

# Supporting Information.

## An index of municipality-level vulnerability to COVID-19 in Mexico.

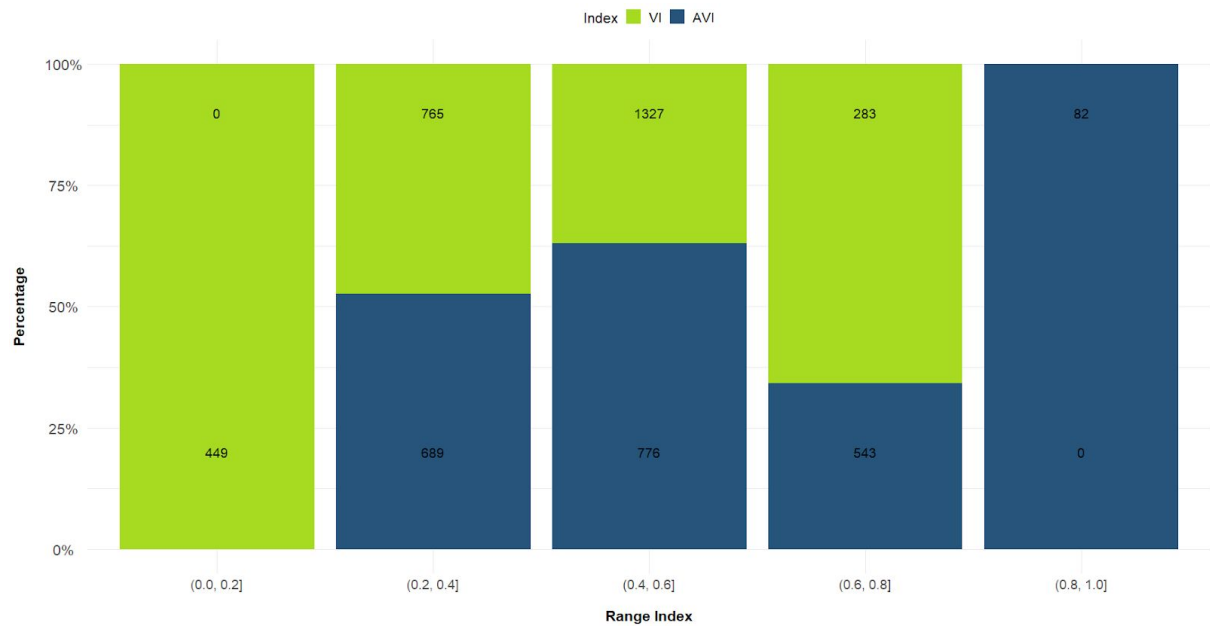
Avila-Ortega, Daniel Itzamna<sup>a✉</sup>, Flores-Santana, Cynthia<sup>a</sup>, Gómez-Hernández, Daniel<sup>b</sup>

<sup>a</sup> Mexican Center of Industrial Ecology. Av. Hidalgo Ote. #63A, Z.P. 61506. Zitácuaro, Michoacán, México.

<sup>b</sup> Facultad de Ciencias, Universidad Nacional Autónoma de México, Mexico City, México.

