# Hospitalizations for diabetes *mellitus* in older people in Brazil from 2001 to 2020: temporal trends and spatial patterns

Heloyse Kelly de Sousa Macedo[1]
Talita Araujo de Souza[2]
Héllyda de Souza Bezerra[3]
Fábia Cheyenne Gomes de Morais Fernandes[4]
Isabelle Ribeiro Barbosa[4]
José Adailton da Silva[3]

## Abstract

*Objective:* To analyze temporal and spatial patterns in the distribution of hospitalization rates for diabetes *mellitus* in older people (60 years or older) in Brazil. *Method:* Ecological study with data from the Hospitalization Information System of the Unified Health System about hospitalizations for diabetes in older people in Brazil from 2001 to 2020. The hospitalization rate/100,000 older people was calculated, and the temporal trend was analyzed using the Joinpoint Regression. Univariate and bivariate MoranMap maps were constructed, and the Skater technique was applied to analyze the association between hospitalization rates and contextual variables by Immediate Urban Articulation Regions. *Results:* Annual rates show that Brazil registered 43.78 hospitalizations for diabetes/100,000 older people in 2001 and 21.55/100,000 older people in 2020, with a significant downward trend (AAPC=-3,4% IC95% -4,5; -2,3). There was an average spatial autocorrelation by global Moran (I<0,3) in the last five years with regions with high rates of hospitalization in the North and Northeast of Brazil. The bivariate analysis showed the formation of clusters with high rates of hospitalization where there was a high coverage of the Family Health Strategy and a supply of professionals, however, in areas with worse social indicators. The Skater map showed clusters of areas with low hospitalization rates in areas of favorable social conditions in Southeast Brazil. *Conclusion:* The expansion of government policies to protect the health of older people has marked a national commitment to the healthy aging of the population, which is reflected in the decline in hospitalization rates for diabetes among older people in Brazil.

**Keywords:** Hospitalization. Elderly. Diabetes Mellitus. Trend. Spatial Analysis.

[1] Universidade Federal do Rio Grande do Norte (FACISA/UFRN), Faculdade de Ciências da Saúde do Trairí. Santa Cruz, RN, Brasil.

[2] Universidade Federal do Rio Grande do Norte (UFRN), Programa de Pós-Graduação em Ciências da Saúde. Natal, RN, Brasil.

[3] Universidade Federal do Rio Grande do Norte (UFRN), Programa de Pós-Graduação em Saúde Coletiva. Natal, RN, Brasil.

[4] Universidade Federal do Rio Grande do Norte (FACISA/UFRN), Faculdade de Ciências da Saúde do Trairí, Programa de Pós-Graduação em Saúde Coletiva. Santa Cruz, RN, Brasil.

[5] Universidade Federal do Rio Grande do Norte (UFRN), Departamento de Saúde Coletiva. Natal, RN, Brasil.

The authors declare there are no conflicts of interest in relation to the present study.

No funding was received in relation to the present study.

Correspondence
Heloyse Kelly de Sousa Macedo
macedoheloyse@hotmail.com

Received: May 31, 2021
Approved: August 31, 2021

http://dx.doi.org/10.1590/1981-22562021024.210107

## INTRODUCTION

Chronic non-communicable diseases (NCDs) are characterized as one of the biggest public health problems in the world, with emphasis on four groups of diseases: cardiovascular diseases, cancers, chronic respiratory diseases and diabetes[1].

Among these diseases, diabetes mellitus (DM) is one of the global health problems that poses the greatest threats in the 21st century due to the risk of developing a series of serious and fatal complications, leading to a greater need for medical care, reduced quality of life and excessive stress in families. Added to this factor, in 2019, it was estimated that 463 million people worldwide had DM, and projections indicate that this number could reach 578 million people in 2030 and 700 million in the year 2045[1,2].

In Brazil, DM is also highlighted, as the country occupies the 4th place in the world ranking with the highest prevalence of DM in the population, recording about 12.5 million cases of diabetes in individuals aged 20 to 79 years old, of which, almost a third of diabetics are concentrated in the older population over 60 years[3,4].

In older people, complications resulting from DM compromise functionality in general, being related to a higher risk of premature death, greater association with other comorbidities, and especially with major geriatric syndromes[4]. In addition, the highest rates of hospital admissions and longer bed occupancy are observed among people aged 60 years and over when compared to other age groups[5].

Thus, due to the complications of DM, the disease imposes a great economic burden on health systems due to the high rates of hospitalizations and greater use of health services, being more impactful in developing countries[4]. This finding was made for the Brazilian public network, with an estimated average cost of R$ 1,478.75 for the year 2014 for a hospitalization of an individual aged 20 to 79 years with DM, while the total costs of hospitalizations attributable to DM, were, approximately R$ 463 million[6,7].

DM is a health problem considered a Primary Care Sensitive Condition (PCSC) and high rates of hospitalizations for PCSC in a population, or subgroup (s), indicate serious problems in accessing the health system or in its performance[8]. In this sense, the analysis of hospitalizations of older people for this cause can help to identify areas that are clearly subject to improvement, highlighting problems that require better follow-up and coordination between the levels of care.

In addition to the health context, it is necessary to emphasize the social context that can also interfere negatively or positively in the illness of this population, being important the social analysis and how this interferes with the health of the older person[9].

Thus, considering that the occurrence of DM cases in Brazil prevails in the older population and several factors can contribute to the complications of this disease, the question is: what is the trend in hospitalization rates for DM in older people in Brazil? Is there a correlation between these hospitalization rates and the supply of primary care health services and social indicators?

Thus, it is observed that the prevalence of DM in older people is an important topic for public health issues and to analyze their behavior in relation to hospitalizations and the social factors that influence these hospitalizations, it is essential as it allows to help in the assessments of the effectiveness of prevention and control strategies that have been adopted over time in Brazil, in addition to supporting prospective planning aimed at reducing its impact on the older population and on the country's economy.

From this, the objective of this study is to analyze temporal and spatial patterns in the distribution of hospitalization rates for DM in older people (60 years old or more) in Brazil based on data collected from the Unified Health System (SUS) in the period between 2001 and 2020.

