Spatial distribution of asthma-related hospitalizations of the elderly in the Brazilian Amazon

Distribuição espacial das internações por asma em idosos na Amazônia Brasileira

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Abstract

Introduction: In Brazil, there are approximately 370,000 asthma-related hospitalizations per year, representing the fourth leading cause of hospitalizations in public health services. In 2007, 157,000 elderly patients were hospitalized, 2.3% of which due to asthma in the Brazilian Amazon. Considering the implications of asthma on the quality of life of the elderly, analyses regarding this issue in the Amazon are surprisingly uncommon. **Objective**: To analyze the geographical and seasonal distribution of asthma-related hospital admissions in the elderly population of the Brazilian Amazon during the period from 2001 to 2007. **Methods**: Descriptive study of short-stay, non-elective hospital admissions, based on Kernel's method, standardized rates of hospitalization in annual and monthly series, seasonal climate, and a comparison of the proportion of hospitalizations during dry, intermediate and rain seasons. **Results**: Asthma-related hospitalizations among the elderly were spatially distributed in the northern and eastern parts of the Brazilian Amazon. The Amazon experienced a decline in the rate of hospitalizations during the study period. Rondônia had approximately twice the number of hospitalizations as the other states, ranging from 10.9 ‰ in 2002 to 13.4 ‰ in 2006 in standardized rates. The rate of hospitalizations during the dry season was as much as three times that of the rain and intermediate seasons, with the highest rates in Rondônia (5.8 ‰) and Mato Grosso (3.3 ‰). **Conclusion**: Asthma-related hospital admissions in the elderly presented a declining trend and a significant seasonal variation, with the highest rate of hospitalizations observed during the dry season.

Keywords: Asthma. Brazilian Amazon. Hospitalizations. Elderly. Climate seasonality.

Resumo

Introdução: No Brasil ocorrem aproximadamente 370 mil internações por asma anualmente, constituindo a quarta causa de hospitalizações pelo sistema público de saúde. Considerando as implicações da asma na qualidade de vida dos idosos, os estudos referentes a essa temática na Amazônia são escassos. **Objetivo**: Analisar a distribuição geográfica e a sazonalidade climática das internações hospitalares por asma em idosos na Amazônia brasileira, no período de 2001 a 2007. **Material e Método**: Estudo descritivo das autorizações de internações hospitalares (AIHs) de curta permanência, não-eletivas, baseado em suavização espacial pelo método de Kernel, taxas padronizadas de internação em séries anuais e mensais e sazonalidade climática e comparação das proporções de internações nos períodos seco, intermediário e chuvoso, ao nível de significância de 5%. **Resultados**: As internações por asma em idosos se distribuem espacialmente na área meridional e oriental da Amazônia brasileira. Toda a Amazônia apresentou declínio nas taxas de internação durante o período estudado. O Estado de Rondônia apresentou aproximadamente o dobro de internações em relação aos outros estados em análise, com variação de 10,9‰ em 2002 a 13,4‰ em 2006 nas taxas padronizadas. No período seco verificou-se até o triplo de internações se comparado ao período de chuvas, com taxas mais elevadas em Rondônia (5,8‰) e Mato Grosso (3,3‰). **Conclusão**: as internações por asma em idosos apresentam tendência decrescente ao longo do período estudado, bem como importante variação sazonal com predominância deste evento durante o período seco.

Palavras-chave: Asma. Amazônia brasileira. Internações. Idosos. Sazonalidade climática.

Introduction

Asthma is a chronic obstructive inflammatory disease characterized by lower airway hyper-responsiveness and variable airflow limitation[2] due to an interaction of genetic predisposition and exposure to allergens[1]. Asthma 'attacks' can be triggered by respiratory infections, environmental pollutants, sudden temperature changes, medications and exercise, among other factors[3].