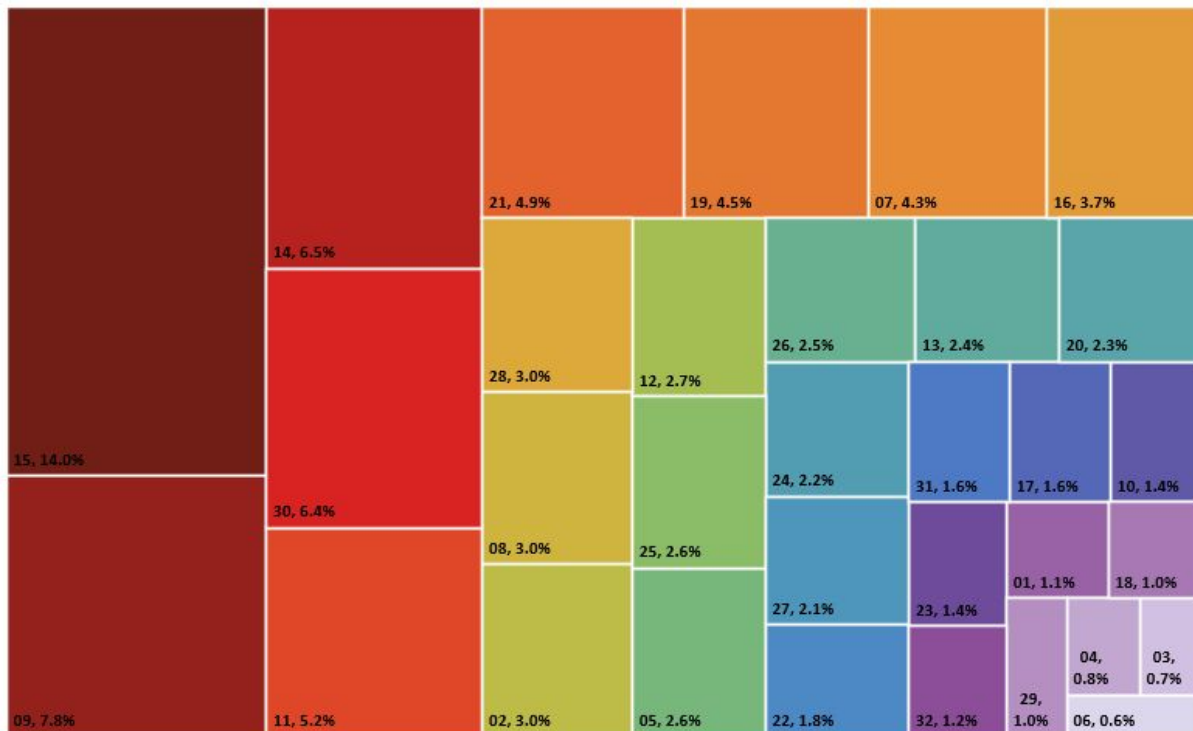
✉ Contact author: [d.avila@cmei.org.mx](mailto:d.avila@cmei.org.mx)

## Figures



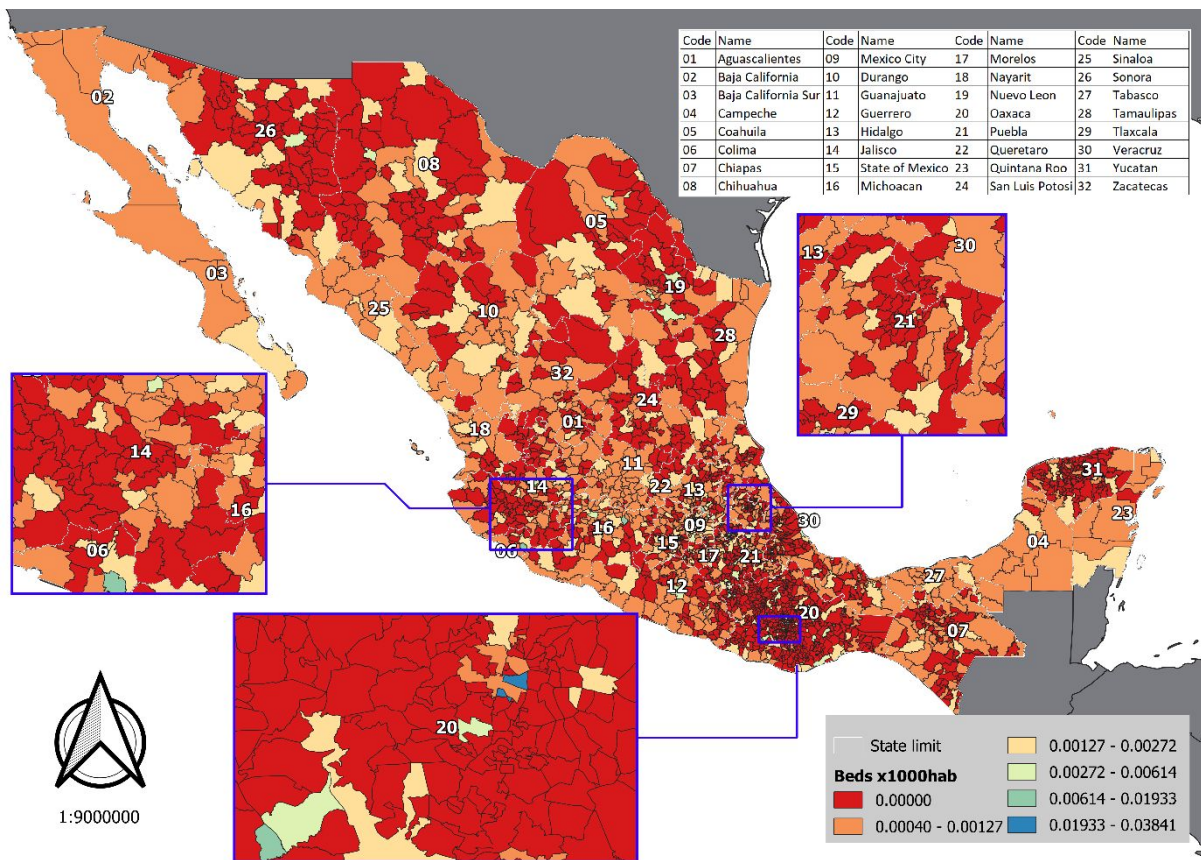
**Supporting Figure 1 | Municipalities share with regards to vulnerability index and adjusted vulnerability index.**

