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Spatial and temporal distribution of cancer mortality in a Brazilian Legal Amazon State between 2000 and 2015

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Artigo original

Spatial and temporal distribution of cancer mortality in a Brazilian Legal Amazon State between 2000 and 2015

Distribuição espacial e temporal da mortalidade por câncer em um estado da Amazônia Legal Brasileira entre 2000 e 2015

Distribution of cancer mortality between 2000 and 2015

Distribuição da mortalidade por câncer entre 2000 e 2015

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Competing interests

The authors declare that they have no competing interests.

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Ethics approval and consent to participate

The study was approved by the Ethics and Research Committee of Júlio Muller Universitary Hospital (CAAE: 98150718.1.40.8124), with ethical approval obtained for mortality data from the referred hospital.

Author's contributions

Noemi Dreyer Galvão and Bárbara da Silva Nalin de Souza designed the study; Mário Ribeiro Alves and Amanda Cristina de Souza Andrade analyzed the data; Jânia Cristiane de Souza Oliveira did literature search; Elicléia Filgueira Santiago de Azevedo drafted the manuscript; Rita Adriana Gomes de Souza revised the manuscript. All authors revised and approved the submitted manuscript.

ABSTRACT

***Objective*:** To analyze the spatial distribution of the four-year rates of mortality from cancer in Mato Grosso state, Brazil, in the period from 2000 to 2015. ***Methodology*:** Ecological design study, in which mortality from neoplasia was analyzed, from 2000 to 2015, for the municipalities of the Mato Grosso state. Mortality rates due to cancer were calculated by the ratio of the sum of deaths by cancer in each quadrennium, divided by the average of the population in the two central years of the period, multiplied by 10,000 inhabitants. Annual percentage change was calculated by the ratio of the linear regression coefficient to the cancer mortality rates in the Mato Grosso state at the beginning of the analyzed period (2000 to 2003). Thematic maps were constructed for each quadrennium using intervals of equal classes. ***Results*:** Cancer caused 31,097 deaths in the Mato Grosso state in the period, 13,058 in women and 18,039 in men, with a male to female ratio of 1.38. The top five causes of cancer death in the period were lung (12.2%), prostate (8.7%), stomach (7.7%), breast (6.0%) and liver (4.7%). There was increase in the number of municipalities with rates greater than 23.67 deaths per 100,000 inhabitants in the period. ***Conclusion*:** There was an increase in cancer mortality and an increase in the proportion of municipalities with higher mortality rates. Higher density of cancer mortality occurred in the municipalities located in the West, Center-South, Southeast and Center-North regions of the state.

Keywords: Neoplasms; Information systems; Mortality Rate; Spatial Analysis; Temporal Distribution.

RESUMO

Objetivo*:** Analisar a distribuição espacial das taxas quadrimestrais de mortalidade por câncer no estado de Mato Grosso, Brasil, no período de 2000 a 2015. ***Metodologia: Estudo de desenho ecológico, no qual foi analisada a mortalidade por neoplasia, de 2000 a 2015, para os municípios do estado de Mato Grosso. As taxas de mortalidade por câncer foram calculadas pela razão da soma das mortes por câncer em cada quadrênio, dividida pela média da população nos dois anos centrais do período, multiplicada por 10.000 habitantes. Uma variação percentual anual foi calculada pela razão do coeficiente de regressão linear para as taxas de mortalidade por câncer no estado de Mato Grosso no início do período analisado (2000 a 2003). Mapas temáticos foram construídos para cada quadriênio usando intervalos de classes iguais. ***Resultados***: O câncer causou 31.097 óbitos no estado de Mato Grosso no período, 13.058 em mulheres e 18.039 em homens, com uma proporção de homens e mulheres de 1,38. As cinco principais causas de morte por câncer no período foram pulmão (12,2%), próstata (8,7%), estômago (7,7%), mama (6,0%) e fígado (4,7%). Houve um aumento no número de municípios com taxas superiores a 23,67 óbitos por 100.000 habitantes no período. ***Conclusão***: Houve aumento da mortalidade por câncer e aumento na proporção de municípios com maiores taxas de mortalidade. Maiores densidades de mortalidade por câncer ocorreram nos municípios localizados nas regiões Oeste, Centro-Sul, Sudeste e Centro-Norte do estado.

