Saúde e Pesquisa
DOI: 10.17765/2176-9206.2021v14n3e8355
e-ISSN: 2176-9206

Hospitalization due to vaccine-preventable diseases in a State of the Amazon Region

Internações por doenças preveníveis por vacina em um Estado da Região Amazônica

Jessica Soares Barbosa[1], Rubenilson Caldas Valois[2], Eliã Pinheiro Botelho[2], Débora Thalita Neri[2], Fabiane Diniz Machado Vilhena[1], Giovanna do Socorro Santos da Silva[3], Glenda Roberta Oliveira Naiff Ferreira[2]

[1] Multiprofessional Residency, Universidade Federal do Pará (UFPA), Bragança PA Brazil.
[2] Postgraduate Course in Nursing, Universidade Estadual do Pará (UEPA), Belém PA Brazil.
[3] Faculty of Nursing, Universidade Federal do Pará (UFPA), Belém PA Brazil.

***Corresponding author**: Jéssica Soares Barbosa - E-mail: jessica.barbosa02@hotmail.com

ABSTRACT
Objective: The distribution of hospitalizations for vaccine-preventable diseases in Pará is provided. Method: An observational, ecological study on hospitalizations for vaccine-preventable diseases between 2009 and 2018 in residents of the state of Pará. Data were retrieved from the hospital data system. Joinpoint, Terraview and Tabwin were used for the analyzes. Results: The hospitalization rate for the 15 - 49 age group showed a significant growth trend during the 2012 – 2018 period. Health regions showed a heterogeneous pattern in the distribution of hospitalization rates for the diseases studied, poor spatial dependence, with clusters of municipalities with very high and very low standards, in different health regions. Conclusions: Screening of priority populations for vaccination and most affected groups of people by hospitalizations related to vaccine-preventable diseases was highlighted. The spatial distribution showed a heterogeneous pattern of hospitalizations in Pará.

Keywords: Hospitalization. Hospital Mortality. Immunization. Vaccines.

RESUMO
Objetivo: descrever a distribuição das internações por doenças imunopreveníveis no Pará. Método: estudo observacional, ecológico sobre as internações por doenças imunopreveníveis ocorridas no período de 2009 a 2018 em residentes do Estado do Pará. Os dados foram extraídos do sistema de informação hospitalar. Para as análises foram utilizados os programas *Joinpoint, Terraview* e Tabwin. Resultados: a taxa de internação na faixa etária de 15 a 49 anos apresentou tendência com crescimento significativo no período de 2012 a 2018. As regiões de saúde apresentaram padrão heterogêneo na distribuição das taxas de internação pelas doenças estudadas, assim como foi demonstrado dependência espacial fraca com aglomerados de municípios com padrão alto-alto e baixo-baixo localizados em regiões de saúde distintas. Conclusões: evidenciou-se a importância do rastreio das populações prioritárias para vacinação e dos mais acometidos por internações relacionadas a doenças imunopreveníveis. A distribuição espacial demonstrou um padrão heterogêneo das internações no Pará.

Palavras-chave: Hospitalização. Imunização. Mortalidade hospitalar. Vacinas.

Received in March 23, 2020
Accepted on November 09, 2020

INTRODUCTION

The maintenance of high vaccination coverage and the identification of susceptible individuals are a challenge for immuno-preventable infection surveillance systems in a globalized world. Recent outbreaks of measles and yellow fever and hospitalization rates due to *Haemophilus influenzae* Type B and tetanus require fast responses and immediate action to reduce hospitalizations and mortality [1-6]. In the Americas, mumps was the disease with the highest number of reported cases in 2018, with 68,290 cases, followed by whopping cough with 23,638 cases, measles with 16,714, yellow fever with 1,326 cases, diphtheria with 894 cases, tetanus with 236 cases, neonatal tetanus with 10 cases, and rubella with 6 cases[3]. The re-emergence of the above diseases has also been reported in Brazil [2-5], between 2016 and 2018, with great intensity in the southeastern states, after the biggest outbreak of yellow fever since 1942. Further, the migration of asymptomatic people from rural to urban areas, environmental changes in ecosystems, high population density in areas where vaccination is not a priority, are crucial factors for the pattern of spatial dissemination that occurred in Brazil when compared to the situation in the Amazon region[2].

In 2017, there was an outbreak of measles in the Brazilian Amazon, linked to population migratory process due to the Venezuelan political crisis. The states of Amazonas and Roraima, with its border with Venezuela, were greatly hit, with proliferation in Pará and other nearby states. Low vaccinal coverage and migration with uncontrolled health surveillance of the borders contributed towards the dissemination of the disease[5].

Needless to say, the epidemiological context affects activities involving the usage of hospital beds. Since one is dealing with vaccine-preventable diseases, the situation impacts the quality of and access to First Health Care (APS)[1-7]. The size and distribution of hospitalizations of several diseases in Brazil are evaluated by hospitalization indexes due to APS sensitive conditions (ICSAP)[7]. However, indexes do not comprise all diseases which feature vaccines provided by the National Immunization Program (PNI) which, since its establishment, made comprehensive many vaccines, established priority groups and extended vaccinal coverage to the whole country[8-9].

