ORIGINAL ARTICLE

Hospitalization and mortality by diabetes mellitus in children: analysis of temporal series

Internação e mortalidade por diabetes mellitus na infância: análise de séries temporais

Interna y mortalidad por diabetes mellitus en la infancia: análisis de series temporais

Maria de Fátima Garcia Lopes Merino[I]
ORCID: 0000-0001-6483-7625

Rosana Rosseto de Oliveira[I]
ORCID: 0000-0003-3373-1654

Paloma Luana de Azevedo Ramos da Silva[I]
ORCID: 0000-0002-9087-497X

Maria Dalva de Barros Carvalho[I]
ORCID: 0000-0002-1377-3331

Sandra Marisa Pelloso[I]
ORCID: 0000-0001-8455-6839

Ieda Harumi Higarashi[I]
ORCID: 0000-0002-4205-6841

[I] *Universidade Estadual de Maringá. Maringá, Paraná, Brazil.*

Corresponding Author:
Maria de Fátima Garcia Lopes Merino
E-mail: fatimamerino@gmail.com

ABSTRACT

Objective: to analyze the trend of hospitalization rates and mortality due to Diabetes Mellitus in children and adolescents in Brazil. **Method:** temporal series study, hospitalization rates and diabetes mortality in children and adolescents. Data were obtained from the Hospital Information System and Mortality Information System, from 2005-2015, with analysis performed by polynomial regression modeling. **Results:** 87,100 hospitalizations and 1,120 deaths from diabetes were analyzed. Hospitalizations rates increased for both genders and all age groups, with an increase for adolescents aged 10-14 years. The mortality rate declined, except for the 15-19-year age group. In the overall mortality trend in Brazil, the South and Southeast showed a decrease, whereas for hospitalizations only the Center-West remained constant, while the others increased. **Conclusion:** however, there was a decrease in infant mortality and increase in hospitalizations.
Descriptors: Diabetes Mellitus; Child; Adolescent; Hospitalization; Mortality.

RESUMO

Objetivo: analisar a tendência das taxas de internação e mortalidade por Diabetes Mellitus em crianças e adolescentes no Brasil. **Método:** estudo de séries temporais, das taxas de internação e mortalidade por diabetes em crianças e adolescentes. Os dados foram obtidos do Sistema de Informações Hospitalares e do Sistema de Informações sobre Mortalidade, de 2005-2015, com análise realizada pela modelagem de regressão polinomial. **Resultados:** foram analisadas 87.100 internações e 1.120 óbitos por diabetes. As taxas de internações apresentaram aumento para ambos os sexos e todas as faixas etárias, com incremento para adolescentes entre 10-14 anos. A taxa de mortalidade apresentou queda, exceto para o grupo etário de 15-19 anos. À tendência da mortalidade geral no Brasil, as regiões Sul e Sudeste apresentaram decréscimo, enquanto que para as internações, apenas a região Centro-Oeste permaneceu constante, enquanto as demais aumentaram. **Conclusão:** ocorreu decréscimo da mortalidade na infância, porém, com aumento das internações.
Descritores: Diabetes Mellitus; Criança; Adolescente; Internação; Mortalidade.

RESUMEN

Objetivo: analizar la tendencia de las tasas de internación y mortalidad por diabetes mellitus en niños y adolescentes en Brasil. **Método:** estudio de series temporales, de las tasas de internación y mortalidad por diabetes en niños y adolescentes. Los datos fueron obtenidos del Sistema de Informaciones Hospitalarias y del Sistema de Información sobre Mortalidad, de 2005-2015, con análisis realizado por el modelado de regresión polinomial. **Resultados:** se analizaron 87.100 internaciones y 1.120 muertes por diabetes. Las tasas de internaciones presentaron aumento para ambos sexos y todas las franjas etarias, con incremento para adolescentes entre 10-14 años. La tasa de mortalidad presentó caída, excepto para el grupo de edad de 15-19 años. A la tendencia de la mortalidad general en Brasil, las regiones Sur y Sudeste presentaron descenso, mientras que para las internaciones, sólo la región Centro-Oeste permaneció constante, mientras que las demás aumentaron. **Conclusión:** ocurrió decrecimiento de la mortalidad en la infancia, sin embargo, con aumento de las internaciones.
Descritores: Diabetes Mellitus; Niño; Adolescentes; Hospitalización; Mortalidad.

