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The distribution of hospital capacities in the face of the covid-19 pandemic in Mexico

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Abstract

This study aims to identify the hospital coverage at the municipal level, from the analysis of the infrastructure and personnel available and their possibilities of expansion, to avoid overload hospital capacity due to the increased demand for critical care, because of the COVID-19 pandemic in Mexico. The study uses the Shapley method, a series of indexes constructed to target the most vulnerable municipalities in the health sector before, during, and after the pandemic, which, in turn, makes possible the development of mitigation measures that could be used to absorb the impacts of this contingency. Concerning municipalities with high and medium exposure, it is highlighted that although cities and metropolitan areas have the necessary health resources, they are not prepared to cover a high demand of patient hospitalization. In the present analysis, it is recommended to continue with policies of social distancing to mitigate the spread of the disease until the needs for attending the demand are met.

Keywords: COVID-19, hospital coverage, vulnerability, resilience, Mexico
JEL Code: I15, I14, H11, N36

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1. Introduction

Humanity went through processes of adaptation and control of diseases such as the black plague that affected Eurasia in the 14th century, passing through the Spanish flu of 1918, measles, and chickenpox in the last century (Dáttilo et al., 2020; Jones et al., 2008). The new SARS-Cov-2 coronavirus, which causes the pandemic due to the COVID-19 disease, has quarantined more than half of the world population, something unprecedented in the history of humanity, which will mean many economic losses and increased social inequalities, among other effects (WHO, 2020).

This new scenario represents a challenge for governments around the world and tests their health systems and their capacities to face this virus. Mexico, with a population of around 127 million inhabitants, is the country with the second largest population in Latin America, which makes the control and mitigation of the pandemic more challenging to manage. We add to this the high levels of inequality in the country; health authorities have conflicts in their mission to help municipalities strengthen their levels of health resilience.

Therefore, to provide timely information on the conditions of the health system at the municipal level in Mexico, this article generates two vulnerability indices: the first analyzes the current needs of the health system at the municipal level. The second examines the specific conditions of hospital coverage in terms of resilience for respiratory diseases. It also seeks to generate an index that makes it possible to measure hospital coverage at the municipal level, the distribution of the number of beds, and personnel available. Its possibilities of expansion to avoid overloading hospital capacity due to increase due to a higher demand for critical care in Mexico. This index identifies which municipalities are most vulnerable before, during, and after the pandemic and, in turn, makes it possible to develop mitigation measures that could be used to absorb the impacts of this contingency, and thus help municipalities to strengthen their levels of healthcare resilience.

Applying these indices allows the regions with the highest intrinsic vulnerabilities to be visualized and, in turn, anticipate the modifications of the relevant variables previously identified in collaboration with the authorities. Remarkably, the necessary information can generate differentiated mitigation and resilience policies by the municipality, mitigation immediate to absorb the impacts of this contingency.

Finally, it should be noted that the situation the world is going through implies that humanity must be more sensitive to inequalities, both economic and social. Since this situation highlights the economic, social, health and humanitarian weaknesses of the countries where the municipalities and the poorest people are the most affected by this situation, which is why it is necessary to generate immediate measures to support and mitigate the effects of COVID-19 (Suárez et al., 2020, WHO, 2020).

This article is divided into five sections: 1) in the first part, a brief analysis of theories of resilience and vulnerability in health issues was generated. The explanation of the variable and the methodology used for index construction and sub-indexes are made. 2) In the second section, the results of the hospital coverage, health demand, and health vulnerability index sub-indices are discussed. 3) In the fourth section, a comparison is made between the specific hospital coverage index, taking as a case of pulmonary diseases and the spread of COVID-19 in Mexico, in addition to a brief analysis of hospital coverage during the contingency and possible effects that this situation will bring to the country. 4) Finally, there is a short discussion of the main conclusions and recommendations of the study.

2. Methodological and Theoretical Aspects

Vulnerability and resilience theories generally analyze three factors. The first is an exogenous driver, that is the threat, in our case COVID-19, when on February 27, 2020, patient zero was detected in Mexico. This virus had been shown to have a lethality of between 3 - 10% depending on the patient's previous health and care conditions and to be highly contagious.

The exogenous factor interacts with endogenous controllers, sensitivity, and adaptability; these factors are generated from the capacity of hospital systems and the susceptibility to the contagion of people living in each territory. In response to the addition of these two factors, it is observed within the public health services; the emphasis is placed on both local and regional coverage. This response is defined by the degree of availability of medical assistance through health institutions. It refers to the ratio of human resources such as medical personnel, nurses, paramedics, and material resources, from specialized hospitals, clinics, or doctor's offices to beds per hospital to the number of inhabitants (Nájera 1996).

Therefore, from the revised theory, it can be concluded that a maximum level of resilience will be reached if there are enough resources. These resources include both human and material, which correspond to adequate coverage that focuses on reducing the contagion curve and avoiding saturation of hospital centers and achieving a distribution of health goods in an equitable, efficient, and egalitarian way.

