









## Social determinants of health and heart failure hospitalizations in Brazil

Determinantes sociais em saúde e internações por insuficiência cardíaca no Brasil

Determinantes sociales de la salud y hospitalizaciones por insuficiencia cardíaca en Brasil

### How to cite this article:

Albuquerque NLS, Oliveira FJG, Machado LD, Araujo TL, Caetano JA, Aquino PS. Social determinants of health and heart failure hospitalizations in Brazil. *Rev Esc Enferm USP*. 2020;54:e03641. doi: <https://doi.org/10.1590/S1980-220X2019002503641>

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### ABSTRACT

**Objective:** To analyze the relationship between social determinants of health and heart failure hospitalizations in Brazil. **Method:** A retrospective ecological study, whose units of analysis were the cities of the Brazilian states. The outcome variable was heart failure hospitalization rate. The independent variables were Family Health Strategy coverage, federal transfer to Primary Care, expenditure on Primary Care, overlapping of the female population and age group above 60 years old. Regressive techniques were adopted for panel data, with estimation of weighted least squares by fixed effect. **Results:** Twenty-six cities were analyzed. Hospitalization rates showed a non-uniform distribution between the areas, with lower median in the North and higher in the South. The regression model identified a relationship between hospitalization rates and Family Health Strategy coverage, federal transfer to Primary Care, and overlapping of the female population. **Conclusion:** Heart failure occurrence, a condition sensitive to Primary Care in Brazil, is influenced by social determinants of health represented by demographic, budgetary, and health service coverage factors.

### DESCRIPTORS

Social Determinants of Health; Heart Failure; Health Promotion; Healthcare Financing; Logistic Models.

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Received: 02/11/2019  
Approved: 01/21/2020

## INTRODUCTION

High hospitalization rates due to ambulatory care sensitive conditions (ACSC) may be associated with limitations on access to Primary Health Care (PHC) services. This represents a warning signal capable of triggering analysis mechanisms and searching for explanations for its occurrence<sup>(1)</sup>. Hospitalizations related to ACSC are those that could have been avoided through the use of basic resources provided in the first level of health care. They are understood as elements that signal problems, capable of translating the real situation of the population and providing subsidies for the improvement and monitoring of PHC<sup>(2)</sup>.

The Brazilian List of Hospitalizations due to Ambulatory Care Sensitive Conditions contains nineteen groups of diagnoses, including cardiovascular disorders such as hypertension, angina, heart failure (HF), and cerebrovascular diseases<sup>(3)</sup>. Such diagnoses reflect on Brazilian public health. HF stands out, which has a high epidemiological impact in Brazil and is influenced by social determinants of health (SDH) such as gender, age, lifestyle, economic conditions, income, and access to health services<sup>(4)</sup>.

The Dahlgren & Whitehead model seeks to highlight the relationship between SDH and health outcomes and is presented in levels. Proximally, there is personal behavior and ways of life that can damage or improve health, being influenced by social and community networks and contextualized by living and working conditions and access to facilities. Distally, there are the broader economic, cultural and environmental conditions of a society, which influence all other layers<sup>(5)</sup>. Understanding the interrelationship between levels allows the identification of points for public policy interventions<sup>(6)</sup>. In this perspective, it is understood that separation between the social and health is contrary to the principles

of integrality and guidelines of the Brazilian Health System (*Sistema Único de Saúde – SUS*)<sup>(7)</sup>.

There is evidence that SDH, especially those related to access to health services and primary services coverage, are related to the trend of hospital admissions due to cardiovascular ACSC<sup>(8-9)</sup>. However, the literature presents gaps regarding the elucidation of the SDH specifically linked to HF.

The present study aimed to analyze the relationship between SDH and HF hospitalizations in Brazil.

## METHOD

### TYPE OF STUDY

This is a retrospective and ecological study.

### SCENARIO

The units of analysis were the cities of the 26 Brazilian states from 2008 to 2016.