INTRODUCTION

Diabetes Mellitus (DM) is a chronic, non-transmissible, progressively progressive disease. Considered one of the biggest public health problems in the world, it represents one of the four major causes of death due to chronic diseases[1].

Data from the International Diabetes Federation (IDF) confirm the growing proportion of people with DM in increasingly younger age groups, with most of them residing in developing countries where the epidemic is most intense. The main types of the disease are Diabetes Mellitus type 1 (DM1) and Diabetes Mellitus type 2 (DM2)[1-2].

DM1 is one of the most common endocrine and metabolic conditions in children and adolescents, with children under the age of five and especially those residing in developing countries[1,3-5]. DM2 affects the general population, and its incidence has also increased among children and adolescents[1,6-8].

In South and Central America, the estimated number of people under the age of 20 with DM1 is 118,600. About 88,300 of these children and adolescents live in Brazil, with 9,600 new cases occurring each year, making it the third country with the largest number of children with DM 1 in the world, behind only the USA and India[1]. In addition, Brazil is among the 32 countries where there is a higher risk of developing DM2[1], and carefully planned control strategies for health assessment and intervention[9].

Despite the current increase in the incidence of DM in children and adolescents, data are still limited for this population[10-11]. In addition, many people remain undiagnosed for long periods of time[1,6], which can lead to complications and worsening of the disease.

Uncontrolled long-term glycemic levels may trigger chronic micro- and macrovascular complications, leading patients to develop neuropathies and amputations, retinopathies, nephropathies and cardiovascular diseases that may occur after puberty or after five to ten years of onset of disease[12-13]. Other serious complications are hypoglycemia and severe hyperglycemia or diabetic ketoacidosis[1,12], which, together with deficient metabolic control, can be the cause of hospital hospitalizations and mortality of DM patients[12-14].

There is a shortage of studies that address the morbidity and mortality of children and adolescents due to DM[15-16]. Thus, it is justified to carry out the present study, considering the importance of knowing the occurrence of hospitalizations and mortality caused by the disease in this age group.

OBJECTIVE

To analyze the trend of hospitalization rates and mortality due to DM in children and adolescents in Brazil.

METHOD

Ethical aspects

This study was waived by assessment of the Research Ethics Committee Involving Human Beings of the *Universidade Estadual de Maringá*, under Opinion number 01/2018, as they were secondary data in the public domain.

Design, place of study and period

This is a longitudinal study that analyzed temporal series of hospital hospitalizations and DM mortality in children and adolescents in Brazil, major Brazilian regions and state capitals, according to gender and age from 2005 to 2015.

Data on hospitalizations were obtained from the Hospital Information System of SUS (SIH/SUS - *Sistema de Informações Hospitalares do SUS*) and deaths from the Mortality Information System of the Ministry of Health (SIM/MS - *Sistema de Informações sobre Mortalidade do Ministério da Saúde*), both available at the electronic address of the Department of Information Technology of SUS (DATASUS - *Departamento de Informática do SUS*). Data was collected in July 2017.

Population and inclusion and exclusion criteria

Hospitalizations and deaths data of children and adolescents with ages between 0 and 19 years with DM diagnosis were analyzed. The maximum age adopted for adolescence was up to 19 years, considering the age established by the World Health Organization[17].

