Trends in hospitalizations for respiratory diseases in Salvador, Bahia State, Brazil, 1998-2009

Tendência das hospitalizações por doenças do aparelho respiratório no Município de Salvador, Bahia, Brasil, no período de 1998-2009

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Abstract

Respiratory diseases are the leading cause of hospitalizations in Brazil (excluding hospital admissions related to childbirth, pregnancy, and postpartum). To analyze the trend and seasonality of hospitalizations for respiratory diseases in Salvador, Bahia State, Brazil, 1998-2009, a time trend study was performed using simple linear regression. Hospitalization rates for all respiratory diseases and specifically for asthma, chronic obstructive pulmonary disease (COPD), and pneumonia were calculated by year and age group. Hospitalizations for all respiratory diseases decreased by 45.6% (β = -2.2; p < 0.001); those due to asthma showed the largest decline (annual average 1.2/10,000), pneumonia showed the largest reduction until 2002, subsequently tending to stabilize, and COPD remained unchanged. The under-5-year age group showed the largest decline in hospitalizations for all respiratory diseases. There was no seasonality in hospitalizations for COPD. There was a reduction in the burden of hospitalizations due to respiratory diseases in Salvador, mainly due to the drop in asthma and pneumonia in children < 5 years. However, the city still has hospitalization rates for respiratory diseases that are higher than in other large Brazilian cities.

Respiratory Tract Diseases; Hospitalization; Seasonal Variations

Introduction

Diseases of the respiratory system are among the principal causes of morbidity and mortality in Brazil. This group includes a wide spectrum of diseases, ranging from infectious diseases such as pneumonia to chronic non-communicable diseases like asthma and chronic obstructive pulmonary disease (COPD).

Among the five leading causes of death in the world, two belong to the group of respiratory diseases: COPD and respiratory tract infections [1]. According to a forecast for the year 2030, despite an expected decrease in the burden of respiratory infections in mortality in the world, there will be an increase in mortality rates from chronic respiratory diseases. However, both subgroups of respiratory diseases will remain among the five leading causes of death, both in high-income and low-income countries [2]. In 2007, COPD accounted for more than three million deaths in the world, 90% of which in developing countries [3].

In Latin America, lower respiratory tract infections like pneumonia cause 6% of deaths [4], while prevalence of asthma symptoms in adolescents exceeded 15% in countries like Paraguay, Peru, and Brazil [5]. In Brazil, during the 1980s and 1990s, morbidity and mortality indicators from respiratory diseases showed a trend towards stability, and these diseases accounted for 16% of all hospitalizations by the end of the two decades [6]. Currently, this group of diseases constitutes the

principal cause of hospitalizations in Brazil, ranging from 16% of all hospitalizations in the State of Paraná to approximately 8% in Sergipe in 2009. In Bahia, in the last two years, diseases of the respiratory tract accounted for 15% of hospital admissions and were the main cause of hospitalizations, not including those related to pregnancy (Hospital Information System. http://www.datasus.gov.br, accessed on 15/May/2010).

Various Brazilian studies have focused on respiratory diseases [7,8], but with few exceptions they have concentrated on mortality in children under five years, and particularly on infectious diseases, especially pneumonia. There is thus a gap in knowledge concerning the epidemiological situation in this important group of causes in the overall and adult population.

In Salvador, the few studies on this problem have only focused on pneumonia [9] and asthma [10]. Published data on the theme can be found mainly in official websites like DATASUS, but without any analysis. Respiratory diseases were the fifth cause of hospitalizations in this city, accounting for more than 9% of all hospitalizations in 2009, not counting those related to pregnancy, labor, and postpartum (Hospital Information System. http://www.datasus.gov.br, accessed on 15/May/2010).

While diseases of the respiratory tract were the principal cause of hospital admissions from 1996 to 2003 [11], there was an improvement in this indicator. This raises the following question: what are the main causes of respiratory diseases involved in this reduction? From this perspective, the current study aimed to analyze the time trend and seasonality of hospitalizations for respiratory diseases and their main types (pneumonia, asthma, and COPD) in Salvador, capital of the Bahia State, from 1998 to 2009.

