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Cancer mortality in the State of Mato Grosso from 2000 to 2015: temporal trend and regional differences

Mortalidade por câncer no estado de Mato Grosso, Brasil, no período de 2000 a 2015: tendência temporal e diferenças regionais

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ABSTRACT: ***Objective*:** To analyze the trend of standardized cancer mortality rate in the state of Mato Grosso according to health regions, from 2000 to 2015. ***Methods*:** Ecological time series study with data on deaths by cancer from the Mortality Information System. The rates were standardized using direct method and calculated by year and health regions. The annual percentage changes (APC) and respective confidence interval (95%CI) were obtained through simple linear regression. Thematic maps were built to show the spatial distribution of rates. ***Results*:** There were 28,525 deaths by cancer registered in Mato Grosso, with the main types being lung, prostate, stomach, breast and liver cancer. The highest mortality rates were found in regions Médio Norte, Baixada Cuiabana and Sul Mato-Grossense. From 2000 to 2015, an upward trend was seen in the mortality rate by cancer in Mato Grosso (APC=0.81%; 95%CI 0.38–1.26), and in four health regions, Garças Araguaia (APC=2.27%; 95%CI 1.46–3.08), Sul Mato-Grossense (APC=1.12%; 95%CI 0.28–1.97), Teles Pires (APC=1.93%; 95%CI 0,11–3,74) and Vale dos Arinos (APC=2.61%; 95%CI 1.10–4.70), while the other regions remained stable. ***Conclusion*:** In the state of Mato Grosso and in the four health regions, cancer mortality rate showed a growing trend. The results point to the need to consider regional differences when thinking about actions for cancer prevention, control and assistance.

Keywords: Neoplasms. Mortality. Spatial analysis. Information systems. Time series studies.

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RESUMO: ***Objetivo*:** Analisar a tendência da taxa padronizada de mortalidade por câncer no estado de Mato Grosso, Brasil, conforme regiões de saúde, no período de 2000 a 2015. ***Métodos*:** Estudo ecológico de séries temporais com dados de óbitos por neoplasias do Sistema de Informação sobre Mortalidade. As taxas foram padronizadas pelo método direto e calculadas por ano e por regiões de saúde. A variação anual percentual (*annual percent change* — APC) e seu respectivo intervalo de 95% de confiança (IC95%) foram obtidos por meio da regressão linear simples. Construíram-se mapas temáticos para descrever a distribuição espacial das taxas. ***Resultados*:** Foram registrados 28.525 óbitos por câncer em Mato Grosso, e os cinco principais tipos de câncer foram de pulmão, próstata, estômago, mama e fígado. As maiores taxas de mortalidade foram encontradas nas regiões Médio Norte, Baixada Cuiabana e Sul-Mato-Grossense. No período de 2000 a 2015 foi observada tendência crescente na taxa de mortalidade por câncer em Mato Grosso (APC=0,81%; IC95% 0,38–1,26), e em quatro regiões de saúde, Garças Araguaia (APC=2,27%; IC95% 1,46–3,08), Sul-Mato-Grossense (APC=1,12%; IC95% 0,28–1,97), Teles Pires (APC=1,93%; IC95% 0,11–3,74) e Vale dos Arinos (APC=2,61%; IC95% 1,10–4,70). As demais regiões apresentaram estabilidade. ***Conclusão*:** No estado de Mato Grosso e em quatro regiões de saúde foi verificada tendência crescente de mortalidade por câncer. Os resultados indicam a necessidade de se considerar as diferenças regionais para as ações de prevenção e assistência ao câncer e de controle.

Palavras-chaves: Neoplasias. Mortalidade. Análise espacial. Sistemas de informação. Estudos de séries temporais.

INTRODUCTION

In low- and middle-income countries, chronic non-communicable diseases such as cancer have grown considerably in recent years[1]. In Brazil, 450 thousand new cases of cancer are estimated for each year of the triennium 2020-2022, excluding non-melanoma skin cancer[2]. Cancer is considered the second leading cause of death in the country, and in 2017 the most frequent types reported were breast, lung, colon and rectum, cervix and pancreas cancer among women and lung, prostate, colon and rectum, stomach and esophagus cancer among men[2,3].

