

Analysis of fatality of cases by the new coronavirus, in the Mexican state of Guanajuato: A cross-sectional study

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Abstract

Background. The spread of infection and disease of SARS-CoV-2 is in all the world affecting more than 200 countries. Mexico has high new cases of disease and death for COVID-19. Although Guanajuato state also has a high number of new cases, the fatality of cases is below the mean in Mexico.

Methods. It was a cross-sectional design, using the database of National Epidemiological Surveillance System in Mexico. It was collected data about age, sex, comorbidities (diabetes, chronic obstructive pulmonary disease, asthma, hypertension, cardiovascular disease, immunosuppression, chronic kidney disease, obesity and smoking), date of death, and real-time reverse transcription polymerase test. The statistical analysis was using Case Fatality Ratio, Chi squared test and *P*-value to show relationship among variables and Odds Ratio and confidence intervals at 95% to show the effect of comorbidities on death due to COVID-19.

Results. There were 100,109 suspected cases, 41.69% were positive for SARS-CoV-2. Age from 50 or higher and male sex had higher effect on fatality by COVID-19. In Guanajuato state, 48.68% of deaths occurred in Instituto Mexicano del Seguro Social, with a case fatality ratio 15.63% and in the Secretaría de Salud del estado de Guanajuato occurred 42.10% of the deaths with a case fatality ratio of 4.14%. Diabetes (OR 5.16, CI95% 4.77–5.59), chronic obstructive pulmonary disease (OR 6.34, CI95% 5.37–7.49), immunosuppression (OR 2.85, CI95% 2.17–3.76), cardiovascular disease (OR 4.20, CI95% 3.51–5.02), hypertension (OR 4.74, CI95% 4.39–5.11), chronic kidney disease (OR 6.27, CI95% 5.30–7.42), obesity (OR 1.87, CI95% 1.72–2.03), and smoking (OR 1.60, CI95% 1.41–1.81) had effect on death by COVID-19. In all cases age and male sex, acted as confounder. Asthma had a preventive effect on death by COVID-19 (OR=0.72, CI95% 0.54–0.97)

Conclusion. Among the Guanajuato population with COVID-19, the main risk factor for dying were advanced age and male sex; diabetes, chronic obstructive pulmonary disease, immunosuppression, cardiovascular disease, chronic kidney disease, obesity, and smoking are risk factors for dying from COVID-19. HIV/AIDS has no effect on fatality from SARS-CoV-2 disease. Asthma is shown as a protective factor for dying from COVID-19.

Background

In November 2019, an outbreak of pneumonia of unknown cause was reported in Wuhan, China [1]. Shortly afterwards it was announced that the cases were due to a new coronavirus, it was called the new coronavirus and later re-named the respiratory distress virus acute 2 (SARS-CoV-2) [2] and causing a disease called novel coronavirus-19 disease (COVID-19) [3].

One of the concerns has been the deaths due to this disease; the Case Fatality Ratio (CFR) is a widely used measure for public health decision-making in relation to COVID-19 [4]. The definition of a COVID-19 death is the result of an illness consistent with a confirmed COVID-19 case [4].

Faced with the imminent arrival of the pandemic to the state of Guanajuato, the state civil authorities initiated preventive actions, such as social isolation, staying at home; closure of educational institutions of all levels as of March 20, 2020 and a week later the closure of restaurants, gyms, public parks and cancellation of massive events and cancellation of meetings with more than 10 people, and that contained, the spread of the infection in the state, although later the numbers of confirmed cases increased and it was decided on March 27 to open a hospital to exclusively serve COVID-19 patients, being the first state in Mexico to have an exclusive hospital for patients with COVID-19 and the subsequent conversion of several hospitals at the state level, due to this and to the preparation, equipment, supplies, human resources for the care of the hospital form of COVID-19 and the timely hospitalization, it

is likely to reflect low CFRs in previous reports [5], compared to that reported throughout Mexico. In addition, on June 22, the COVID Mobile Hospital began operations, also dedicated to treating the same type of patients.

