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*Artículos científicos*

## **Factores sociales que influyen en aumentar el contagio de la covid-19 en México**

*Social Factors that Influence in Increasing the Spread of COVID-19 in Mexico*

*Fatores sociais que influenciam o aumento da propagação da covid-19 no México*

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## Resumen

El objetivo de este trabajo de investigación fue analizar los indicadores de salud y de pobreza que influyen en el aumento de contagios por el coronavirus de tipo 2 causante del síndrome respiratorio agudo severo (SARS-CoV-2) a través de dos modelos predictivos. Se realizó un análisis en 2409 municipios de México en dos periodos de tiempo. Para el periodo dos (13 de julio del 2021) las variables “Neumonía”, “Asma”, “Otra complicación”, “Obesidad” y “Otro caso” influyeron en el contagio de covid-19 en 0.4024, 0.5229, 2.4246, 1.0053 y 1.4788, respectivamente. De igual forma, las carencias de ingresos, vivienda y alimentación fueron variables sociales que influyeron en el número de contagios, debido a que no se pudo mantener “sana distancia”. Se concluye con la demanda de que el Gobierno aplique mayores medidas tanto de salud como de conciencia social al contagio del covid-19, así como de programas sociales en los lugares donde existan personas vulnerables por ingresos, personas con carencia en calidad y espacios de vivienda y personas con carencia en acceso a la alimentación.

**Palabras clave:** covid-19, pandemia, pobreza, salud, vivienda.

## Abstract

The objective of this research work was to analyze the health and poverty indicators that influence the increase in infections by the type 2 coronavirus that causes severe acute respiratory syndrome (SARS-CoV-2) through two predictive models. An analysis was carried out in 2409 municipalities of Mexico in two periods of time. For period two (July 13, 2021) the variables "Pneumonia", "Asthma", "Other complication", "Obesity" and "Other case" influenced the spread of covid-19 in 0.4024, 0.5229, 2.4246, 1.0053 and 1.4788, respectively. Similarly, the lack of income, housing and food were social variables that influenced the number of infections, due to the fact that a "healthy distance" could not be maintained. It concludes with the demand that the Government apply greater measures of both health and social awareness to the contagion of covid-19, as well as social programs in

places where there are vulnerable people due to income, people with a lack of quality and housing spaces. and people with lack of access to food.

**Keywords:** covid-19, pandemic, poverty, health, housing.

## Resumo

O objetivo deste trabalho de pesquisa foi analisar os indicadores de saúde e pobreza que influenciam o aumento de infecções pelo coronavírus tipo 2 causador da síndrome respiratória aguda grave (SARS-CoV-2) por meio de dois modelos preditivos. Uma análise foi realizada em 2.409 municípios do México em dois períodos de tempo. Para o período dois (13 de julho de 2021) as variáveis “Pneumonia”, “Asma”, “Outra complicação”, “Obesidade” e “Outro caso” influenciaram a disseminação da covid-19 em 0,4024, 0,5229, 2,4246, 1,0053 e 1,4788, respectivamente. Da mesma forma, a falta de renda, moradia e alimentação foram variáveis sociais que influenciaram o número de infecções, devido ao fato de que uma "distância saudável" não poderia ser mantida. Conclui com a exigência de que o Governo aplique maiores medidas tanto de saúde como de sensibilização social para o contágio da covid-19, bem como programas sociais em locais onde existam pessoas vulneráveis devido a rendimentos, pessoas com falta de qualidade e espaços habitacionais .e pessoas com falta de acesso a alimentos.

**Palavras-chave:** covid-19, pandemia, pobreza, saúde, habitação.

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## Introduction

In December 2019, an outbreak of pneumonia caused by a new coronavirus, the type 2 coronavirus that causes severe acute respiratory syndrome (SARS-CoV-2), began in the city of Wuhan, Hubei province, China. The virus has spread globally and has caused thousands of deaths and has severely shaken health systems and the economy (Ciotti et al., 2020).

Officially, on March 11, 2020, the World Health Organization (WHO) characterized the coronavirus disease 2019 (covid-2019) as a pandemic. To this day, after almost two years, this pandemic still requires timely responses in health, social and economic matters to cope with the situation in the best possible way. Therefore, it is necessary to carry out research

and data analysis in order to develop public policies on public health with a quantitative basis. Among these policies is, for example, the reallocation of budgets towards issues related to health, as well as attention to social deficiencies, quality of life and housing spaces and accessibility to health services.

At the beginning of the health contingency, to prevent the spread of the virus, the Mexican Ministry of Health (March 11, 2020) issued a series of health protocols, washing hands, keeping distance and social isolation, among others. However, these protocols could not always be followed due to the quality of the housing spaces for some vulnerable population groups.

When analyzing all the information provided by official sources, the following questions arise: which health indicators have a greater influence on contracting covid-19? And what social aspects of poverty favor an increase in the number of cases by covid-19? The hypotheses that are proposed are the following: 1) pneumonia and obesity diseases, among others, increase the spread of covid-19 and 2) the spread of covid-19 occurs when people have a lack of quality and housing spaces .

Derived from the questions, the objective of this research is to analyze the health and poverty indicators that influence the increase in SARS-CoV-2 infections in Mexico through two multiple linear regression models in two time periods. Two periods were carried out to analyze the change in the predictor values with a difference of almost one year, that is, from June 2020 to July 2021.

In order to meet the objective of this research, a situational analysis of covid-19 is included, as well as the consequences of this virus on the social and economic environment, as well as aspects of the quality of housing and health. Subsequently, the methodology and results are described. Finally, there is a section to discuss these results and another to issue conclusions.

