Effect of Health Comorbidities on Death from COVID-19 in Immigrants in Mexico

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Abstract

Background

Comorbidities increase the risk of death for patients with COVID-19, however, little is known about how comorbidities affect immigrants, as well as their prognosis in the case of contracting the virus. Therefore, this article aims to determine which comorbidities are associated with the probability of death among immigrants in Mexico.

Methods

We use a sample of migrants (N = 3,567) registered in the public database published in the National Epidemiological Surveillance System of the Mexican Ministry of Health; the technique used was a Probit regression.

Results

The results show that comorbidities commonly associated with death from COVID-19, are not significant when present in immigrants, also, migrants have fewer comorbidities than the native born. These findings could be explained by the Healthy Immigrant Effect, which states that migration is a self-selection process, in which those who migrate are the healthiest. However, the cases of migrants who have died from COVID-19 are related to the time they have taken to go to hospitals and to problems of access to health care.

Conclusions

The immigrant populations (especially those in transit and refugees) do pose certain challenges to public policies in the countries of destination, so specific measures need to be taken in order to protect immigrant communities from the spread of the virus. It is important to improve the conditions during the migratory journey, avoiding overcrowding, as well as testing in various places (shelters, immigration controls, among others) in order to determine the levels of positivity in this group. However, the detection of more cases of COVID-19 among immigrants, should not equal to the denial for entry. Formal mechanisms should be put into place to guarantee the right to asylum and non-refoulement, even for migrants who test positive for the virus.

Keywords: Immigrants; COVID-19; Comorbidities; Health; Mexico

Effect of health comorbidities on death from COVID-19 in immigrants in Mexico

Background

According to the World Health Organization (WHO), the coronaviruses cause respiratory infections, whose symptoms may range from a common cold to more serious syndromes, such as the Middle East Respiratory Syndrome (MERS) and the Severe Acute Respiratory Syndrome (SARS) [1]. The most recent coronavirus is the cause of the Corona Virus Disease, COVID-19. Since the first case of COVID-19 was registered in Wuhan China in December 2019, countries all over the world started preparing for this emergency by implementing various measures, such as lockdowns and social distancing [2]. Despite such efforts, by mid-April 2021, global deaths amounted to 138,010, 168 [3].

Research has shown that there are certain factors that increase the probability of death, like advanced age and coexistence of certain preexisting diseases [4]. In addition to medical conditions, there are social determinants of health that place certain populations at a higher risk [5]. These factors are determined by socio-economic conditions that reproduce inequalities, which have a detrimental effect on the health of individuals [6]. According to the WHO [1], some of these determinants are: income, education, structural conflict, working conditions, housing, social inclusion and discrimination. Food insecurity and its implications for immigrants and racialized communities have also raised concerns during the pandemic [7].

These factors are usually present in populations of lower socio-economic status or minorities, namely: the poor, the elderly, indigenous communities, people of color and immigrants [8]. Furthermore, it has been suggested that immigration should be studied as a social determinant on its own, since it places individuals in uneven relationships with the

state, particularly with public healthcare institutions [6] and oftentimes they face discrimination, violence and marginalization, leading to health disparities [9,10].

Regardless of the pandemic, migrants -especially those with irregular status- and refugees face many risks derived from the environment in origin, transit and destination countries [11]. An additional risk factor is that they tend to be ineligible for healthcare systems at destination, except in case of emergency care [12,13]. Furthermore, people on the move are especially vulnerable to infectious diseases, due to high mobility, lack of sanitation and water systems, overcrowding living conditions and lack of access to vaccination programs [12,14].

In addition to the usual restrictions to access healthcare and risks associated with the migratory journey and settlement [15], these populations have been severely affected by some of the measures put into place worldwide in order to control the spread of COVID-19 [16]. Travel restrictions, border control reinforcement, the suspension of resettlement refugee programs and humanitarian assistance at borders, and the overcrowding at detention centers, have all exacerbated the health situation of migrants and refugees [11, 17].

In Latin America, migrants and refugees tend to be dispersed among the local population, with restricted access to social protection and healthcare [18], suffering from poverty, precarious living conditions, working under exploitation and illegality, and oftentimes, unaware of their human rights [19]. All of these factors, along with discrimination, unemployment, mobility restrictions, xenophobia and ineligibility for government aid, make them more vulnerable to COVID-19 [20].