The main diagnosis of hospitalization and basic cause of death related to DM is codified according to the 10th revision of the International Classification of Diseases (ICD-10), Chapter IV - Endocrine, nutritional and metabolic diseases, in category E10 to E14 - Diabetes Mellitus[18]. The variables analyzed were: age (0-4, 5-9, 10-14, 15-19 years), gender, hospitalization rate and mortality rate.
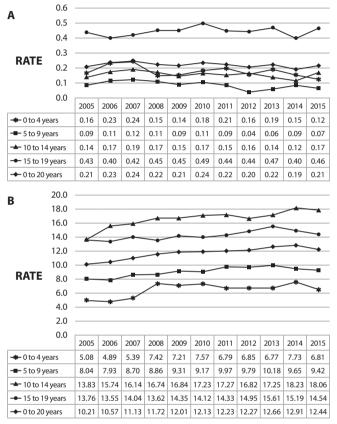
Study protocol

For rate calculation, hospitalizations were selected based on the Brazilian Hospital Hospitalizations Authorizations (AIH (*Autorizações de Internações Hospitalares*) type 1)'s survey, which refer to the initial report in which the DM presented as the main diagnosis of hospitalization. Mortality was determined from the death certificates with DM as the basic cause of death. Hospitalization and mortality rates were calculated by the ratio between the number of events observed and the population of children and adolescents living in that year and place, by gender, multiplied by 10,000 inhabitants.

Analysis of results, and statistics

The trend of mortality rates and hospitalization rates was analyzed using polynomial regression modeling, where rates were considered as dependent variables (y) and year of birth as independent variable (x). The year variable was transformed into the year-center variable (x-2010) and series were smoothed by means of a three-point moving average. The of linear ($y=\beta 0+\beta 1x^1$), square ($y=\beta 0+\beta 1x^1+\beta 2x^2$), and cubic ($y=\beta 0+\beta 1x^1+\beta 2x^2+\beta 3x^3$) polynomial regression were considered. A significant trend was considered in which the estimated model obtained p value <0.05. For the best model choice, dispersion diagram, coefficient of determination (r^2), and residue analysis were also considered. When all the criteria were significant for more than one model and the coefficient of determination was similar, the simplest model was chosen. The analyzes were performed using SPSS software version 20.1.

RESULTS

1,120 deaths and 87,100 hospitalizations due to DM in children and adolescents in Brazil occurred between 2005 and 2015. The mortality rate was 0.21 deaths per DM per 10,000 inhabitants in 2005, maintaining the same value in 2015. The highest occurrence of deaths was in the 15-19 age group, which increased from 0.43 in 2005 to 0.46 in 2015. The DM hospitalization rate was 10.21 in the first year of study, increasing to 12.44 in 2015, with the highest number of hospitalizations for the 10-14 age group, which increased from 13.83 to 18.06 during this same period (Figure 1).

A		2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
0 to 4 years		0.16	0.23	0.24	0.15	0.14	0.18	0.21	0.16	0.19	0.15	0.12
5 to 9 years		0.09	0.11	0.12	0.11	0.09	0.11	0.09	0.04	0.06	0.09	0.07
10 to 14 years		0.14	0.17	0.19	0.17	0.15	0.17	0.15	0.16	0.14	0.12	0.17
15 to 19 years		0.43	0.40	0.42	0.45	0.45	0.49	0.44	0.44	0.47	0.40	0.46
0 to 20 years		0.21	0.23	0.24	0.22	0.21	0.24	0.22	0.20	0.22	0.19	0.21

B		2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
0 to 4 years		5.08	4.89	5.39	7.42	7.21	7.57	6.79	6.85	6.77	7.73	6.81
5 to 9 years		8.04	7.93	8.70	8.86	9.31	9.17	9.97	9.79	10.18	9.65	9.42
10 to 14 years		13.83	15.74	16.14	16.74	16.84	17.23	17.27	16.82	17.25	18.23	18.06
15 to 19 years		13.76	13.55	14.04	13.62	14.35	14.12	14.33	14.95	15.61	15.19	14.54
0 to 20 years		10.21	10.57	11.13	11.72	12.01	12.13	12.23	12.27	12.66	12.91	12.44

Source: SIH/SUS, 2005-2015 and SIM/MS, 2005-2015.