## **General overview of covid-19 and situation of the pandemic in Mexico**

Covid-19 is a disease that emerged in Wuhan, a city belonging to China. This disease has spread rapidly on international scales. In January 2020, the WHO declared the covid-19 outbreak an international public health emergency. The first declared case in the Latin American and Caribbean region was confirmed in February 2020, and the outbreak spread throughout the region months later. According to data from June 2020, the United States and

Brazil accounted for 77% of all cases and 79% of all deaths reported in the region (Pan American Health Organization [PAHO], 2020).

Since the beginning of this health emergency, it has been reported that most cases have occurred in adults and that certain comorbidities can be associated with severe cases and death; however, cases have also been recorded in children under one year of age (Ramos, 2020).

By March 8, 2020, a total of seven cases had been registered in Mexico throughout the country, for which the General Directorate for Health Promotion announced some measures to prevent the spread of covid -19, among who were washing their hands frequently with soap and water or using 70% alcohol-based gel; in case of coughing or sneezing, use the etiquette sneeze, avoid touching your face, nose, mouth and eyes with dirty hands; clean and disinfect surfaces and objects of common use in houses, offices, closed places and transport, and in case of presenting symptoms of any respiratory illness, stay at home and only in case of fever greater than 38 ° C and sore throat or head go to the doctor (Secretaría de Salud, 2020a).

A few days later, the National Day of Healthy Distance was created, which promoted social distancing, for example, in case of having contact with people outside the nuclear family, be at least 1.5 meters away from each other. Similarly, people over 60 years of age had to stay at home in family shelter. Of course, it was recommended to handle a remote greeting, not to greet with a kiss, hand or hug (Ministry of Health, March 11, 2020). The objective of both measures was to reduce the community transmission of covid-19 in Mexico by reducing the effective contact rate (Acuña, Santana and Velasco, 2020). Despite these measures, a month later, on April 8, 2020, cases had increased by 80%; A total of 3,181 cases with 174 deaths had been officially reported (Ministry of Health, August 30, 2021).

As of May 1, 20,739 cases and 1,972 deaths from covid-19 had been confirmed in Mexico. Consequently, the General Directorate of Health communicated that the population should shelter at home to prevent the spread of the virus, which meant not going out unless strictly necessary. However, not everyone, not only in Mexico, but also internationally, can afford to comply with social isolation policies.

## Consequences of covid-19 in the social environment

In the pandemics preceding that of covid-19, mortality rates were higher in the most vulnerable economic sectors. Indeed, people of lower socioeconomic status have worse health conditions because they maintain less healthy lifestyles, work in occupations that involve greater physical wear, are exposed to higher levels of stress and have poorer access to benefits of health (Sanchez, 2020). Covid-19 fits within these patterns and relationships, particularly with the sociocultural strata of insecurity, vulnerability, and risk (French and Monahan, 2020).

The covid-19 pandemic has highlighted the socioeconomic gaps around the world: the poorest places suffer more infections, informal workers who do not have the possibility of staying at home, because their income depends on going out to work, They see the need to continue their activities despite the health risk. Countries with fewer resources suffer to protect their population (Fuentes, 2020). While some people can stay home and carry out their multiple activities from the comfort of home, others find it necessary to go out and expose themselves to a greater risk of contagion (Sánchez, 2020).

The conditions of poverty and inequality in which a large part of Mexican society lives, coupled with macroeconomic fragility and a fragmented health system with few resources, multiply the degree of the challenge facing the country. Despite these limitations, the magnitude of the covid-19 crisis requires a forceful and determined response (Fuentes, 2020). The covid-19 pandemic is imposing many social challenges. In unequal societies, it is imperative to protect the vulnerable population (families with children and young people who subsist in the informal economy) to avoid covid-19, because they lack social security (Vilar, Pérez, Teruel, Alonso y Pérez, 2020).

The social problems related to the pandemic can have a considerable and lasting impact on societies and individuals, so it is appropriate to ensure additional income support for socially disadvantaged people during and shortly after the pandemic. Similarly, Rudnick (2020) suggests taking educational measures to train the general public as well as health care providers on responsible behaviors that protect them and others during a pandemic and other difficult times.

Even today, SARS-CoV-2 is expected to continue to infect millions of people around the world, so the economic impact will be great and millions of people will be pushed into poverty. In Indonesia, for example, the projected 5% economic growth in 2020 dropped to

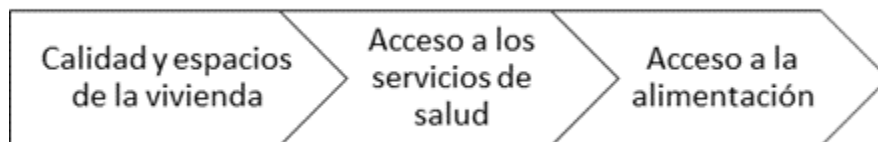
between 4.2% and -4.7%. Additionally, the poverty rate was forecast to rise from 9.2% in September 2019 to 9.7% by the end of 2020, implying that 1.3 million people would be pushed into poverty. On the other hand, the most severe projection indicated that the poverty rate would increase 17.9%, which would imply that 23.4 million more people would become poor. Faced with these data, Indonesia needs to expand its social protection programs to help the new poor, in addition to the existing poor (Suryahadi, Izzati y Suryadarma, 2020).

### **Consequences of covid-19 in the economic environment**

This pandemic, in addition to highlighting the fragility of health services, also revealed the weaknesses of the prevailing economic model in the world: large private and corporate indebtedness that is reflected in the continuous falls of all the world's stock markets, especially when it speaks of an economy that was already seen to be about to fall into a recession such as the Mexican one (Orellana, 2020).

