

## Mortality due to Diabetes Mellitus in northeastern Brazil from 2014 to 2018



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### ABSTRACT

Diabetes Mellitus (DM) is a group of metabolic disorders marked by hyperglycemia, and is

classified into several subtypes. It is currently a major challenge for the world's health systems, with a progressive increase in impact due to urbanization and industrialization, as a result of unhealthy lifestyle habits. This metabolic disorder is among the five main mortality risks in the world, and can trigger acute or chronic complications in the cardiovascular, renal and neurological system, usually with targeted changes in organs, specifically, heart, kidneys, brain and blood vessels in general. This study aims to analyze the mortality from Diabetes Mellitus in the Brazilian Northeast Region between the years 2014 to 2018, through an epidemiological study of time series, with secondary data DATASUS- Ministry of Health, with research of the variables: sex, race, education, age group, marital status, place of occurrence, Northeast, ICD-10 category, diabetes. The data will be expressed in absolute numbers, percentages and descriptive statistics. 101,636 cases were found, 56% of which were female and the highest number, respectively, in the states of Bahia and Pernambuco. Most deaths are concentrated in the category of non-conventional diabetes mellitus, followed by the non-insulin-dependent and insulin-dependent category. As for education, 35% of deaths are in the category of no schooling and 23% with 1 to 3 years of study. Regarding the age group, most deaths are observed from the age of 80, with an increase in the number as the age group increases. There is a prevalence of 58% of deaths in the brown race, followed by white and black race, respectively. Most deaths occurred in married people, with 39% of cases, followed by widowers, 29%, and singles 24%. The most registered place of occurrence was in the hospital, with 63% of deaths and 31% in another health establishment. The epidemiological profile outlined points to the need for articulation of regionalized and peculiar strategies, with health promotion and education, aiming at better management of DM and reduction of mortality rates, especially those of early age groups.

**Keywords:** Diabetes, Deaths, Epidemiology.



## 1 INTRODUCTION

*Diabetes Mellitus* (DM) is, by definition, a heterogeneous group of metabolic disorders marked by hyperglycemia and is classified into several subtypes. It is currently a major challenge for the world's health systems, with a progressive increase in impact due to urbanization and industrialization, as a result of unhealthy lifestyle habits (MORAES, 2020).

This metabolic disorder is among the five main risks for mortality worldwide, and can trigger acute or chronic complications in the cardiovascular, renal, and neurological systems, usually with functional changes in several organs, especially the heart, kidneys, brain, and blood vessels in general (FRANCISCO, 2018).

DM is classified according to its etiopathogenesis and the most frequent subtypes are called type 1 DM, characterized by an autoimmune process that affects pancreatic beta cells, more common in children and adolescents, and type 2 DM, affecting mainly adults, resulting from metabolic alterations, such as, mainly, peripheral insulin resistance (CALLIARI, 2020). Diabetes diagnosed during pregnancy due to hormonal changes is called Gestational Diabetes Mellitus. Another category is made up of specific subtypes, usually caused by genetic alterations (AMERICAN DIABETES ASSOCIATION, 2017).

Type 1 DM is the result of complete insulin deficiency through the destruction of the cells responsible for the production of this hormone, in most cases, by autoimmune mechanism. Type 2 DM has a higher prevalence, around 95% of cases, and is characterized by peripheral resistance to insulin action, increased hepatic glucose production and abnormal lipid metabolism. It is a disease with an insidious course that culminates in pancreatic beta cell failure, and may have an altered course with lifestyle changes, given the great association of the pathology with socio-environmental factors (OLIVEIRA, 2020).

Currently, according to the International Diabetes Federation, there are more than 415 million adults between the ages of 20 and 79 with DM and it is estimated that there will be a progression to 642 million by 2040. In the period from 1980 to 2012, a study showed that 955,455 people over the age of 20 died from DM in Brazil, a number that rises to 1,076,434 if the underlying causes are added (MALHÃO, 2016). In some cases, the complications of DM lead to death, however, diabetes is often not reported as a direct cause, and the statistics on DM mortality can be dissociated from reality (BRESSAN, 2020).

The Brazilian Survey of Surveillance of Risk and Protective Factors for Chronic Diseases by Telephone Survey (VIGITEL) showed that between 2006 and 2017, the number of DM cases increased from 5.5% to 8.9%, increasing 54% in the number of cases among men and 28% in women, especially in the population over 65 years of age and with low education. This fact represents a need for alert,



due to the increase in morbidity and mortality through cardiovascular and cerebrovascular risk, which is accentuated among the elderly (LIMA NETA, 2020).

Chronic Non-Communicable Diseases are directly associated with early mortality rates. In Brazil, DM is among the ten causes of early mortality (between 30 and 69 years of age) along with some cancers, cardiovascular diseases and chronic kidney diseases. It is noteworthy that cardiovascular diseases and chronic renal failure are chronic complications of DM, increasing its impact. Between 2010 and 2016, the Brazilian health system's (SUS) expenditures doubled with DM and chronic kidney diseases, from US\$1.4 million to US\$2.6 million (NILSON, 2020).

Actions such as early diagnosis and immediate initiation of treatment with measures that include medications and lifestyle changes are essential to control DM mortality rates. There are political strategies to reduce these rates, such as the World Health Organization's (WHO) Global Action Plan for the Prevention and Control of Noncommunicable Diseases and the Ministry of Health's Strategic Action Plan for Addressing Chronic Noncommunicable Diseases in Brazil, 2011 to 2022 (LIMA, 2018).

Bearing in mind that the DM is a chronic, disabling disease, with a global prevalence of around 8.3% and generating an important impact on the world's health systems (HUANG, 2020), this is reflected, in an intense search for health services, an increase in the consumption of medicines, an increase in the number of hospitalizations and various degrees of physical disability in affected individuals (FRANCISCO, 2018).

