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ORIGINAL ARTICLE / *ARTIGO ORIGINAL*

Social determinants of intra-urban differentials of admissions by respiratory diseases in Salvador (BA), Brazil

Determinantes sociais dos diferenciais intraurbanos das internações por doenças respiratórias em Salvador (BA), Brasil

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ABSTRACT: ***Introduction:*** Respiratory diseases (RD) represent a significant cause of hospitalization in Brazil, occupying the first position in the rank by group of diseases. ***Objective:*** To identify social determinants (SD) of intra-urban differentials of hospitalizations by RD and their main types (asthma and pneumonia) a study of spatial aggregation was carried out in Salvador (BA), between 2001 and 2007, taking Information Zones (IZ) as unit of analysis. ***Methods:*** Data on hospitalizations were provided by the Health Department of Bahia State. Socioeconomic indicators were obtained from the Demographic Census carried out in 2000, and the number of health centers was acquired from the National Register of Health Services. ***Results:*** Multiple linear regression analysis indicated association between spatial variation of the rates of hospitalization due to RD and income ($\beta = 0.54$, $p < 0.001$) and rate of health facilities per 10,000 inhabitants ($\beta = 2.91$, $p < 0.001$). Crowding was not associated. ***Conclusion:*** The identification of variation in SD in hospitalizations by RD in the IZ of Salvador will help in the decision-making process by public managers in defining goals and effective measures to reduce inequities in health.

Keywords: Social determinants of health. Respiratory tract diseases. Hospitalization. Asthma. Pneumonia. Social Inequity.

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This study is part of the project called "Evolution of social inequalities in morbidity and mortality in urban space", developed by the Institute of Collective Health of *Universidade Federal da Bahia*.

RESUMO: ***Introdução:*** As doenças do aparelho respiratório (DAR) representam relevante causa de hospitalizações no Brasil, onde ocupa a primeira posição. ***Objetivo:*** Para identificar determinantes sociais (DSS) dos diferenciais intraurbanos das internações por esse grupo de doenças e seus principais tipos (asma e pneumonia), conduziu-se estudo de agregados espaciais em Salvador (BA), no período de 2001 a 2007, tendo como unidade de análise Zona de Informação (ZI). ***Métodos:*** Dados sobre internações foram fornecidos pela Secretaria de Saúde do Estado da Bahia. Do Censo Demográfico 2000 foram obtidos os indicadores socioeconômicos e, do Cadastro Nacional de Estabelecimentos de Saúde, o número de Centros e Postos de Saúde. ***Resultados:*** Análise de regressão linear múltipla indicou associação entre variação espacial das taxas de internação por DAR e renda ($\beta = 0{,}54$; $p < 0{,}001$) e proporção de Postos e Centros de Saúde por 10 mil habitantes ($\beta = 2{,}91$; $p < 0{,}001$). Aglomeração não apresentou associação. ***Conclusão:*** A identificação dos DSS da variação das internações por DAR nas ZI de Salvador poderá auxiliar a tomada de decisão pelos gestores públicos na definição de alvos e medidas efetivas para combate das iniquidades em saúde.

Palavras-chave: Determinantes sociais da saúde. Doenças do aparelho respiratório. Internação hospitalar. Asma. Pneumonia. Desigualdade social.

INTRODUCTION

Knowledge of modern medicine and technology aimed at the biological, genetic and environmental factors have contributed to the evolution and development of numerous treatments and ways of diagnosing disease. However, it has not been able to explain the inequalities in health conditions found between regions and social groups. In the context of this insufficiency on the elements involved in the causation of the health-disease process, the interest in the study of the relationship between health and living conditions and the social determinants of health once again resurfaces.

Among the social determinants positively related to increased mortality and morbidity from respiratory diseases are: type of occupation[1], education, income and housing[2]. These determinants have increased the prevalence of respiratory symptoms, as well as the risk of dying from lung disease. Global indicators, such as the Gini index (a marker of the degree of inequality) have also shown this association[3].

The importance of this group of diseases in the world in the coming years is evident with the prediction that, in 2030, chronic obstructive pulmonary diseases and respiratory infections are among the five leading causes of death[4].

The risk of hospitalization or greater severity of these diseases is higher in population groups that have the lowest socioeconomic indicators, such as low income and education, both for chronic respiratory diseases such as asthma and Chronic Obstructive Pulmonary Disease (COPD)[5,6], and for infectious diseases, such as pneumonia[7]. Thus, social determinants are important in determining both the distribution of infectious diseases and chronic non-communicable diseases, although the action mechanisms and consequences may differ[8].

