451 (7.6%)
Abdominal pain	1177 (6.2%)
Irritability	456 (2.4%)
Risk conditions, *n* (%)	
0	18 278 (96.1%)
1	702 (3.7%)
2	38 (0.2%)
Risk conditions, *n* (%)	740 (3.9%)
Pregnancy	351 (1.8%)
Cardiovascular disease	149 (0.8%)
Diabetes	117 (0.6%)
Obesity	57 (0.3%)
Postpartum	14 (0.1%)
Asthma	15 (0.1%)
Chronic neurological disease	16 (0.1%)
Renal disease	11 (0.1%)
Liver disease	15 (0.1%)
Immunodeficiency	21 (0.1%)
Chronic lung disease	9 (0.0%)
Cancer	3 (0.0%)
Hospitalized, *n* (%)	193 (1.0%)
Mechanical ventilation, *n* (%)	16 (0.1%)

IQR = interquartile range

Table 2 Bivariate analysis of the general and clinical factors associated with mortality among Amazonian indigenous Peruvians

Characteristic	*Survived, N* = 18 652	*Deceased, N* = 366	*OR*	95% CI	*P* *
Sex					
Female	10 728 (98%)	169 (1.6%)	1.00		
Male	7924 (98%)	197 (2.4%)	1.58	1.28–1.94	<0.001
Age, median (IQR)	34 (22, 48)	46 (31, 65)	1.04	1.03–1.04	<0.001
Age group					
0–5	793 (99%)	10 (1.2%)	1.00		
6–11	1007 (99%)	8 (0.8%)	0.63	0.25–1.60	0.332
12–17	1351 (100%)	5 (0.4%)	0.29	0.10–0.86	0.026
18–29	4290 (99%)	60 (1.4%)	1.11	0.57–2.18	0.763
30–59	9145 (98%)	163 (1.8%)	1.41	0.74–2.69	0.291
>59	2066 (95%)	120 (5.5%)	4.61	2.40–8.83	<0.001
Number of symptoms					
0–2	5463 (99%)	80 (1.4%)	1.00		
3–4	7395 (98%)	137 (1.8%)	1.27	0.96–1.67	0.097
>4	5794 (97%)	149 (2.5%)	1.76	1.33–2.31	<0.001
Respiratory distress					
No	15 761 (99%)	231 (1.4%)	1.00		
Yes	2891 (96%)	135 (4.5%)	3.19	2.57–3.95	<0.001
General malaise					
No	9041 (98%)	155 (1.7%)	1.00		
Yes	9611 (98%)	211 (2.1%)	1.28	1.04–1.58	0.021
Cough					
No	7292 (99%)	109 (1.5%)	1.00		
Yes	11 360 (98%)	257 (2.2%)	1.51	1.21–1.90	<0.001
Headache					
No	6314 (98%)	149 (2.3%)	1.00		
Yes	12 338 (98%)	217 (1.7%)	0.75	0.60–0.92	0.006
Irritability					
No	18 212 (98%)	350 (1.9%)	1.00		
Yes	440 (96%)	16 (3.5%)	1.89	1.14–3.15	0.014
Convulsion					
No	18 649 (98%)	364 (1.9%)	1.00		
Yes	3 (60%)	2 (40%)	34.16	5.69–205.02	<0.001
Coma					
No	18 603 (98%)	363 (1.9%)	1.00		
Yes	1 (25%)	3 (75%)	153.7	15.95–1481.55	<0.001
Abnormal auscultation					
No	18 500 (98%)	358 (1.9%)	1.00		
Yes	152 (95%)	8 (5.0%)	2.72	1.33–5.58	0.006
Abnormal pulmonary radiography					
No	18 649 (98%)	365 (1.9%)	1.00		
Yes	3 (75%)	1 (25%)	17.03	1.77–164.12	0.014

**P*-value calculated with Chi-square test for categorical variables and Student's *t*-test for numerical variables

Discussion

This population-based study showed that during the 2020 COVID-19 outbreak, Peruvian Amazonian indigenous people had an age-adjusted incidence three times higher than the general population, but the age-adjusted mortality was three times lower, except for the 18–29 age group. In addition, respiratory distress, immunodeficiencies and hospitalization were risk factors for death.

Table 3 Bivariate analysis of the risk conditions associated with mortality among Amazonian indigenous Peruvians

Characteristic	*Survived, N* = 18 652	*Deceased, N* = 366	*OR*	95% CI	*P* *
Have risk conditions					
No	17 937 (98%)	341 (1.9%)	1.00		
Yes	715 (97%)	25 (3.4%)	1.84	1.22–2.78	0.004
Number of risk conditions					
0	17 937 (98%)	341 (1.9%)	1.00		
1	680 (97%)	22 (3.1%)	1.70	1.10–2.64	0.017
2	35 (92%)	3 (7.9%)	4.51	1.38–14.73	0.013
Diabetes					
No	18 543 (98%)	358 (1.9%)	1.00		
Yes	109 (93%)	8 (6.8%)	3.8	1.84–7.85	<0.001
Cardiovascular disease					
No	18 511 (98%)	358 (1.9%)	1.00		
Yes	141 (95%)	8 (5.4%)	2.93	1.43–6.03	0.003
Immunodeficiency					
No	18 635 (98%)	362 (1.9%)	1.00		
Yes	17 (81%)	4 (19%)	12.11	4.06–36.18	<0.001
Cancer					
No	18 650 (98%)	365 (1.9%)	1.00		
Yes	2 (67%)	1 (33%)	25.55	2.31–282.38	0.008
Hospitalized					
No	18 508 (98%)	317 (1.7%)	1.00		
Yes	144 (75%)	49 (25%)	19.87	14.10–27.99	<0.001
Mechanical ventilation					
No	18 638 (98%)	364 (1.9%)	1.00		
Yes	14 (88%)	2 (12%)	7.31	1.66–32.30	0.009

