

Study of potentially avoidable hospitalization geographic variability in three five-year periods

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Abstract

Introduction: Diseases that motivate potentially preventable hospitalization (PH) have the characteristic of being sensitive to prevention, diagnosis and control on an outpatient basis in primary care. **Objectives:** To identify the national trend of potentially avoidable hospitalization between 2001 and 2015; to analyze its geographical pattern at the municipal level and prioritize municipalities. **Method:** Hospital discharge records from the Ministry of Health were used. National prevalence rates and municipal PH ratios, standardized by age and gender, were calculated. Variability statistics were used to analyze and generate maps. **Results:** Among all hospital discharges, 10.39%, 9.81% and 9.26% were classified as PH for each period. The national PH rate did increase in the studied period: from 36.27 to 47.24 per 10,000 population. Diabetes mellitus, gastroenteritis and other diseases of the lower respiratory tract were the most common causes. Geographic patterns of PH were similar for the three periods. A total of 487 priority municipalities were identified, 174 with hospital high use and 313 with overuse, 35.83 % were avoidable hospitalizations, 8.58% and 27.25%, respectively. **Conclusions:** In Mexico there is wide geographical variability in PH, with an almost unchanging geographical pattern.

KEY WORDS: Avoidable hospitalizations. Geographic variability. Mexico.

Introduction

The diseases that motivate a potentially avoidable hospitalization have the characteristic of being sensitive to prevention, diagnosis, treatment and outpatient control in primary health care (PHC) optimal conditions; they receive the name of avoidable hospitalizations (AH).

AHs are a group of hospital discharge codes of the International Classification of Diseases (ICD-10) that represent hospital admissions that could have been avoided should outpatient care have been provided with quality.^{1,2} They have been proposed to evaluate access to PHC, its quality and capacity for prevention, early diagnosis, opportune treatment and effective monitoring of diseases that are sensitive to outpatient

care. Their validity and reliability as an indicator have been assessed by various studies.^{3,4} They have also been used for identification of priority areas and decision-making looking to strengthen PHC and assessment of actions carried out for that purpose.⁵

The study of medical practice geographical variability, carried out in small areas with the purpose to break the cover-up that occurs in investigations with large aggregations, is a methodology that allows to identify with greater certainty the areas where AHs occur, with relative independence of the determinants involved in the incidence of diseases, since it uses the patient place of residence rather than the hospital where he/she was provided care, with the place where individuals live being considered the headquarters from which they interact with PHC services, in health or illness.⁶

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In Mexico, in the evaluation of the Ministry of Health public hospitals performance for the years 2003 and 2011, among other aspects, an analysis of AH causes was included,^{7,8} in 2003, only pneumonia was included, and in 2011 an exclusive series of chapters was integrated where the frequency of hospitalizations for asthma, gastroenteritis, dehydration, angina pectoris, congestive heart failure, hypertension, chronic obstructive pulmonary disease and certain dental conditions was analyzed, which resulted in an AH rate of 29.6 per 10 000 population.

A study of AH in the population of the Mexican Institute of Social Security, sponsored by the Inter-American Development Bank, found that the rate of AH based on a list of 20 causes showed a descending trend: from an age-adjusted rate of 87.5 per 10 000 population in 2001, it went to 72.6 in 2009.⁹

Rodríguez Salgado et al., in their 2015 study on AH for type 2 diabetes mellitus in the three main institutions of the National Health System (Mexican Institute of Social Security, Institute of Security and Social Services of State Workers and the Ministry of Health) found that the nationwide hospitalization rate for this disease was 14 hospitalizations per 10 000 \geq 20-year population. When the condition of affiliation was considered, average hospitalization rate for the population without social security was 15.3 and 12 for the population with social security.¹⁰

Breakdown of data in the studies carried out in Mexico has reached national and state levels; however, data aggregated in large areas tend to cover up the behavior of indicators in more specific areas and do not allow identifying critical regions that are susceptible to corrective actions being focused.⁶ The present study used the geographical variability methodology for the analysis of AHs in three periods: 2001-2005, 2006-2010 and 2011-2015, taking data of the Ministry of Health Hospital units as reference.

On the other hand, as a basis for expecting little variability in this indicator, it should be noted that public health services in Mexico are organized in a pyramidal form: primary care units constitute the basis of PHC and from them are the different programs for the prevention and control the most common diseases in Mexico carried out, and which become clinical guidelines for community-based prevention, diagnosis, treatment and control of said diseases. As examples, mention can be made of diabetes arterial hypertension and acute diarrheal diseases prevention and control programs, as well as vaccination-preventable acute respiratory infections. National standards have

been established for the control of certain risk factors: unhealthy diet, physical inactivity, alcoholism, smoking, just to mention a few.¹¹ In this context, it can be considered that AH estimation will support the definition of health policies in Mexico.

Objectives

- To estimate AHs frequency and tendency, overall and by cause, in three 5-year periods: 2001-2005, 2006-2010 and 2011-2015.
- To analyze the geographical pattern of the reasons for potentially avoidable hospitalizations at the municipal level in the three 5-year periods of study.
- To prioritize municipalities in order to identify areas where health interventions could be carried out.

Method

Hospital discharges of the Ministry of Health from 2001 to 2015 were used,¹² since only in the databases in this area that are made publicly available by this same institution is the record of the municipality of the patient's usual residence found. These data were grouped in the three aforementioned 5-year periods. For AH selection, the guide used by Rodríguez Abrego⁹ and other studies¹³ was taken. We should note that asthma, epilepsy, urinary tract and kidney infection, skin and subcutaneous tissue infection, female pelvic organs inflammatory disease and gastric ulcer are not considered in the Ministry of Health prevention and control priority programs; however, there are sectoral clinical guidelines of some of these diseases for application at primary care level.¹⁴

To calculate the age and gender-standardized AH ratios, the population size by age and gender estimated by the National Population Council was used, and 7 age groups were formed, according to the number of years: 0-4, 5-14, 15-24, 25-44, 45-64, 65-74 and \geq 75.¹⁵ Using the total population rather than the uninsured population as the denominator was preferred, since a significant percentage of social security affiliates are users of Ministry of Health services. The municipality was selected as the unit of analysis for several reasons:

- It represents a closer approach to the patients' residence, which is the place from which individuals relate to and interact with PHC services, especially in causes of illness that are subjected to the analysis here presented.

