

Impact of primary care members on hospitalizations due to ambulatory care sensitive conditions in children under one year of age in the municipality of Betim/MG from 2009 to 2019: an ecological time series analysis

Impacto dos membros da atenção básica nas internações por condições sensíveis à atenção primária em menores de um ano no município de Betim/MG de 2009 a 2019: um estudo ecológico de séries temporais

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ABSTRACT

Introduction: The indicator Hospitalizations for Conditions Sensitive to Primary Care (HPCSC) represents a set of conditions for which effective access to Primary Care (PC) can reduce the risk of hospitalizations. In this sense, it is important to assess whether coverage of PC and its members can influence this indicator in children under one year of age. **Objective:** To evaluate the impact of PC and its members on the HPCSC rate in children under one year of age in the city of Betim/MG. **Methods:** This is an ecological, time series study, carried out in Betim/MG from 2009 to 2019. The HPCSC rate in children under one year of age and the PC coverage of the Family Health Strategy teams (FHSt) and Primary Care teams (PCt) were calculated. Poisson linear regression and joinpoint regression models (through inflection points) were used in the analyses. **Results:** There was a drop in the HPCSC rate in children under one year of age between 2009 and 2019 and an increase in the coverage of PC and its members in the period. A negative association was found between HPCSC, PC coverage and the FHSt component. **Conclusion:** The increase in PC coverage was associated with a reduction in the HPCSC rate in children under one year of age in the city of Betim/MG.

Keywords: Health impact assessment; Primary health care; National health strategies; Child health; Hospitalization.

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RESUMO

Introdução: O indicador Internações por Condições Sensíveis à Atenção Primária (ICSAP) representa um conjunto de agravos para as quais o acesso eficaz à Atenção Básica (AB) pode reduzir o risco de hospitalizações. Nesse sentido, é importante avaliar se as coberturas da AB e de seus membros podem influenciar esse indicador em crianças menores de um ano. **Objetivo:** Avaliar o impacto da AB e de seus membros sobre a taxa de ICSAP em crianças menores de um ano no município de Betim/MG. **Métodos:** Trata-se de um estudo ecológico, de série temporal, realizada em Betim/MG no período de 2009 a 2019. Foram calculadas a taxa de ICSAP em crianças menores de um ano e as coberturas da AB, das equipes da Estratégia Saúde da Família (eSF) e das equipes da Atenção Básica (eAB). Modelos de regressão linear e regressão de *joinpoint* (por pontos de inflexão) de Poisson foram utilizados nas análises. **Resultados:** Observou-se queda na taxa de ICSAP em menores de um ano entre 2009 e 2019 e aumento na cobertura da AB e de seus membros no período. Foi verificada uma associação negativa entre ICSAP, a cobertura de AB e do componente eSF. **Conclusão:** O aumento na cobertura da AB foi associado com a redução na taxa de ICSAP em crianças menores de um ano no município de Betim/MG.

Palavras-chave: Avaliação do impacto na saúde; Atenção primária à saúde; Estratégias de saúde nacionais; Saúde da criança; Hospitalização.

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INTRODUCTION

Primary Health Care (PHC), also called Basic Care (BC), is defined as the set of individual, family and collective health actions that involve promotion, prevention, protection, treatment and rehabilitation, being the gateway preference for users in the Health Care Network (HCN)¹. These actions are offered in Brazil by the Unified Health System (SUS) as a constitutional right and must be offered with equity, through an integrated and articulated HCN².

In Brazil, Family and Community Medicine is predominantly practiced in BC. This specialty, recognized by the National Medical Residency Commission in 1981, is fundamental in consolidating a core of knowledge and practices characterized by a clinic centered on the person (and not the disease), continued care and the management of family and individual therapeutic plans³. Therefore, family and community doctors have a fundamental role in strengthening BC in the country.

One of the most used indicators to evaluate access and quality of BC are Hospitalizations for Primary Care Sensitive Conditions (HPCSC). This indicator represents the set of conditions for which actions coordinated by BC aim to reduce the risk of hospitalizations, minimize psychological consequences and optimize resources for the health system⁴. In Brazil, HPCSC became relevant nationally in 2008, after the publication of the Brazilian HPCSC List, made up of

19 groups of causes of hospitalization and 74 diagnoses, according to the Tenth Revision of the International Classification of Diseases (ICD-10). After that, the list began to be used as an instrument for indirect assessment of the quality of BC, with applicability to evaluate the performance of the Family Health Strategy (FHS) at the national, state and municipal levels⁵.

