Effect of social determinants of health in patients with COVID-19

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Citation: Alejo-Martínez LJ and Serrano-García EA , Effect of social determinants of health in patients with COVID-19, ERSJ 2026,1(3) 125-142

Academic Editor: Hernández-Bautista Porfirio Felipe

Received: 29-July-2025

Revised: 12-October-2025

Accepted: 12-Octoberr-2025

Published: 18-January-2026

Abstract

Introduction: The SARS-CoV-2 virus has caused an increase in mortality and its consequences have been studied little in the context of the social determinants of health in Hermosillo, Sonora.

Objective: To evaluate the effect of social determinants on patients confirmed with COVID-19.

Materials and methods: A cross-sectional study was conducted. Classified as observational, analytical, and retrospective, it characterized patients diagnosed with COVID-19 by assigned unit, level of marginalization, occupation, age group, and sex. The association between the severity of COVID-19 and the level of marginalization was estimated, adjusting for potential confounders.

Results: For the outcome variable of death, logistic regression showed that the probability of occurrence was 1.73 and 1.90 times higher for medium and high levels of marginalization, respectively, compared to low levels of marginalization (1.25-2.37, 95% CI, P=0.001; 1.18-3.07, 95% CI, P<0.001). Multiple logistic regression showed that the probabilities of experiencing a death outcome were 1.30 and 1.21 times higher for medium (0.90-1.8, 95% CI, P=0.15) and high (0.69-2.01, 95% CI, P=0.45) levels of marginalization, respectively, compared to low levels of marginalization, adjusted for age, sex, and vaccination status.

Conclusions: This study concludes that COVID-19 patients treated in the unit, who belong to an area with a higher degree of marginalization, are more likely to be hospitalized and to die from COVID-19 than those with a lower degree of marginalization.

Keywords: SARS-CoV-2, social determinants of health, marginalization index, COVID-19.

INTRODUCTION

The SARS-CoV-2 virus has caused an increase in mortality (1), and its consequences have been studied little in the context of the social determinants of health in Hermosillo, Sonora (2). The health system in Mexico must take

the necessary measures to guarantee the right to health and effective access for all people in the face of the serious risk of contracting COVID-19. It must also prepare for the increased demand for care and, in particular, identify the populations with the greatest vulnerability (3)

The social determinants of health model addresses the social factors that influence the health status of a population. These include social class, occupation, place of residence, gender, indigenous status, and whether one lives in a rural or urban area with high levels of marginalization, as well as access to healthcare resources (5,6). In this theory, facilitating conditions are those that specifically, objectively, and externally enable people to seek care (7). Explanatory variables are identified for certain external constructs based on the assumption that they influence behavior through factors such as knowledge, social influence, social experience, and access. Examples include national regulations, the implementation of local public policies to address the problem, the availability of sufficient resources and capacity to care for critically ill patients, and sociodemographic characteristics (7,8).

Marginalization Index and Degree: This indicator, developed by the National Population Council (CONAPO), considers the population's basic education, housing type (differentiating amenities and infrastructure), localities by size, dispersion, and isolation, and the perception of low monetary income (9)(10). These estimates of the marginalization index for municipalities, localities, and urban areas were obtained from the 2020 Population and Housing Census (11). They will allow us to estimate regional and local inequality in social opportunities for the population of Hermosillo, Sonora (12). COVID-19 Severity: Measuring severity depends on the criteria established for each disease and on epidemiological surveillance systems and their capacity to detect cases. With an unknown disease like COVID-19, severity criteria are not defined or standardized at the beginning of the epidemic. A commonly used criterion is the need for hospital admission and/or ICU admission (13). Other indicators include mortality determined by death certificate data (14).

As cases multiply, in a context of high transmission, the hospital system may become overwhelmed. This could lead to care being provided in other settings, such as homes or paramedical areas, and therefore these cases could be classified as non-severe according to the adopted criteria (15).

