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Trends in hospital admissions and mortality from diabetes mellitus in Rio Grande do Sul: historical series 2000-2020

Tendência das hospitalizações e mortalidade por diabetes mellitus no Rio Grande do Sul: série histórica 2000-2020

Tendencias de la hospitalización y la mortalidad por diabetes mellitus en Rio Grande do Sul: série histórica 2000-2020

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ABSTRACT

Objective: To analyze the trends of hospital admissions and deaths from diabetes mellitus in the 18 host municipalities of the 19 regional health coordination offices and in Rio Grande do Sul, 2000-2020.

Method: Ecological study with secondary data collected in the Hospital Information System, the Mortality Information System, and the Brazilian Institute of Geography and Statistics, from 2000-2020. Coefficients were standardized using the direct method and Prais-Winsten regression analysis.

Results: A downward trend wasfound in the coefficients of hospitalizations for diabetes mellitus in most cities and states. In 2020, for both areas, hospitalizations for diabetes mellitus were below the average of the period. The mortality trend remained stationary in almost all municipalities and in the state.

Conclusion: There was evidence of a decrease in hospitalizations and stationary mortality by DM in most municipalities analyzed, possibly due to the policies and actions implemented in the period, despite the aging of the population.

Descriptors: Diabetes Mellitus. Mortality. Hospitalization. Time series studies.

RESUMO
Objetivo: Analisar a tendência das internações hospitalares e dos óbitos por diabetes mellitusnos 18 municípios-sede das 19 coordenadorias regionais de saúde e no Rio Grande do Sul, 2000-2020.
Método: Estudo ecológico com dados secundários coletados no Sistema de Informações Hospitalares, Sistema de Informação sobre Mortalidade e Instituto Brasileiro de Geografia e Estatística, de 2000-2020. Foi realizada padronização dos coeficientes pelo método direto e análise por regressão de Prais-Winsten.
Resultados: Encontrou-se tendência de diminuição dos coeficientes de internações por diabetes mellitus na maioria dos municípios e Estado. Em 2020, foram observadas hospitalizações por diabetes mellitus abaixo da média obtida no período, para ambos. A tendência de mortalidade permaneceu estacionária em quase todos os municípios e no Estado.
Conclusão: Foi evidenciada diminuição das internações e mortalidade estacionária por DM na maioria dos municípios analisados, possivelmente em virtude das políticas e ações implementadas no período, apesar do envelhecimento da população.
Descritores: Diabetes Mellitus. Mortalidade. Hospitalização. Estudos de séries temporais.

RESUMEN
Objetivo: Analizar la tendencia de hospitalizaciones y muertes por diabetes mellitus en las 18 ciudades sede de las 19 coordinaciones regionales de salud y en Rio Grande do Sul, 2000-2020.
Método: Estudio ecológico con datos secundarios recolectados en el Sistema de Información Hospitalaria, el Sistema de Información de Mortalidad y el Instituto Brasileño de Geografía y Estadística, de 2000 a 2020. Los coeficientes se estandarizaron mediante el método directo y el análisis de regresión de Prais-Winsten.
Resultados: Se encontró una tendencia a la baja en los coeficientes de hospitalizaciones por diabetes mellitus en la mayoría de las ciudades y estados. En 2020, en ambas las áreas, las internaciones por diabetes mellitus estuvieron inferiores al promedio obtenido en el período. La tendencia de mortalidad se mantuvo estacionaria en casi todos los municipios y en el estado.
Conclusión: Se evidenció una disminución de las internaciones y de la mortalidad estacionaria por DM en la mayoría de los municipios analizados, posiblemente en función de las políticas y acciones implementadas en el período, a pesar del envejecimiento de la población.
Descriptores: Diabetes Mellitus. Mortalidad. Hospitalización. Estudios de series temporales.