As an indicator, HPCSC behave differently in relation to age, making it important to study age groups separately. In this sense, studies in the childhood age group have demonstrated the importance of understanding hospitalizations for PHC-sensitive conditions as an important health indicator⁶.

In Minas Gerais (MG), from 2004 to 2013, Arantes and collaborators (2018) described the HPCSC rate in groups of municipalities according to population size. For researchers, not only issues linked to BC, but also other points of the RAS (Secondary Care and Tertiary Care) can influence HPCSC rates. Hence, they highlight the importance of RAS, whether in resolving cases in PHC, in specialized outpatient care or through bed expansion policies and the performance of outpatient surgeries⁷.

Especially in BC, the Family Health Strategy (FHS), created as a strategy to reorganize PHC in the country in accordance with the precepts of the SUS, aims to expand the resolution of actions and improve health indicators, in addition to providing a better cost-effectiveness ratio⁸.

Unlike Primary Care teams (PCt), which are minimally composed of a doctor and nurse, and can fulfill a workload of 20 or 30 hours, Family Health Strategy teams (FHSt) are minimally composed by a doctor, nurse, community health agent and nursing technician, each professional completing 40 hours.

Given this reality, this study aims to evaluate the impact of Primary Care (PC) and the PCt and FHSt members on HPCSC rates in children under one year of age in the city of Betim/MG, from 2009 to 2019.

METHODS

This is an ecological observational study, with a temporal trend, data regarding HPCSC in children under one year old, and the coverage of PC, PCt and FHSt, in the municipality of Betim/MG, from 2009 to 2019.

Data collection was carried out between April and June 2021. Data on hospitalizations in children under one year old were obtained from the SUS Hospital Information System (SIH/SUS) and the total number of children born alive in the Live Birth Information System (SINASC). All Hospital Admission Authorizations (HAA) relating to records of hospitalization of children under one year of age in public, private or philanthropic hospitals that provided services to the SUS, from 2009 to 2019, were included. The information regarding PC and FHSt coverage were collected through the e-Gestor AB of the Ministry of Health, using the month of July of each year as a reference to compose the database^{9,10}. As PC coverage is the sum of coverage of FHSt and PCt members, the calculation of PCt coverage was carried out by subtracting the FHSt component from PC coverage. The population of the municipality of Betim/MG was obtained from the website of the Brazilian Institute of Geography and Statistics (IBGE). Coverage was calculated by the ratio between the covered population and the total population of this municipality, limited to 100%.

The average Gross Domestic Product (GDP) per capita of Betim/MG was used as a proxy variable for socioeconomic status to adjust the model as a possible confounding variable. The socioeconomic covariate GDP per capita was extracted from the IBGE website, with data obtained from 2009 to 2018. The annual value for 2019 was estimated by linear extrapolation¹¹.

HPCSC rates in children under one year of age were considered the outcome variable of the study. To define the causes of hospitalizations, the set of 19 causes listed in the Brazilian List of sensitive conditions for primary care was used⁵. HPCSC rates in children under one year of age were calculated by dividing the total number of hospitalizations by the number of children born alive each year in the municipality of Betim/MG, from 2009 to 2019, multiplied by 1,000. The percentage of coverage of PC and its members (PCt and FHSt) were considered the exposure variables.

Regarding statistical analysis, the main groups of specific causes of HPCSC, that is, those with more than 100 observations in the group, were analyzed using a regression

model. Among these main causes, hospitalization rates for congenital syphilis, which make up the group of diseases related to prenatal care and childbirth, were also calculated. As this is a study involving children under one year of age, and the fact that congenital syphilis represents more than 90% of the total number of hospitalizations in the group "Diseases related to prenatal care and childbirth", it was decided this group would be called "syphilis congenital", as carried out by Júnior et al. (2020)¹².

For the temporal trend analysis, Poisson joinpoint regression techniques (through inflection points) were used (Joinpoint Regression Program version 4.9.0.0)¹³. In this analysis, by realizing where the pattern change occurs, we can check whether the change coincides with some other explanatory variable, in the case of the study, with the change in PC, FHSt, PCt coverage or with the proportional rate of HPCSC.