However, there are variations in vaccine coverage between Brazilian regions, states and municipalities, even those in the same state, with the establishment of risk areas in disease transmission. Territorial heterogeneity also occurred in the state of Pará, Brazil, where there is a great amount of municipalities with low vaccine coverage[10]. Conditions become more serious since the state has one of the lowest municipal human development index (IDHM), low APS coverage and deep social and economic inequalities and where the establishment of great energy-producing projects, road construction, and timber and mineral industries were incapable of improving the

income and life conditions of the populations concerned[11-14].

In spite of the theme´s relevance and updatedness, few studies exist which investigate the huge number of hospitalizations due to immune-preventable diseases as a consequence to high occurrence in recent years, within the context of the state and age groups with great hospitalization rates. In fact, they are relevant factors for the dissemination of the disease described in recent outbreaks[2,5, 15-16].

Consequently, recent recurrence of several immuno-preventable diseases, spatial distribution of measles outbreak in the Amazon, the heterogeneity of the municipalities of the state of Pará with regard to health, social and geographical indexes, and lack of studies on hospitalizations due to the above mentioned diseases raise the hypothesis that the territorial distribution of hospitalizations for vaccine-preventable diseases is not homogeneous in health regions and in the municipalities[1-6,10-16]. Consequently, it is highly important to know the spatial distribution of hospitalization by immune-preventable diseases to evaluate APS quality and access of elderly people. Current paper analyzes the distribution of hospitalizations by immuno-preventable diseases in the state of Pará, Brazil.

METHODOLOGY

Current observational and ecological analysis studies immuno-preventable diseases in the state of Pará, Brazil, between 2009 and 2018. The state of Pará lies in the northern region of Brazil, within the Brazilian Amazon, ranking second in territorial area of 1,247,955.238 km^2, and a population of 7,581,051 in 144 municipalities grouped in thirteen health regions (RS), namely, Metropolitana I, Tocantins, Marajó I, Marajó II, Metropolitana II, Metropolitana III, Rio Caetés, Baixo Amazonas, Tapajós, Xingú, Lago Tucuruí, Carajás, Araguaia (Figure 1) [11,17].

Data were retrieved between October 2018 and July 2019. Data sources on hospitalizations were registered at the database of the National Health System (SIH/SUS), and obtained from the database of the Department of Information of SUS (DataSus) by Tabwin 4.1.5, whilst population tallies were based on the Brazilian Institute of Geography and Statistics (IBGE).

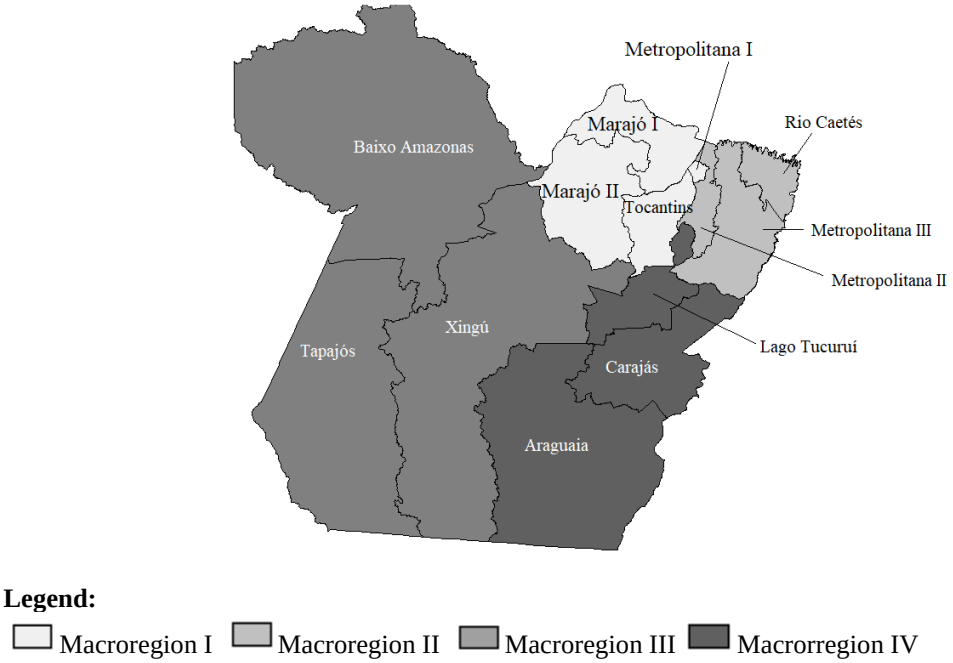

Figure 1. Health Regions and Macroregions of the state of Pará (prepared in Tabwin).

Only hospitalizations of Group I of ICSAP were selected, namely, whooping cough, diphtheria, tetanus, parotitis, rubella, measles, yellow fever, hepatitis B, meningitis by *Haemophilus*, tuberculosis meningitis, military tuberculosis, pulmonary tuberculosis and other types of tuberculosis[7]. Variables comprised hospitalization of people residents in the state of Pará, year of hospitalization, gender, age group, disease and cause, deaths during hospitalization, municipality and health region of residence. Data were stored in spreadsheets of Microsoft Excel, excluding inconsistencies after double checking.

