ORIGINAL ARTICLE

Causes of mortality in older pneumonia patients during 2020 in northeast Mexico

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ABSTRACT

Background: During 2020, all attention was given to COVID-19, it remains to be assessed whether other factors contributed to the older people in-hospital mortality.
Aim: To describe the main factors associated with all-cause in-hospital mortality in older patients with pneumonia.
Methods: This cross-sectional study included a total of 332 records, which were collected from December 1, 2020, to January 5, 2021, from a hospital located in Nuevo León, Mexico. Chi-squares and logistic regressions were performed to determine associations and predisposing factors for in-hospital mortality, respectively.
Results: In the general population, an age above 76, having more than one comorbidity, a respiratory frequency > 29, COVID-19 infection, a BMI >30 and a saturation of oxygen/fraction of inspired oxygen ratio (SpO2/FiO2 ratio) <300 were associated with in-hospital mortality. For both, COVID-19 positive and COVID-19 negative, age >76, more than one comorbidity and an RF >29 were associated with in-hospital mortality whereas a BMI >29 and an SpO2/FiO2 ratio <300 was associated with in-hospital mortality only in COVID-19 positive patients.
Conclusion: During COVID-19 pandemic, BMI and SpO2/FiO2 ratio marked the difference between COVID-19 positive and COVID-19 negative patients' outcomes.
Keywords: Respiratory disease, Morbidity and mortality trends, Risk/risk behavoiur, Infectous disease, Epidemiology

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INTRODUCTION

In 2019, a virus was discovered in China, which was responsible for an acute respiratory syndrome now known as COVID-19, a disease that was declared a pandemic in March 2020. Up to November 21, 2024, there have been 778 million COVID-19 cases with more than 7 million deaths [1]. Several COVID-19 vaccines have been developed, and they began to be administered in December 2020, around a year after the first COVID-19 cases. Currently, COVID-19 is no

longer considered a pandemic; however, the virus responsible for COVID-19 disease, SARS-CoV-2, is still circulating, and several variants have been discovered. For this reason, SARS-CoV-2 currently remains under surveillance.

Sex, age and comorbidities were associated with COVID-19 infection, COVID-19 severity and death due to COVID-19 [2,3]. The Mexican population suffers a high burden of diabetes mellitus, cardiovascular diseases and obesity, with the latter being the leading cause of national disease during 2023, followed by hypertension and type 2 diabetes mellitus [4]. Cardiovascular disease was the main cause of death during 2023, followed by diabetes mellitus and cancer [5]. Diabetes mellitus prevalence increases with age, being present in 10.1% of adults between 20-39 years of age and increasing to 23% in adults over 60 years old [6]. Hypertension is also one of the most common cardiovascular diseases present in the Mexican population, with a prevalence of 10.1% in adults between 20-39 years of age and increasing to 17.4% in adults over 60 years old [6].

Globally, mortality patterns changed dramatically during the COVID-19 pandemic, and several countries have reported the main causes of death, not assigned to COVID-19, which for the United States were cardiovascular diseases, Alzheimer and diabetes, agreeing with reports from Italy and China, these two latter countries adding respiratory diseases to the list [7–9]. Also, a recent study from 2025, analyses the excess non-COVID-19 related deaths from 2020-2024 in United Stated showing that pneumonia was the highest specific cause of death [10].

Excess mortality is the result of the difference between the total number of deaths during an emergency and the number of deaths under normal conditions [11], and specifically in older adults it has been shown that excess deaths among older adults from 2020 and 2021, in age groups of 65-74, 75-84 and above 85, are the highest in India and lowest in Japan, with Mexico being among the 20 countries with the highest excess mortality rates during COVID-19 pandemic [11].

During the pandemic, other studies have investigated other causes of death beside COVID-19 and a report has enlisted the main specific, non-COVID-19 related death causes in Mexicans, which include diabetes, respiratory infections, ischemic heart diseases and hypertensive diseases [12]. Unfortunately, the latter study did not categorized patients by age.