Once the model was defined, the annual percentage change was calculated to assess whether the observed trend would be statistically significant. In this case, the null hypothesis is that the annual variation is zero, that is, rates are neither increasing nor decreasing. The 95% Confidence Intervals (CI) were presented. The calculations were made using the Grid Search Method, a standard program that defined a minimum number of zero to one, maximum number of three joinpoints.

Next, we proceeded with the calculation of the annual percentage change (APC) and the average annual percentage change (AAPC) and their CI defined by the Parametric Method; and linear regression was carried out with the HPCSC trends in children under one year of age and the coverage of PC, FHSt, PCt, and PBI per capita in the municipality of Betim/MG.

Data storage was performed using the Microsoft Office Excel version 2016 program and simple regression statistical analyses were performed using Stata software, version 11.2 (Stata Corp LP, College Station, United States).

As this is a study with official secondary data, in the public domain, it was not necessary to register the research protocol in the CEP/CONEP System, as stated in the Resolution of the National Health Council (CNS/MS) No. 510, dated 7 December. April 2016.

RESULTS

In Betim/MG, from 2009 to 2019, a total of 17,341 hospitalizations were recorded in children under one year of age, of which 19.8% (3,430) were due to HPCSC. The average annual rate of HPCSC in children under one year of age was 47.9 per 1,000 live births. Among the 19 cause groups on the Brazilian HPCSC List, this municipality had no hospitalizations for children under one year of age due to the "angina" component during the period studied, thus totaling 18 groups analyzed.

The group of causes with the highest number of hospitalizations among HPCSC from 2009 to 2019 was bacterial pneumonia (n=1,199; 34.9%), followed by lung

diseases (n=1,000; 29.1%), asthma (n=434; 12.6%), congenital syphilis (n=175; 5.1%), diseases preventable by immunization (n=133; 3.9%), epilepsies (n=130; 3.8%) and infections of ear, nose and throat (n=110; 3.2%). The remaining 11 causes were responsible for less than 2.0% of hospitalizations.

It was observed that there is a general decreasing trend in HPCSC rates throughout the period studied, as shown in Figure 1. However, the joinpoint analysis showed an inflection point in 2016 with a change from a decreasing trend pattern to an increasing one ($p=0.001$).

The trend lines for the percentage of PC, FHSt and PCt coverage in Betim/MG during the years 2009 to 2019 are shown in Figure 2. A significant increase in PC and FHSt coverage is observed over the period studied.

Table 1 presents the temporal trend and annual percentage variations for the proportion of PC coverage, its members and HPCSC rates, as well as for the seven main causes of HPCSC in children under one year of age in the city of Betim/MG.

In the period from 2009 to 2019, there was a significant upward trend in PC coverage (AAPC=6.3; $p=0.001$), FHSt coverage (AAPC=8.5; $p=0.005$) and hospitalization rate due to congenital syphilis (AAPC=20.1; $p<0.001$). A significant reduction trend over the period was observed in hospitalization rates for bacterial pneumonia (AAPC= -18.7; $p<0.001$) and in hospitalization rates for asthma (AAPC= -18.2; $p<0.001$).

PC coverage was 47.1% in 2009 and increased to 93.4% in 2019. FHSt coverage, which was 32.1% at the beginning of the evaluated period, increased to 71.0% in 2019. Furthermore, PCt coverage varied little, from 15.0% in 2009 to 22.3% in 2019.

The average GDP per capita of Betim/MG, in the period from 2009 to 2019, was R\$57,079.88, classified as having a high economic size and occupying 25th place in the state ranking in 2018 (IBGE, 2021)¹⁰.

There was no association between HPCSC rates and municipal GDP per capita, as well as with PCt coverage ($p=0.587$; $R^2=0.034$ and $p=0.270$; $R^2=0.133$, respectively). On the other hand, a statistically significant negative association was observed between HPCSC rates and the percentage of PC coverage ($p=0.032$; $R^2=0.417$), in which a 1% increase in PC in the municipality decreased the HPCSC rate by 0.91%. A negative association was also observed between HPCSC rates and FHSt coverage, that is, a 1% increase in this component coverage would decrease the HPCSC rate by 0.49%. However, this association, although not significant, has p-value below 0.1 ($p=0.096$; $R^2=0.277$).

