Disease burden and medical cost-analysis of Acute Respiratory Infections in a low-income district of Bogotá

Análisis del costo médico y la carga de enfermedad de las Infecciones Respiratorias Agudas en una localidad de ingresos bajos de Bogotá

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ABSTRACT

Objective To estimate the burden of disease and related direct medical cost of Acute Respiratory Infections (ARI) for the health-care system in a low-income district of Bogota, generated by children under age five and senior population over age sixty.
Methods A cross-sectional, retrospective, patient level study was conducted in San Cristobal district from 2008 to 2012 among the subsidized population. All inpatients and outpatients with ARI from three hospitals were reported. The total and average direct medical costs were estimated and are reported in International Dollars (Int$).
Results It is estimated that, for children, ambulatory incidence rate for ARI varied between 54.4 % and 66.3 % and hospitalization rate between 9.2 % and 12.3 %. The mortality rate in the district oscillated between 18.1 and 27.7 deaths per 100 000. The main medical costs were attributed to hospitalizations, and the total medical hospitalization cost per year estimated ranged between Int$ 1 334 352 and Int$ 2 139 597. In the case of senior population, the ambulatory incidence rate fluctuated between 7.6 % and 10.0 %, and the hospitalization rates between 0.6 % and 2.1 %; the mortality rate ranged between 8.9 and 47.8 deaths per 100 000. Hospitalization cost per year was estimated to be between Int$ 88 957 and Int$ 373 382.
Conclusion Direct medical costs due to ARI have an important disease and direct medical cost burden in this low-income district.

Key Words: Colombia, respiratory tract infections, cost of illness, poverty areas (*source: MeSH, NLM*).

RESUMEN

Objetivo Estimar la carga de enfermedad y los costos médicos directos relacionados con las Infecciones Respiratorias Agudas (IRA) para el sistema de salud en una localidad de bajos ingresos de Bogotá, en niños menores de cinco años y adultos mayores de sesenta años.
Métodos Se realizó un estudio retrospectivo transversal a nivel de paciente en la localidad de San Cristóbal desde 2008 y 2012 en la población subsidiada. Se reportaron todos los pacientes hospitalizados y ambulatorios de tres hospitales públicos debido a IRA. Se estimaron los costos médicos directos relacionados. Los costos fueron convertidos en dólares internacionales (Int$).
Resultados En niños. Se estimó que la incidencia ambulatoria para IRA varió entre 54,4 % y 66,3 % y la tasa de hospitalización varió entre 9,2 % y 12,3 %. La tasa de mortalidad en el distrito osciló entre 18,1 y 27,7 muertes por 100 000 niños. Se estimó que el costo de las hospitalizaciones oscilaron anualmente entre Int$ 1 334 352 y Int$ 2 139 597 representado la más importante carga financiera. En adultos, la incidencia ambulatoria fluctuó entre 7,6 % y 10 %. Las tasas de hospitalización variaron entre el 0,6 % y el 2,1 %. Mientras que la tasa de mortalidad varió entre 8,9 y 47,8 muertes por 100 000. Para hospitalizaciones se estimó un costo total por año entre Int$ 88 957 y Int$ 373 382.
Conclusión Los costos médicos debido a IRA tienen una carga económica importante para el sistema de salud y los hogares en esta localidad.

Palabras Clave: Colombia, infecciones del sistema respiratorio, costo de enfermedad, áreas de pobreza, Colombia (*fuente: DeCS, BIREME*).

Worldwide, disease burden caused by Acute Respiratory Infections (ARI) in 2011 was estimated at 117 million Disability Adjusted Life Years and 2.8 million deaths (1,2). ARI are among the leading causes of death in children but diagnosis and attribution are difficult (3). ARIs represent an important economic burden (4).

In Colombia, from 2007 to 2011, the number of reported ARI increased, as well as the number of fatalities. In 2011, a cumulative total of 4,168,783 ARIs cases were reported by the national surveillance system (Sistema Nacional de Vigilancia en Salud Pública) and approximately 706 fatalities were reported in children under five years of age (5). The etiology of ARI is given by a diverse group of bacteria and viruses (6).