Official sources have also documented the excess deaths by cause during COVID-19 pandemic and an excess death of 41.9% was reported for 2020, with the main causes of death being Diabetes, cardiovascular disease and respiratory infection with an increased mortality of 49.3%, 35.6% and 85.6, respectively compared to 2019 [13].

Older adults are at higher risk of acquiring infections, disease-related complications and death [14]. In the present study we aim to describe the main factors associated with all-causes in-hospital mortality in older patients with pneumonia from the zone general hospital No. 4 located in Nuevo Leon Mexico during the COVID-19

MATERIALS AND METHODS:

Study design

This is a cross-sectional study in a cohort of older patients. Medical records were consulted and data in the public repository are de-identified. A total of 356 records were obtained from the Zone General hospital No. 4 database,

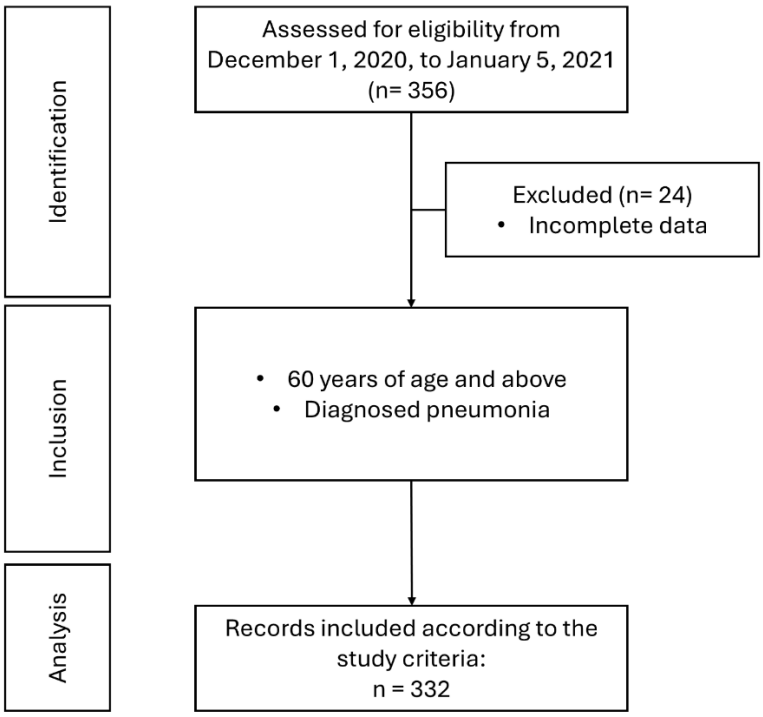

Figure 1. STROBE flow chart representing the study design.

from December 1, 2020, to January 5, 2021. This hospital was reconverted to only admit patients with suspected COVID-19. Due to incomplete data, 24 records were excluded, and 332 records were analyzed. Figure 1 shows the study design.

Eligibility criteria

The present study included patients of 60 years of age and above, admitted to the hospital due to pneumonia. The exclusion criteria applied to those patients who required surgery, were admitted to the hospital due to acute ischemic heart disease, with only a rapid COVID-19 test, patients who opted for voluntary discharge and those who were diagnosed with pneumonia 48 hours after being admitted to the hospital or admitted with other reasons than pneumonia. Pneumonia was diagnosed with the findings on chest X-rays.

Sample Size

A proportion formula was used to determine the minimum sample size. With a hypothesized percentage of frequency of outcome factor in the population of 22% [15], and a 5% confidence limit the calculated minimum sample size was 264.

Outcome: In-hospital mortality

In-hospital mortality was obtained from clinical records

Body mass index (BMI)

BMI was calculated by dividing weight over squared height in meters. Patients were categorized into those with less than 30 BMI and those with a BMI over 30, being the former the reference group in statistical analyses.

Systolic arterial pressure (SAP)

SAP was obtained from clinical records and hospital databases, cutoff points were < 100.9 mmHg and ≥101 mmHg, with the reference for statistical analyses being <100.9.