INTRODUCTION

Diabetes mellitus (DM) is a part of the Brazilian list of Ambulatory Care-Sensitive Conditions (ACSC) that provoke hospitalizations[1] and is considered to be an avoidable death by different lists and in different age groups. DM in children up to 5 years old is an avoidable disease if adequate diagnostic and treatment actions are taken[2]. In people from 5 to 75 years old, it is classified as a reducible disease, if adequate actions are taken for health promotion, prevention, control and care for non-communicable chronic diseases (NCCDs)[3]. Therefore, hospitalizations and deaths by DM can reflect the quality of local health systems, and the collection of epidemiological information can aid decision making[4,5].

According with the National Health Survey (PNS), the proportion of persons with DM in Brazil was 7.7% in 2019. In a comparison between macro-regions, the Southeast and South stood out, with 8.5% and 7.9% respectively, above the national average[6]. Still regarding the possibility of DM, the Surveillance System of Risk and Protective Factors for Chronic Diseases by Telephone Survey (VIGITEL) discovered that, in the city of Porto Alegre, there was an increase in the number of people diagnosed with the disease and, in 2006, the prevalence was 5.6%[7], while in 2021 this number grew to 8.7%[8].

Although the peak of DM incidence is in 55-year-old or older adults, the disease is the seventh greatest cause ofDisability-Adjusted Life Years (DALY). In the current global setting, the suffering caused by this disease, as measured by DALYs, has increased more than the aging of the population. The burden of diabetes is greater in Eastern Europe and developed countries, such as the United States, when it comes to DALYs, but certain trends have been showing an increased prevalence in low-income countries[9].

DM represents 5% of the burden of this disease in Brazil; it is the 3rd most common cause of DALY in women, and the 6th in men[10]. Chronic DM complications represent 80% of years lived with disability (YLD)[10].

And DM becomes increasingly common with population aging. The PNS with data from 2014 and 2015 showed that the age group above 60 has a higher prevalence of DM. The 2019 edition found the same effect of age in DM; in the age group from 18 to 29, its percentage was low (0.6%), while among those from 65 to 74, it reached 21.9%[6].

Brazil has the fifth largest population in the world, and its people are aging fast[11]. In Rio Grande do Sul, the population above 60, from 2000 to 2010, grew nearly 30%. Despite the fact that there was no census in the country in 2020, it can be assumed that the estimates of population aging will be confirmed[8].

Overweight and obesity are known risk factors for DM[12]. The PNS from 2019 showed that the overweight prevalence in the population over 18, for both sexes, was 60.3%, while obesity affected 25.9%[13], while the 2013 PNS found 20.8% in this regard[14]. A publication from the Ministry of Health, based on data from the Food and Nutrition Surveillance System (SISVAN), according to records from primary care information systems, showed that, in Rio Grande do Sul, 39% of the people analyzed were obese[15]. According to VIGITEL, in 2021, the proportional prevalence of obesity in people above 18 in Porto Alegre was 22.6%, with most cases affecting people from 45 to 64 years old[8].

Rio Grande do Sul is organized in 19 regional health coordinationoffices(CRS). The cities which are the headquarters of these CRS, even those classified as having small

populations, stand out due to their infrastructure and regional representativeness. This includes the organization of their health care networks. Thus, monitoring and following NCCDs such as DM can contribute to an evaluation of its impact on the health system.

Considering the aging of the population in the state and the growing issue of obesity, in addition to greater coefficients of the disease in Brazil and in the state, DALYs, and the quality of health services, our goal is to analyze the behavior of DM. Therefore, the goal of this study was to evaluate the historical series trend of hospitalizations and deaths by DM in the cities that headquarter the regional health coordination offices in the state of Rio Grande do Sul, from 2000 to 2020.

METHOD

We carried out an ecological study analyzing the trends of the coefficients of hospitalizations and deaths by DM in the population of the cities that headquarter the regional health coordination offices in Rio Grande do Sul (RS), from 2000 to 2020.