In green, the vulnerability index with municipalities counts, whereas in blue the adjusted vulnerability index with municipalities counts per range.

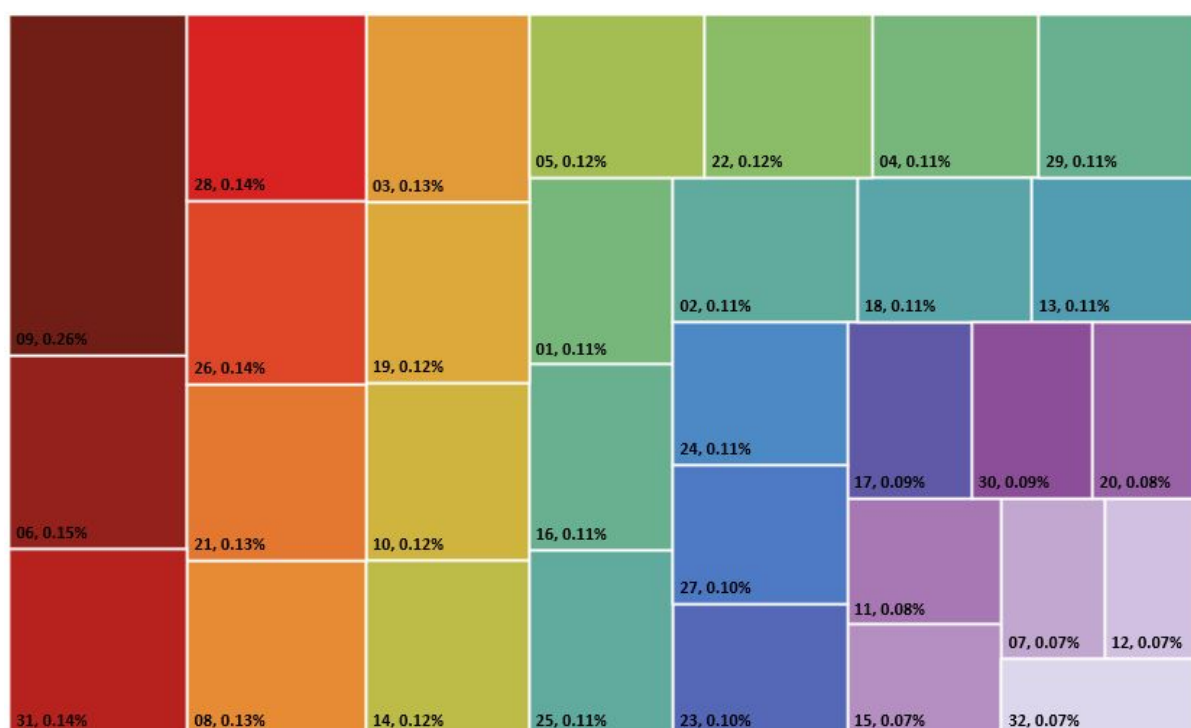


**Supporting Figure 2 | Percentage share of the population at risk (PAR) given comorbidities at the State level.**

Of the total population at risk per municipality, it summarizes it by State. It is showing the percentage share of each State. Numbering classification is the same as Figures 1 and 2 and Extended Figure 3 (below).