In Brazil, there are approximately 12 million people with diabetes. Data show that the number of hospitalizations due to complications of DM has fallen by 11.5% in the last five years, although the number of deaths is still high. Type 2 DM, which corresponds to 90% of all diabetes cases, has shown considerable growth as the world population has undergone the process of demographic transition (GARCIA, 2019). Given the relevance of this disease in global and Brazilian public health, and the lack of up-to-date studies on the subject in the Northeast region of Brazil, it is of great importance to carry out epidemiological studies to describe the situation of this pathology.

Thus, the study of mortality due to Diabetes Mellitus in the Brazilian Northeast Region between 2014 and 2018 is considered to be of paramount importance.

## **2 METHODOLOGY**

An epidemiological, descriptive, time-series study was conducted on mortality due to Diabetes Mellitus in the Brazilian Northeast Region, covering the period from 2014 to 2018.

The data used are secondary data collected in TABNET-DATASUS, SUS Information System, Ministry of Health, through research via the official website, made available by the international



computer network - INTERNET. These were collected in the tab "Vital Statistics" - "General Mortality" - "Brazil by Region and Federation Unit, by ICD-10 category: E10 - E14 and O-24.

The ICD-10 categories include: E10 insulin-dependent diabetes mellitus, E11 non-insulin-dependent diabetes mellitus, E12 malnutrition-related diabetes mellitus, E13 other specific types of diabetes and E14 NE diabetes mellitus.

The following variables were studied: deaths by household, available period (2014-2018), Northeast region, Age group, Schooling, Diabetes (E10 to E-14, O-24), Sex, Race, Marital Status, Federation Unit, and Place of occurrence.

Data analysis was performed by organizing and tabulating the data collected in the Microsoft Office Excel® program, which were exported to the Bioestat 5.3 Program (freely distributed, acquired directly from websites), in which descriptive statistics were performed. These data are presented in absolute numbers, percentages and descriptive statistics with exposure of the mean, median, standard deviation and coefficients of variation. The results obtained were expressed in graphs and tables.

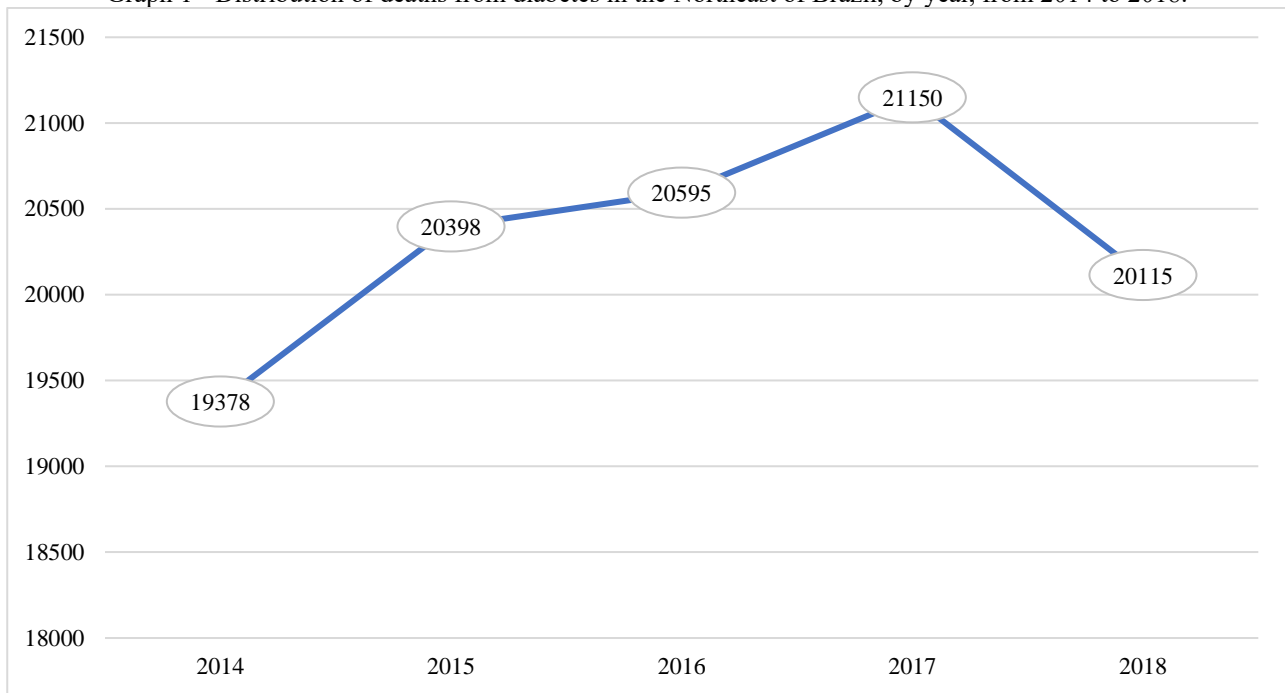
The DATASUS database is a public domain database, its data are freely accessible to the population, researchers and health professionals and fed by the Ministry of Health, it does not allow individual identification and provides population data, and thus does not require submission to a Research Ethics Committee, therefore, this research is in accordance with the recommendations of the Declaration of Helsinki of 1975, revised in 2000, and with Resolution 466/2012 of the National Health Council of Brazil.

### 3 RESULTS

The total number of deaths from diabetes in the Northeast from 2014 to 2018 was 101,636 cases. In the period, the mean = 20,327.2 ( $\pm 651.87$ ) deaths, coefficient of variation (CV) = 3.21%, showing an increasing trend from 2014 to 2017, which reached its peak in 2017 and with a downward trend in 2018. (Graph 1).



