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Hospitalization rates for pneumococcal disease in Brazil, 2004 - 2006

Hospitalizações por doença pneumocócica no Brasil, 2004 - 2006

ABSTRACT

OBJECTIVE: To estimate hospitalization rates for pneumococcal disease based on the Brazilian Hospital Information System (SIH).

METHODS: Descriptive study based on the Hospital Information System of Brazilian National Health System data from January 2004 to December 2006: number of hospitalizations and deaths for pneumococcal meningitis, pneumococcal sepsis, pneumococcal pneumonia and *Streptococcus pneumoniae* as the cause of diseases reported in Brazil. Data from the 2003 Brazilian National Household Survey were used to estimate events in the private sector. Pneumococcal meningitis cases and deaths reported to the Notifiable Diseases Information System during the study period were also analyzed.

RESULTS: Pneumococcal disease accounted for 34,217 hospitalizations in the Brazilian National Health System (0.1% of all hospitalizations in the public sector). Pneumococcal pneumonia accounted for 64.8% of these hospitalizations. The age distribution of the estimated hospitalization rates for pneumococcal disease showed a "U"-shape curve with the highest rates seen in children under one (110 to 136.9 per 100,000 children annually). The highest hospital case-fatality rates were seen among the elderly, and for sepsis and meningitis.

CONCLUSIONS: PD is a major public health problem in Brazil. The analysis based on the SIH can provide an important input to pneumococcal disease surveillance and the impact assessment of immunization programs.

DESCRIPTORS: Pneumococcal Infections, epidemiology. Pneumonia, Pneumococcal. Meningitis, Pneumococcal. Sepsis. Hospitalization. Epidemiologic Surveillance.

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RESUMO

OBJETIVO: Estimar as hospitalizações por doença pneumocócica com base em dados do Sistema de Informações Hospitalares (SIH).

MÉTODOS: Estudo descritivo com base em dados do SIH de janeiro de 2004 a dezembro de 2006: números de hospitalizações e mortes por meningite pneumocócica, sepse pneumocócica, pneumonia pneumocócicca e *Streptococcus pneumoniae* como causa de doenças ocorridas no Brasil. Dados da Pesquisa Nacional por Amostras de Domicílios 2003 foram utilizados para o setor privado. Casos e mortes por meningite pneumocócica notificados no Sistema Nacional de Agravos de Notificação no mesmo período também foram analisados.

RESULTADOS: A doença pneumocócica foi responsável por 34.217 hospitalizações no Sistema Único de Saúde (0,1% de todas as hospitalizações). Pneumonia pneumocócica foi responsável por 64,8% dessas hospitalizações. A distribuição das estimativas de hospitalizações segundo faixa etária mostrou curva em "U", com maior freqüência entre crianças < 1 ano (110-136,9/100.000 crianças/ano). A letalidade hospitalar foi mais alta entre idosos, e entre casos de meningite e sepse.

CONCLUSÕES: Doença pneumocócica é importante problema de saúde pública no Brasil. Análise baseada no SIH pode contribuir para a vigilância epidemiológica da doença pneumocócica e para a avaliação do impacto do programa de vacinação.

DESCRITORES: Infecções Pneumocócicas, epidemiologia. Pneumonia Pneumocócica. Meningite Pneumocócica. Sepse. Hospitalização. Vigilância Epidemiológica.

INTRODUCTION

Streptococcus pneumoniae is a major cause of illness and death worldwide. Clinical manifestations of pneumococcal infection include serious life-threatening invasive disease – meningitis, sepsis, pneumonia with bacteremia, and other conditions such as bone and joint infection and peritonitis. *Pneumococcus* also causes non-invasive diseases such as pneumonia without bacteremia, bronchitis, sinusitis, and otitis media, which accounts for most pneumococcal-related disease. *S. pneumonia* is the most common cause of invasive bacterial disease in children in countries with universal childhood immunization programs against *Haemophilus influenza* type b.[1]