In Brazil, respiratory diseases accounted for the second leading cause of years of life lost due to disability[9], causing negative effects on the health of the population and on the

Brazilian health system. They also constitute a major cause of hospitalization in several cities, including the capital of Bahia, where they ranked fifth in 2009[10]. However, studies on the social determinants of these diseases are focused on childhood age groups[11,12] or on infectious diseases[13-15], with few exceptions[16,17], thereby excluding other social groups. Given this gap, this study examined the relationship between the selected social determinants and intra-urban differentials of hospitalizations for respiratory diseases (RD) in Salvador, Bahia, between 2001 and 2007.

MATERIAL AND METHODS

A study of spatial aggregates was conducted, taking the Information Zones (IZ) as the unit of analysis, which corresponds to each of the 93 areas in which the territory of the city of Salvador was divided. These IZ were defined by the Company of Metropolitan Development from geographic, socioeconomic and planning criteria. Data on hospitalizations were provided by the Department of Information and Communication on Health, Health Department of the Bahia State (SESAB), on physical media (CD-ROM), containing the home address of patients admitted between 2001 and 2007, as well as other variables of interest. Cases considered involved hospitalization due to respiratory diseases classified in ICD 10 Chapter X: J00 to J99.

From the patients' home addresses, the data were geocoded in each Information Zone by the computer program *Localiza* (software developed by ISC/UFBa). Addresses that could not be coded automatically by the program were classified manually, using Google Earth. When there was no record of the name of the neighborhood, a random selection of the possible IZ in which the address was located was performed. Information that could not be geocoded due to non-registration of address or impossibility of identification was discarded and represented 2.46% of the 66,332 total hospitalizations.

From information from the Demographic Census of 2000, the following data were obtained per IZ: income (proportion of householders in permanent private households with monthly income equal to or less than two minimum wages), education (proportion of householders in permanent households with less than eight years of education), household crowding (occupant per room ratio), presence of slums (percentage of homes in subnormal agglomeration), the Gini Index, sanitation (percentage of households with indoor plumbing connected to the global water supply and percentage of households connected to the sewage system and septic tank), garbage collection (percentage of permanent private households with destiny of garbage collected). The number of basic health units per 10 thousand inhabitants was surveyed from the National Registry of Health Establishments (CNES). Through a linear regression analysis (univariate and multivariate), the existence of association between hospitalization for RD (and their main types) and the social indicators were verified, considering a significance level of 0.05. The model with least error and best adjustment was selected. To verify the diagnosis of the adjustment of the linear regression

model, a graphical analysis of the residuals regarding the predicted values was performed, which showed to be approximate to normal. Also, a normality verification was carried out through the histogram and the Shapiro-Wilk test ($p = 0.064$).

The analyzes with hospitalization rates standardized by age showed similar results to those obtained with the crude rates, that is, the same variables with similar p values remained in the best model. Multilevel analysis of socioeconomic variables selected for the study was also performed, but did not demonstrate different results from traditional analysis. The study design was approved by the Research Ethics Committee of the Institute of Collective Health (ISC/UFBa) under protocol no. 043-10/CEP-ISC.

RESULTS

During the study period, 66,330 hospitalizations by RD occurred in Salvador. Among the main types of this group of diseases, pneumonia was the most common, with 30,540 (46%) hospitalizations, followed by asthma, responsible for 11,354 hospitalizations (17.1%). The hospitalization rate in the municipality for the entire cause group decreased in 15.1%, from 34.4 to 29.2 per 10,000 inhabitants in 2001 and 2007, respectively. Table 1 shows the rates of hospitalization for respiratory diseases and their main types (asthma and pneumonia) for each Information Zone of the city of Salvador.

In the univariate analysis, the spatial variation for education, income, Gini Index, occupant per room ratio and number of basic health unites per 10 thousand inhabitants, by ZI, showed a statistically significant association with the spatial variation in the rates of hospitalizations for respiratory diseases (Table 2). Although the socioeconomic indicator with greater effect over the spatial variation of hospitalizations by RD was the Gini Index ($\beta = 102.88$; $p < 0.001$), the confidence interval presented by it was very wide (67.1 to 138.6). The number of basic health units per 10,000 inhabitants was also associated with hospital morbidity by RD, but in the opposite sense than expected. In the multivariate analysis, the model with the best adjustment and least error included the following variables: income ($\beta = 0.54$; $p < 0.001$), water supply ($\beta = 1.40$; $p < 0.001$), number of basic health units per 10,000 inhabitants ($\beta = 2.91$; $p < 0.001$), Gini Index ($\beta = 23.50$; $p < 0.358$), occupant per room ratio ($\beta = -1.94$; $p < 0.152$) and garbage collection ($\beta = -0.27$, $p < 0.169$), with the last three not presenting statistical significance.