Respiratory frequency (RF)

RF was obtained from clinical records and hospital databases, patients were categorized into those with <23 breaths per minute (BPM), those with 24-48 BPM and those with more than 29 BPM, being <23 BPM the reference for statistical analyses.

Saturation of oxygen/fraction of inspired oxygen ratio (SpO2/FiO2)

SpO2/FiO2 was obtained from clinical records and hospital databases. Patients were categorized into those with >300 SpO2/FiO2 ratio and those with <299.9, being ≥300 the reference for statistical analyses.

Glucose

Glucose was obtained from clinical records and hospital databases and patients were categorized into those with <199.9 mg/dl and those with ≥200 mg/dl serum glucose levels. Being <199.9 the reference for statistical analyses.

Albumin

Albumin was obtained from clinical records and hospital databases and patients were categorized into those with ≥3.5 mg/dl and those with <3.49 mg/dl. Being ≥3.5 mg/dl the reference for statistical analyses.

Lactate dehydrogenase (LDH)

LDH was obtained from clinical records and hospital databases and patients were categorized into those with <199.9 IU/L and those with ≥200 IU/L, being <199.9 the reference group for statistical analysis.

COVID-19 diagnosis

COVID-19 diagnosis was obtained from clinical records and hospital databases. A positive PCR test was used to diagnose COVID-19 disease.

Statistical analysis

Qualitative variables were described as frequencies and percentages. For quantitative variables, mean (min, max) and median and interquartile range (IQR) were calculated. For associations, chi-squares were performed, and logistic regression models were performed to determine odd ratios (OR) and 95% Confidence Interval (CI) with mortality as the dependent variable; sex, age, BMI, albumin, dyspnea, SAP, RF, glucose, LDH, SpO2/FiO2 were included as independent variables. Data was analyzed using the SPSS software (Chicago, Illinois, USA). There were no records with missing data in the study.

RESULTS

Characteristics of the population

As seen in table 1, overall, males represented 57.8% and among the factors associated with in-hospital death we found age, with death being most common in patients over 76 years old. An overall in-hospital mortality rate of 53.3% was observed, with hypertension representing the most common comorbidity among deceased patients (19.8%), followed by those with more than one comorbidity (41.8%) and diabetes (6.2%). For non-comorbid patients an 8.5% of death was observed. As seen in table 1, out of 90 COVID-19 negative patients 32 (35.6%) died and from 242 COVID-19 positive

Table 1. Characteristics of the population (n=332).

Characteristics	**Total, n (%)**	**Outcome**		**Chi-square *p*-value**
		Recovery	Death	
		n (%)	n (%)	
Sex				
Male	192 (57.8)	85 (54.8)	107 (60.5)	0.301
Female	140 (42.2)	70 (45.2)	70 (39.5)	
Age				
60-65	94 (28.3)	54 (34.8)	40 (22.6)	<0.001
66-70	85 (25.6)	48 (31.0)	37 (20.9)	
71-75	66 (19.9)	28 (18.1)	38 (21.5)	
>76	87 (26.2)	25 (16.1)	62 (35.0)	
Comorbidities				
Non-comorbid	47 (1.2)	32 (20.6)	15 (8.5)	0.006
Hypertension	80 (24.1)	45 (29.0)	35 (19.8)	
Diabetes Mellitus	22 (6.6)	11 (7.1)	11 (6.2)	
COPD	4 (1.2)	1 (0.6)	3 (1.7)	
Liver disease	1 (0.3)	1 (0.6)	0 (0.0)	
Oncological disease	6 (1.8)	3 (1.9)	3 (1.7)	
Autoimmune disease	2 (0.6	1 (0.6)	1 (0.6)	
Dementia	2 (0.6)	0(0.0)	2 (1.1)	
Two comorbidities	120 (36.1)	46 (29.7)	74 (41.8)	
More than two comorbidities	48 (14.5)	15 (9.7)	33 (18.6)	
COVID-19				
Negative	90 (27.1)	58 (37.4)	32 (18.1)	<0.001
Positive	242 (72.9)	97 (62.6)	145 (81.9)	
Dyspnea				
Yes	308 (92.8)	138 (89.0)	170 (96.0)	0.014
No	24 (7.2)	17 (11.0)	7 (4.0)	
Variable, mean (Min, Max)				
BMI, 28.5 (28.0, 29.0)				
<30	253 (76.2)	126 (81.3)	127 (71.8)	0.042
>30	79 (23.8)	29 (18.7)	50 (28.2)	
SAP, 130.2 mmHg (127.5 mmHg, 132.8 mmHg)				
>100 mmHg	307 (92.5)	147 (94.8)	160 (90.4)	0.126
0-99.9 mmHg	25 (7.5)	8 (5.2)	17 (9.6)	
RF, 25.2 BPM (24.6 BPM, 25.7 BPM)				
0-23 BPM	131 (39.5)	71 (45.8)	60 (33.9)	<0.001
24-28 BPM	141 (52.5)	70 (45.2)	71 (40.1)	
>29 BPM	60 (18.1)	14 (9.0)	46 (26.0)	
SpO2/FiO2, 279.1 (265.8, 292.50)				
>300	156 (47.0)	86 (44.5)	70 (39.5)	0.004
0-299.9	176 (53.0)	69 (44.5)	107 (60.5)	