Consequently, the proposal for the construction of the Vulnerability index in the health sector made up of three dimensions:

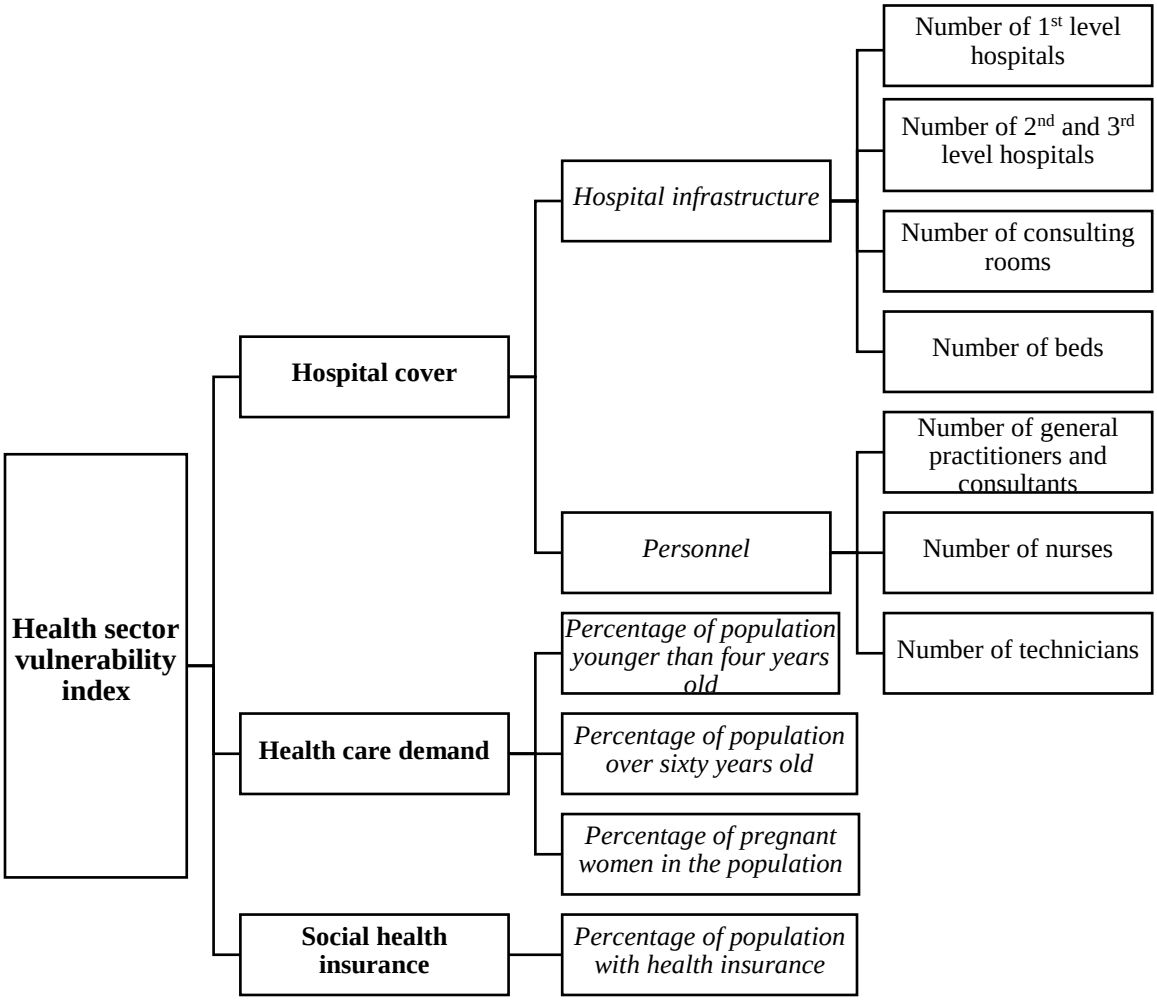
1) The sub-index of hospital coverage: First, a simplified hospital coverage sub-index (PIPE) generated -Personal, infrastructure, procedures, and items of equipment- (Markin, Barbero, & Leow, 2014). This sub-index aims to measure the capacity of care of each of the municipalities of Mexico, identifying if they are prepared to face the current levels of hospital use by the Mexican population.

Two dimensions were considered for the generation of this sub-index: on the one hand, health personnel, which is made up of the number of general practitioners and specialists, nurses, and technical staff. In addition, on the other hand, the infrastructure and equipment. The number of beds in the hospital unit, the number of doctor's offices, and the number of hospitals at the municipal level used for the construction of the sub-index.

2) Sub-index of healthcare demand: This indicator tries to measure the relative pressure of order in the health sector [3], according to the age patterns of the consumption of health goods and services. In this sense, as a proxy for relative demand, the average of children under four years of age, adults over 60 years of age and women of reproductive age was used. CONAPO's projections of the 2015-2030 municipal population were used as the primary source [4].