The first confirmed case of disease by the new coronavirus (COVID-19) in Guanajuato state was reported as beginning of clinical data on March 10, 2020 [3], and the two deaths were registered April 5, 2020 [6].

The World Health Organization (WHO), in the document Diagnostic Tests for SARS-CoV-2: Interim Guidance, recommends the real-time reverse transcription polymerase test (rRT-PCR) for the diagnosis of SARS infection. CoV-2 and COVID-19 [7].

In July 2020, when the number of new cases increased notably in the state, the case fatality ratio was 4.72% at the state level and 10.99% at the national level [5].

The state of Guanajuato is located in the center of the Mexican Republic, with location data: Longitude # 102 ° 5'49.2 "W # 99 ° 40'16.68" W, Latitude 19 ° 54'46.08 "N 21 ° 50'21.84 "N [8]. The state had 5,486,372 inhabitants, which represented 4.88% of the Mexican population, according to the 2010 census [9].

The objective was to analyze the fatality among confirmed cases of COVID-19 in Guanajuato State from Mexico, until October 2, 2020, and the effect of comorbidities on it.

Methods

It is a cross-sectional analytical study of fatality by COVID-19 confirmed cases, in Guanajuato State from Mexico, registered in the database of the Sistema Nacional de Vigilancia Epidemiológica (SINAVE) de la Dirección General de Epidemiología (DGE), of confirmed and discarded cases of COVID-19 [10].

The database was used until October 2, 2020, of the confirmed cases of COVID-19 in Guanajuato state from Mexico and the deaths registered as result of COVID-19. The database from SINAVE is the registry of all suspected, confirmed and discarded cases from COVID-19, from Secretary of Health from Mexico.

As a universe, all the records included in the database were up to October 2, 2020.

The selected records in the analysis were those registries with complete data. There were no exclusion criteria and the elimination criteria were incomplete records in their data.

According to the guidelines of SINAVE/DGE, a suspected case was one with a clinical finding considered greater (cough, fever, headache or dyspnea and accompanied by at least one of the following: myalgia, arthralgia, odynophagia, chills, chest pain, rhinorrhea, anosmia, dysgeusia or conjunctivitis) [11].

A confirmed case of COVID-19 is a person with a positive rRT-PCR test for SARS-CoV-2, regardless of the clinical data presented [12].

The institutions that registered cases of COVID-19 in Guanajuato state were: Instituto Mexicano del Seguro Social (IMSS), Secretaría de Salud del estado de Guanajuato (SSG), Instituto de Seguridad Social y Servicios a los Trabajadores del Estado (ISSSTE), Petróleos Mexicanos (PEMEX), Secretaría de la Defensa Nacional (SEDENA), Secretaría de Marina (SEMAR), instituciones privadas e IMSS Oportunidades.

The sociodemographic variables age and sex were included. As independent variables, the presence of comorbidities (diabetes, chronic obstructive pulmonary disease, asthma, immunosuppression, hypertension, cardiovascular disease,

renal chronic disease, obesity, smoking), health system where the patient was attended, if the patient was in Intensive Care Unit (ICU) and result positive to rRT-PCR test.

The dependent variable was the date of death and COVID-19 as cause of death, registered in database of SINAVE/DGE [10].

Procedures

After approval by the Research Ethics Committee of the Campus Celaya-Salvatierra of the University of Guanajuato, the Excell[®] (Microsoft Corp.), database was reviewed and it was copied to the STATA 13.0[®] database (Stata Corp., College Station, TX, USA). All procedures were accord of General Law of Health (Mexico) and Declaration of Helsinki.

Statistical analysis.

Descriptive statistics were performed for all variables and an epidemiological curve was designed for confirmed cases with a date of death. CFR was computed, by health institution, with the number of deaths and total of confirmed cases of COVID-19. Tabulation of comorbidities for confirmed cases and death was performed. To show associations of comorbidities and deaths between confirmed and discarded cases, was calculated the Chi-squared test, degrees of freedom and *P* value were calculated; in case of not calculate Chi-squared test, were calculated Z for two proportions, to show the effect of the comorbidities on deaths in confirmed cases, Odds Ratio (OR) and 95% confidence intervals (95% CI) were calculated.