In Indonesia, it was estimated that covid-19 would reduce the rate of economic growth, so tax breaks were granted to companies and workers who earn less, as well as an existing social assistance program, such as conditional transfer programs of cash and non-cash food assistance (Suryahadi et al., 2020). In the case of Mexico, particularly in Mexico City, an economic contraction was also expected during the first year of the pandemic, which would further aggravate poverty and inequality rates (World Bank, 2020). Once the impacts of social inequality in Mexico are taken into consideration, it is of great importance to evaluate the parameters that define poverty in Mexico, as well as to analyze the way in which these parameters or variables put people at risk of acquiring covid. -19.

The National Council for the Evaluation of Social Development Policy [Coneval] (2010) is the body in charge of defining, identifying and measuring poverty in Mexico. Figure 1 shows some of the indicators that Coneval uses to measure existing poverty in Mexico.

**Figura 1.** Indicadores de Pobreza CONEVAL

Fuente: Elaboración propia con base en Coneval (2010)

Poverty and low income levels are factors related to the increase in covid-19 infections. However, it is pertinent to deepen and analyze how poverty indicators such as deficiencies, both in housing quality and in health and food services, contribute to this phenomenon. Likewise, it is opportune to take into account other poverty indicators, such as the number of people in extreme poverty, the total number of vulnerable individuals by income, as well as the non-vulnerable in order to have a broader picture and thus formulate inclusive proposals.

### **Covid-19 and the quality of housing**

Poor living conditions in low- and middle-income countries, including poor sanitation, running water, and overcrowding, can facilitate the transmission of covid-19. In addition, in addition to what has already been mentioned, the increase in poverty levels, interrupted schooling, lack of access to school feeding schemes, reduced access to health facilities and the interruption in vaccination in children also contribute. ; other challenges are the inability to implement effective public health measures, such as social distancing, hand hygiene, timely identification of infected people with self-isolation, and the universal use of masks (Zar, Dawa, Bueno, & Castro, 2020).

In Mexico, the quality of housing is an indicator formulated by the National Housing Commission (Conavi). In this formulation, two subdimensions are included: the construction material of the dwelling and its spaces. According to these criteria, a population in a situation of deprivation due to housing quality and space is considered to be people who reside in dwellings that present at least one of the following characteristics: 1) the material of the dwelling's floors is made of earth, 2) the material of the roof of the house is made of cardboard sheet or waste, 3) the material of the walls of the house is made of mud or Bajareque, reed,



bamboo or palm, cardboard sheet, metallic or asbestos, or waste material and 4) the ratio of people per room (overcrowding) is greater than 2.5 (Coneval, 2010).

The quality of housing became more important as of 2020, since one of the measures to prevent the spread of SARS-CoV-2 is social isolation, that people remain inside their homes. Therefore, it is essential that the home has efficient and safe conditions that help reduce the spread of the disease (Santa, 2020). This is due to the fact that the occupation of the home is total during a health contingency such as that of covid-19 (Welcome, 2021).

Good levels of hygiene in public spaces, work and home, among others, improve overall health and quality of life (Castresana, 2020). Similarly, López, Quesada and López (2019) show the influence that housing conditions have on the occupant's health. In short, these characteristics have an impact on people's quality of life and health.

### **Covid-19 and population health**

Although social factors contribute to obtaining covid-19, health factors must also be taken into account, that is, the health of the population and how certain conditions make some individuals more vulnerable to contracting the covid disease. -19. People with chronic diseases, for example, are at higher risk of developing a severe form of coronavirus and dying (Sánchez, 2020). However, epidemiological data suggests that there is no single measure that can be taken to completely prevent an epidemic, but by combining certain recommendations, the probability of transmission can be reduced. Hence the need to continuously establish actions to reduce the transmission of this virus in the community and in health care centers.

Many of the patients infected by SARS-CoV-2 present the conditions of pneumonia, asthma and obesity; It is significant to analyze in a general way how these health conditions place the population with these diseases in the vulnerable sector.

### **Pneumonia**

Covid-19 pneumonia can be detected from abnormalities in computed tomography images of the chest, even in asymptomatic patients, as lesions can rapidly evolve to a diffuse ground-glass opacity predominance or consolidation pattern within one to three months. weeks after the onset of symptoms, peaking about two weeks after onset. Likewise, old age, male gender, underlying comorbidities, and progressive radiographic deterioration may be risk factors for prognosis in patients with covid-19 pneumonia. (Shi *et al.*, 2020).

## **Asthma**

When treated and closely monitored, asthma is not life-threatening, however, if someone with asthma has an asthma attack and does not have access to an inhaler or ventilator it can be fatal, which is why medical professionals warn people with asthma to be careful. Also, because there has been no data distinguishing asthma attacks from common COVID-19 symptoms, symptoms related to the virus can be mistaken for a routine asthma attack and deter people from seeking medical care. (Cione *et al.*, 2020).

## **Obesity**

Mexico's response to covid-19 is hampered by a double synergistic challenge: non-communicable diseases such as obesity, diabetes and hypertension, as well as social inequality; In addition, these diseases increase the probability of serious illness and death (Gutierrez and Bertozzi, 2020).

To avoid obesity, as well as the risk of contagion from covid-19, it is necessary that the basic food basket includes fresh products such as fruits and vegetables; Similarly, avoid processed foods that are high in fat, sugar and salt as much as possible (Organization of the United Nations for Food and Agriculture [FAO]-Economic Commission for Latin America and the Caribbean [ECLAC], 2021).