Information Systems (IS): Any health information system for epidemiological surveillance must meet the minimum requirements established by NOM-017-SSA2-2012 for establishments that provide public services (16). Furthermore, to measure morbidity, the following characteristics must be considered: time,

place, and person; whether patients are being treated for the first time; the time or date of diagnosis; and the relative proportion by vaccination status (COVID-19 and seasonal influenza vaccination) (16).

Mexico has made progress in developing an Information System (IS) for the standardized recording of variables of interest related to COVID-19. The Mexican Social Security Institute (IMSS) uses the Online Notification System for Epidemiological Surveillance (SINOLAVE)(17). The Single Epidemiological Surveillance Information System and databases are also useful for registering and monitoring new cases and recurrences, respectively (17).

This information system aims to collect, consolidate, and record data on patients treated by IMSS institutions with suspected or confirmed respiratory illness to ensure data quality, which will support the comparison of health interventions (17). In Hermosillo, this data is collected by healthcare personnel in family medicine units and at General Zone Hospital #14 with a Burn Unit (HGZ #14 c/UQ). This is where systematically recorded information is collected on variables such as: sociodemographic (age, birth status, place of residence, indigenous status), occupation, assigned family medicine unit, date of symptom onset, clinical data at the time of collection, and place of care, "Suspected Viral Respiratory Disease Case Study Form" (18). Additionally, the results of rapid antigen tests for SARS-CoV-2 and RT-PCR tests for SARS-CoV-2 are recorded, along with their corresponding dates of performance and result delivery (19). Manual procedures, such as user data entry, generate expected errors in a large database, and patients can also introduce bias when providing registration information (20).

Relationship between health inequities and COVID-19: There is international evidence of how health inequities can affect people's health and increase their susceptibility to COVID-19 and death from it. For example, in an urban area of Spain, an increase in cases was found among the poorest groups compared to the wealthiest, mainly during the second pandemic peak, with a risk of 1.67 (95% CI: 1.41-1.96) in the highest income quintile for men and 1.71 (95% CI: 1.44-1.99) for women (21). Income inequalities at the area level in the incidence of COVID-19 were present to varying degrees in all four waves. In the second wave (October 1, 2020 to December 6, 2020), the relative risk (RR) for census tracts in the poorest income quintile compared to the richest was 1.43 (95% confidence interval [CI]: 1.22–1.67) for men and 1.58 (95% CI: 1.35–1.83) for women. Subsequently, inequalities in vaccination coverage also emerged (22). Equity-oriented policy responses included "health hotels"

or home delivery of essential goods for people with COVID-19 who lacked adequate conditions for isolation (22).

Some articles discuss the winter season and the different waves to distinguish peak moments during the COVID-19 pandemic, as well as different characteristics of the virus and its impact on the population (23, 24, 25).

Other variables, such as occupation, were also considered. Studies conducted in California compared the incidence and mortality rates of the COVID-19 outbreak and found them to be higher in the public transportation industry compared to all other industries combined. This finding may be due to the fact that many transit workers have jobs that involve close and frequent contact with coworkers and the public. For example, in New York City, among transit workers who died from COVID-19 early in the pandemic, 57% worked in public-facing positions. Furthermore, taxi and bus drivers had the highest COVID-19 mortality rates among all occupational groups (26,27).

Globally, there are population groups whose exercise of rights is systematically compromised and where lower levels of well-being exist, along with a high prevalence of inequities and inequalities in access to healthcare, which significantly contributes to morbidity, disability, and premature mortality (28). In the Americas, issues related to social gradient, inequalities, and inequities in health increase the risk of dying from communicable diseases, non-communicable diseases, and injuries (5).

In Mexico, the COVID-19 pandemic was faced under vulnerable conditions, despite being a middle-income country; four out of ten people live in poverty (41.9%) (28). In areas with higher concentrations of poverty, there is a lower probability of receiving quality hospital care and higher mortality rates (29). Other prominent factors include gaps in access to social rights: food, education, housing, and social security (30).