3) Scope of social health insurance. Finally, to identify the range of social health insurance, the percentage of the population without social health insurance is used as an indicator. The study data source was the administrative registry of the National Secretary of Health[5]

Figure 1. Health vulnerability index



Source: The authors

Finally, a specific hospital coverage index for pulmonary diseases generated, consisting of two dimensions: 1) specific infrastructure, which contains the number of beds and clinics for pulmonary illnesses; 2) personal; which is composed of the number of pulmonologists in a municipality.

The Health Vulnerability Index (IVS) is weighted by categories where the weight of each component was calculated from the Shapley decomposition. This approach estimates the relative contributions of various explanatory variables and variance of each part of the index. The steps for the construction of the IVS were:

1) An index with average or equal weights was generated (Israel, 2007)

$$IVCC = \frac{1}{3} * Hospital\ cover + \frac{1}{3} * health\ care\ demand\ + \frac{1}{3} * Health\ insurance\ capacity$$

2) In a second stage, the percentage of contributions of the variables that make up the index to the total variance of the previously estimated index was calculated (Olivera and Fuerte, 2020)

$$\theta = \beta_1 * x_1 + \beta_2 * x_2 + \cdots + \beta_k * x_k$$

Where θ is the index, β_i represents the relative contribution of each component used in the index, which in the initial step has an equal value β_i = β_j and must add up to one to maintain the identity and consistency in the estimation decomposition to be developed and *x1, x2, ..., xk* represent the components of the index, so the partial R-square for the variable xj can be calculated by the Shapley- Owen decomposition

With the above method, the weight of each subcomponent can be calculated. In this way, each category evaluated from zero to one. When added to the next dimension and weighted concerning the relative representativeness of its components, it can be re-read from zero to one. Where levels close to 1 indicate less vulnerability and municipalities with levels close to 0 show greater exposure.

3. Hospital Capacity and Sanitary Vulnerability

The application of the methodology proposed in diagram 1, starts from the development of the dimension of analysis of health personnel by a municipality, this dimension allows comparison of the number of health personnel distributed at the municipal level in Mexico. This dimension of analysis includes, with more significant, but marginal importance, both nursing personnel and doctors in general, and slightly lower than the others. The Alpha Cronbach test was applied to assess if the composition of the dimension is internally consistent, whose values above 0.7 indicate that the developed index or size is used to measure the reliability of a measurement scale.

The development of the hospital infrastructure dimension gives marginally more importance to second and third-level hospitals existing in a municipality, as well as to the number of general practitioners consulting rooms. The hospital coverage sub-index is significant, with 0.94 points of the Alpha Cronbach.

From these two dimensions, the hospital coverage sub-index was developed, which shows the balance of the relative weights between the infrastructure and the health personnel in the current distribution at the municipal level for both dimensions. Based on the construction of the sub-index, it is possible to see significant differences in the distribution of hospital coverage in the country. As can be seen in map 1, the municipalities with capital cities concentrate a large part of hospital personnel and infrastructure, drawing much attention to the south-central area of the country. In all these cases, despite their socio-economic characteristics, they have greater access to personnel and infrastructure than several municipalities in the central and northern areas of the country. It should be noted that the type of hospital infrastructure is focused on family offices and first-level hospitals.

Table 1. Hospital Coverage and Priority Care Population

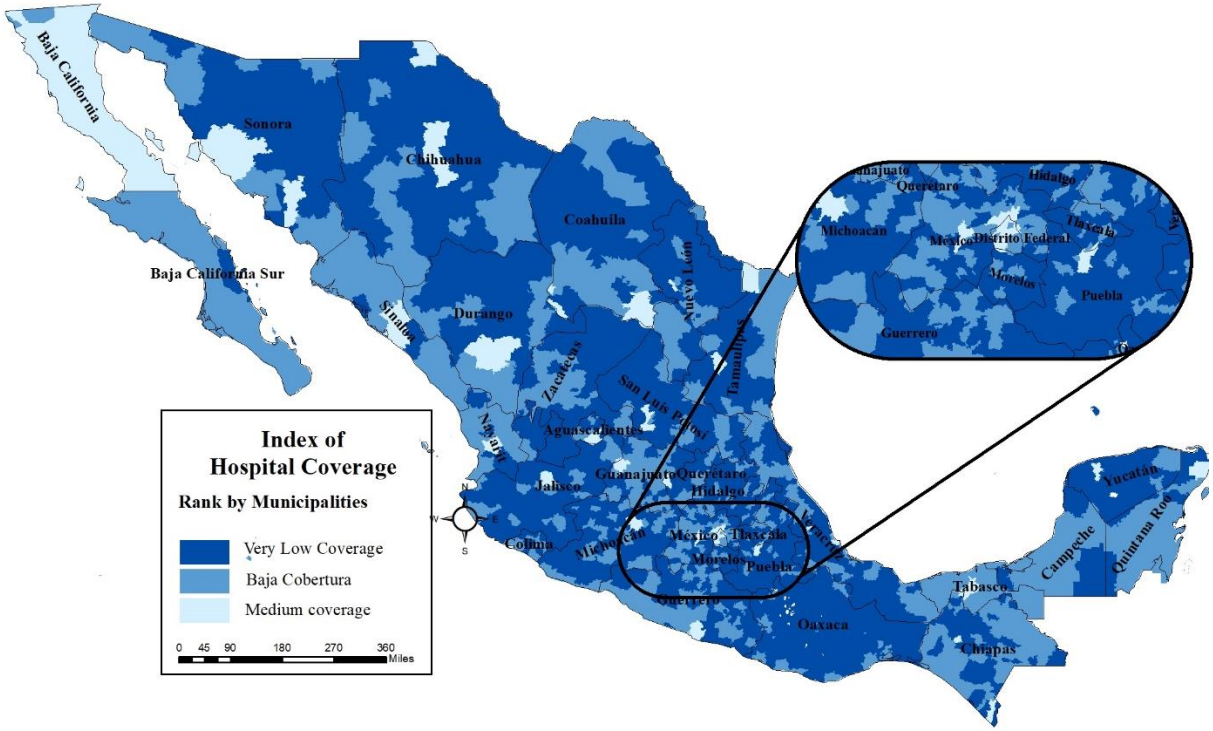
Hospital coverage sub-index	Number of municipalities	Estimated population	Percentage
Very Low Coverage	2,007	34,085,465	27.20%
Low coverage	387	50,950,466	40.65%
Medium coverage	63	40,291,866	32.15%
Total	2,457	125,327,797	100%