- The pathologies that require more complex health levels for their resolution transcend the territorial organization of health services to open population due to various problems, including the reference and counter-reference system.
- Patient flow between levels of medical care is independent of hospital coverage, which is driven by the offer or users' preference.
- The organization of health care services to the open population is not subject to territorial regulations as in social security, where the affiliate's residence plays an important role for the assignment of medical correspondence units.
- Regionalization by health jurisdictions or by hospitals are geographic demarcations exclusively used for administration and planning of government services.

With regard to the study of AH rates behavior by period and by cause at the national level, it required the use of a direct standardization method, taking the sum of the population of the three five-year periods according to age and gender as a reference.

To study AH geographical variability at the municipal level, an indirect rate standardization method was used, where the gross hospitalization rate by nation-wide age and gender was taken as the mean for each period, based on which the AH ratios were estimated by municipality. In this analysis, the municipalities were stratified depending on the AH ratios, ordered from 1 to 5: ≤ 0.50 , 0.80-0.51, 0.81-1.19, 1.20-1.49 and ≥ 1.50 .

To classify the municipalities according to priority level, the probabilistic classification method¹⁶ was used according to their frequency of location in the identified strata, with five resulting groups: hospital overuse, high use, average use, low use and underuse. The former two represent the areas of hospital overuse and were colored with black and dark gray color on the maps; the latter two groups represent the regions with hospital service underutilization and were marked with blue sky and green colors, respectively. The medium use group was painted in yellow.

General descriptive statistics were estimated to study the AH ratios geographical variability (mean, median, standard deviation, variance, minimum and maximum value, percentiles 1, 5, 10, 20, 25, 50, 75, 80, 90, 95 and 99). To study the AH ratios degree of variability, the 1/99, 5/95, 10/90, 20/80 and 25/75 ratios percentile variation (PVR) were obtained. Finally, the component systematic variation (CSV) was estimated in order to assess frequency distributions systematic variance for each period, with the values being

close to 1, as expected for the estimator; lower values indicate that uncertainty or chance is present.

For the generation of maps the Digital Map of Mexico version 1.6 and the 2014 Geostatistical Framework of the National Institute of Statistics and Geography (INEGI – *Instituto Nacional de Estadística y Geografía*) were used.¹⁷

AHs relative importance for each period was obtained by tabulating their proportion with reference to total hospital discharges, as well as their percentage distribution by causes and age groups (Table 1), and standardized rates were obtained with the direct method of AH by age and gender according to total, causes and age groups (Table 2).

AH ratios geographical distributions per municipality stratified for each 5-year period were depicted in maps, where the assumed geographical pattern and the degree of dispersion of the figures obtained through the referred estimators are appreciated (Fig. 1). Based on these geographical distributions and the probabilistic classification method, the priority municipalities shown in figure 2 were obtained; finally, the priority municipalities were listed according to the municipal code assigned by INEGI (Table 3).

Results

A total of 35 223 193 hospital discharges were studied during the 2001-2015 period; 25 % corresponded to the first 5-year period, 34 % to the second and 41 % to the third.

Out of total of hospital discharges, 10.39, 9.81 and 9.26 % were classified as AH for each 5-year period, respectively (Table 1). Although, proportionally, there was a slight percentage decrease for these hospitalization causes, in absolute numbers, they increased 14.23 % on average during the course of the studied period: 898 833, 1 188 416 and 1 339 721 (Table 1).

By disease causes, diabetes mellitus, gastroenteritis and other lower respiratory tract diseases were the ones with the highest percentage (total per period), accounting for approximately half the AHs at each 5-year period. However, when the average growth column is observed, an increase in their relative importance at the expense of a decrease in avoidable conditions, gastroenteritis, nutritional deficiencies, ears, nose and throat infections, bacterial pneumonia, asthma, other lower respiratory tract diseases and heart failure was appreciated in 12 cases during the studied period.