In Mexico, the country faced the COVID-19 pandemic under vulnerable conditions, despite being a middle-income country; four out of ten people live in poverty (41.9%) (28). In areas with higher concentrations of poverty, there is a lower probability of receiving quality hospital care and higher mortality rates (29). Other factors that stand out are gaps in access to social rights: food, education, housing, and social security (30).

COVID-19 resulted in a phenomenon of great impact and social significance (31). It was recognized as a public health emergency of international concern and subsequently declared a pandemic by the WHO in 2020, when it spread to numerous countries, including Mexico (32).

The health system in Mexico must take the necessary measures to guarantee the right to health and effective access for all people in the face of the serious risk of contracting COVID-19. It must also prepare for the increased demand for care and identify the most vulnerable populations. To this end, it is essential to contribute to and utilize population-based diagnostic measures and impact assessments at the local level (28).

At the Mexican Social Security Institute (IMSS), the study, based on the work carried out by the National Population Council (CONAPO) on health inequities, serves to explore social equity using sociodemographic variables in the population affected by COVID-19. Thus, evaluation measures are established to improve the quality of care at the institution that serves more than 45% of the population (3). First, the vulnerable groups most affected by severe COVID-19 in the study population are identified. This provides a starting point and justification for research with greater investment (34). With this evidence, targeted strategies can be proposed, for example: adherence to and improvement of action algorithms for patients with COVID-19 in the area of medical care (35,36). For the IMSS, this research contributes to measuring and fulfilling the objective of health equity. Finally, it contributes elements to the public discussion to identify points of conflict and support decision-making in the organization of health care (35).

Finally, the objective of the study was to evaluate the effect of social determinants of health in patients confirmed with COVID-19 at General Hospital of Zone 14 with Burn Unit, Hermosillo, Sonora.

MATERIALS AND METHODS

The study was conducted at General Hospital Zone #14 with a burn unit, located in Hermosillo, Sonora. This secondary-level unit serves the northern region of Hermosillo and is the referral hospital for patients covered by the Mexican Social Security Institute (IMSS) with severe respiratory illness.

The study design was cross-sectional, observational, analytical, and retrospective, covering the period from April 11, 2020, to October 31, 2022. The dependent variable was the severity of COVID-19, as measured by hospital discharge. The independent variables were the degree of marginalization, used to measure socioeconomic status based on housing conditions, education, population size (less than 5,000 inhabitants), and employment with a salary exceeding two minimum wages. This information is detailed in a public database compiled by INEGI and calculated by CONAPO in quintiles: very low, low, medium, high, and very high degree of marginalization.

The study population consisted of patients diagnosed with COVID-19 confirmed by RT-PCR and rapid antigen tests, diagnosed by COVID-19 and by epidemiological association at General Hospital Zone #14 with Burn Unit, from April 7, 2020, to October 31, 2022.

The sample size was calculated using the EPI-TOOLS program (47) based on the proportion of cases from 2020 to 2022 in the population of Hermosillo, Sonora, up to week 48, according to the epidemiological report (references 37, 38). With a 95% confidence level and a power of 0.80% (48), a sample of 84 individuals was obtained.

The protocol was submitted to the ethics and research committee for review and approval, as it did not represent a risk and the data was kept confidential.

Patients treated at General Hospital Zone #14 with a Burn Unit and diagnosed with COVID-19 who had a confirmatory COVID-19 test (patients with a positive RT-PCR test, SARS-CoV-2 antigen test, clinical diagnosis, or epidemiological link) were included. Patients diagnosed with COVID-19 and treated at General Hospital Zone #14 with a Burn Unit who lacked information on their usual residence were excluded. Patients whose outcome was unknown due to transfer or abandonment of the unit, or loss to follow-up, were also excluded.

A univariate analysis of the main measurements was performed. Measures of central tendency such as mean, mode, and median were obtained, as well as frequencies, proportions, and percentages. Subsequently, a bivariate analysis was performed with the dependent variables (death and recovery; outpatient vs. inpatient management) compared with the independent variables (degree of marginalization). To analyze the study hypothesis, the difference between groups was demonstrated using Fisher's chi-square test for unrelated dichotomous qualitative variables. Finally, a multivariate analysis was performed on the variables that were significant within the 95% confidence interval. The free software packages Excel and STATA were used for this purpose.