DISCUSSION

In the present study, carried out in the city of Betim/MG, it was observed that the average annual rate of HPCSC in children under one year old between 2009 and 2019 was

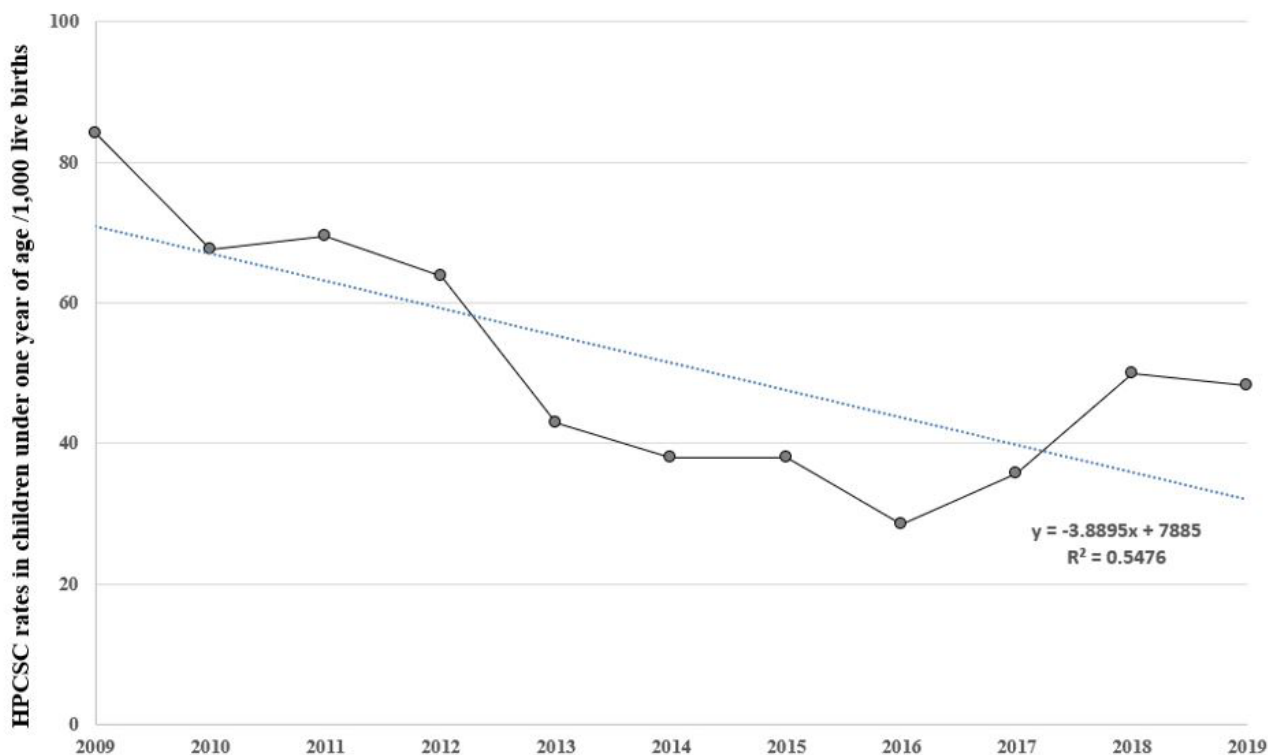


Figure 1. Linear trend in rates of Hospitalizations for Primary Care-Sensitive Conditions in children under one year of age, Betim/MG, 2009-2019.