The elderly are vulnerable to a range of diseases, with the natural aging process gradually reducing bodily functions and physiological resistance in the individual. With respect to asthma, reduced lung function compromises the immune system and becomes a risk factor[4] facilitating the onset of other respiratory infections or exacerbating the disease[5]. Cases of asthma and other lower respiratory tract diseases are directly related to a greater likelihood of hospitalization and debilitation in the elderly [4,6,7].

Annually there are approximately 370 000 hospitalizations for asthma in Brazil, becoming the fourth leading cause of hospitalizations by the Unified Health System (SUS)[8]. In a study conducted among residents of São Paulo, there was a stable trend in hospital admissions for asthma in the elderly between 1995 and 2000[9]. Admission records from 2005 show asthma as accounting for 18.7% of all respiratory problem admissions and 2.6% of total admissions, a decline from previous decades[10]. In 2007, the Amazon reported admissions in the elderly population totaling 157 055 in the SUS, with asthma accounting for 3 554 (2.3%)[8].

Specific studies on forest burning in Asia have shown an increased incidence of asthma and acute respiratory infections (ARI)[11-14] in those areas. Studies in the Southeast have also shown an increasing trend in hospitalizations for asthma and other respiratory diseases related to biomass burning in urban areas[15-18], with a greater frequency of hospitalization for respiratory diseases in the dry season for various age groups[19-20].

The Amazon is exposed to constant an-

Rev Bras Epidemiol
2010; 13(3): 1-10 2 Spatial distribution of asthma-related hospitalizations of the elderly in the Brazilian Amazon
Rodrigues, P.C.O. *et al.*

thropic action as such burning has because common practice for land use and timber. This agricultural frontier area initiated intense migration beginning in 1970[21]. Deforestation, however, is not distributed evenly but concentrated along the so-called "arc of deforestation", which covers the southeast of Maranhão, northern Tocantins, south of Pará, northern Mato Grosso and Rondônia, south of the Amazon and southeast of Acre, concentrating over 85% of fires that occur in Brazil during the dry season in that region[22]. During this time, levels of fine particulate matter ($PM_{2,5}$) in this area range from 300 to 600µg/m³ in intense fire areas[23].

Epidemiological aspects relating to asthma have been extensively studied worldwide. However, studies relating to asthma are lacking in the elderly population of the Brazilian Amazon, an area where significant emissions of air pollutants is an issue.

This study aims to examine the geographical distribution and climatic seasonality of hospital admissions for asthma in the elderly in the states that compose the Brazilian Amazon during the period of 2001 to 2007.

Material and methods

We conducted a descriptive study on hospital admissions for asthma in the elderly of the Brazilian Amazon over the period 2001 to 2007, with attention to the geographical distribution and climatic seasonality. Individuals living in the states of the Brazilian Amazon and were over 60 years of age, considered elderly as defined by WHO[1], formed the study population. The total population of the region is approximately 24,5 million inhabitants, of which about 6.0% are aged[24].

The study covered the current area of the Brazilian Amazon comprised of the entire states of Acre, Amapá, Amazonas, Mato Grosso, Pará, Rondônia, Roraima and Tocantins, as well as, a portion of the state of Maranhão located west of longitude 44° – total area is equivalent to 61.0% of the country. While part of the state of Maranhão does not belong to the Amazon region it was included in full in the study as the unit of analysis was defined as micro region and states.

The Brazilian Amazon region generally has hot and humid climate[25], with exception of some drier areas in the state of Mato Grosso, Tocantins and Maranhão. The rains, though regular, are not equally distributed throughout the year, fluctuating between significant seasonal rain and drought. In this study, the months were grouped together to form rainy, intermediate and dry seasons based on averages of monthly precipitation records from the National Institute of Meteorology[26]. The rainy season is designated as the months from December to March, having a large surplus of water. The intermediate season, the months of April, May, October and November; and the dry season from June till September[27]. In the northern hemisphere, which includes the states of Amapá, Roraima, and portions of Amazonas and Pará, the dry and rainy season is reversed; however interim periods remain the same[26].