Palavras-chave: Neoplasias; Sistemas de informação; Taxa de Mortalidade; Análise espacial; Distribuição Temporal.

INTRODUCTION

Chronic noncommunicable diseases are responsible for most deaths worldwide. It is estimated that cancer is at the top of the basic causes of death and is the most important barrier to increasing life expectancy in the world[1].

In 2016, about 41 million deaths were due to chronic noncommunicable diseases and of these, 9 million (22%) had cancer as a basic cause[1]. Worldwide, projections for the year 2030 indicate the occurrence of 26 million new cases and 17 million deaths from the disease[2]. These numbers express the importance of cancer as a leading cause of death worldwide[3].

In Brazil, between 1996 and 2010, 2,023,038 deaths from cancer occurred, with 53.9% affecting men and 46.1% women[4]. In the year 2017, the five primary locations with the highest death rates in the male population in the country were: bronchi and lung with 15.60 per 100,000, followed by prostate with 14.24 per 100,000, thirdly the stomach with 8.82 per 100,000, in fourth the esophagus with 6.41 per 100.000 and in fifth place the liver and biliary tract with 5.71 per 100.000. In the female population, for the same year, the primary location that showed the highest rate was the breast with 13.22 per 100,000, secondly that of the bronchi and lung with 9.20 per 100,000, followed by cervical cancer with 5.14 per 100,000, in the fourth place the colon with 4.62 per 100,000 and in the fifth place the pancreas with 4.06 per 100,000[5].

The estimate of new cases of cancer in Brazil for the period 2020 to 2022 is 625 thousand and for the state of Mato Grosso, were estimated crude rates of 252.04 per 100,000 for men and 217.31 per 100,000 for women[6].

Spatial analysis of data allows the analysis of cases according to the distribution in a specific geographical area. However, it is worth mentioning that the spaces are not homogeneous, because the spatial differentiation implies several other singularities, such as culture, education, income, genetic and housing characteristics[7].

In this way, the relevance of this study is unique, since the environment has characteristics that can act as risk factors for the occurrence of cancer. In addition, scientific production on the theme of cancer, using geoprocessing as an analysis tool, is still little explored, which further highlights the importance of this study, aiming to analyze the spatial distribution of the four-year rates of mortality from neoplasia, in the period from 2000 to 2015 in the State of Mato Grosso, Brazil.

METHODOLOGY

Ecological design study, in which mortality from neoplasia (by municipality of residence) was analyzed, from 2000 to 2015, for the state of Mato Grosso.

The Brazilian Legal Amazon corresponds to the area of operation of the Superintendence of Development of the Amazon - SUDAM, being formed by the states of Rondônia, Acre, Amazonas, Roraima, Pará, Amapá, Tocantins, Mato Grosso and the western part of the State of Maranhão. It has an area of approximately 5,015,067.749 km², corresponding to approximately 58.9% of the Brazilian territory[8].

Data on the estimated population of the state were acquired from IBGE (Institute of Geography and Statistics, in portuguese)[8] for the year 2018 (3,441,998 inhabitants, with a population density of 3.36 inhabitants per km2 and a territorial area of 903,206,997 km²). The Mato Grosso state is divided into 7 geographic regions and 141 municipalities (Figure 1).

Mortality data were obtained from the databases of the Mortality Information System (SIM, in portuguese)[9] provided by the Mato Grosso State Department of Health. Cancer deaths were analyzed under codes C00 to C97, according to the 10th ICD-10

(International Classification of Diseases). These deaths refer to individuals of all ages. Population estimates by age group were collected from the website of the Department of Informatics of the Unified Health System, the Brazilian public health system[10].

Mortality rates due to cancer were calculated by the ratio of the sum of deaths by cancer in each quadrennium, divided by the average of the population in the two central years of the period, multiplied by 10,000 inhabitants. The rates were adjusted by the direct method by age groups, with intervals of four years, considering as a standard population the distribution of the world population[11]. In order to reduce instability in the analysis of data on mortality by municipality, we sought to smooth out random fluctuations by grouping rates in four-year periods: 2000 to 2003; 2004 to 2007; 2008 to 2011; 2012 to 2015.

