ORIGINAL ARTICLE

MORTALITY BY DIABETES MELLITUS TENDENCY
TENDÊNCIA DE MORTALIDADE POR DIABETES MELLITUS
TENDENCIA DE MORTALIDAD POR DIABETES MELLITUS

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ABSTRACT

Objective: to analyze the tendency of mortality due to diabetes mellitus. *Method:* this is a quantitative, ecological study with deaths due to diabetes mellitus registered in the Health Sciences Data Platform of the Oswaldo Cruz Foundation, in the Mortality Information System and in the Brazilian Institute of Geography and Statistics, in the 2000 to 2015, from Brazil and Ceará, used as a sample of this study. The data was collected by means of electronic spreadsheets and polynomial regression trends were analyzed considering $p < 0.05$ as significant. *Results:* 764,418 deaths from diabetes mellitus were recorded in Brazil and 28,583 in the state of Ceará. The regression model showed significant values ($p < 0.001$), as well as high coefficients of determination ($r2 \geq 0.90$) in trend curves, with a growth in national mortality and a state decrease. *Conclusion:* the trend of mortality due to DM in Brazil, especially for females, increased. The less alarming scenario was shown in the State of Ceará. It is necessary to implement strategies aimed at reducing this burden in order to avoid the high number of deaths in the country. *Descriptors:* *Diabetes Mellitus*; Mortality; Ecological studies; Time series studies; Nursing; Epidemiology.

RESUMO

Objetivo: analisar a tendência da mortalidade por diabetes mellitus. *Método*: trata-se de estudo quantitativo, ecológico, com os óbitos por diabetes mellitus registrados na plataforma de Ciências de Dados Aplicados à Saúde da Fundação Oswaldo Cruz, no Sistema de Informação sobre Mortalidade e no Instituto Brasileiro de Geografia e Estatística, no período de 2000 a 2015, do Brasil e Ceará, utilizados como amostra deste estudo. Coletaram-se os dados por meio de planilhas eletrônicas e analisaram-se as tendências pela regressão polinomial considerando-se significante o valor de $p<0,05$. *Resultados*: registraram-se 764.418 mortes por diabetes mellitus no Brasil e 28.583 no Estado do Ceará. Demonstrou-se pelo modelo de regressão valores significativos ($p<0,001$), assim como elevados coeficientes de determinação ($r^2 \geq 0,90$) nas curvas de tendência, com crescimento na mortalidade em âmbito nacional e diminuição estadual. *Conclusão*: elevou-se a tendência de mortalidade por DM no Brasil, principalmente para o sexo feminino. Mostrou-se no Estado do Ceará o panorama menos alarmante. Faz-se necessário a implementação de estratégias que visem a reduzir esse agravo a fim de se evitar o elevado número de óbitos no país. *Descritores*: *Diabetes Mellitus*; Mortalidade; Estudos Ecológicos; Estudos de séries Temporais; Enfermagem; Epidemiologia.

RESUMEN

Objetivo: analizar la tendencia de la mortalidad por diabetes mellitus. *Método:* se trata de un estudio cuantitativo, ecológico, con los óbitos por diabetes mellitus registrados en la plataforma de Ciencias de Datos Aplicados a la Salud de la Fundación Oswaldo Cruz, en el Sistema de Información sobre Mortalidad y en el Instituto Brasileño de Geografía y Estadística, en el periodo de 2000 a 2015, de Brasil y Ceará, utilizados como muestra de este estudio. Los datos fueron recogidos por medio de planillas electrónicas y se analizaron las tendencias por la regresión polinomio considerando significante el valor de $p < 0,05$. *Resultados:* se registraron 764.418 muertes por diabetes mellitus en Brasil y 28.583 en el Estado de Ceará. Se demostró por el modelo de regresión valores significativos ($p < 0,001$), así como elevados coeficientes de determinación ($r2 \geq 0,90$) en las curvas de tendencia, con crecimiento en la mortalidad a nivel nacional y disminución estadal. *Conclusión:* se elevó la tendencia de mortalidad por DM en Brasil, principalmente para el sexo femenino. Se mostró en el Estado de Ceará el panorama menos alarmante. Se hace necesario la implementación de estrategias encaminadas a reducir ese agravio a fin de evitar el elevado número de muertes en el país. *Descriptores:* *Diabetes Mellitus*; La Mortalidad; Estudios ecológicos; Estudios de Series Temporales; Enfermería; Epidemiolgía.