## METHOD

This is an ecological population-based study with a mixed design, time trend and multiple groups, based on secondary data recorded in the SUS Hospital Admissions Information System (SIH-

SUS), of the Informatics Department of the Unified Health System[10].

Hospital admissions resulting from DM were considered as the outcome variable, categorized based on the International Statistical Classification of Diseases and Related Health Problems - 10th Revision (ICD-10 - code E11 to E11.9), which occurred in Brazil in older people (60 years or more) in the period between 2001 and 2020, by place of residence.

Hospitalization rates/100,000 older people were calculated for Brazil, large geographic regions and for Immediate Urban Articulation Regions (RIAU). Population data by geographic area and by age were obtained from information from the Demographic Censuses and 2010 inter-census projections on the website of the Brazilian Institute of Geography and Statistics (IBGE)[11].

For the analysis of temporal trends rates of hospitalizations for DM in older people, the national territory and the five major geographic regions (North, Northeast, South, Southeast and Midwest) were considered, according to the country's political-administrative organization.

For the analysis of spatial distributions, the RIAU were used. These correspond to a reorganization of Brazilian municipalities proposed by the IBGE, demonstrating an analysis of the Brazilian territorial dynamics in which the networked relationships of cities are established as fundamental elements of interconnection of management, infrastructure and productive activities, allowing for the establishment of understandings of the socio-spatial transformations taking place in the country[12]. Analyzes by RIAU were used to the detriment of municipalities in order to minimize bias in calculating rates for small areas.

For the analysis of temporal trends in hospitalizations for DM in older people in Brazil and in the five Brazilian regions, the *Joinpoint* Regression analysis was performed. This type of analysis is useful for describing changes in trend data[13].

In this model, the *Annual Percentage Change* (APC) was estimated, based on the trend of each segment. To quantify the trend over the period of the years analyzed, the *Average Annual Percent Change* (AAPC) was calculated, based on the accumulated geometric average of the APC trends[13].

To perform the spatial autocorrelation analysis of the outcome variable, the Moran Global index was used, which assesses the spatial interdependence relationship between all polygons in the study area and expressed through a single value for the entire region. The analysis of this index provides statistical significance ($p$ value), in which values very close to zero indicate the non-significant spatial autocorrelation of the values between its neighbors; values below 0.50 indicate weak autocorrelation; values between 0.50 and 0.75 are characterized as medium autocorrelation and values above 0.75 demonstrate strong autocorrelation[14].

To verify the distribution pattern of these spatial autocorrelation rates of the outcome variable, the univariate local Moran test was applied (*Local Indicators of Spatial Association* – LISA), with the aim of verifying whether there was spatial dependence in the occurrence of hospitalizations for DM in older people in the 482 RIAU in Brazil and, for that, the average rates per quinquennium were calculated: 2001-2005; 2006-2010; 2011-2015; 2016-2020. Thus, the *MoranMap* was presented to assess the formation of clusters classified as: high-high, low-low, low-high and high-low[15]. The calculation of rates per quinquennium was used to avoid random fluctuations in the occurrence of events.

Assuming the process of social determination of health and disease phenomena, we sought to analyze the spatial association between the average rate of hospitalization for DM in older people in the last five years (2016-2020) by RIAU and independent variables that are related to the outcome variable. Therefore, the bivariate local Moran test was applied and the *MoranMap* was presented with the areas classified as high-high, low-low, low-high and high-low[15]. For this analysis, the independent variables represented by the contextual indicators of the RIAU were: (V1) Coverage of the Family Health Strategy (FHS); (V2) Offer rate of FHS Nurses per 100,000 inhabitants; (V3) Offer rate of FHS Physicians per 100,000 inhabitants; (V4) Proportion of poor people; (V5) Municipal Human Development Index (MHDI); (V6) Aging rate. The evaluation period took into

account the last five years as it is more recent data, thus providing a better evaluation of the current period.

Finally, a multivariate analysis was performed, in which the *Skater* technique or regionalization method was applied, which allows for grouping smaller areas into larger areas that, in addition to being contiguous, also have similarities according to the associated attributes[16]. In this technique, all variables were standardized by Z score, using the formation of 5 clusters, in which we sought to analyze the spatial association between the average rate of hospitalization for DM in older people in the last five years (2016-2020) by RIAU and independent variables.

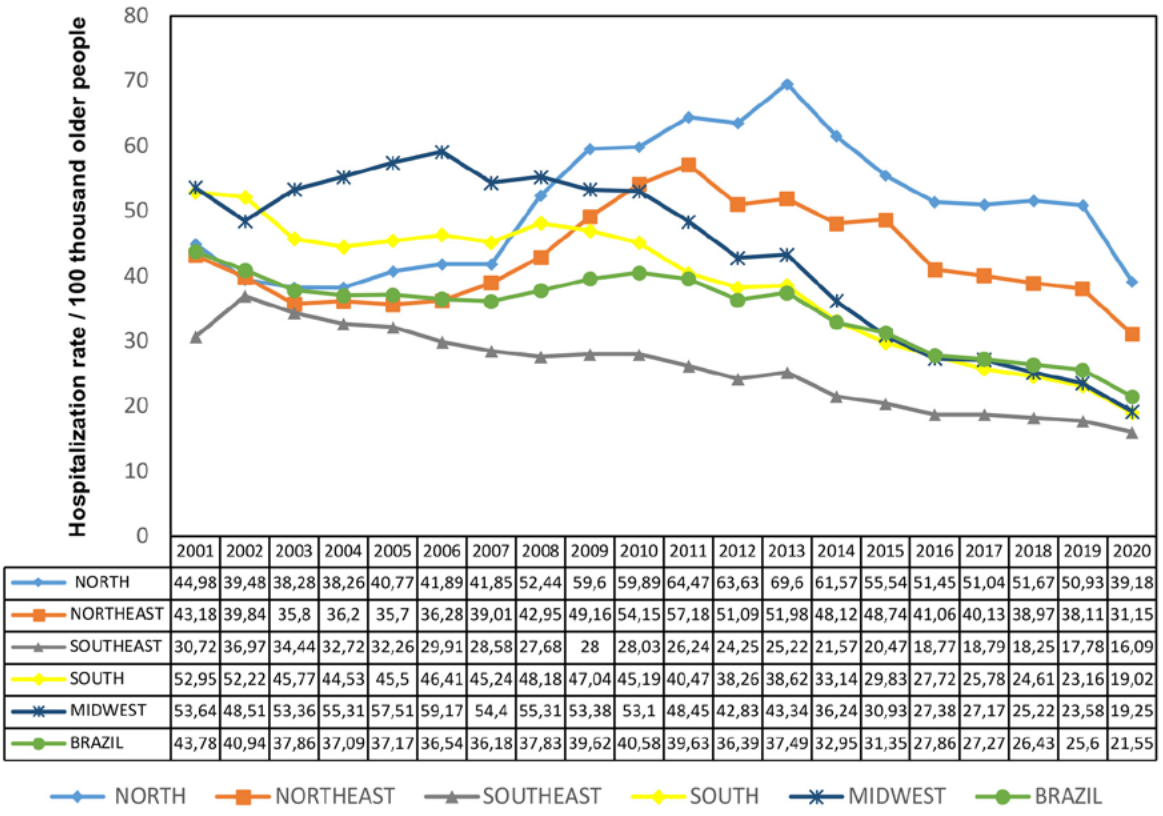
This research used secondary data available on official websites of the Ministry of Health of Brazil, being exempt from consideration by a research ethics committee, in accordance with Resolution 466/2012 of the National Health Council.