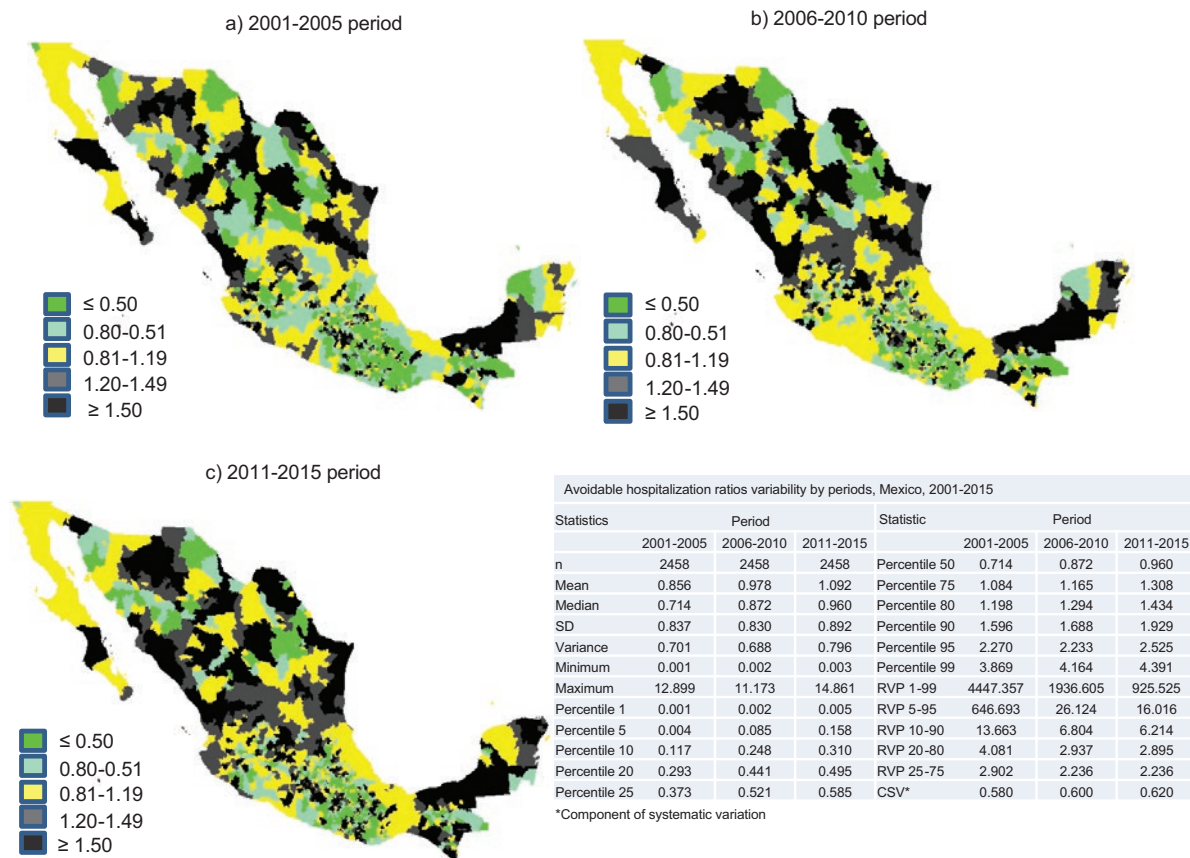


Figure 1. Avoidable hospitalization ratios geographical patterns by municipality in three 5-year periods. Mexico, 2001-2015.

The 0-4, 25-44, 45-64 and ≥ 75 years' age groups had a higher percentage of AH at each 5-year period (total AH).

For disease causes according to age group, in all three periods, frequency in the 0-4 and 5-14 groups was observed to be concentrated on diseases that are preventable with vaccination, gastroenteritis, nutritional deficiencies, ear, nose and throat infections; bacterial pneumonia, asthma and other lower respiratory tract diseases. AHs due to avoidable conditions, hypochromic anemia, hypertension, angina pectoris, diabetes mellitus, urinary tract and kidney infections; skin and subcutaneous tissue infections, female pelvic organs inflammatory disease, diseases related to prenatal care and delivery and gastric ulcer occurred with higher frequency in the age groups between 15 and 64 years. In the older age groups, ≥ 65 years, heart failure and stroke were the most common causes of AH.

Table 2 shows age and gender-standardized AH rates according to the 5-year period, cause and age group. Following the same order of analysis in Table 1, an average increase of 9.21 % was observed in the

national rate according to the 5-year period: 36.27, 44.60 and 47.24 per 10 000 population.

Diabetes mellitus, gastroenteritis and other lower respiratory tract diseases were the diseases with higher AH rates at each 5-year period. Stroke had the fourth highest rate in the first 5-year period and was replaced by diseases related to prenatal care and delivery in the second and last periods.

For disease causes, an increase was appreciated in the rates throughout the studied period, except in preventable conditions, gastroenteritis and bacterial pneumonia, which had a slight decrease. There were 8 causes that had an increase higher than 10 %: diseases related to prenatal care and delivery; urinary tract and kidney infections, vaccination-preventable diseases, epilepsy, skin and subcutaneous tissue infections, hypochromic anemia, other lower respiratory tract diseases and arterial hypertension.

By age groups, total expenses for AH stood out in the 45-64, 25-44, 0-4 and ≥ 75 years' groups in the first two 5-year periods; at the third 5-year period, the 5-14 years' group replaced the ≥ 75 years' group in the fourth position of the groups with the highest rates, although with little difference.

Table 1. Total avoidable hospitalizations by study period, cause and age groups. Mexico, 2001-2015

Causes of avoidable hospitalizations	2001-2005 five-year period									2006-2010 five-year period			
	Age groups							Total		Age groups			
	0-4	5-14	15-24	25-44	45-64	65-74	≥ 75	n	%	0-4	5-14	15-24	25-44
Diseases that are preventable with vaccination	43.99	8.65	10.70	18.41	11.56	3.99	2.69	4160	0.46	37.96	12.10	10.87	19.10
Avoidable conditions	6.96	7.54	13.27	31.22	26.00	8.64	6.36	17712	1.97	5.09	6.57	12.77	33.55
Gastroenteritis and complications	53.09	14.53	6.17	10.45	7.84	3.53	4.39	155186	17.27	40.22	26.86	6.16	9.85
Hypochromic anemia	22.12	6.63	10.85	25.21	16.64	8.07	10.47	2626	0.29	10.55	9.44	9.99	25.66
Nutritional deficiencies	58.13	12.39	3.25	5.25	5.92	4.52	10.52	10908	1.21	42.77	24.57	4.14	6.19
Ear, nose and throat infections	47.14	25.36	9.22	11.43	4.26	1.22	1.36	33836	3.76	38.74	31.55	9.60	11.73
Bacterial pneumonia	39.76	9.14	4.21	10.36	11.86	8.72	15.94	26557	2.95	31.84	19.49	4.65	10.22
Asthma	37.58	25.56	5.41	14.01	10.96	3.48	3.01	45608	5.07	35.53	31.66	5.18	12.66
Other lower respiratory tract diseases	47.85	6.25	1.02	3.02	10.29	11.97	19.60	93815	10.44	32.44	21.02	1.53	3.13
Arterial hypertension	0.18	0.50	2.08	15.05	39.24	21.18	21.75	33923	3.77	0.17	0.53	2.12	13.71
Angina pectoris	0.00	0.00	0.78	12.03	44.59	23.52	19.09	8581	0.95	0.00	0.00	0.79	10.02
Heart failure	1.96	0.94	1.81	8.66	28.76	24.33	33.54	29807	3.32	1.48	1.22	1.81	8.91
Stroke	0.53	0.66	1.76	8.70	27.70	23.66	36.99	45499	5.06	0.41	0.56	1.64	8.04
Diabetes mellitus	0.23	1.58	3.65	17.45	46.45	18.86	11.79	179433	19.96	0.19	1.49	3.28	16.61
Epilepsy	22.26	18.74	17.70	27.60	9.57	2.30	1.82	22646	2.52	21.33	24.45	16.06	23.93
Urinary tract and kidney infections	8.76	13.53	20.52	28.83	15.71	5.79	6.87	48377	5.38	8.91	15.43	19.27	25.88
Skin and subcutaneous tissue infections	12.96	16.58	12.43	25.82	21.29	6.01	4.91	37634	4.19	10.32	15.81	11.43	25.64
Female pelvic organs inflammatory diseases	0.17	1.58	28.79	56.37	11.17	1.21	0.70	18319	2.04	0.26	1.50	26.66	56.59
Diseases related to prenatal care and delivery	0.99	1.61	65.80	31.46	0.14	0.00	0.00	40671	4.52	0.99	1.85	64.83	32.19
Gastric ulcer	1.34	1.52	4.07	23.46	35.56	15.25	18.80	43535	4.84	1.42	2.00	3.32	20.28
Total avoidable hospitalizations	21.96	8.51	9.09	16.34	21.65	10.78	11.66	898833	100.00	15.16	12.26	9.85	16.14
% of AH in relation to total discharges								10.39					
Total hospital discharges								8649840					