Material and methods

A time series study was performed, analyzing the time trend and seasonality of annual hospitalization rates for respiratory diseases and their most common types (asthma, COPD, and pneumonia), covering the population of Salvador from 1998 to 2009. Starting with the first year in this series, the causes of hospitalizations were classified according to the 10th Revision of the International Classification of Diseases (ICD-10), in which diseases of the respiratory system correspond to Chapter X (J00 to J99). Population data were obtained from the Brazilian Institute of Geography and Statistics (Instituto Brasileiro de Geografia e Estatística – IBGE), while hospital admissions data came from the Hospital In-

formation System (SIH), with free access on the DATASUS website.

Hospitalization rates were calculated, respectively, by dividing the number of admissions for respiratory diseases (total and for each of the three types analyzed) according to gender, year, and age group (0-4 years, 20-64 years, and ≥ 65 years) by the total population, by gender and age bracket, as specified in the numerator, with 10 thousand inhabitants as the multiplication factor. Age brackets were defined so as to facilitate comparison of the results with those of other studies and to include children, adults, and the elderly separately. For purposes of comparison as well, the hospitalization rates for respiratory diseases were calculated for the State of Bahia and Brazil. Trend curves for hospitalization rates were also constructed for all respiratory diseases and for their most common types, by year of occurrence and age group. Simple linear regression (least squares method) was used in statistical analyses to verify the time trend and seasonal variation, using Stata (version 10, Stata Corp., College Station, USA), with statistical significance set at 0.05. The independent variable (calendar year) was not centralized.

Results

From 1998 to 2009, there were 113,559 hospitalizations for respiratory diseases in the Brazilian Unified National Health System (Sistema Único de Saúde – SUS) in Salvador. During this period, the hospitalization rates for this group of causes decreased by 45.6%, from 48.3 per 10,000 inhabitants in 1998 to 26.2 per 10,000 in 2009. The mean annual decline was 2.2 hospitalizations per 10,000 inhabitants ($R^2 = 0.80$; $p < 0.001$). This reduction was smaller than for the State of Bahia and for Brazil as a whole, which showed mean annual decreases of 5.4 hospitalizations per 10,000 inhabitants ($R^2 = 0.81$; $p < 0.001$) and 4.4 per 10,000 (coefficient -4.4; $R^2 = 0.96$; $p < 0.001$), respectively (Figure 1).

Among the respiratory diseases, pneumonia, asthma, and COPD showed the highest hospitalization rates during this period, accounting respectively for 49%, 18%, and 4% of all hospitalizations for this group of causes. Figure 2 shows the time trends for asthma, COPD, and pneumonia during the study period. Asthma showed the largest decline during this period (88%), with a mean annual drop of 1.2 hospitalizations per 10 thousand inhabitants ($R^2 = 0.92$; $p < 0.001$) and a greater intensity from 2003 to 2006 (coefficient -2.3; $p < 0.027$). For pneumonia, the sharpest declines occurred in the rates up until 2002, with

