

Determinants of COVID-19 Severity: A Retrospective Analysis of Clinical and Epidemiological Factors in Durango, Mexico

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SUMMARY

Background: The COVID-19 pandemic, caused by SARS-CoV-2, has had a devastating global impact, with millions of confirmed cases and deaths. This study focused on analyzing 63,252 patient records from the state of Durango, Mexico, to identify clinical and epidemiological factors associated with disease severity. **Methods:** The study employed a descriptive, observational, and retrospective approach, based on open data from the SISVER platform. A descriptive analysis was conducted to summarize demographic and clinical characteristics. A multivariate analysis was performed using the graph of relative inertias to assess how the covariates (comorbidities) were associated with hospitalization, intubation, and death in the patients. Subsequently, odds ratios tests were calculated to evaluate the associations between specific clinical variables, such as pneumonia, obesity, and other comorbidities, and intubation.

Results: We were found that the majority of cases (93.8%) were treated on an outpatient basis, while 6.2% required hospitalization. Hypertension, diabetes, and obesity were the most prevalent comorbidities. The mortality rate in the population was 2.1%, particularly in Jurisdiction I, corresponding to the capital city. Pneumonia was strongly associated with intubation (OR = 9.03, 95% CI = 1.0232 – 44.3230, $p = 0.03$), and obesity also showed an increased risk (OR = 2.64, 95% CI = 1.0021 – 22.4210, $p = 0.02$). These findings underscore the importance of identifying and managing comorbidities in patients infected with SARS-CoV-2.

Conclusion: The results highlight the relevance of social determinants of health and the need for public policies that address inequalities in the context of appropriately managing risk factors to reduce morbidity and mortality associated with COVID-19 in Mexico.

Keywords: COVID-19; comorbidities; morbidity and mortality.

INTRODUCTION

The disease caused by the novel coronavirus of 2019 (COVID-19), identified in December 2019, is considered a global public health emergency, reaching pandemic status as declared by the World Health Organization [1]. As of January 2023, a total of 367 million confirmed cases of COVID-19 and 4.4 million deaths due to this disease were recorded worldwide

[2]. The spread of the virus and its variants has affected nearly all countries, with a sustained increase in cases across all impacted regions. In Mexico, the first case was reported on February 28, 2020, and since then, the number of infected individuals has increased exponentially, reaching a total of 7,633,355 confirmed cases and 334,336 deaths as of October 25, 2024 [3]. In the state of Durango, Mexico, this emerging viral phenomenon resulted in a cumulative total of 82,201 confirmed cases and 3,704 deaths by

the same period, with the current dominant variant in Mexico being Omicron, B.1.1.529 [3,4].

The effects of SARS-CoV-2 on the human body can be classified as mild, moderate, severe, and critical. In the latter two categories, significant clinical manifestations have been identified, including severe respiratory distress, the need for mechanical ventilation, and, in many cases, patient death [5,6]. The severity of this disease has been linked to the presence of pre-existing comorbidities such as hypertension, diabetes, obesity, and cardiovascular diseases, which significantly increase the risk of developing severe complications. This may be due to SARS-CoV-2's ability to exacerbate underlying inflammatory and metabolic processes in these patients [7-9]. However, in addition to pre-existing comorbidities, the social determinants of health—defined as the conditions in which people are born, grow, live, work, and age, including the healthcare system—can influence the population's response to SARS-CoV-2 infection [10,11]. These circumstances result from the distribution of money, power, and resources globally, nationally, and locally, which are in turn shaped by the policies adopted by each country [12,13].

In this regard, Abrams EM & Szeffler SJ [14], in their work, highlight that factor such as race/ethnicity, poverty, median income level, housing density, housing insecurity, access to healthcare, occupation, transportation/mobility patterns, education, air quality, food insecurity, old age, among others, could increase SARS-CoV-2 morbidity [14]. Similarly, Salgado de Snyder, V. N., et al. [15], pointed out in their study that the social determinants identified as risk factors for developing severe illness from a SARS-

CoV-2 infection include working in an essential job, living in a geographic area with a high population density of Latinos and Blacks, overcrowded living conditions at home, and being unable to consistently practice preventive behaviors to avoid infection—conditions commonly exacerbated by inequalities and poverty [15]. In this context, Mexico is one of the countries with the greatest social and economic diversity, based on its cultural and ecological wealth [16]. In Durango, Mexico, healthcare services are divided into four regions known as Health Jurisdictions (Figure 1), which differ in population size and access to healthcare services. Difficult access or lower educational levels are the main factors that may act as social determinants predisposing individuals to severe outcomes from a SARS-CoV-2 infection.