In Latin America, little is known about how COVID-19 has affected immigrants, and Mexico is no exception. The country has traditionally been studied by migration scholars, mainly due to its historical migration dynamics with the United States, and the fact that the US-Mexico migration flow constitutes the biggest migration corridor in the world [21]. Due

to a shift in migration flows, Mexico has now become a country of destination, mainly for migrants coming from other countries in Latin America [22]. There are 1.2 million international migrants residing in Mexico, who constitute around 0.96% of the country´s total population. Most of the migrants come from the Americas, amounting to 317, 331, the majority born in the United States [23].

Recent shifts in mobility patters have renewed interest in Mexico, now as a destination country. Some of these new flows are: migrant caravans from Central America; policy measures taken by the U.S. and deportations from overcrowded detention centers in the U.S., bound to Mexico and other countries [16, 24, 25]. Central Americans constitute the most vulnerable migrant group in Mexico [26], due to conditions at home countries, their migration journey (frequently entailing multiple dangers and violations of their human rights), barriers accessing public health services and overcrowded living conditions in shelters [27, 28]. Furthermore, since 2018, Central Americans have consistently ranked among the top six asylum seeker destination countries [29].

In this context, the United Nations (UN), the Office for the High Commissioner for Human Rights (OHCHR), the WHO, and the UNHCR, have recommended governments to adopt an inclusive approach against COVID-19, considering the precarious situation of immigrants and refugees. These organizations have suggested to provide immigrants indiscriminate access to preventive measures, testing and treatment [30].

The Federal Government has implemented an "Action Plan for Migrants´Access to Healthcare during COVID-19", which consists of a multi-level coordination to follow up positive cases and provide health assistance for immigrants in shelters, mainly in the southern and northern border states [31]. Despite these measures, the fatality rate for migrants in Mexico is 6.05% and 29.18% of tested immigrants was positive [32]. These results could be

explained due to the fact that asylum seekers and refugees in the Mexican border states have an increased risk of contracting infectious respiratory diseases [33]; also, migration correlates positively with incidence of COVID-19 [34].

Since the pandemic started, there has been an interest to determine which comorbidities tend to have negative effects in patients who contract SARS-CoV2. Cardiovascular diseases, diabetes, hypertension and Chronic Obstructive Pulmonary Disease (COPD) complicate the health conditions of patients with COVID-19 [35, 4]. However, most of these studies involve the native-born population, while little is known about the effects of these preexisting diseases in immigrants. For this reason, the paper aims to determine which comorbidities are associated with the probability of death among immigrants in Mexico.

Immigrants´ health in times of COVID-19

The severity of respiratory viruses is associated with certain preexisting health conditions [36]. An increase in mortality was mostly associated with cardiovascular diseases [37], while advanced age patients (especially over 65) with comorbidities have more elevated admission rates into the Intensive Care Unit (ICU), as well as higher mortality rates [38]. A meta-analysis showed that the most common preexisting comorbidity in patients with COVID-19 is hypertension (15.8%), followed by cardiovascular and cerebrovascular diseases (11.7%), diabetes (9.4%) and co-existing infections (HIV and Hepatitis B).

Other comorbidities present in less proportion are malignancy, COPD and other respiratory system-related diseases, renal disorders and immunodeficiency states [39]. Despite the vulnerability of migrants, little research has been conducted regarding how COVID-19 has affected this group [40]. Some studies carried out in Europe at the beginning of the pandemic show that immigrants who contract COVID-19 have lower or similar death

rates when compared to non-migrants while hospitalization rates are higher for the latter [40-42].

Immigrants coming from low- or middle-income countries have higher mortality rates [43]. A study that compared characteristics of COVID-19 deceased patients by migration status, concluded that age, ischemic heart disease, hypertension and autoimmune disease, were the most frequent conditions and comorbidities in deceased migrants [41]. On the other hand, another research showed that the number of deaths correlated with comorbidities was lower for immigrants, however, the positivity rates varied according to the origin of the immigrants [44].

Singapore is one of the countries with lower case-fatality ratio in the world [45]. 88% of confirmed cases nationwide were concentrated among low-skilled migrant workers living in dormitories [46]. Ngiam et.al. [47] conducted a study to determine trends in hospitalized cases of these workers and they found that most migrants were asymptomatic and only 5.3% had a preexisting medical condition. Low mortality rates are partly explained by the migrants´ young age and fewer comorbidities, compared to local cases [47].