An annual percentage change was calculated by the ratio of the linear regression coefficient to the cancer mortality rates in the Mato Grosso state at the beginning of the analyzed period (2000 to 2003). Adopt a 5% significance level.

To explore the spatial distribution of cancer mortality rates, thematic maps were constructed for each quadrennium using intervals of equal classes (0.00; between 0.01 and 12.52; between 12.53 and 23.67; between 23.68 and 36.21; between 36.22 and 48.00; above 48.00). The intervals were defined from the distribution of rates in the first quadrennium (2000-2003). The geographical unit of analysis were the 141 municipalities of Mato Grosso. The municipalities of Itanhangá and Ipiranga do Norte were created in 2005, which made it impossible to calculate the mortality rate for the quadrennium from 2000 to 2003 and were declared as missings. The cartographic bases were obtained from the Brazilian Institute of Geography and Statistics[12]. The Kernel maps were built with an adaptive radius. Nine strata were used, divided into equal intervals.

For data analysis, the software STATA version 12.0 and the ArcMap Program version 10.3 were used. The study was approved by the Ethics and Research Committee of Júlio Muller Universitary Hospital.

RESULTS

In the period from 2000 to 2015, cancer caused 31,097 deaths in the Mato Grosso state, 13,058 in women and 18,039 in men, with a male to female ratio of 1.38. The top five causes of cancer death in the period were lung (12.2%), prostate (8.7%), stomach (7.7%), breast (6.0%) and liver (4.7%). The mortality rate in the state in the quadrenniums from 2000 to 2003, 2004 to 2007, 2008 to 2011 and 2012 to 2015 was 30.0, 32.4, 32.8 and 33.2 per 100,000 inhabitants, respectively, indicating an average annual increase of 8.3% ($p = 0.030$) (data not shown).

Figure 2 shows the proportion of municipalities according to the intervals of equal classes defined in the maps. There is an increase in the proportion of municipalities with mortality rates between 23.68 to 36.21, between 36.22 to 48.00 and above 48.00. For the remaining intervals (0.00; between 0.01 and 12.52; between 12.53 to 23.67), there was a downward trend.

Figure 3 shows the four-year trends in cancer mortality rates according to municipality. There is increase in the number of municipalities with rates greater than 23.67 deaths per 100,000 inhabitants in the period. The regions with the highest rate in the quadrenniums were West, Center-South, Southeast, Center-North and North, while the Northeast and Northwest regions had the lowest rates.

The kernel intensity map (Figure 4) confirms that the highest density of cancer mortality occurred in the West, Center-South, Southeast and Center-North regions of the state and the lowest in the Northeast and Northwest regions. This pattern tends to be maintained throughout the quadrenniums. For the North and Northwest regions there is a decrease in mortality densities over the four-year period. The Northeast region had the lowest densities in the entire period studied.

DISCUSSION

There was an average annual increase of 8.3% in cancer mortality rates and an increase in the proportion of municipalities with higher mortality rates. The municipalities located in the West, Center-South, Southeast and Center-North regions of the state presented higher density of cancer mortality.

The results of this study identified space and time patterns that point to an increase in standardized rates of cancer mortality in the State of Mato Grosso from 2000 to 2015.

According to IBGE data on the age distribution of the population, at least 80% of the state population is concentrated below 50 years of age. However, according to the Mato Grosso Oncology Care Action Plan, even though the state has a predominantly younger population, cancer has appeared as the second cause of death in mortality statistics (excluding external causes). In addition, there was also an increase in proportional cancer mortality, from 10.8% in 2001 to 14.3% in 2013[13].

The pattern shown in the state was different from the national pattern, where general rates for the disease have been showing some stability[4]. A study that described the main groups of causes of death from chronic non-communicable diseases between 1990 and 2015 according to estimates from the GBD (Global Burden of Disease) 2015 study, showed that, for Brazil, the standardized mortality rates for cancer went from 142.7 per 100,000 inhabitants (1990) to 133.5 per 100,000 inhabitants (2015), considered stable for the analyzed period[14].