The RS health system has a decentralized organization, functioning in 19 CRS represented by 18 cities - since the capital Porto Alegre is responsible for two different regions. The cities that headquarter CRSs are: Alegrete, Bagé, Cachoeira do Sul, Caxias do Sul, Cruz Alta, Erechim, Frederico Westphalen, Ijuí, Lajeado, Osório, Palmeira das Missões, Passo Fundo, Pelotas, Porto Alegre, Santa Cruz do Sul, Santa Maria, Santa Rosa, and Santo Ângelo.

Data was collected from May to October 2022 by four scientific initiation scholarship recipients. Hospitalizations for DM were collected from the Hospital Information System of the Unified Health System (SIH/SUS), according to place of residence, sex, and age group. Hospitalization coefficients were calculated according to the equation: [(number of hospitalizations for DM in the municipality per sex and age group in the year/population of the municipality per sex and age group in the year) x 10,000 residents].

The number of deaths by DM of the population that resides in each municipality in the study and in the state of Rio Grande do Sul was collected from the Mortality Information System(SIM) through TABNET - which shows vital statistics according to sex and age group. Specific mortality coefficients were calculated using the following formula: [(number of deaths by DM in the municipality per sex and age group in the year/population of the municipality per sex and age group in the year) x 10,000 residents].

To describe coefficients of hospitalizations and mortality caused specifically by DM, we standardized the values using the direct method, considering the population of the state of

Rio Grande do Sul in 2010. Information on hospitalizations and deaths was collected according to sex and age group, in order to carry out direct standardization, but analysis did not consider these separations.

Data from the public databases of the federal government were collected and prepared for analysis using the software Microsoft Excel 2010. The statistical analysis used the software Stata 11.

We used *Prais-Winsten* Regression for trend analysis, presenting the regression coefficients, confidence intervals of 95%, and p-values of statistical tests[16]. The trends were considered to be growing when they showed a positive value and $p<0.05$; and decreasing when coefficients were negative and $p<0.05$; when $p\geq0.05$, trends were consideredstationary.

The information systems used in this study were available in the public domain, preventing identification of the individuals. Thus, the study did not require approval from a Research Ethics Committee.

RESULTS

The trend analysis in the state of Rio Grande do Sul showed, starting in 2011, a fall in the coefficients of hospitalizations by DM. In the period analyzed, considering the mean values presented, the municipalities of Santa Maria, Caxias do Sul, and Lajeado had the lowest coefficients of DM hospitalizations, all below 5 hospitalizations per 10.000 residents. On the other hand, the highest mean values of DM hospitalizations were reported in the municipalities of Osório, Palmeira das Missões, Bagé , and Cruz Alta, with values above 14 hospitalizations per 10.000 residents. In 2020, year of the coronavirus disease (COVID-19) pandemic, coefficients in all municipalities were lower than their average, except in Caxias do Sul. Still in 2020, Rio Grande do Sul presented a mean of 6.27 per 10.000 residents, below that of the cities of Bagé (11.93), Palmeira das Missões (7.18), and Porto Alegre (6.92) (Table 1).

Table 1 - Coefficient of hospitalizations by diabetes mellitus (DM) in the municipalities that headquarter regional health coordinationoffices (CRS) in the state of Rio Grande do Sul, from 2000 to 2020. Rio Grande do Sul, 2020