Research on immigrant health has documented different health statuses and mortality rates between migrants and locals [48-51]. Oftentimes, results show that immigrants tend to have better health outcomes, less chronic diseases and lower mortality rates than the native-born at countries of destination [52, 53]. Even though immigrants´ health advantage has received various explanations [54], the strongest hypothesis is that of the Healthy Immigrant Effect (HIE).

The HIE states that migration is a self-selection process, in which healthier and younger people are more likely to migrate, since they need to be in good shape to endure the migration journey and go through the adaptation process in receiving societies [55, 48].

Adaptability and non-observable patterns, such as resilience and motivation, also explain the health selection processes [53]. It is also likely that migrants used to have better habits and healthier lifestyles at their countries of origin, compared to the native-born at their destinations [56].

It has been proved, however, that the longer immigrants have resided in destination countries, the more likely it is for their health to deteriorate and ultimately converge with the health status of the native-born [57]. This could be explained by acculturation, increased exposure to low socioeconomic status, reduced access to health care, lack of social inclusion and adoption of health-averse behaviors, such as smoking or poor diets [58,55]. Another complementary hypothesis is the Salmon Effect or Salmon Bias [59, 49], which states that migrants tend to return to their countries of origin when their health is deteriorating, so only the healthiest migrants remain in destination countries.

Methods

Database

The information was obtained from a database published by the Ministry of Health of Mexico, this began to be built in April 2020 with the first case of COVID-19 in the country. The database is public and can be found on the website of the National Epidemiological Surveillance System [32]. This site was launched as an integrated national surveillance system to collect information on all individuals with COVID-19 throughout the country. Each state is responsible for monitoring cases and reporting to the Federal Ministry of Health. Thus, the Federal Ministry of Health gathers all the data through the National Epidemiological Surveillance System published by the General Direction of Epidemiology on a daily basis. The population studied are persons who are part of mixed migrant flows (economic migrants and asylum seekers), of non-Mexican nationality, who are in Mexico or

transiting through the country, many of them with the intention of requesting asylum in the United States. In total, there were 3,567 registered migrants as of January 2021.

Measure

The variables used in the study are found in Table 1. The included comorbidities are based on different studies that have shown a strong association with the probability of death from COVID-19 [60, 36, 61]. The makeup of the group countries was integrated considering certain migratory patterns shared by each country block [21, 62]; for that reason, they were grouped into four groups: a) Central Americans: Belize, Costa Rica, El Salvador, Guatemala, Honduras and Nicaragua

b) South Americans: Argentina, Brazil, Chile, Colombia, Ecuador, Peru, Uruguay and Venezuela

c) Caribbeans: Cuba, Dominican Republic, Haiti and Jamaica

d) Others: United States, Spain, Germany, France, Italy, China, Canada and others

In addition, we added some variables in order to describe the migrant clinical characteristics: patient type, days elapsed, and whether the patient required admission to ICU or intubation, since it has been documented that the treatment of manifestations derived from the immune response triggered by the SARS-CoV-2 coronavirus are associated with the development of more severe symptoms of COVID-19 [63]. Various studies have shown that the variables smoking, sex and age groups are relevant to explain death from COVID-19. The same happens with the variables smoking, sex and age group [4, Author].

Table 1. Description of Dependent and Independent Variables

Variables	Explanation	Values
Dependent variable		
Migrant death	Indicates whether or not the patient died from COVID-19.	1 death; 0 otherwise
Independent variables		
Hypertension	Identifies whether the patient has a diagnosis of hypertension.	1 has hypertension; 0 otherwise
Cardiovascular	Identifies whether the patient has a diagnosis of cardiovascular disease.	1 cardiovascular conditions; 0 otherwise
Obesity	Identifies whether the patient has a diagnosis of obesity.	1 if obese; 0 otherwise
Diabetes	Identifies whether the patient has a diagnosis of diabetes.	1 has diabetes; 0 otherwise
Immunosuppression	Identifies whether the patient is immunosuppressed.	1 immunosuppressed; 0 otherwise
Pneumonia	Identifies whether the patient was diagnosed with pneumonia.	1 if pneumonia is present; 0 otherwise
Asthma	Identifies whether the patient has a diagnosis of asthma.	1 holds asthma; 0 otherwise
COPD	Identifies whether the patient has a diagnosis of COPD	1 with a diagnosis of COPD;
Nationality groups	Identifies the region of origin of the patient who has migrated.	1= Central America; 2= South America 3= Caribbean region and 4= Other
Smoking	Identifies if the patient has a smoking habit	1 has a smoking habit; 0 otherwise
Days elapsed	It is the difference between the date of admission and the date of symptom onset.	