The outcome variable analyzed was HF hospitalization rate by medical diagnosis, listed as I50 in the International Classification of Diseases (ICD-10). To select the independent variables, the conceptual framework of the Dahlgren & Whitehead model was used<sup>(10)</sup>. SDH of the distal, intermediate, and macro layers were included as sociodemographic, health service coverage, and PHC financing indicators.

### DATA COLLECTION

Data collection was carried out by consulting secondary publicly accessible databases, between August and September 2018. The sources of secondary data collection for each variable are described in Chart 1.

**Chart 1** – Secondary data collection sources – Fortaleza, CE, Brazil, 2018.

Variable	Secondary data collection sources
HF hospitalization rates (INTERN)	Hospital Information System of the Unified Health System (SIH/DATASUS – <i>Sistema de Informações Hospitalares do Sistema Único de Saúde</i> )
Population estimate	Brazilian Institute of Geography and Statistics (IBGE – <i>Instituto Brasileiro de Geografia e Estatística</i> )
Proportion of the population covered by the Family Health Strategy (FHS_R)	Primary Care Department (PCD)
Age group from 60 years old (IDOS)	DATASUS
Percentage of the female population (POPM)	DATASUS
Federative expenditure on Primary Care (TSUS)	Brazilian National Health Fund (NHF)
Expenditure by cities in the Primary Care subfunction (DSUS)	Information System on Public Health Budgets (SIOPS – <i>Sistema de Informações sobre Orçamentos Públicos em Saúde</i> )

The number of HF hospitalizations was extracted from DATASUS portal, selecting general hospitalization information, by place of residence, starting in 2008. After selecting

the state, it was established as a line variable year/month of care and the content of hospitalizations. The process was repeated for each Brazilian state.

Estimates of the population residing in Brazilian cities were taken from the Brazilian Institute of Geography and Statistics<sup>(11)</sup>. Expenditure on the PHC subfunction was analyzed using the sum of the annual expenditure on PHC of all cities in each Brazilian state. SIOPS access was given in the tab “Values declared by federative units”, with option “Cities” being selected. Expenditure history by subfunction was consulted – consolidated by office, by stage of expenditure and by FUs (Federal Units). Subsequently, each state was individually selected, encompassing the consolidation of all cities and their committed expenses. Among the subfunctions served, PHC was selected because it is the object of this study.

Federal transfer to PHC was extracted through the sum of the total amount sent annually to all cities in each state directed to this level of care. Therefore, the “Consolidated Payment Consultation” tab was consulted on the NHF portal, applied to all cities and considering the municipal transfer as a type of transfer. The total value of PHC was selected, and the monetary variables were updated at constant prices, being deflated by the Consumer Price Index (CPI), made available by IBGE, as well as analyzed in per capita values.

#### ANALYSIS AND TREATMENT OF DATA

HF hospitalization rate per 10,000 inhabitants was calculated considering the number of hospitalizations in the year in the numerator, divided by the denominator population estimate of the same year, multiplied by 10,000. Two decimal places were used for this indicator.

Data were tabulated in the Microsoft Excel 2016 program. Distribution of the hospitalization rate by region in the studied time horizon was calculated using standardized mean, median, and quartiles, presented in box plot graphs produced in R software version 5.3. The result was adjusted to 10,000 inhabitants.

To plot the distribution of the Family Health Strategy (FHS) coverage and the expenditure paid by the cities on PHC, the mean of these indicators was calculated by region, and, for Brazil, in each year of the time horizon.

Inferential analysis was performed through regressive techniques using panel data, employing the methodology for estimating fixed effect weighted least squares<sup>(12)</sup>, as shown below.

$$INTERN_{it} = C + \beta_1 (T\_ESF_{it}) + \beta_2 (DSUS_{it}) + \beta_3 (TSUS_{it}) + \beta_4 (POP_{it}) + \beta_5 (IDOS_{it}) + \varepsilon_{it}$$

The equation sought to estimate the relationships of the explanatory variables (Chart 1) on the dependent variable HF hospitalization. In this analysis, raw data collected from secondary sources were used, without calculating means or

medians, and deflated values per capita when dealing with monetary variables.