RESULTS

During the period from April 7 to October 31, 2022, at General Hospital Zone No. 14 with Burn Unit in Hermosillo, Sonora, a total of 5,354 patients with suspected COVID-19 were enrolled in the following study. Of these, 3,221 (60.16%) were confirmed and 2,133 (39.83%) were ruled out using RT-PCR testing (1,595). 438 (28.46%) were managed on an outpatient basis, and 1,157

(72.53%) were hospitalized. Additionally, 1,540 (28.76%) were diagnosed using rapid antigen tests; of these, 867 (57.14%) were treated on an outpatient basis and 672 (42.86%) were hospitalized. It was found that less than 2% (87 cases) were confirmed by clinical diagnosis; all of these were hospitalized and died in the unit (TABLE 1). Of the 3221 confirmed patients, the outcome or death was described as part of the first objective, resulting in a total of 980 deaths: 540 (29%) were confirmed by laboratory testing (RT-PCR), 353 (22.93%) by rapid antigen test, and 87 (1.62%) by clinical diagnosis (Table 1).

Table 1. Percentage of patients diagnosed with COVID-19 according to diagnostic test, HGZ 14 with UQ Hermosillo 2020-2022

	Total		COVID-19 confirmed								
					CONF ASO		CONF Ag		CONF OP		p Value[b]
Variables	**N**	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**	
Clinical Severity											
Outpatient	2,633	49.18	438	28.46	0	0	867	56.33	0	0	**p<0.001[b]**
Hospitalized	2,721	50.82	1,157	72.53	0	0	672	43.66	87	100	
Outcome Severity	2,133	39.84									
Improvement	4,145	77.42	1,055	66.14	0	0	1,186	77.06	0	0	**p<0.001[b]**
Death	1,209	22.58	540	33.85	0	0	353	22.93	87	100	
Total	5,354	100	1,595	29.79	0	0	1,539	28.74	87	1.62	
Degree of Marginalization [a]											
Very Low	1,899	83.83	977	61.25	0	0	871	56.59	51	58.62	**p=0.005[b]**
Low	1085	13.37	489	30.65	0	0	569	14.74	27	31.03	
Medium	167	2.07	93	5.83	0	0	70	1.95	4	4.59	
High	50	0.43	27	1.69	0	0	19	0.26	4	4.59	
Very High	20	0.30	9	0.56	0	0	10	0.45	1	1.14	
Total	3,221	100	1,595	49.51	0	0	1,539	47.78	87	2.61	
Female	2,882										
Male	2,472	46.17	834	51.17	0	0	673	42.34	58	64.2	**p<0.001[b]**
Age											
0-19	390	7.28	42	2.63	0	0	115	7.47	0	0	**p<0.001[b]**
20-59	3,245	60.61	865	54.23	0	0	989	64.26	28	32.18	
60 and over	1,719	32.11	688	43.13	0	0	435	28.27	59	67.82	
Total	5,354	100	1,595	29.79	0	0	1,539	28.74	87	1.62	
IMSS Worker											**p<0.001[b]**
YES	418	21.2	265	38.8	0	0	418	27.16	0	0	
NOT	1121	78.8	1,330	52.4	0	0	1,121	72.83	87	100	
Total	3221	100	1595	49.52	0	0	1539	47.78	87	2.7	
Pregnancy											
YES	90	8.58	17	1.07	0	0	73	4.74	0	0	
NOT	958	91.41	440	98.93	0	0	601	95.26	7	100	
COVID -19 Vaccination											
Complete	822	25.52	186	11.66	0	0	634	41.2	2	2.3	**p<0.0001[b]**
Incomplete	138	4.28	43	2.7	0	0	94	6.11	1	1.15	
Not Vaccinated	2,261	70.2	1,366	85.64	0	0	811	52.7	84	96.55	
Influenza Vaccination											
YES	330	10.25	176	11.03	0	0	154	10.01	0	0	**p=0.004[b]**
NOT	2891	89.75	1419	88.97	0	0	176	11.03	87	100	

Source: Study protocol developed at General Hospital Zone #14 with burn unit, Hermosillo, Sonora (2020-2022). SINOLAVE database (2020-2022).
ASO= Associated, Ag=Amtigen, OP = Opiniom
a: CONAPO marginalization index database by postal code (2020);
b: Chi square test.