Year	Alegrete	Bagé	Cachoeira do Sul	Caxias do Sul	Cruz Alta	Erechim	FW	Ijuí	Lajeado	Osório	Palmeira das Missões	Passo Fundo	Pelotas	POA	Santa Maria	Santa Rosa	SCS	Santo Ângelo	RGS
2000	14.23	15.37	4.22	3.41	12.74	11.59	7.21	25.00	20.87	27.25	21.31	25.21	13.46	8.70	4.12	9.61	11.63	12.94	12.58
2001	15.60	11.30	9.02	3.25	12.26	12.26	8.68	19.20	11.26	19.17	19.55	27.45	14.11	8.53	3.77	7.11	14.31	8.46	10.53
2002	14.03	14.73	10.37	2.83	11.88	12.30	7.75	15.78	9.97	16.14	16.71	18.45	12.53	8.65	2.99	9.55	14.81	19.35	12.84
2003	11.65	13.49	6.40	2.88	7.64	10.36	11.01	13.48	6.67	19.17	10.96	17.73	8.53	7.22	2.94	7.50	12.49	17.62	9.52
2004	8.20	13.97	7.96	2.79	14.10	11.23	7.88	13.38	4.85	16.14	13.18	14.44	7.95	7.56	2.15	5.71	8.16	17.80	12.58
2005	12.92	15.85	7.82	3.18	14.48	11.30	5.27	13.33	3.33	19.99	11.67	12.26	7.10	7.28	3.03	7.99	8.05	15.75	11.11
2006	11.48	18.90	9.47	2.56	19.96	7.70	6.94	9.60	3.80	18.28	9.74	10.78	6.24	7.33	1.83	9.50	8.80	15.80	11.64
2007	11.59	14.78	6.51	3.13	18.70	7.62	10.00	9.35	4.51	19.99	20.29	13.61	6.83	7.05	1.42	4.70	9.07	19.01	11.51
2008	9.72	16.28	6.66	3.91	30.95	7.53	2.70	8.02	3.58	20.58	16.43	21.47	6.98	9.93	2.98	4.74	10.48	16.32	11.54
2009	7.17	16.70	8.31	2.74	21.20	7.33	12.12	6.88	3.12	25.41	18.05	11.73	7.50	9.76	2.30	6.58	14.54	16.08	10.94
2010	9.97	15.63	7.81	3.30	24.32	7.52	5.76	6.90	2.70	19.17	20.91	11.47	6.87	9.79	3.38	7.24	9.67	9.57	10.59
2011	9.30	15.05	5.19	2.90	20.37	6.14	7.88	4.18	3.43	14.30	19.56	7.80	7.39	8.97	2.56	8.51	9.28	10.05	9.40
2012	9.80	16.43	5.08	2.39	18.79	6.32	5.58	4.76	4.74	17.76	13.83	10.70	6.26	9.98	3.25	7.56	7.74	9.46	9.16
2013	8.31	16.48	6.61	2.79	11.42	4.83	5.98	2.55	3.28	8.77	16.44	7.85	5.05	8.98	3.25	6.31	7.52	4.33	8.29
2014	9.84	14.37	7.70	2.71	13.96	7.11	3.20	2.17	2.44	8.46	8.09	7.90	5.63	9.45	2.78	6.01	6.82	6.84	8.50
2015	4.87	13.71	11.60	3.06	8.72	5.41	4.55	3.07	2.01	4.70	4.44	10.68	5.83	9.35	1.93	6.62	3.95	6.90	7.82
2016	4.51	9.76	12.70	4.45	8.19	5.83	2.93	4.18	1.94	3.38	13.65	8.44	5.93	9.31	2.44	4.54	3.95	5.47	7.11
2017	4.09	12.63	12.0	6.18	7.53	4.08	6.75	1.80	1.30	6.86	20.03	7.78	6.04	8.23	2.02	3.05	3.26	5.74	6.74
2018	5.97	11.42	9.66	7.10	6.67	3.75	6.28	2.14	2.31	4.02	14.11	8.35	5.28	7.42	2.45	4.67	3.47	5.93	6.40
2019	4.18	12.20	6.09	5.29	5.85	3.16	5.19	2.53	1.10	11.54	8.63	4.85	5.65	7.65	2.91	3.89	5.13	4.07	6.07
2020	4.45	11.93	4.50	5.00	4.53	3.11	4.29	2.72	1.17	4.83	7.18	4.82	4.21	6.92	2.66	3.11	5.11	5.58	6.27
Mean	9.14	14.33	7.89	3.61	14.01	7.45	6.43	8.14	4.69	14.57	14.51	12.56	7.40	8.48	2.72	6.40	8.49	11.10	9.58

Source: Hospital Information System of the Unified Health System (SIH-SUS).