Thanks to previous qualitative research, and information from the health sector, it is possible to create a scenario of means of reducing covid-19 based on the health and sociocultural environment presented in Mexico. The following section presents the process of preparing the multiple linear regression model by the method of ordinary least squares, which will later allow the formulation of public policies that support the reduction of the spread of the covid-19 virus.

## **Materials and methods**

The research carried out was quantitative and probabilistic. Likewise, an analysis of national data was carried out, which was grouped by cases of contagion in 2,409 municipalities in Mexico. Said analysis was carried out in two periods of time: 1) from January 1 to June 20, 2020 and 2) from January 1, 2020 to July 13, 2021. These two periods were carried out to know the change in the predictors after a year and to know if the same variables were the ones that affected the contagion of covid-19, as well as to know the change

in value in the predictors and to be able to ensure the impact of the variables used in the research. The methodology is presented in several subsections: 1) data source, 2) data analysis, 3) model and 4) scenario with poverty variables.

### **Data source**

Data on health and social aspects of poverty were collected, including those associated with covid-19. For this, the Open Data section of the General Directorate of Epidemiology was consulted. For period one, data from 172 days, 267,983 records of infected people were included; for period two, 560 days were included, a total of 2,604,711 infected people (Ministry of Health, August 30, 2021).

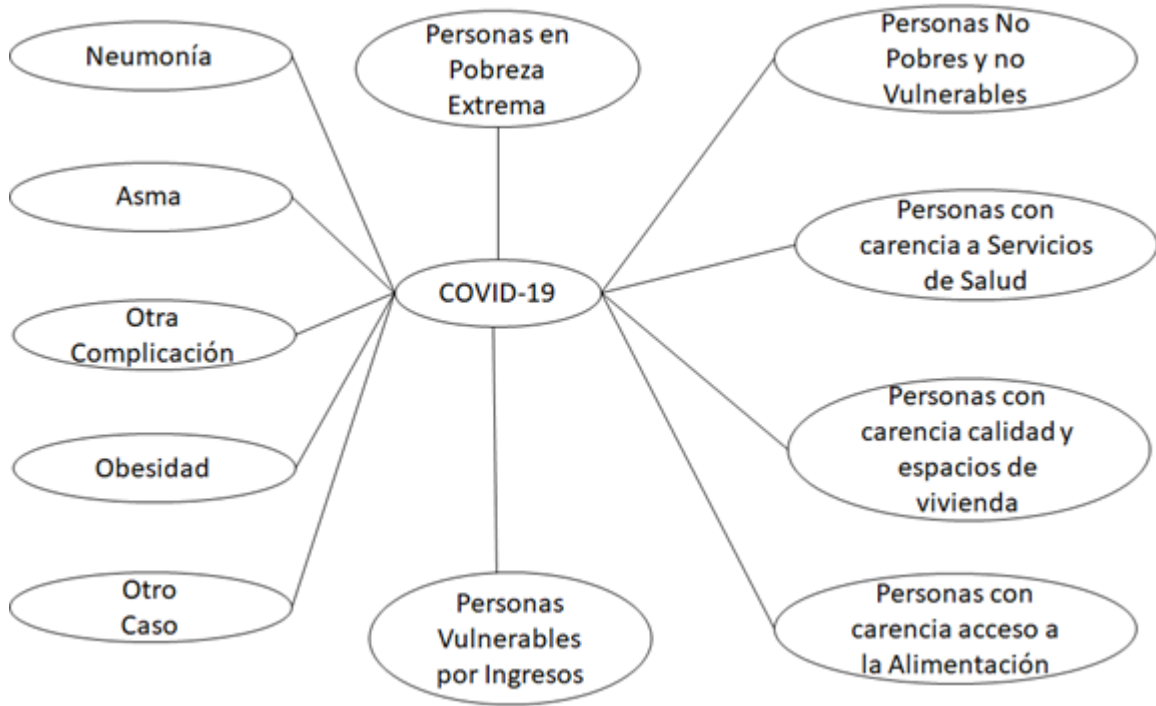
As for poverty data, these were collected from Coneval (2015). For this, the “dynamic consultation” of the council was used, which presents the results of poverty measurement at the municipal level in Mexico. Thus, 2,409 poverty data records were obtained by municipality of each federal entity.

### **Analysis of data**

A database was created with health aspects regarding patients with covid-19. As part of this process, the corresponding data tables were made in terms of health and geographic aspects. Subsequently, a union of data by municipality and federal entity was carried out and poverty data was added. Likewise, data correlations were made and the variables presented in Figure 2 and described in Table 1 were selected, as they are the ones with the highest correlation with covid-19 infection.

Figura 2. Variables de estudio utilizadas para el modelo predictivo de contagio por covid-