## RESULTS

From 2001 to 2020, there were 1,445,497 hospital admissions for DM in older people aged 60 years or more in Brazil. The analysis of the annual rates of hospitalization for DM shows that Brazil registered a rate of 43.78 admissions/100,000 older people in 2001 and 21.55/100,000 older people in 2020 (Figure 01).



The Regions that presented the highest hospitalization rates over the years analyzed were the North Region (69.6/100,000 older people in 2013), Midwest Region (59.17/100,000 older people in 2006), Northeast Region (57.18 /100,000 older people in 2011) and the South Region (52.95/100,000 older people in 2001), all with values above the highest Brazilian rate (43.78/100,000 older people in 2001). The Southeast Region was the only one to present values lower than these (36.97/100,000 older people people in 2002) (Figure 1).




| | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| NORTH | 44,98 | 39,48 | 38,28 | 38,26 | 40,77 | 41,89 | 41,85 | 52,44 | 59,6 | 59,89 | 64,47 | 63,63 | 69,6 | 61,57 | 55,54 | 51,45 | 51,04 | 51,67 | 50,93 | 39,18 |
| NORTHEAST | 43,18 | 39,84 | 35,8 | 36,2 | 35,7 | 36,28 | 39,01 | 42,95 | 49,16 | 54,15 | 57,18 | 51,09 | 51,98 | 48,12 | 48,74 | 41,06 | 40,13 | 38,97 | 38,11 | 31,15 |
| SOUTHEAST | 30,72 | 36,97 | 34,44 | 32,72 | 32,26 | 29,91 | 28,58 | 27,68 | 28 | 28,03 | 26,24 | 24,25 | 25,22 | 21,57 | 20,47 | 18,77 | 18,79 | 18,25 | 17,78 | 16,09 |
| SOUTH | 52,95 | 52,22 | 45,77 | 44,53 | 45,5 | 46,41 | 45,24 | 48,18 | 47,04 | 45,19 | 40,47 | 38,26 | 38,62 | 33,14 | 29,83 | 27,72 | 25,78 | 24,61 | 23,16 | 19,02 |
| MIDWEST | 53,64 | 48,51 | 53,36 | 55,31 | 57,51 | 59,17 | 54,4 | 55,31 | 53,38 | 53,1 | 48,45 | 42,83 | 43,34 | 36,24 | 30,93 | 27,38 | 27,17 | 25,22 | 23,58 | 19,25 |
| BRAZIL | 43,78 | 40,94 | 37,86 | 37,09 | 37,17 | 36,54 | 36,18 | 37,83 | 39,62 | 40,58 | 39,63 | 36,39 | 37,49 | 32,95 | 31,35 | 27,86 | 27,27 | 26,43 | 25,6 | 21,55 |

**Figure 1.** Temporal distribution of hospital admission rates in the SUS (per 100,000 older people) for DM in older people aged 60 years and over in Brazil and regions, 2001-2020. Source: SIH-SUS – DATASUS/MS.

In Brazil, from 2001 to 2020, the rates of hospitalizations for DM in older people showed a significant reduction trend (AAPC= -3.4% 95%CI -4.5; -2.3), with three points of change in the period (*joinpoints*). With emphasis on the periods of the first and third *joinpoints*, in which hospitalizations for DM in older people in Brazil decreased significantly each year (Table 1).

The Southeast, South and Midwest regions showed a trend towards a significant reduction in hospitalizations, but the Southeast Region (AAPC= -4.0% 95%CI -4.5; -3.5) did not show *joinpoints*.

For the North (AAPC= -0.0% 95%CI -2.0; 2.0) and Northeast (AAPC= -1.2% 95%CI -2.5; 0.2) regions, two joinpoints were formed, interspersing segments of significant increases and decreases (Table 1).

The spatial analysis of hospitalization rates showed strong spatial autocorrelation by Moran Global values only in the last five years (I<0.3). However, all maps showed the formation of RIAU clusters with high hospitalization rates.

In the first two five-year periods, the high-high *cluster* was concentrated in the Midwest region. In the last two five-year periods, the North and Northeast regions presented high-high *clusters* (Figure 2). Also noteworthy is the formation of *clusters* of low hospitalization rates (Low-Low) in the Southeast over all five-year periods, with a gradual increase in Low-Low aggregates over the years (Figure 2).