Figure 1 – Historical series of mortality rates (A) and hospitalization (B) due to Diabetes Mellitus in children and adolescents by age group, 2005 to 2015, Brazil

Polynomial regression analysis showed that there was a trend towards a decline in DM mortality rates in all age groups analyzed, except for the 15-19 age group that remained constant (p=0.319), but with the highest value of mean mortality rate (β0=0.44). In relation to the trend of hospitalization rates, there was an increase in all age groups, especially the age of 10 to 14 years, which presented an average annual increase of 0.26 (p<0.001; r^2=0.85) (Table 1).

When the trend of DM mortality, according to Brazilian gender and regions, was observed, there was a decrease for females in Brazil (p=0.001) and in the South (p=0.006). For males, rates showed a significant trend only in the Northeast and Center-West, which increased at the beginning of the study period, with a subsequent decrease, in addition to having the highest values of mean mortality rate (β0=0.24 and β0=0.22 respectively). The Southeast was the only one that showed a decrease in DM mortality in children and

adolescents, with a mean annual decrease of 0.006 (p=0.001). It is worth mentioning that the mean DM mortality rates among females were higher in all regions when compared to males (Table 2).

Table 1 - Mortality trend and hospitalization due to Diabetes Mellitus in children and adolescents, according to age group, 2005 to 2015, Brazil

Mortality				
	Model	R^2	*p* value	Trend
0-19 years	y=0.22 – 0.003x	0.80	0.001	↓
0-4 years	y=0.18 – 0.005x	0.56	0.021	↓
5-9 years	y=0.09 – 0.007x	0.85	**<0.001**	↓
10-14 years	y=0.16 – 0.004x	0.85	**<0.001**	↓
15-19 years	y=0.44 – 0.002x	0.14	0.319	-

Hospitalization				
	Model	R^2	*p* value	Trend
0-19 years	y=11.92 + 0.24x	0.92	**<0.001**	↑
0-4 years	y=6.71 + 0.19x	0.51	0.032	↑
5-9 years	y=9.28 + 0.21x	0.88	**<0.001**	↑
10-14 years	y=16.84 + 0.26x	0.85	**<0.001**	↑
15-19 years	y=14.40 + 0.20x	0.93	**<0.001**	↑

Source: SIH/SUS, 2005-2015 and SIM/MS, 2005-2015.

Table 2 - Mortality trend and hospitalization due to Diabetes Mellitus in children and adolescents, according to gender, Brazil and large regions, 2005 to 2015, Brazil

Mortality					
		Model	R^2	*p* value	Trend
Brazil	Male	y=0.18 – 0.001x	0.12	0.352	-
	Fem	y=0.26 – 0.005x	0.81	0.001	↓
North	Male	y=0.20 – 0.001x	0.01	0.776	-
	Fem	y=0.25 – 0.003x	0.10	0.412	-
Northeast	Male	y=0.24 + 0.004x – 0.002x²	0.60	0.027	↑/↓
	Fem	y=0.32 – 0.006x	0.43	0.057	-
Southeast	Male	y=0.16 – 0.006x	0.81	0.001	↓
	Fem	y=0.22 – 0.003	0.12	0.354	-
South	Male	y=0.11 – 0.007x	0.39	0.069	-
	Fem	y=0.24 – 0.01x	0.69	0.006	↓
Center-West	Male	y=0.22 + 0.01x – 0.005x²	0.93	**<0.001**	↑/↓
	Fem	y=0.27 – 0.002x	0.01	0.833	-