2011-2015 five-year period														Average growth	
			Total		Age groups								Total		
45-64	65-74	≥ 75	n	%	0-4	5-14	15-24	25-44	45-64	65-74	≥ 75	n	%		
13.30	3.80	2.87	4397	0.37	56.34	12.70	7.17	12.83	7.56	2.26	1.13	7179	0.54	5.01	
26.67	8.51	6.83	18313	1.54	3.97	5.60	12.91	34.01	28.87	8.45	6.19	17974	1.34	-12.03	
7.99	3.81	5.11	169950	14.30	34.25	25.55	7.24	12.11	10.13	4.45	6.27	136998	10.23	-16.02	
21.19	10.15	13.02	3242	0.27	9.52	7.78	8.72	25.26	25.20	10.35	13.17	4473	0.33	4.55	
6.29	4.41	11.63	10398	0.87	44.15	25.13	3.80	5.30	6.85	4.18	10.59	10726	0.80	-12.95	
5.41	1.37	1.59	39440	3.32	39.65	31.12	8.47	10.88	6.34	1.60	1.93	35469	2.65	-11.07	
11.78	7.83	14.18	26624	2.24	34.59	18.95	4.13	9.04	11.97	7.26	14.06	23209	1.73	-16.30	
10.05	2.88	2.04	53272	4.48	40.28	32.98	4.48	10.49	8.22	1.98	1.57	53983	4.03	-7.40	
9.78	11.60	20.50	123960	10.43	33.28	20.33	1.56	2.89	9.50	10.80	21.64	139405	10.41	-0.10	
37.59	21.95	23.93	51980	4.37	0.12	0.44	2.57	13.71	37.66	21.02	24.48	63597	4.75	7.94	
44.25	25.03	19.90	12155	1.02	0.00	0.00	0.55	9.73	46.01	23.98	19.73	14171	1.06	3.48	
29.39	24.10	33.10	38769	3.26	1.24	1.16	1.76	8.62	31.26	23.48	32.48	42508	3.17	-1.46	
27.98	23.48	37.89	62515	5.26	0.31	0.48	1.40	7.32	28.93	23.54	38.02	73391	5.48	2.67	
47.25	18.69	12.49	261412	22.00	0.18	1.54	3.44	16.85	47.91	18.04	12.04	303597	22.66	4.32	
9.73	2.39	2.12	31801	2.68	21.31	25.67	15.82	21.89	10.63	2.53	2.15	41366	3.09	7.01	
16.42	6.40	7.69	69269	5.83	9.34	15.11	17.13	23.45	18.34	7.16	9.47	98045	7.32	10.79	
24.25	6.76	5.79	53628	4.51	9.93	14.10	10.82	25.89	26.00	7.33	5.93	68670	5.13	6.98	
12.81	1.24	0.93	22373	1.88	0.23	1.60	27.28	54.29	14.47	1.22	0.92	27334	2.04	0.04	
0.13	0.00	0.00	76106	6.40	0.46	1.84	65.48	32.08	0.13	0.00	0.00	106869	7.98	20.80	
35.51	16.11	21.36	58812	4.95	1.40	1.84	3.15	18.96	36.72	16.20	21.72	70757	5.28	2.93	
22.87	11.23	12.49	1188416	100.00	13.05	10.91	10.93	16.69	24.26	11.25	12.91	1339721	100.00	14.23	
			9.81										9.26		
			12108324										14465029		

Table 2. Gender and age-adjusted avoidable hospitalization standardized rate per 100 000 population by study period, cause and age groups. Mexico, 2001-2015