In Brazil, the analysis of trend in mortality by type of cancer from 1996 to 2010 showed a significant trend of increase and differences in relation to sex and between regions of the country. Up to 2030, an increase in rates is estimated for the North and Northeast regions and stability or decrease in the other regions[4]; however, another study that covered a longer and more recent period (1990 to 2015) showed that mortality by type of cancer in Brazil remains stable[5].

These mortality rates deserve a regionalized analysis that is able to associate a broader and integrated perspective of changes in socioeconomic, demographic, epidemiological dimensions and in the availability of health services in each health region[6], since health regions in Mato Grosso are spatially heterogeneous, with very evident inequalities[7].

This study is remarkably relevant because the space, that is, the health regions, can present unique carcinogenic agents[8] that, combined with genetics, behavioral factors and the aging process of the population possibly interfered in the carcinogenesis processes. In addition,

the scientific production on cancer, using the health regions of Mato Grosso as a research variable, is still little explored, which further emphasizes the importance of this investigation.

The objective of this study was to analyze the temporal trend of standardized cancer mortality rates in the state of Mato Grosso according to health regions from 2000 to 2015.

METHODS

This is an ecological time series study in which the trend of standardized cancer mortality rate in the state of Mato Grosso from 2000 to 2015 was analyzed. Deaths with codes of the underlying cause of death were selected, such as malignant neoplasms (tumors) in Chapter II (codes C00 to C97)[9]. Data were obtained from the Mortality Information System (SIM) and made available by the Mato Grosso State Health Department, grouped by state and by health regions. Census and intercensal population estimates were obtained with the Department of Informatics of the Unified Health System (SUS)[10].

The state of Mato Grosso is part of the Mid-West Region of Brazil and in 2021 had an estimated population of 3,567,234 inhabitants. It is made up of 141 municipalities, organized into 16 health regions[11]: Alto Tapajós, Araguaia Xingu, Baixada Cuiabana, Centro Norte, Garças Araguaia, Médio Araguaia, Médio Norte Mato-Grossense, Noroeste Mato-Grossense, Norte Araguaia Karajá, Oeste Mato-Grossense, Oeste Mato-Grossense, Sudoeste Mato-Grossense, Sul-Mato-Grossense, Teles Pires, Vale do Peixoto and Vale dos Arinos.

Health regions have heterogeneous sociodemographic and health characteristics. According to the Mato Grosso index, which evaluated six dimensions of development (socioeconomic; epidemiological; availability of health services; appreciation of primary care; health expenditures; and public-private mix), only two health regions— Teles Pires and Norte Araguaia Karajá— are part of the upper quartile, while four are in the lower quartile (Oeste Mato-Grossense, Sudoeste Mato-Grossense, Noroeste Mato-Grossense and Médio Norte Mato-Grossense)[7].

Cancer mortality rates were calculated for 100,000 inhabitants and standardized by the direct method, using the distribution of the world population as a standard[12,13]. Rates were estimated for each year of the study period, for the state, and for health regions.

Absolute and relative frequencies of variables sex, age group, underlying cause of death and health regions were calculated. To estimate the time trend of the standardized cancer mortality rate from 2000 to 2015, a linear regression model was used, and the annual percentage change (APC) (ratio of the regression coefficient in relation to the mortality rate at the beginning of the analyzed period) and respective 95% confidence intervals (95%CI) were calculated. The trend was considered stable when the regression coefficient did not differ from zero ($p>0.05$), increasing when APC was positive, and decreasing when APC was negative. A significance level of 5% was adopted. Data analysis was performed using Stata, version 16.

In order to show the progression of cancer mortality in each health region, thematic maps were built using ESRI's ArcGis 10.5 software. The digital mesh of municipalities in the state of Mato Grosso was obtained from the Brazilian Institute of Geography and Statistics (IBGE) (https://cidades.ibge.gov.br, accessed on 05/26/2021). To generate a digital mesh

of the 16 health regions, the municipalities were united through command "dissolve". The study was approved by the Research Ethics Committee of Hospital Universitário Júlio Müller (Certificate of Presentation of Ethical Appreciation: 98150718.1.40.8124).