Hospitalization					
		Model	R^2	*p* value	Trend
Brazil	Male	y=10.01 + 0.24x	0.83	0.001	↑
	Fem	y=13.77 + 0.31x	0.96	**<0.001**	↑
North	Male	y=4.47 + 0.26x	0.65	0.009	↑
	Fem	y=6.53 + 0.36x	0.77	0.002	↑
Northeast	Male	y=7.58 + 0.38x	0.88	**<0.001**	↑
	Fem	y=9.59 + 0.60x	0.99	**<0.001**	↑
Southeast	Male	y=11.86 + 0.11x	0.74	0.003	↑
	Fem	y=16.77 + 0.21x	0.93	**<0.001**	↑
South	Male	y=12.76 + 0.30x	0.86	**<0.001**	↑
	Fem	y=17.18 + 0.16x – 0.07x²	0.91	**<0.001**	↑/↓
Center-West	Male	y=13.81 + 0.20x – 0.08x²	0.94	**<0.001**	↑/↓
	Fem	y=21.78 – 0.10x – 0.19x²	0.94	**<0.001**	↑/↓

Source: SIH/SUS, 2005-2015 and SIM/MS, 2005-2015.

Table 3 – Mortality trend due to Diabetes Mellitus in children and adolescents, Brazil and state capitals, 2005 to 2015

Place	Mortality rate			
	Model	R²	p value	Trend*
North	y=0.22 – 0.002x	0.12	0.357	-
Rondônia	y=0.27 + 0.02x	0.34	0.098	-
Acre	y=0.15 – 0.04x	0.79	0.001	↓
Amazonas	y=0.07 + 0.003x	0.07	0.497	-
Roraima	y=0.25 + 0.07x	0.05	0.551	-
Pará	y=0.30 – 0.008x	0.74	0.003	↓
Amapá	y=0.20 + 0.01x	0.28	0.139	-
Tocantins	y=0.19 + 0.001x	0.002	0.901	-
Northeast	y=0.27 – 0.001x	0.07	0.499	-
Maranhão	y=0.26 + 0.001x	0.01	0.773	-
Piauí	y=0.43 + 0.01x	0.07	0.493	-
Ceará	y=0.17 – 0.009x	0.52	0.028	↓
Rio Grande do Norte	y=0.32 – 0.01x	0.23	0.194	-
Paraíba	y=0.33 – 0.01x	0.40	0.067	-
Pernambuco	y=0.26 + 0.01x	0.61	0.013	↑
Alagoas	y=0.30 – 0.004x	0.09	0.434	-
Sergipe	y=0.26 + 0.03x	0.62	0.012	↑
Bahia	y=0.29 – 0.006x	0.37	0.081	-
Southeast	y=0.19 – 0.004x	0.62	0.011	↓
Minas Gerais	y=0.25 – 0.004x	0.25	0.172	-
Espírito Santo	y=0.22 – 0.02x	0.57	0.019	↓
Rio de Janeiro	y=0.25 – 0.02x	0.77	0.002	↓
São Paulo	y=0.13 + 0.001x	0.09	0.428	-
South	y=0.17 – 0.009x	0.67	0.007	↓
Paraná	y=0.24 – 0.01x	0.39	0.073	-
Santa Catarina	y=0.11 – 0.02x	0.65	0.009	↓
Rio Grande do Sul	y=0.13 – 0.004x	0.32	0.112	-
Center-West	y=0.22 + 0.005x + 0.002x²	0.74	0.017	↓/↑
Mato Grosso do Sul	y=0.28 – 0.03x	0.59	0.015	↓
Mato Grosso	y=0.31 + 0.03x	0.65	0.008	↑
Goiás	y=0.16 +0.04x +0.004x²-0.003x³	0.80	0.010	↓/↑/↓
Distrito Federal	y=0.16 + 0.006x	0.05	0.554	-

Source: SIM/MS, 2005-2015.