19



Fuente: Elaboración propia

**Tabla 1.** Descripción de variables utilizadas en el modelo predictivo de contagio del covid-

19

Variable	Descripción
Covid-19 (Y)	Número de personas con covid-19 con resultado Positivo SARS-CoV-2, agrupados por municipio y entidad de residencia
Neumonía (X <sub>1</sub> )	Paciente con diagnóstico de neumonía
Asma (X <sub>2</sub> )	Paciente con diagnóstico de asma
Otra complicación (X <sub>3</sub> )	Paciente con diagnóstico de otras enfermedades y con exclusión de neumonía, asma. Enfermedad pulmonar obstructiva crónica (EPOC), diabetes, inmunosupresión, hipertensión, cardiovascular, obesidad, insuficiencia renal crónica y hábito de tabaquismo
Obesidad (X <sub>4</sub> )	Paciente con diagnóstico de obesidad
Otro caso (X <sub>5</sub> )	Identifica si el paciente tuvo contacto con algún otro caso diagnosticado con SARS-CoV-2
Personas en pobreza extrema (X <sub>6</sub> )	Indicador de pobreza acerca de personas en situación de pobreza extrema
Personas vulnerables por ingresos (X <sub>7</sub> )	Indicador de pobreza sobre personas que no presentan carencias sociales y su ingreso es menor o igual a la línea de bienestar (Coneval, 2014)
Personas no pobres y no vulnerables (X <sub>8</sub> )	Indicador de pobreza sobre personas cuyo ingreso es superior a la línea de bienestar y que no tiene carencia social alguna (Coneval, 2014)
Personas con carencia de servicios de salud (X <sub>9</sub> )	Se considera que una persona se encuentra en situación de carencia por acceso a los servicios de salud cuando no cuente con adscripción o derecho a recibir servicios médicos de alguna institución que preste servicios médicos, incluyendo al Seguro Popular, a las instituciones de seguridad social (Instituto Mexicano del Seguro Social [IMSS], Instituto de Seguridad y Servicios Sociales para los Trabajadores del Estado [Issste], Pemex, Ejército o Marina) o los servicios médicos privados (Coneval, 2014)

Personas con carencia en calidad y espacios de vivienda (X <sub>10</sub> )	Son las personas que residen en viviendas que presentan, al menos, una de las siguientes características: 1) el material de los pisos es de tierra, 2) el material del techo es de lámina de cartón o desechos, 3) el material de los muros es de embarro o bajareque, de carrizo, bambú o palma, de lámina de cartón, metálica o asbesto, o material de desecho y 4) la razón de personas por cuarto (hacinamiento) es mayor que 2.5 (Coneval, 2014)
Personas con carencia de acceso a la alimentación (X <sub>11</sub> )	Es la población que vive en hogares que presentan un grado de inseguridad alimentaria moderado o severo (Coneval, 2014)

Fuente: Elaboración propia con base en el Coneval (2014) y la Dirección General de Epidemiología (Secretaría de Salud, 30 de agosto de 2021)

### Model

Two multiple linear regression models were carried out using the ordinary least squares method for both period one and two with the Gretl 2021 statistical software. This in order to measure the effect of the health and poverty variables that are presented in Table 1 on the cases of contagion of covid-19. As a dependent variable we have "Number of confirmed cases of covid-19 by municipality of Mexico". As independent variables we have "Pneumonia", "Asthma", "Other complication", "Obesity", "Other case", "People in extreme poverty", "Vulnerable people by income", "Non-poor and non-vulnerable people", "People with a lack of health services", "People with a lack of quality and housing spaces" and "People with a lack of access to food", which is represented for the models in the different periods in equation 1.

$$Y = \beta_0 + \beta_1 X_1 + \dots + \beta_{11} X_{11} + u \quad (1)$$

## Scenario with variable: "People with a lack of quality and housing spaces" and "Contagions by covid-19"

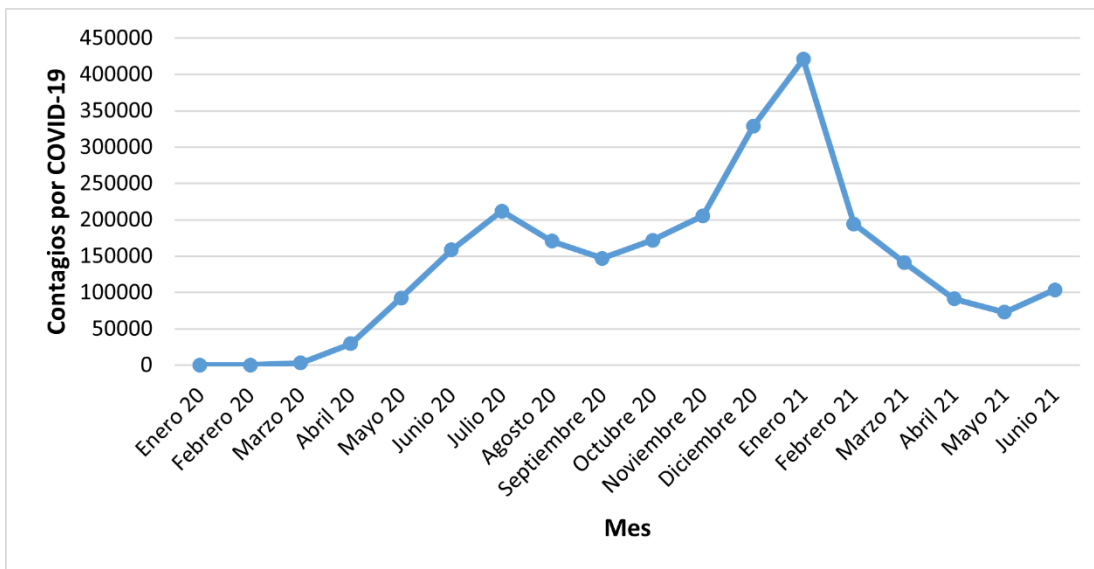
A scenario was created with the independent poverty variable "Covid-19 scenario" and "Actions to reduce the number of people with a lack of quality and housing spaces". To do this, an estimate of the variable was made with the estimating coefficients of the model for period two, from January 1, 2020 to July 13, 2021, and the average values of the variables were considered. The scenario was made with equation 2.

$$\hat{Y} = -\beta_0 + \beta_1\bar{X}_1 + \beta_2\bar{X}_2 + \beta_3\bar{X}_3 + \beta_4\bar{X}_4 + \beta_5\bar{X}_5 + \beta_6\bar{X}_6 + \beta_7\bar{X}_7 - \beta_8\bar{X}_8 + \beta_9\bar{X}_9 + \beta_{10}\bar{X}_{10} + \beta_{11}\bar{X}_{11} \quad (2)$$