Variables	Explanation	Values
Patient type	Identifies the type of care the patient received on the unit. It is labeled as outpatient if he/she returned home or is labeled as hospitalized if he/she was admitted to the hospital.	1 if the case is ambulatory; 0 if the patient is hospitalized
Intensive Care Unit	Identifies whether the patient required admission to an Intensive Care Unit.	1 admitted to ICU; 0 otherwise
Intubated	Identifies if the patient required intubation or not.	1 intubated patient; 0 otherwise
Sex	Biological distinction that classifies people into men or women.	1 if female; 0 otherwise
Age groups		
0-29	Patients in the age range from 0 to 29 years old	0 -29 years=1
30-59	Patients in the age range of 30 to 59 years old	30-59 years=3
60 and older	Patients in the age range of 60 years and over	65-120 years=3

Source. Author's elaboration

Procedures and Data Analysis

To evaluate the likelihood of death for COVID-19 among migrants, a probit regression analysis was performed [64], through the equation:

$$Pr\ (y = 1|x) = \emptyset(xb)$$

Where $\emptyset$ the standard cumulative normal probability distribution and xb is called the probit index. Since xb has a normal distribution, the interpretation of a probit coefficient$b$, is that an additional unit of the predictor leads to an increase of b standard deviations of the probit index. Then, the log likelihood function for the probit is:

$\ln L = \sum w_j \ \ln \emptyset\left(x_j b\right) + \ \sum w_j ln \ \left[1 - \emptyset\left(x_j b\right)\right]$ where w_j are weights

The probit model uses the normal cumulative probability distribution function:

$$F(Z) = \int_{-\infty}^{Z_0} \frac{1}{\sqrt{2\pi\sigma}} \ e^{-(z-\mu_2)^2/(z-\mu_2)}$$

The model estimates the influence that the variables have on the probability of dying because of COVID-19 when considering the values of the explanatory variables. This latter fact is calculated by the partial derivative $\partial P_i / \partial X_{ij} = f(X_i{}'\beta)\beta_j$

where $f(\ldots)$ is the probability distribution function of a variable with a standard normal distribution, so that $\partial P_i / \partial X_{ij}$ it also depends on the values taken by the independent variables (X) . As a measure of goodness-of-fit for this model, the Mc Fadden R^2 called pseudo R-squared is considered.

$$R^2 = 1 - \frac{Ln\ L_0}{LnL(\beta_{mv})}$$

Where:

$Ln\ L_0$ is the logarithm of the likelihood function under the constraint that all coefficients, except the constant, are zeros and $Ln\ L\ (\beta_{MV})$ is the logarithm of the unconstrained maximum likelihood function. Thus, in a probit model the evaluation of the coefficients is the same as for an OLS model. According to the goodness-of-fit test for the probit model, pseudo- R2 value was very similar to McFadden's R2 value, which was found as 0.530. In addition, very low value of Akaike Information Criteria (AIC) and the negative value of Bayesian Information Criteria (BIC) ensure that the goodness-of-fit of the probit model was satisfactory.

Results

Table 2 shows the main characteristics of the migrants. The data shows that the positivity rate was 29.18; there were slightly more positive cases among men (29.80%) than women (28.72%). The most common region of birth of migrants was South America (20.3%) since there were more countries within this region. The average age of migrants is 36 years old and men were one year older than women at the mean. The proportions of comorbidities among migrants were slightly higher in men for all of them, except for obesity (6.64%). On the other hand, hypertension was the most frequent disease among migrants (8.86%), followed by diabetes (4.26%) and cardiovascular diseases (1.4%). In the risk conditions, the presence of asthma was the only disease with the highest percentage among migrant women. Smoking was the highest percentage among migrants who reported having a risk condition.

In relation to the severity of cases was only 1.43 in ICU and 0.95 in intubated migrants. On the contrary, 91.9 of the cases were ambulatory. Also, the variable days elapsed, defined as the difference between the date of admission and the date of symptom onset, averaged 3 days.