Historical series was given by absolute frequency and rate. Lethality rates were determined by the number of deaths during the year, divided by the number of hospitalizations during the same year, and multiplied by 100. Crude hospitalization rate was calculated by the number of hospitalizations during the year divided by total resident population during the same year, multiplied by 10,000. Whereas crude mortality rate used the number of deaths during the years, divided by total resident population during the same year, multiplied by 100,000, for the hospitalization crude rate for gender and age group, the number of hospitalizations of the year per group divided by population expectation by gender and age group was employed. In the case of less than one-year-old babies, numbers retrieved from the 2010 census were used.

Trend analysis was undertaken from estimates of the Annual Percentage Variation (APC), at 95%, and significance level at $p < 0.05$ of hospitalization rate. [18] Regression model of Joinpoint® 4.7.0.0 was employed, with rates and year under analysis as dependent and independent variables, respectively. Model was adjusted by the configuration of the program

standard to obtain maximum scores in change. Increasing trend occurred when APC was positive and a decreasing trend occurred when APC was negative, both at $p < 0.05$. A stationary trend was detected when $p > 0.05$, indicating that rate remained stable.

Data were grouped per five years (2009 - 2013) and (2014 - 2018) to calculate standardized rates per region and hospitalization rates per municipality. Census 2010 data and the 2015 estimates were used as population denominator. Hospitalization rate directly adjusted by age was calculated to describe hospitalization distribution by health regions and reduce the influence of the population´s age structure. Data were then transcribed in Tabwin 4.1.5. to visualize the graph in the map.

The exploratory visualization of spatial data by Moran statistics showed whether there was any spatial dependency between the municipalities and detect the events´ distribution pattern in clusters. Rates were consequently moderated by Bayesian global empirical method, with a reduction of fluctuations associated with small areas. Global univariate Moran analysis was applied for each study period, according to the Local Indications of Spatial Association (LISA) method by local Moran analysis which compared the value of hospitalization rate for each municipality with that of its neighbors. The clusters´ spatial representation was provided by Moran Map with grouping sites: Q1 is high-high standard; Q2 low-low (positive spatial association and similarity between neighbors); Q3 high-low and Q4 low-high (negative spatial association with neighbors featuring different values). Statistically significant level was set at $p<0.05$. Datum SIRGAS-2000, longlat. Graphs and tables were elaborated by Microsoft Excel.

Since researchers did not have any contact with the hospitalized people (public domain secondary data sources were used), approval by the Committee for Ethics in Research was not required, following Paragraph One of Art. 1 of Resolution 510, published on April 7, 2016, by the National Health Council. Researchers complied with all ethical guidelines on research with human beings as recommended by Resolution of the NHC n 466 of 12/12/2012.

RESULTS

There were 4,963 hospitalizations with regard to the diseases mentioned above between 2009 and 2018. Analysis of absolute frequency revealed variations in hospitalizations and deaths during the period proposed, with peak reported in 2014. Highest death rates occurred between 2012 and 2016, with 9.6% and 9.7% of hospitalizations ending in death, respectively (Table 1).

Hospitalization and mortality rates were lower than 1 in 10,000 inhabitants and 100,000 inhabitants, respectively. The two numbers decreased till 2012, followed by oscillations throughout the years, with highest rates in 2014. A similar behavior was reported with regard to hospitalization rates for females even though oscillations occurred in male hospitalization. Highest hospitalization rates for immune-preventable diseases were registered for the 0 – 4-year-old group, with 2.13 cases per

10,000 inhabitants, and for the 50 - <50-year-old group, with 1.73 cases for 10.000 inhabitants. Variations in hospitalization rates in age groups 0 – 4-year-old and 5 – 14-year-old, with a peak in 2014. On the other hand, hospitalization rates were highest in 2009 when the age groups 15 – 49 years old and 50 - <50 years old, with a decrease in hospitalization rates for the former age group (Table 1).

Table 1. Distribution of number of hospitalizations, deaths, lethality, mortality rate and hospitalization rate by vaccine-preventable diseases according to age groups and gender. State of Pará, Brazil. 2009-2018

Variables	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**
Hospitalization	551	458	461	355	461	633	498	482	563	501
Deaths	37	31	40	34	36	56	38	47	37	37
Lethality	6.7%	6.8%	8.7%	9.6%	7.8	8.8%	7.6%	9.7%	6.6%	7.4%
Hospitalization rate*	0.73	0.6	0.59	0.45	0.58	0.78	0.61	0.58	0.67	0.59
Mortality rate **	0.49	0.41	0.52	0.43	0.45	0.69	0.46	0.57	0.44	0.44
Gender										
Males	0.92	0.77	0.81	0.57	0.67	0.93	0.77	0.74	0.87	0.77
Females	0.53	0.44	0.37	0.33	0.48	0.64	0.44	0.42	0.47	0.41
Age group										
0 - 4 years old	0.55	0.43	0.47	0.52	1.04	2.13	1	0.5	0.51	0.85
5 - 14 years old	0.17	0.18	0.19	0.13	0.15	0.22	0.13	0.15	0.2	0.18
15 - 49 years old	0.76	0.63	0.59	0.46	0.54	0.6	0.6	0.61	0.7	0.6
50 years old and over	1.73	1.32	1.33	0.87	1.04	1.36	1.04	1.08	1.25	0.91