In 2010, the incidence of respiratory viruses, according to the Colombian National Institute of Health (Instituto Nacional de Salud, INS) showed that the respiratory syncytial virus caused 62 % of the cases studied, followed by influenza viruses (24 %) and parainfluenza viruses (8 %). Children are

the most affected group (7). Another age group highly vulnerable to ARI is senior population, causing hospitalizations and mortalities (8).

ARIs are one of the main causes of hospitalization, generating an important health utilization and absenteeism, therefore, impacting the economic system (3,6,9-12). In 2012, nationally, the associated mortality for ARIs was estimated at 13.35 deaths per 100,000 children under five (13).

There is limited data about the direct medical and epidemiological burden of these infections, especially among the low-income population (12,14,15). Understanding the direct medical cost of ARIs is important in order to prioritize a more efficient health intervention to decrease the economic and disease burden. Therefore, the aim of this study is to estimate the direct medical cost of ambulatory and hospitalized cases of ARIs in a low-income district of Bogota, based on a population of children under five years of age and seniors over sixty years of age.

The population of Bogota accounts for more than 15 % of the country's population. Located in Bogota, the district of San Cristobal had an estimated population of 409,799 in 2011 (16). In 2012, the Gross National Income per capita was estimated at Int$ 4,758.01 for San Cristobal district only (16-19). Approximately 34.0 % of the population of San Cristobal is classified in the two lowest income strata of the country (16,17).

Similarly to the rest of the country, the health system of the population of San Cristobal is covered by two regimes: contributive and subsidized. The contributive system, representing 62.1 % of the district population, includes patients that can afford a premium rate. The subsidized regime, representing 37.9 % of the district population, consists of patients that are not able to pay a premium rate and are allowed to seek health services from public healthcare providers (12,17,20).

METHODS

A cross-sectional retrospective study was conducted to assess the burden of disease and direct medical cost attributable to ARI between January 2008 and December 2012, in children under five and seniors over sixty years, of the subsidized population, in three hospitals. These two age groups are at considerably higher risk of contracting ARIs and developing severe forms of the diseases (5,21,22).

The Individual Registry of Health Services (Registro Individual de Prestación de Servicios or RIPS) was used, which include the following patient information: identification number, patient name, age, gender, home address, insurance status (subsidized or contributive), purpose of the consultation, treatment, start and end dates of treatment and medical diagnosis codified according to the International Statistical Classification of Diseases and Related Health Problems version 10 (ICD-10) (12,23).

ARIs, according to the INS definition, are defined as "a group of infectious diseases caused by microorganisms that affect the upper and lower respiratory tract over a period of fifteen days, and can vary from a common cold to more severe complications such as pneumonia". For this study, the guidelines of the INS to classify ARIs were used, taking into account the following ICD-10 codes (6, 24):

• Acute infections of the upper respiratory tract: J00 to J06.
• Influenza (excluding influenza with pneumonia): J09, J10.1, J10.8, J11.1, J11.8.
• Pneumonia (including influenza with pneumonia): J10.0, J11.0 and J12 to J18
• Other acute infections of the lower respiratory tract: J20 - J22.

The RIPS information from three public hospitals was analyzed, covering all patients within the subsidized system. The three hospitals correspond to increasing levels of complexity: San Cristobal Hospital (first healthcare level), San Blas Hospital (second healthcare level) and La Victoria Hospital (third healthcare level) (17).

The total size of the subsidized population of the studied age groups was calculated from estimations provided by the National Bureau of Statistics [Departamento Administrativo Nacional de Estadística] in 2012 (16,17). For both age groups, the burden of disease caused by ARIs was assessed using RIPS databases and the definition of burden of disease was restricted to the related morbidity and mortality of ARIs, and related ambulatory and hospitalized cases.

Using these individual patient records, the ICD-10 codes, the predefined time period and target population, patients with an ambulatory episode or hospitalization in one of the three hospitals were selected. The mortality rates for both groups caused by ARIs were estimated based on the mortality database of Bogota's Health Services taking into account, for example, unspecified pneumonia as the main cause of death (25,26).