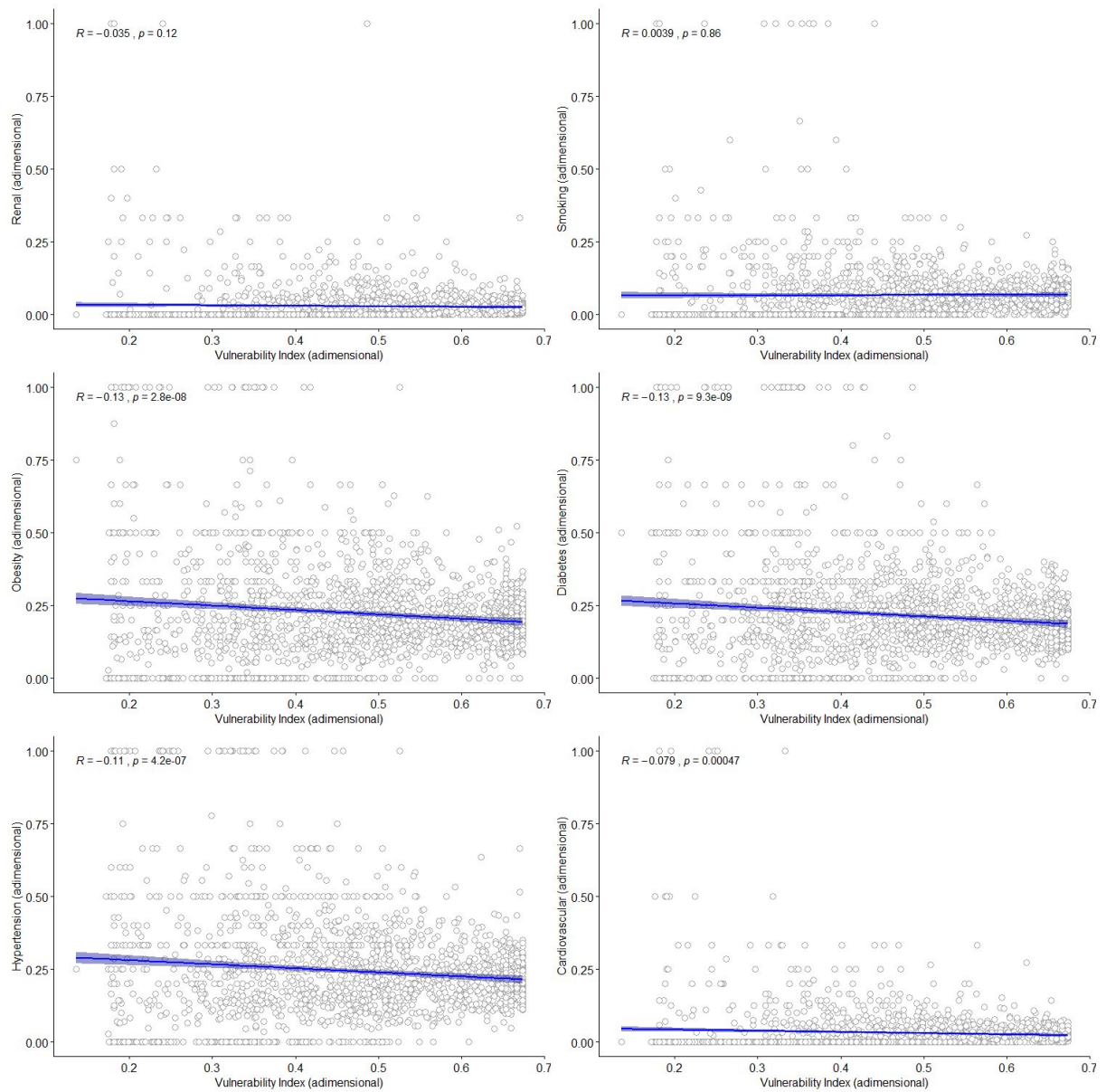


**Supporting Figure 3 | Available hospitalization beds per thousand inhabitants.**  
It only includes hospitalization beds from private and public institutions at the municipal level.



**Supporting Figure 4 | Percentage share of the population with access to infrastructure (PAI) given comorbidities at the State level.**

Of the total population with access to infrastructure per municipality, it summarizes it by State. It is showing the percentage share of each State. Numbering classification is the same as Figures 1 and 2 and Extended Figure 3 (above).



**Supporting Figure 5 | Pearson correlation analysis of comorbidities in COVID-19 cases and the Vulnerability Index.**

From top-left to bottom, and left to right: renal disease, smoking, obesity, diabetes, hypertension and cardiovascular disease correlations against the vulnerability index.

## Tables

This table is attached in electronic format (Excel), as it is composed of rows (ST1).

**Supporting Table 1 | Cumulated COVI-19 cases in Mexico (SSA, 2020).**

Age cohort	Score
0 to 9	0.0078
10 to 19	0.0156
20 to 29	0.0313
30 to 39	0.0625
40 to 49	0.1250
50 to 59	0.2500
+60	0.5000

**Supporting Table 2 | Age cohort scoring.**

This table is attached in electronic format (Excel), as it is composed of multiple tabs (ST3).