Patients with COVID-19 were characterized according to socioeconomic level. It was found that 92.64% (2984) had "Very Low" and "Low" levels of marginalization; 167 patients (5.18%) had "Medium" levels; and 70 (2.17%) had "High" and "Very High" levels (Table 2). Subsequently, for each level of marginalization—"Very Low" and "Low," "Medium," and "High" and "Very High"—the percentage of patients requiring hospitalization was 57.84%, 79.04%, and 82.86%, respectively, showing a proportional relationship between hospitalization and increasing levels of marginalization (Chi2 P<0.001) (Table 2).

Table 2. Percentage of patients diagnosed with COVID-19 according to management and evolution, HGZ 14 with UQ Hermosillo 2020-2022

	Total		COVID-19									
			Ambulatory		Hospitalization		p^b	Improvement		defunción		Valor p^b
Variables	n	%	n	%	n	%		n	%	n	%	
Marginalization index	3221	0.02	0.97	0.01	0.97	0.01	**p^b<0.001**	0.97	0.00	0.97	0.00	**p^b=0.0006**
Degree of marginalization[a]												
Very low	1,899	58.96	813	62.3	1,086	56.68	**p^b<0.001**	1,335	59.57	564	57.55	p^b = 0.001
Low	1,085	33.69	445	34.1	640	33.40		770	34.36	315	32.14	
Medium	167	5.18	35	2.68	132	6.89		97	4.33	70	7.14	
High	50	1.55	8	0.61	42	2.19		26	1.16	24	2.45	
Very high	20	0.62	4	0.31	16	0.84		13	0.58	7	0.71	
SEX												
Female	1,656	51.41	809	61.99	847	44.21	**p^b<0.001**	1,258	56.14	398	40.61	**p^b<0.001**
Male	1,565	48.59	496	38.01	1,024	54.53		983	43.86	582	59.39	
Middle ages	50.26	21.16	34.91	15.17	60.71	18.06		43.23918	19.57588	66.31	15.00547	**p^b<0.001**
median	48	32-67	33.00	15.00	63	25.00	**p<0.001[d]**	39	29 -55	68	56 -77	p^d <0.001
0-19	157	4.87	112	8.58	45	2.35	**p^b<0.001**	153	6.83	4	0.41	
20 a 59	1,882	58.43	1,105	84.67	777	40.55		1,589	70.91	293	29.9	
60 and over	1,182	36.7	88	6.74	1,094	56.98		499	22.27	683	69.69	
ASSIGNMENT												
UMF 02	1,165	36.555	477	40.8	688	59.2		816	36.72	341	35.34	
UMF 37	677	21.243	261	38.5	416	61.45		459	20.66	218	22.59	
HGMFS 68	346	10.857	97	28.03	249	71.97		219	9.86	127	13.16	
UMF 63	331	10.386	146	44.11	185	55.89		236	10.62	93	9.64	
UMF 65	322	10.104	202	62.73	120	37.27		259	11.66	63	6.53	
HGMF 6	84	2.6357	11	13.1	73	86.9		48	2.16	36	3.73	
Total	3,187	100	1,295	41	1,892	59		2,222	100	965	100	
IMSS worker												
YES	683	21.2	670	51.34	13	0.68	**p^b<0.001**	678	30.25	5	0.51	**p^b<0.001**
NO	2,538	78.8	635	48.66	1,903	99.32		1,563	69.75	975	99.49	
Influenza vaccination												
SI	330	10.25	225	17.24	105	5.48	**p^b<0.001**	283	12.63	52	5.31	**p^b<0.001**
NO	2,891	89.75	1,080	82.76	1,811	94.52		1,963	87.59	928	94.69	
COVID-19 vaccination												
Complete	822	25.52	515	62.65	307	37.35	**p^b<0.001**	671	29.94	151	15.41	**p^b<0.001**
Incomplete	138	4.28	25	18.12	113	81.88		88	3.93	50	5.1	
Not applied	2,261	70.2	765	33.83	1,496	66.17		1,482	66.13	779	79.49	
Total	3221	100	1305	40.52	1916	59.48		2241	68.57	980	30.43	