The hospital records were obtained through the database of the Hospital Information System of the Unified Health System (SIH-SUS) as provided by the Ministry of Health[8]. Authorization of hospital admissions (AIH) records for short stay, paid/non-elective hospitalization for asthma between 2001 and 2007 were collected. Variables utilized in the analysis included: year and month of admission: state and micro region; ICD-10 principal diagnosis of asthma and secondary diagnosis status asthmaticus. The population data and digital grids of the Brazilian Amazon by micro region and state were obtained from the Brazilian Institute of Geography and Statistics (IBGE).

The data transfer system of SUS improves each year, with higher rates of accuracy beginning in 2000[28-30]. Therefore, for higher levels of reliability, records from the SUS between 2001 and 2007 were selected for this study.

To illustrate the distribution of hospitalization occurrences' for asthma in the elderly, maps of the Amazon were designed

Spatial distribution of asthma-related hospitalizations of the elderly in the Brazilian Amazon
Rodrigues,P.C.O. et al.

3

Rev Bras Epidemiol
2010; 13(3): 1-10

identifying areas of greatest concentration of the disease and hot areas. In descriptive spatial analysis, as generated through the TerraView 3.2.0 program, the standardized rate indicator of hospitalization for asthma in the elderly was presented in the Kernel estimation, using as parameters a grid of 200 columns for the region, with quartic function algorithm, adaptive radius, calculation of density of 10 slices and accuracy 12. Matrix calculating, took into account the centroid of the micro region, but the vector map was plotted in states for better viewing. The standardization of rates was done by the age structure of the elderly in Brazil stratified as 60-69, 70-79, 79< years of age.

Through spatial distribution analysis, states were selected with the highest rates of hospitalization for the annual and monthly series. The monthly series were calculated using average rates of gross admission. For analysis of seasonal climate the proportion of hospitalizations according to periods of drought, rain or intermediary were used with the ratio of proportions. To verify that the proportions were different from each other, we performed a chi-square test at a significance level of 5% through the EPI-Info 3.2.2.

Ethical Considerations

This study was approved by the Research Ethics Review Board of University Hospital Júlio Muller, as 388/CEP/HUJM/07.

Results

Hospital admissions for asthma in the elderly were distributed spatially in the southern and eastern portions of the Brazilian Amazon. The main hotspots were found in the center-south of Rondônia with mortality rates reaching 10.9 with admissions at 13.6 ‰, while other areas such as the north-central Amazon held at 0.74 ‰ admissions. Hot areas were also observed in Mato Grosso and the border between the states of Tocantins and Pará which ranged between 2.5 to 13.4 ‰ (Figure 01). For the states of Maranhão, Tocantins, Pará and Mato Grosso a reduction was seen in hospitalization rates between 2001 and 2007.