There are available safe and effective vaccines to prevent pneumococcal disease (PD) in children under two. The heptavalent pneumococcal conjugate vaccine (PCV7) has shown significant impact in reducing PD rates in countries where universal childhood immunization programs have been implemented.[8,21] Both the 10-valent (PCV10) and the 13-valent conjugate pneumococcal vaccines have recently been made available.[5,26]

In Brazil, the PCV7 has been available in the Brazilian National Health System (*Sistema Único de Saúde*, SUS) since 2002, but only for children under five with high risk of PD. This strategy has resulted in low vaccine coverage as we estimated based on administrative data that less than 5% of children under 12 months were vaccinated in 2009. The 23-valent pneumococcal polysaccharide vaccine is also available for the elderly (≥ 60 years), and adults and children two years of age and older with chronic conditions. In March 2010, the PCV10 was introduced for routine immunization of infants (four doses at two, four, six and 12 months of age) with catch-up vaccination for children under two in the first year of the program. Effective surveillance of PD is essential to monitor this program's impact.

Pneumococcal surveillance systems focusing on invasive pneumococcal disease (IPD) are very heterogeneous and have different notification rules, case definitions, case reporting coverage, data collection, health information system utilization, quantity and quality of laboratories so data comparability is a problem.[18]

A laboratory-based surveillance system of IPD has been active in Brazil since 1993 (Network Surveillance System for the Bacterial Agents Responsible for Pneumonia and Meningitis, *Sistema Regional de*

Vacinas – SIREVA II). This network provides data on pneumococcus serotype distribution and antimicrobial resistance but with limited population coverage. The linking of laboratory data with epidemiological and clinical information needs to be strengthened.[3]

The use of data based on clinical diagnosis, hospital admissions and outpatient consultations in pneumococcal burden of disease studies and surveillance systems has been limited as recent reviews of vaccine impact studies in the US and Europe have shown.[8,21] The clinical diagnosis has high sensitivity but low specificity for PD, and laboratory-based systems have been prioritized, particularly for IPD. Hospital admissions and consultations have more often been used to estimate pneumococcal pneumonia and otitis due to the limited contribution of diagnostic laboratory tests in these conditions.

A population-based time series analysis based on hospital admissions data have shown that this is a feasible, valid and useful approach for measuring the impact of pneumococcal conjugate immunization programs, especially when there are good quality national hospital databases with clear inclusion criteria and appropriate methodological strategies. Studies in England and Wales, US and Australia have shown similar tendencies for PD decline and seasonal variation when comparing active surveillance and hospital information data.[8,15,19]

The Brazilian National Health System provides a free-access, good quality national hospital database (*Sistema de Informações Hospitalares* – SIH) and estimates of hospitalization and case-fatality rates for PD in Brazil may effectively and efficiently contribute to the assessment of the potential impact of an universal childhood pneumococcal immunization program.[13]

The present study aimed to estimate hospitalization rates for PD in Brazil based on SIH-SUS data.

METHODS

A descriptive study based on SIH-SUS data was conducted. Data on hospital admissions, which occurred from January 1st, 2004 to December 31st, 2006, due to the clinical syndromes of interest – pneumococcal meningitis, pneumococcal sepsis, pneumococcal pneumonia and *S. pneumoniae* as the cause of diseases – as the main diagnosis were obtained from the SIH-SUS. This database has information on individual cases of illness with data on patient demographic characteristics, length of hospital stay, diagnoses at discharge, disease outcome, and hospital reimbursement rates.

Since the SIH-SUS covers only the public sector, estimates of hospitalizations in the private sector were calculated to obtain national population estimates. Data from the 2003 Brazilian National Household Survey showed 72.9% of all clinical hospitalizations were in the SUS and were used to estimate hospitalization rates in the private sector.[4]

Meningitis is a mandatory notifiable disease in Brazil, and data from the Notifiable Diseases Database (*Sistema de Informação de Agravos de Notificação* – SINAN) for the same period were also analyzed. SINAN database includes aggregate data on population frequency of notifiable diseases and their outcomes according to age group, clinical syndromes and etiological agents, and good quality information on meningitis.[13]

Annual age-specific hospitalization rates for PD were calculated using the total number of hospitalizations for each clinical syndrome based on SIH-SUS data and population estimates in Brazil for each year studied obtained from the Instituto Brasileiro de Geografia e Estatística (Brazilian Institute of Geography and Statistics).