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INTRODUCTION

Diabetes mellitus (DM) is a chronic condition, especially in developing countries, due to the severity of its complications. It is also shown to be a health problem due to population growth and aging, greater urbanization, an increasing prevalence of obesity and unhealthy lifestyles.[1] It was estimated that 285 million individuals over 20 years of age with DM in the world in 2010 and by 2045 this figure could reach 628.6 million.[2]

The DM was ranked in the fourth and eighth position among the main causes of death in the great majority of developed countries.[3] It is reported that characteristics such as chronicity, high prevalence and high incapacitating potential make the burden generated by significant DM. In the United States, disease costs in the United States are estimated at $ 245 billion related to drug costs, lost productivity, and disability.[4] It is reported that in Spain the annual average health cost of the disease, in 2013, it was 5,809 euros per patient, 8.2% of the Spanish public health expenditure.[5] It is noted that in Brazil, up to 15.3% of the hospital costs of the Unified Health System (UHS) in the period of 2008 to 2010, were attributed to diabetes.[6]

In recent decades, the high mortality rates and the burden generated by the disease in the capitals and states of the Northeast region of Brazil have been verified.[7-8] The need to evaluate the parameters of illness and death of a population is highlighted because this analysis can subsidize the proposal of public policies and the assessment of the management and planning of promotion and prevention actions carried out by the health services. It is understood that, this approach can be given by the historical series study of mortality trend.

It is fundamental to the clinical care in health and, especially, to the Nursing, to understand how the disease behaves throughout history. It is perceived that through this information, subsidies are generated so that the Nursing consultation, aimed at the patient with DM, collaborates in solving their needs, improving well-being and creating an environment for education that can decrease the risk factors for the complications of the disease and to promote self-care.[9-10]

The United Nations World Health Organization's sustainable development agenda [11] is integrated to ensure healthy lives and promote well-being for all ages at all levels, to monitor and reduce premature mortality from chronic non-communicable diseases (CNCDs) such as DM. It is hoped with this study, to provide subsidies for the planning of health actions at regional and national levels. It is pointed out tendencies that can aid in the decision making to confront the DM and make possible the reduction of costs, the reduction of the early mortality and the reduction of the associated complications and comorbidities.

In this way, temporal studies are considered vital for the understanding of disease trends, in this case DM. It should be pointed out that such research contributes to professionals who work, from direct patient care, to managers, in the creation, modification or direction of public policies. It is shown that nursing clinical care, based on epidemiological studies, becomes a prominent part of this panorama, since it is present from the primary level to the most complex.

OBJECTIVE

- To analyze the trend of mortality by Diabetes Mellitus (DM).

METHOD

This is a quantitative, ecological, historical-type study with a mortality rate for DM from Brazil and the State of Ceará, from 2000 to 2015, as a way of observing changes in mortality trends. The raw data were collected from three sources: 1) the Health Sciences Data Platform of the Oswaldo Cruz Foundation (FIOCRUZ), which, among others, collects data from the Mortality Information System (MIS), from 1996 to 2014;12 2) DATASUS database, via Tabnet, which gathers the data for the year 201513 and 3) Finally, the data of the resident populations obtained through the Brazilian Institute of Geography and Statistics (IBGE).[14]

The number of deaths by the available filters of the selected sources was counted. It is reported that the first filter was an "ICD-10 chapter" (endocrine nutritional and metabolic diseases); later, the filter "category ICD-10" was selected, where the diagnoses of E10 to E14 were chosen. It is shown that, in this first stage, the data referring to Brazil were computed. The filter "Deaths by federal unit of residence" was then applied and the State of Ceará was chosen as the UF in question. The variable "def_sexo" was used for the evaluation of the data according to sex.