Causes of avoidable hospitalizations	2001-2005 five-year period								2006-2010 five-year period			
	Age groups							Total	Age groups			
	0-4	5-14	15-24	25-44	45-64	65-74	≥ 75		0-4	5-14	15-24	25-44
Diseases that are preventable with vaccination	0.06	0.01	0.02	0.03	0.02	0.01	0.00	0.16	0.06	0.02	0.02	0.03
Avoidable conditions	0.04	0.05	0.09	0.22	0.21	0.07	0.05	0.73	0.04	0.04	0.09	0.23
Gastroenteritis and complications	2.79	0.82	0.37	0.65	0.55	0.24	0.30	5.73	2.62	1.70	0.39	0.62
Hypochromic anemia	0.02	0.01	0.01	0.03	0.02	0.01	0.01	0.10	0.01	0.01	0.01	0.03
Nutritional deficiencies	0.21	0.05	0.01	0.02	0.03	0.02	0.05	0.40	0.17	0.10	0.02	0.02
Ear, nose and throat infections	0.54	0.31	0.12	0.15	0.07	0.02	0.02	1.23	0.59	0.46	0.14	0.17
Bacterial pneumonia	0.36	0.09	0.04	0.11	0.14	0.10	0.19	1.03	0.32	0.19	0.05	0.10
Asthma	0.58	0.42	0.09	0.25	0.23	0.07	0.06	1.71	0.73	0.63	0.10	0.25
Other lower respiratory tract diseases	1.52	0.21	0.04	0.11	0.44	0.50	0.82	3.64	1.54	0.98	0.07	0.14
Arterial hypertension	0.00	0.01	0.03	0.20	0.60	0.32	0.32	1.49	0.00	0.01	0.04	0.27
Angina pectoris	0.00	0.00	0.00	0.04	0.17	0.09	0.07	0.38	0.00	0.00	0.00	0.05
Heart failure	0.02	0.01	0.02	0.10	0.39	0.32	0.44	1.31	0.02	0.02	0.03	0.13
Stroke	0.01	0.01	0.03	0.16	0.57	0.48	0.74	2.01	0.01	0.01	0.04	0.19
Diabetes mellitus	0.01	0.10	0.25	1.25	3.79	1.51	0.93	7.85	0.02	0.14	0.32	1.62
Epilepsy	0.17	0.15	0.15	0.25	0.10	0.02	0.02	0.87	0.26	0.29	0.19	0.28
Urinary tract and kidney infections	0.14	0.24	0.38	0.56	0.34	0.12	0.15	1.93	0.23	0.40	0.50	0.66
Skin and subcutaneous tissue infections	0.17	0.23	0.18	0.39	0.37	0.10	0.08	1.51	0.21	0.32	0.23	0.51
Female pelvic organs inflammatory diseases	0.00	0.01	0.20	0.41	0.09	0.01	0.01	0.73	0.00	0.01	0.22	0.47
Diseases related to prenatal care and delivery	0.01	0.02	1.00	0.51	0.00	0.00	0.00	1.55	0.03	0.05	1.82	0.90
Gastric ulcer	0.02	0.02	0.07	0.41	0.71	0.30	0.36	1.89	0.03	0.04	0.07	0.45
Total avoidable hospitalizations	6.69	2.78	3.11	5.87	8.85	4.33	4.63	36.27	6.90	5.44	4.36	7.13

				2011-2015 five-year period								Average growth	
			Total	Age groups								Total	
45-64	65-74	≥ 75		0-4	5-14	15-24	25-44	45-64	65-74	≥ 75			
0.02	0.01	0.00	0.17	0.17	0.04	0.02	0.03	0.02	0.01	0.00	0.28		21.49
0.18	0.06	0.05	0.69	0.03	0.04	0.09	0.22	0.17	0.05	0.04	0.63		-4.89
0.51	0.24	0.33	6.41	1.96	1.38	0.36	0.59	0.44	0.20	0.28	5.21		-3.13
0.03	0.01	0.02	0.12	0.02	0.01	0.01	0.04	0.04	0.01	0.02	0.16		14.06
0.02	0.02	0.05	0.39	0.20	0.11	0.01	0.02	0.02	0.01	0.04	0.41		0.91
0.08	0.02	0.02	1.49	0.59	0.44	0.11	0.14	0.07	0.02	0.02	1.38		3.89
0.12	0.08	0.14	1.00	0.33	0.17	0.04	0.08	0.09	0.05	0.11	0.87		-5.64
0.20	0.06	0.04	2.01	0.91	0.70	0.09	0.20	0.14	0.03	0.03	2.10		7.03
0.45	0.54	0.96	4.69	1.94	1.12	0.08	0.14	0.42	0.49	0.98	5.17		12.35
0.73	0.43	0.47	1.95	0.00	0.01	0.06	0.31	0.77	0.43	0.50	2.09		11.86
0.20	0.11	0.09	0.46	0.00	0.00	0.00	0.05	0.21	0.11	0.09	0.46		6.83
0.43	0.35	0.48	1.46	0.02	0.02	0.03	0.13	0.43	0.32	0.45	1.40		2.17
0.66	0.55	0.89	2.35	0.01	0.01	0.04	0.19	0.68	0.56	0.90	2.40		6.14
4.62	1.83	1.23	9.79	0.02	0.18	0.38	1.83	4.68	1.77	1.18	10.05		8.56
0.12	0.03	0.03	1.20	0.37	0.42	0.24	0.32	0.14	0.03	0.03	1.55		21.31
0.42	0.17	0.20	2.58	0.38	0.58	0.61	0.81	0.57	0.23	0.30	3.47		21.71
0.49	0.14	0.12	2.02	0.28	0.38	0.27	0.64	0.58	0.16	0.13	2.45		17.46
0.11	0.01	0.01	0.82	0.00	0.02	0.27	0.51	0.12	0.01	0.01	0.95		9.14
0.00	0.00	0.00	2.80	0.02	0.08	2.55	1.18	0.00	0.00	0.00	3.84		35.22
0.78	0.36	0.47	2.21	0.04	0.05	0.08	0.49	0.84	0.37	0.50	2.37		7.90
10.17	5.01	5.60	44.60	7.29	5.76	5.35	7.92	10.44	4.87	5.61	47.24	9.21	

Table 3. List of municipal codes according to the National Institute of Statistics and Geography and hospital use priority level