Legend: *per 10,000 inhabitants ** per 100,000 inhabitants

Hospitalization (APC: – 0.2%; IC: -4.0; 3.7; *p*=0.9) and mortality rates (APC: 0.4% IC: -4.3; 5.3; p=0.8) showed stationary trends, similar to hospitalization rates for gender (males: APC: -0.2; IC95%: -3.8 - 3.6; *p*=0.9; females: APC: -0.4; IC95%: -5.4; 4.8; *p*=0.8). Results involved age groups 0 - 4 years old (APC: 5.7%; IC95%: -12.2; 27.2; *p*=0.5), 5 - 14 years old (APC: 0.4%; IC95%: -4.1; 15; *p*=0.8) and 50 years old and over (APC: -4%; IC 95%: -8.1; 0.3; p=0.06). Only hospitalization rates for age group 15 - 49 years old revealed a change; between 2009 and 2012, the trend was stable (APC: -11.9%; IC 95%: -22.5; 0.2; p=0.52), but there was a significant growth (APC: 4.7%; IC 95%: 0.2; 9.5; *p*=0.04) between 2012 and 2018.

Hospitalizations for tuberculosis reached 78% of total number (3,872); 7.3% were hospitalized for whooping cough (363); 5.3% (265) for parotitis; 4.5% (223) for hepatitis B; 2.9% (142) for tetanus; 0.8% (42) for diphtheria; 0.5% (24) for measles; 0.25% (11) for rubella and 0.25% (11) for yellow fever; 0.2% (10) for *Haemophilus.*Table 2 shows hospitalization rates for immuno-preventable diseases according to age groups. Highest hospitalization rate for tuberculosis, hepatitis B and tetanus occurred within the 50-years- old group and over. Highest

hospitalizations rates for diphtheria, whooping cough, *Haemophilus influenzae B*, mumps and measles occurred with less than one-year-old babies.

Table 2. Hospitalization rate (10,000 inhabitants) per disease according to age group, State of Pará, Brazil, 2009-2018

Diseases causing hospitalization	Less than 1 year		1 - 4 years old		5 - 14 years old		15 - 49 years old		50 years or more	
	Rate	**n**	**Rate**	**n**	**Rate**	**n**	**Rate**	**n**	**Rate**	**N**
Tuberculosis	5.1	72	1.3	78	0.9	141	5.6	2.320	11.9	1.261
Hepatitis B	0.1	2	0.3	16	0.2	30	0.3	124	0.5	51
Diphtheria	2	29	0.1	6	0.01	1	0.01	5	0.01	1
Tetanus	0.4	6	0.02	1	0.1	12	0.2	74	0.5	49
Whooping cough	19.6	278	0.9	52	0.17	27	0.01	3	0.03	3
Haemophilus influenzae	0.21	3	0	0	0.01	2	0.01	3	0.02	2
Mumps	1.1	16	0.9	56	0.3	53	0.3	137	0.03	3
Rubella	0	0	0.03	2	0.04	6	0.005	2	0.009	1
Measles	0.4	5	0.1	5	0.04	6	0.02	7	0.01	1
Yellow fever	0	0	0	0	0.02	3	0.02	8	0	0

Figure 2 shows the distribution of hospitalization rates for vaccine-preventable diseases according to the several Health Regions. Between 2009 and 2013, the Tapajós HR recorded a rate of 7.1 hospitalizations per 10,000 inhabitants; in Metropolitana I HR, the rate was 5.2 hospitalizations per 10,000 inhabitants. In the Lower Amazon and Metropolitana II HR, 3.44 and 3.11 hospitalizations per 10,000 inhabitants were recorded, respectively. In Tocantins, Marajó II and Araguaia HRs there were 2.4; 2.3 and 2.06 hospitalizations per 10,000 inhabitants, respectively. In the Marajó I, Metropolitana III, Rio Caetés and Xingú HRs, there were 1.7; 1,6; 1.5 and 1.3 hospitalizations, respectively. Meanwhile, hospitalization rates 0.73 and 1 occurred in the Carajás and Lago Tucuruí HRs (Figure 2A).