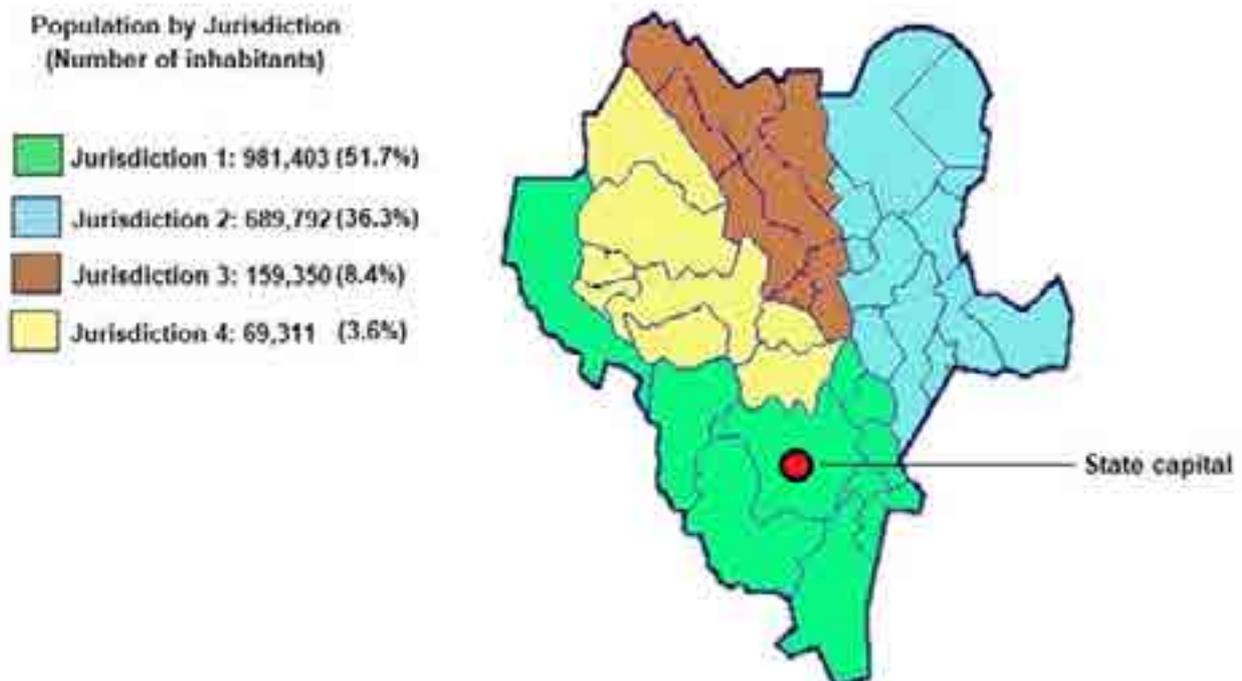
The objective of our study was to describe the clinical and epidemiological profile of patients infected with SARS-CoV-2 in the Health Jurisdictions of the Ministry of Health of Durango, Mexico, and to associate it with an increased risk of developing severe clinical manifestations due to SARS-CoV-2.

MATERIALS AND METHODS

Study Design

This is a descriptive, observational, and retrospective study based on the review of open data from the SISVER platform of patients treated in the four health jurisdictions of the state of Durango, Mexico.

Figure 1. Distribution of the population by health jurisdictions in Durango, Mexico.



Study Population

The population included all patients treated for symptoms consistent with COVID-19, excluding patients who were repeated in the SISVER platform database between April 5, 2020, and January 21, 2022.