Direct medical costs caused by the disease include costs of visits, drugs and diagnostic tests. The number of visits could be derived from RIPS. Treatment procedure was taken from national guidelines and costs from the hospital standard procedure cost (27,28). Ambulatory cases were categorized in two groups: the first group. ARIs cases excluding pneumonias, it was assumed that both age groups were treated with antipyretics; the second group, including all causes of pneumonia, consisted of ICD 10 codes (J10.0, J11.0 and J12 to J18). It was also assumed that, for both age groups, diagnosis was obtained through thorax X-ray and patients were treated with antipyretics and antibiotics. The average cost per treatment for each age group and healthcare level was estimated.

Data about hospitalizations, administered treatments and related direct costs (diagnostic, treatment, pharmaceutical and medical devices costs) registered in RIPS and retrieved for analysis were used to calculate the average cost per patient. The cost of treatment items included bed-cost per day, the physician's salary, oxygen therapy and the cost of the Intensive Care Unit if applicable. The pharmaceutical cost included the different costs of antibiotics, antipyretics, nebulized bronchodilator therapies and other medications.

In order to compare the different costs by year, all costs were converted to real prices in 2008. To convert nominal prices of a specific year during the period between 2008 and 2012 into real prices, the cumulative inflation rate from 2008 until a specific year was applied (29). Colombian pesos were then converted to international dollars Int$, using the purchasing power parity from the International Monetary Fund (30,31).

RESULTS

In the temperate climate of the northern hemisphere, ARIs have a clear seasonal peak during winter (32,33). In this study, a consistent epidemiological peak in April, which historically is the rainiest month, was observed in children (32). The epidemiological peak is less pronounced (Figure 1.b) in senior population. During the pandemic A (H1N1) of 2009, the epidemiological peak emerged earlier in September and was more evident (Figure 1) in both age groups.

Children of the subsidized regime presented an ambulatory incidence between 54.4 % in 2012 and 66.3 % in 2009 (Table 1). Seniors of the subsidized regime presented an ambulatory incidence between 7.6 % in 2008 and

10.0 % in 2010 (Table 1). A hospitalization rate between 9.2 % in 2010 and 12.3 % in 2012 (Table 1) was identified for children, and between 0.6 % in 2008 and 2.1 % in 2012 for seniors (Table 1). The death rate varied between 18.1 deaths and 27.7 deaths per 100,000 children in 2010 and 2012, respectively, and for seniors, death rate ranged between 8.9 deaths and 47.8 deaths per 100,000 for the years 2008 and 2011, respectively (Table 1).