FW – Frederico Westfalen; POA – Porto Alegre; SCS – Santa Cruz do Sul; RGS – Rio Grande do Sul.

The trends of mortality by DM in Rio Grande do Sul remained stable during the period. The minimum value found was 2.85 deaths per 10.000 residents in 2015, and the highest was 3.49 deaths in 2019. The lowest coefficients of death by DM found in the historical series were in the municipalities of Santa Maria (2.34), Osório (2.46), and Ijuí (2.62). In Palmeira das Missões, Bagé, Cachoeira do Sul, Santa Cruz do Sul, Cruz Alta, Porto Alegre, and Lajeado, the mean death coefficients were higher than the state average. In 2020, 11 municipalities evaluated presented death coefficients higher than the mean in the whole period, albeit with no statistical significance (Table 2).

Table 2 - Coefficient of deaths by diabetes mellitus (DM) in the municipalities that headquarter regional health coordination offices (CRS) in the state of Rio Grande do Sul, from 2000 to 2020. Rio Grande do Sul, 2020

Year	Alegrete	Bagé	Cachoeira do Sul	Caxias do Sul	Cruz Alta	Erechim	FW	Ijuí	Lajeado	Osório	Palmeira das Missões	Passo Fundo	Pelotas	POA	Santa Maria	Santa Rosa	SCS	Santo Ângelo	RGS
2000	3.16	4.56	5.07	3.41	6.34	3.05	4.79	3.99	4.75	1.83	5.06	2.72	4.59	3.20	2.75	2.11	4.26	3.21	3.37
2001	2.88	4.27	3.28	3.25	4.81	2.54	1.43	2.91	3.60	2.04	4.42	2.36	4.12	3.07	2.33	5.12	3.22	3.22	3.07
2002	2.86	4.48	3.59	2.83	3.97	3.16	3.23	2.08	5.76	1.65	1.03	2.81	3.02	3.37	1.62	3.84	3.21	3.33	3.19
2003	3.96	3.94	2.76	2.88	2.81	2.20	2.42	3.40	2.18	4.91	4.04	4.08	2.91	3.38	2.86	2.52	3.06	3.22	3.12
2004	2.34	4.05	3.33	2.79	3.47	3.12	2.34	3.51	1.94	2.52	5.26	3.49	3.32	4.38	2.30	3.19	1.67	3.08	3.20
2005	3.19	3.72	3.05	3.18	5.91	3.64	4.84	2.79	2.57	2.65	5.24	4.18	3.22	4.20	2.01	3.72	3.78	1.15	3.34
2006	3.45	4.10	3.09	2.56	4.47	2.33	3.94	2.53	3.35	1.72	3.37	2.82	2.99	3.61	2.19	2.96	3.14	2.80	3.11
2007	2.77	4.15	4.77	3.13	5.49	1.58	4.62	2.77	3.11	1.07	6.39	3.94	4.60	3.37	2.47	3.15	2.71	4.38	3.29
2008	3.52	4.15	3.32	3.91	3.95	3.55	3.16	1.84	4.27	3.67	4.88	2.76	3.25	2.78	1.42	2.36	3.13	3.75	3.16
2009	3.26	4.74	4.94	2.74	3.49	2.57	1.94	2.53	2.81	2.77	5.03	2.75	3.68	3.13	1.96	2.91	3.51	3.04	3.12
2010	3.18	4.70	5.57	3.30	4.01	2.49	2.89	2.08	3.67	3.48	2.74	3.41	3.22	3.08	2.18	2.99	4.89	3.38	3.16
2011	4.33	4.95	4.95	2.90	3.96	2.99	3.47	2.14	3.46	3.29	4.72	2.77	3.08	5.05	1.66	3.37	4.51	3.24	3.13
2012	2.15	3.82	3.59	2.39	4.20	2.53	2.95	2.41	2.70	2.51	4.85	2.61	2.63	3.15	2.18	3.00	4.45	2.35	3.03
2013	2.47	4.73	3.95	2.79	5.23	2.33	3.79	2.19	4.06	0.64	5.28	2.35	3.05	3.32	2.02	2.48	5.13	1.88	3.10
2014	3.86	4.42	3.75	2.71	4.37	2.46	2.15	1.92	3.49	1.26	0.82	3.02	2.19	3.22	1.87	1.68	3.43	1.95	2.87
2015	2.99	5.24	4.67	3.06	6.05	2.39	2.37	1.96	4.22	1.99	3.68	3.24	2.36	2.92	2.06	2.92	3.38	2.04	2.85
2016	2.53	5.82	3.38	2.51	5.12	2.88	0.00	1.90	4.75	1.34	6.75	2.86	2.31	3.22	2.22	3.75	4.19	2.59	3.03
2017	3.32	5.13	5.53	3.40	2.53	2.49	1.29	2.06	2.75	2.19	5.50	2.54	2.14	2.87	3.48	3.04	3.53	2.80	3.04
2018	3.02	4.41	4.88	3.85	7.30	2.44	2.13	2.46	3.02	3.23	8.06	2.45	3.12	3.54	3.49	3.12	5.28	3.09	3.48
2019	2.14	4.09	3.22	2.96	4.27	3.36	2.30	4.59	2.73	2.47	3.69	3.82	2.79	3.97	3.01	3.66	4.81	2.99	3.49
2020	1.89	4.91	4.07	2.67	6.26	2.53	2.43	2.88	3.01	4.51	4.81	4.74	2.43	3.80	3.11	2.67	4.05	4.85	3.42
Mean	3.01	4.49	4.04	3.01	3.67	2.70	2.79	2.62	3.44	2.46	4.55	3.13	3.10	3.46	2.34	3.07	3.78	2.97	3.17