Table 3 presents the results of the univariate and multivariate analyzes of two types of respiratory diseases, one chronic (asthma) and one infectious (pneumonia). The univariate analysis showed a statistically significant positive association between the spatial variation of the rate of hospitalization for both diseases and the following determinants: education, income and Gini Index.

In the multivariate analysis, the following variables remained significant for the spatial variation of hospitalizations for asthma: income ($\beta = 0.08$; $p = 0.002$), water supply ($\beta = 0.27$; $p = 0.001$), garbage collection ($\beta = -0.09$; $p = 0.032$) and basic health units per 10,000 inhabitants

Table 1. Hospitalization rates for respiratory diseases, pneumonia and asthma in different areas of Salvador, 2001 – 2007.

IZ	RD Rate	Asthma Rate	Pneumonia Rate	IZ	RD Rate	Asthma Rate	Pneumonia Rate
1	10.16	1.12	3.94	37	33.30	5.23	18.18
2	16.95	2.64	5.79	37A	15.93	2.02	5.56
3	9.3	1.03	4.39	38	70.04	9.23	22.74
4	14.54	2.58	6.97	38A	11.92	0.96	5.89
4A	9.53	0.56	3.36	38B	37.54	4.29	21.99
5	16.71	1.70	4.90	39	50.74	6.42	20.74
6	39.24	7.18	18.03	40	26.31	2.89	9.95
7	29.82	5.25	14.81	41	42.45	6.27	17.49
8	6.54	0.27	2.25	42	40.74	5.04	18.63
9	7.56	0.50	2.35	43	30.26	4.89	15.29
10	4.08	0.29	1.36	44	32.27	5.66	14.97
11	30.72	4.97	12.87	45	6.07	1.78	2.83
12	36.00	6.24	14.67	46	3.36	0	1.18
13	13.35	2.21	6.07	47	24.38	3.50	10.98
14	15.28	1.49	5.52	48	32.47	6.75	15.35
15	46.44	6.24	18.60	49	40.96	9.07	19.45
15A	15.12	1.26	6.84	49A	5.46	1.44	3.16
15B	51.76	9.66	17.25	50	29.49	4.06	12.70
16	22.23	2.77	7.74	51	33.92	4.89	15.13
17	23.42	3.93	10.55	52	33.67	6.86	16.05
17A	24.62	4.88	8.49	53	61.37	13.99	30.78
18	29.19	5.66	12.81	53A	11.81	1.71	6.57
19	21.02	3.95	9.13	54	24.03	4.48	12.02
20	30.29	5.54	12.51	55	21.65	3.10	9.34
21	3.42	0.17	1.31	56	9.11	0.90	3.20
21A	25.98	5.20	10.39	57	34.81	7.30	16.69
22	12.54	1.67	6.19	58	33.14	4.61	16.63
23	67.81	15.58	32.07	59	55.18	10.86	28.64
23A	47.57	6.56	19.68	60	38.74	5.99	20.18
24	81.01	10.13	46.58	61	25.50	4.02	11.61
24A	19.48	7.08	7.08	61A	14.62	1.78	7.52
24C	45.32	4.82	5.79	62	32.42	5.96	17.36
24D	31.85	5.06	11.61	63	35.66	4.07	17.37
24E	39.65	12.15	15.99	64	29.75	4.44	15.25
25	28.35	4.20	9.97	64A	5.36	1.79	1.79
26	11.37	1.78	3.57	65	30.42	4.91	16.08
27	39.94	7.77	18.42	66	36.73	5.93	19.73
28	23.50	4.95	8.82	67	25.24	4.21	14.69
29	15.50	2.65	6.73	67A	1.03	0	0
30	40.91	7.51	19.32	68	51.81	13.29	24.99
31	31.12	4.66	16.85	69	36.08	7.31	18.55
31A	14.89	1.92	7.44	70	4.77	0.71	2.52
32	36.23	6.83	14.50	71	41.14	8.79	24.28
33	34.07	5.05	12.74	71A	28.11	4.11	18.00
34	43.30	6.77	18.43	72	22.85	3.54	13.27
35	25.44	4.54	12.72	73	50.60	11.23	26.20
36	38.29	7.6	16.96				

RD: respiratory diseases.

($\beta = 0.42$; $p = 0.005$). Regarding pneumonia, the variables with significant influence on its hospitalization rate were: income ($\beta = 0.33$; $p < 0.004$) and basic health units per 10,000 inhabitants ($\beta = 1.04$; $p < 0.003$). The Gini Index did not remain statistically significant in multivariate analysis for both pathologies.