A significant downward trend was observed in the crude rates of hospitalization for all states studied except Tocantins. The state of Rondonia presented the greatest drop in hospitalization rates in the year 2002 ($\beta = 0.57$) yet was still nearly double the rates found in other states throughout the series, ranging from 11.8 ‰ to 7.2 ‰ in 2002 and 2006, respectively (Figure 2).
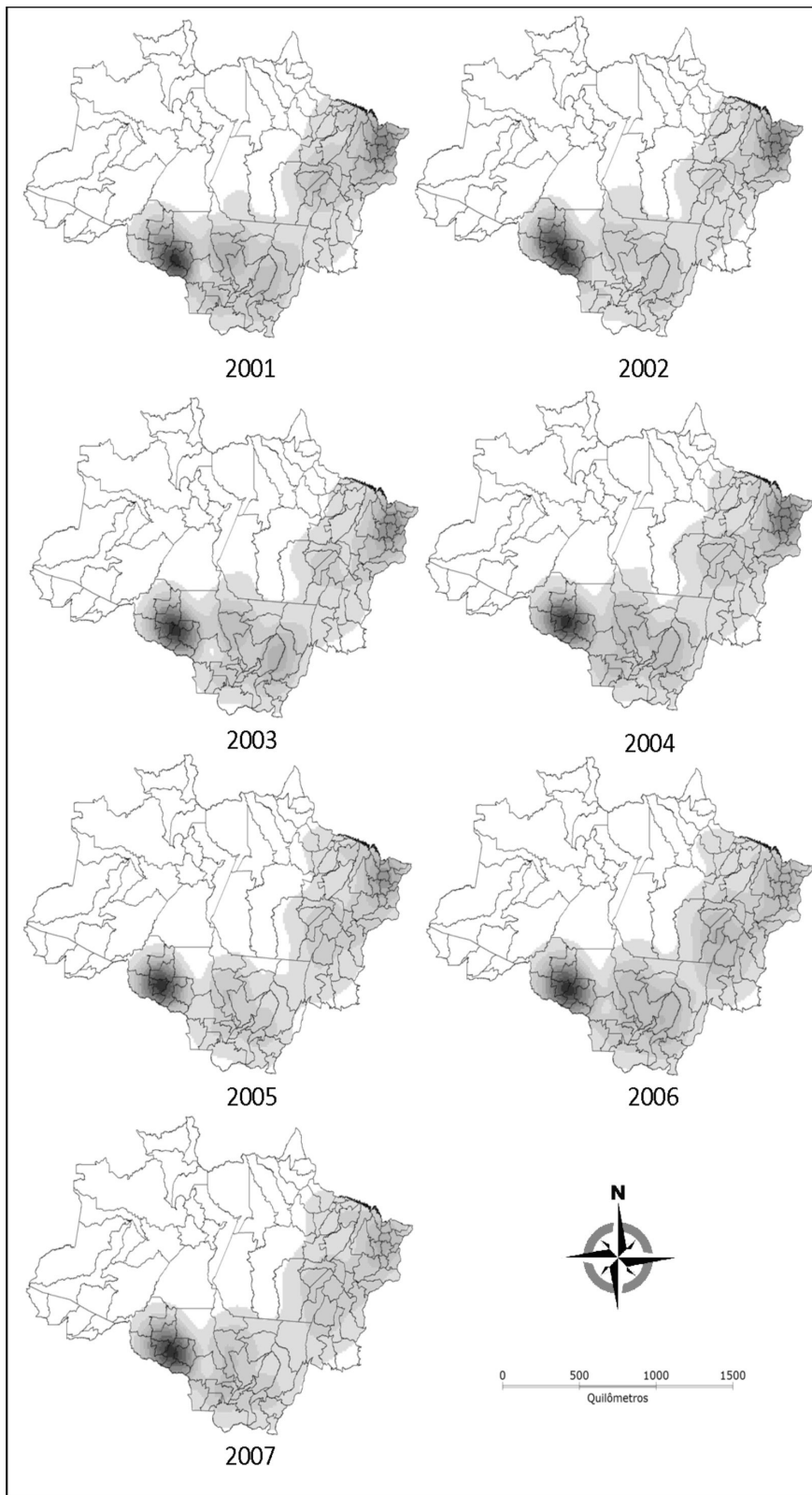
Monthly hospitalization rates for asthma in the elderly were found highest in the months from July to October. February observed a decline in admissions where March had peak attendances. The states of Rondonia and Mato Grosso held the highest monthly rates with up to 5.8 ‰ and 3.3 ‰ respectively (Figure 03).

The proportion of asthma hospitalization in the elderly was higher in the dry season, both when compared to the intermediate period and rainy season with double and even triple the volume of admissions (Table 01).

Discussion

The spatial distribution of asthma admissions in the Amazon showed "hot spots" mainly in south-central Rondônia. The state of Rondônia was found as an exception with extreme asthma admissions rates in the elderly. Similarities are easily drawn between the map of spatial distribution across the Brazilian Amazon and the spatial configuration of the "arc of deforestation".