Figure 1

Time trend in hospitalization rates for respiratory diseases. Salvador, Bahia State, Brazil, 1998-2009.
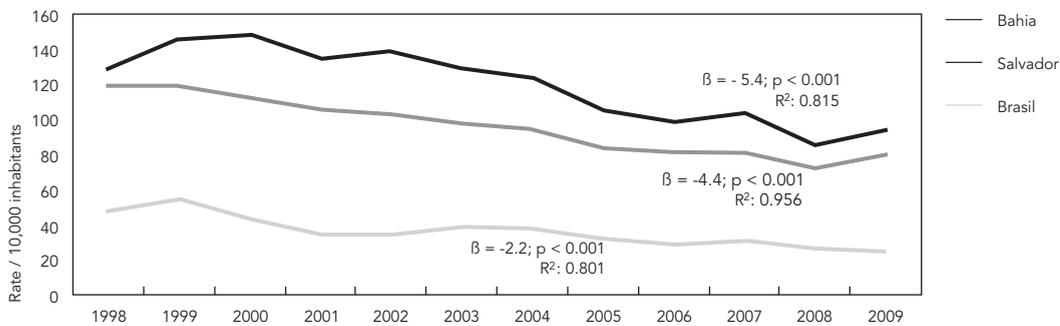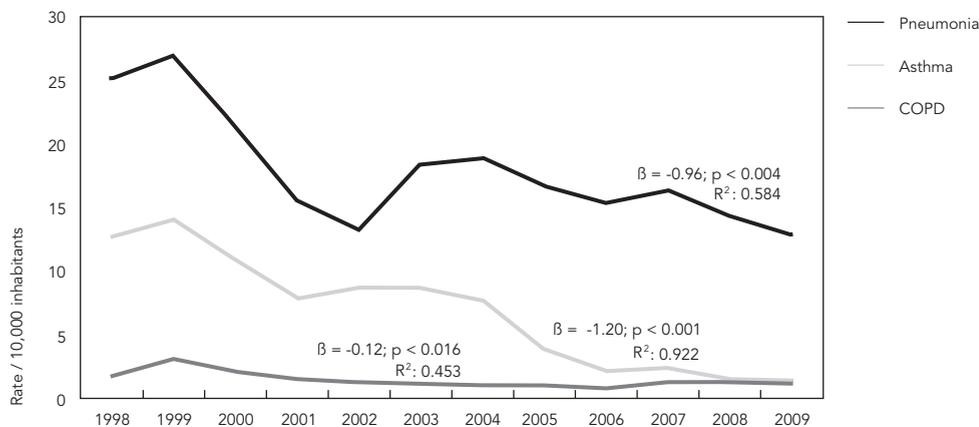

Figure 2

Time trend in hospitalization rates for pneumonia, asthma, and chronic obstructive pulmonary disease (COPD). Salvador, Bahia State, Brazil, 1998-2009.

a mean annual reduction of 3.5 hospitalizations per 10,000 inhabitants ($R^2 = 0.88$; $p < 0.019$), after which there was an increase, tending subsequently towards stability (coefficient -0.95; $R^2 = 0.88$; $p < 0.002$). The mean annual rate of decline during the period was 0.96 ($R^2 = 0.58$; $p < 0.004$). Hospitalizations for COPD remained practically unaltered, with rates varying from 1.8 per 10,000 inhabitants in 1998 to 1.15 per 10,000 in 2009 (coefficient -0.12; $p < 0.016$).

During the entire period, males showed higher hospitalization rates for respiratory diseases in general and for the specific types studied. The difference between the sexes was sharper for COPD, where men accounted for 62.7% of hospitalizations in 1998 and 59.4% in 2009. There was a drop in hospitalizations in both sexes and for all the diagnoses, with different intensities. Women showed a larger decline in hospitalizations for asthma, thus increasing the difference between the sexes (5.5% in 1998 and 17.7% by 2009). The opposite occurred with COPD and pneumonia. While there was a 39.2% drop in the hospitalization rate for COPD among men, the reduction in

women was 30.7%, so that females accounted for 40.6% of these hospitalizations by the end of the period. For pneumonia, the difference between the sexes decreased from 11.8% to 7.9%.

As for age groups, as shown in Table 1, when considering 1998-2009 as a whole, the highest hospital admissions rates, except for COPD, occurred in children up to four years of age, the age bracket that also showed the largest drop in all the causes analyzed, declining at a mean annual rate of approximately 17 cases per 10,000 inhabitants ($R^2 = 0.79$; $p < 0.001$) for respiratory diseases and 9 per 10,000 inhabitants asthma ($R^2 = 0.91$; $p < 0.001$) and pneumonia (R = 0.65; $p < 0.002$).