DISCUSSION

The results of this study showed that the social determinants influence on the spatial variation of rates of hospitalization for respiratory diseases. Areas of Salvador whose population had lower levels of education and income had higher risk of hospitalization for

Table 2. Coefficients (β) of linear regression obtained for the association between hospitalization rates for respiratory diseases and social determinants. Salvador, 2001 – 2007.

Determinants	Bivariate analysis		Multivariate analysis *	
	β	p-value	β	p-value
Schooling	0.43	0.000		
Income	0.46	0.000	0.54	0.000
Water supply	0.31	0.273	1.40	0.000
Sewer network	0.02	0.762		
Garbage collection	-0.08	0.620	-0.27	0.169
Gini Index	102.88	0.000	23.50	0.358
Slums	0.14	0.443		
Occupant/room	-1.58	0.402	-1.94	0.152
Basic health units and health centers/10.000 inhabitants	2.84	0.002	2.91	0.000

*Model with lower error and better adjustment. MSE: 11.01. R-adj: 0.51.

Table 3. Coefficients (β) of linear regression obtained for the association between hospitalization rates for pneumonia and asthma and social determinants of health. Salvador, 2001 – 2007.

Determinants	Pneumonia				Asthma			
	Bivariate		Multivariate*		Bivariate		Multivariate*	
	β	p-value	β	p-value	β	p-value	β	p-value
Schooling	0.26	0.000			0.09	0.000		
Income	0.26	0.000	0.33	0.000	0.09	0.000	0.08	0.002
Water supply	0.03	0.811	0.63	0.000	0.01	0.853	0.27	0.000
Sewer network	-0.03	0.287			-0.01	0.284		
Garbage collection	-0.11	0.171	-0.14	0.172	-0.05	0.088	-0.09	0.032
Gini Index	56.49	0.000			20.52	0.000	5.55	0.319
Slums	0.16	0.092			0.07	0.046		
Occupant/Room	-0.14	0.877			0.03	0.992		
Basic health units and health centers/10.000 inhabitants	0.84	0.007	1.04	0.003	0.35	0.053	0.42	0.005

*Model with lower error and better adjustment. Pneumonia (MSE: 5.69/R-adj: 0.47). Asthma (MSE: 2.40/R-adj: 0.40).

respiratory diseases, particularly for asthma and pneumonia. However, this influence was small in magnitude, since, for an increase of 5% in the spatial variation of rates of hospitalization for RD to occur, it would be necessary that there was an increase of approximately 9% in the proportion of heads of households with less than eight years of schooling or with an income of less than two minimum wages. For pneumonia and asthma, this increase would have to be even greater, 15% and 62%, respectively. Schooling lost its effect after being adjusted by income, possibly because it is almost always the main determinant of family income, thus not having any effect independently of this. Only one study was found in the literature on the social determinants of respiratory diseases analyzed from spatial aggregates. This study was conducted in people over 65 years of age in the U.S., and found similar results for income and education[18].

It is noted that, even if one considers the non-equivalence between the measures of effect produced by studies of aggregates and those obtained by individual studies, one should recognize that in spite of the disease having a biological expression in the individual, there is, in its production process, the mediation of factors that represent life conditions determined by the socioeconomic structure. Thus, among the inquiries from individual analyses, there is one carried out the U.S. with adults between 18 and 65 years old, which found no correlation between income and education levels and severity of asthma[19]. In the study by Eisner et al.[20], the highest educational level was associated with lower risk of hospitalization for asthma among adults. Yet, as in the present study, this relationship was only attained when this indicator was analyzed separately. Low income, however, remained associated even after multivariate analysis. A more recent study[21] showed an inverse gradient between income level and hospitalization rates for asthma and COPD. Other authors have also demonstrated the adverse effect of the worst income and education rates on respiratory diseases[5,22,23], but they do not correlate these determinants with the outcome of hospitalization.

Families with higher incomes may be able to provide more goods, services and resources, which would contribute to the prevention of adverse health events[24], such as hospitalizations for respiratory diseases. Blanc et al.[19], in an individuated study, observed the influence of income on the severity of asthma only when evaluated from the average annual family income. This association did not occur when the income was analyzed in terms of area.