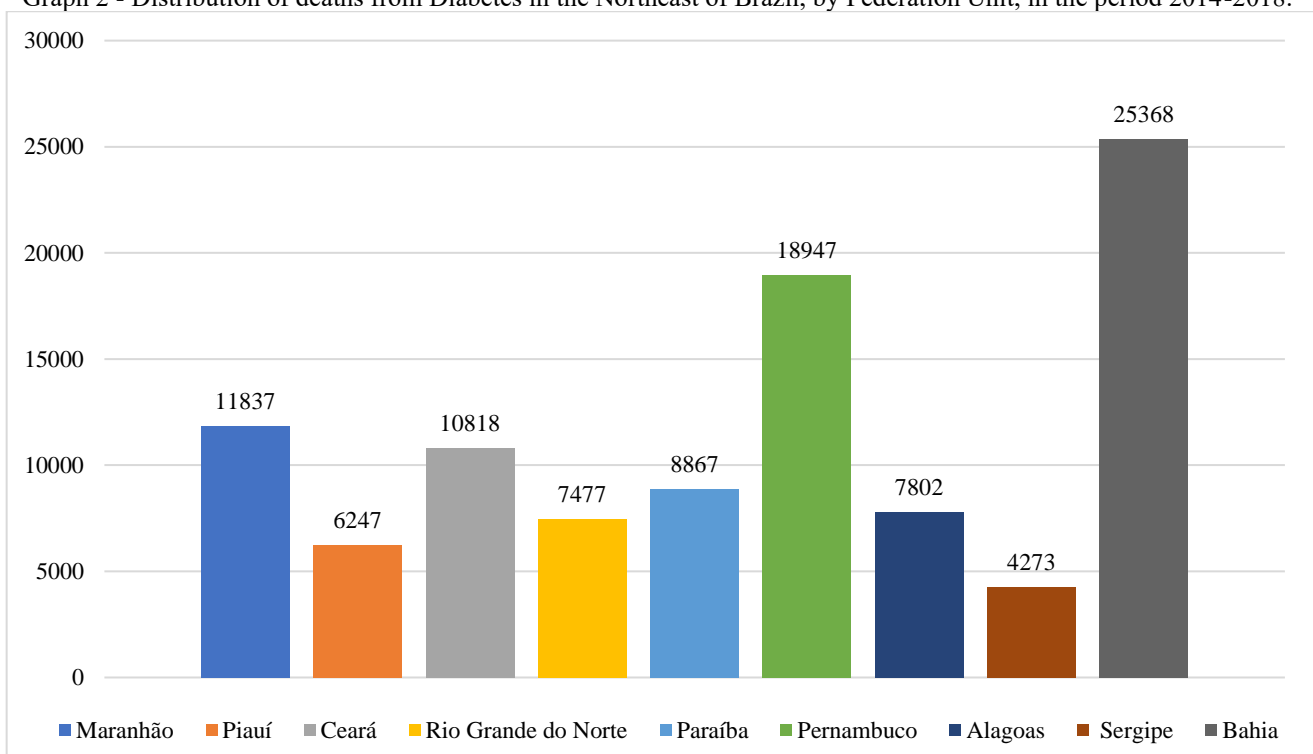
Graph 1 - Distribution of deaths from diabetes in the Northeast of Brazil, by year, from 2014 to 2018.



Source: Prepared by the authors, with data MS/SVS/CGIAE - Mortality Information System – SIM, 2020.

When studying the distribution of deaths from diabetes in the Northeast, by Federation Unit, in the period under study (Graph 2), it was found that Bahia was the state with the highest number of deaths, followed by Pernambuco and Maranhão. The states of Piauí and Sergipe had the lowest numbers of deaths from diabetes.

Graph 2 - Distribution of deaths from Diabetes in the Northeast of Brazil, by Federation Unit, in the period 2014-2018.



Source: Prepared by the authors, with data MS/SVS/CGIAE - Mortality Information System – SIM, 2020.



The descriptive statistics of these data, shown in Table 1 below, allow us to visualize the profile of the distribution of means, standard deviation, and VC of these deaths in the period under study.