Year-by-year analysis of the data (not presented) indicates a drop in hospitalization rates for pneumonia in children under five years, with a sharper decrease until 2002, with an annual reduction of 27.6 hospitalizations per 10,000 inhabitants ($p < 0.049$; $R^2 = 0.77$). Starting that year, the rates declined by 8.8 hospitalizations per 10,000 inhabitants per year ($p < 0.002$; $R^2 = 0.86$). This difference was also seen in the elderly, who showed an annual reduction in hospitalization rates for this disease from 6.8 per 10,000 inhabitants ($p < 0.001$; $R^2 = 0.99$) until

2002, when there was an increase in the rates, although not statistically significant (coefficient 1.25; $p < 0.243$). The opposite occurred with asthma, that is, a more intense reduction from 2003 to 2006 in children (coefficient -19.6; $p < 0.015$) and the elderly (coefficient -2.1; $p < 0.196$) when compared to the previous period.

The elderly showed the most hospitalizations for COPD during the period (14.7 per 10,000). In this age group, hospitalization rates for all respiratory diseases and for COPD in particular declined by an annual average of 4.0 per 10,000 ($R^2 = 0.68$; $p < 0.001$) and 1.5 per 10,000 ($R^2 = 0.59$; $p < 0.003$), respectively. The mean drop in hospitalizations for asthma was no more than one case per 10,000 in this age bracket. A similar trend appeared in the 20-64-year bracket for all diagnoses (Table 1). Despite predominance in the elderly, during the 11 years of this study there were 179 admissions for COPD in children 0 to 4 years of age, the majority (58.7%) in 2008 and 2009.

The study showed seasonal variation in hospitalizations for respiratory diseases (Figure 3). Beginning in March, there is an increase in these hospitalizations, with the highest rates from April to June ($p < 0.001$), after which the rates decline again. There is also a statistically significant increase ($p < 0.002$) in the month of November, but at lower levels than in the peak months. Asthma and pneumonia showed the same seasonal pattern as the group of respiratory diseases as a whole, with monthly medians for the hospitalization coefficients ranging from 0.77 to 1.99 in May and from 0.30 to 0.95 in February, respectively. COPD showed no seasonal fluctuations.

Discussion

Hospitalization rates for respiratory diseases in the city of Salvador showed an important downward trend from 1998 to 2009. However, the reduction was smaller than for Brazil and the State of Bahia, and the city also showed higher hospitalization rates for this group of diseases, and specifically for asthma and pneumonia, as compared to the city of São Paulo [12], where the heavy air pollution aggravates symptoms in persons with respiratory diseases [13,14]. The more unfavorable socioeconomic conditions in the population of Salvador and the lower coverage of primary healthcare services in this city may help account for this difference.

Among the types of respiratory diseases studied in Salvador, asthma showed the largest drop in the rates in both sexes, followed by pneumonia. The largest reduction in these hospitalizations was due to an important decrease in cases
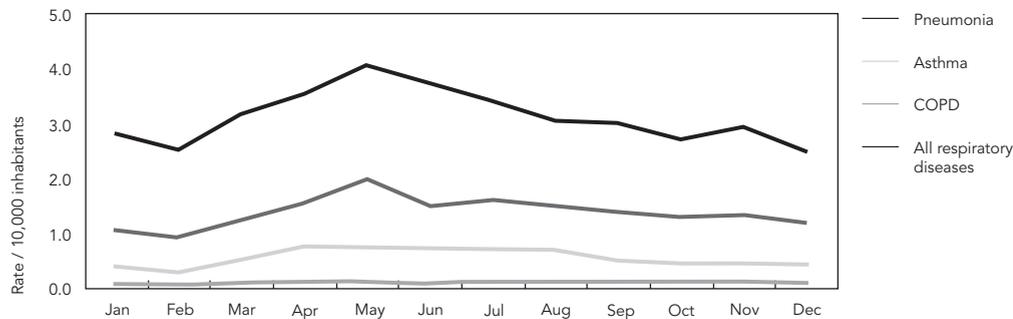
Table 1

Hospitalization rates for all respiratory diseases, pneumonia, asthma, and chronic obstructive pulmonary disease (COPD) according to month of occurrence. Salvador, Bahia State, Brazil, 1998-2009.