**Table 1.** Temporal trend in SUS admission rates for DM in older people aged 60 years and over for Brazil and large geographic regions, from 2001 to 2020.

| Geographical area | Starting year | Final year | APC ($IC_{95\%}$) | *p* | AAPC ($IC_{95\%}$) | *p* |
|---|---|---|---|---|---|---|
| North region | | | | | | |
| Seg. 1 | 2001 | 2004 | -5.4 (-14.8; 5.1) | 0.300 | -0.0 (-2.0; 2.0) | 1.0 |
| Seg. 2 | 2004 | 2012 | 8.2* (5.2; 11.2) | <0.05 | | |
| Seg. 3 | 2012 | 2020 | -5.7* (-7.8; -3.5) | <0.05 | | |
| Northeast region | | | | | | |
| Seg. 1 | 2001 | 2005 | -5.4* (-9.6; -1.0) | <0.05 | -1.2 (-2.5; 0.2) | 0.1 |
| Seg. 2 | 2005 | 2011 | 9.3* (5.8; 12.8) | <0.05 | | |
| Seg. 3 | 2011 | 2020 | -5.7* (-7.0; -4.5) | <0.05 | | |
| Southeast region | | | | | | |
| Seg. 1 | 2001 | 2020 | -4.0* (-4.0; -4.5) | <0.05 | -4.0* (-4.5; -3.5) | <0.05 |
| South region | | | | | | |
| Seg. 1 | 2001 | 2004 | -6.2* (-11.9; -0.2) | <0.05 | -4.9* (-6.2; -3.6) | <0.05 |
| Seg. 2 | 2004 | 2009 | 1.9 (-2.1; 6.0) | 0.300 | | |
| Seg. 3 | 2009 | 2020 | -7.6* (-8.3; -6.8) | <0.05 | | |
| Midwest region | | | | | | |
| Seg. 1 | 2001 | 2009 | 1.2 (-0.5; 2.9) | 0.200 | -4.9* (-5.7; -4.0) | <0.05 |
| Seg. 2 | 2009 | 2020 | -9.0* (-10.0; -8.1) | <0.05 | | |
| Brazil | | | | | | |
| Seg. 1 | 2001 | 2004 | -6.1* (-11.4; -0.6) | <0.05 | -3.4* (-4.5; -2.3) | <0.05 |
| Seg. 2 | 2004 | 2011 | 1.5 (-0.4; 3.5) | 0.100 | | |
| Seg. 3 | 2011 | 2020 | -6.1* (-7.1; -5.1) | <0.05 | | |

Seg.: Segment; APC: Anual Percentage Change; AAPC: Average Annual Percent Change; $IC_{95\%}$: 95% confidence interval; *APC is significantly different from zero at the alpha = 0.05 level. Source: SIH-SUS – DATASUS/MS.

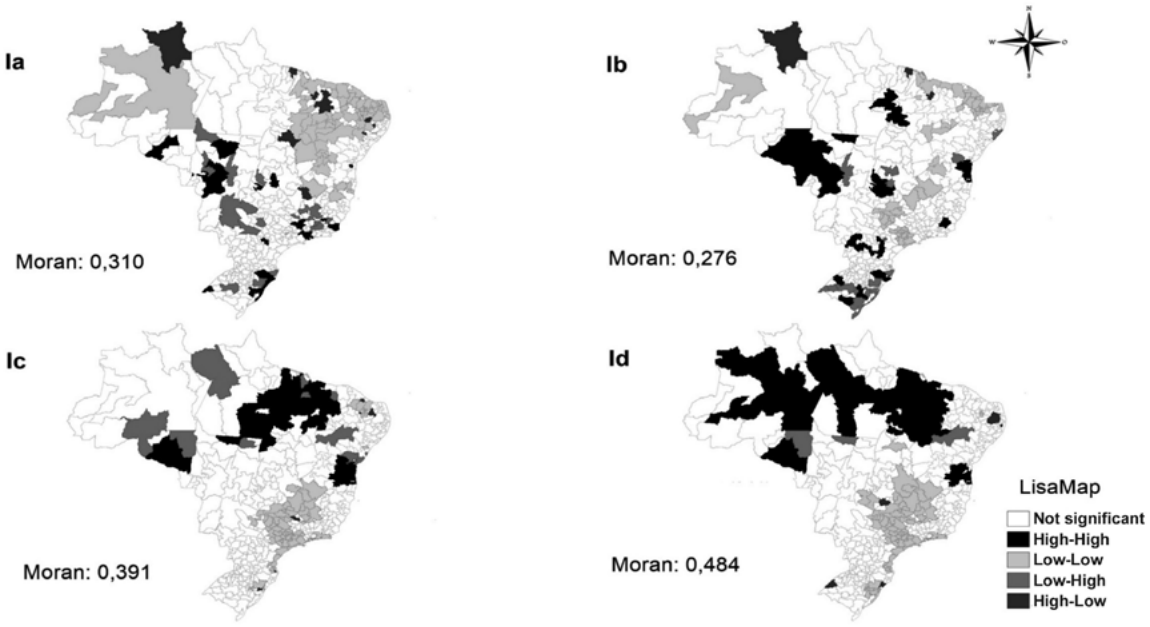



**Figure 2.** *LisaMap* and Moran Global values of hospitalization rates in the SUS (per 100,000 older people) for DM in older people (60 years or more) by RIAU in Brazil, 2001-2020. - Ia: 2001-2005; Ib: 2006-2010; Ic: 2011-2015; Id: 2016-2020.

Source: SIH-SUS – DATASUS/MS.

The bivariate spatial analysis (Figure 3) showed the formation of *clusters* with high rates of hospitalization for DM and a high percentage of FHS coverage in RIAUS in the states of Maranhão, Piauí, Paraíba and Southern Bahia (High-high). On the other hand, for the state of São Paulo and for the South Region, low rates of hospitalizations for DM and low percentages of FHS coverage (low-low) were pointed out.

Regarding the supply of nurses and doctors from the FHS, the formation of *clusters* with high rates of hospitalizations due to DM and a high supply of professionals from the FHS in a large part of the North Region and in some Northeastern states, specifically Maranhão, Piauí and Rio Grande do Norte (High-high). The North region also showed the formation of a High-high *cluster* when the hospitalizations with the indicator 'percentage of poor people' were analyzed (Figure 3).

For the MHDI, the graphs showed that the South, Southeast and Midwest regions concentrated the lowest rates of hospitalizations for DM and higher MHDI values (Low-high), however, there were small distributions of high percentages of hospitalizations and high MHDI in RIAU in the South Region, specifically in Maringá, Criciúma and São Miguel do Oeste (High-high). In the North region, there were high hospitalization rates and a low MHDI index (High-low) (Figure 3).