Source: Mortality Information System(SIM).

FW – Frederico Westfalen; POA – Porto Alegre; SCS – Santa Cruz do Sul; RGS – Rio Grande do Sul.

Regarding hospitalizations by DM, most municipalities showed a reduction, and in 11 of them this trend was significant. The cities of Cachoeira do Sul, Caxias do Sul, and Cruz Alta, on the other hand, showed an increase in their coefficients, albeit with no statistical significance. The state of Rio Grande do Sul as a whole recorded a reduction on the trends of hospitalizations by DM in the period analyzed (Table 3).

Table 3 - Trends of the coefficient of hospitalizations by diabetes mellitus (DM) in the municipalities that headquarter regional health coordinationoffices (CRS) in the state of Rio Grande do Sul, from 2000 to 2020. Rio Grande do Sul, 2020

Municipalities	Coefficient	CI 95%	P-value	Trend
Alegrete	-0.512	-0.640 a -0.383	<0.001	Decreasing
Bagé	-0.156	-0.372 a 0.060	0.147	Stationary
Cachoeira do Sul	1.290	-1.247 a 3.828	0.301	Stationary
Caxias do Sul	0.108	-0.026 a 0.242	0.109	Stationary
Cruz Alta	0.411	-1.306 a 0.483	0.348	Stationary
Erechim	-0.460	-0.536 a -0.385	<0.001	Decreasing
Frederico Westphalen	-0.250	-0.348 a 0.152	<0.001	Decreasing
Ijuí	-1.045	-1.467 a -0.623	<0.001	Decreasing
Lajeado	-0.681	-1.054 a -0.307	0.001	Decreasing
Osório	-0.969	-1.440 a -0.498	<0.001	Decreasing
Palmeira das Missões	-0.390	-0.886 a 0.105	0.116	Stationary
Passo Fundo	-0.870	-1.120 a -0.541	<0.001	Decreasing
Pelotas	-0.412	-0.643 a -0.182	0.001	Decreasing
Porto Alegre	-0.032	-0.181 a 0.117	0.658	Stationary
Santa Maria	-0.038	-0.097 a 0.021	0.198	Stationary
Santa Rosa	-0.238	-0.361 a -0.114	0.001	Decreasing
Santa Cruz do Sul	-0.450	-0.685 a -0.213	0.001	Decreasing
Santo Ângelo	-0.621	-0.990 a -0.252	0.002	Decreasing
Rio Grande do Sul	-0.327	-0.402 a -0.253	<0.001	Decreasing