**P* value calculated with Chi-square test

Table 4 Independent associated factors with COVID-19 mortality among Amazonian indigenous Peruvians

Factors	*Odds ratios*	95% CI	*P*
Male sex	1.29	1.04–1.61	0.019
Age	1.03	1.03–1.04	<0.001
Respiratory distress	2.47	1.96–3.10	<0.001
Immunodeficiency	18.67	6.12–56.99	<0.001
Hospitalization	13.31	9.17–19.33	<0.001

Amazonian Indigenous Peruvians suffered three times the incidence compared with the general population, and this is in accordance with other studies that have shown a seroprevalence as high as 70% in urban areas of the Loreto region during the same period we studied.[12] Several reasons could explain these findings. In rural or remote areas, it may have been more difficult to disseminate and implement protocols for the prevention of transmission and contact tracing in these populations. Also in these remote areas, there were a lack of diagnostic tests, human health resources and mass media. It is also possible that there has been less accessibility to personal protective equipment such as masks.[13] On the other hand, we observed that 44% of cases had respiratory distress and 366 died, but only 193 were hospitalized suggesting that there was a serious lack of access to hospitalization, probably due to the collapse of the health system at the first months of the pandemic as well as cultural reasons that lead to non-use of services.[14]

Indigenous presented lower mortality compared with the general Peruvian population. This is consistent with a previous study performed in the Peruvian Amazonas region (0.8–3.40%) and a study performed in Brazil Indigenous (1.4–3.2%)[15] but differed from a Mexican study that found a higher mortality rate among indigenous people (17.2%) compared with the general Mexican population (11.0%).[16] Differences in the frequency of the risk conditions could explain this finding. The Mexican Indigenous population presents a higher frequency of comorbidities compared with

Amazonian indigenous individuals from Brazil and Peru. The frequency of risk conditions such as cardiovascular disease among indigenous people is half that of Peruvian national rates.[17] Crossover immunology responses to malaria infection have also been proposed as a protective factor against COVID-19.[18] Although the frequency of risk conditions was apparently lower in this population, their presence was associated with higher mortality, so they are still important to consider in preventive measures.

Surprisingly, we found that the indigenous group aged 18–29 years was the only one that presented a higher mortality risk compared with the general population. This was not observed in the other age groups, and we believe this could be due to the high prevalence of HIV among this population—more than half of the cases with immunodeficiencies among Indigenous were in this age group. In recent years, HIV infection has expanded through all the Amazonian communities, reaching the most isolated areas. A study conducted in four indigenous communities in the Amazon found that HIV prevalence was 2.1%[19], which was higher compared to the general population (0.3%).[20] This suggests that although this population does not have a high prevalence of cardiovascular disease, HIV could be one of the main causes of COVID-19 mortality in this population.[19]

This study has some limitations that should be considered. First, the data come from the Surveillance System that may underreport the frequency of cases and deaths among jungle and rural areas, mostly where Indigenous people live. Second, there exists the possibility that we excluded other people who are indigenous but did not consider themselves as they are which could be underestimating the incidence rate among Amazonian Indigenous population. Third, it is important to consider that in rural areas there is common mortality underreporting, which could underestimate the mortality and infection rates. It is necessary to develop and implement protocols for the detection and treatment of vulnerable groups. On the other hand, this is the first population-based study to address the impact of COVID-19 on minority ethnic groups in Peru and the results will help to understand how the indigenous community was affected to plan future strategies for possible future pandemics.

In conclusion, during the first wave of COVID-19 in Peru, the indigenous population presented an incidence three times higher compared with the general population and had low accessibility to hospital treatment or other measures such as mechanical ventilation. Strengthening of the health care system serving this population is necessary. Our results will be useful for planning strategies for future epidemics affecting ethnic minority populations.

Data sharing statement

This study was based on an analysis of existing datasets that are available online. Merge dataset could be requested upon reasonable request to the corresponding author.

Author contributions

GS: conceptualization and design, data curation and statistical analysis, writing – Original draft preparation, supervision and writing – reviewing and editing. MR: conceptualization and design, acquisition and quality of data, supervision and writing – reviewing and editing. AS: data curation and statistical analysis, writing – original draft preparation and writing – reviewing and editing. LO: acquisition and quality of data and writing – reviewing and editing. KM: acquisition and quality of data, data curation and statistical analysis and writing – reviewing and editing. NF: acquisition, quality of data and writing – reviewing and editing. JV: acquisition and quality of data, data curation and statistical analysis and writing – reviewing and editing. CM: conceptualization and design, writing – original draft preparation, supervision and writing – reviewing and editing.

Supplementary data

Supplementary data are available at the *Journal of Public Health* online.

Ethics committee approval

No ethical approval was required, as the study analyzed anonymized surveillance data.

Declaration of Competing Interest

None.

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