RESULTS

From 2000 to 2015, 28,520 deaths from cancer occurred, which represented 12.8% of the total deaths in the state of Mato Grosso: 58% of cases being among males, 59.1% being among the aged 30 to 69 years old and 36.5% aged 70 years or older. The main types of cancer with the highest mortality in the state were lung, prostate, stomach, breast, and liver. The Baixada Cuiabana (37.3%), Sul Mato-Grossense (17.1%), Teles Pires (8.6%), Oeste Mato-Grossense (6.7%) and Médio Norte Mato-Grossense (5.8%) were equivalent to 75.5% of all cancer deaths and were the most affected regions in the state (Table 1).

The standardized cancer mortality rate in Mato Grosso went from 74.3 per 100,000 inhabitants in 2000 to 82 per 100,000 inhabitants in 2015 (Table 2). In 2000, three health regions had mortality rates higher than 80/100,000 inhabitants (Médio Norte, Baixada Cuiabana and Sul Mato-Grossense), while in 2015, in addition to these, three other had rates above this value (Alto Tapajós, Teles Pires and Arinos Valley). On the other hand, regions Araguaia Xingu, Norte Araguaia Karajá and Médio Araguaia maintained the lowest rates between 2000 and 2015 (Figure 1).

Figure 2 shows the historical series of the standardized cancer mortality rate for the health regions. Baixada Cuiabana, Teles Pires and Sul-Mato-Grossense had the highest mortality rates over the period, while Norte Araguaia Karajá had the lowest rates. A general upward trend was observed in the state of Mato Grosso (APC=0.81%; 95%CI 0.38–1.26) and in the following regions: Garças Araguaia (APC=2.27%; 95%CI 1.46–3.08), which maintained rates, per 100,000 inhabitants, between 40.1 and 60 until 2010 and between 60.1 and 80 in 2015; Sul-Mato-Grossense (APC=1.12%; 95%CI 0.28–1.97), which always reached values above 80 in the period; Teles Pires (APC=1.93%; 95%CI 0.11–3.74), which presented values between 60.1 and 80 at the beginning of the series and above 80 after 2005; and Vale dos Arinos (APC=2.61%; 95%CI 1.10–4.70), with rates between 40.1 and 60 in 2000, between 60.1 and 80 until 2010, and above 80 in 2015. The remaining regions showed a trend towards stability (Table 3).

DISCUSSION

Since 2000, cancer has been the third leading cause of death in the state of Mato Grosso and, in 2015, it accounted for 14.7% of all deaths in the state. In the period analyzed, most deaths were among males and aged 60 years or older. The five most frequent types of cancer in the state were lung, prostate, stomach, breast, and liver. This result is similar to that observed in a study on mortality by main types of cancer in the world, being the most frequent, for men, lung, liver, stomach, colorectal, and prostate; and, for women, breast, lung, colorectal, cervical uterus, and stomach[14].

Table 1. Distribution of cancer deaths from 2000 to 2015 according to sex, age group, cause and health regions of the state. Mato Grosso, Brazil, 2000 to 2015.

Variables	n	%
Sex		
Female	11,973	42
Male	16,546	58
Age range (years)		
<40	2,596	9.1
40-59	8,811	30.9
60-69	6,746	23.7
70 and older	10,362	36.3
Leading causes of cancer mortality		
Lung	3,512	12.3
Prostate	2,472	8.7
Stomach	2,229	7.8
Breast	1,709	6
Liver	1,344	4.7
Brain	1,269	4.5
Esophagus	1,183	4.2
Cervix	1,163	4.1
Pancreas	1,008	3.5
Colon	918	3.2
Health region		
Alto Tapajós	852	3
Araguaia Xingu	335	1.2
Baixada Cuiabana	10,632	37.3
Centro Norte	882	3.1
Garças Araguaia	979	3.4
Médio Araguaia	438	1.5
Médio Norte Mato-Grossense	1,666	5.8
Noroeste Mato-Grossense	846	3
Norte Araguaia Karajá	77	0.3
Norte Mato-Grossense	666	2.3
Oeste Mato-Grossense	1,922	6.7
Sudoeste Mato-Grossense	766	2.7
Sul-Mato-Grossense	4,868	17.1
Teles Pires	2,441	8.6
Vale do Peixoto	718	2.5
Vale dos Arinos	432	1.5

Table 2. Standardized cancer mortality rates (100,000 inhabitants) according to year and health regions in the state. Mato Grosso, Brazil, 2000 to 2015.