**Supporting Table 3 | Key-code catalog from the 2018 National Health and Nutrition Survey (NHNS)(INEGI and INSP, 2019).**

This table is attached in electronic format (Excel), as it is composed of multiple tabs (ST4).

**Supporting Table 4 | Comorbidities statistics per State, municipality, sex and age cohort.**

State Code	State Name	BedsX1000 hab	Total Beds	State Code	State Name	BedsX1000 hab	Total Beds
01	Aguascalientes	0.00054091	1,552	17	Morelos	0.00074333	1,833
02	Baja California	0.00103400	3,984	18	Nayarit	0.00060850	1,299
03	Baja California Sur	0.00119200	998	19	Nuevo León	0.00044000	6,716
04	Campeche	0.00077727	1,103	20	Oaxaca	0.00025119	2,870
05	Coahuila	0.00054842	3,726	21	Puebla	0.00041843	7,912
06	Colima	0.00156000	1,105	22	Querétaro	0.00054167	2,505
07	Chiapas	0.00025932	3,610	23	Quintana Roo	0.00082800	1,597
08	Chihuahua	0.00034119	4,746	24	San Luis Potosí	0.00029586	2,800
09	Mexico City	0.00260250	23,213	25	Sinaloa	0.00076833	3,491
10	Durango	0.00054974	2,168	26	Sonora	0.00036333	4,012
11	Guanajuato	0.00044413	4,979	27	Tabasco	0.00072529	2,579
12	Guerrero	0.00033556	2,313	28	Tamaulipas	0.00060977	4,953
13	Hidalgo	0.00063548	3,054	29	Tlaxcala	0.00066900	1,433
14	Jalisco	0.00034864	9,541	30	Veracruz	0.00034208	7,139
15	Mexico State	0.00050864	12,365	31	Yucatán	0.00016406	2,776
16	Michoacán	0.00059283	5,103	32	Zacatecas	0.00026672	1,020

**Supporting Table 5 | Hospitalization beds per thousand inhabitants at the State level.**

It includes total available beds per State.