Logistic regression models were generated and it was determined whether age group and sex acted as confounders, with the Likelihood Ratio Test (LRT) and *P*-value.

In all cases, to demonstrate statistical significance, the alpha value was set at .05.

Statistical analysis was performed in STATA 13.0 (Stata Corp., College Station, TX, USA).

Results

100,919 records were obtained from the SINAVE/DGE database [10] until October 2, 2020. 810 records (0.8%) were eliminated due the absence of the rRT-PCR test result, leaving 100,109 records of suspected cases.

Of the 100,109 suspected cases, 41.69% were positive for SARS-CoV-2 (Table 1).

Table 1 Distribution of results of rRT-PCR test in suspected cases of COVID-19 (n=100,109)

Results of rRT-PCR test	n	%
Negative	58,375	58.31
SARS-CoV-2	41,734	41.69

Source: SINAVE/DGE [10]

Table 2 shows that among those who died from COVID-19, those over 60 years of age predominated with 61.75% and men with 64.62%. Among the confirmed cases that did not die, those aged between 12 and 49 years and female (52.62%) predominated.

Table 2 Distribution of deaths by COVID-19, by age group and sex

Variable	Deaths		No deaths		X ² (df) P-value	Z for two proportions (P-value)
	n	%	n	%		
Age group (years)					NA	
0 a 2						
3 a 5	7	0.23	266	0.69		-3.00 (.003)
6 a 11	1	0.03	261	0.67		-4.28 (.00001)
12 a 49	0	0.00	553	1.43		-6.59 (.00001)
50 a 59	485	16.20	26,129	67.45		-56.20 (.00001)
60 to 69	652	21.78	6,063	15.65		8.79 (.00001)
70 or higher	1,225	40.93	4,279	11.05		46.54 (.00001)
	623	20.82	1,190	3.07		45.90 (.00001)
Sex					330.41 (1) .0001	
Male	1,934	64.62	18,356	47.38		
Female	1,059	35.38	20,385	52.62		

Source: SINAVE/DGE [10]

Regarding deaths, they remained at low levels from March to May, with less than 10 deaths per day, but they increased notably as of June 2020, reaching more than 50 deaths in a single day in July 2020 (Figure 2)

Figure 1. Epidemiological curve of deaths by COVID-19 until October 2, 2020(n=3,728)

72.89% of the confirmed cases in the state were treated by the SSG, 22.33% by the IMSS. 2.52% by ISSSTE, 1.66% by private institutions, 0.88% by Pemex, and of the confirmed deceased cases, those attended by the IMSS of the state of Guanajuato (48.68%) predominated, followed by those attended by the Health Institute System Government of the State of Guanajuato (42.10%) (Table 3).

Table 3 Distribution of deaths by COVID-19 by health care system in the state of Guanajuato

System	Deaths		No deaths		Case Fatality Ratio
	n	%	n	%	%
IMSS	1,457	48.68	7,862	20.29	15.63
SSG	1,260	42.10	29,159	75.26	4.14
PEMEX	44	1.47	324	0.84	11.96
ISSSTE	36	4.90	1,017	1.76	3.42
SEDENA	13	0.43	107	0.28	10.83
SEMAR	1	0.03	2	0.01	33.33
Private	73	2.44	621	1.60	10.52
IMSS-OPORTUNIDADES	0	0.00	1	0.00	0
MUNICIPAL	0	0.00	1	0.00	0

Source: SINAVE/DGE [10]

Among the confirmed and deceased cases, 78.45% were hospitalized, showing a strong effect of being hospitalized and dying; this reflects to the severity of COVID-19 (Table 4).

Table 4 Distribution of confirmed COVID-19 cases by type of care

Type of care	Deaths		No deaths		X ² (df) P-value	OR (CI95%)
	n	%	n	%		
Ambulatory	645	21.55	34,644	89.42	9800 (1) .0001	30.78
Hospitable	2,348	78.45	4,097	10.58		(28.05 - 33.78)

df Degree of freedom OR Odds Ratio CI95% Confidence intervals 95%

Source: SINAVE/DGE [10]

Only 12.90% of the confirmed cases that died were in the ICU (Table 5).