Health region	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Alto Tapajós	70.9	84.2	84.7	75.9	69.8	48.4	86.1	84.3	65.1	67.7	70.1	63.6	64.9	62	62.1	81.2
Araguaia Xingu	29.4	34	46.4	41.2	27	34.3	42.9	39.5	52.2	21.3	74.3	41.2	46.9	41.1	57.6	37.5
Baixada Cuiabana	90.1	88	80.6	88.5	98.3	95.8	95.5	90.6	102.8	91.3	87.5	100.5	98.3	95.5	92.6	94.7
Centro Norte	77	56.5	78.5	70.5	81.9	74	51	58.4	68.4	81	72.9	64.4	72.8	58.6	77.2	67.2
Garças Araguaia	49.2	45	55.3	52.6	59.5	56.4	55.1	57.8	61.5	56.8	54.8	59.8	63.7	64	70.4	64.6
Médio Araguaia	57.4	21.7	26.4	56.2	57.2	30.7	57	62.3	59.8	54.9	68.4	40.9	55.1	47.7	62.6	52.9
Médio Norte Mato-Grossense	84.6	68.5	67.5	83.1	68.6	92.3	72.6	72.7	82.4	74.7	69.7	91.8	67.9	76.1	99.2	84.6
Noroeste Mato-Grossense	43.4	94.1	81	61	66.8	88.2	77.4	65.3	58.9	74.4	83.7	74.3	71.9	62.3	56	68.5
Norte Araguaia Karajá	17.9	39.2	64.6	55.2	6.1	15	65.2	56	25.1	21	23.7	23.6	16.4	28.7	13.4	13.7
Norte Mato-Grossense	39.5	70.4	79	63.3	83	56.4	69	84.2	88.9	85.5	78.9	78.2	76.7	74.7	63	63.9
Oeste Mato-Grossense	71.7	72.3	58.9	74.4	74.4	69.5	81	77	78.7	62	88.8	67.9	71.9	71.1	79	72.6
Sudoeste Mato-Grossense	42.2	67.4	56.5	82.3	41.7	58.5	71.9	73.1	59	56.5	75.4	54.4	61.9	61.3	71.4	57.8
Sul-Mato-Grossense	83	68.5	81	69.9	92	86.2	90.7	84	86.7	86.8	84.9	90.5	96.7	92.3	87.2	87.3
Teles Pires	74.4	74.1	102.5	109.2	92	97.7	88.2	87.4	106.8	84.4	88.2	118.6	102.9	103.1	114.5	97.8
Vale do Peixoto	58.7	54.4	51.5	81.9	71.1	54.4	64.3	61.2	62.2	55.9	69.5	67	57.7	84.1	64.6	74.7
Vale dos Arinos	54	64.5	43.1	60.7	72.5	65.4	82.7	62.4	88.8	65.2	66.9	71.3	75.6	73.4	83.1	87.8
Mato Grosso	74.3	73.1	73.4	78.2	82.1	79.7	82.7	79.3	85.2	77.6	80.2	85.1	83.9	81.9	84.1	81.7

Cancer has a multifactorial nature and depends on intrinsic factors such as age, gender, ethnicity/race and genetic inheritance or heredity, as well as modifiable factors such as tobacco use and alcohol consumption, physical inactivity, overweight and obesity, inadequate diet, socioeconomic status, and chemical, physical and biological agents[15,16]. Cancer deaths, in turn, are associated with the time between diagnosis and start of treatment, access to health services and preventive actions, which represents a substantial challenge for health systems in all regions of the world. This setting demands investments in prevention and care policies, especially considering long-term exposure to occupational, environmental and individual risk factors[8,14].