Ethical Declarations

The study was conducted in accordance with the guidelines established in the Declaration of Helsinki and following the Guidelines for Good Clinical Practices of the International Conference on Harmonization, as well as the requirements of the Mexican regulatory body. According to the regulations of the General Health Law on Health Research, under Title II, which addresses ethical aspects of human research, Article 17 defines the risk of research as the probability that the research subject may suffer harm as an immediate or delayed consequence of the study. This research is considered risk-free as it employs retrospective documentary research techniques and methods, with no intentional intervention or modification of the physiological, psychological, or social variables of the individuals participating in the study. Therefore, we did not deem it necessary to implement informed consent.

Clinical Evaluation

To assess the clinical and epidemiological data, we included cases that were admitted with symptoms consistent with the operational definition of COVID-19 disease, confirmed by real-time RT-PCR and positive antigen testing.

Inclusion Criteria

Individuals infected with SARS-CoV-2 with a positive RT-PCR and antigen test from the four health jurisdictions of the Durango Health Services, recorded on the SINAVE platform between April 5, 2020, and January 21, 2022, were included.

Exclusion Criteria

Patients without clinical symptoms of SARS-CoV-2 infection and those with no positive RT-PCR or antigen test were excluded.

Elimination Criteria

Files with illegible or incomplete data were excluded.

Inclusion of Variables

For the epidemiological characteristics, we used variables such as age, sex, comorbidities, symptoms, and nationality.

Differences Between Jurisdictions

To conduct a comparative analysis of the data collected from the four Health Jurisdictions of the state of Durango, given that each jurisdiction presents distinct demographic and socioeconomic characteristics, an analysis was performed to elucidate how these patterns influence the transmission and clinical outcomes of patients.

Data Collection

Open data were obtained from the General Directorate of Epidemiology with the approval of Dr. Christian Zaragoza, General Director. Participant confidentiality was ensured by omitting identifying information from related materials. The researcher affirms and upholds the principle of the participant's right to privacy and will comply with applicable privacy laws. Participant anonymity was guaranteed by using numerical codes corresponding to the treatment data in the digital records.

Definition of Conditions

The conditions analyzed as comorbidities in this study, including smoking, were defined based on the clinical records available on the SISVER platform. Smoking was classified as "active smoker" and included patients who reported current tobacco use during medical consultations or whose medical history indicated active smoking at the time of evaluation. The remaining conditions, due to the retrospective nature of the study, were defined according to the diagnoses recorded in the clinical files by healthcare professionals, following standard diagnostic criteria used in routine medical practice.

Statistical Analysis

A descriptive statistical analysis was conducted to summarize the demographic and clinical characteristics of patients. Categorical variables included sex, type of care received (outpatient or hospitalized), deaths, and comorbidities such as hypertension, diabetes, obesity, cardiovascular disease, chronic kidney disease, chronic obstructive pulmonary disease, asthma, immunosuppression, and tobacco use. Continuous variables, such as age, were summarized using the mean and standard deviation.

To evaluate the relationship between specific covariates and severe outcomes, such as hospitalization,

intubation, or death, a multivariate analysis of relative inertia was performed. Subsequently, risks were calculated using the odds ratio test for the outcome “intubation” (which was identified in the multivariate analysis as the outcome most strongly associated with the covariates) and the covariates: pneumonia, hypertension, diabetes, obesity, cardiovascular diseases, chronic kidney disease, chronic obstructive pulmonary disease, asthma, immunosuppression, and tobacco use. These results were reported with their corresponding 95% confidence intervals. A p -value < 0.05 was considered statistically significant. All statistical analyses were performed using SPSS version 25 (IBM Corp., Armonk, NY, USA) and RStudio version 4.0.5.

RESULTS

A total of 63,252 valid records were analyzed, corresponding to patients distributed across the four health jurisdictions. The majority of cases (61.9%) were from Jurisdiction I, followed by Jurisdiction II with 20.4%, Jurisdiction III with 13.1%, and Jurisdiction IV with 4.6% (Figure 2).

Of the cases, 54.7% were female patients (34,595), while 45.3% were male (28,657). The mean age for female patients was 38.8 years, with a standard deviation of 12.7 years. For male patients, the mean age was similar at 36.9 years, with a standard deviation of 17.9 years. The overall age range was 10 to 81 years, with the most frequent age group being 30 to 39 years (22.1%), followed by the 20 to 29 years group (21.8%) (Table 1).