The panel data regression methodology unified the cross-sectional variables of observation units (N) with time series (T). The data referring to the Brazilian states in the period from 2008 to 2016 were evaluated using Eviews 10. The regressive modeling of panel data was tested and adjusted according to the parameters of the literature for better adjustment and definition of the model, seeking to estimate unbiased and robust coefficients from a statistical point of view.

To guarantee the robustness of the model estimators, Breusch-Pagan-Godfrey and White Heteroscedasticity tests were performed, identifying the need to use the Weighted Least Squares (WLS) method to correct heteroscedasticity in the estimation<sup>(12)</sup>.

Durbin-Watson and Breusch-Godfrey serial autocorrelation tests were also performed, identifying the presence of a serial correlation of the residuals. The correction was carried out by adopting an autoregressive parameter of the lagged dependent variable in a period,  $INTERN_{t-1}$ .

Finally, using the Hausman test, it was found that the estimation performed by fixed effects of panel data presents greater robustness for regressive parameters<sup>(13)</sup>.

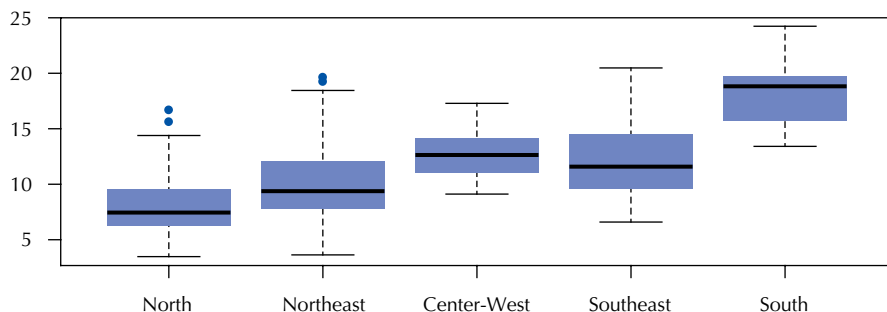
#### ETHICAL ASPECTS

All data collected are available for public access, thus dispensing with authorization by the Research Ethics Committee.

#### RESULTS

There were 2,171,286 HF hospitalizations in Brazil between 2008 and 2016. HF hospitalization rates showed non-uniform distributions among Brazilian regions in that period. The lowest median (7.440) was found in the North and the highest (18.83) in the South (Figure 1). In all regions there was a reduction in the HF hospitalization rate over time.

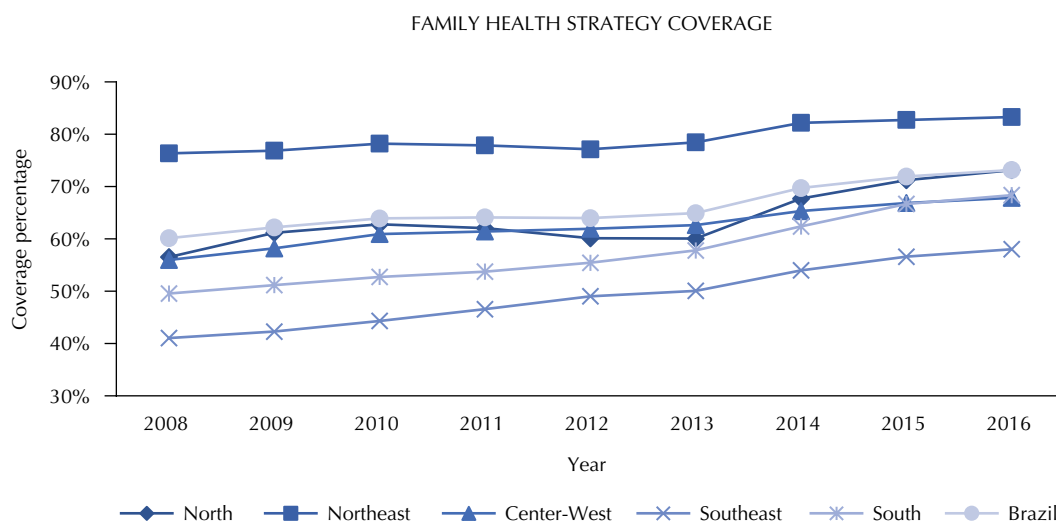
It should be noted that there was an important variation in the rate between states in the same region. During the period, the northern state that had the lowest mean was Amapá, with 5.60 hospitalizations per 10,000 inhabitants, and the highest mean was identified in Tocantins, with 12.68 for the same standardization. In northeastern states, the lowest average was identified in Sergipe, 4.68, and the highest in Piauí, 15.82. Center-western states were the most homogeneous, with the highest rate in Goiás, 13.99, and the lowest in Mato Grosso do Sul, 11.28. In southeastern states, rates were around 10 hospitalizations per 10,000 inhabitants, except for Minas Gerais, which had an mean of 17.9 cases. In southern states, Santa Catarina had the lowest rate, 16.70, and Paraná, the highest, 21.10.