For population estimates of annual age-specific hospitalization rates for PD, in addition to estimating the rates in the private sector, we also included the estimated number of cases of pneumococcal meningitis reported under the diagnosis "unspecified bacterial meningitis".

Case-fatality was defined as in-hospital death. Age-specific case-fatality rates (CFR) were estimated based on the number of deaths/confirmed cases for each clinical syndrome registered in the SIH-SUS and SINAN.

A search was performed using the International Classification of Diseases – 10th Revision (ICD-10) codes: A40.3 – pneumococcal sepsis; G00.1 – pneumococcal meningitis; J13 – pneumococcal pneumonia; and B95.3 – *S. pneumoniae* as the cause of diseases. The numbers of hospitalizations for related syndromes (meningococcal meningitis – A39.0, *Haemophilus* meningitis – G00.0, meningitis due to other bacteria – G00.2, G00.3 and G00.8, unspecified bacterial meningitis – G40.3, unspecified sepsis – A41.9, all causes sepsis – A40-A41, and all causes pneumonia – J12-J18) were also obtained to assess the relationship of pneumococcal hospitalizations with these clinical syndromes. SIH data were retrieved from CDs provided by DATASUS (SIH data for 2004 and 2005 were recorded on 20 December 2007; data for 2006 were recorded on 28 November 2008). SINAN was accessed online on February 2009.

RESULTS

In the three-year study period there were 34,217 hospitalizations for PD in the SIH-SUS database, accounting for 0.1% of all hospitalizations (34,260,055) in the public sector in Brazil. Of these, 47.1% were in children

under five. Variations in hospitalization rates for PD in the public sector (SUS) by year of diagnosis were small, except in children under one and 1 to 4, with possibly a general downward tendency (Table 1).

The highest hospitalization rates were seen in infants (Figure 1). The most common clinical syndrome was pneumonia (64.8% of all hospitalizations for PD) (Figure 2). *S. pneumoniae* as the cause of diseases (ICD-10, B95.3), sepsis and meningitis accounted for 13.7%, 12.3%, and 9.3% of PD hospitalizations in the SUS, respectively.

During the study period, there were 3,165 hospitalizations for pneumococcal meningitis registered in the SIH-SUS and 4,336 hospitalizations when estimates for the private sector were included. During this same period, 4,032 cases of pneumococcal meningitis were registered in the SINAN, which is 7% lower than that seen in the SIH-SUS including estimates for the private sector.

A causal pathogen was identified in 41.4% of hospitalizations for bacterial meningitis reported in the SIH-SUS. *Pneumococcus* accounted for 31.3% of all cases of bacterial meningitis with an identified pathogen, with slight variation by year of diagnosis and age group. Assuming the same proportion of pneumococcal meningitis in the hospitalizations for "unspecified bacterial meningitis", *Pneumococcus* accounted for an additional 4,384 hospitalizations due to bacterial meningitis, totalizing 7,549 hospital admissions for pneumococcal meningitis in the SUS.

The annual estimated hospitalization rates for PD by clinical syndrome and age group was based on SIH-SUS data and included estimates of hospitalization in the private sector for all clinical syndromes and estimates of additional pneumococcal meningitis cases reported under "unspecified bacterial meningitis" (Table 2). This approach led to a more significant increase in hospitalization rates among children under one, but the general trend was unchanged.