Source: own elaboration with data from the Ministry of Health

The hospital coverage sub-index when compared with the priority care population, that is, the health demand, we observe that only 63 municipalities have an average coverage and even these only provide care to 32.15% of the country's population, while 387 towns in the low range and cover 40.65% of this total demand. The very low coverage municipalities encompass 27.20% of the people that are dispersed in more than 2007 towns throughout the country.

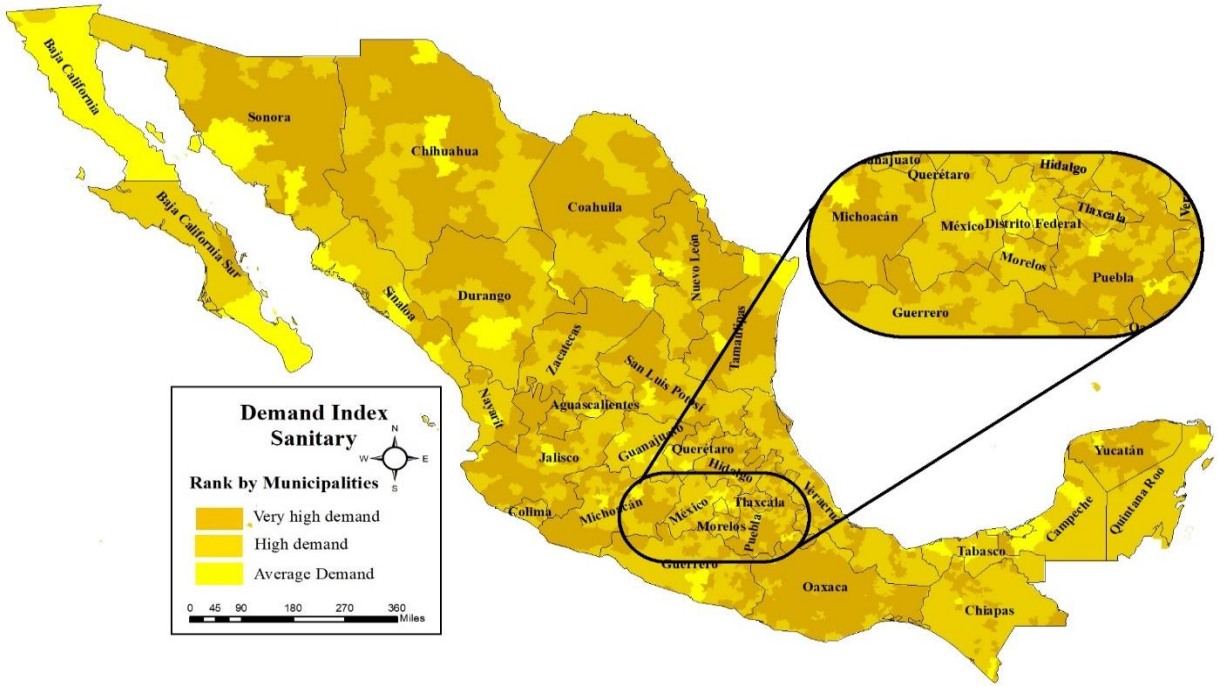
The next stage developed generated a health demand index that focuses on the population groups that use the health system the most. The sub-index contemplates the dimensions of the population: groups of children under four years of age, women of reproductive age and people over 60 years, the index shows a higher weight of women of reproductive age and children under four years. This weight has a high correlation with the most common diseases in Mexico, such as ARIs and ADDs, delivery care, as well as chronic-degenerative conditions. These groups represent a strain on current hospital coverage that, in many cases, is overstretched in certain regions.