The five main causes of death from cancer in the period for the state, considering the anatomical location, were lung, prostate, stomach, breast and liver. With the exception of liver cancer, which appears only in Mato Grosso, the others are also among the five main types of cancer that kill the most in Brazil, although not in the same order[15].

Estimates from Global Cancer Observatory show that, worldwide, lung cancer remains the leading cause of cancer mortality, with 1.8 million deaths predicted in 2018, representing about 1 in 5 cancer deaths. Prostate cancer is considered the fifth leading cause of cancer death in men, and breast cancer the first in women, accounting for about 1 in 4 cancer cases in this group. Stomach cancer remains an important cancer worldwide, accounting for about 783,000 deaths, equivalent to 1 in 12 deaths from cancer, while liver cancer is considered the fourth leading cause of cancer death worldwide[3].

The profile of deaths presented in the state has been associated with more urbanized, industrialized regions with an aging population, in line with developed countries in the West. On the other hand, the state continues to live with deaths due to types of cancer associated with infections, such as stomach cancer, which have a high potential for prevention and tend to be more prevalent in countries of low and medium development[16].

Cancer is a multifactorial disease, however, according to the WHO (World Health Organization), some risk factors are related to most deaths from chronic noncommunicable diseases, including cancer, having an important contribution to the burden of diseases. Among these factors, smoking, excessive alcohol consumption, inadequate diet and physical inactivity stand out[17].

Data from the National Health Survey for Mato Grosso[18], showed that only 37.0% of the state's population aged 18 or over reported recommended consumption of fruits and vegetables, while 52.9% were classified as insufficiently active (behind Rondônia state only), 24.3% reported weekly alcohol consumption and 12.8% as current users of tobacco products.

There was also a higher proportion of deaths for men. This can be explained by the fact that the three main types of cancer were more present in this group. A study that aimed to analyze the temporal trend of cancer mortality in Brazil in the period from 1996 to 2010, in addition to calculating the projection of mortality for the period from 2011 to 2030, showed that 53.9% of deaths affected men and 46.1% were female. In addition, there was stability in female mortality and a significant increase in the trend for males between 1996 and 2008[4].

Literature data have pointed out that men and women have different life expectancies and habits, with greater female demand for health services and, consequently, with women adopting greater preventive health care than men[19].

Spatial analysis of cancer mortality, through the use of maps, is an important tool to evaluate health risks, especially when this type of analysis considers environmental aspects, as the visualization of information allows a better understanding of how relationships occur, and can contribute to the identification of priority territories, as well as a better understanding of the health-disease process and health planning actions[20].

The use of geoprocessing also allows for a historical analysis of the demand for care in health services, helping to optimize care in health units and producing important changes in epidemiological and operational indicators[21].

The use of this analysis allowed us to identify that the regions of the state that had the highest mortality rates were the West, Center-South, Southeast, Center-North and North regions. These regions showed differences that can be expressed through socioeconomic indicators of the municipalities that integrate them, with also an inequality in installed capacity and in public and private investments, especially in those with less economic dynamism[22]. Despite this diversity, what can be observed is that, in general, these regions have less availability of primary care services, and some also have low health care expenditures (West Region), low availability of specialized assistance establishments (West and North Regions) and low outpatient care per inhabitant in medium and high complexity (West, North and Center-North Regions)[23,24].

Specifically with regard to primary health care services, they serve as a gateway to the health care network. The low availability of these services may impair the identification, in the initial phase, of the first lesions suggestive of cancer and, consequently, determine the specialized services as the predominant places for the diagnosis of the disease, since the confirmation of the lesions requires procedures and supplies available only in medium and high complexity services[25].

Another characteristic of the state is that, with the exception of some municipalities in the Center-South region, agriculture and services are the economic base of practically all regions of the same[23].