It is possible to relate this phenomenon to the number of outbreaks of fire throughout the study period as well as the influence of smoke coming from Mato Grosso, Acre and even Bolivia[27,31]. However, there is an inverse trend of hospitalization records for asthma and hotspots in the states that make up the arc of deforestation. Most likely the improvement of technological devices to detect hot spots in forest areas and improvements in the quality of health services to strengthen primary care could account for this.

Rev Bras Epidemiol
2010; 13(3): 1-10   4   Spatial distribution of asthma-related hospitalizations of the elderly in the Brazilian Amazon
*Rodrigues,P.C.O. et al.*

Figure 1 – Spatial distribution according to the Kernel smoothing method for annual standardized asthma-related hospitalization rates (‰ inhabitants) in the elderly in the Brazilian Amazon, 2001 to 2007.

Spatial distribution of asthma-related hospitalizations of the elderly in the Brazilian Amazon
Rodrigues,P.C.O. et al.

5

Rev Bras Epidemiol
2010; 13(3): 1-10
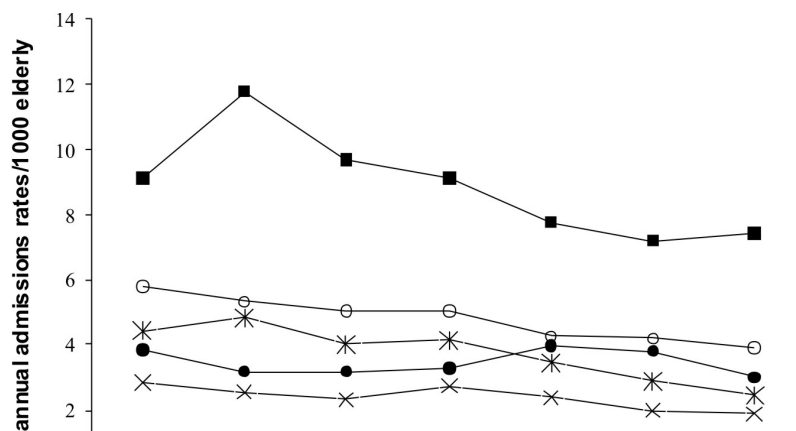
	2001	2002	2003	2004	2005	2006	2007
—✳— Maranhão	4.44	4.80	4.03	4.14	3.43	2.87	2.41
—○— Mato Grosso	5.81	5.32	5.02	5.05	4.25	4.18	3.91
—✕— Pará	2.85	2.58	2.31	2.70	2.41	1.99	1.86
—■— Rondônia	9.11	11.76	9.69	9.13	7.79	7.22	7.43
—●— Tocantins	3.88	3.19	3.18	3.30	3.99	3.81	3.01

* Tendência/*Trend*: Rondônia β =0,57 (p = 0,039); Mato Grosso β =0,31 (p < 0,000); Maranhão β =0,38 (p < 0,000); Tocantins (p = 0,82); Pará β =0,14 (p = 0,013).