Table 5 Distribution of confirmed COVID-19 cases by admission to the Intensive Care Unit

Was in ICU?	Deaths		No deaths		X ² (df) P-Value	OR (CI95%)
	n	%	n	%		
Yes	303	12.90	208	5.08	125.28 (1) .0001	2.77 (2.30 - 3.33)
No	2,045	87.10	3,889	94.92		

ICU Intensive Care Unit df Degree of freedom OR Odds Ratio CI95% Confidence intervals 95%

Source: SINAVE/DGE [10]

In table 6 is shown that number of patients in ICU and OR are higher in ISSSTE, PEMEX, SEDENA and private hospitals and SSG, as an effect of stay in ICU and risk to death; this is for severity of COVID-19. In IMSS there are only a few patients that stayed in ICU.

Table 6 Distribution of stay in the Intensive Care Unit and deaths by Health Service System

Health Service System	Deaths		No deaths		X ² (df) P-value	OR (CI95%)
	n	%	n	%		
IMSS					0.46 (1) .5	0.82
ICU						(0.46 - 1.45)
Yes	19	1.72	33	2.09		
No	1,085	98.28	1,547	97.91		
SSG					115.29 (1) .0001	3.43
ICU						(2.71 - 4.35)
Yes	203	20.28	131	6.89		
No	798	79.72	1,769	93.11		
ISSSTE					23.69(1) .0001	16.55
ICU						(3.72 - 73.56)
Yes	15	11.45	2	0.78		
No	116	88.55	256	99.22		
PEMEX					79.06 (1) .0001	495.00
ICU						(66.69 - 4674.07)
Yes	36	94.74	2	3.51		
No	2	5.26	55	96.49		
Private					15.93 (1) .0001	3.59
ICU						(1.87 - 6.89)
Yes	22	36.67	30	13.39		
No	38	63.33	186	86.11		
SEDENA					13.70 (1) .0001	8.63
ICU						(2.41 - 30.89)
Yes	7	53.85	10	11.90		
No	6	46.15	74	88.10		

ICU Intensive Care Unit df Degree of freedom OR Odds Ratio CI95% Confidence intervals 95%
Source: SINAVE/DGE [10]

Following the elimination criteria, the numbers of records eliminated due to incomplete data are presented; the percentages of records deleted are very small and do not affect the result of the statistical analysis (Table 7).

Table 7 Registries eliminated by missing data on comorbidities

Comorbidity	Deaths		No deaths	
	n	%	n	%
Diabetes	4	0.13	11	0.03
Chronic Obstructive Pulmonary Disease	3	0.10	4	0.01
Asthma	2	0.07	2	0.01
Immunosuppression	3	0.10	4	0.01
Hypertension	2	0.07	5	0.01
VIH/SIDA	1	0.03	8	0.02
Cardiovascular disease	2	0.07	4	0.01
Obesity	1	0.03	5	0.01
Chronic kidney disease	2	0.27	28	0.05
Smoking	4	0.13	9	0.02

Source: SINAVE/DGE[10]

In the population of confirmed COVID-19 cases, it was found that the greatest effect is obtained with chronic kidney disease, COPD, diabetes, hypertension and cardiovascular disease with OR higher than 5, for immunosuppression conditions, the OR was 3.91. In all these comorbidities age group and sex acted as confounders. For obesity and smoking as risk factors to death in COVID-19 the OR 2.20 and 1.71, respectively. Asthma shown a protective effect for death to COVID-19 (Table 8).

Table 8 Distribution of comorbidities and deaths among confirmed cases of COVID-19, OR and adjusted by age and sex.