## Results

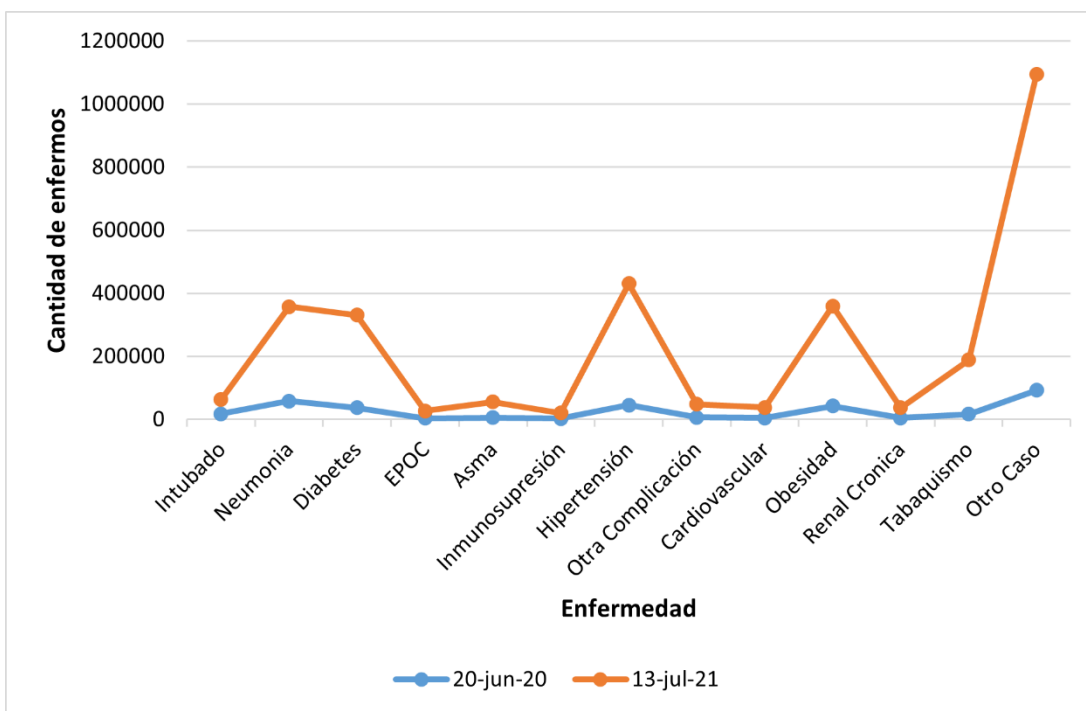
Figure 3 presents the cases of contagion by covid-19 during the period between January 2020 and June 2021. Similarly, figure 4 shows the results of the covid-19 health variables. There it is clearly seen that some variables have grown, but have a similar behavior in both periods; the most representative: "Pneumonia", "Diabetes", "Hypertension", "Obesity" and "Smoking". On the other hand, the variable "Other case", which is the highest, refers to having been infected with people who have covid-19. Figure 5 shows the number of people related to poverty, and economic inequality is perceived, since a large number of people are not poor and another similar number lacks access to food.

**Figura 3.** Contagios de covid-19 por mes



Fuente. Elaboración propia a partir de datos abiertos de covid-19 de la Secretaría de Salud en México

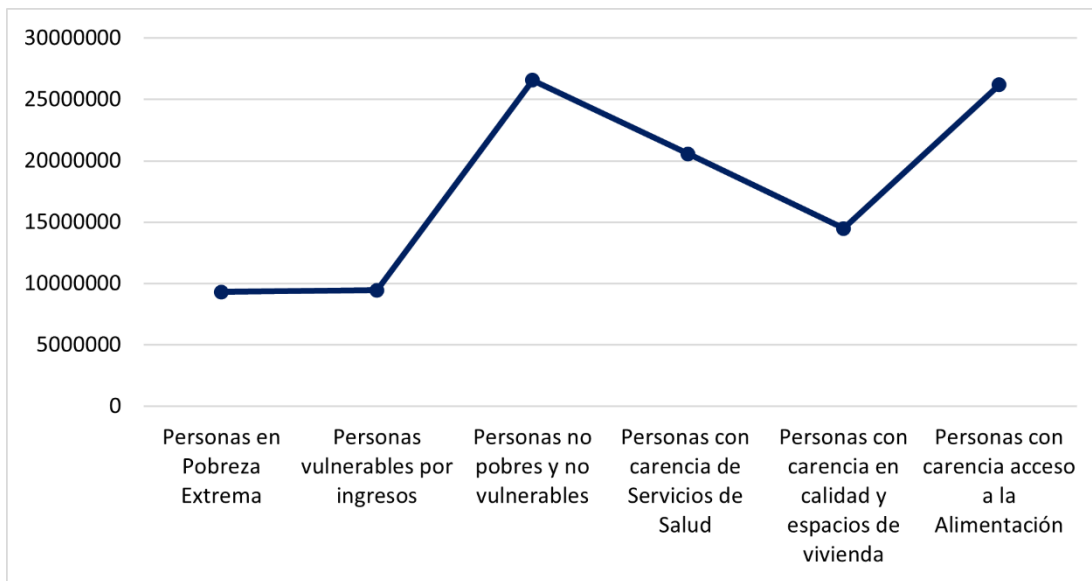
**Figura 4.** Número de casos de enfermedades de las variables de salud



Fuente. Elaboración propia a partir de datos abiertos de covid-19 de la Secretaría de Salud en México



**Figura 5.** Número de personas relacionados con pobreza



Fuente: Coneval (2015)

### Empirical model

To test the research hypothesis that conditions an increase in covid-19 in the population of the municipalities of Mexico, Table 2 presents the results of the models that include the estimated and statistical coefficients of decision, as well as the test of F as validity of the models.