Glucose, 185.1 mg/dl (170.6 mg/dl, 199.6 mg/dl)				
<200 mg/dl	228 (58.7)	119 (76.8)	109 (61.6)	0.003
≥200 mg/dl	104 (31.3)	36 (23.2)	68 (38.4)	
Albumin, 3.3 mg/dl (3.2 mg/dl, 3.4 mg/dl)				
>3.5 mg/dl	125 (37.7)	73 (47.1)	52 (29.4)	0.001
<3.5 mg/dl	207 (62.3)	82 (52.9)	125 (70.6)	
LDH, 403 IU/L (371 IU/L, 434.4 IU/L)				
<200 IU/L	43 (13.0)	25 (16.1)	18 (10.2)	0.107
≥200 IU/L	289 (87.0)	130 (83.9)	159 (89.8)	

COPD chronic obstructive pulmonary disease, BMI body mass index, LDH lactate dehydrogenase, SpO_2/FiO_2 Saturation of oxygen/fraction of inspired oxygen ratio.

patients 145 (60%) died. Dyspnea, BMI, RF, SpO2/FiO2, glucose, and albumin were associated with increased in-hospital mortality.

Factors associated with in-hospital mortality in older patients with pneumonia

As shown in table 2, among the factors associated with in-hospital mortality an age >76, a RF >29 BPM, a positive COVID-19 PCR test, a BMI >30 and SpO2/FiO2 <300, were predisposing factors for in-hospital mortality in older patients with pneumonia**.**

Factors associated with in-hospital mortality in older COVID-19 positive and negative patients with pneumonia

We then evaluated whether the predisposing factors for in-hospital mortality differed between COVID-19 positive and COVID-19 negative patients. Table 3 shows that smong the differences between the aforementioned groups, RF >29 BPM, BMI and SpO2/FiO2 were predisposing factors for in-hospital mortality in COVID-19 positive patients.

DISCUSSION

In general, there were more older and comorbid patients in the COVID-19 positive group. Ages >76 were predisposing factors for in-hospital mortality in both COVID-19 positive and COVID-19 negative groups, and this follows the mean life expectancy trend in Mexicans living in Nuevo León, which is 67.7 and 75.9 for men and women, respectively, and with a national mean of 71.6 for 2020 [16].

An in-hospital mortality rate of 53.3% was reported in the present study and compared to the overall mortality rate reported in people over 60 in the general Mexican population during 2024, which was 66.1%, we observe a lower mortality rate [17]. Specifically in Nuevo León, a mortality rate of 65% was reported 2024 [17]. Compared to 2019, a year before the pandemic, given that in Mexico the first COVID-19 cases were reported in february 2020, the mortality rate was 64.2% in the national territory whereas in Nuevo León, mortality in people above 60 was 62.5% [17]. When COVID-19 infection is taken into account, nationally, in people above 65, COVID-19 caused was 18.56% of total deaths during 2020

Table 2. Factors associated with in hospital mortality in older patients with pneumonia (n=332).