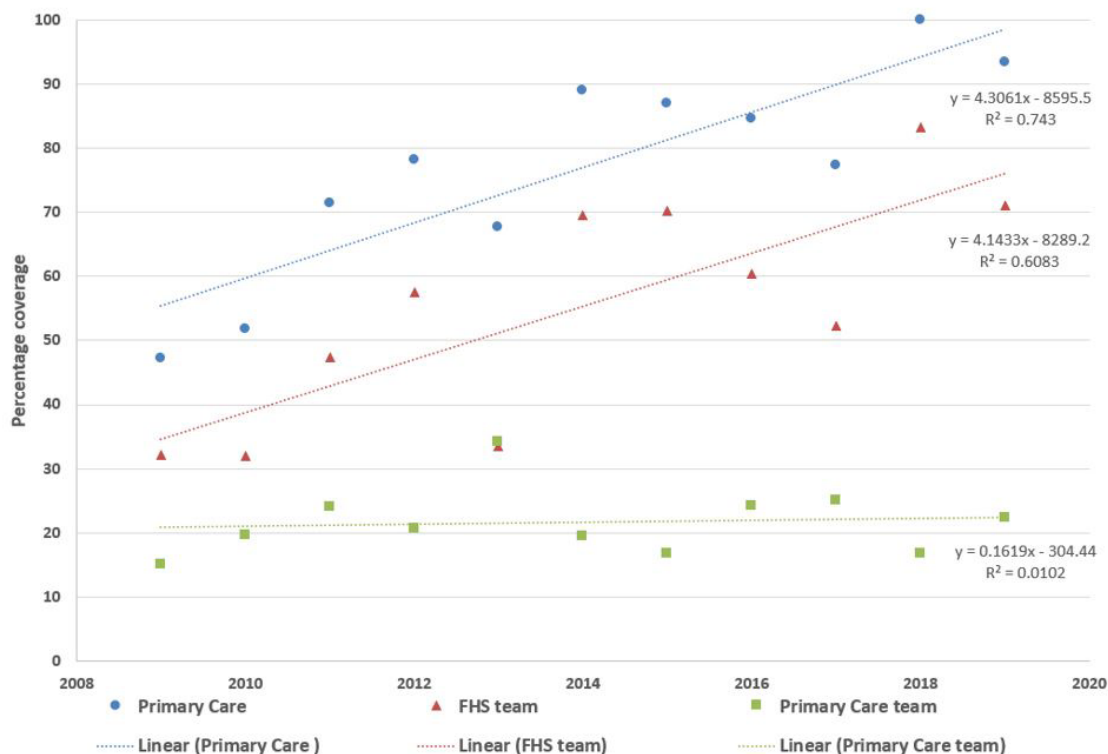


Figure 2. Linear trend of coverage percentages of Primary Care and its members (Family Health teams and Primary Care teams), Betim/MG, 2009-2019.

47.9 per 1,000 live births. Furthermore, PC coverage was negatively associated with the HPCSC rate in this period ($p=0.032$; $R^2=0.417$).

In a study in this same age group, in the State of Bahia, the median municipal rates were 46 avoidable hospitalizations per 1,000 live births in 2012, which corroborates the results of this study. In Brazil, from 2000 to 2015, 3,138,540 HPCSC were registered in children under one year old, with HPCSC rates varying from 72.7/1,000 live births to 48.14/1,000 live births⁴.

Regarding the coverage of primary health services, the increase in coverage in the FHS and PHC modality stands out during the period, and, more intensely, from 2014 onwards. The transition process to FHS in the municipality of Betim/MG occurred later in relation to Brazil and Minas Gerais. Thus, FHSt coverage more than doubled (2.2 times) from 32.0% in 2009 to 71.0% in 2019, while PC coverage almost doubled (1.98 times) from 47.0% in 2009 to 93.0% in 2019.

According to the Ministry of Health¹⁴, in 2020, the country achieved 64.0% FHS coverage and 76.0% PC coverage. In the same year, in the State of Minas Gerais, FHS coverage was 78.0% and PC coverage was 88.0%. In a study on the trend of HPCSC and associated factors in the city of Porto Alegre/RS from 2008 to 2013, FHSt coverage increased from 7.5 to 31.2% in the period, that is, approximately four times¹⁵.

Thus, it is clear that FHS coverage in Minas Gerais and Betim/MG is greater than the Brazilian average, which demonstrates progress in the transition of the care model. However, there is still room for progress in expanding coverage and consolidating the FHS in Betim, considering the prevalence of existing HPCSC.

Regarding the most frequent causes of HPCSC, the magnitude of respiratory diseases (pneumonia, lung diseases and asthma) stood out in the set of conditions that most affected children under one year of age in the city of Betim/MG, being bacterial pneumonia (34, 9%) a main cause. A very different epidemiological situation is observed in Brazil, as shown in a study by Júnior and collaborators (2018)⁴ which, of the total number of hospitalizations, infectious gastroenteritis was the main cause (39.2%). According to the authors, hospitalizations for infectious gastroenteritis may be related to sanitation conditions, access and drinking water supply, which are still precarious in some regions.