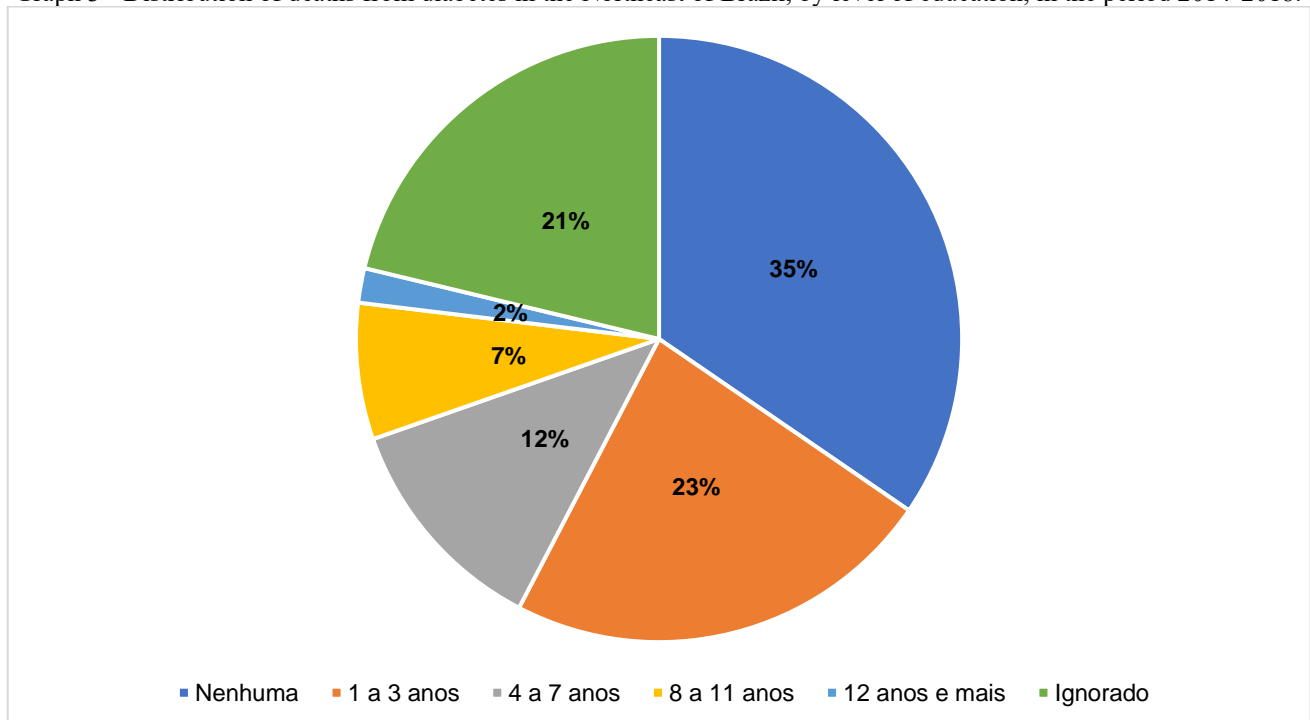
Table 1 - Descriptive statistics of the distribution of deaths due to Diabetes in the Federated Units of Northeast Brazil, 2014-2018.

<i>Federation Unit</i>	<i>Medium and Standard deviation</i>	<i>Coefficient of variation</i>
<i>Maranhao</i>	2367.4±119.3	5,0%
<i>Piaui</i>	1249.4±63.7	5,1%
<i>Ceara</i>	2163.6±105.1	4,9%
<i>Rio Grande do Norte</i>	1495.4±39.4	2,6%
<i>Paraiba</i>	1773.4±52.2	2,9%
<i>Pernambuco</i>	3789.4±266.3	7,0%
<i>Alagoas</i>	1560,4 ±118,4	7,6%
<i>Sergipe</i>	854.6±72.4	8,5%
<i>Bahia</i>	5073,6 ±242,3	4,8%

Source: Prepared by the authors, with data MS/SVS/CGIAE - Mortality Information System – SIM, 2020.

Regarding schooling (Graph 3), there was a high number of deaths due to diabetes with none=35,131 cases, followed by 1 to 3 years of schooling=23,456 cases, unknown=21,588 cases, 4 to 7 years of schooling=12,194 cases, 8 to 11 years of schooling=7,395 cases, and 12 years and more of schooling=1,872 cases.

Graph 3 - Distribution of deaths from diabetes in the Northeast of Brazil, by level of education, in the period 2014-2018.

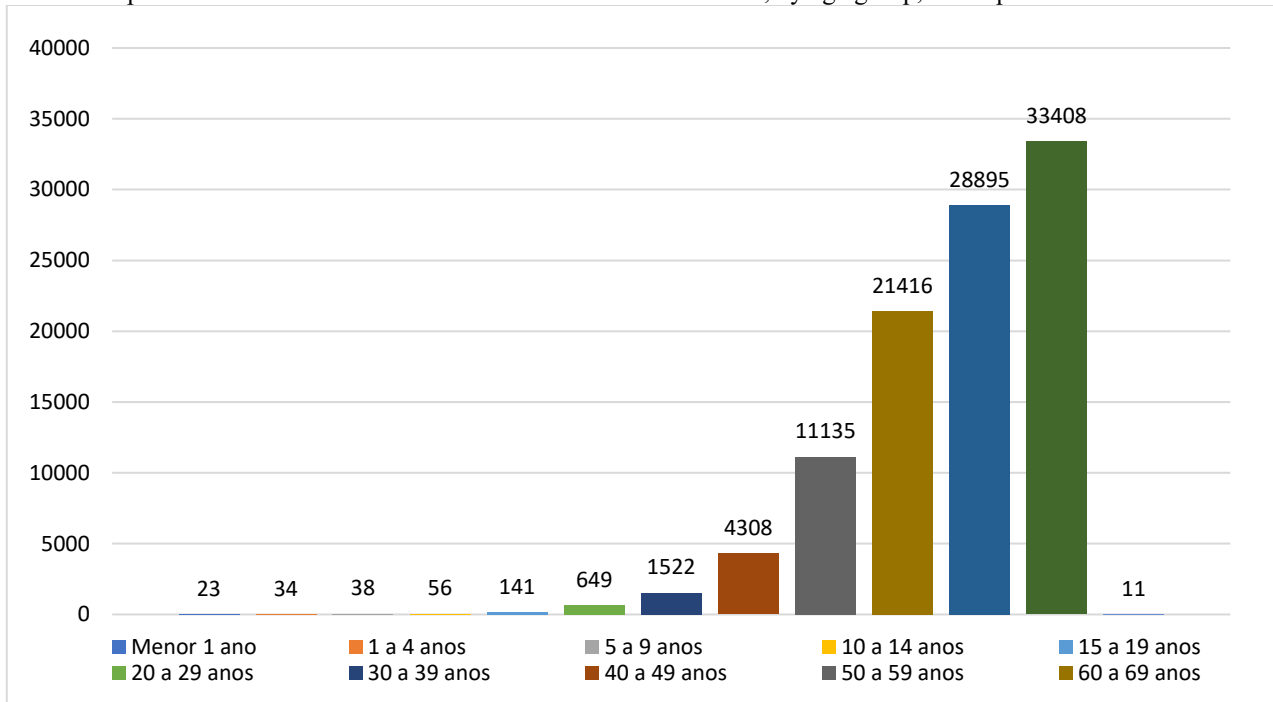


Source: Prepared by the authors, with data MS/SVS/CGIAE - Mortality Information System – SIM, 2020.