Variable	OR (95%CI)	*p*-value
Sex		
Male	Ref.	
Female	0.73 (0.43, 1.24)	0.250
Age		
60-65	Ref.	
66-70	1.04 (0.53, 2.05)	0.906
71-76	1.85 (0.88, 3.90)	0.104
76+	4.13 (1.99, 8.56)	<0.001
Comorbidities		
None	Ref.	
One comorbidity	2.32 (1.03, 5.24)	0.043
More than one comorbidity	3.22 (1.42, 7.29)	0.005
Respiratory frequency (BPM)		
0-23	Ref.	
24-28	1.15 (0.66, 1.99)	0.621
>29	3.80 (7.73, 8.38)	0.001
COVID-19		
Positive	3.69 (1.96, 6.93)	<0.001
Laboratory results		
Glucose >200 mg/dl	1.53 (0.84, 2.80)	0.164
BMI >30 kg/m2	1.98 (1.06, 3.71)	0.032
Albumin <3.5 g/dl	1.41 (0.82, 2.41)	0.215
LDH >200	1.33 (0.63, 2.83)	0.452
SpO_2/FiO_2 <300	2.31 (1.33, 4.03)	0.003

CI confidence interval, OR odds ratio.

and 21.58 % during 2021, and in people of 65 years an above, mortality rate was 9.7% and 11% for 2020 and 2021, respectively [18]; compared to our results, we observe 60% mortality rate in COVID-19 positive patients. The discrepancies could be due to the low number of patients recruited in the present study.

Regarding causes of death, in other populations and in Mexicans, comorbidity burden has been reported to be the most significant risk factor for mortality [3]. In Mexico, cardiovascular diseases were the leading cause of death during 2023, followed by diabetes Mellitus and cancer [5]. Mexico is one of the countries with the highest incidence of diabetes being among the first place in 2021 for people with diabetes (20-79 years) from estimated in North America and the Caribbean [19]. According to national reports whe incidence of diabetes was 24.9% during 2018 for people over 70 years and 25.8% for those between 60-69 years of age [20]. In the studied population people with diabetes as a single comorbidity was 6.6%. However, diabetes is often accompanied by other comorbidities such as hypertension. In our population, there were

Table 3. Factors associated with in hospital mortality in older patients with pneumonia depending on COVID-19 diagnosis (n=332).

Variable	COVID-19 negative (n=90)			COVID-19 positive (n=242)	
	OR (95%CI)	p-value		OR (95%CI)	p-value
Sex					
Male	Ref.			Ref.	
Female	0.40 (0.11, 1.46)	0.166		0.92 (0.50, 1.71)	0.793
Age					
60-65	Ref.			Ref.	
66-70	1.35 (0.35, 5.66)	0.679		0.95 (0.42, 2.15)	0.894
71-76	2.18 (0.29, 16.58)	0.45		1.48 (0.63, 3.52)	0.370
76+	12.90 (2.16, 77.08)	0.005		3.21 (1.36, 7.59)	0.008
Comorbidities					
None	Ref.			Ref.	
One comorbidity	2.35 (0.30, 18.62)	0.419		3.10 (1.25, 7.91)	0.018
More than one comorbidity	18.26 (1.50,223.16)	0.023		2.73 (1.11, 6.73)	0.029
Respiratory frequency (BPM)					
0-23	Ref.			Ref.	
24-28	3.56 (0.74, 17.03)	0.113		0.75 (0.40, 1.41)	0.373
>29	4.74 (0.78, 28.87)	0.091		4.07 (1.42, 11.69)	0.009
Laboratory results					
Glucose >200 mg/dl	0.76 (0.14,4.18)	0.753		1.70 (0.84, 3.41)	0.138
BMI >30 kg/m2	1.04 (0.24, 4.42)	0.961		2.45 (1.16, 5.19)	0.019
Albumin <3.5 g/dl	1.24 (0.37, 4.16)	0.726		1.41 (0.74, 2.67)	0.294
LDH >200	0.35 (0.05, 2.45)	0.293		1.97 (0.84, 4.65)	0.121
SpO_2/FiO_2 <300	2.62 (0.43, 16.10)	0.298		2.33 (1.27, 4.31)	0.007

BMI body mass index, BPM beats per minute, CI confidence interval, LDH lactate dehydrogenase, OR odd ratio, RF respiratory frequency, SpO_2/FiO_2 saturation of oxygen/fraction of inspired oxygen ratio.