Hospital underuse										Hospital low use				
04005	08022	13068	15121	20047	20154	20239	20356	20492	21047	21169	05011	15073	20193	20463
05004	08024	13069	15124	20050	20156	20240	20359	20494	21052	21171	05021	15093	20201	20491
05006	08027	13072	15125	20051	20159	20242	20361	20499	21060	21175	05031	15096	20204	20495
05014	08028	13075	16063	20058	20161	20246	20362	20506	21065	21177	07006	15099	20211	20503
05027	08030	13081	17008	20059	20162	20249	20366	20512	21069	21188	07007	15104	20222	20509
05036	08046	13082	17011	20061	20163	20254	20367	20514	21070	21193	07011	15106	20231	20511
06005	08053	13083	17020	20063	20167	20255	20368	20521	21079	21209	07022	15114	20236	20518
06008	08057	14048	19005	20065	20169	20256	20370	20522	21092	21214	07023	15116	20252	20519
06010	09014	14049	19006	20069	20170	20257	20373	20524	21093	26044	07026	15123	20253	20520
07004	10008	14051	19008	20074	20171	20258	20374	20531	21096	26047	07038	16034	20266	20523
07010	10029	14056	19009	20077	20172	20260	20379	20532	21098	26062	07044	16041	20267	20529
07013	11024	14063	19012	20080	20175	20262	20380	20533	21099	29022	07059	16080	20270	20530
07014	12002	14097	19018	20084	20178	20263	20382	20534	21102	29042	07064	16098	20284	20537
07018	12006	14103	19019	20086	20179	20273	20383	20536	21103	29054	07066	17016	20306	20539
07021	12010	14111	19021	20092	20182	20274	20384	20538	21106	30110	07083	17022	20309	20540
07033	12018	14125	19026	20095	20187	20279	20391	20543	21114	30171	07115	19010	20314	20542
07036	12025	15005	19031	20097	20189	20280	20396	20544	21115		07119	20009	20315	20552
07039	12031	15010	19032	20098	20192	20283	20397	20546	21118		08003	20046	20316	20556
07047	12032	15011	19034	20100	20194	20286	20406	20548	21119		08037	20048	20321	20568
07053	12041	15018	19037	20102	20195	20287	20408	20550	21120		08039	20049	20323	21007
07056	12045	15020	19039	20104	20197	20289	20409	20551	21121		09016	20064	20324	21020
07058	12047	15027	19045	20105	20199	20291	20410	20553	21124		10003	20071	20325	21031
07060	12052	15028	19046	20106	20203	20292	20411	20555	21125		10024	20072	20328	21032
07061	12053	15029	19047	20108	20205	20293	20416	20560	21126		10027	20078	20332	21081
07063	12061	15030	19048	20109	20208	20294	20423	20561	21129		11004	20081	20340	21097
07070	12062	15037	19049	20112	20209	20298	20424	20563	21131		12028	20082	20363	21104
07072	12071	15038	19050	20113	20210	20299	20426	20564	21133		12039	20085	20372	21117
07080	12072	15044	19051	20116	20212	20303	20429	20566	21136		12040	20093	20375	21166
07081	12074	15046	20004	20117	20216	20317	20430	21012	21137		12042	20101	20390	21203
07082	12076	15051	20007	20118	20217	20322	20449	21013	21138		12051	20110	20393	21205
07085	12077	15054	20015	20119	20218	20329	20457	21015	21142		12063	20120	20399	21206
07093	12078	15060	20016	20126	20219	20333	20459	21018	21144		13025	20121	20413	26017
07106	12079	15062	20017	20127	20221	20341	20461	21019	21146		13028	20133	20428	29041
07111	12080	15067	20018	20128	20223	20343	20466	21022	21147		13032	20134	20433	29050
07112	12081	15072	20022	20131	20225	20344	20468	21026	21148		13033	20135	20434	29051
07113	13012	15076	20027	20132	20226	20346	20469	21027	21149		13046	20137	20439	29053
07114	13020	15081	20029	20136	20227	20347	20475	21033	21150		13078	20147	20440	29059
07116	13036	15084	20032	20138	20228	20348	20478	21034	21151		13079	20149	20446	30201
07118	13037	15098	20033	20140	20233	20349	20480	21036	21152		14050	20151	20448	
08001	13048	15100	20038	20142	20234	20350	20481	21037	21159		14116	20155	20450	
08004	13051	15101	20040	20145	20235	20351	20483	21040	21161		15036	20160	20452	
08008	13061	15109	20041	20146	20237	20353	20487	21041	21163		15059	20176	20454	
08020	13066	15118	20045	20148	20238	20354	20488	21046	21165		15069	20180	20458	