With regard to the age group (Graph 4), it was observed that most deaths occurred in the age group 80 years and over, observing that from the age group 50 to 59 years, the number of deaths due to diabetes increases substantially in all age groups above this age, however, deaths occurred in all age groups.

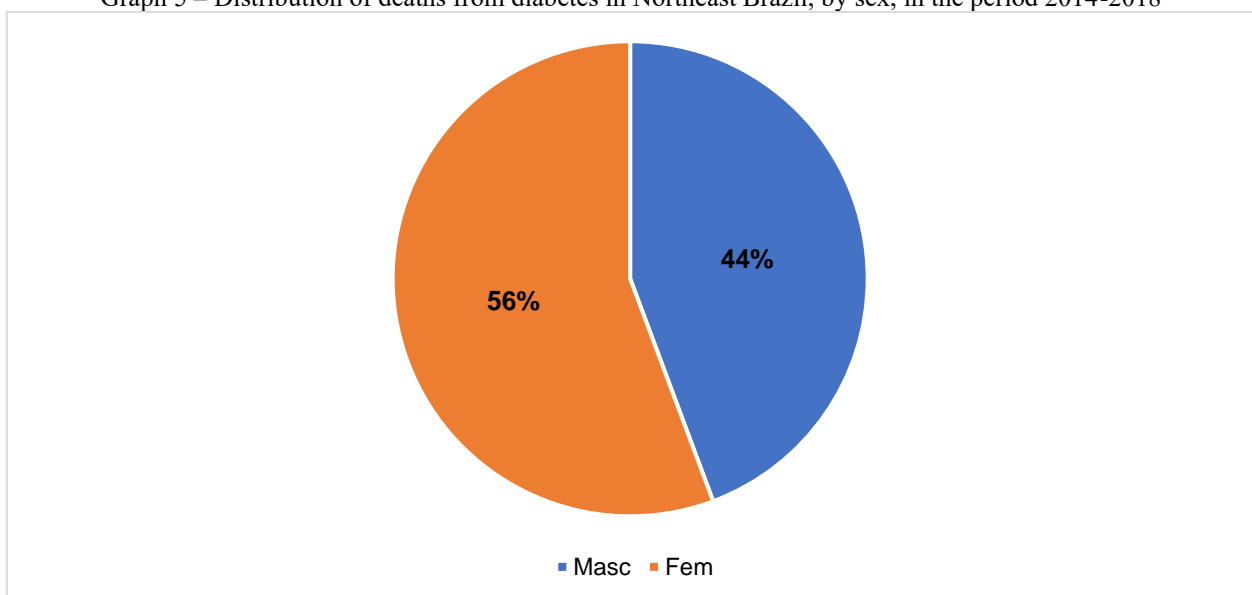
Graph 4 - Distribution of deaths from Diabetes in the Northeast, by age group, in the period 2014-2018.



Source: Prepared by the authors, with data MS/SVS/CGIAE - Mortality Information System – SIM, 2020.

Regarding gender, females stood out in terms of the number of deaths due to diabetes, totaling 56,587 deaths, while males accounted for 45,040 deaths (Graph 5).

Graph 5 – Distribution of deaths from diabetes in Northeast Brazil, by sex, in the period 2014-2018