For the variable 'aging rate', it was possible to observe high rates of hospitalizations and low rates of population aging over a large area in the North Region (High-low). High rates of hospitalization and high rates of population aging were observed for the RIAU in the states of Rio Grande do Sul, Belo Horizonte and Paraíba (High-high) (Figure 3).

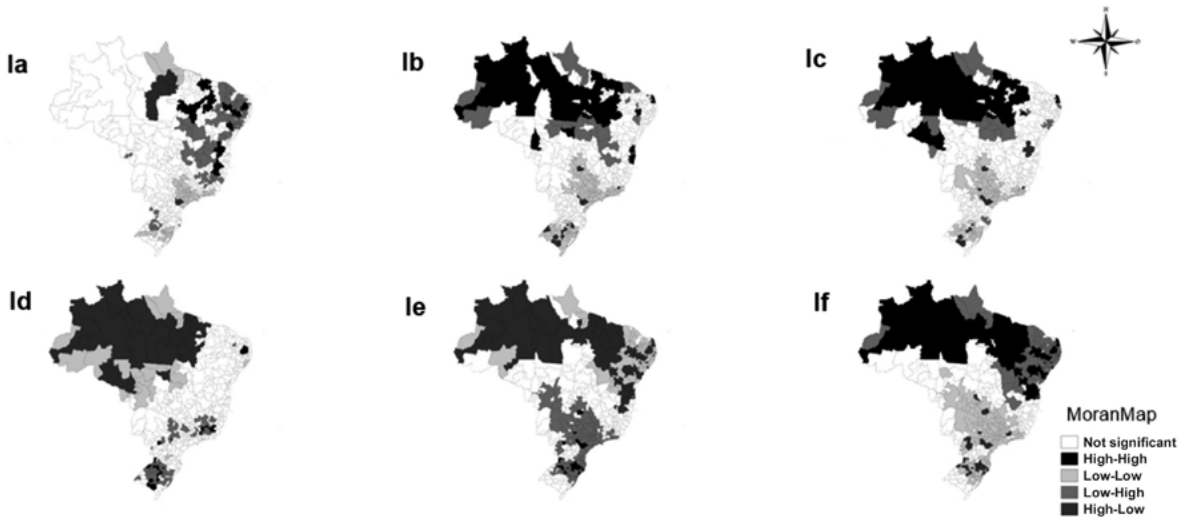
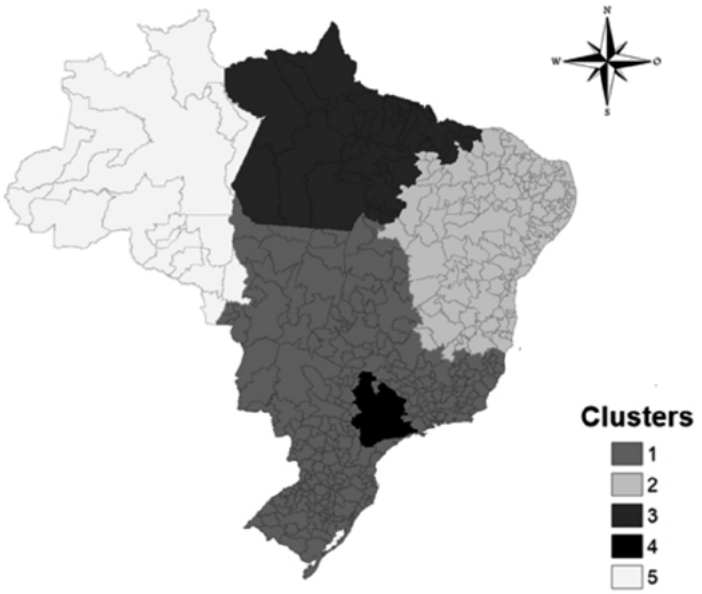



**Figure 3.** Bivariate *MoranMap* between the hospitalization rate for DM in older people (60 years old or more), social indicators and the supply of health services by RIAU in Brazil, 2016-2020. - Ia: Hospitalization x FHS Coverage; Ib: Hospitalization x Offer of Nurses; Ic: Hospitalization x Offer of Doctors; Id: Hospitalization x Aging; Ie: Hospitalization x MHDI; If: Hospitalization x Poor people.

Source: SIH-SUS – DATASUS/MS.

The analysis using the Skater technique (Figure 4) identified the C3 *cluster* composed mainly of states in the North Region (Amapá, Pará and Tocantins) and part of the state of Maranhão in the Northeast, with the characteristic high rates of hospitalizations for DM (Z=1.21) and the highest percentage of poor population (Z=1.24), second lowest rate of population aging (Z=-1.41), the lowest MHDI in the country (Z=-1.12) and lower coverage of the FHS (Z=-0.15). However, this *cluster* presents the second best offer of nurses and doctors in the FHS in Brazil (Figure 4).

There was also the formation of a C4 *cluster* comprising 29 RIAU in the state of São Paulo; this had the lowest rates of hospitalization for DM (Z=-0.76) while it had the worst indicators of offers of service and health professionals, with a low FHS coverage rate (Z=-2.47 ) and low supply of nurses and physicians (Z=-1.19 and Z=-1.14, respectively), however, this *cluster* was the one with the best MHDI index (Z=1.13), the lowest percentage of poor people (Z=1.02) and the second highest rate of population aging (Z=0.16) (Figure 4).




Cluster centers:

| | TAX_INTER | COB_ESF | O_ENF | O_MED | IDHM | POBRES | ENVELHECIM |
|---|---|---|---|---|---|---|---|
| C1 | -0.282912 | 0.0308621 | -0.393321 | -0.310357 | 0.61967 | -0.661916 | 0.345268 |
| C2 | -0.259035 | 0.480239 | 0.509334 | 0.301096 | -1.0042 | 1.01805 | -0.0574569 |
| C3 | 1.21854 | -0.15268 | 1.08332 | 1.14007 | -1.12828 | 1.24669 | -1.41926 |
| C4 | -0.762532 | -2.47278 | -1.19207 | -1.14874 | 1.13668 | -1.02962 | 0.165222 |
| C5 | 0.737386 | 0.13627 | 1.38668 | 1.64171 | -0.551535 | 0.631277 | -1.87616 |

**Figure 4.** Skater map for analysis of hospitalization patterns for DM in older people (60 years and over) and their relationship with social indicators and health service provision by RIAU in Brazil, 2016-2020.