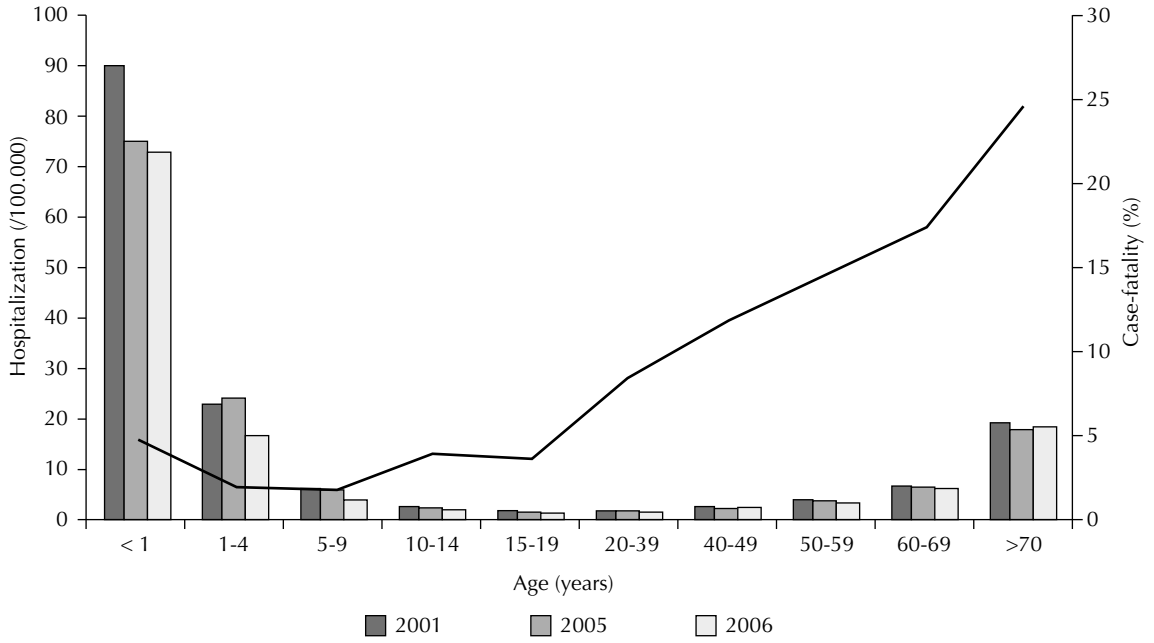
There were 4,204 hospitalizations for pneumococcal sepsis in the public sector and other 1,555 were estimated for the private sector, totaling 5,759 hospital admissions over the three-year study period.

Pneumococcus accounted for 2.6% of overall sepsis hospitalizations in the SIH-SUS. A causal pathogen was identified in most sepsis cases reported in the SIH-SUS. "Unspecified sepsis" accounted for only 6.6% of all hospitalizations for sepsis. The proportion of cases in which the etiologic agent was not identified increased by age group, reaching 17.1% in adults aged 60 to 69 years. The rate of *Pneumococcus* among all causes of sepsis varied according to age, and was higher in children aged 1 to 4 (5.2%).

Table 1. Annual hospitalization rates (per 100,000 population) for pneumococcal disease in the public sector according to year of diagnosis, clinical syndrome and age group. Brazil, 2004–2006

Age (years)	2004					2005					2006				
	Meningitis	Sepsis	Pneumonia	Other	All	Meningitis	Sepsis	Pneumonia	Other	All	Meningitis	Sepsis	Pneumonia	Other	All
<1	6.46	16.12	63.26	4.23	90.06	5.31	12.04	53.57	4.07	74.99	4.35	11.36	55.60	1.82	73.14
1 to 4	1.38	1.67	17.16	2.80	23.01	0.99	1.32	19.31	2.79	24.40	0.88	1.36	12.93	1.48	16.65
5 to 9	0.95	0.42	3.65	1.28	6.30	0.93	0.37	3.65	0.94	5.88	0.52	0.37	2.56	0.68	4.14
10 to 14	0.48	0.42	1.37	0.47	2.74	0.62	0.22	1.18	0.60	2.62	0.50	0.25	0.86	0.44	2.05
15 to 19	0.61	0.10	0.85	0.37	1.92	0.52	0.12	0.70	0.34	1.68	0.31	0.07	0.68	0.27	1.33
20 to 39	0.49	0.13	0.92	0.43	1.97	0.41	0.15	0.86	0.43	1.84	0.31	0.15	0.81	0.31	1.58
40 to 49	0.41	0.30	1.44	0.52	2.67	0.39	0.56	1.13	0.54	2.31	0.35	0.39	1.30	0.52	2.56
50 to 59	0.42	0.57	2.32	0.89	4.20	0.34	0.56	1.95	0.98	3.83	0.28	0.62	1.88	0.65	3.42
60 to 69	0.42	1.13	4.11	1.19	6.85	0.27	1.05	3.64	1.52	6.48	0.28	1.22	3.79	1.26	6.56
≥70	0.14	3.94	12.08	3.29	19.45	0.20	3.77	10.94	3.13	18.04	0.16	4.27	11.32	2.84	18.58
All	0.68	0.84	4.51	0.94	6.97	0.59	0.70	4.03	0.94	6.25	0.45	0.74	3.51	0.67	5.38