There was a significant downward trend in the hospitalization rate for asthma in Betim, with an annual variation of -18.2%, and in the hospitalization rate for bacterial pneumonia, with an annual variation of -18.7%. In a study carried out in Minas Gerais on hospitalizations in children under one year of age for conditions sensitive to primary care in the period from 2008 to 2018, a decreasing trend was also observed in hospitalizations for asthma (annual variation of -9.6%) and pneumonia bacterial infections (annual variation of -56.2%) and an increase

Table 1. Analysis of temporal trends by regression using inflection points (joinpoints) of the indicators: rate of hospitalizations for causes sensitive to primary care in children under one year of age and coverage of Primary Care and its members in the municipality of Betim/MG, 2009- 2019.

Variables	Tendency			Full period	
	Period	APC	CI 95%	AAPC	CI 95%
Coverage					
PC	2009-2019	6.3 *	3.2; 9.4	6.3 *	3.2; 9.4
FHSt	2009-2019	8.5 *	3.2; 14.1	8.5 *	3.2; 14.1
PCt	2009-2019	1.6	-4.8; 8.3	1.6	-4.8; 8.3
HPCSC					
HPCSC rates	2009-2016	-13.5 *	-18.0; -8.7	-4.8	-10.7; 1.5
	2016-2019	19.1	-5.8; 50.6		
Bacterial pneumonia	2009-2019	-18.7 *	-22.7; -14.4	-18.7 *	-22.7; -14.4
Lung diseases	2009-2011	38.0	-3.6; 97.6	7.6	-0.6; 16.4
	2011-2014	-26.9	-47.5; 1.8		
	2014-2019	22.7 *	14.2; 31.9		
Asthma	2009-2019	-18.2 *	-22.4; -13.8	-18.2 *	-22.4; -13.8
Congenital syphilis	2009-2019	20.1 *	12.8; 27.9	20.1 *	12.8; 27.9
Diseases preventable by immunization	2009-2019	-1.0	-7.7; 6.2	-1.0	-7.7; 6.2
Epilepsies	2009-2019	1.6	-5.9; 9.7	1.6	-5.9; 9.7
Infections of ear, nose and throat	2009-2019	-1.8	-9.3; 6.3	-1.8	-9.3; 6.3

Legend: APC = annual percentage change; AAPC: average annual percentage change; CI95% = confidence interval 95%; FHSt = Family Health Strategy teams; PC = primary care; PCt: primary care teams.

*Significantly different from zero ($p < 0,05$).

(annual variation of 25.6%) in diseases preventable by immunization and sensitive conditions, with emphasis on congenital syphilis, which presented 4.20/10,000 cases in 2008 to 56.1/10,000 in 2018¹⁶.

It is important to emphasize that the Popular Pharmacy Program, which offers free medicines to the population, can have a major impact on the rates of respiratory diseases observed in the study. In 2011, this program began offering the population free medicines indicated for the treatment of hypertension, diabetes and asthma, through the "Health Has No Price" strategy. In relation to bacterial pneumonia, the National Immunization Program of Brazil implemented, since 2010, the pneumococcal 10-valent conjugate vaccine. Studies indicate that after this implementation, there was a 19% lower prevalence of hospitalization for community-acquired pneumonia in children under one year of age¹⁷.

There was a significant upward trend in the hospitalization rate for congenital syphilis in Betim, with an annual variation of 20.1%. This scenario is still a challenge for public health, as, in addition to affecting child growth and development, it directly impacts prolonged stays and the costs of avoidable hospitalizations. The recent upward trend in HPCSC rates

observed in this study may reflect the increase in congenital syphilis rates, which may also indicate gaps in prenatal care. The increase in the rate of hospitalization for congenital syphilis is also observed in Brazil, as shown in the study by Júnior and collaborators (2018)⁴. From 2000 to 2015, in relation to the groups of specific causes of HPCSC in Brazilian children in the neonatal period, the hospitalization rates for congenital syphilis showed an annual percentage increase of 24.8%⁴.

In 2011, the Ministry of Health launched Rede Cegonha as a way to achieve changes in the delivery and birth care model, in order to expand access and qualification of care and management practices in women's and children's health care¹⁸. Rede Cegonha promoted greater detection of gestational syphilis, which becomes important for the prevention of congenital syphilis when reporting and treating cases of gestational syphilis. In the opposite direction, and directly affecting care for pregnant women diagnosed with syphilis in Brazil, there was a recent shortage of Benzathine Penicillin, which lasted for a few years from 2013¹⁹.