Figure 1. ARIs ambulatory cases. Children and seniors

a. ARIs ambulatory cases for children
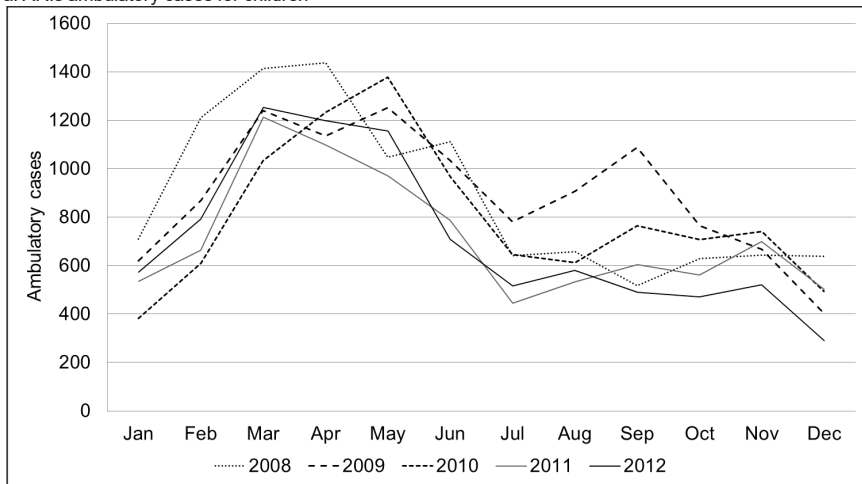
b. ARIs ambulatory cases for seniors
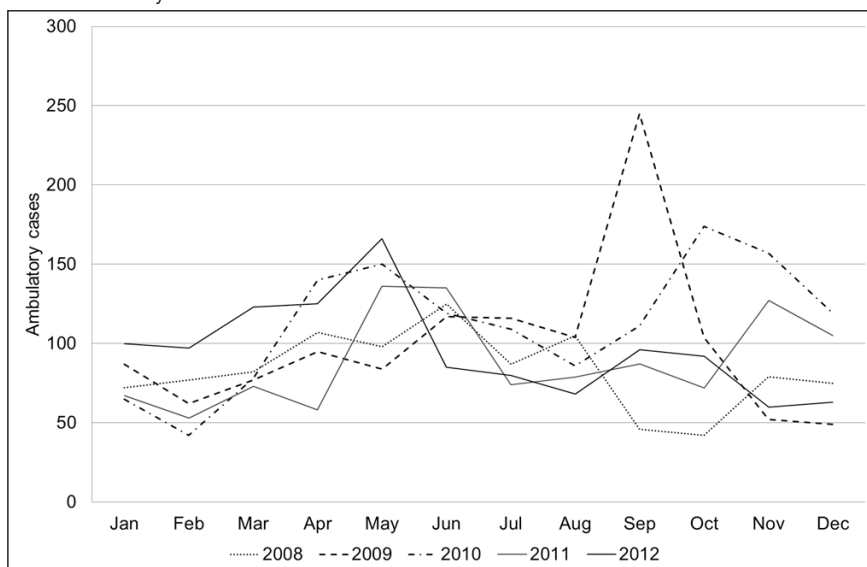
Table 1. ARIs Burden of disease for both age groups

Burden of disease	2008	2009	2010	2011	2012
	Children under five				
Total ambulatory cases	11.170	11.239	10.001	9.059	8.939
Total hospitalization cases	1.645	1.676	1.546	1.937	2.017
Total deaths	12	12	8	11	12
District population under five	45.344	44.736	44.166	43.820	43.366
Subsidized children population at district level (37.9 %)	17.185	16.955	16.739	16.608	16.436
Subsidized incidence ambulatory cases %	65.0	66.3	59.7	54.5	54.4
Subsidized hospitalization rate %	9.6	9.9	9.2	11.7	12.3
District mortality rate per 100. 000 children	26.5	26.8	18.1	25.1	27.7
	Seniors over sixty				
Total ambulatory cases	1.014	1.203	1.373	1.083	1.191
Total hospitalization cases	71	116	134	185	310
Total deaths	3	6	11	18	14
District population over sixty	33.577	34.919	36.345	37.652	39.028
Subsidized senior population district level (37.9 %)	12.726	13.234	13.775	14.270	14.792
Subsidized incidence ambulatory cases %	8.0	9.1	10.0	7.6	8.1
Subsidized hospitalization rate	0.6	0.9	1.0	1.3	2.1
District mortality rate per 100. 000 seniors	8.9	17.3	30.3	47.8	35.9

For children, the average cost per ambulatory ARIs, excluding pneumonias, was estimated between Int$ 15.6 in 2012 and Int$ 26.9 in 2009. The average cost per ambulatory ARIs for all pneumonias was estimated between Int$ 45.2 in 2012 and Int$ 60.8 in 2009. For all ambulatory cases, a total cost per year was estimated between Int$ 209,174 in 2011 and Int$ 284.570 in 2009. It was observed that the maximum value for the total cost occurred in 2009, during the influenza pandemic of A (H1N1).