Table 4 – Hospitalization trend due to Diabetes Mellitus in children and adolescents, Brazil and state capitals, 2005 to 2015

Place	Hospitalization rate			
	Model	R²	p value	Trend*
North	y=5.48 + 0.33x	0.12	0.357	-
Rondônia	y=12.27 + 1.10x	0.34	0.098	-
Acre	y=6.93 – 0.47x	0.79	0.001	↓
Amazonas	y=4.33 + 0.23x - 0.09x³	0.07	0.497	-
Roraima	y=10.59 - 0.80x - 0.16x² + 0.09x³	0.05	0.551	-
Pará	y=3.91 + 0.30x	0.74	0.003	↓
Amapá	y=3.32 + 0.37x	0.28	0.139	-
Tocantins	y=11.99 + 0.42x – 0.18x²	0.002	0.901	-
Northeast	y=8.56 + 0.50x	0.07	0.499	-
Maranhão	y=5.65 + 0.77x	0.01	0.773	-
Piauí	y=9.04 + 0.78x	0.07	0.493	-
Ceará	y=8.07 – 0.14x	0.52	0.028	↓
Rio Grande do Norte	y=7.32 + 0.39x	0.23	0.194	-
Paraíba	y=9.77 + 1.17x	0.40	0.067	-
Pernambuco	y=12.32 + 0.37x	0.61	0.013	↑
Alagoas	y=6.53 + 0.22x – 0.11x²	0.09	0.434	-
Sergipe	y=6.37 + 0.08x	0.62	0.012	↑
Bahia	y=8.98 + 0.60x	0.37	0.081	-

In terms of hospitalizations due to DM, according to gender, there was a trend for rates to increase in almost all regions, with the exception of the Center-West for both genders and the South region for females (p<0.001), which showed a decrease in end of period. It should be noted that the highest hospitalization rates were for females, with the Northeastern and North having an average annual increase of 0.60 (r²=0.99) and 0.36 (r²=0.77) respectively (Table 2).

Overall, mortality rates showed a downward trend for the South (p=0.007) and Southeast (p=0.011), and a decrease followed by a slight increase for the Center-West (p=0.017). In the North, the states of Acre and Pará tended to decrease, and in Pará there was the highest average mortality rate in the region (β0=0.30). In the Northeast, the states of Pernambuco (p=0.013) and Sergipe (p=0.012) had increased mortality, and Ceará had a decrease (-0.009 per year, p=0.028). For the Southeast, the states of Espirito Santo (p=0.019) and Rio de Janeiro (p=0.002) also showed a trend to decrease mortality due to DM. São Paulo State stood out with the lowest average mortality rate (β0=0.13). In the South, only Santa Catarina State (p=0.009) had a reduction, even though Brazil had the second lowest rate (β0=0.11, r²=0.65). In the Center-West, there was a decrease in mortality in Mato Grosso do Sul State (-0.03 per year), and elevation in Mato Grosso (0.03) (Table 3).

Regarding temporal series of hospitalization rates due to DM, only the Center-West showed a constant trend (p=0.543) in relation to the proportion that all other regions showed an increase in rates, especially in the Northeast region, which had an annual increase mean of 0.50 (p<0.001). The North showed a growing trend in all states, especially in Rondônia (β1=1.10, p=0.002), which also had the highest average hospitalization rate in the region (β0=12.27). In the Northeast, Paraíba had the highest average annual increase in the period (1.17, p<0.001). In the South, only Rio Grande do Sul remained constant (p=0.541), while the other states showed an increase in hospitalizations. In the Center-West, Mato Grosso do Sul showed an increase in hospitalizations (0.30, r²=0.91), and the states of Mato Grosso and Goiás fell in the last years of study. The highest average hospitalization rate due to DM in Brazil was in the Federal District (β0=29.84) (Table 4).

DISCUSSION

DM approach in children and adolescents is necessary due to the increase in the incidence and prevalence of the disease in this population, with variations in rates between countries and between populations with different socioeconomic conditions, implying important long-term consequences for these individuals and the whole society[6,14].