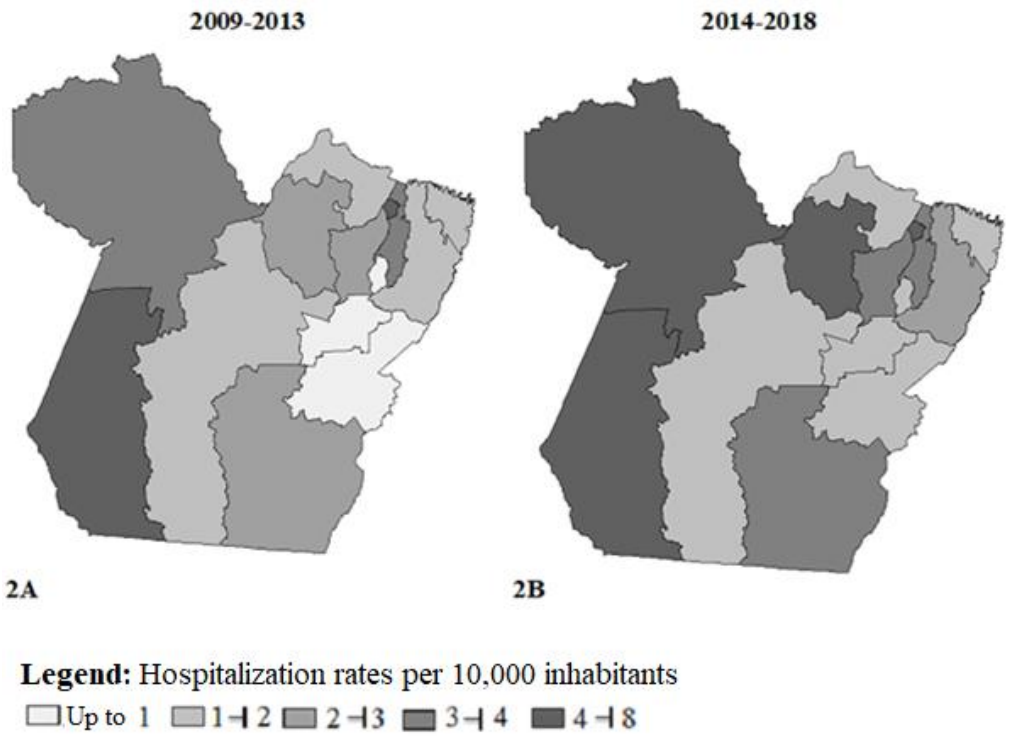

Figure 2. Distribution of hospitalization rates for age groups for immuno-preventable diseases (per 10,000 inhabitants), per health region. State of Pará, Brazil. 2009 - 2013 and 2014 - 2018.

Between 2014 and 2018, the Tapajós (5.4) and Baixo Amazonas (5.2) HRs had the highest hospitalization rates per 10.000 inhabitants, followed by Marajó II (4.13) and Metropolitana I (4.08) HRs. The HRs of Tocantins, Metropolitana II and Araguaia had 3.99; 3.4 and 3.2 hospitalizations per 10,000 inhabitants, respectively. In the HR of Metropolitana III, hospitalization rate reached 2.5 per 10,000 inhabitants. In Marajó I, Xingú, Lago Tucuruí, Rio Caetés and Carajás HRs there were 1.95; 1.9; 1.65; 1.3 and 1.3 hospitalizations per 10,000 inhabitants, respectively (Figure 2B).

Moran Global index of 0.23 and p = 0.003 during the 2009 - 2013 period reveals spatially dependent municipalities and low similarity rates, featuring three clusters. There were two groups of municipalities with high hospitalization rates surrounded by other municipalities with high rates too (high-high standard). The first cluster comprised four municipalities in the Tapajós HR (Itaituba, Trairão, Jacareacanga, Novo Progresso) and the second cluster comprised municipalities of two HRs, or rather, Metropolitana I (Ananindeua, Benevides and Santa Bárbara) and Metropolitana II (Acará). A single group with a great number of municipalities was detected with a low rate spatial standard surrounded by other municipalities with low hospitalization rates for immune-preventable diseases (low-low standard), within the HRs of Carajás (Dom Eliseu, Itupiranga, Nova Ipixuna, Marabá, São João da Araguaia, São Domingos do Araguaia, São Geraldo do Araguaia, Brejo Grande do Araguaia,

Eldorado dos Carajás, Rondon do Pará, Piçarra) and Lago Tucuruí (Breu Branco, Goianésia, Tucuruí, Jacundá, Novo Repartimento) (Figure 3).