Source: The Brazilian National Health System Hospital Database (SIH-SUS)



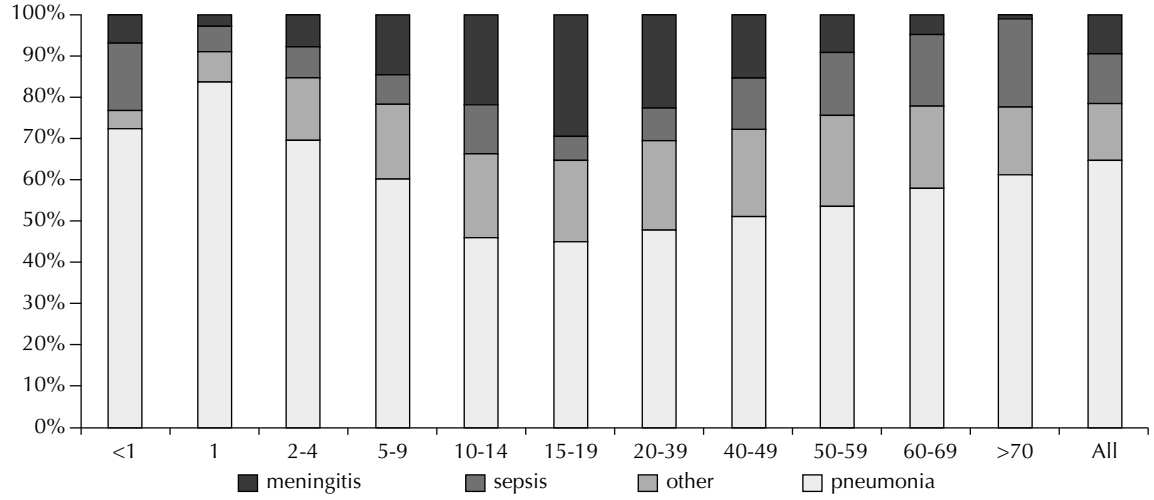
Source: The Brazilian National Health System Hospital Database (SIH-SUS)

Figure 1. Annual hospitalization rates and in-hospital case-fatality rates for pneumococcal disease in the Brazilian National Health System, by age group and year of diagnosis. Brazil, 2004–2006.

There were 22,161 hospitalizations due to pneumococcal pneumonia reported in the SIH-SUS. There were estimated an additional 7,587 hospitalizations when the private sector was included, totalizing 29,748 hospitalizations.

Pneumococcus was identified as the causal pathogen in 1% of overall hospitalizations for pneumonia (2,254,815) in the SIH/SUS, accounting for 1.4% of pneumonia hospitalizations among children under one and 0.7% among adolescents and adults aged 15 to 69 years.

There were 4,687 hospital admissions due to "*S. pneumoniae* as the cause of diseases" in the SUS from 2004 to 2006 in all age groups. An additional 1,734 hospital admissions were estimated in the private sector, totalizing 6,421 hospitalizations.



Source: The Brazilian National Health System Hospital Database (SIH-SUS)

Figure 2. Distribution of hospitalizations for pneumococcal disease in the public sector, by clinical syndromes and age groups. Brazil, 2004–2006.