For seniors, the average cost per ambulatory ARI episode, excluding pneumonias, was estimated between Int$ 15.5 in 2012 and Int$ 24.9 in 2009. The average cost per episode for all pneumonias was estimated between Int$ 43.0 in 2012 and Int$ 71.7 in 2008. For all ambulatory cases. a total cost per year was estimated between Int$ 29.631 in 2008 and Int$ 46.774 in 2010. The average cost incurred per hospitalized child due to ARIs in first healthcare level hospitals was estimated between Int$ 228.5 in 2009 and Int$ 280.5 in 2012. In second healthcare level hospitals. the average cost per hospitalized patient was estimated between Int$ 717.8 in 2012 and Int$ 785.6 in 2008. Finally. in third healthcare level hospitals. the average was estimated between Int$ 1.067.5 in 2010 and Int$ 1.492 in 2011 (Table 2). The total amount for the three hospitals was estimated per year between Int$ 1.334.352 in 2010 and Int$ 2.139.597 in 2011 (Table 2).

Table 2. Hospitalized children: average and total cost
per healthcare level and year

Description	2008 (%)	2009 (%)	2010 (%)	2011 (%)	2012 (%)
Level 1					
Total diagnostic tests cost Int$	3 398,6 (7,1)	6 302,1 (12,4)	4 940,1 (12,2)	4 876,9 (9,9)	3 786,2 (9,8)	3 786,2 (9,8)
Total treatment care cost Int$	37 008,6 (77,5)	36 706,7 (72,4)	30 697,5 (76,1)	38 359,6 (77,8)	28 264,6 (73,0)	28 264,6 (73,0)
Total Pharmaceutical cost Int$	4 502,8 (9,4)	4 566,6 (9,0)	2 834,3 (7,0)	3 994,6 (8,1)	5 057,9 (13,1)	5 057,9 (13,1)
Medical devices costs Int$	2 840,7 (5,9)	3 158,7 (6,2)	1 865,7 (4,6)	2 059,2 (4,2)	1 603,1 (4,1)	1 603,1 (4,1)
Total level 1 Int$	47 750,6	50 734,0	40 337,6	49 290,2	38 711,7	38 711,7
Total number of cases	180	222	164	179	138	138
Average hospitalized cost Int$	265,3	228,5	246.0	275,4	280.5	280.5
Level 2					
Total diagnostic tests cost Int$	77 070,9 (18,3)	78 012,6 (20 0)	97 097,1 (20,3)	79 990,5 (14,1)	99 371.5 (16.7)	99 371.5 (16.7)
Total treatment care cost Int$	278 220,0 (66,2)	248 716,2 (63,9)	270 084,7 (56,6)	331 621,1 (58,5)	354 254.5 (59.7)	354 254.5 (59.7)
Total Pharmaceutical cost Int$	39 371,3 (9,4)	38 966,9 (10,0)	68 492,3 (14,3)	104 071,2 (18,4)	88 474.8 (14.9)	88 474.8 (14.9)
Medical devices costs Int$	25 626,0 (6,1)	23 454,0 (6,0)	41 691,7 (8,7)	51 263,7 (9,0)	51 525.6 (8.7)	51 525.6 (8.7)
Total level 2 Int$	420 288,2	389 149,7	477 365,8	566 946,5	593 626.4	593 626.4
Total number of cases	535	518	617	737	827	827
Average hospitalized cost Int$	785,6	751,3	773,7	769,3	717,8	717,8
Level 3					
Total diagnostic tests cost Int$	94 793,7 (9,4)	97 483,2 (9,3)	80 919,4 (9,9)	127 596,8 (8,4)	134 646,4 (10,4)	134 646,4 (10,4)
Total treatment care cost Int$	841 886,2 (83,1)	831 231,0 (79,2)	604 196,2 (74,0)	1 125 911,5 (73,9)	950 061,6 (73,1)	950 061,6 (73,1)
Total Pharmaceutical cost Int$	38 794,5 (3,8)	85 711,5 (8,2)	102 395,6 (12,5)	230 194,5 (15,1)	178 292,2 (13,7)	178 292,2 (13,7)
Medical devices costs Int$	37 114,1 (3,7)	34 615,9 (3,3)	29 137,2 (3,6)	39 657,3 (2,6)	36 413,5 (2,8)	36 413,5 (2,8)
Total level 3 Int$	1 012 588,5	1 049 041,5	816 648,4	1 523 360,1	1 299 413,7	1 299 413,7
Total number of cases	930	936	765	1 021	1 052	1 052
Average hospitalized cost Int$	1 088,8	1 120.8	1 067,5	1 492,0	1 235,2	1 235,2
Total hospitalized costs Int$	1 480 627,4	1 488 925,3	1 334 351,9	2 139 596,7	1 931 751,8	1 931 751,8