Figure 2. Distribution of COVID-19 cases by jurisdiction

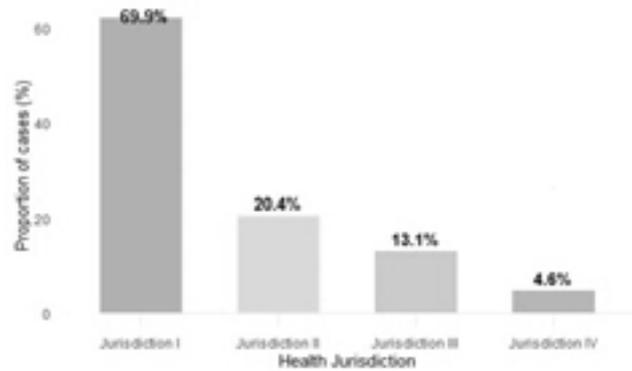


Table 2 presents the distribution of patients according to the type of care received (outpatient or inpatient) and the number of recorded deaths, broken down by jurisdiction. Of the 63,252 patients analyzed, most (93.8%) received outpatient care, while only 6.2% required hospitalization. This pattern was consistent across the four jurisdictions, although Jurisdiction IV had a slightly higher percentage of hospitalizations (8.6%) compared to the others (Figure 3).

Table 1. Demographic Distribution of Patients Analyzed by Jurisdiction

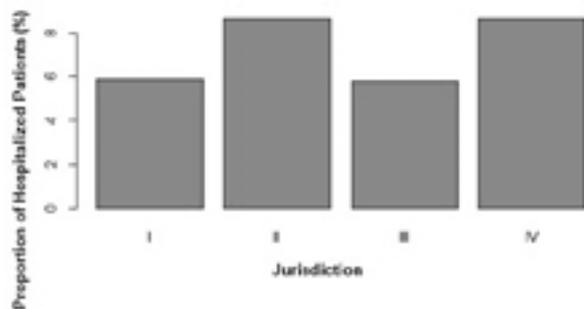
Category	Jurisdiction I	Jurisdiction II	Jurisdiction III	Jurisdiction IV	Total
Number of Patients	39,143 (61.9%)	12,927 (20.4%)	8,302 (13.1%)	2,880 (4.6%)	63,252 (100%)
Female Sex (%)	21,347 (61.7%)	7,146 (20.7%)	4,452 (12.9%)	1,650 (4.8%)	34,595 (54.7%)
Mean Age (Female)	-	-	-	-	38.8 (12.7)*
Mean Age (Male)	-	-	-	-	36.9 (11.9)*
Age Range (General)	-	-	-	-	10 – 81 years
Most Frequent Age	-	-	-	-	30-39 years (22.1%) 20-29 years (21.0%)

*SD

Table 2. Distribution of Patients According to Type of Care and Deaths by Jurisdiction

Category	Jurisdiction I	Jurisdiction II	Jurisdiction III	Jurisdiction IV	Total
Total of Patients	39,143 (61.9%)	12,927 (20.4%)	8,302 (13.1%)	2,880 (4.6%)	63,252 (100%)
Outpatient (%)	36,845 (94.1%)	11,905 (92.1%)	7,820 (94.2%)	2,631 (91.4%)	59,201 (93.8%)
Hospitalized (%)	2,298 (5.9%)	1,022 (7.9%)	482 (5.8%)	249 (8.6%)	4,051 (6.2%)
Total Deaths (%)	464 (1.2%)	107 (0.8%)	84 (1.0%)	45 (1.6%)	1,326 (2.1%)

Figure 3. Proportion of hospitalized patients by jurisdiction



Regarding deaths, 1,326 fatalities were recorded, representing 2.1% of the total patients. Jurisdiction I reported the highest number of deaths, with 464 cases (1.2%), followed by Jurisdiction II with 107 deaths (0.8%). Jurisdictions III and IV reported 84 (1.0%) and 45 (1.6%) deaths, respectively. These results underscore that, while most patients did not require hospitalization, the absolute number of deaths is notable in Jurisdiction I due to its larger volume of cases, while the proportion of deaths in Jurisdiction IV underscores a higher relative risk within a smaller population.