Table 2. Estimated overall hospitalization rates[a] (per 100,000) for pneumococcal disease according to year of diagnosis, clinical syndrome and age group. Brazil, 2004–2006.

Age (years)	2004					2005					2006				
	Meningitis	Sepsis	Pneumonia	Other	All	Meningitis	Sepsis	Pneumonia	Other	All	Meningitis	Sepsis	Pneumonia	Other	All
<1	22.42	22.09	86.65	5.80	136.96	18.73	16.49	73.39	5.58	114.18	15.78	15.57	76.17	2.49	110.01
1 to 4	4.51	2.29	23.50	3.84	34.15	3.44	1.81	26.45	3.82	35.51	2.94	1.86	17.71	2.03	24.54
5 to 9	3.46	0.58	4.99	1.76	10.79	2.42	0.50	5.00	1.29	9.21	1.94	0.51	3.51	0.93	6.89
10 to 14	1.74	0.57	1.88	0.65	4.83	1.61	0.30	1.62	0.82	4.35	1.61	0.34	1.18	0.60	3.73
15 to 19	1.96	0.14	1.16	0.50	3.76	1.91	0.16	0.96	0.47	3.51	0.99	0.09	0.93	0.37	2.39
20 to 39	1.51	0.18	1.26	0.59	3.54	1.20	0.20	1.17	0.59	3.16	0.96	0.21	1.11	0.43	2.70
40 to 49	1.22	0.41	1.98	0.72	4.33	0.66	0.35	1.55	0.74	3.30	1.05	0.54	1.78	0.71	4.07
50 to 59	1.17	0.78	3.18	1.22	6.35	0.49	0.77	2.67	1.35	5.27	0.89	0.84	2.58	0.89	5.19
60 to 69	1.04	1.55	5.63	1.63	9.85	0.50	1.44	4.98	2.08	9.00	0.87	1.67	5.20	1.73	9.47
> 70	0.58	5.40	16.55	4.51	27.03	0.61	5.16	14.99	4.28	25.05	0.54	5.85	15.51	3.89	25.78
All	2.22	1.15	5.84	1.29	10.50	1.64	0.96	5.52	1.28	9.40	1.50	1.02	4.81	0.92	8.24

[a] Including estimates of "unspecified bacterial meningitis" attributed to *Pneumococcus* and estimates of hospital admissions in both the public and private sector, assuming that the public sector accounts for 72.9% of all clinical hospitalizations.

During the three-year period studied, 2,746 hospitalizations for PD in the SIH-SUS resulted in death: 1,674 from sepsis, 672 from pneumonia, 377 from meningitis and 26 due to "*S. pneumonia* as the cause of diseases" (Table 3). The highest CFRs were seen for pneumococcal sepsis (39.8%), followed by pneumococcal meningitis (11.9%), pneumococcal pneumonia (3.0%) and "*S. pneumonia* as the cause of diseases" (2.1%) and in the older age groups (Figure 1). Pneumococcal CFRs did not change significantly by year of diagnosis (Table 3).

During the same period, 1,276 deaths caused by pneumococcal meningitis were reported in the SINAN, resulting in an overall case-fatality rate of 31.7% in all age groups (Table 3).

DISCUSSION

The annual hospitalization rates by age in Brazil are similar to those reported in other studies in developed countries before the implementation of pneumococcal immunization program for children. PD age distribution has a "U"-shape curve with the highest rates seen in children under two and in those aged 60 and more.[11,15,20] The burden of PD is considerable with a large annual number of hospital admissions.