Source: Study protocol developed at General Hospital Zone #14 with burn unit, Hermosillo, Sonora (2020-2022). SINOLAVE database (2020-2022),
a: CONAPO marginalization index database by postal code (2020)
b: Chi-square test
c: Student's t-test
d: Mann-Whitney U test

In the outcome variable (death or improvement) in patients with COVID-19 according to their degree of marginalization: it was observed that as the degree of marginalization increased, so did the percentage of deaths among the groups, being less than 30% in the very low and low degree of marginalization with a statistically significant difference (Pearson Chi2= 18.09, P<0.001) (Table 2). Other variables were characterized and summarized in Table 3.

Table 3. Percentage of patients diagnosed with COVID-19 according to management and evolution, HGZ 14 Hermosillo 2020-2022

	Total		COVID-19									
			Ambulatory		Hospitalization		p[a]	Improvement		Death		Valor p[a]
Variables	n	%	n	%	n	%		n	%	n	%	
OCCUPATION												
Farmers	3	0.09	1	0.08	2	0.1	**p=0.0001**	2	0.09	1	0.1	**p=0.001**
Drivers	18	0.56	1	0.08	17	0.89		9	0.4	9	0.92	
Merchants	33	1.02	1	0.08	32	1.67		16	0.71	17	1.73	
Unemployed	188	5.84	78	5.98	110	5.74		140	6.25	48	4.9	
Employed	771	23.94	278	21.99	484	25.26		590	26.33	181	18.47	
Nurses	297	9.22	190	22.22	7	0.37		293	13.07	4	0.41	
Students	65	2.02	45	3.45	20	1.04		63	2.81	2	0.2	
Managers/Owners	3	0.09	0	0	3	0.16		1	0.04	2	0.2	
Homeowners	617	19.16	102	7.82	515	26.88		348	15.53	269	27.45	
Retired/Pensioner	570	17.7	46	3.52	524	27.35		236	10.53	334	34.08	
Laboratory Technicians	17	0.53	17	1.3	0	0		17	0.76	0		
Teachers	4	0.12	0	0	4	0.21		4	0.18	0		
Doctors	177	5.5	168	12.87	9	0.47		174	7.76	3	0.31	
Workers	4	0.12	0	0	4	0.21		1	0.04	3	0.31	
Other	237	7.36	66	5.06	171	8.92		135	6.02	102	10.41	
Other Professionals	6	0.19	0		6	0.31		3	0.13	3	0.31	
Other Workers	211	6.55	203	15.56	8	0.42		209	9.33	2	0.2	
Total	3221	100	1305	40.52	1916	59.48		2241	68.57	980	30.43	

Source: Study protocol developed at General Hospital Zone #14 with burn unit, Hermosillo, Sonora (2020-2022). SINOLAVE database (2020-2022)
a: Chi-square test

A logistic regression was also performed to evaluate the association between socioeconomic level and its effect on COVID-19 patients. The results showed that, compared to patients with low and very low levels of marginalization, hospitalization was required 2.75 times more often in the subgroup with medium levels of marginalization and 3.52 times more often in the subgroup with high levels of marginalization (1.88–4.02, 95% CI, $p < 0.001$, 1.88–4.02, 95% CI, $p < 0.001$) (Table 4). Subsequently, adjustments were made for age, sex, and vaccination status in a multiple logistic regression, yielding hospitalization prevalence ratios of 2.47 and 2.60 for medium and high levels of marginalization, respectively, compared to low levels of marginalization (Table 4).