Table 3 shows the distribution of the main comorbidities among patients in the different jurisdictions. The most prevalent comorbidities were hypertension, obesity, and diabetes, while respiratory diseases such as COPD and asthma affected a smaller percentage of the population. Diabetes was present in 7.4% of total cases, with the highest prevalence in Jurisdiction II, where it reached 8.6%. Hypertension affected 11.6% of patients overall, with the highest prevalence in Jurisdiction I (11.8%) and the lowest in Jurisdiction IV (9.7%). Obesity was observed in

9.7% of patients, with variable distribution across the jurisdictions. Jurisdiction II had the highest prevalence (11.4%), while Jurisdiction IV had the lowest (5.2%).

Regarding respiratory diseases, COPD was reported in 0.6% of cases, being more common in Jurisdiction IV (1.1%). Similarly, asthma affected 2.4% of patients, with Jurisdiction I reporting the highest percentage (2.8%), and in total, 1,174 patients had pneumonia (1.8%). Other comorbidities, such as cardiovascular diseases and chronic kidney disease, affected a relatively low percentage of patients, with prevalences below 1.5% in all jurisdictions. Immunosuppression was reported uniformly across all jurisdictions, affecting approximately 0.6% of patients. Lastly, smoking was an important comorbidity, present in 6.3% of total cases, with the highest prevalence in Jurisdiction I (8.4%).

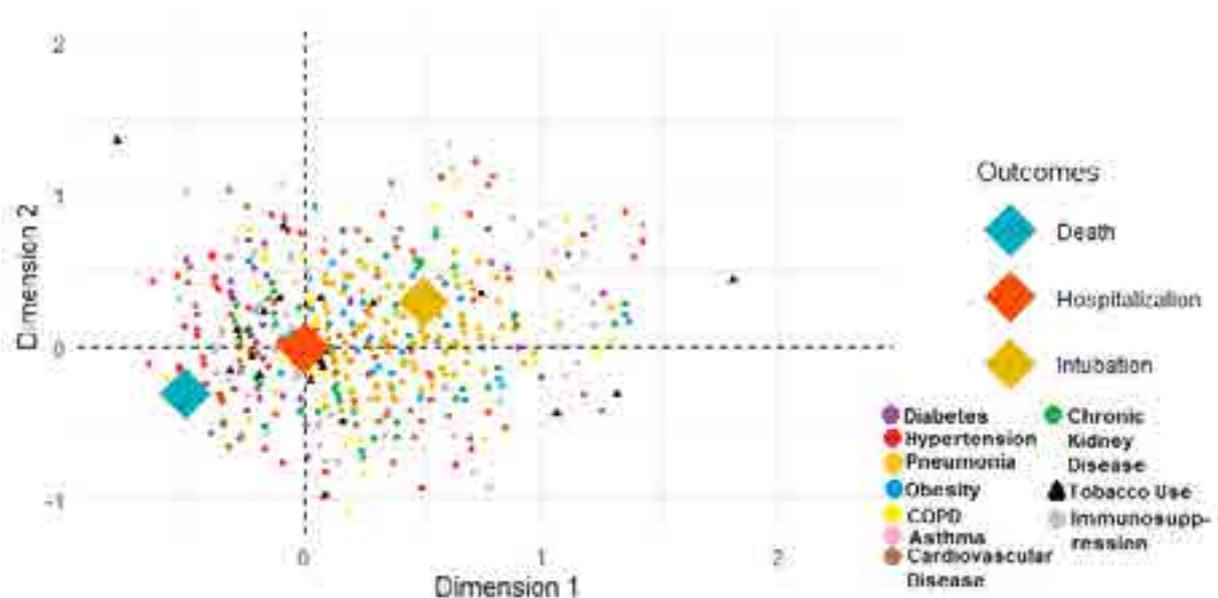
A multivariate analysis was conducted to evaluate the relationship between various covariates and the three severe outcomes included in the study (hospitalization, intubation, and death), using the graph of relative inertias. Relative inertia is a measure that identifies the individual contribution of each covariate to the total variability of the model, providing information about the specific weight of each variable in predicting the outcome. This measure is particularly useful for highlighting the variables with the greatest influence on clinical outcomes.