It was decided, in order to standardize the time series, to take the year 2000 as the initial year. It is reported that this attitude was adopted because it is possible to identify studies that evaluate the same object before

2000.[15] It is emphasized that gross mortality rates (per 100,000 inhabitants) were calculated by the formula:

$$\text{Mortality rate due to DM} = \frac{\text{Num. of death due to DM}}{\text{Resident population during the period}} \times 100.000$$

The trends were determined by the polynomial model where $Y = \beta_0 + \beta_1 X + \beta_2 X^2 \ldots \beta_n X^n$, where Y is the mortality rate (dependent variable) and X, the years (independent variable). It is understood that the degree of the polynomial was considered from the precision measurement of the coefficient of determination r^2, that is, those with a value closer to one were selected. Note that when different grades presented similar coefficients, we opted for the model with lower grade.[16-7]

The central variable with 2007 was used as a midpoint to avoid collinearity between the terms of the regression equation. It should be noted that the data presented normal distribution verified by means of the Kolmogorov-Smirnov test and that the analysis of the residues confirmed the assumption of heteroscedasticity of the models. Trends significance was analyzed by means of linear regression and a value of $p < 0.05$ was considered significant.

Data was tabulated and analyzed in Statistical Package for Social Sciences (SPSS), version 20.0, and graphical representations with their trend lines and equations were made in Microsoft Excel 2016 software.

This work was carried out without the need for prior approval of a research ethics committee because they are public domain data, available for consultation of the population.

RESULTS

The 16-year historical series showed 764,418 deaths in Brazil for DM, with 56.4% (n = 431,376) attributed to females. It is shown by the same series, it was possible to find 28,583 DM deaths in the State of Ceará, with the majority of females (n = 16,793, 58.7%) (Table 1).

Table 1. Number of DM deaths in Brazil (BR) and Ceará (CE) by sex. Fortaleza (CE), Brazil, 2018

	Mortality due to DM				
Year	M BR	M CE	F BR	F CE	Total BR/CE
2000	14.864	461	20.409	706	36.440
2001	14.823	534	20.237	813	36.407
2002	15.366	477	21.258	761	37.862
2003	15.954	523	21.530	749	38.756
2004	16.907	482	22.336	715	40.440
2005	17.504	531	22.808	779	41.622
2006	19.605	701	25.438	930	46.674
2007	20.442	682	27.272	952	49.348
2008	21.961	806	28.483	1.135	52.385
2009	22.691	908	29.411	1.264	54.274
2010	24.002	860	30.872	1.276	57.010
2011	25.588	1052	32.285	1.549	60.474
2012	24.954	962	31.800	1.312	59.028
2013	25.718	940	32.296	1.317	60.271
2014	25.764	944	32.105	1.272	60.085
2015	26.800	926	32.836	1.263	61.825
Total	332.943	11.789	431.376	16.793	792.901

Key: M - Male; F - Female. Source:[12]

It was verified, in analysis to figure 1, that the Brazilian line presented increase in mortality, but no peaks; On the other hand, the State of Ceará had periods with great increases in mortality due to this disease, especially in 2011. The same results are found in the analysis of mortality by sex, according to figures 2 and 3. It is shown that curves of

Garces TS, Moreira TMM, Sousa GJB et al.   Mortality by diabetes mellitus tendency.