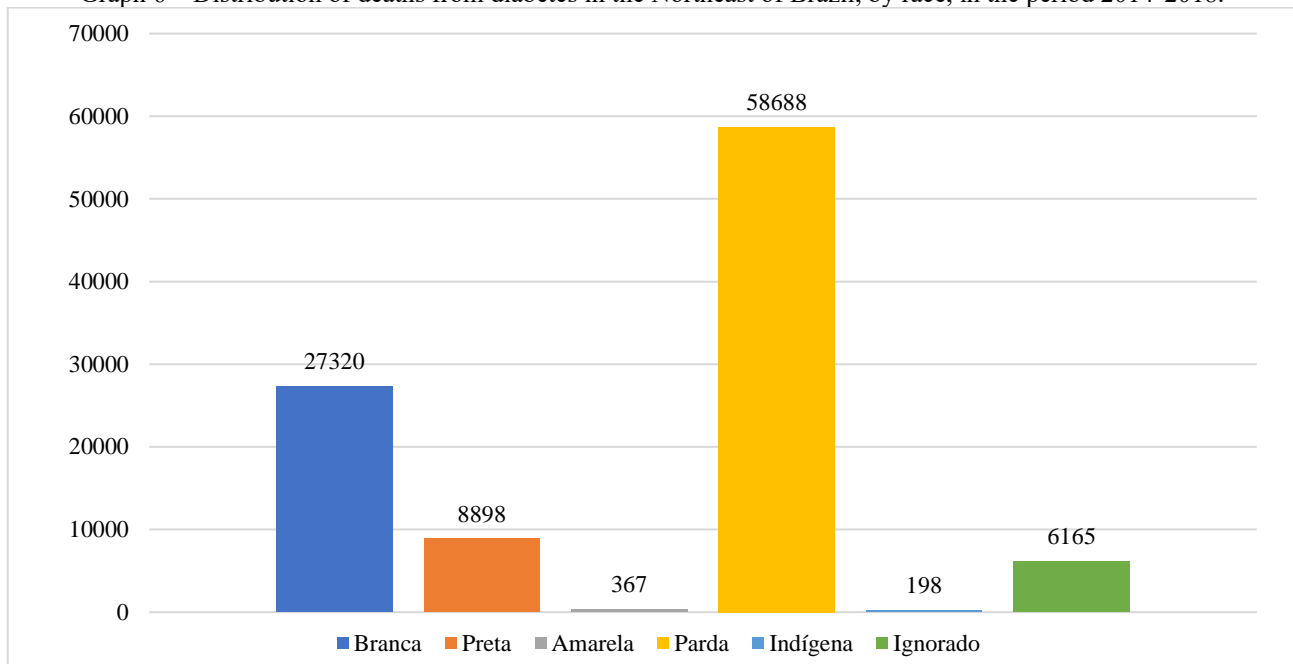


Source: Prepared by the authors, with data MS/SVS/CGIAE - Mortality Information System – SIM, 2020.



As for race (Graph 6), brown women prevailed, with the highest number of deaths, representing 58%, followed by white with 27%, black with 9%, ignored 6%, yellow <1% and indigenous <1%.

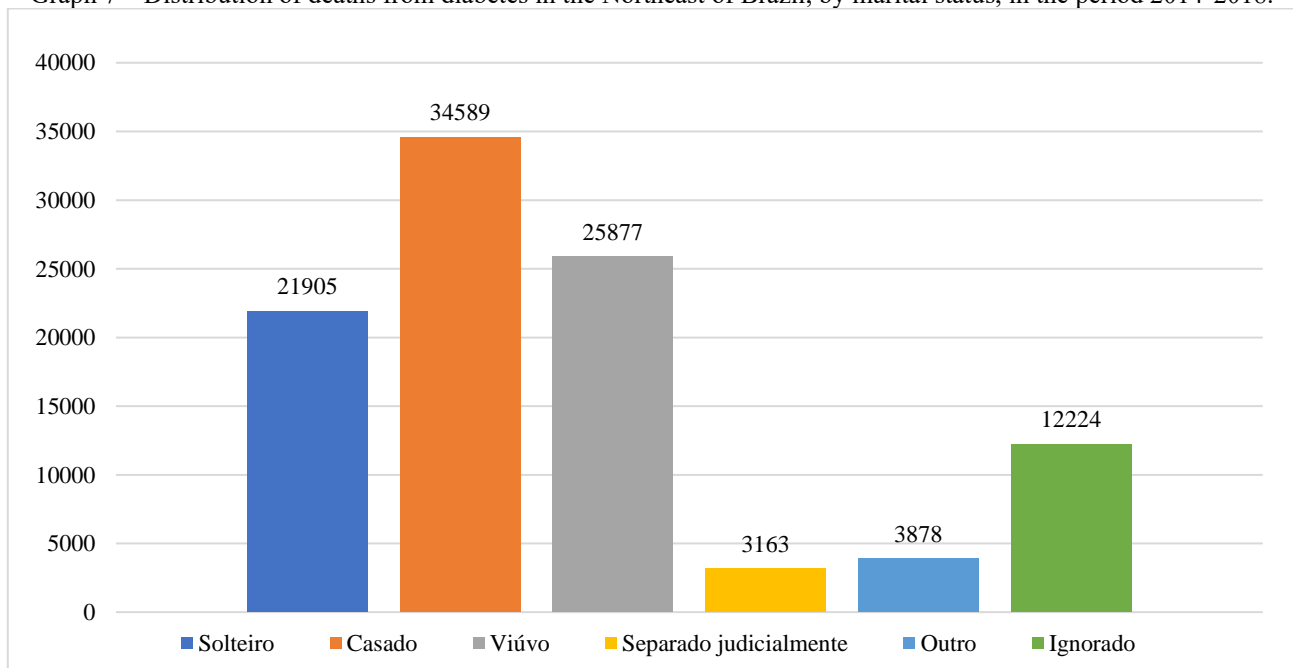
Graph 6 – Distribution of deaths from diabetes in the Northeast of Brazil, by race, in the period 2014-2018.



Source: Prepared by the authors, with data MS/SVS/CGIAE - Mortality Information System – SIM, 2020.

With regard to marital status (Graph 7), the majority of deaths occurred in married 39%, widowed 29%, single 24%, separated 4%, other 4%.

Graph 7 – Distribution of deaths from diabetes in the Northeast of Brazil, by marital status, in the period 2014-2018.



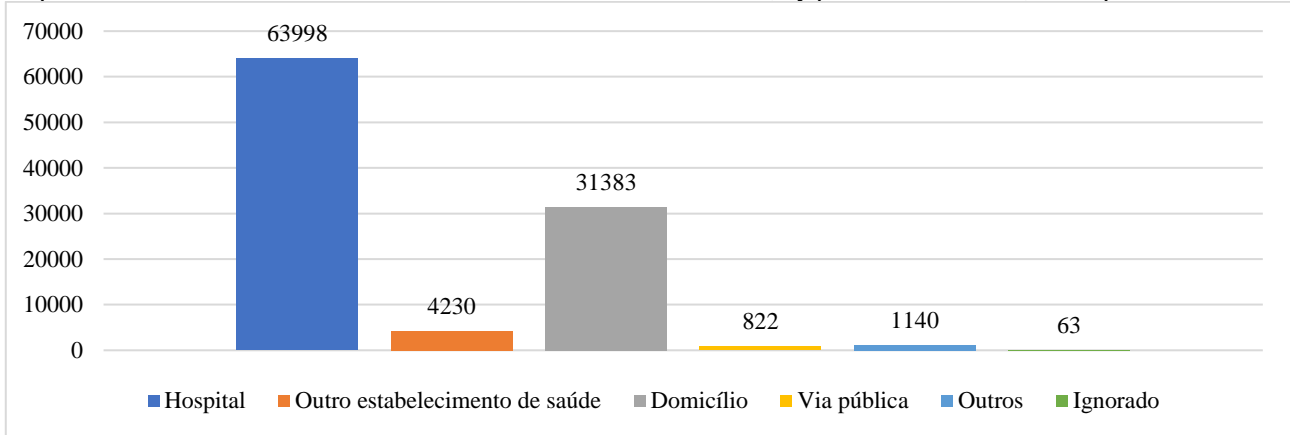
Source: Prepared by the authors, with data MS/SVS/CGIAE - Mortality Information System – SIM, 2020.