State Code	State Name	POP	PAR	PAI	%PAR-POP	%PAI-POP	%PAI-PAR
01	Aguascalientes	1,395,794	883,762	1,009	0.6332	0.0007	0.0011
02	Baja California	3,521,242	2,322,739	2,628	0.6596	0.0007	0.0011
03	Baja California Sur	771,294	510,921	661	0.6624	0.0009	0.0013
04	Campeche	967,319	634,400	729	0.6558	0.0008	0.0011
05	Coahuila	3,132,017	2,010,864	2,441	0.6420	0.0008	0.0012
06	Colima	760,333	491,540	718	0.6465	0.0009	0.0015
07	Chiapas	5,563,869	3,397,339	2,361	0.6106	0.0004	0.0007
08	Chihuahua	3,727,984	2,333,346	3,099	0.6259	0.0008	0.0013
09	Mexico City	9,041,395	6,087,660	15,631	0.6733	0.0017	0.0026
10	Durango	1,836,460	1,108,847	1,365	0.6038	0.0007	0.0012
11	Guanajuato	6,117,205	4,046,411	3,329	0.6615	0.0005	0.0008
12	Guerrero	3,629,733	2,137,959	1,457	0.5890	0.0004	0.0007
13	Hidalgo	3,014,258	1,854,189	1,968	0.6151	0.0007	0.0011
14	Jalisco	8,238,991	5,081,330	6,186	0.6167	0.0008	0.0012
15	Mexico State	17,056,666	10,975,012	8,040	0.6434	0.0005	0.0007
16	Michoacán	4,757,482	2,887,439	3,284	0.6069	0.0007	0.0011
17	Morelos	2,000,527	1,271,255	1,183	0.6355	0.0006	0.0009
18	Nayarit	1,252,363	782,162	835	0.6245	0.0007	0.0011
19	Nuevo León	5,454,848	3,525,115	4,404	0.6462	0.0008	0.0012
20	Oaxaca	4,096,998	1,798,204	1,514	0.4389	0.0004	0.0008
21	Puebla	6,478,819	3,828,287	5,123	0.5909	0.0008	0.0013
22	Querétaro	2,197,938	1,444,142	1,674	0.6570	0.0008	0.0012
23	Quintana Roo	1,645,237	1,086,577	1,062	0.6604	0.0006	0.0010
24	San Luis Potosí	2,825,157	1,741,249	1,840	0.6163	0.0007	0.0011
25	Sinaloa	3,104,610	2,048,463	2,323	0.6598	0.0007	0.0011
26	Sonora	3,000,127	1,939,883	2,675	0.6466	0.0009	0.0014
27	Tabasco	2,515,926	1,651,838	1,693	0.6566	0.0007	0.0010
28	Tamaulipas	3,590,486	2,345,441	3,304	0.6532	0.0009	0.0014
29	Tlaxcala	1,347,932	744,305	853	0.5522	0.0006	0.0011
30	Veracruz	8,434,163	5,024,703	4,554	0.5958	0.0005	0.0009
31	Yucatán	2,208,236	1,272,811	1,809	0.5764	0.0008	0.0014
32	Zacatecas	1,642,388	968,955	652	0.5900	0.0004	0.0007

#### Supporting Table 6 | Population summary per State.

POP = population of a given State, PAR = population at risk given comorbidities, PAI = Population access to infrastructure (beds). %PAR-POP = Percentage of the population at risk of the total population at a given State. %PAI-POP = Percentage of the population with access to infrastructure of the total population at a given State. %PAI-PAR = Percentage of the population with access to infrastructure of the population at risk at a given State.