Table 2. Characteristics of the migrant population

	Category	Male	Female	All
		n=2,047	n=1,520	n=3,567
Reported cases	Yes	28.72%	29.80%	29.18%
	No	71.28%	70.20%	70.82%
Hypertension	Yes	10.21%	7.04%	8.86%
	No	89.69%	92.96%	91.08%
Cardiovascular	Yes	1.56%	1.18%	1.40%
	No	98.29%	98.68%	98.46%
Obesity	Yes	6.55%	6.64%	6.59%
	No	93.45%	93.36%	93.41%
Diabetes	Yes	4.54%	3.88%	4.26%
	No	95.41%	96.12%	95.71%
Immunosuppression	Yes	0.88%	0.66%	0.78%
	No	99.02%	99.34%	99.16%
Pneumonia	Yes	7.13%	4.41%	5.97%

	Category	Male	Female	All
Asthma	No	92.33%	95.39%	93.64%
	Yes	4.15%	4.67%	4.37%
COPD	No	95.75%	95.26%	95.54%
	Yes	1.03%	0.13%	0.64%
Nationality groups	No	98.88%	99.87%	99.30%
	Central America	13.09%	9.61%	11.61%
	South America	17.64%	23.88%	20.30%
	Caribbean Region	18.51%	16.64%	17.72%
	Other countries	50.76%	49.87%	50.38%
Smoking	Yes	10.26%	6.38%	8.61%
	No	89.74%	93.62%	91.39%
Age	Mean	37.24	35.85	36.65
Days elapsed	Mean	2.71	3.12	2.87
Patient type	Hospitalized	9.09%	6.78%	8.10%
	Ambulatory	90.91%	93.22%	91.90%
ICU	Yes	1.71%	1.05%	1.43%
	No	6.94%	5.66%	6.39%
Intubated	Yes	1.12%	0.72%	0.95%
	No	7.52%	5.99%	6.87%
Age	Mean	37.24	35.85	36.65

Source. Author's elaboration, from the MMH (2021a).

The results in table 3 explore the relationship between comorbidities (obesity, cardiovascular diseases, hypertension and diabetes), risk conditions (immunosuppression, pneumonia, asthma, smoking and COPD), case characteristics and the dependent variable: probability of migrant death. Note that the marginal effect values reported from the probit regression model is calculated having controlled for all other explanatory variables assessed at their mean values. The results report the probit model with marginal effects for the probability of death due to COVID-19 in the migrant population. Only three factors were found to be significant and negative: coming from South America, being at ICU, and the patient type variable.

The significant marginal effect values revealed that the probability of a migrant coming from South America, decreases by 1.6 percentage points (pp) for each point increased on the probability of death, with all other explanatory variables equal to their means. The probability of death from COVID-19 also decreases by 2.5 pp if the patient is admitted to the Intensive Care unit. Of note, the patient type variable also has significant negative relationship with the probability of death by the coronavirus (29.7 pp).

We also identified that five factors had a significant but positive relationship with the dependent variable (probability of migrant death due to COVID-19): obesity, immunosuppression, being intubated, days elapsed and age. These marginal effect values revealed that the probability of death from COVID-19 for migrant people is increased by 1.3 pp if a migrant is obese, by 2.5 pp if the patient is intubated, by 0.03 pp if migrant has immunosuppression, by 1.2 pp if the migrant is in the range of 30-59 years old and by 3 pp if the migrant is 60 years old and over.

In the end, for each day elapsed from experiencing symptoms to being hospitalized, the probability of death for Coronavirus in migrant population increases by 0.02 pp. Reminder, all other explanatory variables are equal to their means, as stated above.

Table 3. Marginal effects of the explanatory variables on the probability of death from COVID-19

	Probit regression			**Marginal effects**	
	Coef	Std Error	P value	dy/dx	Std Error
Nationality groups (ref: Central America)					
South America	-0.825 **	0.324	0.011	-0.016 **	0.006
Caribbean Region	-0.283	0.283	0.318	-0.007	0.007
Other	-0.140	0.229	0.541	-0.004	0.006
Hypertension	-0.166	0.183	0.365	-0.004	0.004
Cardiovascular	0.010	0.069	0.882	0.000	0.002
Obesity	0.572 ***	0.223	0.01	0.013 ***	0.005