Figure 2 – Annual asthma-related hospitalization rates (‰ inhabitants) in the elderly for the states of Maranhão, Mato Grosso, Pará, Rondônia and Tocantins, 2001 to 2007.
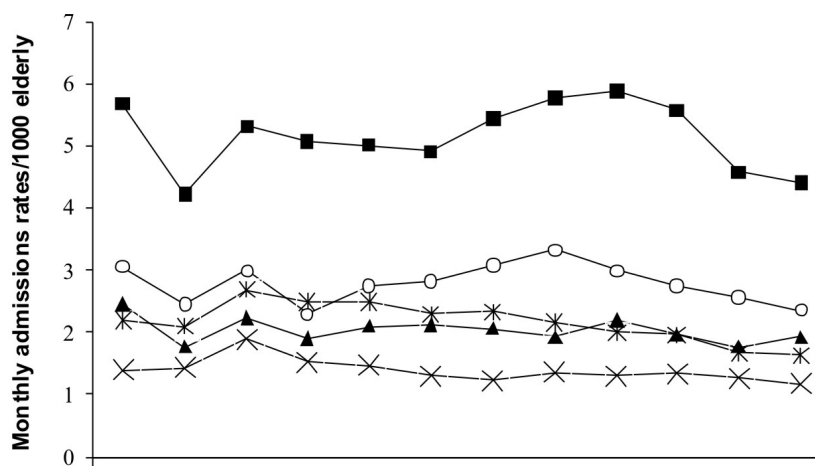
	Jan	Fev	Mar	Abr	Mai	Jun	Jul	Ago	Set	Out	Nov	Dez
—✳— Maranhão	2.18	2.09	2.70	2.50	2.48	2.31	2.33	2.16	1.99	1.95	1.67	1.61
—○— Mato Grosso	3.05	2.46	2.97	2.30	2.74	2.82	3.07	3.32	2.99	2.75	2.55	2.35
—✕— Pará	1.39	1.43	1.89	1.52	1.45	1.30	1.24	1.36	1.28	1.32	1.26	1.17
—■— Rondônia	5.67	4.20	5.31	5.09	5.00	4.92	5.43	5.76	5.87	5.58	4.57	4.40
—▲— Tocantins	2.47	1.76	2.23	1.89	2.11	2.12	2.05	1.93	2.18	1.96	1.75	1.94

Figure 3 – Monthly asthma-related hospitalization rates (‰ inhabitants) in the elderly for the states of Maranhão, Mato Grosso, Pará, Rondônia, and Tocantins, 2001 to 2007.

Table 01 – Absolute value, proportion and rate of admissions of the elderly for asthma during dry intermediate and rainny periods in the Brazilian Amazon states (including Maranhão, Mato Grosso, Pará, Rondônia and Tocantins) 2001 to 2007.

| Year | Period of the year | | | | | | Ratio* | |
| | Dry | | Intermediate | | Rainny | | Dry/ Intermediate | Dry/Rainny |
	n	%	n	%	n	%		
2001	3.548	69.20	1.579	30.80	1.567	30.64	2.25	2.26
2002	3.608	69.32	1.597	30.68	1.669	31.63	2.26	2.16
2003	3.479	70.81	1.434	29.19	1.400	28.69	2.43	2.49
2004	3.474	72.19	1.338	27.81	1.730	33.24	2.60	2.01
2005	3.280	70.52	1.371	29.48	1.429	30.35	2.39	2.30
2006	3.325	73.14	1.221	26.86	1.109	25.01	2.72	3.00
2007	3.342	75.44	1.088	24.56	922	21.62	3.07	3.62
Mean	3.437	71.42	1.375	28.58	1.404	29.00	2.50	2.45

Source: IBGE - MS/Datasus. 2001 to 2007.
n = absolute value % = proportion
* p-value < 0.000 to test χ^2 for comparison of proportions.

The entire border of the Amazon ecosystem, also an agricultural frontier, has an intense migration of people from other regions of the country. Thus, these individuals affront climatic variations and exposure to potentially allergenic agents such as fungi, pollen, and pollution emitted by burnings in nearby regions. The maps which were constructed from standardized rates of hospitalization, showed little influence of the population density of the newly occupied area of the Amazon. Taking into account access to hospitals in the geographic areas, the capitals of Belem, Manaus, Rio Branco, Boa Vista and Macapá were depicted as "hotspots".

The trend of reducing rates of hospitalization for asthma among the elderly may have followed the general movement of admissions in the SUS[8], both due to improvements in hospital care and the expanding network of primary care[32]. Although asthma is a chronic disease, it can be treated in primary health care[2], requiring hospitalization only for the most serious cases[3,32].