Atlas of Human Development in Brazil of the United Nations Development Program (UNDP). Source: SIH-SUS – DATASUS/MS.

## DISCUSSION

Despite the increasing propensities in the prevalence of DM in Brazil and worldwide[1,4], the results of the present study show that there has been a trend towards a reduction in hospitalizations for DM in older people aged ≥60 years in Brazil in the last 20 years.

Several factors can be related to explain this change, among them, in 2001, there was the implementation of the guidelines of the Plan for the Reorganization of Attention to Hypertension and Diabetes[17] which was the basis for organizing a Diabetes Detection Campaign at the national level, this aimed at mass testing of the population to detect individuals with DM in order to standardize services and train SUS professionals to meet this demand.

From the DM Detection Campaign, changes were induced in the monitoring and treatment of DM, improvements in the dispensing of medications, greater access to references to control complications, educational actions aimed at nutritional guidelines and physical activities[17].

Furthermore, it is observed that in the years that there were notable declines in hospitalizations in this study, they subsequently correspond to the periods of implementation of policies established by the Federal Government that aimed to improve the quality of life of older people in Brazil.

As an example of such policies instituted in the country, we can mention the formulation of the Older People Statute created in 2003 and the Pact for Health established in February 2006, both, respectively, aimed at ensuring social rights such as the assistance of a minimum wage for all older people who were on the poverty line, as well as maintaining the theme of aging as a fundamental discussion in the health area[18,19].

In concession to the formulation of the Pact for Health, in March 2006 there was a historic milestone in the strengthening of Primary Health Care (PHC) with the rise of the Family Health Strategy (FHS) by the National Primary Care Policy (NPCP), which was reformulated in 2017 and, in all stages of planning and implementation, the health of the older person was configured as one of the strategic areas for the performance of Primary Care[20].

It is worth noting that in the same year of this historic milestone in the Brazilian health system, in October 2006 the National Health Policy for the Older Person (NHPOP) was approved, which had plans for the healthy aging of the population[21].

Considering the reality of the Brazilian population aging and the combination of these policies to protect the health of older people, the PHC offers programs and actions that support users in this age group, corresponding to consultations with different specialties and multidimensional assessments guided by the Health Handbook of the Older Person; the Hiperdia Program, which aims to prevent and control CNCDs such as Hypertension and Diabetes; Home Care Program; Among other education and health actions[18-22].

In this context, the FHS is a privileged space for comprehensive health care for the older person, in which the effective insertion of these users in Health Units, with the combination of these population protection policies, may be directly contributing to the reduction of hospitalizations for preventable causes throughout Brazil, such as DM.

Another important demonstration of this study (Table 1 and Figure 2) is that although a trend towards a reduction in hospitalizations of older people in Brazil caused by DM was evidenced, the high rates of hospitalizations that still prevail are unevenly distributed among the major regions of the country. While in the Midwest, South and Southeast, the hospitalization rates for DM are decreasing, in the North and Northeast there is a slow tendency to decrease.

According to Pagotto[23], the high prevalence of hospitalizations and associated factors are mainly related to economic and social issues. The results of the bivariate and multivariate analysis (Figure 3 and Figure 4) of this study corroborate this finding, since when comparing the hospitalization rate with social indicators, such as the percentage of poor people and the MHDI, the North and Northeast, in addition to concentrating the highest rates of hospitalizations, being substantially notorious in the last five-year periods analyzed, they also presented greater vulnerabilities among all regions of the country, recording high rates of hospitalizations with a high percentage of poor people and low MHDI in the periods analyzed.

Other surveys have also found similar values of these indicators for both regions and claim that there are social and economic gaps between the North/Northeast and the rest of the country, understanding that these are factors that negatively affect the health conditions of these populations[24-26].

When we sought to assess the association between population aging and the hospitalization rate in this study, the results also showed the lowest aging rate in the country for the North and Northeast regions. In accordance with the data from this study, a survey that sought to understand the reasons for the declines in life expectancy of the population in different countries[27] found that social inequality, poverty and low quality of health care were determinants that contributed to the decrease in longevity in individuals over 65 years of age among all countries analyzed.

When the hospitalization rates and FHS coverage were investigated, it was identified that in the North, despite the high hospitalization rates, there was no *cluster* formation with FHS coverage in a large extent of the region. Soares[28] states in his study that the structuring of FHS in the North is unfavorable

and insufficient, and this is due to the deployment of teams in places outside its coverage area, which denotes a weakness in the service and makes it difficult for the user to bond with the health unit.

North and Northeast stood out with the largest supply of nurses and doctors at FHS, when compared to the others. This finding can be attributed to the implementation of the *Mais Médicos* Program (PMM), which was an emergency provision in the call for doctors to compose the FHS in territories with a shortage of this professional class. In 2018, more than 18,000 doctors were integrated into the PHC workforce, with the Northeast being one of the most favored regions with the program, which denotes an attempt to exercise equity in health by government entities, as these regions present remarkable socioeconomic vulnerabilities in its population[29,30].

Finally, we can highlight the most favorable scenario for the Midwest, South and especially the Southeast regions, which generally had the lowest rates of hospitalizations with a constant reduction in these rates and presented the best indicators of socioeconomic conditions and greater aging of the population.

Studies explain that the trend of these indicators for these regions is associated with the concentration of wealth and resources, reflecting in a good state of health and quality of life in these regions, especially in the state of São Paulo, which is characterized as the most rich in the country and where there is the highest percentage of older people with income above five minimum wages[31-33].

Despite the low FHS coverage rates and the offer of professionals, especially in São Paulo, Oliveira[34] reports in his study that these macro-regions have greater geographic accessibility to low, medium and high complexity care services, allowing greater chances of using such services and, consequently, better prevention of health problems.

Added to this factor, São Paulo is one of the cities with the greatest coverage of beneficiaries of private health plans in Brazil[35], which raises the hypothesis that there may be more hospitalizations of older people caused by DM in the capital, however, they are not paid for by the SUS.

Finally, the spatial behavior of DM, the geographic and cultural complexities and the disparities in socioeconomic conditions of life reinforce the need to produce information that collaborate to formulate strategies to reduce morbidity in this population.