Regarding the place of occurrence (Graph 8), deaths occurred more frequently in the hospital, representing 63% of deaths due to diabetes, however, a high number occurred at home, representing 31%, in another health facility, representing 4%, 1% on public roads and 1% others.

Graph 8 - Distribution of deaths from diabetes in the Northeast of Brazil, by place of occurrence, in the period 2014-2018.



Source: Prepared by the authors, with data MS/SVS/CGIAE - Mortality Information System – SIM, 2020.

Table 2, referring to the ICD-10 category, shows that Unspecified Diabetes Mellitus is the category with the highest number of deaths, with a slight decrease in 2016; followed by non-insulin-dependent diabetes mellitus, which has shown an increasing trend over the years; subsequently, insulin-dependent diabetes mellitus was the third category, showing an increasing trend in deaths over the study period; in number.

Far below, still in table 2, comes Diabetes mellitus related to malnutrition, which showed a decrease in 2018; then come the other specified types of Diabetes mellitus, with peaks in 2014 and 2017, demonstrating stability in the number of deaths, and finally Diabetes mellitus in pregnancy, which also showed a trend of stability and represented the lowest number of deaths from Diabetes in the period studied.



Table 2 - Distribution of deaths due to Diabetes in the Northeast, by ICD-10 category, by year, 2014-2018.

<i>ICD-10 Category</i>	<i>2014</i>	<i>2015</i>	<i>2016</i>	<i>2017</i>	<i>2018</i>	<i>TOTAL</i>
<i>E10 Diabetes mellitus insulino-dependente</i>	805	961	1035	1216	1281	5298
<i>E11 Diabetes mellitus nao-insulino-dependente</i>	1840	1962	2224	2706	2937	11669
<i>E12 Diabetes mellitus related to malnutrition</i>	213	217	215	207	164	1016
<i>E13 Other spec types of diabetes mellitus</i>	96	77	77	94	90	434
<i>E14 Diabetes mellitus NE</i>	16422	17177	17040	16924	15638	83201
<i>O24 Diabetes mellitus in pregnancy</i>	2	4	4	3	5	18

Source: Prepared by the authors, with data MS/SVS/CGIAE - Mortality Information System – SIM, 2020.

#### 4 DISCUSSION

The Northeast is the region of Brazil with the largest number of states in the Federation, totaling nine states and It has a geographical dimension with an area of 1,554,291,607 kilometers (IBGE, 2010). The data collected in this research, with the Mortality rates Diabetes Mellitus, in the Northeast region of Brazil, showed a progressive perspective of increase between the years 2014 and 2017, followed by a decrease in 2018.

A study (MACEDO, 2019) pointed out that in 2012, 9,305 cases of Diabetes Mellitus were registered in the Brazilian Northeast, with a predominance of 72.9% for type 2 of the disease. Two years after this study, in 2014, as this research showed, 19,378 cases of deaths were registered, indicating an increase more than double, continuing with increasing numbers in the years 2015 to 2017. This points to the need for attention in the face of a pathology with an intense impact and a high and alarming perspective. On the other hand, the increase in public health policies created in order to stimulate the early diagnosis and treatment of the disease justifies the increase in the reported numbers.

The most populous federative units in the Northeast Region are, in order: Bahia, Pernambuco, Ceará and Maranhão. However, the number of deaths, in order, was: Bahia, Pernambuco and Maranhão. The state of Ceará ranked fourth with 10,818 registered cases. A study carried out between 2000 and 2015 by GARCES (2018), showed a number of deaths of 28,583 cases in Ceará, which already had a lower proportion, compared to Brazil, which in this same time frame, registered 764,148 deaths due to DM (GARCES, 2018).

The social context in which the individual is inserted directly contributes to the outcome of his/her pathology. Knowledge and attitudes are related to the development of acute and chronic complications of DM. Schooling and beliefs about health and disease are important factors in the development of self-care behavior and control of DM (GARDA, 2019). The present study contemplates this fact, demonstrating a context in which the highest number of deaths is in individuals with low or no schooling, with 35% of deaths (35,131 cases) in people with no schooling, 23% of



deaths (23,456 cases) in people with 1 to 3 years of schooling, and 21% of deaths (21,588 cases) in people with unregistered schooling.

The change in the demographic profile and aging patterns, as well as the long-term repercussions of social transformations, have built a peculiar trend of morbidity and mortality in populations, especially in developing countries, such as Brazil. In 2020, it is estimated that 46.4% of deaths will be due to cardiovascular diseases, especially diabetes. There are, however, few studies regarding the aging pattern of poor regions, such as the Brazilian Northeast, not making clear the peculiarities regarding population aging and the health conditions of this location (PEREIRA, 2020).

In line with this fact, the number of deaths increases, as indicated by the data explained here, as the age group increases, following the propensity implied by diabetes, which contributes to the wear and deterioration of blood vessels and organs, with the highest number of deaths (33,408 cases) registered from the age of 80 years. followed by 28,895 cases of deaths in the 70-79 age group and 21,416 cases in the 60-69 age group.