Hospital high use					Hospital overuse								
01002	01002	12070	19042	25017	32052	01003	07043	10004	14018	19015	20570	26067	29033
01010	01010	13001	20003	25018	32056	01004	07045	10007	14019	19016	21003	26070	29034
03002	03002	13003	20037	26015		01006	07048	10012	14025	19020	21011	26071	29037
03003	03003	13006	20060	26050		01007	07050	10014	14029	19023	21056	27001	29044
04002	04002	13015	20076	26057		01008	07052	10018	14040	19027	21073	27002	29047
05001	05001	13019	20158	26066		01009	07065	10020	14055	19035	21113	27003	30019
05028	05028	13030	20173	28001		03001	07068	10028	14060	19036	21155	27004	30173
07003	07003	13043	20181	28010		03009	07071	10032	14075	19040	21160	27005	30184
07034	07034	13047	20196	28011		04003	07074	10036	14082	19044	21191	27006	30195
07035	07035	13054	20213	28021		04004	07084	11001	14085	20001	23008	27007	31019
07042	07042	13055	20230	28032		04006	07088	11002	14089	20006	23009	27008	31096
07054	07054	13057	20269	28033		04007	07089	11003	14118	20019	23010	27010	32037
07055	07055	13073	20276	28035		04009	07091	11014	15012	20020	25002	27011	
07099	07099	13084	20277	28037		04010	07097	11015	15017	20026	25003	27012	
07104	07104	14024	20281	29001		04011	07098	11016	15021	20031	25004	27013	
08007	08007	14037	20296	29005		05002	07103	11026	15040	20035	25005	27014	
08018	08018	14038	20300	29008		05003	07107	11028	15074	20042	25008	27017	
08059	08059	14042	20318	29012		05007	07108	11029	15080	20073	25009	28003	
08064	08064	14062	20320	29014		05009	07109	11030	15082	20123	25010	28006	
10001	10001	14064	20326	29021		05012	07110	11031	15110	20177	25012	28007	
10006	10006	14077	20345	29030		05015	08006	11034	15117	20190	25013	28008	
10011	10011	14081	20371	29038		05019	08011	11037	17003	20191	25014	28012	
10017	10017	14092	20394	29046		05020	08012	11041	17005	20250	25015	28014	
10021	10021	14094	20400	29055		05024	08013	12008	17012	20295	26001	28015	
10025	10025	15009	20415	30074		05025	08016	12012	17014	20311	26008	28017	
10031	10031	15105	20432	30138		05032	08017	12034	17015	20313	26010	28019	
10035	10035	15107	20443	30185		05033	08021	12035	17019	20337	26013	28022	
11018	11018	16011	20444	31008		05037	08023	12055	17021	20338	26014	28024	
11025	11025	16014	20447	31021		05038	08025	12066	18001	20364	26023	28025	
11035	11035	16024	20484	31057		06002	08029	13029	18005	20369	26024	28026	
11038	11038	16056	20496	31061		06006	08032	13031	18008	20378	26026	28031	
11039	11039	16071	20497	31065		06007	08033	13040	18009	20387	26028	28040	
11042	11042	16076	20500	31085		06009	08034	13053	18010	20419	26031	28043	
11044	11044	16081	21006	31102		07002	08035	13058	18011	20431	26032	29003	
11046	11046	16099	21009	32014		07008	08036	13059	18012	20435	26033	29006	
12005	12005	16103	21141	32020		07009	08038	13060	18015	20436	26034	29007	
12013	12013	17017	21196	32022		07016	08040	13077	18016	20442	26038	29009	
12019	12019	17024	23005	32029		07017	08043	14004	18018	20476	26040	29011	
12022	12022	17025	23007	32032		07019	08048	14005	19002	20498	26041	29013	
12046	12046	17031	24007	32035		07025	08050	14006	19003	20501	26042	29016	
12049	12049	18006	24044	32036		07028	08052	14013	19007	20517	26048	29018	
12059	12059	19024	25006	32049		07037	08058	14014	19011	20545	26053	29020	
12060	12060	19038	25011	32050		07040	08067	14015	19014	20558	26063	29025	

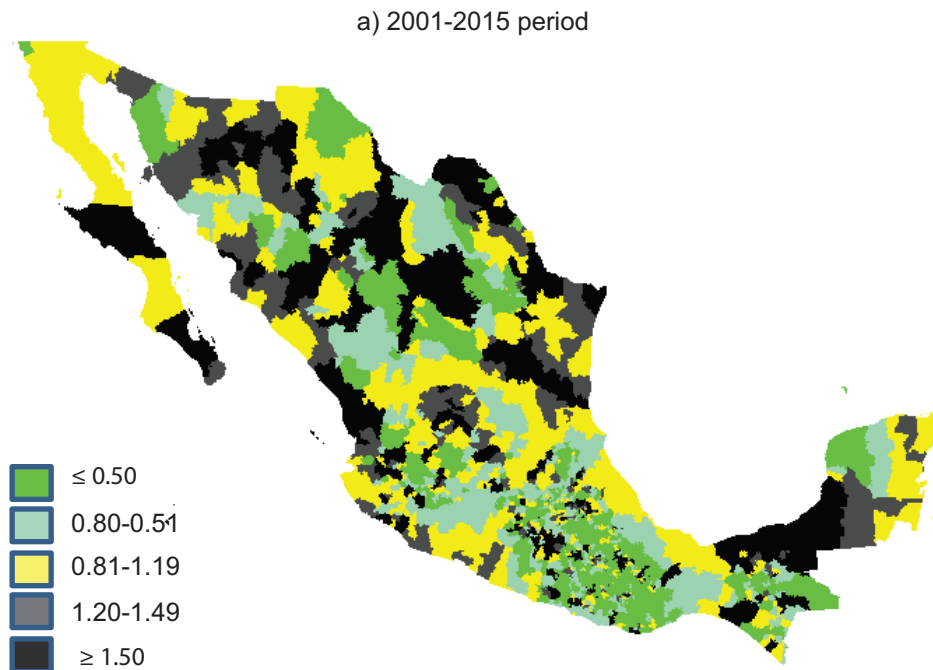


Figure 2. Municipalities' priorities dependent on belonging strata according to avoidable hospitalization ratios at 5-year periods. Mexico 2001-20015.

By cause and age groups, considering the four highest values, the rates behavior was similar at each 5-year period, with few variations. In the case of arterial hypertension, angina pectoris, heart failure, stroke, diabetes mellitus and gastric ulcer, the 25-year old and older groups are clearly appreciated to have had the highest rates; in the case of vaccination-preventable diseases, ear, nose and throat infections; epilepsy and diseases related to prenatal care and delivery, the highest rates were located in the ≤ 25 -year age groups. For the remaining diseases, greater variability was identified in the age groups with high AH rates.

The AH ratios geographic patterns at the municipal level observed in the maps for the three 5-year periods have similarities (Fig. 1), with higher similarities being observed between the second and third 5-year periods. The fact that there were several points of high or very high AH ratio concentration across the entire country, the center of which remained fixed during the three 5-year periods, from which the size of the conglomerate according to the municipalities that were included in the upper strata was reduced or broadened stands out; for example, the southern part of the Gulf of Mexico coast, which encompassed the coastal municipalities of Veracruz, Tabasco and Campeche, or neighboring municipalities of the states of Sinaloa and Nayarit, to mention a few of the groupings that

are visible in the upper strata. The same was observed when lower strata spatial behavior in the three 5-year periods was addressed, which was notorious in municipalities belonging to Guerrero and Oaxaca.