However, as it is an ecological approach, the study has limitations inherent to its methodology, being subject to the bias of underreporting. Despite these limitations, this study is relevant for the survey of priority areas for the development of actions to prevent DM and other chronic diseases associated with it.

## CONCLUSION

Even if slowly, the expansion of government policies to protect the health of the older person marked a national commitment to the healthy aging of the population, this can be observed through the positive results, with the decline in hospitalization rates for DM in older people aged 60 years and over in Brazil in the last 20 years.

However, there are still regional disparities in hospital admission rates, which are strictly related to socioeconomic and care inequalities in the Brazilian territory resulting from historical legacies that demarcate the political and economic makeup of the country.

In this context, the findings are important data because they are strong indicators for the development and redirection of new public policies that aim to minimize this process of inequalities in Brazil and improve existing strategies in PHC for the prevention and control of DM in older people, especially in regions with high hospitalization rates.

Edited by: Marquiony Marques dos Santos

## REFERENCES


1. World Health Organization. Classification of Diabetes Mellitus [Internet]. Geneva: WHO; 2019 [cited 2121 Mar. 31]. Available from: https://www.who.int/publications/i/item/classification-of-diabetes-mellitus.
2. International Diabetes Federation. IDF Diabetes Atlas: People living with diabetes. 9th. ed. Brussels: IDF; 2019 [cited 2021 Mar. 31]. Available from: https://www.diabetesatlas.org/en/resources/.
3. Brasil. Ministério da Saúde. Vigitel Brasil 2019 : vigilância de fatores de risco e proteção para doenças crônicas por inquérito telefônico: estimativas sobre frequência e distribuição sociodemográfica de fatores de risco e proteção para doenças crônicas nas capitais dos 26 estados [Internet]. Brasília, DF: MS; 2020 [cited 2021 Mar. 15]. Available from: https://www.saude.gov.br/images/pdf/2020/April/27/vigitel-brasil-2019-vigilancia-fatores-risco.pdf .
4. Sociedade Brasileira de Diabetes. Diretrizes da Sociedade Brasileira de Diabetes 2019-2020 [Internet]. São Paulo: SBD; 2019 [cited 2021 Mar. 31]. Available from: https://www.diabetes.org.br/profissionais/images/DIRETRIZES-COMPLETA-2019-2020.pdf.
5. Marques AP, Montilla DER, de Almeida WS, de Andrade CLT. Hospitalization of older adults due to ambulatory care sensitive conditions. Rev Saúde Pública. 2014;48(5):817-26. Available from: https://doi.org/10.1590/S0034-8910.2014048005133.
6. Sociedade Brasileira de Diabetes. O impacto econômico de hospitalizações atribuídas ao diabetes e suas complicações [Internet]. São Paulo: SBD; 2018 [cited 2021 Mar. 31]. Available from: https://www.diabetes.org.br/publico/notas-e-informacoes/1630-o-impacto-economico-de-hospitalizacoes-atribuidas-ao-diabetes-e-suas-complicacoes .
7. Quarti MR, Rosa RS, Correa MG, Araújo DV, Bahiak LR, Toscano CM. Disease and economic burden of hospitalizations attributable to diabetes mellitus and its complications: a nationwide study in Brazil. Int J Environ Res Public Health. 2018;15(2):e294. Available from: https://doi.org/10.3390/ijerph15020294.
8. Alfradique ME, Bonolo PF, Dourado I, Lima-Costa MF, Macinko J, Mendonça CS, et al. Ambulatory care sensitive hospitalizations: elaboration of brazilian list as a tool for measuring health system performance. Cad Saúde Pública. 2009;25(6):1337-49. Available from: https://doi.org/10.1590/S0102-311X2009000600016.
9. Rocha PRD, David HMSL. Determinação ou Determinantes?: uma discussão com base na Teoria da Produção Social da Saúde. Rev Esc Enferm USP. 2015;49(1):129-35. Available from: https://doi.org/10.1590/S0080-623420150000100017.
10. Brasil. DATASUS: Departamento de Informática do SUS [Internet]. Brasília, DF; DATASUS; 1991 -. Sistema de informações hospitalares do SUS. 2021 [cited 2021 Ago. 19]. Available from: http://www2.datasus.gov.br/DATASUS/index.php?area=0202&id=11633 .
11. Instituto Brasileiro de Geografia e Estatística. Base de informações do Censo Demográfico 2010: resultados do universo por setor censitário [Internet]. Brasília, DF: IBGE; 2011 [cited 2021 Ago. 19]. Available from: https://www.ibge.gov.br/ .
12. Instituto Brasileiro de Geografia e Estatística. Divisão Urbano Regional [Internet]. Brasília, DF: IBGE; 2013 [cited 2021 Fev. 28]. Available from: https://www.ibge.gov.br/geociencias/cartas-e-mapas/redes-geograficas/15777-divisao-urbano-regional.html?=&t=o-que-e.
13. Kim HJ, Fay MP, Yu B, Barrett MB, Feuer EJ. Comparability of segmented line regression models. Biometrics. 2004;60(4):1005-14. Available from: https://onlinelibrary.wiley.com/doi/abs/10.1111/j.0006-341X.2004.00256.x.
14. Neves MC, Ramos FR, Camargo ECG, Camara G, Monteiro AM. Análise exploratória espacial de dados sócio-econômicos de São Paulo. An GIS Bras. 2000;1(1998):1-10. Available from: http://www.dpi.inpe.br/gilberto/papers/marcos_gisbrasil2000.pdf.
15. Dantas AP, de Azevedo UN, Nunes AD, Amador AE, Marques M V, Barbosa IR. Analysis of suicide mortality in brazil: spatial distribution and socioeconomic context. Rev Bras Psiquiatr. 2018;40(1):12-8. Available from: https://doi.org/10.1590/1516-4446-2017-2241.
16. Vasconcelos CH, Fonseca FR, Laurence M, Lise Z, de Lourdes M, Simões N. Fatores ambientais e socioeconômicos relacionados à distribuição de casos de leptospirose no Estado de Pernambuco, Brasil, 2001 – 2009. Cad Saúde Colet. 2009;20(1):49-56. Available from: http://www.cadernos.iesc.ufrj.br/cadernos/images/csc/2012_1/artigos/CSC_v20n1_49-56.pdf.
17. Brasil. Ministério da Saúde. Plano de reorganização da atenção à hipertensão arterial e ao Diabetes Mellitus [Internet]. Brasília, DF:MS; 2001 [cited 2021 Apr. 24]. Available from: http://bvsms.saude.gov.br/bvs/publicacoes/reorganizacao_campanha.pdf.
18. Brasil. Ministério da Saúde. Lei nº. 10.741, de 01 de outubro de 2003. Dispõe sobre o Estatuto do Idoso e dá outras providências. Diário Oficial da União. 2003. Available from: http://www.planalto.gov.br/ccivil_03/leis/2003/l10.741.htm.