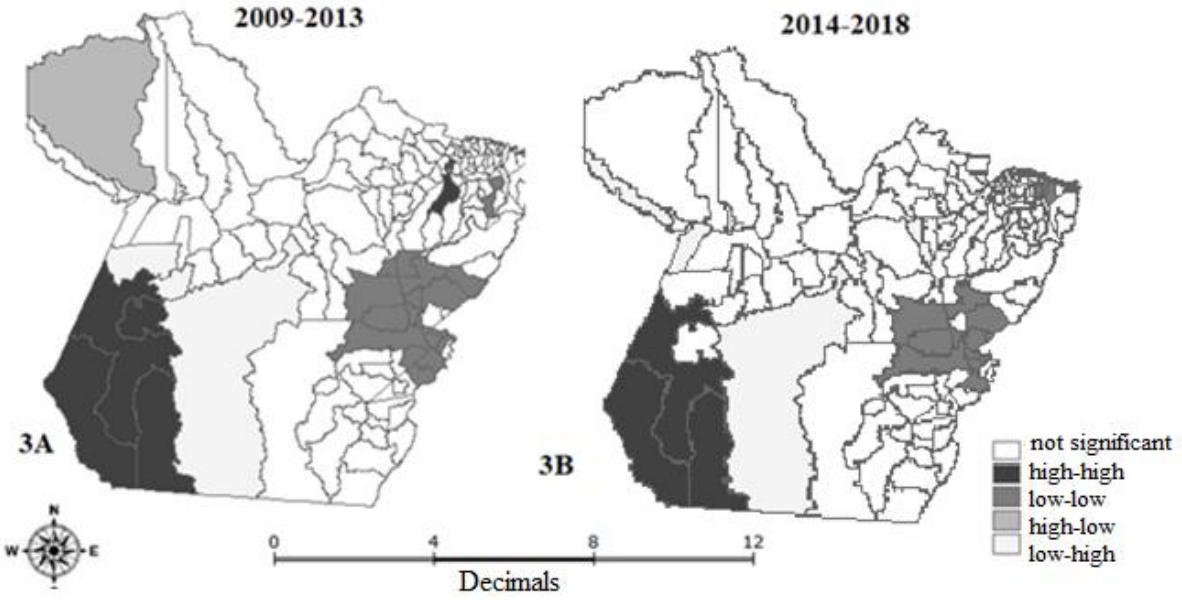

Figure 3. Moran Map of crude rates moderated by immuno-preventable hospitalizations per municipality. State of Pará, Brazil, 2009-2013 and 2014-2018.

During the 2014-2018 period, the result of Moran Global index 0.15 and *p*-rate 0.015 showed weak spatial self-co-relationship with the presence of three clusters. The first cluster was composed of three municipalities with high hospitalization rates and surrounded by municipalities with similar rated municipalities, namely the entire Tapajós region (Novo Progresso, Itaituba and Jacareacanga). On the other hand, two clusters of municipalities were registered with low hospitalization rates surrounded by municipalities featuring the same rates. The first comprised three municipalities of the Rio Caetés HR (Bragança, Tracuateua and Capanema) and the second comprised municipalities of the Carajás HR (Itupiranga, Nova Ipixuna, Marabá, São João da Araguaia, São Domingos do Araguaia, São Geraldo do Araguaia, Rondon do Pará and Bom Jesus do Tocantins) and Lago Tucuruí (Goianésia and Novo Repartimento) (Figure 3).

DISCUSSION

In current study, hospitalization rate of the age group 15-49-years-old had a significant increase during the 2012-2018 period, revealing that there were problems in the group´s APS with its vaccine calendar, comprising vaccine against Hepatitis B, dual adult vaccine (dT), yellow fever and triple viral vaccine[8]. The ICSAP index evaluated APS and/or the use of hospital care[7].

A high percentage rate of Brazil municipalities showed inadequate vaccine coverage for Bacillus Calmette-Guérin (BCG), tetra viral (measles, mumps,

rubella and chickenpox) and yellow fever[10]. In fact, current analysis revealed the age group with regard to hospitalizations due to the disease under analysis. Hospitalization rate for hepatitis B had low rates in less than one-year-old babies, but high in the 50 or over years old group. Results demonstrate indirectly success in the immunization strategy in priority age groups, especially the administration of vaccines in the first hours of life when still at the maternity[8]. In the case of adults, the dissemination of hepatitis B vaccine was slow. It was given to 20–24-years-old people in 2011; to 25-29-years-old people in 2012 and for the 30–49-years-old group it was available in 2013[19]. Current study also revealed that the hospitalization rate for tuberculosis had an inverse development when compared to that of hepatitis B, although BCG is administered at birth[8]. An increase in hospitalization for older age groups has been detected. A study conducted in Riberão Preto SP Brazil revealed a large number of people over 64 years old hospitalized for tuberculosis[16].

Highest hospitalization rates for whooping cough, diphtheria and meningitis by *Haemophilus influenzae* occurred among less than one-year-old babies. Vaccination for these diseases starts during the first two month of life. Tetanus is also included in the vaccine timetable[8], although in current analysis the highest hospitalization rates for tetanus occurred in older groups. The literature corroborates greater hospitalization rate for whooping cough in less than one-year-old babies[20-21]. In this case, age and premature condition are a risk for a worsening of the disease and, consequently, hospitalization in ICUs[21]. In the case of children, lack of immunization for the more prevalent childhood diseases provides a greater hospitalization risk[4].

Analysis of hospitalization rates for measles, mumps and rubella evidences a larger commitment against measles and mumps in less than one-year-old babies, whereas there were no cases for rubella within this age bracket. Hospitalization for measles was described in recent studies over time and within outbreak conditions in the US and in Israel, in the case of less than five-year-old children, reported with greater frequency in complications[22-23]. Several measles outbreaks occurred in Brazil during the last ten years in several states, including Pará[5].

Although these countries have in common the occurrence of outbreaks and hospitalizations for these diseases, the vaccine calendar is different. However, vaccine is guaranteed by the government in the case of children[8,24-26]. In Israel, the delay of tetra vaccine, administered in a single dose, on the 12th month, is very low. The vaccine replaced the measles, mumps and rubella vaccine within the routine immunization calendar in Israel in 2008[24]. In the US, the triple viral vaccine is administered between the 12th and 15th month (CDC, 2020), whereas in Brazil, the triple viral vaccine is administered on the 12th month and measles-mumps-rubella-chickenpox vaccine on the 15th month[8]. Previous studies demonstrated protection related to vaccine with low risk of hospitalization for mumps, rubella and measles[27-28].