Table 4. Effect of social determinants on COVID-19 patients according to severity. Hermosillo, Sonora HGZ 14 (2020-2022). Simple and multiple logistic regression model

Variables	Simple β [b]	Simple IC 95	Simple p-value	Multiple β [c]	Multiple IC 95	Multiple p-value
Degree of marginalization[a]						
Low	1.00			1.00		
Medium	2.75	1.88 - 4.02	**p<0.001**	2.47	1.56 - 3.90	**p<0.001**
High	3.52	1.88 - 6.59	**p<0.001**	2.60	1.23 - 5.50	**p=0.013**
Age						
0-19	1.00			1.00		
20-59	1.75	1.22 - 2.50	**p<0.001**	2.96	2.04 - 4.29	**p<0.001**
60 and over	30.94	20.57 - 46.55	**p<0.001**	64.10	41.29 - 99.52	**p<0.001**
Sex						
Woman	1.00			1.00		
Man	2.06	1.78 - 2.38	**p<0.001**	2.17	1.81 - 2.60	**P<0.001**
Seasonal vaccine						
Vaccinated	1.00			1.00		
Not	3.59	2.82 - 4.58	**p<0.001**	3.16	2.32 - 4.30	**p<0.001**
COVID-19 vaccine						
Complete	1.00			1.00		
Incomplete	7.58	4.81 - 11.96	**p<0.001**	15.47	9.29 - 25.75	**p<0.001**
Not applied	3.28	1.92 - 3.87	**p<0.001**	2.39	3.71 - 5.81	**p<0.001**
Intercept	-1460.23					
R^2	1428.18					
N	3221.00					

Source: Study protocol developed at General Hospital Zone #14 with burn unit, Hermosillo, Sonora (2020-2022). SINOLAVE database (2020-2022).
a: CONAPO postal code marginalization index database (2020);
b: simple logistic regression model;
c: multiple logistic regression model

For the outcome variable of death, logistic regression showed that the odds ratio (OR) was 1.73 and 1.90 times for medium and high levels of marginalization, respectively, compared to low levels of marginalization (1.25-2.37, 95% CI, P=0.001; 1.18-3.07, 95% CI, P<0.001) (Table 5). In multiple logistic regression, the probabilities of experiencing a death outcome were 1.30 and 1.21 times for medium (0.90-1.88, 95% CI, P=0.15) and high (0.69-2.01, 95% CI, P=0.45) levels of marginalization, respectively, compared to low levels of marginalization (Table 5).

Cuadro 5. Effect of social determinants on COVID-19 patients according to whether they died, HGZ 14 Hermosillo Sonora (2020-2022). Simple and multiple logistic regression model.

	Simple					Multiple			
Variables	**β [a]**	**IC 95**			**Valor p**	**β**	**IC 95**		**Valor p**
Grado marginación[a]									
Low	1					1			
Medium	1.73	1.258	-	2.37	**p=0.001**	**1.30**	0.90251 - 1.88029		**p=0.158**
High	1.90	1.18	-	3.07	**p=0.008**	**1.21**	0.698621 - 2.10342		**p=0.494**
Age									
0-19	1					1			
20-59	7.05	2.593	-	19.18	**p<0.001**	9.34	3.42 - 25.46		**p<0.001**
60 and over	52.4	19.27	-	142.23	**p<0.001**	66.33	24.34 - 180.76		**p<0.001**
Sex									
Woman	1					1			
Man	1.87	1.61	-	2.18	**p<0.001**	1.79	1.51 - 2.13		**p<0.001**
Seasonal vaccine									
Vaccinated	1					1			
Not	2.53	1.86	-	3.43	**p<0.001**	1.81	1.29 - 2.55		**p=0.001**
COVID-19 vaccine									
Complete	1					1			
Incomplete	2.52	1.71	-	3.73	**p<0.001**	3.31	2.132046 - 5.1325		**p<0.001**
Not applied	2.34	1.92	-	2.84	**p<0.001**	2.39	1.92 - 2.98		
Intercept	-1971								
R^2	824.64								
n	3221								

Source: Study protocol developed at General Hospital Zone #14 with burn unit, Hermosillo, Sonora (2020-2022). SINOLAVE database (2020-2022).
a: CONAPO postal code marginalization index database (2020); b: simple logistic regression model; c: multiple logistic regression model

DISCUSSION.