Currently, Mato Grosso is the state that most produces soy, corn, cotton and cattle in Brazil, having become, for several years, a strategic territory for the expansion of agribusiness[26], in whose model predominates large monoculture properties, intensive use of chemical and pesticide fertilizers to control unwanted species and use of biotechnology (transgenics)[27]. This issue was evidenced by the higher cancer mortality rates in cities close to BR-163 (a federal highway) (Figure 3), which can probably be explained by the relationship between soy production (with transgenics and use of pesticides, which have highly carcinogenic potentials) and the presence of the highway to transport production to other countries[28].

The state has some municipalities that concentrate a large part of the national agricultural production, such as some municipalities located in the central and southeast regions. Consequently, due to the chemical-dependent production method, in these municipalities there are high rates of consumption of pesticides[29].

The relationship between exposure to pesticides and cancer development has been established in several studies[30-33], being modulated by type of product used, time of exposure and amount absorbed by the body[34]. It is important to highlight that the entire population is susceptible to multiple exposures to pesticides, through the consumption of contaminated water and food, and not only farmers and workers in the pesticide production chain[35].

A possible limitation of the study concerns the incorrect or incomplete filling of information on death certificates in relation to the causes. There was no correction of rates for deaths from ill-defined causes. However, deaths from these causes have decreased in recent decades in all Brazilian regions, especially in cities outside the capitals[36,37]. This has indicated an improvement in the quality of the information recorded in the Mortality Information System, especially for the group of malignant neoplasms, where the quality of information about the basic cause registered in the system can be considered better than for other groups of causes[38].

In 2015, the UN adopted a set of 17 goals as part of a sustainable development agenda. One of the goals is related to the reduction of premature mortality due to noncommunicable diseases through prevention and treatment. It has therefore become a global priority to monitor trends in mortality due to these diseases, provided by quality information systems, in order to verify whether national and global commitments are being achieved[39].

Thus, the description of cancer mortality can bring important contributions to epidemiological studies based on the person-space-time triad. Studies of this magnitude are necessary, especially in Mato Grosso, since studies on this topic are scarce, and knowing this reality can potentially contribute to the identification of priority regions for intervention aiming to reduce mortality rates.

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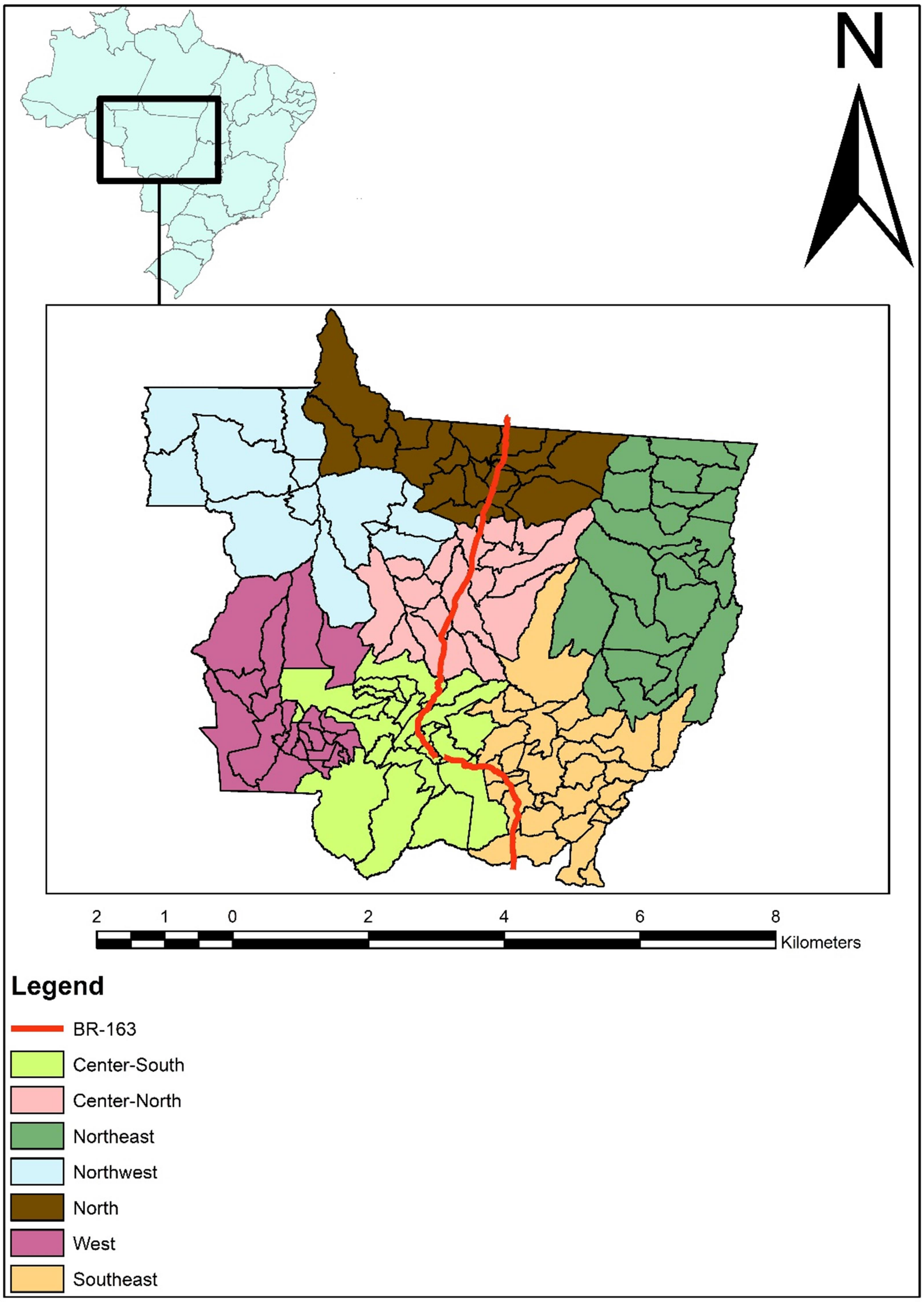