Cancer mortality rate in the whole Mato Grosso at the end of the study period (81.7/100,000 inhabitants) was lower than in the Midwest Region (86.1/100,000 inhabitants) and in Brazil

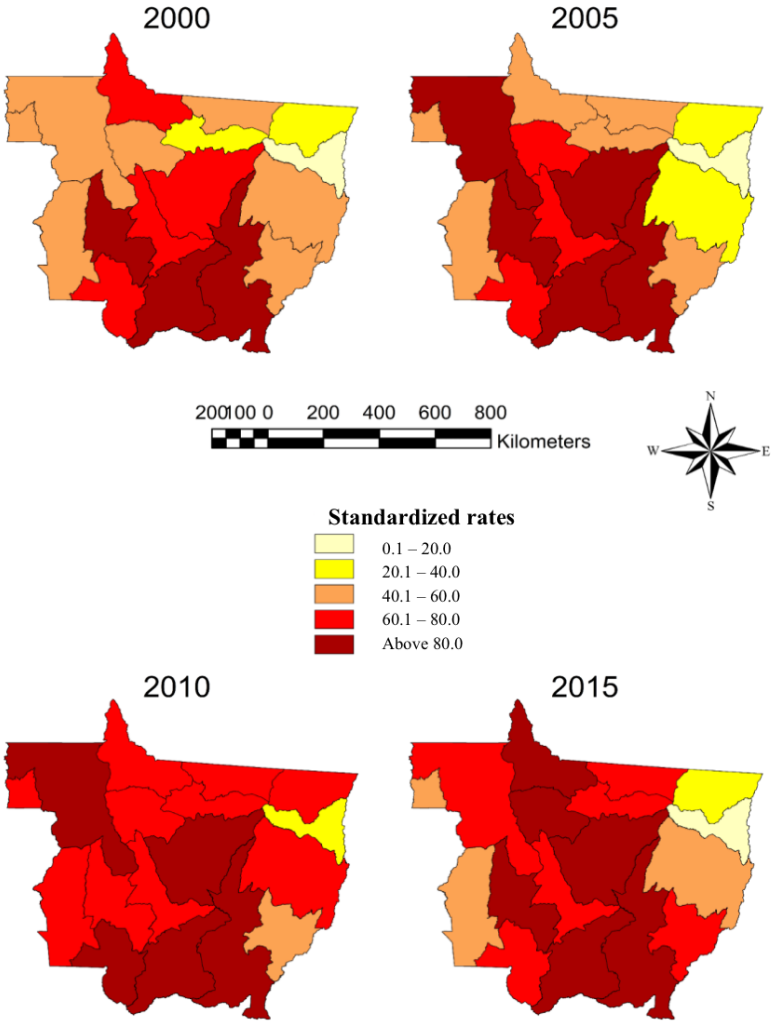

Figure 1. Standardized cancer mortality rates (100,000 inhabitants) in the years 2000, 2005, 2010 and 2015 according to health regions of Mato Grosso, Brazil, 2000 to 2015.

(87.6/100,000 inhabitants),[2] as well as in developed countries such as the United States of America (91.0/100,000 inhabitants), Canada (92.8/100,000 inhabitants), United Kingdom (102.6/100,000 inhabitants) and Japan (85.2/100,000 inhabitants)[14].

The highest cancer mortality rates in the period were found in Baixada Cuiabana, Teles Pires and Sul-Mato-Grossense regions. Health regions are in different stages of demographic and epidemiological transition[17], and this may be one of the explanations for the higher incidence of cancer and, consequently, higher mortality in some of them[18,19].

The state of Mato Grosso showed an increasing trend in cancer mortality rates, as did the health regions Garças Araguaia, Sul-Mato-Grossense, Teles Pires and Vale dos Arinos, whose populations represented about one third of the state inhabitants. This growth contrasts with that observed in Brazil as a whole, which was stable between 1990 and 2015[15,20], and with that observed in the Midwest Region in a more recent period (1999 to 2017)—also stable[21].

The growth in the mortality rate in the state and in some of its health regions may reflect population growth[19], partially attributed to the intense migratory flow motivated by agribusiness[22], as well as changes in the frequency and distribution of the main cancer risk factors, some of which are related to socioeconomic development[14] and increased environmental and occupational exposure to chemical agents such as pesticides, heavy metals and benzene[23-26].