The results of the analysis generally show a greater tendency of the covariates toward intubation ($r = 0.7362$, $p = 0.02$). Furthermore, the covariates pneumonia and obesity exhibited the highest relative inertias toward intubation. Pneumonia had a relative inertia of $r = 0.6754$, $p = 0.03$, while obesity showed a value of $r = 0.6259$, $p = 0.04$ (Figure 4).

Table 3. Comorbidity Distribution by Jurisdiction

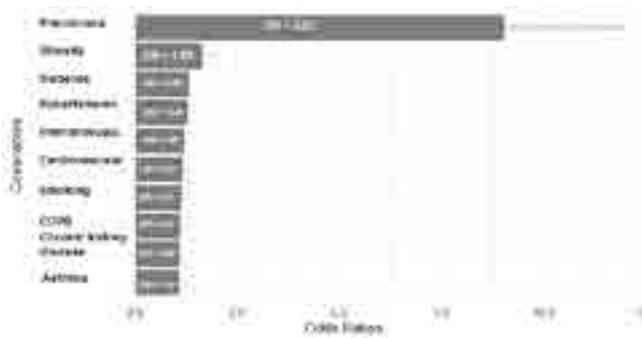
Comorbidity	Jurisdiction I	Jurisdiction II	Jurisdiction III	Jurisdiction IV	Total
Diabetes (%)	2,914 (7.4%)	1,115 (8.6%)	675 (8.1%)	195 (6.8%)	4,899 (7.4%)
Hypertension (%)	4,622 (11.8%)	1,503 (11.6%)	924 (11.1%)	279 (9.7%)	7,328 (11.6%)
Pneumonia (%)	554 (0.8%)	332 (0.5%)	189 (0.3%)	99 (0.15%)	1,174 (1.8%)
Obesity (%)	3,815 (9.7%)	1,468 (11.4%)	813 (9.8%)	151 (5.2%)	6,247 (9.7%)
COPD (%)	253 (0.6%)	116 (0.9%)	92 (1.1%)	33 (1.1%)	494 (0.6%)
Asthma (%)	1,092 (2.8%)	238 (1.8%)	190 (2.3%)	26 (0.9%)	1,546 (2.4%)
Cardiovascular Disease (%)	402 (1.0%)	161 (1.2%)	113 (1.4%)	23 (0.8%)	699 (1.1%)
Chronic Kidney Disease (%)	286 (0.7%)	90 (0.7%)	87 (1.0%)	11 (0.4%)	474 (0.7%)
Tobacco Use (%)	3,290 (8.4%)	498 (4.5%)	190 (2.3%)	26 (0.9%)	4,004 (6.3%)
Immunosuppression (%)	238 (0.6%)	83 (0.6%)	46 (0.6%)	20 (0.7%)	387 (0.6%)

Figure 4. Multivariate analysis using the graph of relative inertias between specific covariates and severe outcomes, such as hospitalization, intubation, or death



Once it was observed that most covariates were more strongly associated with intubation, the association between each covariate (comorbidities) and intubation was evaluated using the Odds Ratio test (Figure 5). The odds ratios reflect the strength of the association between each covariate and the risk of a patient requiring intubation. Significant associations were found between intubation and pneumonia, with an OR of 9.03 (95% CI: 6.82 - 11.96, $p = 0.03$). Similarly, a strong association was identified between obesity and intubation, with an OR of 1.84 (95% CI: 1.35 - 1.98, $p = 0.001$).

Figure 5. Risk association between different covariables and intubation by COVID



*No statistical significance

DISCUSSION

The findings of this study, which analyzed 63,252 valid records of COVID-19 patients, offer a comprehensive epidemiological and clinical profile of the disease across distinct health jurisdictions in Durango, Mexico. Jurisdiction I, representing the most densely populated region, accounted for 61.9% of total cases, with a notable mortality rate of 2.1%. This highlights the severity of the pandemic in this area, likely influenced by multiple factors, including access to healthcare, the capacity of health infrastructure, and the demographic composition of the population, given that a significant portion of Durango's inhabitants reside there.