Diabetes	0.133	0.184	0.471	0.014	0.008
Immunosuppression	0.632*	0.367	0.085	0.003 *	0.004
Pneumonia	-0.014	0.016	0.389	0.000	0.000
Asthma	-0.302	0.378	0.425	-0.007	0.008
COPD	-0.314	0.415	0.448	-0.007	0.009
Smoking	-0.324	0.331	0.328	-0.007	0.007
Days elapsed	0.091 ***	0.023	0	0.002 ***	0.001
Patient type	-2.799 ***	0.903	0.002	-0.297 ***	0.242
ICU	-1.136 ***	0.276	0	-0.025 ***	0.006
Intubated	1.144 ***	0.276	0	0.025 ***	0.006
Sex	-0.076	0.172	0.659	-0.002	0.004
Age (ref_0-29yrs)					
30-59 yrs	0.801***	0.292	0.006	0.012 ***	0.003
60 yrs and over	1.354 ***	0.308	0	0.030 ***	0.007

Source. Author's elaboration, from the MMH (2021a).
***0.01 significance level
** 0.05 significance level
* 0.1 significance level.

Discussion

International evidence shows that the population with the highest risk of contracting SARS-CoV2 and developing complications are those who have comorbidities [65]; the World Health Organization identified 14 high-risk underlying health conditions in COVID-19 patients [66-68]. Comorbidities have different implications, since it has been found that patients admitted into intensive care have a greater number of comorbidities, compared to those who do not enter this area [35], in addition to presenting fewer encouraging results in their COVID-19 diagnoses [69] and a higher probability of developing severe symptoms [70].

Studies have repeatedly shown that comorbidities, such as cardiovascular diseases, diabetes, hypertension, and COPD [4, 65], are significantly associated with an increased risk of death related to SARS-CoV2 [61]. A relevant aspect is that most of these studies were carried out on people who are already settled in a given context, which does not necessarily

include immigrants. Our findings for immigrants show a different behavior. The comorbidities that are commonly associated with death from COVID-19 [60, 38] were not significant for immigrants, as was found in some exploratory studies, where they also found that only a low percentage of migrants had comorbidities [47, 44], leading to lower mortality rates compared to locals [40-42].

In the context of the COVID-19 pandemic, our results could be explained by the HIE, considering migration as a self-selection process [71, 56], and thus those who decide to migrate are usually the healthiest among their communities, as well as the fittest to adapt to the destination contexts [55, 48]. This is consistent with various studies [52, 53] that have shown that immigrants have fewer comorbidities, as well as better health outcomes and lower mortality rates, compared to the native-born in destination countries. This explanation is complemented by the Salmon effect, that points to the likelihood of migrants returning to their home countries once they find out they suffer from deteriorating health conditions [59, 49]; this could be the case of migrants who were aware of the high risk of contagion and decided to return to their home countries.

Regarding obesity as a variable associated with death from COVID-19, another study found similar evidence in Mexico (Author). In the case of migrants, these results could be due to acculturation and the adoption of local eating patterns, which are exacerbated by high prevalence of obesity in Mexico [72], in addition to being one of the countries whose population has gained the most weight during the pandemic [73]. For that reason, the longer immigrants have resided in the country, the more likely their health becomes similar to that of locals, as other studies have shown [58, 57]. Age, like other studies for locals and migrants show [47,38], correlates positively with the probability of death. The problem is aggravated

among older adults, since the probability of death for each additional year of age becomes exponential, as has been found in another study (Author).

Regarding groups by nationalities, almost all have the same probability of death, this can be explained by the risks associated with the migratory journey [15], accommodation in transit and destination countries, as well as by the measures implemented in each country at border controls, which caused overcrowding and unsanitary conditions [17, 11]. The findings also show that Central Americans are more vulnerable to death, especially when compared to South Americans. Coincidently, the biggest asylum seeker group in Mexico comes from Central American countries [29], in addition to being the most vulnerable migrants in Mexico [26]. For this reason, our findings could be related to different evidences that show that the Central Americans in shelters or temporary camps suffer from overcrowding, poor living conditions, as well as greater problems accessing public health services [27,28].

Regarding health services, research has shown that migrants are almost always ineligible for health systems with the exception of emergency care [12, 13], and they report lower usage of health services, compared to the native born [7]. According to our findings, if migrants were treated in hospitals and were admitted to the ICU according to the severity of their condition due to COVID-19, they would be more likely to survive. Barriers faced by immigrants to enter hospitals, as well as an evaluation of the Federal Government´s "Action Plan for Access to Health for Migrants during COVID-19" [31], are beyond the scope of this investigation. However, our results show that the more they wait to go to a hospital to be treated or hospitalized, the more their probability of death increases. For this reason, rapid access to healthcare for immigrants, preventive campaigns targeting them specifically, and their inclusion in the immunization plans (respecting the age, areas of residence, among other criteria applicable to any other citizen) are uncomplicated measures that could save lives.