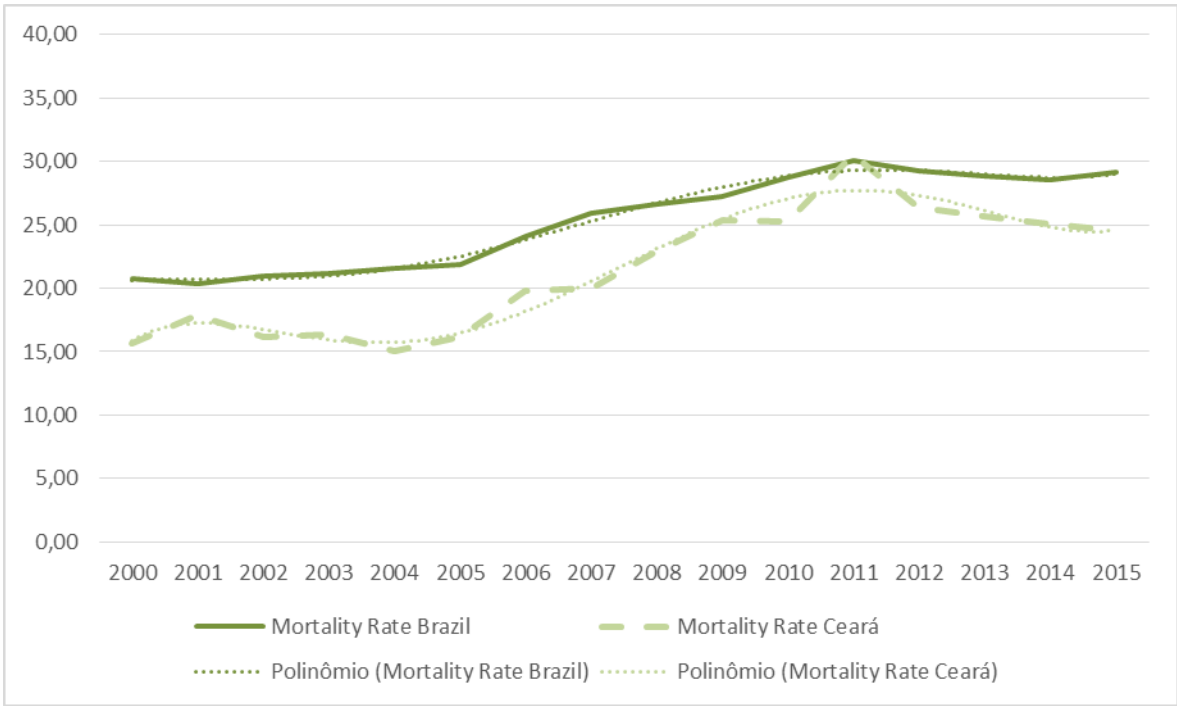mortality trends in Brazil and Ceará by DM in   females showed higher elevation.

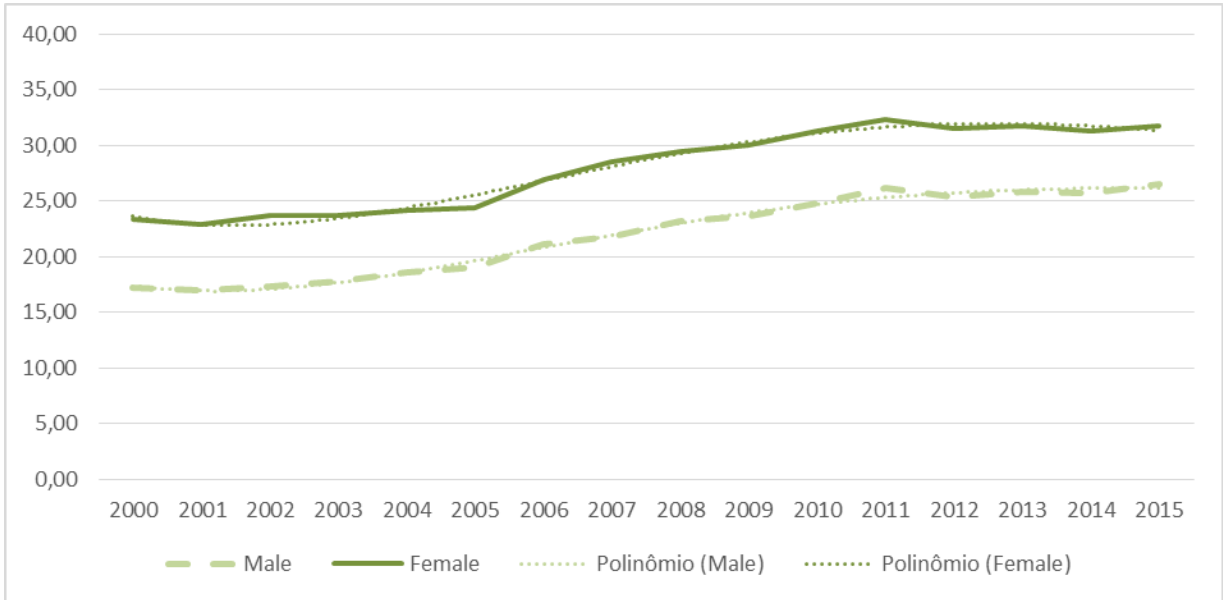Figure 1. Mortality rate for DM in Brazil and Ceará. Fortaleza (CE), Brazil, 2018. Source:[12]