The most important finding of this research is the discovery that the degree of marginalization in the population of Hermosillo, Sonora, affects the mortality and hospitalization rates among COVID-19 patients.

Compared to other studies, such as that of Ortiz-Hernández et al., the population of Hermosillo, Sonora, has a lower percentage of people with high and very high levels of marginalization. Furthermore, their study used health insurance coverage as a confounding variable, resulting in greater variability. They used 252,761 observations of confirmed cases, all data being at the national level, and observed progressive percentages of pneumonia and intubation as the marginalization index increased by region (53). However, they only used data from the first and second waves (53). It is important to

highlight that both articles contribute to supporting and confirming that a higher degree of marginalization is associated with a proportional increase in health complications (53). Meanwhile, for future studies, it would be interesting to explore Poison regression, as in the cited article (53).

The social determinants of health in the context of COVID-19 are structural, stemming from the lack of a unified health system in all countries, the shortage of healthcare units, services, and resources, and the inequalities in access to medical care (54).

Some limitations of the study lie in the power of association, as the sample size decreases in the highest levels of marginalization. This could reflect the difficulties in accessing health services as the level of marginalization increases. It is also related to the lower proportion of people in the highest levels of marginalization covered by the Mexican Social Security Institute (IMSS). However, this is a strength at the local level for identifying the most vulnerable population, and interventions targeting this population to improve access to health services would be beneficial.

Another important limitation is that the index and level of marginalization were obtained from an open-access database containing summary measures of socioeconomic status linked to patients' usual residence. It also represents a very important analytical strength, since information on the socioeconomic level of the population was gathered in a short time, but when interpreting the results, care must be taken to avoid falling into an ecological fallacy (55).

Throughout the course of this pandemic and its ongoing study to understand the evolution of SARS-CoV-2 disease, poor prognostic factors have been established (56). Among these, it has been observed that males and people over 60 years of age are at greater risk of a poor outcome. According to the results obtained in this study, cases were found to have a homogeneous distribution (men, 48.59% and women, 51.41%) and a median age of 48 years. In Mexico, where in the first year two men died for every woman, Hermosillo, particularly HGZ 14, saw 20% more deaths among men compared to women (53).

Regarding age, the 60 and over age group was the most affected (accounting for almost 70% of all deaths). We have noted the scarcity and disparity of disaggregated data on sex differences in disease severity, comorbidities, recovery rate, length of hospital stay, and number of tests performed (57).

Furthermore, in Mexico, it has been found that as socioeconomic level decreases, the probability of suffering from obesity (58), hypertension (58), and diabetes (59) increases.

This may reflect the indirect effect of socioeconomic level on outcomes of greater comorbidity and death in COVID-19. Finally, analyses of social inequality in natural disasters and the current pandemic suggest that the most marginalized populations suffer disproportionately. One possible intervention would be training healthcare personnel on these findings to significantly contribute to improving health by addressing its social problems and structural determinants (60). There is evidence that shows how in our country vulnerable population groups are suffering a disproportionate impact in terms of both infection and severity and mortality as a result of COVID-19 (61). The discrepancies in the incidence and mortality of COVID-19 in vulnerable populations could be related to a greater risk of exposure to SARS-CoV-2. For example, lack of health and economic services, overcrowding, family problems, unsanitary housing and environment, social insecurity, discrimination, and jobs that require in-person work (transport services, employees, medical care, among others) (26,27,61).

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