In the context of the COVID-19 pandemic, even when migrants have low comorbidities, they are considered population of concern, whose health is at great risk. This is so, because of structural factors that have historically placed them at a disadvantage, such as repeated violations of their human rights in countries of origin, transit and destination [11], dangerous and unsanitary conditions of the migratory journey [74], lower use of health services [75] and persistent inequities in food access [7]. The pre-existing low socioeconomic condition in this group is a serious situation that exacerbates the aforementioned problems. Therefore, it is necessary to design strategic actions that reduce the probabilities of contagion and death by COVID-19 in this vulnerable group.

Conclusions

Countries have taken different measures to maintain control of the spread of COVID-19 in their population, such as quarantine, physical distancing, use of face masks, antibacterial gel and recurrent hand washing, actions designed for their local population. However, the migrant population (especially those in transit and refugees) has various challenges, such as the lack of water and sanitation systems and overcrowding, that makes them more prone to infectious diseases [12,14].

The findings in this study show that migrants have low comorbidities, which are not associated with their chances of death from COVID-19. This could be explained due to the fact that the majority of the people who migrated are young and with low pre-existing diseases (see Table 2), which is in accordance with the HIE, since it is necessary to have certain physical conditions to carry out the migratory journey and to adapt in the transit and destination societies [55, 48]. Despite such results, immigrant populations do pose certain challenges to public policies in the countries of destination, so specific measures need to be taken in order to protect immigrant communities from the spread of the virus.

Moreover, it is important to improve the conditions during the migratory journey, avoiding overcrowding, as well as testing in various places (shelters, immigration controls, among others) in order to determine the levels of positivity in this group. Therefore, it is necessary to reverse the current government strategy regarding limited testing for COVID-19. More tests should be available for immigrants, in order to determine with greater certainty, the level of infections, the percentage of asymptomatic patients and the fatality rate. However, the detection of more cases of COVID-19 among immigrants, should not equal to the denial for entry. Formal mechanisms should be put into place to guarantee the right to asylum and non-refoulement, even for migrants who test positive for the virus.

It is important to recognize some limitations in our study, first, when using data from the National Epidemiological System, these are collected with samples obtained by people who are tested for COVID-19 in laboratories and public or private hospitals, but not of those who did not get tested. In general, migrants report lower use of health services, compared to the native-born [75], so it is possible that immigrants with an initially mild COVID case decided to remain home or at the shelters, and thus it is impossible to determine whether they had any comorbidities that led to their deceases.

Second, there is no information on the immigration status of the sample, nor any indication that may shed light to whether they were in transit, live in shelters, or time of residence in Mexico. This information is important because it may help determine future public policies targeting a certain migrant profile that may be more prone to contracting COVID-19 and dying from it. Despite these limitations, our study concurs with others of an exploratory nature carried out in different contexts [41, 42, 45]. Our evidence follows the same trend that has been found in other parts of the world, in which comorbidities are less

frequent in immigrants and their prognosis after contracting COVID-19 is more optimistic, when compared to non-migrants.

List of abbreviations

COPD: Chronic Obstructive Pulmonary Disease

HIE: Healthy Immigrant Effect

ICU: Intensive Care Unit

MERS: Middle East Respiratory Syndrome

MMH: Mexican Ministry of Health

OHCHR: Office for the High Commissioner for Human Rights

PP= Percentage Points

SARS: Severe Acute Respiratory Syndrome

UN: United Nations

UNHCR: United Nations High Commissioner for Refugees

WHO: World Health Organization

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Availability of supporting data

The datasets generated and/or analyzed during the current study are available in the Mexican Ministry of Health repository: https://www.gob.mx/salud/documentos/datos-abierto-152127

Authors' contributions

All authors contributed to proposal development and write-up of the research. All authors assisted in data interpretation, critical review of the manuscript and approved the final version of the manuscript.

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University approved the study.

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Consent for publication

All authors consent for publication of this study.

Competing interests

The authors declare that they have no competing interests.

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