According to the 2016 Pan American Health Organization (PAHO) report, the increase in the incidence

of congenital syphilis can be attributed to the improvement of the surveillance system, the expansion of access and distribution of rapid tests and the shortage of penicillin¹⁹. In this sense, both the recent increase in the trend of congenital syphilis rates, which coincides with the increase in the trend of HPCSC, and the coverage of PC, which was negatively associated with these hospitalizations, demonstrate the importance of primary care in reducing HPCSC rates in children under one year of age. Increasing PC coverage and better prenatal care to detect cases of gestational syphilis and effectively treat these cases are essential for HPCSC rates to return to a downward trend.

In this study, it was observed that HPCSC rates in children under one year of age, from 2009 to 2019, showed a general decreasing trend, with a negative average annual percentage variation of 4.8%. However, when analyzing the inflection point (joinpoints), a decreasing trend was evident until 2016, and then an increasing one from 2016 to 2019. As shown in a study by Júnior and collaborators (2018),⁴ Brazil showed a reduction in the percentage annual rate of 7.4% between 2000 and 2015. Another study, from 2012 to 2014, in the State of Ceará, described a positive percentage variation in two health regions, 4.8% and 7.7%²⁰. In the case of Betim/MG, the increase in HPCSC, in the period from 2016 to 2019, may also have been influenced by factors linked to PHC work processes, care models and the management of tackling the main public health problems.

In the regression analysis, it was observed that a 1% increase in FHSt coverage decreased the HPCSC rate by 0.49%. Furthermore, the analysis carried out with PC coverage was significantly associated with the HPCSC rate, in which each 1% increase in coverage could imply a 0.91% increase in the HPCSC rate. The expansion of FHSt coverage directly increased PC coverage, thus showing the importance of prioritizing the FHS in reducing HPCSC rates. In the municipality of Montes Claros, in Minas Gerais, when the period in which the city had a population coverage of more than 70% for the FHS was exclusively evaluated, important correlations were recorded that point to the interdependence of a growing number of teams on the reduction of the rate of hospitalization, the amounts paid and even the number of daily stays generated by HPCSC²¹.

Regarding the non-association of HPCSC rates with the variables municipal GDP per capita and PCt coverage, an integrative review of the literature showed that 82% of the articles indicated the influence of social determinants and conditions of health, with the development of HPCSC²². It would be important to analyze other socioeconomic variables in relation to the outcome of this study, even if GDP did not show an association.

As a limitation of the study, we can mention the lack of public data on other socioeconomic variables, within the historical series analyzed, which would be important to evaluate other associations with the analyzed outcome. To alleviate this lack of information and limitations, the municipal GDP per capita variable was used as a proxy for the

municipality's socioeconomic condition. Another limitation is working with secondary data, even with advances in SUS Health Information Systems in recent years. It is known that the quality and availability of data may not portray the entire reality of hospitalizations in children under one year of age.

It is important to highlight that there are still many barriers to accessing quality in PC. The clarification between the coverage of PC, HFS and HPCSC taxes indicates that the panorama of HPCSC trends can be positively modified through health policies focused on improving the health of children under one year of age. Special attention should also be given to prenatal care, with a focus on detecting cases of gestational syphilis and appropriate treatment to prevent congenital syphilis. Therefore, the definition of new strategies for implementing, expanding and consolidating the HFS model, over time, should result in improvements in the quality and resolution of access to healthcare services in PC.

In conclusion, therefore, the increase in PC coverage was significantly associated with the reduction in the HPCSC rate in children under one year old in Betim, from 2009 to 2019. As the increase in PC coverage was similar to the increase of FHSt coverage in the period, the importance of the FHS as a preferred strategy for reducing HPCSC in children under one year of age in this municipality is reinforced.

AUTHOR'S CONTRIBUTION

Conceptualization, Research, Methodology and Writing: DAMD and JDLB. *Project Administration, Supervision and Writing – original draft:* DAMD and JDLB. *Data Curation and Formal Analysis:* DAMD, PRB and JDLB. *Writing, Reviewing and Editing:* PRB, MLS, LLSS and JDLB.

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