Map 1. The sub-index of hospital coverage



Source: Authors with data from the Ministry of Health

Map 2. The sub-index of Sanitary Demand



Source: Authors with data from the Ministry of Health

Table 2. Population according to health demand

Health Demand Index	Number of municipalities	Estimated population	Percentage
Very High Demand	1,663	15,071,341	12.02%
High demand	698	48,830,358	38.96%
Average demand	96	61,426,098	49.02%
Total	2,457	125,327,797	100%

Source: Authors with data from the Ministry of Health

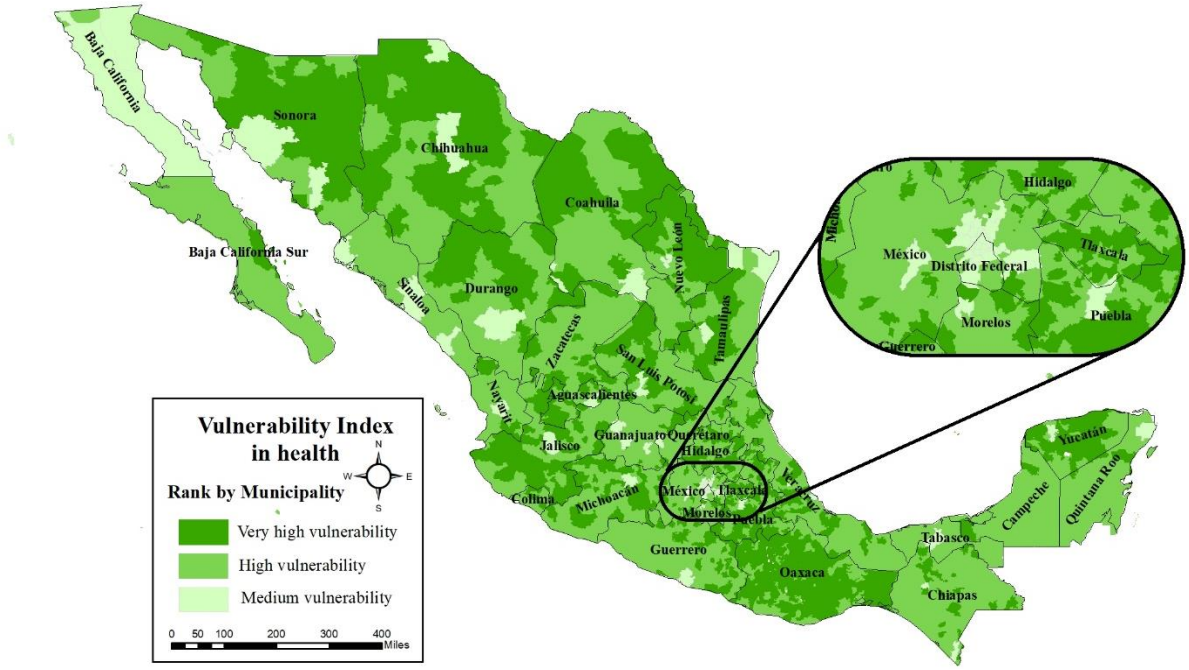
Analyzing map 2, we observe that the pressure of health demand has some correspondence to the lack of hospital coverage, although it is seen that the subscript has a high and very high demand in most of the country. The contrast between the health demand and the population served shows that the demand concentrated in 96 municipalities, with almost fifty percent of the country's total population. In contrast, the other fifty percent focused on districts with medium demand.

For the final construction of the Health Vulnerability Index, the dimensions that make up the sub-indices of hospital coverage, health demand, and additionally, the scope of social insurance, represented as the population without healthcare cover, are integrated. From the four-dimensions, an index was obtained where levels close to 1 indicate a less vulnerability, and municipalities levels relative to 0 indicate a greater vulnerability.

The index, at the municipal level in Mexico, shows a medium to high health vulnerability throughout the country, with a few exceptions such as the regions of the Valley of Mexico or the capitals of the States where despite the high concentration of health demand, they have a medium hospital coverage.

In sum, it is highlighted that the municipalities that show less vulnerability in health, in their majority are the capitals of districts; Besides, given the socio-economic characteristics of the country, the towns of the regions: South West; of the Sierra Tarahumara and the Huasteca region are the municipalities that present a high index of vulnerability due to not having sufficient health resources and having a limited health system in their hospital coverage capabilities and primary care; this highlights previous discussions on the limitations of the health system that, apart from the contingency of COVID-19, were already straining to satisfy the priority demand of its inhabitants.

Map 3. Health vulnerability index



Source: own elaboration with data from the Ministry of Health

4. Hospital capacity in times of COVID

From the IVS generated with data before the arrival of the first cases of COVID-19, an additional index was created. In this case, a multiplicative index was used that allows the developed IVS to be modified, showing the municipalities that have capacities of pulmonary care required to treat the SARS-CoV-2 virus. The applied method is very similar to the previous one. However, once the IVS has been developed, it is multiplied with the Vulnerability index in Respiratory diseases - IVEN. The IVEN is generated from three dimensions, consulting rooms for respiratory disease, beds for this type of disease, and medical personnel specialized in pneumology. [6].