Comorbidity	Deaths		Non-deaths n %	x ² (df) P-value	OR (CI 95%)	OR (CI 95%) adjusted by age group	OR (CI 95%) adjusted by sex
	n	%					
Diabetes				2000	5.16	2.35	5.23
Yes	1,250		4,733	(1)	(4.77 -	(2.16 - 2.57)	(4.84 - 5.67)
No	41.82		12.22	.0001	5.59)		
	1,739		33,997				
	58.18		87.78				
COPD				615.21	6.34	1.57	6.64
Yes	214		465	(1)	(5.37 -	(1.31 - 1.88)	(5.61 - 7.86)
No	7.16		1.20	.0001	7.49)		
	2,776		38,272				
	92.84		98.80				
Asthma				4.72	0.72	0.64	0.78
Yes	47		839	(1)	(0.54 -	(0.47 - 0.88)	(0.58 - 1.05)
No	1.57		2.17	.03	0.97)		
	2,944		37,900				
	98.43		97.83				
Immunosuppression				61.06	2.85	1.94	2.92
Yes				(1)	(2.17 -	(1.42 - 2.63)	(2.21 - 3.85)
No	63		290	.0001	3.76)		
	2.11		0.75				
	2,927		38,447				
	97.89		99.25				
Hypertension				1.800	4.74	1.90	4.80
Yes	1,406		6,110	(1)	(4.39 -	(1.74 - 2.07)	(4.44 - 5.19)
No	47.01		15.77	.0001	5.11)		
	1,585		32,626				
	52.99		84.23				
HIV/AIDS				1.24	0.60	0.49	0.54
Yes	5		107	(1)	(0.25 -	(0.19 - 1.26)	(0.22 - 1.32)
No	0.17		0.28	.3	1.48)		
	2,987		38,626				
	99.83		99.72				
CVD				294.12 (1)	4.20	1.61	4.13
Yes	167		538	.0001	(3.51 -	(1.32 - 1.96)	(3.45 - 4.94)
No	5.58		1.39		5.02)		
	2,824		38,199				
	94.42		98.61				
Obesity				219.59 (1)	1.87	1.84	1.92
Yes	844		6,729	.0001	(1.72 -	(1.68 - 2.02)	(1.77 - 2.09)
No	28.21		17.37		2.03)		
	2,148		32,007				
	71.79		82.63				
Chronic kidney disease				594.13 (1)	6.27	4.19	6.02
Yes	209		459	.0001	(5.30 -	(3.46 - 5.09)	(5.08 - 7.14)
No	6.99		1.18		7.42)		

	2,780	38,280				
	93.01	98.82				
Smoking			56.15	1.60	1.50	1.39
Yes	312	2,632	(1)	(1.41 -	(1.31 - 1.72)	(1.23 - 1.58)
No	10.44	6.80	.0001	1.81)		
	2,677	36,100				
	89.56	93.20				

COPD Chronic Obstructive Pulmonary Disease CVD Cardiovascular Disease

Source: SINAVE/DGE[10]

Discussion

Worldwide, confirmed cases had been reported in 215 countries with 34,161,721 cases, of which there have been 1,016,986 deaths, with a case fatality ratio of 2.98%; in Mexico, 753,090 confirmed cases with 78,492 deaths had been reported, with a case fatality ratio of 10.42% [13].

In the Guanajuato population, as of October 2, 2020, 41,734 confirmed cases had been detected, of which 2,993 died, having a case fatality ratio of 7.17% [10].

Advanced age is a risk factor for dying from COVID-19 [14,15]. In the Guanajuato population, 40.93% of the deaths were in persons aged 60 to 69 years and 20.82% in persons aged 70 or over (Table 2), confirming that the highest fatality is in ages over 60 years.

Male sex has also been considered as a risk factor for severity of COVID-19 or fatality from the same disease; 67.4% of the deceased were men according to Leung's review [14] and in the Guanajuato population, 64.62% of the deceased were men (Table 2).

On June 1, 2020 throughout Mexico the social distancing campaign was concluded and this led to an increase in confirmed cases and deaths from COVID-19 as shown in figure 1, starting in June. deaths increased, with the month of July showing the highest daily numbers of deaths (Figure 1).

In the state of Guanajuato, confirmed cases were treated more frequently in SSG, IMSS, ISSSTE [10] and the CFR were very different between institutions; SSG despite attending to most of the confirmed cases (72.89%) in the state, the CFR was much lower than in the IMSS (4.1 and 15.63%, respectively) (Table 3).