**Tabla 2.** Estimaciones de los parámetros de regresión del modelo predictivo de contagios por covid-19

Variable dependiente: "Contagio por covid-19"						
Parámetro	Periodo uno: 1-01-2020 a 20-06-2020			Periodo dos: 1-01-2020 a 13-07-2021		
	Coef	Valor p		Coef	Valor p	
(Constante)	-3.363	0.007	**	-21.6885	0.1218	
Neumonía	0.9358	< 0.0001	***	0.4024	< 0.0001	***
Asma	0.3008	0.093	*	0.5229	0.301	
Otra complicación	1.9973	< 0.0001	***	2.4246	< 0.0001	***
Obesidad	1.0427	< 0.0001	***	1.0053	< 0.0001	***
Otro caso	0.1481	< 0.0001	***	1.4788	< 0.0001	***
Personas en pobreza extrema	-0.002	< 0.0001	***	-0.0192	< 0.0001	***
Personas vulnerables por ingresos	-0.0007	< 0.0001	***	0.0072	0.0053	***
Personas no pobres y no vulnerables	-0.001	< 0.0001	***	0.0111	< 0.0001	***
Personas con carencia de servicios de salud	0.0003	0.037	**	-0.0147	< 0.0001	***
Personas con carencia en calidad y espacios de vivienda	0.0024	< 0.0001	***	0.0151	< 0.0001	***
Personas con carencia en acceso a la alimentación	-0.0004	<0.0001	***	0.0112	<0.0001	***
	<i>F = 11575.04 Valor p (de F)</i> 0.0000			<i>F = 18835.94 Valor p (de F)</i> 0.0000		

Fuente: Elaboración propia a partir de los resultados de los modelos

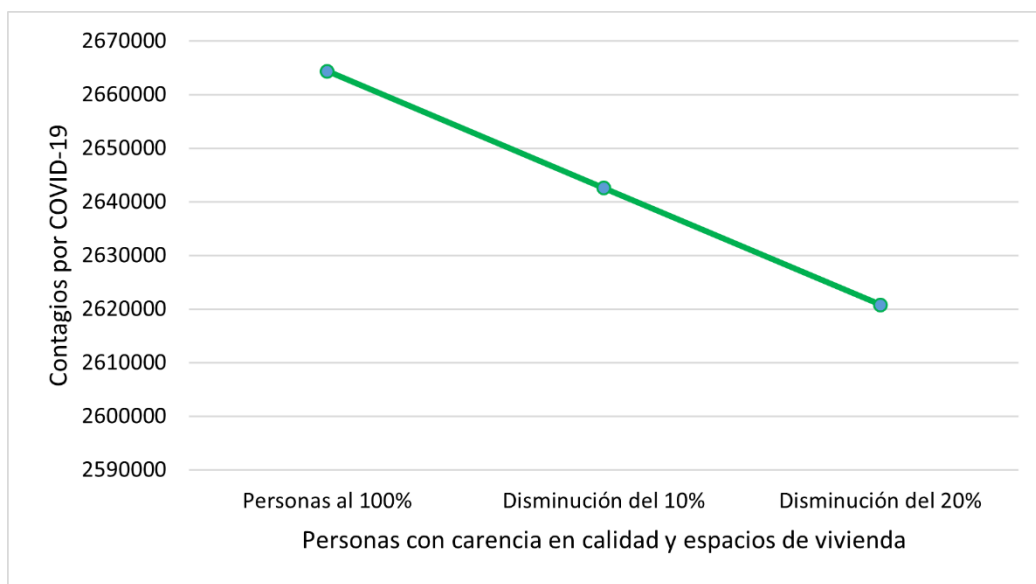
The coefficients of the functional relationship of the number of covid-19 cases with the health variables ("Pneumonia", "Asthma", "Other complication", "Obesity" and "Other case"), presented in equation 1 resulted with positive signs for both time periods and were

statistically significant according to the t statistic, since they were significantly different from zero at a 5% level.

### Scenario with poverty variables

A scenario is presented: "Covid-19 scenario and lack of housing quality". Said scenario measures the behavior of covid-19 with changes in actions of 10% and 20%, focused on reducing the number of people with a lack of quality and housing spaces. Undoubtedly, the Mexican Government must seek the appropriate actions to be able to reduce this deficiency. These actions may be to grant facilities to make sanitization spaces, as well as to provide the drinking water service more frequently, or to grant material to make rooms and avoid overcrowding, in such a way that the "healthy distance" can be carried out both in spaces for sleeping and living. This is shown in figure 6.

**Figura 6.** Escenario de personas con carencia en calidad y espacios de vivienda y covid-19



Fuente: Elaboración propia

## Discussions

Two time periods were analyzed and it was found that the selected variables had similar impacts, although some of them increased their predictive values. For the health variables ("Pneumonia", "Asthma", "Other complication", "Obesity" and "Other case"), there were positive signs for both time periods, which indicates that these variables influence contracting covid -19. For period two (January 1, 2020 to July 13, 2021), "Pneumonia", "Asthma", "Other complication", "Obesity" and "Other case" present an impact of 0.4024, 0.5229, 2.4246, 1.0053 and 1.4788, respectively. Similarly, for period two, the variables that present the highest values to have a contagion of covid-19 are "Other complication", "Obesity" and "Other case".