Source: Data from the study.

According with the results from table 4, we found that most municipalities presented an increase in their coefficients of death by DM in the period. Nonetheless, these trends were not statistically significant, and are considered to be stationary; the exceptions are the municipalities of Pelotas and Santa Cruz do Sul, which presented significant trends of decreasing and increasing coefficients, respectively. The state as a whole showed a slight growth in this indicator; however, as was the case with the municipalities that headquarter the CRSs, the trend of mortality by DM was stationary.

Table 4 - Trends of the coefficients of deaths by diabetes mellitus (DM) in the municipalities that headquarter regional health coordination offices (CRS) in the state of Rio Grande do Sul, from 2000 to 2020.Rio Grande do Sul, 2020.

Municipalities	Coefficient	CI 95%	p-value	Trend
Alegrete	- 0.028	- 0.067 a 0.010	0.136	Stationary
Bagé	0.376	- 0.006 a 0.082	0.091	Stationary
Cachoeira do Sul	0.036	- 0.033 a 0.104	0.289	Stationary
Caxias do Sul	- 0.005	- 0.037 a 0.027	0.745	Stationary
Cruz Alta	0.040	- 0.035 a 0.116	0.278	Stationary
Erechim	- 0.009	- 0.038 a 0.019	0.500	Stationary
Frederico Westphalen	- 0.089	- 0.0181 a 0.004	0.059	Stationary
Ijuí	- 0.029	- 0.099 a 0.041	0.403	Stationary
Lajeado	- 0.023	- 0.097 a 0.051	0.522	Stationary
Osório	0.018	- 0.079 a 0.116	0.700	Stationary
Palmeira das Missões	0.059	- 0.061 a 0.180	0.317	Stationary
Passo Fundo	0.021	- 0.049 a 0.090	0.540	Stationary
Pelotas	- 0.078	- 0.121 a - 0.033	0.002	Decreasing
Porto Alegre	0.001	- 0.047 a 0.049	0.978	Stationary
Santa Maria	0.033	- 0.023 a 0.090	0.234	Stationary
Santa Rosa	- 0.021	- 0.073 a 0.030	0.401	Stationary
Santa Cruz do Sul	0.071	0.007 a 0.136	0.033	Increased
Santo Ângelo	0.014	- 0.083 a 0.112	0.761	Stationary
Rio Grande do Sul	0.001	- 0.020 a 0.023	0.891	Stationary

Source: Data from the study.

DISCUSSION

The analysis indicated a trend of reduction in hospitalizations by DM in most municipalities and in the state of Rio Grande do Sul as a whole. In 2020, there were less hospitalizations by DM than the mean in the whole period analyzed for most municipalities and for the state. Regarding mortality, the trend remained stationary for all municipalities and the state.