Specification	Rates	β	p-value	R²
Respiratory diseases				
General population	35.4	-2.2	**< 0.001**	0.80
0-4 years	236.7	-17.0	**< 0.001**	0.79
20-64 years	12.5	-0.7	**< 0.001**	0.77
≥ 65 years	84.9	-4.0	< 0.001	0.68
Pneumonia				
General population	17.3	-0.9	< 0.004	0.58
0-4 years	148.4	-9.1	< 0.002	0.65
20-64 years	3.3	-0.2	< 0.019	0.44
≥ 65 years	28.2	-0.2	< 0.790	-
Asthma				
General population	6.3	-1.2	**< 0.001**	0.92
0-4 years	54.9	-9.0	**< 0.001**	0.91
20-64 years	0.9	-0.2	**< 0.001**	0.82
≥ 65 years	4.9	-0.9	**< 0.001**	0.81
COPD				
General population	1.5	-0.1	< 0.016	0.45
0-4 years	0.7	0.1	< 0.458	-
20-64 years	1.2	-0.1	< 0.005	0.55
≥ 65 years	14.7	-1.5	< 0.003	0.59

Figure 3

Hospitalization rates for all respiratory diseases, pneumonia, asthma, and chronic obstructive pulmonary disease (COPD) according to month of occurrence, Salvador, Bahia State, Brazil, 1998-2009.

among children under five years, since there was only a slight decrease in individuals over 65 years, while the rates remained stable in younger adults. The decrease was greater than in the city of Recife, and was most intense from 2003 to 2006. An asthma control program called ProAR was implemented in Salvador in 2002, and the reduction has been attributed to this program [10]. ProAR is a public health intervention program aimed at assisting patients with a confirmed diagnosis of severe asthma. Present in four Health Units, its main activities include specialized medical care, pharmaceutical care, and patient education. As of 2010, more than 4,000 patients had enrolled, with the majority still in follow-up. Through multidisciplinary care and free medication, the program has helped reduce asthma-related expenditures, both for families served by the program and for the SUS, due to the reduction in hospitalizations. It has also improved patients' quality of life by 74% and reduced absenteeism at school and work [15]. The intensification in the reduction of hospitalizations for asthma in Salvador during the period immediately after the program was implemented indicates its possible impact on these rates. Beginning in 2007, the capacity of ProAR reached saturation due to limited human resources, thus preventing the enrollment of new patients, which could explain the slowdown in the reduction in hospitalizations for asthma after 2006. In addition, the decrease in these hospitalizations concentrated in the lower age bracket may also have been related to improved living conditions in the city of Salvador, since other studies have shown an association between socioeconomic conditions and asthma [16] and hos-

pitalizations for this disease [17,18]. The idea that socioeconomic conditions contribute more to improving health status as compared to medical interventions is defended by McKeown et al. [19] and discussed by Link & Phelan [20]. In the last two decades, the city of Salvador has improved some of its social indicators, including a decrease in the illiteracy rate, increase in family income, and greater access to basic services [21].

In Salvador, during the study period, children under five years of age accounted not only for the highest hospitalization rates for respiratory diseases (except for COPD), but also for the largest reduction in these rates, especially for asthma. Importantly, asthma diagnosis in this age bracket is difficult to confirm, due to limitations in performing lung function tests. However, dyspnea and recurrent wheezing in this age group are believed to indicate the presence of asthma when other causes of the problem have not been identified.