A critical insight from the analysis is that 93.8% of the patients received outpatient care, indicating that most cases were mild and did not necessitate hospitalization. However, the 6.2% of patients requiring hospitalization and the 2.1% mortality rate point to the vulnerability of certain subgroups that may not be receiving timely or adequate medical intervention. The predominance of outpatient management mirrors trends reported in other studies, where a significant proportion of COVID-19 patients exhibit mild symptoms manageable at home, while

those admitted to hospitals typically face more severe disease courses [17-20].

The pattern of comorbidities observed in this population aligns with existing literature, with hypertension, obesity, and diabetes identified as major contributors to the severity of COVID-19 [21,22]. As noted by Gallo et al. [23], hypertension is often linked with advanced age and other cardiovascular risk factors that may predispose individuals to infection [23]. However, in this study, the median age was relatively young at 38 years, yet 11.6% of patients were hypertensive, suggesting that factors beyond advanced age are at play. Yamazaki O et al. [24], have also demonstrated that the association between pre-existing hypertension and hospital mortality in COVID-19 patients may be largely explained by the concurrent presence of other risk factors such as obesity, diabetes, cardiovascular disease, and chronic kidney disease [24]. Further investigation into the role of hypertension, independent of these co-factors, in the progression of COVID-19 is warranted.

Obesity, present in 9.7% of patients, emerged as a significant risk factor, consistent with findings that obese individuals are more likely to require intubation and face severe complications [25,26]. Michalakakis et al. [27], have highlighted the specific inflammatory and immunological challenges posed by obesity, which increase susceptibility to severe respiratory infections and exacerbate the morbidity and mortality of SARS-CoV-2 infections [27]. Our study corroborates these findings, demonstrating a strong association between obesity and the need for intubation, underscoring the necessity of addressing obesity as a modifiable risk factor in both the prevention and management of COVID-19.

The significant association between pneumonia and intubation emphasizes the need for proactive clinical vigilance in managing respiratory complications in COVID-19 patients. This is in line with existing research, which identifies pneumonia as a critical factor that escalates the need for mechanical ventilation and increases mortality risk [28,29]. With 92.9% of intubated patients in this study also diagnosed with pneumonia, healthcare providers must prioritize the early detection and treatment of this condition, particularly in high-risk patients.

Variations in the prevalence of comorbidities across jurisdictions may reflect disparities in healthcare access, socioeconomic status, and lifestyle factors. For instance, Jurisdiction II exhibited the highest prevalence of obesity (11.4%), indicating the need for region-specific interventions. The results underscore the importance of a comprehensive, multidisciplinary public health approach, not only addressing the infectious disease itself but also the underlying risk factors that predispose individuals to severe COVID-19. This approach should include health promotion, education on chronic disease management, and the enhancement of primary healthcare systems to ensure that individuals with comorbidities receive appropriate

care and follow-up.

By addressing these multifaceted factors, healthcare systems can better manage the pandemic's impacts and improve outcomes for vulnerable populations, particularly in regions with high comorbidity prevalence and healthcare disparities.

CONCLUSION

This study underscores the substantial burden of comorbidities in COVID-19 patients and their profound impact on disease outcomes, particularly in relation to severity. The strong association between pneumonia and the need for intubation highlights the critical importance of early identification and management of respiratory complications. Furthermore, the recognition of key modifiable risk factors, such as obesity and hypertension, should inform targeted public health strategies aimed at reducing the risk of severe COVID-19 manifestations. The findings reinforce the necessity of a multidisciplinary, patient-centered approach to the management of COVID-19, which integrates early clinical intervention, tailored comorbidity management, and public health initiatives focused on prevention and health promotion in at-risk populations. This holistic approach will be vital in mitigating the long-term impacts of COVID-19, especially in vulnerable demographic groups.

ACKNOWLEDGMENTS

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CONFLICT OF INTEREST

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

DATA AVAILABILITY STATEMENT

The original contributions presented in the study are included in the article further inquiries can be directed to the corresponding author.

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