Table 4 (concluded)

Place	Hospitalization rate			
	Model	R^2	*p* value	Trend*
Southeast	$y=14.30 + 0.18x$	0.62	0.011	↓
Minas Gerais	$y=15.96 + 0.27x$	0.25	0.172	-
Espírito Santo	$y=11.81 + 0.41x$	0.57	0.019	↓
Rio de Janeiro	$y=9.99 - 0.34x +0.08x^2 + 0.02x^3$	0.77	0.002	↓
São Paulo	$y=15.12 + 0.21x$	0.09	0.428	-
South	$y=14.70 + 0.25x$	0.67	0.007	↓
Paraná	$y=15.34 + 0.31x$	0.39	0.073	-
Santa Catarina	$y=13.90 + 0.55x$	0.65	0.009	↓
Rio Grande do Sul	$y=14.50 + 0.02x$	0.32	0.112	-
Center-West	$y=16.84 +0.07x$	0.74	0.017	↓/↑
Mato Grosso do Sul	$y=11.58 + 0.30x$	0.59	0.015	↓
Mato Grosso	$y=11.63 +0.35x - 0.18x^2$	0.65	0.008	↑
Goiás	$y=17.65 - 0.20x - 0.08x^2$	0.80	0.010	↓/↑/↓
Distrito Federal	$y=29.84 + 0.03x$	0.05	0.554	-

Source: SIH/SUS, 2005-2015.

The findings of the present study identified reductions in mortality rates and increased hospitalization rates due to DM in children and adolescents in Brazil between 2005 and 2015, with regional differences.

An Australian study addressing mortality in the population aged 1 to 17 years with DM1 did not reveal a significant trend in mortality due to the small number of deaths[19]. However, although studies on DM mortality vary in relation to populations, diagnosis, periods, duration of DM and age at diagnosis, making it difficult to compare the studies directly with each other[20] in a cohort study conducted in Norway with patients with the diagnosis of onset of DM in childhood (0-14 years) in two periods of time (1999-2012, 1973-1982) also showed a decrease in mortality by the disease in the most recent research period[20]. Likewise, the total number of DM deaths among US people aged between 1 and 19 years showed a decrease between the periods studied (2000-2002 and 2012-2014)[21].

The variations observed in relation to the trend of mortality in children and adolescents by DM in the Brazilian capitals corroborate with part of the research findings that assessed DM mortality in the general population. DM mortality assessment with people under 40 years of age also showed a decrease in the South and Southeast. However, there was a divergence in the results for the North and Northeast, since in the present study the mortality trend was constant and among older individuals the mortality trend was increasing[22].

DM mortality rates vary according to the socioeconomic conditions of the countries and regions[14], being lower in places where infant mortality has decreased and health spending is higher[12]. However, it is worth emphasizing that due to the difficulties faced in the detection of the disease, many children still die from DM, without the diagnosis being defined[3].

An analysis of the occurrence of childhood DM1 in 88 countries pointed to the high mortality due to the disease due to factors related to inefficient care and the difficulty of accessing health services[3]. A similar situation occurs with children and adolescents with type 2 of the disease, exposed to factors that contribute to the development of complications of DM and that may lead to worsening of the disease and death, since this age group presents a higher risk when compared to adults[7].

Mortality rates were higher in females, and the age group with the highest number of deaths was adolescents aged 15 to 19 years. Likewise, an Australian study found that the female gender presented a higher risk of DM mortality, but with a higher prevalence of deaths in the 10-14 age group[19].

In relation to hospitalizations, there was a trend of increased hospitalizations due to DM in childhood in all regions of Brazil, especially in adolescents aged 10 to 14 years, and this increase was observed in most Brazilian capitals. These results may be related to complications that occur in this age group due to carelessness with the disease, which is common among adolescents and due to age characteristics, when glycemic control tends to be more neglected[13,23-24]. It may also be related to the higher incidence of diagnoses in this age group, as reported in a previous study[25].