Comparisons of national IPD hospitalization rates are difficult since studies used different case definitions (main diagnosis or all diagnosis), hospital admission databases (administrative or specific) and rate calculation methods. However, three comparable studies found similar average national annual PD hospitalization rates in the US, England and Wales and Singapore before the implementation of immunization programs.[14,15,22,24]

Regional studies or those including only specific health services also call for careful comparisons. A study in the metropolitan area of Santiago, Chile based on confirmed cases found lower average IPD annual hospitalization rates in children under 14, but PD surveillance in Chilean health care centers found higher rates than in our study.[1,12]

Comparisons for specific clinical conditions can help identify population and health care differences not evident with all-inclusive PD data. The annual hospitalization rates for pneumococcal meningitis in children and hospital CFR rates in the present study are considerably higher than those reported in the US and Spain.[6,25] Antibiotic use is high in Brazil, even before hospital care, preventing laboratory confirmation.[23,27] This justifies the inclusion of the proportion of pneumococcal meningitis among bacterial meningitis cases with unidentified pathogen. We estimated two CFRs for pneumococcal meningitis, one based on hospital data (SIH-SUS), which was higher than that in developed

Table 3. Case fatality rates (%) for pneumococcal disease by year of diagnosis, clinical syndrome and age group. Brazil, 2004–2006.

Age (years)	2004						2005						2006					
	Meningitis (SINAN)[a]	Meningitis (SIH)[a]	Sepsis (SIH)[a]	Pneumonia (SIH)[a]	Other (SIH)[a]	All (SIH)[a]	Meningitis (SINAN)[a]	Meningitis (SIH)[a]	Sepsis (SIH)[a]	Pneumonia (SIH)[a]	Other (SIH)[a]	All (SIH)[a]	Meningitis (SINAN)[a]	Meningitis (SIH)[a]	Sepsis (SIH)[a]	Pneumonia (SIH)[a]	Other (SIH)[a]	All (SIH)[a]
<1	33.56	13.40	21.07	1.12	0.73	5.56	33.97	12.21	18.46	1.15	0.76	4.69	36.08	12.95	15.43	0.96	0	3.90
1 to 4	34.55	10.00	14.61	0.41	0	1.77	38.82	3.10	17.44	0.16	0	1.19	36.59	17.80	18.03	0.75	0	2.99
5 to 9	17.95	5.84	14.71	0.17	0	1.96	17.48	4.03	11.86	0	0	1.38	24.76	5.38	10.45	0.22	0.82	1.89
10 to 14	14.94	4.76	16.44	0.42	0	3.54	11.84	4.63	15.38	1.45	0	3.05	18.00	12.36	20.45	0	0	5.51
15 to 19	13.85	5.08	35.00	0.61	0	3.74	10.26	6.86	13.04	2.88	0	4.22	22.81	5.77	0	1.74	2.17	2.68
20 to 39	30.83	15.93	62.82	2.74	0	9.43	27.73	15.04	39.33	1.54	0.38	7.27	25.90	14.87	48.42	1.99	0	8.61
40 to 49	33.48[b]	16.85	57.58	6.94	0.87	12.95	43.66[b]	13.79	67.24	3.53	0	11.49	41.13[b]	7.59	51.69	4.42	0	11.23
50 to 59		18.64	75.00	5.20	0	14.86		18.37	56.79	2.85	1.41	11.75		27.27	63.92	6.40	0	17.22
60 to 69	40.54	31.58	62.14	8.29	0.93	17.34	43.66	20.00	63.27	8.28	0.71	15.95	31.94	7.69	70.18	9.04	1.69	18.95
≥70	61.54	30.00	72.16	14.57	1.65	24.16	40.82	46.67	71.78	13.93	1.68	24.25	50.00	33.33	72.92	13.11	2.78	25.44
All	30.86	12.38	38.95	3.08	0.41	7.93	31.40	10.44	39.04	2.70	0.52	7.19	32.64	13.11	41.50	3.36	0.80	9.13

[a] In-hospital case fatality rates for sepsis, pneumonia, other syndromes and all syndromes are based on data retrieved from the Brazilian Hospital Database (SIH/SUS). For meningitis, case-fatality rates (CFRs) are based on both SIH and data from the Notifiable Diseases Database (SINAN). [b] Case-fatality rates for the age group 40–59 years as a whole.

countries, and the other one based on mandatory notification data (SINAN), which was even higher especially in infants and children under five. SINAN data includes confirmed cases with positive laboratory data, and possibly more serious cases, cases treated in tertiary care hospitals with higher co-morbidities rates, and deaths in the emergency department, not included in hospitalization data.