Smoking showed a significant relationship on fatality from COVID-19 and the effect on fatality was that those who died were almost twice as likely to have been smokers (Table 8). Despite reports of absence of association between smoking and severity of COVID-19 by Liuppi and Henry [16] and in further analysis of that data, by Guo [17], demonstrates a significant association between smoking and COVID-19 severity and is considered the most important preventive risk factor [18].

Some risk factors for dying from COVID 19 have been identified as obesity, diabetes and cardiovascular disease [19-21], SARS-CoV-2 enters the cell by binding to the angiotensin converting enzyme 2 (ACE2); ACE2 dysregulation in diabetes can predispose to severe lung damage [22] and this protein has a protective role in diabetes and cardiovascular disease [23], losing this effect in the presence of SARS-CoV-2 and explaining why people with diabetes and vascular disease have worse clinical outcomes [24].

Among the confirmed deceased cases, 47.1% had hypertension, 41.82% diabetes, 28.21% obesity (Table 8), confirming that people with these pathologies develop more severe courses of COVID-19 [24].

The effect of comorbidities in relation to death from COVID-19 showed a significant effect for all, except asthma, HIV / AIDS, with ORs greater than 1 (Table 8). HIV / AIDS did not show any effect on fatality of cases and asthma showed a protective effect for dying from COVID, which has been consistent in the Mexican population [5, 25].

When analyzing age and sex as potential confounders of the different pathologies, both showed that they have a confounding effect on the effect of comorbidities on fatalities from COVID-19 (Table 8). And this is explained by the fact that age and sex are known to be risk factors for dying from SARS-CoV-2 disease [14-15].

Strengths

Some cases were eliminated from the analysis because they did not have the rRT-PCR result (0.8%), and some did not have data about comorbidities however they were very low percentages, none reached 1%, so they did not affect the final result.

The number of records is large, which gives greater strength to the statistical analysis of the data, which is reflected in the narrow 95% confidence intervals.

Weaknesses

When using a Mexican government database, the quality of the data depends on who collected the information, considering that they are official data for the state of Guanajuato and that they may be subject to bias. In database is not registered the severity of asthma and the protective effect on death could be a bias.

Conclusion

Among the Guanajuato population with COVID-19, it is confirmed that advanced age and male sex are risk factors for dying.

Diabetes, COPD, immunosuppression, cardiovascular disease, chronic kidney disease, obesity, and smoking are risk factors for dying from COVID-19 in the Guanajuato population.

HIV / AIDS has no effect on fatality from SARS-CoV-2 disease.

Asthma is shown as a protective factor for dying from COVID-19 in the Guanajuato population, which had already been reported in the Mexican population.

Declarations

Ethics approval and consent to participate.

The protocol was approved by Bioethics Committee of Campus Celaya-Salvatierra of the University of Guanajuato with registry CBCCS-05230042020. Informed consent was waived by Ethics committee. Informed consent was not used because only work with database from Secretary of Health. Personnel identifiers were not obtained.

Consent for publication

Not applicable.

Availability of data and materials

The dataset supporting the conclusions of this article is available in the Open Science Framework repository [26], Padilla-Raygoza N. Analysis of mortality in Guanajuato population until October 2, 2020. OSF. 2020. Doi: <http://doi.org/10.17605/OSF.IO/RU2ZF>

Competing interests

The authors declare that they have no competing interests.

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Authors' contributions

NP-R, designed the protocol, analyzed the data and wrote the first draft of the manuscript; GF-V participated in analysis of data and to write the first draft of the manuscript; EN-O participated in analysis of data and to write the first draft of the manuscript; EL-L participated in design the study, searching literature, and to write the first draft of the manuscript; MJG-L participated in to write the protocol, review the database and to write the first draft of the manuscript; FJM-V obtained the database and participated in analysis of data and to write the first draft of the manuscript; DAD-M review the protocol, searching the literature and participated in to write the first draft of the manuscript. All authors read and approved the final manuscript.