**Figure 1** – Box plots of HF hospitalization rates in Brazilian regions between 2008 and 2016.

FHS coverage also varied between regions in the studied time horizon. Coverage showed an upward trend in most of the period in all regions (Figure 2). The Northeast showed

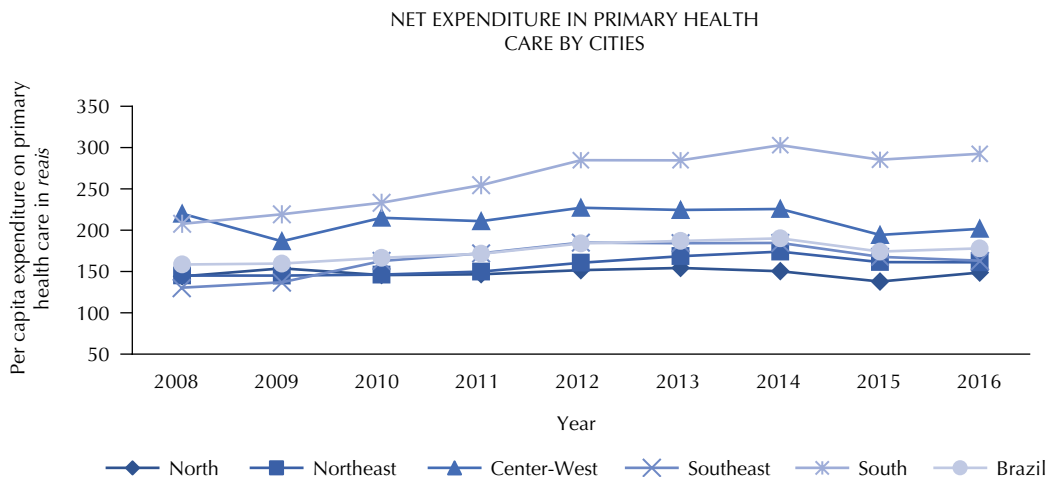
coverage between 76.85% (2008) and 83.28% (2016), while the Southeast showed coverage between 41.04% (2008) and 58.01% (2016).



**Figure 2** – Representation of health service coverage in Brazilian regions between 2008 and 2016.

The per capita expenditure on PHC of the cities is shown in Figure 3, from which it appears that the South presented values that varied between R\$ 207.66 (2008) (R\$ is the

symbol that represents the Brazilian currency *reais* (BRL)) and R\$ 292.38 (2016), and the North fluctuated between R\$ 144.18 (2008) and R\$ 163.13 (2016).



**Figure 3** – Per capita expenditure on PHC paid by cities, presented by Brazilian regions between 2008 and 2016.

The relationships between the dependent variables and the number of HF hospital admissions are shown in the

result of regression in panel data at 95% confidence interval (Table 1).