Figure 2. Mortality rate by DM in Brazil by sex. Fortaleza (CE), Brazil, 2018.
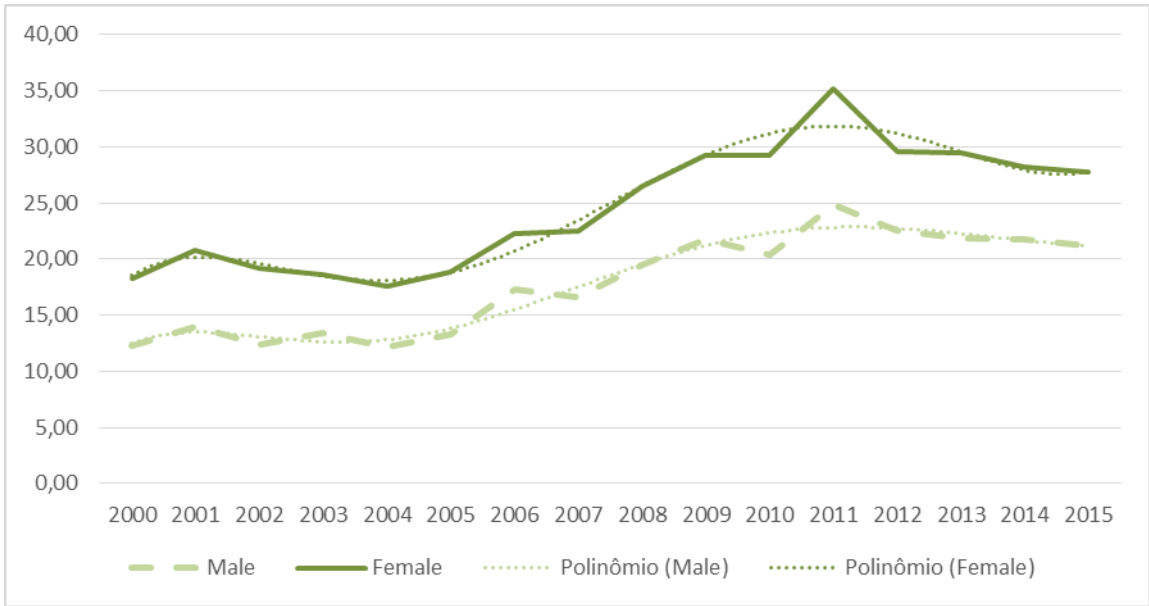Source:[12]

Figure 3. Mortality rate by DM in Ceará according to sex. Fortaleza (CE), Brazil, 2018. Source:[12]

Table 2 shows the analysis of mortality trends in Brazil and Ceará. The regression   model showed significant values (p <0.001), as well as high coefficients of determination

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Garces TS, Moreira TMM, Sousa GJB et al.   Mortality by diabetes mellitus tendency.

(r2≥0.90), which indicates an increasing tendency of Brazilian and decreasing mortality in Ceará in both sexes.

Table 2. Analysis of the trend for DM in Brazil and Ceará individually and by sex. Fortaleza (CE), Brazil, 2018

Location	Sex	Polynomial function							r^2	p	Tendency
		β_0	β_1	β_2	β_3	β_4	β_5	β_6			
Brazil		19.85	1.35	-0.70	0.15	-0.01	3.10^{-4}		0.98	<0.001	Grow
	M	18.59	-1.65	0.48	-0.03	7.10^{-4}	-	-	0.99	<0.001	Grow
	F	25.31	-2.21	0.58	-0.03	8.10^{-4}	-	-	0.98	<0.001	Grow
Ceará		20.54	2.55	0.11	-0.08	-0.02	9.10^{-4}	-8.10^{-6}	0.95	<0.001	Decrea
	M	7.69	7.68	-3.56	0.69	-0.06	2.10^{-3}	-4.10^{-5}	0.95	<0.001	Decrea
	F	11.82	10.29	-4.28	0.70	-0.04	1.10^{-3}	-2.10^{-7}	0.95	<0.001	Decrea

Legend: ß-polynomial model; r2-Determination Coefficient; p - significance of the regression model. F = Female, M- Male. Grow -Growing, Decrea-Decreasing.

DISCUSSION

DM is considered one of the main causes of mortality in Brazil. It is noted that its prevalence is high and worrying becoming evident in the scenario of epidemiological and political discussions. It is noticed that, in this scope, some authors warn that one is in the course of a probable pandemic[15] where it becomes relevant to be attentive to the mortality data related to the disease.