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Figures

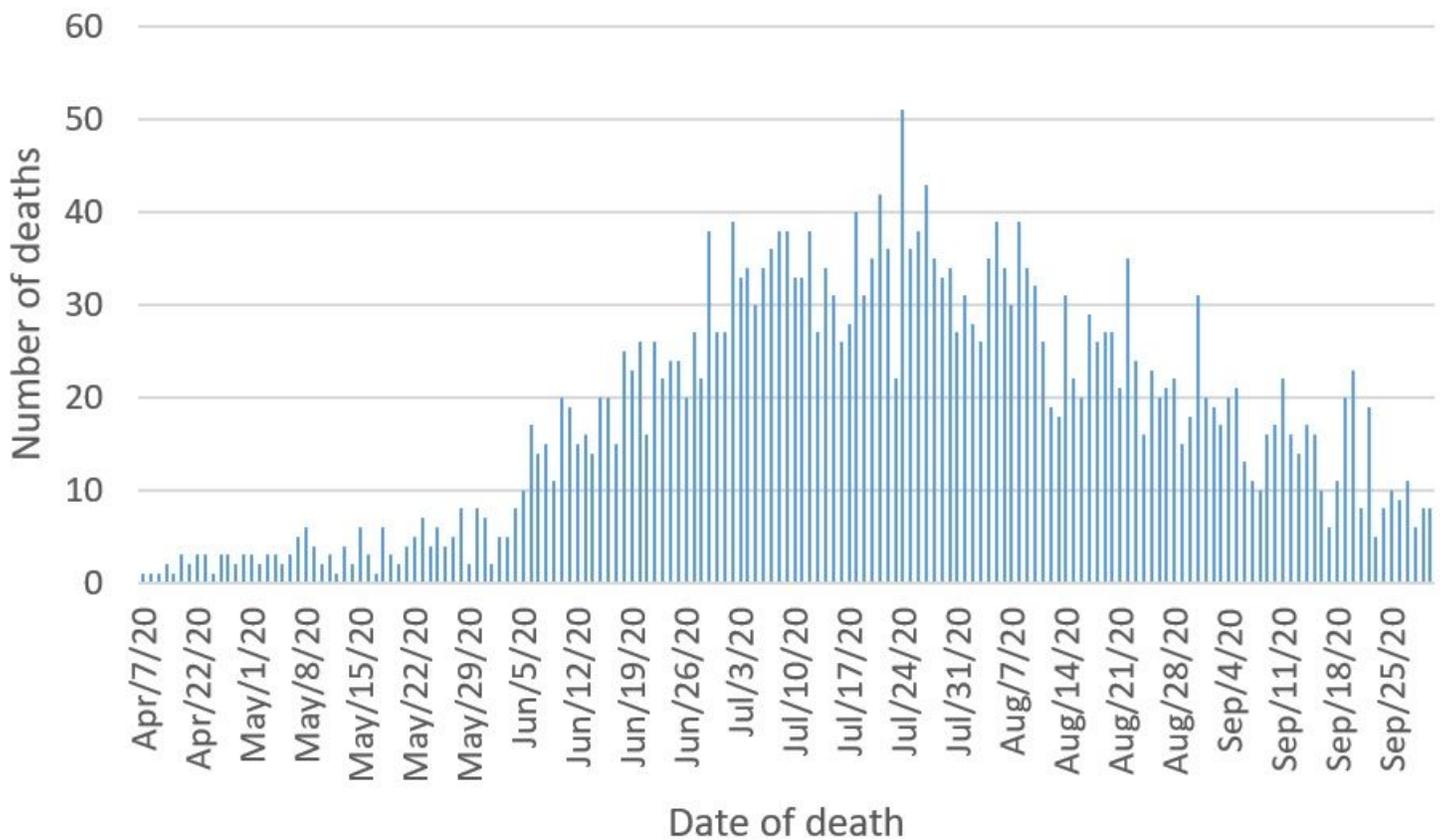


Figure 1

Epidemiological curve of deaths by COVID-19 until October 2, 2020(n=3,728). Source: SINAVE/DGE[10]