**Table 1** – Results of panel data estimation of the impact of SDH on HF hospitalization rate from 2008 to 2016 – Fortaleza, CE, Brazil, 2018.

Variable	Hospitalization rate ( $\beta$ ) <sup>a</sup>	SD <sup>b</sup>	P value	95% CI <sup>c</sup>	
				Minimum	Maximum
Constant	6.664	-1.273	0.0000	4.151	9.176
FHS coverage rate (FHS_R)	-0.028	0.013	0.0418	-0.055	-0.001
Expenditure by cities on the Primary Care subfunction (DSUS)	-0.003	0.002	0.1102	-0.007	0.0007
Federal transfer to Primary Care (TSUS)	-0.026	0.007	0.0007	-0.041	-0.011
Female population (POPM)	0.552	0.192	0.0046	0.172	0.931
Age component from 60 years old (IDOS)	-3.25 and -07	2.05E-07	0.1135	-7.29E-07	7.84E-08
Hospitalization rate in the previous period (INTERN <sub>t-1</sub> )	0.744	0.042184	0.0000	0.661	0.828
Observations	208	Breusch-Pagan-Godfrey test	0.001	Breusch-Godfrey test	0.004
R <sup>2</sup>	0.9783	White test	0.000	Durbin-Watson test	1.997
Number of states	26	Hausman test	0.004		

<sup>a</sup> Regression coefficient. <sup>b</sup> Standard Deviation. <sup>c</sup> 95% Confidence Interval.

## DISCUSSION

The study identified wide variations in the rate of HF hospitalization between Brazilian regions in the analyzed period. The variation pattern was also evident among the states in the same region. The important heterogeneity of hospitalizations for this diagnosis highlights the need to understand SDH that are related to the phenomenon.

Hospitalization trend due to ACSC and chronic ambulatory care sensitive conditions (CACSC) is usually presented in the literature in studies of local scope, mostly revealing stabilization or decrease in hospital admissions for these reasons<sup>(1,14)</sup>.

The results displayed in the present study expand available knowledge on SDH involved in the occurrence of HF hospitalizations by composing a broad overview that includes diversity of health conditions of an entire country in an interval of almost a decade. The important variations in the hospitalization rate support evidence from the literature on the presence of different health conditions between the regions of the country<sup>(15)</sup>, indicating that the SDH influence is not homogeneous.

In the Dahlgren & Whitehead model<sup>(10)</sup>, health is the result of a set of interrelated causes and distributed in five layers<sup>(16)</sup>. The regressive model of this study indicated that the following SDH have an impact on the occurrence of HF hospitalization: FHS coverage rate, federal transfer to PHC, overlapping of the female population and HF hospitalization rate in the previous period.

FHS coverage rate represents the SDH referring to health services, which are in the middle layer of the Dahlgren

& Whitehead model<sup>(10)</sup>. Within the scope of ACSC, the performance of FHS has an important relevance in Brazil, since it can be considered the main initiative of the country to increase the quality of care provided at the primary level of health care<sup>(17)</sup>.

The findings show that FHS coverage expanded in all Brazilian regions, between 2008 and 2016. The discrepancy in coverage between regions is evident, despite having gradually decreased in the period. A recent analysis<sup>(15)</sup> supports these results by identifying that primary health care services increased in Brazil between 2000 and 2016 through FHS, with emphasis on the regions less favored by public and private assistance offer.

The comparison of the results points to the existence of an association between FHS coverage and hospitalization rate, which is confirmed by the regressive model. The Northeast, from 2008 to 2016, remains with a percentage of coverage considerably higher than the others. The median of HF hospitalizations in the Northeast is the second lowest in the country, showing a relationship with its percentage of FHS coverage, as evidenced by the regression model modeled in this study. Despite the investment in strengthening the expansion of FHS, this region presents per capita expenditure paid in PHC below the Brazilian average, showing limited allocation of resources in other areas of PHC level.