For seniors hospitalized due to ARIs at first healthcare level hospitals, the average cost per patient was estimated between Int$528, 2 in 2010 and Int$582,

8 in 2008. For second healthcare level hospitals, the average cost per patient was estimated between Int$887, 1 in 2009 and Int$1,130in 2012. At the third healthcare level hospitals, the average was estimated between Int$ 1,352.5 in 2012 and Int$2,440.5 in 2010 (Table 3). For the three hospitals, the total cost per year was estimated between Int$88,957 in 2008 and Int$373,382 in 2012 (Table 3).

Table 3. Hospitalized seniors: average and total cost per healthcare level and year

Description	2008 (%)	2009 (%)	2010 (%)	2011 (%)	2012 (%)
Level 1					
Total diagnostic tests cost Int$	85.1 (3.6)	1,058.0 (17.5)	512.7 (9.3)	240.5 (29)	451.6 (6.8)
Total treatment care cost Int$	1,775.6 (76.2)	3,958.8 (65.3)	4,414.5 (74.8)	7,556.8 (92.5)	5,533.6 (83.7)
Total Pharmaceutical cost Int$	411.0 (17.6)	902.2 (14.9)	793.5 (14.3)	321.5 (3.9)	587.3 (8.9)
Medical devices costs Int$	59.4 (2.5)	141.9 (2.3)	88.2 (1.6)	49.7 (0.6)	35.3 (0.5)
Total level 1 Int$	2,331.1	6,060.9	5,538.9	8,168.4	6,607.8
Total number of cases	4	11	11	15	12
Average hospitalized cost Int$	582.8	551.0	503.5	544.6	550.6
Level 2					
Tota diagnostic tests Int$	4,236.5 (22.7)	3,224.2 (18.2)	1,897.7 (4.6)	4,141.9 (10.9)	33,799.7 (18.4)
Total treatment care cost Int$	9,655.1 (51.7)	7,755.9 (43.7)	22,928.4 (55.6)	17,153.7 (45.1)	84,744.1 (46.0)
Total Pharmaceutical cost Int$	3,532.6 (18.9)	3,686.4 (20.8)	13,683.0 (33.2)	11,593.9 (30.5)	57,144.3 (31.0)
Medical devices costs Int$	1,255.9 (6.7)	3,075.6 (17.3)	2,739.4 (6.6)	5,117.4 (13.5)	8,496.1 (4.6)
Total level 2 Int$	18,680.1	17,742.2	41,248.4	38,006.9	184,184.2
Total number of cases	18	20	40	40	163
Average hospitalized cost Int$	1,037.8	887.1	1,031.2	927.0	1,130.0
Level,3					
Total diagnostic tests cost Int$	10,220.7 (15.0)	16,811.5 (11.5)	25,838.5 (12.8)	33,577.3 (15.4)	28,585.4 (15.7)
Total treatment care cost Int$	49,020.5 (72.1)	108,251.5 (74.1)	134,615.6 (66.5)	145,425.8 (66.9)	110,862.6 (60.7)
Total Pharmaceutical cost Int$	5,715.5 (8.4)	15,456.0 (10.6)	36,668.3 (18.1)	33,887.4 (15.6)	39,413.6,(21.6)
Medical devices costs Int$	2,989.3 (4.4)	5,472.5 (3.7)	5,436.6 (2.7)	4,448.4 (2.0)	3,728.7 (2.0)
Total level3 Int$	67,945.9	145,991.5	202,559.0	217,339.0	182,590.2
Total number of cases	49	85	83	129	135
Average hospitalized cost Int$	1,386.7	1,717.6	2,440.5	1,684.8	1,352.5
Total hospitalized costs Int$	88,957.1	169,794.6	249,616.3	263,514.3	373,382.2

DISCUSSION

Few studies have been conducted to calculate the average cost or yearly direct medical cost caused by ARIs. To the extent of our knowledge, this is the first study that correlates direct economic costs to an epidemiological burden in Colombia.