For the variable "Persons in extreme poverty", the coefficients were negative for both periods, which were not eliminated because they were part of the model. But it is observed that for period two, the variable presents a more negative behavior, since it went from -0.002 to -0.0192, that is, the variable had a negative change, which indicates that it does not affect people in extreme poverty.

Similarly, for the variable "Vulnerable people by income", the coefficients showed a change, that is, for period one there was a negative coefficient (-0.0007) and for period two a positive coefficient (0.0072), which indicates that the contagion by covid-19 has changed over time and now affects vulnerable people due to income. Therefore, it is important to monitor this variable, since economic income has been complicated in this time of pandemic. The same behavior occurred with the variable "Persons not poor and not vulnerable", since this, from having a negative value (-0.001) in period one, became positive (0.111) in period two, which indicates that for this last period, it affects non-poor and non-vulnerable people more, this could be due to the fact that they celebrate more social events and have greater mobility.

For the variable "People with lack of Health Services", the coefficient decreased, that is, from being positive (0.0003) in period one it became negative in period 2 (-0.0147), which implies that the lack of health services do not influence the contagion by covid-19 for period two, this may be due to the work that the Government of Mexico has done through the Ministry of Health and all the logistics that have been carried out, for which which is worth further investigation.

Likewise, regarding the variable “People with a lack of quality and housing spaces”, positive signs are presented for both periods, the most recent being 0.0151; Table 2 shows that this predictor grew, which indicates that they can acquire covid-19 due to this deficiency. This is important to analyze because there is a population with these deficiencies, which cannot follow the sanitization measures because they do not have quality and housing spaces, that is, they cannot wash their hands as many times as required, in addition to not having access to drinking water services and live in overcrowding, for which they cannot maintain a healthy distance from family members who go out to work every day.

For the variable "People with lack of access to food", the coefficient for period two was positive (0.01129); this coefficient for period one was negative (-0.0004), which indicates that covid-19 can be spread by having this lack of food.

This research complements the work of other authors. For example, Fuentes (2020) says that the poorest neighborhoods in his country suffer more infections. However, here in Mexico the type of shortcomings (vulnerable people due to income, quality and housing spaces and access to food) are being provided, which are the ones that have an impact to increase the number of infections by covid-19.

On the other hand, Sánchez (2020) also commented on people who have to continue with their daily lives, and even if they use face masks and gloves, the risk of getting covid-19 does not change. This is related to the variable "Other case", since they are the people who have been in contact with people infected with covid-19, such is the case of health personnel, who have been infected in areas where there is no lack of quality and housing spaces and, consequently, they were left without health services, some definitively (death) and others temporarily (when the doctors infected them and kept the quarantine). Hence the urgency of formulating policies so that the Government provides support to vulnerable communities due to these deficiencies, according to Vilar et al. (2020).

It is also important to train communities with housing quality and space deficiencies so that they become aware of covid-19 (Rudnick, 2020). This is also consistent with the results, since the Mexican government will have to invest in actions both to reduce the lack of quality and spaces for housing and food. For this, in the results section, a scenario is presented that indicates the percentage of actions that the Government has to consider to reduce the social lack of quality and housing spaces and thus reduce the cases of contagion by covid-19.

On the other hand, Orellana (2020) stated that an economic recession is expected in Mexico due to the pandemic. Similarly, the World Bank (2020) projected an increase in poverty and inequality rates. It is important to consider that in Mexico there are 20.5 million people with a lack of access to health services, so it is urgent that the Government take the necessary economic measures.

The limitations of this work are the lack of follow-up per patient, since there are no open access statistics that include this data.

## Conclusions

The objective was met and the health and poverty indicators that influence the increase in infections by covid-19 were analyzed and, derived from the results, it is concluded that it is necessary for the Government to apply greater measures of both health and social awareness. to the contagion of covid-19, as well as social programs in the municipalities where there are: 1) vulnerable people due to income, 2) people with a lack of quality and housing spaces and 3) people with a lack of access to food, this applies to both urban and rural areas. Well, people with these deficiencies cannot follow sanitary measures such as washing their hands frequently, because they do not have the spaces to do so, in addition to the fact that some people live in overcrowding and go out to work every day and return to infect the family. Similarly, expand health services to prevent diseases such as pneumonia, asthma, obesity and other complications to reduce the spread of covid-19. It is important to consider the scenario presented in the results section where it is shown that, with actions of at least 10% to reduce the lack of quality and housing spaces, the number of cases of contagion by covid-19 can be reduced. 19.

It is suggested to increase awareness measures in people, because, although it is broadcast in the mass media such as television, not all people have access, especially in rural communities, where there are deficiencies and they do not watch television, for lack of time or not having electricity, or not having a digital television signal, or living in overcrowding and not having spaces to watch television (news). It is urgent that the Mexican Government take measures on social deficiencies to avoid the increase or re-emergence of covid-19 in areas where there is a higher rate of poverty.

Likewise, the research strengths are the presentation of the scenario related to the lack of quality and housing spaces to help the Government take the necessary steps to reduce said lack of quality and have less contagion and spread of the virus.

On the other hand, the weakness that appears in this research is the lack of data related to: 1) economic aspects for each person who was infected, 2) contagion for the second time, and 3) days to recover for each patient, since He considers that these would be adequate indicators to make other models with aspects of health and poverty.

### **Future lines of research**

The results that were found contribute to an in-depth study of the interaction between people and mobility in housing from the point of view of quality and housing space. Similarly, they contribute to carry out an analysis of pneumonia, asthma and obesity diseases in the population to avoid the spread of covid-19.

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