Regarding the concentration of AHs in absolute numbers, in the first 5-year period, the municipalities that were between 20 and 49 % above the AH mean rate (187) or ≥ 50 % (294) concentrated 42.72% of total AH (15.17 and 27.55 %, respectively); in the second 5-year period, 43.04 % of AHs were concentrated (14.44 and 28.60 %) in the municipalities located at the same stratifications above AH mean rate (235 and 335 respectively); and in the third 5-year period, 45.67% of AHs were concentrated (11.74 and 33.93%, respectively) in 301 and 452 municipalities according to the aforementioned stratification. As it can be appreciated, the highest number of AHs was concentrated in the highest stratum of each 5-year period.

The table in figure 1 shows the of geographical variability statistics of the AH ratios by municipality. High variability it was observed in the three 5-year periods, which was more pronounced in the first one, followed by the second; the third was the one that had greater stability. The highest variabilities were identified in the 1/99 and 5/95 percentile ratios (RVP) extremes, which were significantly reduced in the 10/90 RVP and were approached in the three five-year periods in the 20/80 and 25/75 RVPs, which validates the cutoff values for

data presentation in the maps from 20/80 on. The CVS indicates high variability, since the values close to 1 were as expected, which means that uncertainty is present in the AH ratios spatial behavior.

The map of priority municipalities by hospitalization over- or underuse also shows similarity with the geographical patterns described for each 5-year period (Fig. 2). The exercise yielded 487 priority municipalities, 174 with high use of hospital resources and 313 with overuse; both concentrated 35.83 % of AHs occurred in the three 5-year periods (8.58, 5 and 27.25 %, respectively). Conversely, 577 priority municipalities were identified, 166 with low use and 411 with underuse, which hardly concentrated 6.91 % of AHs in the three periods (2.81 and 4.10 %, respectively). In the middle part, 1353 municipalities were concentrated (with no preventable hospitalizations being reported in 41 municipalities during the period), with 57.26% of avoidable hospitalizations.

Finally, table 3 presents the list of priority municipalities' municipal codes, with hospital over-, high, low and underuse. The municipal codes can be located on the INEGI website.

Discussion

According to our results, AHs in the Ministry of Health hospitals ranged between 9.26 and 10.39 %, which is similar to the 10 % reported by Rodríguez Abrego et al. regarding medical services at the Mexican Institute of Social Security. In both institutions, the most common causes of AH are diabetes mellitus, gastroenteritis, respiratory diseases, diseases associated with prenatal care and delivery and urinary tract infections.

In the Ministry of Health, the national AH rate has increased in the 2001-2015 period from 36.27 to 47.24 per 10 000 population. Rodríguez Abrego et al.⁹ found that the national AH rate had decreased from 87.5 per 10 000 population in 2001 to 72.6 in 2009. The discrepancy between both studies in terms of rates and their behavior lies mainly in the study periods (2001-2015 versus 2001-2009), the source of hospital discharges (Ministry of Health versus Mexican Institute of Social Security), different populations for the calculation of rates (total population versus Mexican Institute of Social Security affiliates) and the possible impact of measures applied by that institution to reduce AH.

In a 2011 study on hospital performance by the Ministry of Health,⁸ the AH rate was found to be 29.6 per 10 000 population, including only 5 diseases as

reference; it is probable that if the 20 diseases included in the present study would have been considered, the figures would have been comparable to those herein reported.

Rodríguez Salgado et al.¹⁰ found that the national hospitalization rate for diabetes in 2014 was 14 hospitalizations per 10 000 population aged ≥ 20 years. When the condition of affiliation was considered, the average hospitalization rate for the population without social security was 15.3 and 12.0 per 10 000 population for the population with social security. We found a rate of AH for diabetes of 7.85 in 2001-2005, 9.79 in 2006-2010 and 10.05 per 10 000 population between 2011 and 2015. In the research by Rodríguez, the rate was calculated in a single year in a population aged ≥ 20 years and it was not standardized by age or gender.

The study of AH through medical practice geographical variability offers the opportunity to identify priority areas; in our research, municipalities with underuse or overuse of hospital resources were identified, taking as reference the national mean. This division determined that the resident population of those municipalities, depending on case, is receiving less or more attention than it needs. It would even be questionable if the population with usual domicile in the municipalities located in the mean considered as acceptable or at limits close to it are receiving unnecessary attention, especially if the characteristics of the diseases that cause AH are considered: they can be prevented, diagnosed and treated in primary care medical units.

Ecological studies such as the one carried out have the limitation of not determining the causes of AH variability; therefore, in future investigations it will be necessary to evaluate them and integrate proposals for solution that might be dissimilar and in accordance to the multiplicity of factors involved in the different regions of the country.

One possible explanation could be that the incidence or prevalence of diseases between municipalities are different; however, standardization by age and gender indicated that this possible reason has little explanatory power for the variability found between neighboring municipalities with epidemiologically equivalent populations.

Therefore, the hypothesis of uncertainty would have to be resorted to, which establishes accessibility problems, the supply of services, the lack of clinical guidelines or non-adherence to the agreed criteria for outpatient management of potentially preventable diseases as the main explanatory variables.

Accessibility problems might explain the concentration of municipalities with low and underuse in Guerrero, Oaxaca and Chiapas, where there is a significant number of indigenous languages' speakers and the territory is rough.¹⁸ With regard to the supply of services, in Tabasco there are municipalities with overuse, as there are in the southern part of Veracruz or north of Campeche; according to data of the Ministry of Health, between 2001 and 2015, Tabasco was the second state with the largest number of consulting rooms, beds and doctors per 10 000 population, with Mexico City being at first place.¹⁹

Regarding non-adherence to or ignorance of the criteria for the management of the pathologies included in the concept of AH, a study conducted in Mexico indicates that only 45 % of doctors applied the sectoral clinical guidelines criteria for the management of chronic-degenerative diseases.²⁰ This finding suggests that the national AH variability obtained in a context of low adherence to standards might change, as it has occurred in other countries^{21,22} or in the Mexican Institute of Social Security,⁹ where it is constantly stressed that primary care should adhere to established criteria and that patients should receive the hospital care that is really necessary in relation to disease evolution and control.^{23,24}

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