As seen in Table 3, the weighting of weights shows that the number of pulmonologists and the number of said offices largely vulnerability within the index, this means that the lack of qualified personnel is a bottleneck in the case of respiratory diseases that generate over-demand in hospital capacity.

Table 3. Index of pneumology capacity

Pneumology care capacity index	Number of municipalities	Estimated population	Percentage
Without pneumological capacity	2,344	71,539,723	57.08%
Low capacity in pulmonary care	76	36,246,830	28.92%
Average capacity in pulmonary care	37	17,541,244	14.00%
Total	2,457	125,327,797	

Source: own elaboration with data from the Ministry of Health

As can be seen in Table 3, only 37 municipalities, which are mostly capital cities of the center of the country, have a medium capacity level in respiratory diseases before the arrival of the COVID-19 pandemic. While 76 municipalities, which contain around 36,246,830 inhabitants, have health systems with low capacity for specific care. Furthermore, more than 95% of the country's cities (2344 municipalities), which have more than 57% of the total population, do not have specific health resources for respiratory diseases. In other words, the cities do not have beds and clinics with the necessary medical specifications to treat lung infections, nor do they have medical professionals specialized in pulmonology. The scenario shows a degree of vulnerability in around 71,539,723 persons who would need to move to a different location to be treated if they develop an illness that requires care from a specialist in pulmonology, as is the case of those acutely ill with COVID-19.

However, apart from the fact that the municipalities with specific average coverage are, in turn, those with the lowest vulnerability indexes, the absolute number of pulmonology physicians and specific infrastructure, in most cases, is deficient for the size of the population that they must attend. For example, the municipality of Ecatepec has 1,692, 644 inhabitants, according to data from hospital resources of the Ministry of Health for the year 2018. This municipality had only three pulmonologists, three consulting rooms, and two specialized beds for pulmonology. This example means that a doctor should cover about 564,214 inhabitants.

Concerning the coverage capacity, to date (May 26, 2020), COVID-19 patients comprise 53.1% of the total capacity of beds destined for hospitalization. However, according to the Secretariat's calculations, the percentage of admission for other diseases must be added to this percentage, which generates relative pressure on the health system by increasing the rate of use of health resources to 70%.

In addition, there are municipalities that, to date, are already saturating their health coverage; it is the case of Tijuana, Iztapalapa, and Ecatepec municipalities. That has hospital use of beds by patients hospitalized for the SARS-CoV2 virus disease of 100%, 70%, and 60%, respectively. The saturation of the system means that, if we add to the above percentages the percentages of patients hospitalized for other diseases, their health systems, apart from being municipalities with low health vulnerability, are on the verge of complete saturation.

Therefore, the National Health Secretariat, in coordination with the federal government, regional and municipal governments, launched a series of public policies to avoid saturation of the health system. In this sense, they generated a "Hospital Conversion COVID-19" plan, which aims (Mendoza & Suarez, 2020) "to guarantee that the organization of medical care services is executed under the principles of opportunity, quality and efficiency of human resources, materials and finances for the benefit of the population, thereby influencing the prevention and control of the pandemic due to the SARS-CoV2 virus disease in Mexico" (Salud S. d., 2020, p.13)

Table 4. Number of hospitalized by COVID-19 and all beds by state, Mexico 22/06/2020

State	Hospital beds	Casos COVID-19 acumulados	Patients activos COVID -19	Patients hospitalized by COVID -19 actives	Patients intubated	Percentage of use
Aguascalientes	966	1906	626	129	3	13
Baja California	2,153	7,898	1,148	365	14	17
Baja California Sur	695	1,254	416	50	7	7
Campeche	790	1,383	520	123	4	16
Chiapas	2,259	2,912	1,032	104	1	5
Chihuahua	2,915	400	161	47	3	2
Mexico City	15,632	3,850	892	328	31	2
Coahuila	2,915	2,638	331	135	7	5
Colima	649	42,903	8,338	1,509	105	233
Durango	1,542	1,374	647	102	5	7
Guanajuato	3,657	5,014	1,934	448	26	12
Warrior	2,075	4,423	1,117	326	37	16
gentleman	1,367	3,300	853	280	14	20
Jalisco	6,460	5,217	1,812	456	28	7
Michoacán	2,648	29,424	5,844	2,025	99	76
Morelos	1,047	4,659	1,544	252	11	24
Mexico	8,282	2,420	472	182	1	2
Nayarit	714	1,344	486	135	7	19
New Lion	4,077	3,902	1,547	290	10	7
Oaxaca	2,321	4,140	1,214	411	38	18
Puebla	4,012	7,870	3,014	598	42	15
Queretaro	881	1,743	427	186	10	21
Quintana Roo	1,030	2,970	692	168	9	16
San Luis Potosi	2,021	2,392	923	115	3	6
Sinaloa	2,382	6,771	1,323	326	15	14
Sonora	2,894	5,520	1,181	240	12	8
Tabasco	1,583	8,715	2,875	257	20	16
Tamaulipas	2,977	4,348	1,528	238	7	8
Tlaxcala	714	2,067	545	166	9	23
Veracruz	4,999	8,420	2,227	803	38	16
Yucatan	1,800	3,239	962	216	9	12
Zacatecas	999	706	281	75	1	8
Total	89,456	185,122	46,912	11,085	626	12