Evidence suggests, however, that it is also necessary to give attention to the distribution of income among individuals, for in many societies, the relative income appears to be more strongly associated with health than absolute measures[25]. Relative income was analyzed in this study through the Gini Index, used as a marker of the degree of inequality in the distribution of household income among individuals. This index was the major determinant of both hospitalizations for asthma and pneumonia, and of RDs as a whole, increasing hospitalization rates by more than 50%, but it lost its magnitude when associated with other variables. A study called the International Study of Asthma and Allergies in Childhood (ISAAC)[3], conducted in Brazil, demonstrated the importance of this index on the prevalence of asthma in children between 13 and 14 years old.

Household crowding did not influence the spatial variation in rates of hospitalizations for respiratory diseases, asthma and pneumonia in Salvador. In the U.S., however, a positive association was observed between household crowding and these rates in a study[18] that used the percentage of households with more than one person per room as an indicator of crowding. Individual investigations have also identified this as a possible social determinant of hospitalizations for respiratory diseases and their types. In addition to being a reflection of the socioeconomic status, crowding also represents factors that are directly involved in the etiology of the disease, for the high concentration of residents in the house acts as a risk factor for greater likelihood of pathogen transmission through respiratory droplets[14]. The lack of correlation between household crowding and hospitalizations by RD in this study may have been caused by the inadequacy of the indicator used (occupant per room ratio). This hypothesis is supported by the low inequality found for the indicator of crowding used in Salvador, seeing as 90% of the areas that make up the city had an average household density of less than one occupant per room, and only two areas had more than three people per room, making it impossible to capture the influence of socioeconomic factors on hospitalizations for RD, as described in other studies. The construction of the indicator, by failing to distinguish the dormitory room, may have reduced the degree of crowding in some areas.

As basic health units and health centers are the gateway to the health system, the demand should be addressed at this level of attention, and hospitalization should happen only for cases that are presented in their most severe forms. Ecological study conducted in the U.S. (1994) showed that areas with more clinicians per capita had lower rates of hospitalization for respiratory diseases[18]. However, unlike what was expected, a higher concentration of basic health units and health centers was accompanied by a greater spatial variation in rates of hospitalization for respiratory diseases, especially for asthma and pneumonia. The reverse effect observed in this study is probably a result of the inability of these primary care units in solving the population's health problems and needs, thus having the referral to hospitals as a first alternative. Another hypothesis to be addressed is the difficulty of access to health services or poor perception of the disease in the poorest communities, causing the demand for health care to occur only when there is a worsening of the disease, when the hospitalization of most of the demand that comes to health centers becomes necessary. For example, in a study conducted in Belo Horizonte, no children under five years old who was admitted due to worsening asthma had ties to the basic health units for the monitoring of their condition. The authors emphasized that because they did not receive periodic control of their disease, children had high levels of repeat visits to the emergency room, causing the fragmentation of care to result in a high social cost[26].

The extension of the sewer network and water supply in Salvador in recent years decreased inequalities between areas that make up the city in relation to these indicators used in this study as a proxy for living conditions and, although they still exist, they were not large enough to allow identification of the role of these indicators of living conditions on admissions for RD.

Among the limitations of this study, those that result from problems related to the use of data from Hospitalization Authorizations (HR), such as incorrect or inadequate completion of hospital records, should be highlighted. Additionally, the Hospital Information System only has data from public and private hospitals registered to the Unified Health System (SUS), thus excluding from the analysis the share of the population with the best socioeconomic conditions. This may have homogenized the study population, precluding the identification of a greater influence of some selected living conditions indicators and of the hospitalizations for RD and its types. Another problem that may have contributed to the reduction of disparities in the population studied is that the data refer to the number of hospital admissions, and the same patient may have been counted more than once if they have had a recurrence of admission, which is probably more common in poorer populations, due to the difficulty in maintaining the treatment and control of the disease. The possibility of errors in the geocoding of cases due to incorrect completion of the address of inpatients is not ruled out.

In spite of these restrictions, the results presented in this study confirm the importance of the social determinants of spatial variation in hospitalizations for RD, asthma and pneumonia. The indicators of living conditions, resulting from the way these groups are included in the production structure and reproduction process of society[27], are intermediaries of the social determination process[28], thus acting as mediators of the effect of organization of society on health. The consistency of the performance of social determinants on the health condition confirms the importance of intersectoral action to resolve the problems identified, since their control is beyond the scope of the health sector. Their identification may contribute to decision-making by public managers in setting targets and effective measures to combat health inequities.

Further studies should be carried out to strengthen and validate these findings. One of the main challenges for the measurement of health inequalities is the selection of relevant social indicators that are capable of giving visibility to the dynamic social interactions[29]. In this sense, it is recommended that future studies adopt new indicators for the variables that did not present association with hospitalization for RD in this study, but which have been validated by other authors, such as household crowding.

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