State	Name	POP	PAR	PAI	PAR-A	PAI-A	BEDS	% (de) increase PAR-A	% (de) increase PAI-A	Beds Non-PAI	Beds Non-PAIA
1	Aguascalientes	1395794	883762	1009	1006934	1162	1552	0.1394	0.1521	0.6503	0.7493
2	Baja California	3521242	2322739	2628	2872530	3259	3984	0.2367	0.2403	0.6596	0.8181
3	Baja California Sur	771294	510921	661	549147	715	998	0.0748	0.0824	0.6626	0.7172
4	Campeche	967319	634400	729	629424.8	768	1103	-0.0078	0.0537	0.6609	0.6964
5	Coahuila	3132017	2010864	2441	2254765	2808	3726	0.1213	0.1502	0.6552	0.7536
6	Colima	760333	491540	718	473517.7	719	1105	-0.0367	0.0015	0.6496	0.6505
7	Chiapas	5563869	3397339	2361	3590429	2645	3610	0.0568	0.1202	0.654	0.7326
8	Chihuahua	3727984	2333346	3099	2666103	3585	4746	0.1426	0.1569	0.653	0.7554
9	Mexico City	9041395	6087660	15631	7369360	19149	23213	0.2105	0.2251	0.6734	0.8249
10	Durango	1836460	1108847	1365	1255029	1617	2168	0.1318	0.1846	0.6297	0.746
11	Guanajuato	6117205	4046411	3329	4448143	3871	4979	0.0993	0.1629	0.6685	0.7774
12	Guerrero	3629733	2137959	1457	2290340	1624	2313	0.0713	0.1147	0.6298	0.702
13	Hidalgo	3014258	1854189	1968	1838605	2035	3054	-0.0084	0.0343	0.6443	0.6664
14	Jalisco	8238991	5081330	6186	5983351	7495	9541	0.1775	0.2117	0.6484	0.7856
15	Mexico State	17056666	10975012	8040	12633036	9441	12365	0.1511	0.1742	0.6502	0.7635
16	Michoacán	4757482	2887439	3284	3169412	3684	5103	0.0977	0.1218	0.6435	0.7219
17	Morelos	2000527	1271255	1183	1338068	1303	1833	0.0526	0.1011	0.6453	0.7105
18	Nayarit	1252363	782162	835	835300.3	953	1299	0.0679	0.1411	0.6429	0.7336
19	Nuevo León	5454848	3525115	4404	4065785	5344	6716	0.1534	0.2134	0.6557	0.7956
20	Oaxaca	4096998	1798204	1514	2090286	1696	2870	0.1624	0.1204	0.5276	0.5911
21	Puebla	6478819	3828287	5123	4265245	5918	7912	0.1141	0.1551	0.6475	0.7479
22	Querétaro	2197938	1444142	1674	1600038	1968	2505	0.108	0.1756	0.6682	0.7855
23	Quintana Roo	1645237	1086577	1062	1232688	1206	1597	0.1345	0.1356	0.6652	0.7554
24	San Luis Potosí	2825157	1741249	1840	1822428	2028	2800	0.0466	0.1023	0.6571	0.7243
25	Sinaloa	3104610	2048463	2323	2297500	2710	3491	0.1216	0.1668	0.6654	0.7764
26	Sonora	3000127	1939883	2675	2152493	3033	4012	0.1096	0.134	0.6667	0.756
27	Tabasco	2515926	1651838	1693	1754939	1925	2579	0.0624	0.1368	0.6565	0.7463
28	Tamaulipas	3590486	2345441	3304	2661535	3730	4953	0.1348	0.129	0.6671	0.7531
29	Tlaxcala	1347932	744305	853	693812.7	774	1433	-0.0678	-0.0924	0.5952	0.5402
30	Veracruz	8434163	5024703	4554	5377161	5165	7139	0.0701	0.1341	0.6379	0.7234
31	Yucatán	2208236	1272811	1809	1412486	2143	2776	0.1097	0.1848	0.6517	0.7721
32	Zacatecas	1642388	968955	652	934304.1	620	1020	-0.0358	-0.0494	0.6392	0.6076

**Supporting Table 7 | State summary for population with access to infrastructure and beds.** POP = Population in each state; PAR = Population at risk, PAI = population with access to infrastructure; PAI-A = population with access to infrastructure from adjusted vulnerability index; BEDS = Total hospitalization beds available. %(de)increase PAR-(A) = percentage of decrease/increase population at risk ; %(de)increase PAI-(A) = percentage of decrease/increase population with access to infrastructure; %BedsNon-PAI = percentage of beds in use by population with access to infrastructure; %BedsNon-PAIA = percentage of beds in use by population with access to infrastructure from adjusted vulnerability index.