It should be noted that, despite the aging of the population and the nutritional transition, with increased overweight and other factors associated with DM, several public policies to deal with the diseased were implemented in the period analyzed[11]. The Plan to Reorganize Health Care for Arterial Hypertension and Diabetes Mellitus (HiperDia) was conceived to identify cases, train personnel, and diagnose and distribute medication[17]. Furthermore, the period saw an increase in medication provided by the Popular Pharmacy[18], easier access to Family Health Strategy services[19], restrictions to smoking[20], and encouragement of healthy lifestyle habits due to the plan of strategic actions against non-transmissible chronic diseases[21], all of which are public policies that may have contributed to reduce hospitalizations. This set of policies and actions contributed to facilitate access and the effectiveness of care, including changes in user lifestyle; thus, it involved essential aspects for the quality of assistance in these populations[22].

The decrease in hospitalizations by DM in this study was also found in other investigations carried out in Brazil. In Paraná, an ecological study from 2000 to 2012 reported that general rates of hospitalization by DM showed a decreasing trend, from 10.4 to 9.34 hospitalizations/10.000 residents[23]. In the state of Bahia, a cross-sectional study with secondary data from 2012 to 2018 showed a mean rate of hospitalizations by DM of 9.8/10,000 residents in the first year, with a growing trend until 2017, which decreased to 7.1/10,000 residents in 2018[24]

The reduction in hospitalizations by DM found in 2020 was credited to the COVID-19 pandemic. The authors of a research that analyzed the impact of the COVID-19 pandemic in hospitalizations by NCCD in Brazil compared the period from 2017 and the beginning of the pandemic, starting in March 2020. They found a reduction of 27% in hospitalization rates for all NCCD in all regions. Regarding DM, there was a decrease in 24% in hospitalizations during the pandemic[25]. An ecological study described the number of DM hospitalizations in Brazilian regions from 2016 to 2020, showing that in 2020 there were 2,387 less hospitalizations, when compared to 2019[25].

The trend and magnitude of DM has varied from country to country. In Australia, for example, complication and hospitalization rates due to heart attacks and cardiac arrest in DM patients has decreased, while hospitalizations due to amputations and hyperglycemia have increased[26]. In the United States, from 2008 to 2018, there was a 2.5% growth of DM hospitalizations[27]. In England, people with DM had a higher likelihood of being hospitalized by any cause, proving the severity of the disease[28].

Regarding mortality, similar investigations were carried out in several places of Brazil; however, their results were different from the previous study, which showed a trend of stability in most municipalities and in the RS as a whole.

Ecological studies showed increased DM mortality in the Federal District from 2010 to 2019[29], in Piauí from 2009 to 2019[30], despite a small decrease in 2018, and in Ribeirão Preto, from 2018 to 2010, due to an increase in the prevalence of the disease[31].

Another study comparing trends of death by DM in Brazil and in the state of Ceará specifically, from 2000 to 2015, through a polynomial regression analysis, showed that deaths in the country grew, but in the Ceará, they decreased[32]. In Paraná, the trend of DM mortality was growing from 1984 to 2000, and then stationary until 2014, despite an increase in the prevalence of the disease[33].

The Global Disease Burden showed that DM was the 9th greatest cause of mortality worldwide[9]. A recent study showed that mortality by DM decreased in high-income countries, especially due to cardiovascular complications. On the other hand, the death rates increased in medium-income countries[34].

In addition to the limitations intrinsic to ecological studies, this study also was limited by the fact that collection in this information system did not allow distinguishing the type of DM regarding the dependence on insulin. The SIH/SUS also does not allow checking whether the individuals were ever hospitalized again, nor does it consider multimorbidity, which can interfere in the burden of the disease[35]. However, the analysis used a robust method adequate to time series, and the standardization of the coefficients eliminated the structural differences caused by sex and age among the different locations.

The follow up of hospitalizations and deaths by DM is a fast and cheap process, which can contribute to decision making and the implementation of measures to control NCCD and evaluate the quality of the health system; furthermore, it can be monitored by municipal health secretariats.

CONCLUSION

This study showed a decrease in hospitalizations and a stationary mortality by DM in most cities analyzed, possibly due to the policies and actions implemented in the period, despite the aging of the population.

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