Figure 1 - Location and regional division of Mato Grosso state, Brazil.

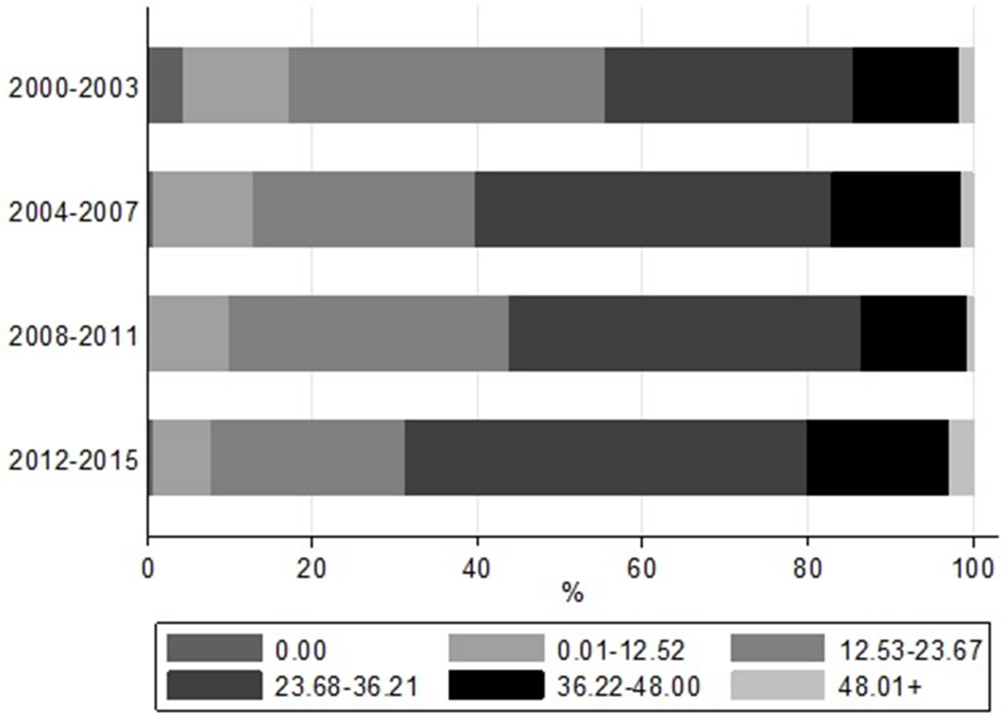

Figure 2 - Proportions of cancer mortality rates in the municipalities of Mato Grosso state (2000-2015).