Source: Prepared based on data from the National Health Secretariat updated 22/06/2020

With the above measures, the Government will try to stop the hospital saturation that, as mentioned, is already affecting several municipalities in the country, also if we consider the projections of the disease. The estimated demand by patients with symptoms related to COVID -

19 will peak in mid-jun. This over-demand implies immediate action by the authorities and implementation of all its guidelines and operations, given that if we increase the increasing number of cases. We consider that 20 percent of patients with COVID-19 require hospital care for more than 15 days of hospitalization, the hospital coverage capacities of some cities will be exceeded, and additional facilities will be required.

Once the peak of COVID-19 cases and the overload in the hospital capacity of the different States and municipalities have passed, the hospital system and the family doctor's office system will face the accumulated demand for non-essential health services. The excess demand from requirements for the application of vaccines against coronavirus if they are produced in this year. Spikes in infections are expected to retest hospital capacity and the level of coverage nationwide.

5. Conclusions

Before the arrival of the first cases of COVID-19, hospital distribution coverage stressed because of the demand for medical services throughout the country. When the extraordinary request for assistance or the need for the intervention of a doctor in some specialty outside family medicine, patients require trips of between 3 to 10 km, in the case of capital cities and between 1 to 12 hours, in the case of small municipalities (Galindo Pérez & Suárez Lastra, 2018).

This pressure accounted for by the unequal spatial distribution of resources and the concentration of specialists in the urban megalopolis. This observation ratifies "Theory of Central Places" developed by Christaller, in which the location of settlements are explained through goods and services, within the area of influence of an identified central place, and according to the degree of specialization will be more or less their area of effect (Sánchez, 2015).

Besides, this vulnerability is aggravated if the lack of specific resources for respiratory diseases is identified; these results show the importance of generating protection policies for these municipalities. About municipalities with high and medium vulnerability, it observed that although cities and metropolitan areas have the necessary health resources, they are not prepared to supply a very high demand for hospitalizations. Therefore, it is required to keep proper distance policies in force, to flatten the contagion curve, and avoid oversaturation of health services.

It should be noted that until Monday, June 22, there were 185.122 accumulated confirmed cases and close to 22 584 deaths due to COVID-19, and patients reported in several municipalities with very high vulnerability. This situation highlights the economic, social, health, and humanitarian weaknesses of the country where the districts and the poorest people are the most affected.

Table 5. Dimensions of the Health Vulnerability Index

MUNICIPALITY	State	Population	Vulnerability Index	Number hospitals	Number of beds	Number of Doctors	Number of nurses	Number of offices	Accumulated covid19 cases	Active covid19 cases	Hospitalized	Intubated
Guadalajara	Jalisco	1499330	0.84064	76	5047	4382	10120	1424	1670	614	168	5
Puebla	Puebla	1673165	0.8009	107	3409	3097	5649	1054	5064	2042	359	22
Iztapalapa	Mexico City	1830835	0.73796	80	1971	2680	4210	926	7587	1257	251	19
Lion	Guanajuato	1645986	0.7043	84	2482	2690	5077	801	2388	865	168	8
Ecatepec de Morelos	Mexico	1692644	0.66959	75	1248	1847	3183	700	3541	756	289	11
Gustavo A. Madero	Mexico City	1184801	0.66935	84	2687	3514	6395	1010	5568	983	235	15
Monterrey	New Lion	1106817	0.66697	98	3630	3675	7567	1608	1145	499	90	4
Tijuana	Baja California	1736099	0.60407	83	1238	1587	2693	609	2606	168	87	3
Cuauhtémoc	Mexico City	546713	0.53985	98	3058	3664	7063	1506	2553	491	95	6
Juarez	Chihuahua	1446305	0.51408	53	1580	1559	3297	560	1699	139	63	5
HIGH VULNERABILITY MUNICIPALITIES												
St. Bartholomew Zoogocho	Oaxaca-	327	0.00067	1	0	1	1	1	0	0	0	0
San Cristóbal Suchixtlahuac	Oaxaca-	367	0.00066	1	4	0	0	1	0	0	0	0
Santa Maria Salina	Oaxaca-	291	0.00065	1	2	0	1	1	0	0	0	0
Saint Philip of Jesus	Sonora	434	0.00065	1	0	0	1	1	0	0	0	0
Santo Domingo Tonaltepec	Oaxaca-	254	0.00065	1	0	1	2	0	1	0	0	0
Onavas	Sonora	478	0.00064	1	0	0	0	1	0	0	0	0
Santo Domingo Yodohino	Oaxaca-	331	0.00064	1	3	0	1	1	1	0	0	0
San Miguel Tulancingo	Oaxaca-	315	0.00063	1	0	0	1	1	0	0	0	0
Santiago Nejapilla	Oaxaca-	213	0.00063	1	0	1	1	1	0	0	0	0
San Mateo Tlapiltepec	Oaxaca-	232	0.0006	1	2	0	1	1	0	0	0	0

Own elaboration source based on data from the Ministry of Health updated to 22/06/2020

These municipalities began to generate mobile medical attention centers; military infrastructure was made available to the health secretary, among other measures. Therefore, it is necessary to create immediate steps, to support and mitigate the effects of COVID-19 in highly vulnerable municipalities.