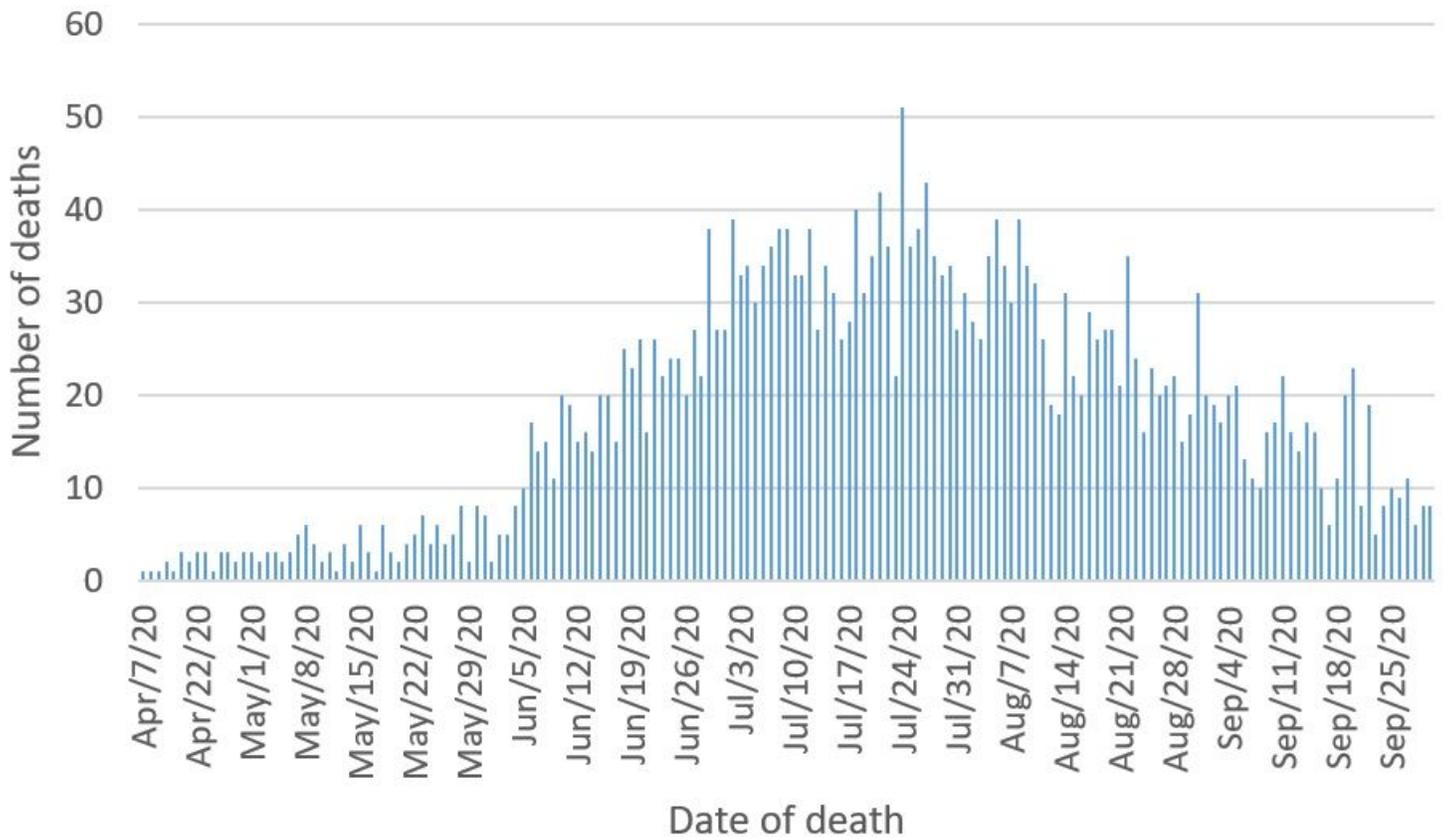


Figure 1

Epidemiological curve of deaths by COVID-19 until October 2, 2020(n=3,728). Source: SINAVE/DGE[10]