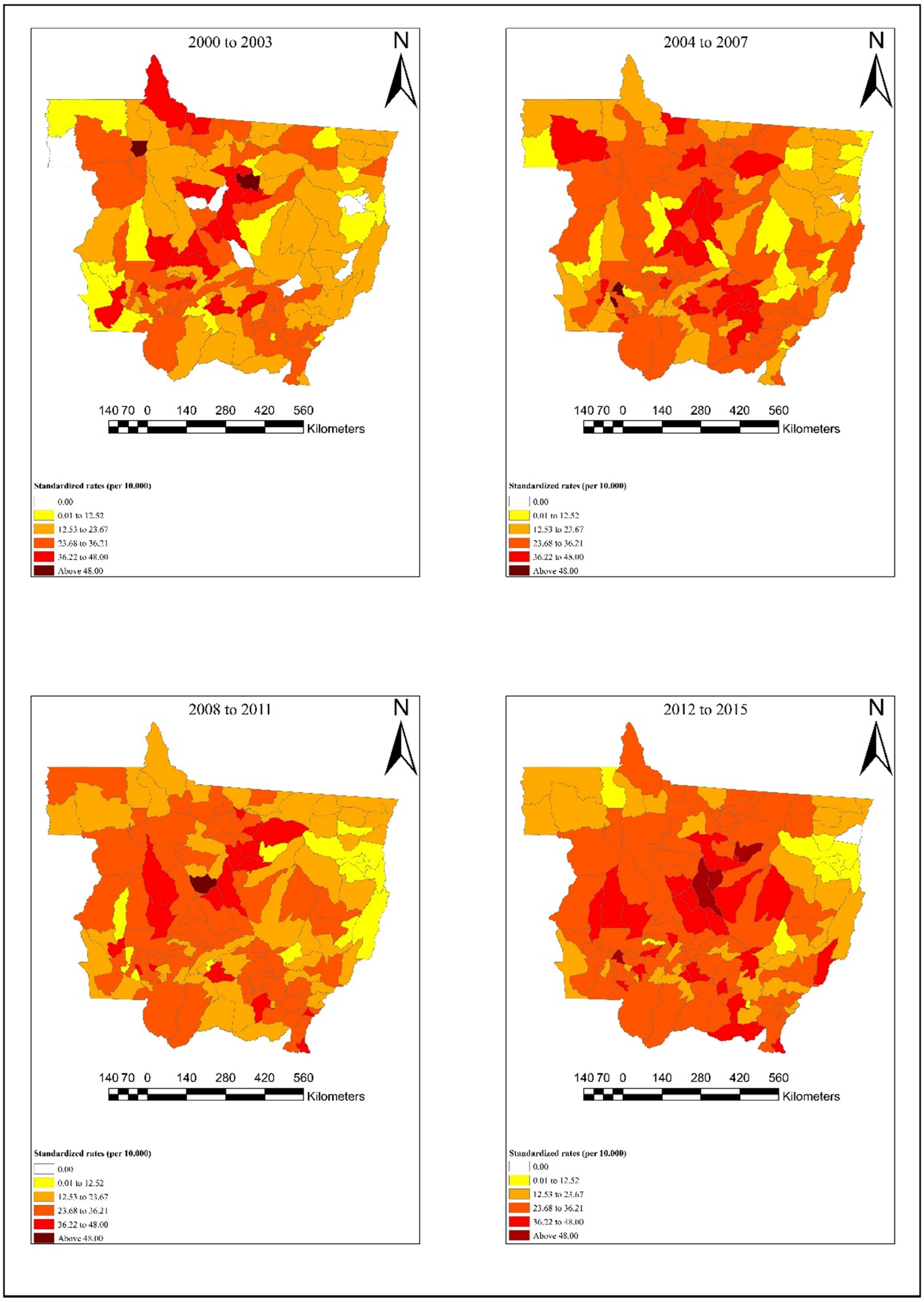

Figure 3 - Cancer mortality rates in the municipalities of Mato Grosso state (2000-2015).