Deaths due to DM were significantly recorded in the Brazilian Northeast from the age group of 50 to 59 years, demonstrating a failure in the disease control process, since with adequate management and good glycemic control, complications from the pathology are not expected at this stage of life.

In the age group between 0 and 29 years, 941 deaths due to diabetes were recorded in the period from 2014 to 2018 in the northeast region, with the highest number concentrated in the age group of 20 to 29 years (649 deaths), followed by the age group of 15 to 19 years with 141 deaths. In Brazil, a study (MERINO, 2019) found a total of 1,120 deaths and 87,100 hospitalizations due to DM in children and adolescents from 2005 to 2015, with the highest occurrence of deaths in the age group between 15 and 19 years. As it is one of the main chronic diseases of youth, the impact on public health is relevant, as this pathology increases the individual's morbidity and mortality, and it is necessary care aimed at harm reduction and prevention of early mortality.

A study conducted between 2006 and 2014 (CONFORTIN, 2019) showed that diabetes, along with diseases of the circulatory system, cancer, and chronic respiratory diseases, accounted for 63.7% of all premature deaths from chronic non-communicable diseases in 2011. This same study showed that the risk of premature death would fall to 22% in 2020, but even with such a reduction, it is still high in quantity, as it is related to preventable and controllable causes.

A study conducted in Bahia (FALCÃO, 2020) identified a higher frequency of hospitalizations for DM in females. However, this same study shows higher mortality rates in males. It is noteworthy that sex implies human life expectancy, to the detriment of developed cultural and social values. In most populations, men have higher mortality rates, mainly due to external causes and in younger age groups. Causes such as chronic non-communicable diseases are reserved for women, as they maintain



greater longevity (SIVIERO, 2019). This explains the fact that here there is a higher mortality rate (56%) for females in the Northeast region.

The concept of race and ethnicity, in health sciences, contemplates not only the phenotypic characteristics, but also the socioeconomic context involved. However, there is a methodological complexity in the use of these variables, because there is no consensus regarding this categorization of populations and their use in the development of definitions (MORETTO, 2016). In any case, there was a predominance of mortality due to diabetes in the brown race, accounting for 58% of the deaths, which was the vast majority of the population studied.

There was a predominance of deaths in married people (39%) and widows (29%). In this sense, certain sociodemographic and clinical characteristics influence adherence to self-care practices in diabetes control, however, (BOAS, 2011) did not find significant epidemiological differences in relation to marital status and occupation.

In the study of the places of death due to diabetes in the Northeast region, a higher number (63%) in a hospital environment and 4% in another health establishment was demonstrated, indicating a strengthening of the referral and counter-referral system at the health care levels. However, death at home (with a significant number of 31%) cannot necessarily be considered a negative factor, especially in the context of chronic-degenerative diseases, as in the case of diabetes, as long as the individual is being monitored with specialized guidance, under the concepts of palliative care (RODRIGUES, 2020).

The most common causes of death on public roads are external causes. However, between 2014 and 2018, in the Northeast region, there were 822 deaths from DM, a significant number, mainly because it is a controllable chronic disease and preventable complications, denoting a relevant public health problem. However, we did not find any literature that allows any comparison to discuss this finding.

The highest mortality rate due to diabetes is reserved for the unspecified category of the disease, totaling 83,201 cases of deaths, demonstrating a failure in the identification of the subtype of the pathology or in the records, since in Brazil the statistics on mortality are based on the information contained in the death certificates.

Overall, there was an increase in the number of deaths, especially in the non-insulin-dependent category, between 2014 and 2018, considering that type 2 DM has a higher and progressive incidence, through the aging process, association with sedentary lifestyle, obesity, and lifestyle (GARCIA, 2018). The causes of death due to insulin-dependent diabetes are mainly diabetic ketoacidosis and hyperosmolar hyperglycemic coma, caused by very high blood glucose peaks (COUSIN, 2020). In the Northeast region of Brazil, deaths in this category accounted for a total of 5,298 cases in the period from 2014 to 2018, with an increasing line in the number of deaths.



It is worth mentioning that the category Diabetes Mellitus related to malnutrition presented a significant number of 1,016 deaths in the period studied. DM related to malnutrition has a different pathophysiology from other classic forms of diabetes, a notable fact is the relationship with the social character of the disease, presented through the great relationship with the lack of resources of the affected population, constituting an important public health problem (DE SÁ, 2019).

## 5 CONCLUSION

Based on this study, a total of 101,636 cases of deaths due to Diabetes Mellitus were found between 2014 and 2018 in the Northeast region, showing an increasing trend from 2014 to 2017 and a subsequent decrease in 2018.

The current scenario, due to the high rates cataloged, points to the need for intervention measures, based on scientific evidence, at all levels of care in the Brazilian public health system. In addition, it is necessary to observe the peculiarities of the population of northeastern Brazil, in order to develop specific regionalized strategies.

The present study showed alarming information, with considerable numbers of deaths in all nine states of the region. Deaths were observed even in young populations, in contrast to the natural history of diabetes, since it is a disease with preventable complications.

Formidable topics, such as the high number of deaths on public roads, deaths in non-habitual age groups, and deaths in diabetes related to malnutrition, expose great fragility and lack of care in the implementation of methods of control and management of DM in the Northeast region of Brazil.

In addition, a relationship with an unfavorable outcome was also pointed out in individuals with less schooling, suggesting that this social determinant of health is a point to be explored in the development of health promotion and education practices.

With the data exposed and discussed, it is intended to contribute to a better understanding of the particulates observed during the appreciation of the topics analyzed and, with this, it is expected to facilitate the development of improvements.



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