Mato Grosso is known as the barn of Brazil for being the leader in production of agricultural commodities (soybean, corn, cotton) and cattle, whose agribusiness represents 50.5% of its gross domestic product (GDP)[27]. The state is one of the largest consumers of pesticides in the country[28]. Thus, it is important to discuss environmental exposure as a contributing

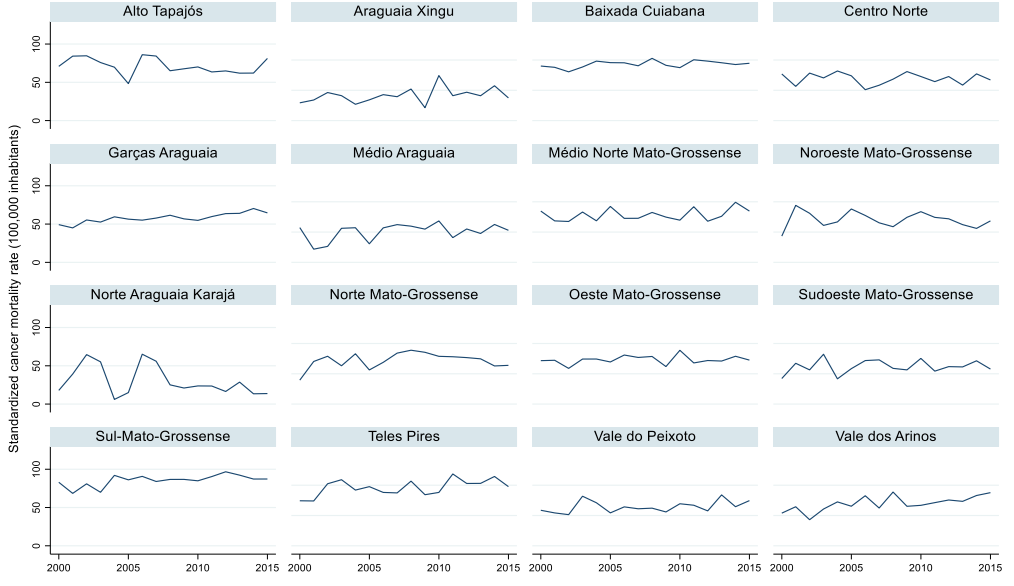

Figure 2. Historical series of standardized cancer mortality rates (100,000 inhabitants) according to health regions of the state. Mato Grosso, Brazil, 2000 to 2015.

factor to cancer incidence and mortality, namely to pesticides. Despite the biological and epidemiological plausibility[25,26,29,30], assessment of the carcinogenic potential of pesticides is complex, requiring new methodological approaches and the disaggregation of analyzes by type of cancer, so that this relationship can be examined with more clarity and caution.

Studies have pointed the relationship between exposure to pesticides and cancer morbidity and mortality in Brazil and in the state of Mato Grosso[23,31-35]. Research that evaluated the use of pesticides and cancer mortality in monoculture regions in Brazil put Mato Grosso as a high concentration spot of mortality rates for breast, uterus and prostate cancer in the south of the state and surroundings of the municipalities with the highest estimated use of pesticides[23].

The growth in cancer mortality rates in some regions of the state may also result from inequality in access to health services. In Mato Grosso, long distances separate the municipalities from their regional headquarters, where there is greater service installed capacity,

Table 3. Temporal trend of standardized cancer mortality rates according to health regions in the state. Mato Grosso, Brazil, 2000 to 2015.