As expected, the highest hospitalization rates for COPD occurred in individuals over 65 years of age, who showed a small but significant drop in hospitalizations for this disease. Importantly, the situation with COPD in Salvador is better than in other Brazilian cities like São Paulo, which not only shows higher rates, but also an upward trend in adults and the elderly, with an increase of more than 600% in the latter (from 2.7 hospitalizations/10,000 inhabitants in 1998 to 16.6 in 2004) [12]. The authors attribute this fact to the population's aging and longer exposure to smoking over the years. However, Salvador is also experiencing this aging process, with a percentage growth of individuals over 60 years of age very

similar to that of São Paulo (Hospital Information System. http://www.datasus.gov.br, accessed on 15/May/2010). Although COPD shows a lower impact on hospitalizations than other diseases, it requires attention, because among the causes of hospitalization evolving to death, COPD has the highest post-hospitalization death rate [12]. In Rondônia, an increase in mortality from this cause was detected in the elderly population [22]. No previous studies on COPD exist in the city of Salvador, so it was impossible to compare the magnitude of mortality from this disease. There were an unusually large number of hospitalizations of children under five years due to COPD in Salvador in the years 2008 and 2009. As is known, COPD symptoms in individuals under 40 years of age and occasionally in children is associated with alpha-1 antitrypsin deficiency, an infrequent disease, and/or to childhood respiratory problems resulting from prematurity or infections. Still, since these are rare events, with complex and questionable diagnosis, we have no way of ensuring the validity of these findings in the younger age brackets in the current study. Errors in the diagnosis or in coding the cause of hospitalization may be some of the plausible hypotheses.

Pneumonia is the principal cause of hospitalization in all age groups, and its overall drop was due mainly to the decrease in hospitalizations among children. From 1995 to 2004 the main reduction in hospitalizations from pneumonia was among infants (less than one year of age) [8]. This may have resulted from measles control in Salvador, since pneumonia was the most frequent complication of this viral illness, and also from vaccination against *Haemophilus influenzae* type b, since the latter showed a strong association with reduction in hospital morbidity from pneumonia in Salvador among children under five [9]. In addition, the possible improvement in living conditions in Salvador and access to primary care [23] are plausible hypotheses, to the extent that they allow outpatient treatment of cases of pneumonia, thus not requiring hospitalization. Meanwhile, the tendency towards stable hospitalization rates for pneumonia beginning in 2002 resulted from the slowdown in the drop in hospitalizations among children under 5 years and the increase in the elderly. Silva et al. [9] observed that the increase in hospitalizations from pneumonia that occurred after that year coincided with the introduction of the tetravalent vaccine (DPT + Hib) in the annual immunization calendar in order to fight *H. influenzae* type b, suggesting that some factor related to the new vaccine is interfering in the immunization's effectiveness, thus leading to stability in hospitalizations for pneu-

monia among children since that year, following a downward trend.

Men were hospitalized more for respiratory diseases, especially for COPD, as compared to women, thus showing a difference between the genders. This may be partially explained by higher tobacco consumption by men in all age brackets [24]. In addition, women tend to pay more attention to signs and symptoms and seek medical care more frequently and earlier when compared to their male peers [25], possibly resulting in fewer hospitalizations among females. As for asthma, the difference between the sexes increased during the period, due to a sharper drop in hospitalizations among females. However, the opposite occurred with COPD, leading to a reduction in the difference between the sexes during the 12-year period under study. The increase in smoking among women, although beginning later, may help explain this finding, given that smoking is the leading cause of COPD. Monteiro et al. [26] demonstrated that while there was a decline of approximately 37% in smoking prevalence among Brazilian men, the decrease was smaller among women (32%). In some cities in the South and Southeast, smoking is almost as prevalent in women as in men [27], and although there is still a difference in Salvador (12.4% for men and 8.1% for women), this same trend may also be taking place in the city, given that one of its principal outcomes, namely hospitalizations for chronic obstructive pulmonary disease, has increased among women.

The existence of seasonality in hospitalizations for respiratory diseases in general and specifically for asthma and pneumonia, whereby their increase coincides with the rainy season from March to June in Salvador, confirms the trend shown in a previous study [9], even though the city is located in the tropics and thus displays only a slight variation in temperature. A similar result was also reported in a study in Ceará, with more cases of respiratory diseases reported by health services from May to June [28].