	VIndex	Renal	Smoking	Obesity	Diabetes	Hypertension	Cardiovascular
VIndex	1	-0.03532	0.0039	-0.12534	-0.12957	-0.11421	-0.07914
Renal	-0.03532	1	-0.01106	-0.00771	0.13142	0.17618	0.03085
Smoking	0.0039	-0.01106	1	0.02144	0.04206	-0.00303	-0.0132
Obesity	-0.12534	-0.00771	0.02144	1	0.04829	0.12319	0.01729
Diabetes	-0.12957	0.13142	0.04206	0.04829	1	0.28095	0.14987
Hypertension	-0.11421	0.17618	-0.00303	0.12319	0.28095	1	0.20387
Cardiovascular	-0.07914	0.03085	-0.0132	0.01729	0.14987	0.20387	1

**Supplementary Table 8 | Correlation analysis of present comorbidities in effective COVID-19 cases with the vulnerability index.** Pearson correlation analysis of present comorbidities in effective COVID-19 cases across all municipalities and the vulnerability index.

## Equations

Supporting equation 1

$$Non - smokers = \{P1\_1 = 2 \text{ and } P1\_2 = 3 \text{ and } P1\_4 = 3 \text{ } P1\_1 = 8 \text{ and } P1\_2 = 3 \text{ and } P1\_4 = 3 \text{ } P1\_1 = 9 \text{ and } P1\_2 = 3 \text{ and } P1\_4 = 3\}$$

Supporting equation 2

$$Non - obese - teenagers = \{P4\_1\_2, P4\_1\_3, P4\_1\_5, P4\_1\_6, P4\_1\_7, P4\_1\_8, P4\_1\_8, P4\_1\_9, P4\_1\_10 = 2\}$$

Supporting equation 3

$$Non - obese - adults = \{P1\_1 = 2 \text{ and } P1\_6 = 3; P1\_1 = 2 \text{ and } P1\_7 = 3; P1\_1 = 2 \text{ and } P1\_7 = 4; P1\_1 = 2 \text{ and } P1\_7 = 5\}$$

Supporting equation 4

$$Non - diabetic - adults = \{P3\_1 = 3 \text{ and others} = null\}$$

Supporting equation 5

$$Non - hypertense - adults = \{P4\_1 = 2\}$$

Supporting equation 6

$$Non - cardiovascular - adults = \{P5\_1 = 2 \text{ and } P5\_2\_1 = 2 \text{ and } P5\_2\_2 = 2 \text{ and } P5\_2\_3 = 2\}$$

Supporting equation 7

$$Non - renal - adults = \{P6\_1\_1 = 2 \text{ and } P6\_1\_2 = 2 \text{ and } P6\_1\_3 = 2$$

Supporting equation 8

$$Non - smoking - adults = \{P13\_1 = 2 \text{ and } P13\_2 = 3 \text{ and } P13\_4 = 3 \text{ } P13\_1 = 8 \text{ and } P13\_2 = 3 \text{ and } P13\_4 = 3 \text{ } P$$

## References

INEGI and INSP (2019) *Encuesta Nacional de Salud y Nutrición. 2018. ENSANUT. Estructura de la base de datos*. Mexico City, Mexico. Available at:

[https://ensanut.insp.mx/encuestas/ensanut2018/doctos/otros/ensanut\\_2018\\_estructua\\_base\\_datos.pdf](https://ensanut.insp.mx/encuestas/ensanut2018/doctos/otros/ensanut_2018_estructua_base_datos.pdf).

SSA (2020) *Datos Abiertos - Dirección General de Epidemiología, Dirección General de Epidemiología*. Available at: <https://www.gob.mx/salud/documentos/datos-abiertos-152127>

(Accessed: 20 August 2020).