The increase in hospitalizations due to DM in childhood had already been verified in a previous study among children under five[26] and also among the population aged 0 to 18 years[27]. Diabetic ketoacidosis and the hyperosmolar hyperglycemic state are the main severe acute complications that may occur during the course of DM1 and 2, and may be responsible for most hospitalizations and death among children and adolescents[14,27].

A study carried out in Italy on the trend of hospitalizations due to DM over ten years, in all age groups, pointed out that despite the decrease in mortality, as in the present study, there was also an increase in the hospitalization rates of patients with lower age or equal to 19 years[28].

When there is comparison of results of hospitalizations due to DM and gender, the present study showed a higher rate for both genders, although in the North and Northeast states, the highest occurrences were with female patients.

A study with people with DM1 and younger than 18 years found higher odds of diabetic ketoacidosis for females[29]. Diabetic ketoacidosis events, which account for most hospitalizations in DM patients, can be attributed in greater numbers to females because girls, during puberty, have higher insulin resistance[30].

Despite being a relevant topic and of public health interest, few Brazilian studies have demonstrated the behavior of deaths and hospitalizations due to DM in children and adolescents. There is a lack of data on infant mortality rates, especially in less developed countries[3,15-16,19], and few epidemiological studies assessing changes in hospital hospitalization rates for acute diabetic complications over time and space[28].

Increasingly younger individuals being diagnosed with DM each year, living with the disease throughout their lives, and requiring daily care and controls, may also lead to an increase in intercurrences in the next years[1]. Morbidity and premature death of children and young people due to DM have a great impact on public health and reduce the life expectancy for those affected at younger ages, being one of the main chronic diseases in youth[31].

As the development of complications is related to the duration of DM and its chronicity, children and adolescents with the disease represent a population at high risk of developing complications throughout life[1,5]. Therefore, it is important to recognize these people as a vulnerable population, besides guiding the recognition

of the disease, identifying the symptoms and providing care for harm reduction and prevention of early mortality.

Study limitations

The study presents some limitations by the use of secondary data, subject to errors in the codification of the diagnoses. It was also not possible to identify hospitalization situations due to co-morbidities common to DM and the cases of re-hospitalizations. However, the results are valid considering its importance to help health professionals in the implementation of preventive actions of the complications of DM common in children and adolescents, and that can trigger hospitalizations and deaths, often avoidable. Therefore, health education actions are necessary for this population.

Contributions to Nursing, Health, and Public Policy

The contribution was based on the knowledge about the epidemiology of this disease, as well as its distribution by regions of the country, indicating relevance of DM among children and adolescents and its consequences, besides pointing to the need for nurses and situational diagnosis of the country and, in particular, its region context, in order to improve the public health setting related to childhood DM.

In the nursing context, research should contribute to encouraging the development of educational strategies on the subject that involve both children and adolescents with DM and health professionals and the population in general, and contribute to minimize

the damages caused by the disease reducing complications that leading to hospitalization and early death of this population.

CONCLUSION

The study showed that hospitalizations due to DM in children and adolescents have increased in Brazil in recent years, following the trend of increasing incidence and hospitalizations in the world. The age group between 10-14 years presented a greater number of cases of hospitalizations with a trend to elevate. It was also possible to conclude that the Center-West, South and Southeast are the regions with the highest average annual hospitalization rates due to DM in this age group. The study also confirms that although the mortality rates of children and adolescents in the country remained stable in the period, the highest prevalence were in children between 15 and 19 years, and the female had the highest mortality risk.

Thus, the results obtained in this study demonstrate that DM in children and adolescents, due to its chronic nature and the damages caused by difficulties in the management of the disease throughout life, can trigger serious complications that mainly affect adolescents, leading to hospitalizations and, in some cases, to death.

These findings can contribute to the planning of preventive and educational actions for this population, involving health professionals, family members and patients, in order to reduce the risks of complications considering the characteristics of the chronic disease and its unfolding throughout life. In addition, it is expected to raise an alert for the prevalence and complications of DM at an early age in specific regions of the country.

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