Distribution of hospitalization for immuno-preventable diseases in the state of Pará occurred in a heterogeneous form in

HRs, with the growth of the number of regions with high rates, from 2 HRs (Tapajós and Metropolitana I) in the first period, for 4 HRs (Tapajós, Metropolitana I, Baixo Amazonas and Marajó II) during the second one, with a concentration of HRs in western and northern Pará, in spite of the fact that it passed from 7.1 hospitalizations per 10,000 inhabitants in the Tapajós HR in the 2009 - 2013 period to 5.4 hospitalizations per 10,000 inhabitants in the 2014 – 2018 period.

The result of spatial exploratory visualization analysis also evidenced grouping of the spatial high-high and low-low standards in very different types of territories. However, during the second period, high-high clusters decreased and low-low increased.

HRs of Tapajós and Metropolitana I had the highest rates and grouping in high-high standard municipalities and featured distinct characteristics with regard to territorial dynamics. The first HR had the worst health and economic indexes, low population density, greater number of municipalities with low IDHM, high children´s mortality rates and less populations covered by the family health teams (eSF). In the Metropolitano group, only the municipality of Acará had low IDHM rates and low sESF coverage[11-12]. As a rule, the expansion of the population covered by ESF in all these municipalities between 2009 and 2018[12], failed to make any impact in reducing hospitalization rates. It is highly relevant to verify aspects related to the availability of vaccine rooms and immunobiological drugs in these places.

The distribution heterogeneity pattern in hospitalization for immuno-preventable diseases corroborates evidence from Ribeirão Preto SP Brazil with regard to hospitalizations for tuberculosis. In this study, spatial analysis identified the group with the greatest risk within a prison center, a condition for social vulnerability due to inadequate physical structure and with high human agglomeration rates[16]. Vaccine coverage in Chile has been related to the population´s life conditions[29].

Spatial self-co-relationship revealed, in the two periods, a great group of municipalities with low-low standards, particularly in the Carajás and Lago Tucuruí HRs. The region features the state´s greatest internal gross product *per capita*, with great mineralization works in the municipalities of the region. It also attracts people for several other activities, with economic expansion in agriculture and stockbreeding, industries and service[30]. However, population expansion in these territories also require an increase in health services.

Current study has been limited by the quality of information from databases and by hospitalizations in government-run hospitals. Complementary studies which relate epidemiological factors and evaluation of assistance flows will make possible further in-depth studies on the impact of hospitalization by vaccine-preventable diseases.

CONCLUSION

Current study demonstrated age profile of hospitalizations for immuno-preventable diseases and demonstrated the success in immunization against hepatitis B

in less than one-year-old babies. Greater efforts should be undertaken in activities and vaccinal control against whooping cough for less than one-year-old babies; against mumps and measles in the 0 – 4 age group and against tuberculosis, hepatitis B and tetanus especially for more than 50-years-old people. Current study demonstrates the importance of tracking priority people for vaccines and more affected groups related to immune-preventable people.

Spatial distribution in hospitalization shows a decrease of high-high standard groups and evidences protection areas with low-low standards, or rather, a heterogeneous hospitalization pattern in the state of Pará, Brazil.

REFERENCE

1. Eom H, Park Y, Kim J, Yang J-S, Kang H, Kim K, et al. Occurrence of measles in a country with elimination status: amplifying measles infection in hospitalized children due to imported virus. PLoS ONE. 2018;13(2):e0188957.

2. Possas C, Lourenço-de-Oliveira R, Tauil PL, Pinheiro FP, Pissinatti A, Cunha R V et al. Yellow fever outbreak in Brazil: the puzzle of rapid viral spread and challenges for immunisation. Mem. Inst. Oswaldo Cruz [Internet]. 2018; 113(10): e180278.

3. World Health Organization. vaccine-preventable disease monitoring system, 2020 global summary. Global and regional immunization profile. Region of the Americas. 2020. [cited 8/11/2020] Available at: https://www.who.int/immunization/monitoring_surveillance/data/gs_amrprofile.pdf?ua=1

4. Williamson G, Ahmed B, Kumar OS, Ostrov BE, Ericson JE. Vaccine preventable diseases requiring hospitalization. Pediatrics. 2017;140(3):e20170298.

5. Goldani LZ. Measles outbreak in Brazil, 2018. Braz J Infect Dis [Internet]. 2018; 22(5): 359-359.

6. Escosteguy CC, Pereira AGL, Marques MRVE, Lima TRA, Galliez RM, Medronho RA. Febre amarela: perfil dos casos e fatores associados ao óbito em hospital referência no estado do Rio de Janeiro, 2017–2018. Rev Saude Publica. 2019; 53:89.

7. Ministério da Saúde (BR), Secretaria de Atenção à Saúde. Portaria Nº 221, de 17 de abril de 2008. Define a lista brasileira de Internações por Condições Sensíveis à Atenção Primária. Brasília (DF); 2008.

8. Ministério da Saúde (BR), Secretaria de Vigilância em Saúde, Departamento de Vigilância das Doenças Transmissíveis. Manual de normas e procedimentos para vacinação. Brasília (DF); 2014.

9. Domingues CMAS, Teixeira AMS. Coberturas vacinais e doenças imunopreveníveis no Brasil no período 1982-2012: avanços e desafios do programa nacional de imunizações. Epidemiol Serv Saúde. 2013; 22(1): 9-27.