It is suggested that nurses should be aware of such data, since they actively participate in the control of this epidemic. It is stated that, its clinical care is present in several aspects of DM. It is shown, what examples have been given about the role of Nursing to these people. It is reported that it is present in the strengthening of social support networks for children with this morbidity, with the valorisation and strengthening of the role of culture in their health[18]. It is characterized as a transforming tool in the linkage to the elderly patient[19]. It should be emphasized that Nursing care optimizes the self-care of people with diabetic ulcers and pregnant women.[20]

In this study, it was demonstrated that, between 2000 and 2015, the trend of DM mortality in Brazil has followed an increasing trend. It is understood that these data corroborate time-series research that sought to evaluate the trend of mortality by DM in all Brazilian capitals and evidenced that the trend curve was on the rise in the period evaluated.[21] It should be emphasized that these numbers may be underreported, since , often in the death declaration, there is no mention of DM, but rather its complications, particularly cardiovascular and cerebrovascular complications.[22] In Brazil, when the overall burden of NCD was assessed, a 160% increase in mortality by DM in gross numbers and this data also corroborates those of this study.[11]

It is confirmed, from the exposure in this research of the general data of DM mortality in Brazil, evidenced by research in all regions of the world: the disease has killed on a large scale. It is known that the challenge is to intensify investments in the care network, with a focus on prevention, diagnosis and treatment of the disease.

The Brazilian population was stratified by sex, when the female audience presented a trend of increasing tendency of greater perception. It is shown that this finding differs from another time series of mortality by CNCD that showed stability in the trend curve of Brazilian female mortality.[23] Variation in the prevalence of the disease between the sexes has been pointed out, without it being possible to affirm the existence of a trend [6,23-4] It is stated that DM is prevalent in males, usually associated with habits and lifestyles such as sedentary lifestyle, obesity, non-consumption of fruits and / or vegetables, smoking, stress and family history.[25]

Metabolic factors related to the risk of complications and death in diabetics show that men had a higher mean systolic blood pressure and lower mean total cholesterol levels when compared to women. On the other hand, the mean body mass index and fasting plasma glucose concentrations were higher in females.[24]

The increase in DM mortality rates among women is explained by the higher prevalence of cognitive disorders and depression caused by the chronic condition.[26] These changes are shown to lead to the non-adoption of healthy behaviors, which end up with complications of the disease and, ultimately, death.

Because of the divergence in the prevalence of these factors between the sexes, there is no consensus in the literature

regarding the association of DM mortality with sex, instigating the need for further investigations.

It was observed, in relation to the State of Ceará, a drop in the general mortality trend curve by DM, in contrast to the national scenario. It is reported that this data is particularly important, since, previously, the data pointed to a greater trend of DM mortality in the states and capitals of the Northeastern region.[7-8]

When the data were stratified by sex, a trend curve for the trend of mortality for women in the State of Ceará was denoted. It is shown that this data is consistent with those obtained at the national level and in the Northeast region.[8,23]

It is inferred that, although the trend of decreasing mortality trend was verified, overall, in Ceará, the year of 2011 was affected by the significant increase in the number of deaths. It should be noted that data from the Brazilian Ministry of Health and the Health Secretariat of the State of Ceará drew attention to this, however, it was not evident what led to the abrupt increase in the mortality rate in the year in question and not even the which led to a decrease in subsequent periods.[27] It is said that the fact that the mortality trend due to DM has decreased in the State of Ceará is very important, however, it should be noted that mortality rates are still very high.

This study was limited by the underreporting of public databases and by the fact that the calculated mortality rate was not adjusted for deaths from ill-defined causes. It is reported that the research presents, as strengths, the capacity to estimate the trends of mortality in Brazil and Ceará in general and by sex. It is shown that such data is important and may serve to implement preventive measures to combat DM.

CONCLUSION

It is concluded that this study brings important data about the trend of general mortality due to DM, since this curve is growing in Brazil. It is noted that the fact that the trend of DM mortality in female subjects has been more representative is disturbing and that there is constant observance.

It is verified that the trend of general mortality due to DM in Ceará was decreasing, given this relevant and encouraging. It is concluded that it is necessary to evaluate it with caution, since the factors responsible for the curve downgrade were not clarified,

therefore, it is necessary to carry out studies that seek to investigate this data.

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