References

Dáttilo, W., Castro, A., Guevara, R., MacGregor, I., & Ribeiro, S. (2020). COVID-19 most vulnerable Mexican cities lack the public health infrastructure to face the pandemic: new temporally - explicit model. *Physical Sciences*, 1-23.

Galindo Pérez, C., & Suárez Lastra, M. (2018). Servicios de salud del ISSSTE en la Zona Metropolitana de la Ciudad de México¿ Qué pasaría si nos enfermáramos todos?. . *Gestión y política pública, 27(2),* , 475-499.

Jones, K. E., Patel, N. G., Levy, M. A., Storeygard, A. B., Gittleman, J. L., & Daszak, P. (2008). Global trends in emerging infectious diseases. Nature, 451(7181), 990-993.

Israeli, O. (2007). A Shapley-based decomposition of the R-square of linear regression. The Journal of Economic Inequality, 5(2), 199-212.

López, F., & Aguilar, A. (2004). Niveles de cobertura y accesibilidad de la infraestructura de los servicios de salud en la periferia metropolitana de la Ciudad de México. *Investigaciones Geográficas, Boletín del Instituto de Geografía*, 185-209.

Markin, A., Barbero, R., & Leow, J. (2014). Inter-Rater Reliability of the PIPES tool: Validation of a Surgical Capacity Index for Use in Resource-Limited settings. *Societé Internationale de Chirurgie*, 2195 - 2199.

Nájera, P. (1996). *Cobertura regional, patrones de utilización y accesibilidad geográfica a los servicios de atención a la salud de primer nivel en el Estado de México.* Ciudad de México: UNAM.

Olivera, M., & Fuerte, M. d. (2020). Poppy Cultivation and Eradication in Mexico, 2000–2018: the Effects of Climate. En V. Lyubchich, Y. Gel, K. H. Kilbourne, T. J. Miller, N. K. Newlands, & A. Smith, *Evaluating Climate Change Impacts* (págs. 380 -398). Routledge - Taylor and Francis.

PNUD. (2020). *Los Impactos Económicos del COVID-19 y las desigualdades de género recomendaciones y lineamientos de Políticas Públicas.* Panamá: PNUD.

Salud, S. d. (2020). *Lineamientos de Reconversión Hospitalaria.* Ciudad de México: Gobierno de México.

Salud, S. N. (2012). *La Calidad de la atención a la Salud en México a través de sus instituciones.* Ciudad de México.

Sánchez, D. (2015). Accesibilidad a los servicios de salud: debate teórico sobre determinantes e implicaciones en la política pública de salud. *Revista Médica de Instituto Mexicano*, 82-89.

SEDESOL. (2015). *Sistema Normativo de Equipamiento Urbano.* Ciudad de Mexico: SEDESOL.

Suárez, M., Valdés, C., Galindo, C., & Guzmás, E. (2020). *Vulnerabilidad ante COVID-2019 en México.* Ciudad de México: UNAM.

Tbé, C., Almarán, C., & Espallargues, M. (2010). *Development of a structural capacity index for oncological surgery in acute hospitals.* Barcelona: El Sevier Doyma.

WHO, W. H. (2020). *COVID-19 Strategic Preparedness and Response Plan: Operational planning guidelines to support country preparedness and response.* Geneva: WHO.

Zhang, Y., & Xu, J. (2020). *A Novel Coronavirus (COVID-19) Outbreak. A call for action.* CHEST.

[1] With a gross domestic product of 1,221 trillion USD, for 2018, Mexico ranks second in economic level in Latin America; however, it also has a Gini index of 0.45 is a country with high inequality with contrasting realities between its municipalities.

[2] In particular, the sensitivity analyzed from the medical system considers the most vulnerable people, such as the elderly, people with chronic-degenerative diseases, immunosuppressed and pregnant people. However, in the context of the study, we will analyze the level of sensitivity of the patients added at the municipal level

[3] http://www.dgis.salud.gob.mx/contenidos/basesdedatos/recursossector.html

[4] https://datos.gob.mx/busca/dataset/proyecciones-de-la-poblacion-de-mexico-y-de-las-entidades-federativas-2016-2050

[5] http://sinba08.salud.gob.mx/cubos/ccubopobcensal2010CA.html

[6] The reports from Italy and Spain that had high mortality showed that COVID, unlike other SARSs, has a direct effect on the cardiac system so that for future analyzes, cardiac care could be combined.