144 patients with both diabetes and hypertension. Taking this into account, the prevalence of diabetes in the studied population was 50%. Hypertension is also of the most common comorbidities in our population and considering patients with 2 comorbidities, there were 241 cases with hypertension, which corresponds to 72.5%, which agrees with literature for this age group with an expected incidence of 76.9 % [21]. Having more than two comorbidities was associated with in-hospital mortality in the studied population.

BMI was associated with in-hospital mortality in COVID-19 positive patients. In this subgroup 17 (18.9%) patients had a BMI greater than 30. Obesity is a major public health problem in Mexico, with a reported 37% incidence in adults during 2020-2023 [22], and it has been already pointed out as a risk factor for hospitalization, intensive care unit admission, invasive mechanical ventilation, and

mortality in COVID-19 positive patients [23–25]. The present article agrees by demonstrating that this is also the case in older patients. Specifically in the Mexican population from Nuevo León, a study has reported that obesity is associated with infection and an increased severity of COVID-19 [2]. Chronic inflammation could be one of the potential mechanisms by which obesity might be predisposing to COVID-19 infection and death [26]. Chronic inflammation might cause an increase of inflammatory molecules compared to non-obese patients when infected with COVID-19 [27]. In Mexicans, obesity has also been associated with other factors that predispose to systemic infections, alteration of immune response and an increased risk of severe COVID-19 disease such as vitamin D deficiency, intestinal dysbiosis and a possible increased expression of the SARS-CoV-2 receptor ACE-2 in adipose tissue [26].

We show in the present study that a respiratory frecuency above 29 is a predisposing factor for in-hospital mortality, however it is not specifically associated with death due to COVID-19 given that a RF >29 is also associated with in-hospital death in COVID-19 negative patients. Higher respiratory rate has already been associated with in-hospital mortality in patients with pneumonia (n=705,728), with an OR of 1.72 for a RF of 29-33 BPM and an OR of 2.55 for patients with a RF of 33 BPM [28]. Respiratory frequency is included in several scales of in-hospital mortality prediction such as the National early warning score (NEWS) where a low RF (8-11 BPM) and high RF (21-25) adds risk points [29].

Another factor that was significantly associated with in-hospital mortality in COVID-19 positive patients was a SpO2/FiO2 ratio of <300. Several drawbacks have been reported when using SpO2/FiO2 ratio including anemia, excessive motion, low perfusion, skin color, among others [30]. In patients with COVID-19 pneumonia a multivariate analysis performed in 272 patients revealed that only SpO2/FiO2 level was found to be an independent parameter associated with 30-day mortality [31,32]. The latter agrees with our study.

We recognize that our study has limitations such as the low number of patients, which only came from a general hospital that was reconverted to a COVID-19 hospital during the pandemic. Furthermore, given that this is a geriatric population it is possible that some comorbidities are underdiagnosed. Results could vary depending on the population; therefore, more studies should be performed in a larger cohort and in different populations. Important conditions such as frailty and dependency should be included in future studies. Another limitation is that this is not recent data and SARS-CoV-2 has evolved since. According to our analysis special attention should be taken when taking care of patients above 76 or with a diagnosis of diabetes mellitus or more than two comorbidities, with a respiratory frequency > 29, a BMI > 30 or SpO2/FiO2 <300.

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Ethics approval and consent to participate: The study was conducted in accordance with the Declaration of Helsinki and approved by the Institutional Review Board

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ΒΙΒΛΙΟΓΡΑΦΙΑ

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