19. Brasil. Ministério da Saúde. Portaria nº. 399, de 22 de fevereiro de 2006. Divulga o Pacto Pela Saúde 2006 – Consolidação do SUS e aprova as Diretrizes Operacionais do Referido Pacto. Saúde Légis. 2006. Available from: http://bvsms.saude.gov.br/bvs/saudelegis/gm/2006/prt0399_22_02_2006.html

20. Brasil. Ministério da Saúde. Portaria nº. 2.436, de 22 de setembro de 2017. Aprova a Política Nacional de Atenção Básica, estabelecendo a revisão de diretrizes para a organização da Atenção Básica, no âmbito do Sistema Único de Saúde (SUS). Saúde Légis. 2017. Available from: https://bvsms.saude.gov.br/bvs/saudelegis/gm/2017/prt2436_22_09_2017.htm.

21. Brasil. Ministério da Saúde. Portaria nº. 2.528, de 19 de outubro de 2006. Aprova a Política Nacional de Saúde da Pessoa Idosa (PNSPI). Saúde Légis. 2006. Available from: http://bvsms.saude.gov.br/bvs/saudelegis/gm/2006/prt2528_19_10_2006.html

22. Nicolau S, Batista KJD, Moura AA, Montarroyos JS. Práticas de educação em saúde realizadas por enfermeiros para pacientes do programa Hiperdia. J Manag Prim Health Care. 2018;9(e9):1-9. Available from: https://doi.org/10.14295/jmphc.v9i0.507

23. Pagotto V, Silveira EA, Velasco WD. Perfil das hospitalizações e fatores associados em idosos usuários do SUS. Ciênc Saúde Colet. 2013;18(10):3061-70. Available from: https://doi.org/10.1590/S1413-81232013001000031.

24. Barreto ML. Desigualdades em saúde: uma perspectiva global. Ciênc Saúde Colet. 2017;22(7):2097-2108. Available from: https://doi.org/10.1590/1413-81232017227.02742017.

25. Hissa-Teixeira K. Uma análise da estrutura espacial dos indicadores socioeconômicos do nordeste brasileiro (2000-2010). EURE. 2018;44(131):101-24. Available from: http://dx.doi.org/10.4067/S0250-71612018000100101.

26. Pochmann M, Caetano LCS. Spatial concentration of production and social inequalities. Rev Bras Estud Urb Reg. 2020;22:1-25. Available from: https://doi.org/10.22296/2317-1529.rbeur.202004.

27. Ho JY, Hendi AS. Recent trends in life expectancy across high income countries: Retrospective observational study. BMJ. 2018;362(15):1-10. Available from: http://doi.org/10.1136/bmj.k2562.

28. Soares Filho AM, Vasconcelos CH, Dias AC, de Souza AC, Merchan-Hamann E, da Silva MRF. Atenção primária à saúde no Norte e Nordeste do Brasil: mapeando disparidades na distribuição de equipes. Ciênc Saúde Colet. 2020;1-10. Available from: http://www.cienciaesaudecoletiva.com.br/artigos/atencao-primaria-a-saude-no-norte-e-nordeste-do-brasil-mapeando-disparidades-na-distribuicao-de-equipes/17843?id=17843.

29. Goncalves RF, Bezerra AFB, Tanaka OY, dos Santos CR, Silva KSBE, de Sousa IMC. Influência do Mais Médicos no acesso e na utilização de serviços de saúde no Nordeste. Rev Saúde Pública. 2019;53:1-10. Available from: https://doi.org/10.11606/s1518-8787.2019053001571.

30. Pinto HA, Sales MJT, Oliveira FP, Brizolara R, de Figueiredo AM, Santos JT. O Programa Mais Médicos e o fortalecimento da Atenção Básica. Divulg Saúde Debate. 2014;(51):105-20. Available from: https://doi.org/10.1136/bmj.k2562.

31. de Albuquerque MV, Viana ALA, de Lima LD, Ferreira MP, Fusaro ER, Iozzi FL. Regional health inequalities: changes observed in Brazil from 2000-2016. Ciênc Saúde Colet. 2017;22(4):1055-64. Available from: https://doi.org/10.1590/1413-81232017224.26862016 .

32. Viacava F, Porto SM, Carvalho CC, Bellido JG. Desigualdades regionais e sociais em saúde segundo inquéritos domiciliares (Brasil, 1998-2013). Ciênc Saúde Colet. 2019;24(7):2745-60. Available from: https://doi.org/10.1590/1413-81232018247.15812017.

33. de Melo NCV, Ferreira MAM, Teixeira KMD. Condições de vida dos idosos no Brasil: uma análise a partir da renda e nível de escolaridade. OIKOS. 2014;25(1):4-19. Available from: https://periodicos.ufv.br/oikos/article/view/3687.

34. de Oliveira RAD, Duarte CMR, Pavão ALB, Viacava F. Barriers in access to services in five health regions of Brazil: Perceptions of policymakers and professionals in the Brazilian Unifed National Health System. Cad Saúde Pública. 2019;35(11):1-9. Available from: https://doi.org/10.1590/0102-311X00120718 .

35. São Paulo, Secretaria Municipal de Saúde. Saúde suplementar na cidade de São Paulo [Internet]. São Paulo: SMS; 2015 [cited 2021 Apr. 21]. (Boletim ISA Capital - SP, 19). Available from: https://www.prefeitura.sp.gov.br/cidade/secretarias/upload/saude/arquivos/publicacoes/ISA_2015_SS.pdf.