Health region	B	p	APC (%)	IC95%	Trend
Alto Tapajós	-0.72	0.21	-1.05	(-2.73–0.70)	Stable
Araguaia Xingu	0.98	0.16	3.36	(-1.47–8.16)	Stable
Baixada Cuiabana	0.52	0.11	0.57	(-0.10–1.26)	Stable
Centro Norte	-0.16	0.78	-0.19	(-1.66–1.26)	Stable
Garças Araguaia	**1.11**	**<0.01**	**2.27**	**(1.46–3.08)**	**Growing**
Médio Araguaia	1.11	0.13	1.98	(-0.72–4.58)	Stable
Médio Norte Mato-Grossense	0.62	0.25	0.77	(-0.63–2.10)	Stable
Noroeste Mato-Grossense	-0.31	0.68	-0.69	(-4.29–2.86)	Stable
Norte Araguaia Karajá	-1.67	0.12	-9.36	(-21.30–2.59)	Stable
Norte Mato-Grossense	0.70	0.35	1.63	(-1.91–5.35)	Stable
Oeste Mato-Grossense	0.30	0.49	0.39	(-0.74–1.59)	Stable
Sudoeste Mato-Grossense	0.40	0.54	0.94	(-2.22–4.10)	Stable
Sul-Mato-Grossense	**0.95**	**0.01**	**1.12**	**(0.28–1.97)**	**Growing**
Teles Pires	**1.43**	**0.04**	**1.93**	**(0.11–3.74)**	**Growing**
Vale do Peixoto	0.79	0.14	1.34	(-0.49–3.17)	Stable
Vale dos Arinos	**1.75**	**0.01**	**2.61**	**(1.10–4.70)**	**Growing**
Mato Grosso	**0.61**	**<0.01**	**0.81**	**(0.38–1.26)**	**Growing**

B: linear regression coefficient; APC: annual percent change; 95%CI: 95% confidence interval, bold: significant associations.

as well as from large centers of cancer care[36], making early diagnosis and timely treatment difficult. For example, the actions and services of oncology specialized care are distributed in five care macro-regions, and their offer is concentrated in the center-north macro-region, which includes health regions Baixada Cuiabana (where the state capital is located), Centro Norte, Médio Norte Mato-Grossense and Noroeste Mato-Grossense[18,19].

In addition, Mato Grosso did not implement the state plan to combat chronic non-communicable diseases (NCDs), whose strategies involve surveillance actions, health promotion and a comprehensive care network. Little has been invested in health care networks, whose primary care is the organizer and coordinator of care[37]. Specific cancer surveillance actions, which include the construction and permanent improvement of a specialized oncology information system and dissemination of information generated on it, are essential for strategic decisions at all management levels[2,20,38]. The same goes for health promotion actions and prevention of the main risk factors for cancer, considering the long period of exposure to occupational, environmental and individual risk factors[8,14], and access to cancer diagnosis and care through the strengthening and expansion of cancer treatment network within SUS[39].

This study used secondary data obtained from SIM, and its results depend on the quality of records, especially considering under-registration and identification of underlying cause of death. In Brazil, there was an improvement in the quality of vital statistics with the active search for deaths and high coverage of the information system[40], which for the year 2015 was 94.3%[41]. In the state of Mato Grosso, the percentage of ill-defined death causes (chapter XVIII of the ICD-10) represented 6.01% of all deaths and increased from 7.9% in 2000 to 6.6% in 2015. However, a difference was acknowledged in the proportion of ill-defined causes between regions, being higher from 2000 to 2015 in Norte Araguaia Karajá (23.1%), Norte Mato-Grossense (13.3%), Araguaia Xingu (11.2%) and Centro Norte (10.7%)[10], which may have interfered with the findings.

Additionally, this study did not include incidence or survival rates, which provide more accurate information on the impact of cancer on the population when analyzed in conjunction with mortality rates[42]. Comparison with other studies was also difficult, as most studies assess specific types of cancer.

On the other hand, the present study advances by disaggregating the mortality rates by health region, which allows one to understand local reality and the differences within the state, raising hypotheses regarding socio-environmental factors health services of Mato Grosso territory that are associated with cancer mortality.

The results point to the need for specific prevention, assistance and control actions related to cancer throughout the state of Mato Grosso and, particularly, in the health regions Garças Araguaia, Sul-Mato-Grossense, Teles Pires and Vale dos Arinos, which presented an upward trend in mortality rates.

Furthermore, this study contributes by broadening the debate on regionalization as a fruitful space for organizational arrangements of health actions and services for the development of policies and programs that strengthen universal and integral access to health policies in the state, taking into account the marked regional inequalities.

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ETHICS COMMITTEE IDENTIFICATION/APPROVAL NUMBER

Ethics Committee of Hospital Universitário Júlio Muller (CEP-HUJM) CAAE: 98150718.1.0000.8124, opinion number 3,048,183 of 11/20/2018; and Research Ethics Committee of the Mato Grosso State Health Department (SES- MT) CAAE: 98150718.1.3003.5164, opinion number 3,263,744 of 04/12/2019.

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