For both age groups, we observed that the incidence of ambulatory ARI episodes followed a seasonal pattern with one peak corresponding to the rainy period in April (Figure 1). This seasonal pattern offers us trustful consistency of the data. Furthermore, the yearly incidence of ambulatory cases for both age groups has a decreasing trend over the study period, especially for children, reaching its lowest level in 2012 (Table 1). Regarding yearly hospitalization rates, an increase in both age groups was noticed, reaching a maximum rate in 2012 for children (Table 1), for whom an overall increase in mortality rate at the district level with a value of 27.7 per 100,000 children was found. This value is higher than the national level of 13.45 per 100,000 children in 2012 (13, 26). In the subsidized population, the mortality rate may be more relevant due to a higher presence of risk factors. In seniors, the trend in the number of ambulatory cases and deaths is not clear probably because of the presence of co-morbidities.

In hospitalization cases, there is an increasing trend in the average and yearly total cost for both age groups, reaching a maximum level for children, in 2011 and for seniors in 2012; these costs increases are driven by the tertiary healthcare level.

Regarding hospitalization costs, compared to other national studies with children, we can see that our results of hospitalized pneumonia costs are close to the findings of Santamaria et al., of Int $1,525.3 (34) and Castaneda-Orjuela et al. of USD $1,175 (9). For seniors, our results of hospitalized cases are consistent with the ones by Ordonez et al. of USD $1,932 (35).

Taking into account only the subsidized population is a limitation of these results, as well as the use of administrative data. ARI cases were selected based on the ICD-10 registration in the RIPS database and the records of cause of death in the mortality database, nonetheless, the strength of the administrative data is the inclusion of all subsidized population. A further limitation is that, for ambulatory cases, the average cost was calculated based on national medical protocols and not on patient records, which underestimates the direct ambulatory cost. To simplify our findings for the hospitalized costs, we calculated the average cost, which limited the

statistical distribution of the data. Also, direct medical and indirect costs spent by households were not considered since these costs could represent a high economic burden for households.

In order to diminish the impact of ARIs and other diseases caused by pneumococcus and seasonal influenza viruses. Colombia introduced a Pneumococcal Conjugated Vaccine in 2009 for children (37). Similarly, the seasonal influenza vaccine was included in 2009 in the national immunization schedules for children under 60 months old (38). For population aged 60 and older, the influenza vaccine was introduced in 2009 (38) and the pneumococcal polysaccharide vaccine in 2011 (10).

Despite the introduction of these vaccines, increases in hospitalization rates, mortality rates and related direct medical costs due to ARI in these two age groups were observed. Our analyses require better surveillance data in order to typify the pathogens that cause the disease burden of ARIs. Additional studies are also needed to provide a better understanding of the immunization campaigns including effectiveness, vaccines serotype coverage and timeliness.

Finally, socioeconomic factors could contribute to the observed increases in severity and mortality due to ARIs. The increases in the severity in children could be explained by the high percentage of young mothers with limited education and inadequate knowledge of prenatal and neonatal care (17,22). In this community, there are administrative and geographical barriers that could impede access to health facilities and treatments; the households could avoid bringing patients to health providers due to transportation costs and inadequate housing and sanitary conditions could also exacerbate the increase in severity of ARIs. In addition, San Cristobal district has experienced increases in rainfall levels in the past years, which may also explain the increases in severity of ARI. Other factors, such as malnutrition in children, passive smoking and air pollution, may also be involved in the increase of the severity of ARIs.

Direct medical costs of ARI represent an important economic burden on the subsidized health system of this community. The low-income stratum experiences a higher economic and disease burden than the national average stratum. Our findings highlight the need for further studies in the introduction of new vaccination strategies and evaluation of social, economic and environmental indicators related to economic and disease burden of ARI ♦

Conflicts of interests: None.

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