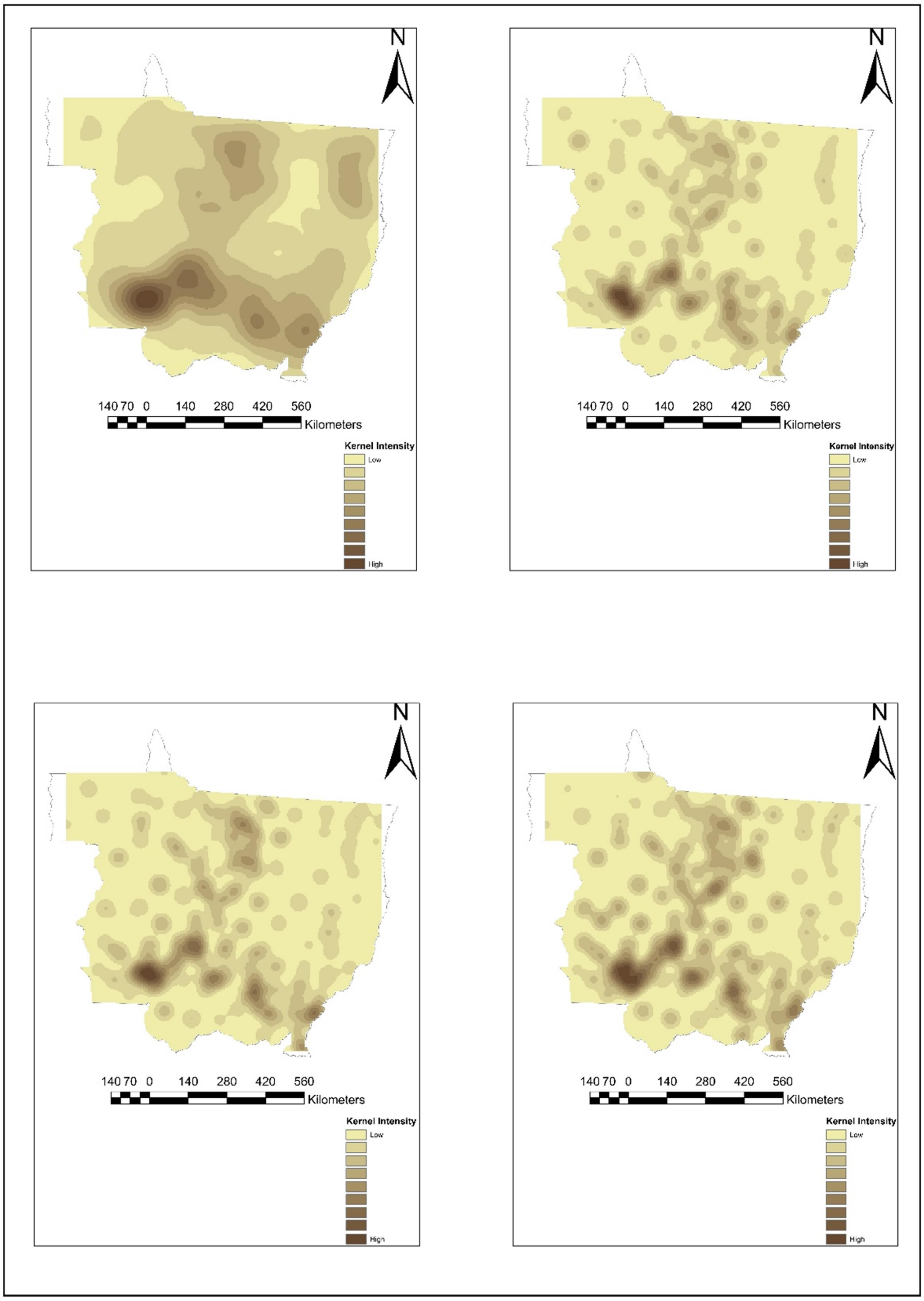

Figure 4 - Kernel intensity of cancer mortality densities (2000 to 2015).