Comparisons of national annual pneumonia hospitalization rates are complex due to different clinical diagnostic practices and medical nomenclatures and require careful analysis. However, methods have been proposed to improve time series comparisons from both a scientific and a health technology assessment perspective.[9,17] Grijalva's study in the US found a higher national annual pneumococcal pneumonia hospitalization rates among adults (18 years and more) than observed in this study, even when correction to include private sector was considered.[9] Differences in the access to secondary care in hospital settings, in care practices, health information systems, and true variations in population PD incidence and lethality rates may account for the differences in hospitalization rates between the two countries.

Our study has some limitations. The validity of administrative databases depends on data quality of SIH and SINAN databases.[13] Our search for ICD-10 codes in the main diagnosis at discharge may have underestimated PD hospitalization rates as PD may be listed as a secondary diagnosis or even not listed at all. Errors and inconsistencies in diagnostic codes may occur. Non-confirmation of *Pneumococcus* as the etiological agent is also a limitation. PD rates may have been affected by different clinical and laboratory practices, such as the frequency of collecting clinical specimens for culture in suspected cases, antibiotic use and culture techniques, which may vary among different health facilities and Brazilian regions. Information on specific pneumococcal serotypes causing disease is not available in the SIH and SINAN databases.

Since information on hospitalization rates in the private sector is not available, we used data from a national household survey to estimate them in private care settings. This approach may have overestimated PD rates since PD is more frequent among poor populations who are predominantly SUS users. The proportion of hospitalizations for acute serious infectious diseases is probably higher in the SUS. Nevertheless, meningitis is a notifiable disease in Brazil and we were able to use SINAN database to check our estimates, assuming that bacterial meningitis cases always require hospitalization. There was a small difference between the estimates based on SIH-SUS data including hospitalizations in the private sector (4,336) and confirmed cases registered in the SINAN database

(4,032). Underreporting in the SINAN is concerning. There were differences in both databases in the number of cases registered according to age with more cases reported in the SIH-SUS than SINAN for some age groups, particularly children (data not shown). In studies conducted in other countries, the proportion of underreported meningitis cases varied by etiological agent, and was lower for meningococcus and higher for other bacteria, including *Pneumococcus* and virus.[10]

Both invasive and non-invasive diseases may be registered under the pneumococcal pneumonia code. The diagnosis at discharge of pneumococcal pneumonia probably accounts for identified cases of *S. pneumoniae*. The low proportion of pneumococcal pneumonia in all hospitalizations for pneumonia in the SUS (1.0% for all ages; 1.4% among infants) corroborates this hypothesis. In a prospective study conducted in Salvador, northeastern Brazil, *Pneumococcus* was identified in 1.8% of blood cultures from children hospitalized for pneumonia.[16]

PD hospitalization rates are probably underestimated. Less severe syndromes (pneumonia and other diseases), for which blood cultures are less frequently taken, are probably underdiagnosed in routine care and underrepresented in this study. On the other hand, more serious cases with death but not hospitalized were not included either. Despite these limitations, this study provides valid nationwide estimates of PD hospitalization rates.

Mild IPD, particularly pneumonia and bacteremia without focus may be treated at outpatient settings. These cases were not included in the present study. Non-invasive PD rates, although more frequent, are much more difficult to be estimated. The etiological agent is not identified in the majority of cases of pneumonia and otitis media. The Brazilian National Outpatient Database does not include diagnoses and standardized diagnostic data for outpatient consultations and notification systems should be developed for these cases to be included in the estimates.

Surveillance of IPD may be improved by integrating information from different sources and increasing its sensitivity and specificity, as seen in other countries.[7] The SIH-SUS database has a nationwide coverage, easy access and a great volume of data, thus it is a potential source to complement information from laboratory-based and sentinel surveillance, especially in the less developed areas with weak surveillance systems.[2]

PD is a major public health problem in Brazil. This study points out that the use of hospitalization annual rates should be an important part of a PD surveillance that can monitor the implementation and impact of PD vaccination program.

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