In contrast, the southern area has the highest paid per capita expenditure on PHC in the period analyzed and the second lowest FHS coverage in the country. Despite the high investment in the PHC level, the average HF

hospitalization rate in this region is the highest in the country. The amount of expenditure on PHC only reduces HF when an important portion is aimed at strengthening the expansion of FHS.

The result of the regressive analysis that highlights FHS coverage as a causal factor for HF hospitalizations is supported by available evidence indicating that access and use of PHC services contributes to reducing hospitalization rates, in addition to improving general indications of health care, increasing equity, and reducing socioeconomic inequalities<sup>(18)</sup>.

FHS coverage is dependent on health macro-policies, which include priorities and financing mechanisms. Analysis of the regressive model shows that the financial execution of municipal own resources in PHC was not statistically significant. This was possibly due to the high variability in execution between cities in the same state.

In terms of health financing, despite the increasing participation of cities, federal financing is still considered the defining agent of health policy in Brazil<sup>(19)</sup>, with the Variable Primary Care Level (*Piso da Atenção Básica variável – PAB variável*) providing financial incentives for maintaining and expanding FHS.

Federal transfer to PHC showed a predominantly upward dynamism in the evaluated period and showed a causal relationship with the occurrence of HF hospitalizations. It was identified that each real currency unit per capita transferred by the federal government to PHC impacts the reduction of 0.02 in the hospitalization rate due to the disease.

Since the onset and complication of HF are linked to modifiable risk factors<sup>(20)</sup> that can undergo intervention through the performance of primary health care, the financing of this component is extremely relevant. Quantification of the impact achieved in this study provides subsidies for the planning of macro health policies aiming at reducing the occurrence of HF in Brazil and in countries with similar behavior of SDH.

In the distal layer of the Dahlgren & Whitehead model<sup>(10)</sup> is an intrinsic characteristic of the human being such as gender, age and hereditary factors. The age component from 60 years old did not show statistical significance in the model of this study. The analysis of gender as an independent variable showed that the HF hospitalization rate is higher in regions where the size of the female population overlaps with the male. It was identified that the female overlap positively impacts the hospitalization rate by 0.55.

The literature recognizes that there are gender differences in the phenotype and risk factors for HF<sup>(20)</sup>. In younger age groups, the disease is more prevalent in men. However, the highest prevalence of HF is present in the older age groups and in these age groups the female gender overlaps<sup>(21)</sup>. The recognition of this finding in a population study like this provides subsidies for understanding the occurrence of the phenomenon by not only identifying the relationship between gender and hospitalization, but also in quantifying it.

The adjustment variable  $INTERN_{t-1}$  in the model indicates a pattern of regularity in which about 74% of the hospitalization rate of the previous period influences the rate of the following year. It is considered that part of this impact is due to the high number of HF hospital readmissions. The chronicity of the disease alternates between periods of stabilization and decompensation, which commonly culminate in a new hospital admission<sup>(22)</sup>.

However, macro analysis of the results allows one to infer that the influence of the previous period on HF hospitalization rate is also composed of other SDHs that were not included in the model. As it is an ecological study, only SDHs that had data related to the Brazilian population in the country's public data systems were addressed. SDH, such as hereditary factors, lifestyle, social and community networks, living and working conditions and others, certainly have a relationship with risk factors for HF and, consequently, for hospital admissions. However, obtaining these data is characteristic of local studies and not of those from public databases.

The regression model that assessed the relationship of five SDH and HF hospitalization rate identified that two positively impact the reduction of the phenomenon: FHS coverage and federal transfer to PHC. Overlapping of the female population and hospitalization rate from the previous period are variables that increase HF hospitalization. The age component above sixty years old and expenditure by cities on PHC, on the other hand, are not related to the outcome in the level of significance adopted.

The analysis results of aggregated data over the nine-year period fostered the relevance of SDH in HF hospitalizations in Brazil. It is pertinent that information on the impact of health coverage and investments in the occurrence of the disease be considered in the health planning and budget instruments of the three governmental spheres to reduce the burden of the disease in Brazil.