Still, caution is recommended when interpreting the results of this study using secondary data, possibly affected by underreporting, incorrect diagnosis, altered diagnoses to inflate reimbursement for hospitalizations, and ill-defined (unknown) causes, among other sources of error. Diagnostic reliability is affected mainly by the precarious information sometimes contained on patient charts and by inherent problems in ICD coding and completion of Authorizations for Hospital Admissions (AIH). Still, from 1998 to 2007 in Salvador, in only 1.06% of hospitalizations the diagnostic classification was either unavailable, not filled in, or invalid. However, the

use of chapters or groups of causes rather than the specific condition may minimize this error [29]. Since the data analyzed here are from the AIH, they do not represent all the hospitalizations in the city, but only those in public hospitals or hospitals outsourced by the SUS, thereby excluding from the analyses the population segment with better socioeconomic conditions.

In addition, since no trustworthy information was available on the portion of the population in Salvador covered by the SUS, we used the city's total population as the denominator for calculating the hospitalization rates, which therefore must have been underestimated. However, this information probably includes more than 60% of the city's population, since only some 30% have private health plans (Hospital Information System. http://www.datasus.gov.br, accessed on 15/May/2010). Another limitation to the study is the fact that it did not contemplate intra-urban differences in Salvador, since it analyzed aggregated data for the entire city. It is thus possible that the trends presented here are not occurring identically in all areas of the city. It is also important that the data presented here refer to the number of hospital admissions and not to the number of patients hospitalized, which may thus be counting the same patients more once if they have been readmitted within a very short period of time.

Despite some reservations concerning data from the SIH, the variety of studies using this data source and the results showing their internal consistency reinforce the system's importance and usefulness [29]. By portraying the more severe clinical forms, the use of hospitalization rates becomes a relevant indicator of the burden of disease not controlled by primary care [10]. In the case of the respiratory diseases analyzed here (pneumonia, asthma, and COPD), which are sensitive to primary care, hospitalization from these causes further represents an indicator of the effectiveness of this level of care [30]. Such information on the current situation with respiratory diseases in Salvador can contribute to the analysis of health managers' priorities.

As for the observed decrease in the burden of respiratory diseases for hospitalizations in this city, mainly involving a drop in hospitalizations for asthma and pneumonia in children under five years of age, Salvador showed higher rates than those in other Brazilian State capitals, despite possible underestimation, since data on hospitalizations are influenced not only by medical need, but also by the supply of hospital beds and professionals. To search for additional explanations for this phenomenon, additional studies are recommended that seek to identify the reasons why only children showed a relevant drop in the rates. It is also necessary to investigate the problem's spatial distribution according to socioeconomic indicators in order to allow identifying areas most heavily affected by respiratory diseases.

Resumo

As doenças do aparelho respiratório são a principal causa de hospitalizações no Brasil, excluídas as relacionadas ao parto, gravidez e puerpério. Para analisar a tendência e sazonalidade das hospitalizações por doenças do aparelho respiratório em Salvador, Bahia, 1998-2009, realizou-se um estudo de série temporal mediante regressão linear simples. Calcularam-se as taxas de internação por doenças do aparelho respiratório, asma, doença pulmonar obstrutiva crônica (DPOC) e pneumonia, por ano e grupos de idade. As hospitalizações por doenças do aparelho respiratório reduziram 45,6% (β = -2,2; p < 0,001); aquelas por asma apresentaram maior declínio (média anual de 1,2/10.000); as por pneumonia exibiram queda mais acentuada até 2002, tendendo posteriormente à estabilidade; por DPOC permaneceram inalteradas. A faixa etária < 5 anos apresentou maior queda em todas as causas de doenças do aparelho respiratório. Não houve sazonalidade nas hospitalizações por DPOC. A carga de doenças do aparelho respiratório nas hospitalizações em Salvador reduziu, principalmente, devido à asma e pneumonia em < 5 anos, mas este município ainda apresenta taxas de hospitalização por estas causas mais elevadas que outras capitais brasileiras.

Doenças Respiratórias; Hospitalização; Variações Sazonais

Contributors

All the authors contributed to the project's design and execution, data analysis and interpretation, writing the article, relevant critical revision of the intellectual content, and approval of the final version.

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