It is known that among the physiological resilience of the elderly the respiratory system becomes more difficult to diagnosis. According to some authors, the disease may be under-diagnosed by the interpretation of dyspnea as a natural consequence of age and the existence of non-specific symptoms found in other pathologies such as chronic obstructive pulmonary disease, congestive heart failure, hypothyroidism, cancer and bronchiectasis[33, 34]. Another possibility relates to the bias regarding the severity of disease and disability leading health professionals to regard asthma as symptoms of other diagnoses including: allergic bronchitis, bronchial asthma, allergic attack, chronic bronchitis, among others[2].

Seasonal asthma admissions in the elderly were significant, with a higher number of hospitalizations prevailing in the dry season. In the months from July to October the rates of hospitalization for asthma in the elderly were the highest, especially in the areas of Rondônia and Mato Grosso. These states, as well, held the largest number of outbreaks of fire during the study period. Further research[11-14] found similar occurrences with fire burning in Asia and an association with an increase in hospitalizations for asthma and other respiratory illnesses. Though, higher rates in the period may be explained by the decrease in relative humidity during this season and the consequent increase in the amplitude between maximum and minimum temperatures[27].

Spatial distribution of asthma-related hospitalizations of the elderly in the Brazilian Amazon
Rodrigues,P.C.O. et al.

7

Rev Bras Epidemiol
2010; 13(3): 1-10

Contrary to this study, the seasonal distribution of hospitalization rates for asthma for children in the Brazilian Amazon is higher during the rainy season[35]. Although most hospitalizations of the elderly occurred during the dry period, all states had a peak in hospitalizations in March, the transition between the rainy and intermediate season, with the exception of the Amazonas state which presented the admission peak in April. Biogenic material (fungi, spores, bacteria and a variety of organic particles) present in humid air, could account for these peaks[36], as well as the concentration of fungi in the environment during the rainy season. Atkinson et al.[37] and Dales et al.[38] observed a correlation between fungal spores and asthma exacerbations in the United States. In Brazil, Valença et al.[39] found in Brasilia, a prevalence of emergency visits for asthma for children during the rainy season, possibly influenced by changes in microorganisms concentrations in the environment.

Rosa et al.[20] suggests that the reduced number of hospital admissions of children during December, January and February may be due to the corresponding holiday season for most professionals, thus peaking in March, where Nesti and Goldbaum[40] found that the return of children to school could influence the infection of other children. Overturf[41] suggests that children may be asymptomatic carriers of various diseases; this could influence the contagion of the elderly, causing subsequent asthma attacks, possibly because children's need for close interpersonal contact and constant direct physical contact with adults [42].

One limitation of this study may be the SUS database hospital admission records. We calculated the reported admissions which ultimately may include the same patient repeatedly if admitted more than once during the study period – thus inflating the representation of distribution of asthma in the population confounding with the severity of cases. In addition, we analyzed only the AIH, therefore, including predominantly only the lower socioeconomic classes who are reliant upon the public health system[8]. Despite this limitation, on average 85% of the population are exclusive users of SUS[43] and the reliability of data in the AIH for epidemiological research and demographics has been demonstrated[28-30].

In conclusion, hospitalizations for asthma in the elderly show a decreasing trend over the study period. Based on our findings, we suggest an expansion of health awareness, prevention and care to the elderly population, particularly in asthma care and taking into consideration the unique social, demographic and epidemiological characteristics of the Brazilian Amazon. We suggest that further medical education be offered to professionals in these regions to aid in the differential diagnoses of asthma in the elderly population as the seasonal variation for asthma during the dry season places the elderly at risk.

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Rev Bras Epidemiol
2010; 13(3): 1-10
8
Spatial distribution of asthma-related hospitalizations of the elderly in the Brazilian Amazon
Rodrigues, P.C.O. et al.

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Rev Bras Epidemiol
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Rodrigues,P.C.O. et al.