This study has the limitation of acquiring information from a secondary source. Health information systems may have underreporting and failures in the diagnostic classification. However, since the information from these information systems contributes to support health management in Brazil and planning within the scope of SUS, its use in this study was considered relevant. In order to minimize possible registration failures, a long historical series and rigorous statistical treatment were used.

## CONCLUSION

HF hospitalization rates in Brazilian regions are explained by the behavior of SDH of the distal, intermediate and macro layers as Family Health Strategy coverage, federal transfer to PHC and overlapping of the female population. The regressive model also indicates that hospitalizations that occurred in the previous period also influence the phenomenon occurrence in later years. The information provided by the study represents a subsidy for planning health macropolicies aimed at reducing hospitalizations.

## RESUMO

**Objetivo:** Analisar a relação entre determinantes sociais em saúde e internações por insuficiência cardíaca no Brasil. **Método:** Estudo ecológico retrospectivo, cujas unidades de análise foram os municípios dos estados brasileiros. A variável desfecho foi a taxa de internação hospitalar por insuficiência cardíaca, e as variáveis independentes foram a cobertura da Estratégia Saúde da Família, repasse federal ao bloco da Atenção Básica, despesa executada com Atenção Básica, sobreposição da população feminina e componente etário acima de 60 anos. Adotaram-se técnicas regressivas por dados em painel, com estimação dos mínimos quadrados ponderados por efeito fixo. **Resultados:** Foram analisados 26 municípios. Taxas de internação pelo diagnóstico apresentaram distribuição não uniforme entre as regiões, com mediana mais baixa na região Norte e mais alta na Sul. O modelo de regressão identificou relação entre taxa de internação pelo diagnóstico e cobertura da Estratégia Saúde da Família, repasses federais à Atenção Básica e sobreposição da população feminina. **Conclusão:** Ocorrência de insuficiência cardíaca, uma condição sensível à Atenção Primária no Brasil, é influenciada por determinantes sociais em saúde representados por fatores demográficos, orçamentários e de cobertura de serviços de saúde.

## DESCRITORES

Determinantes Sociais da Saúde; Insuficiência Cardíaca; Promoção da Saúde; Financiamento da Assistência à Saúde; Modelos Logísticos.

## RESUMEN

**Objetivo:** Analizar la relación entre los determinantes sociales de la salud y las hospitalizaciones por insuficiencia cardíaca en Brasil. **Método:** Estudio ecológico retrospectivo, cuyas unidades de análisis fueron los municipios de los estados brasileños. La variable de resultado fue la tasa de hospitalización por insuficiencia cardíaca, y las variables independientes fueron la cobertura de la Estrategia de Salud Familiar, la transferencia federal al bloque de Atención Primaria, el gasto en Atención Primaria, la superposición de la población femenina y un componente de edad superior a 60 años. Se adoptaron técnicas regresivas para datos de panel, con estimación de mínimos cuadrados ponderados por efecto fijo. **Resultados:** Se analizaron 26 municipios. Las tasas de hospitalización debido al diagnóstico mostraron una distribución no uniforme entre las regiones, con una mediana más baja en el norte y más alta en el sur. El modelo de regresión identificó una relación entre la tasa de hospitalización para el diagnóstico y la cobertura de la Estrategia de Salud Familiar, las transferencias federales a Atención Primaria y la superposición de la población femenina. **Conclusión:** La aparición de insuficiencia cardíaca, una afección sensible a la atención primaria en Brasil, está influenciada por determinantes sociales en la salud representados por factores demográficos, presupuestarios y de cobertura de los servicios de salud.

## DESCRIPTORES

Determinantes Sociales de la Salud; Insuficiencia Cardíaca; Promoción de la Salud; Financiación de la Atención de la Salud; Modelos Logísticos.

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#### Financial support

*Coordenação de Aperfeiçoamento de Pessoal de Nível Superior – CAPES. Graduate Program in Nursing at the Universidade Federal do Ceará.*

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