10. Braz RM, Domingues CMAS, Teixeira AMS, Luna EJA. Classification of transmission risk of vaccine-preventable diseases based on vaccination indicators in brazilian municipalities. Epidemiol Serv Saúde. 2016; *25*(4):745-54.

11. Instituto Brasileiro de Geografia e Estatística. Cidades: Pará: panorama. Pará: IBGE; c2019 [cited 24/11/2019]. Available at: https://cidades.ibge.gov.br/brasil/pa/panorama

12. Ministério da Saúde (BR), Sala de gestão estratégica. Equipes de saúde da família: cobertura populacional no estado do Pará. Brasília (DF); 2019.

13. Leite AS, Filgueiras GC, Martins CER, Ramos SS. O perfil socioeconômico dos municípios mineradores paraenses: formação de clusters a partir do IFIRJAN. Novos Cadernos NAEA. 2018; 21(3):143-160.

14. Rodrigues JC. O arco norte e as políticas públicas portuárias para o oeste do estado do Pará (Itaituba e Rurópolis): apresentação, debate e articulações. Revista NERA. 2018; 21(42): 202-28.

15. Santos BV, Lima DS, Fontes CJF. Inte rnações por condições sensíveis à atenção primária no estado de Rondônia: estudo descritivo do período 2012-2016. Epidemiol Serv Saúde [online]. 2019; 28(1) e2017497.

16. Yamamura M, Freitas IM, Santo Neto M, Chiaravalloti Neto F, Popolin MAP, Arroyo LH et al. Análise espacial das internações evitáveis por tuberculose em Ribeirão Preto, SP (2006-2012). Rev Saude Publica. 2016;50:20.

17. Comissão Intergestores Bipartite (CIB). Resolução nº 140 de 09 de agosto de 2018. Pará, 2018. Aprova com base na configuração das regiões de saúde existentes a instituição das Macrorregiões de Saúde do Estado do Pará. Belém, PA; 2018.

18. Kim J, Kim HJ. Consistent model selection in segmented line regression. J Stat Plan Inference. 2016;170:106-16.

19. Ministério da Saúde (BR), Secretaria de Vigilância em Saúde. Nota Técnica Conjunta n.º 02/2013/CGPNI/DEVEP e CGDHRV/DST-AIDS/SVSE/MS. Ampliação da oferta da vacina da hepatite B para a faixa etária de 30 a 49 anos em 2013. Brasília (DF); 2013.

20. Mançaneira JF, Benedetti JR, Zhang L. Hospitalizations and deaths due to pertussis in children from 1996 to 2013. J pediatr. 2016;92:40-5.

21. Abu-Raya B, Bettinger JA, Vanderkooi OG, Vaudry W, Halperin SA, Sadarangani M. Members of the canadian immunization monitoring program, active (IMPACT), Burden of children hospitalized with pertussis in Canada in the acellular pertussis vaccine era, 1999–2015. Journal of the Pediatric Infectious Diseases Society, 2018.

22. Ben-Chetrit E, OsterY, Jarjou'i A, Megged O, Lachish T, Cohen MJ et al Measles-related hospitalizations and associated complications in Jerusalem, 2018-2019. Clin Microbiol Infect. 2019; (19)30485-9.

23. Hester G, Nickel A, LeBlanc J, Carlson R, Spaulding AB, Kalaskar A, Stinchfield P. Measles Hospitalizations at a United States Children's Hospital 2011–2017. Pediatr Infect Dis J. 2019; 38(6):547–52.

24. Stein-Zamir C, Israeli A. Age-appropriate versus up-to-date coverage of routine childhood vaccinations among young children in Israel. Hum Vaccin Immunother. 2017 ;13(9):2102-21.

25. Centers for Disease Control and Prevention. Recommended Child and Adolescent Immunization Schedule for ages 18 years or younger -2020. [cited 08/11/2020]. Available at: https://www.cdc.gov/vaccines/schedules/downloads/child/0-18yrs-child-combined-schedule.pdf

26. Pickering LK, Orenstein WA. Licensure, Approval, and Uptake of Vaccines in the United States. J Pediatric Infect Dis Soc. 2018; 26;7(suppl_2):S46-S48.

27. 27 Veneti L, Borgen K, Borge KS, Danis K, Greve-Isdahl M, Konsmo K. et al. Large outbreak of mumps virus genotype G among vaccinated students in Norway, 2015 to 2016. Euro Surveill. 2018;23(38):1700642

28. La Torre G, Saulle R, Unim B, Meggiolaro A, Barbato A, Mannocci A et al. The effectiveness of measles-mumps-rubella (MMR) vaccination in the prevention of pediatric hospitalizations for targeted and untargeted infections: A retrospective cohort study. Hum Vaccin Immunother. 2017;13(8):1879-83.

29. Fuenzalida M, Cobs V. Análisis de patrones territoriales de contextos de vida de niños hasta 6 años y su potencial influencia en la cobertura de programas de inmunización en Chile. Salud Colectiva . 2018;14(1):93-107.

30. Palheta JM, Oliveira Neto AC. Por uma outra territorialização na Amazônia Paraense. Revista NERA. 2018.;41(21):354-72.