

Mortality Profile and Spatial Analysis of Neoplasms in a São Paulo Countryside Municipality in the Biennium 2019-2020

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Perfil de Mortalidade e Análise Espacial de Neoplasias em um Município do Interior Paulista no Biênio 2019-2020

Perfil de Mortalidad y Análisis Espacial de Neoplasias en un Municipio del Interior Paulista en el Bienio 2019-2020

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ABSTRACT

Introduction: Cancer is one of the leading causes of death worldwide, and socioeconomic and environmental differences reflect in mortality rates among different regions. **Objective:** To characterize and describe the profile of the population who died due to neoplasms in the municipality of *Ribeirão Preto/SP*, according to sex, race/color, age and place of residence in the biennium 2019-2020, and establish an association with COVID-19 deaths in 2020. **Method:** Cross-sectional, observational study, with data collected from death certificates by some type of neoplasm as the underlying cause and absolute and relative frequency of the population profile of deaths, mortality rates, and grouping by systems according to the ICD-10. Deaths according to the economic characteristics of the municipality's regions were identified, and maps were created with the main causes, relating to economic conditions according to data of IBGE in addition to standardized mortality ratio. **Results:** There were 1,766 deaths, mostly in the age range of 61-80 years (52.8%), with an increase of 19.4% in 2020. Neoplasms of the digestive system were more prevalent (33.7%), but the most affected organ was lung (14.4%). Of the total, 8.9% of deaths were associated with COVID-19 infection. The Central region presented the highest mortality rate (2.5/thousand inhabitants), but the North Zone had the highest standardized mortality ratio (27.9/thousand inhabitants). The study suggests that there was a heterogeneous distribution across the municipality, with vulnerabilities such as income, which contributed to the analyzed outcome. **Conclusion:** It's important to consider socioeconomic-spatial disparity of *Ribeirão Preto* for the creation and implementation of neoplasms prevention, screening and treatment programs for the population.

Key words: Neoplasms/mortality; Spatial Analysis; Socioeconomic Factors; Demography; COVID-19.

RESUMO

Introdução: O câncer é uma das principais causas de óbito em todo mundo. Diferenças socioeconômicas e ambientais refletem nas taxas de mortalidade entre diferentes Regiões. **Objetivo:** Caracterizar e descrever o perfil da população que foi a óbito por neoplasias em Ribeirão Preto/SP, segundo sexo, raça/cor, faixa etária e local de residência (2019-2020) e estabelecer uma relação com óbitos por covid-19 em 2020. **Método:** Estudo transversal, observacional, com análise de dados de declarações de óbito por algum tipo de neoplasia como causa básica e cálculos de frequências absolutas e relativas do perfil populacional de óbitos, coeficientes de mortalidade, e agrupamentos por sistemas, segundo a CID-10. Identificaram-se os óbitos com características econômicas das Regiões do município, e os mapas com as principais causas foram elaborados, relacionando-os com a condição econômica, segundo dados do IBGE, além da taxa padronizada de mortalidade. **Resultados:** Ocorreram 1.766 óbitos, com predomínio da faixa etária de 61-80 anos (52,8%). Houve crescimento de 19,4% em 2020. As neoplasias mais prevalentes foram no sistema digestivo (33,7%), porém o pulmão foi o órgão mais acometido (14,4%). Do total, 8,9% dos óbitos estiveram associados à infecção pela covid-19. O Centro apresentou maior coeficiente de mortalidade (2,5/mil habitantes), contudo a Zona Norte mostrou maior taxa padronizada de mortalidade (27,9/mil habitantes). O estudo sugere que houve distribuição heterogênea pelo município, com vulnerabilidades como renda, que contribuiu com o desfecho analisado. **Conclusão:** É importante considerar a disparidade socioeconômica-espacial de Ribeirão Preto na criação e aplicação de programas de prevenção, rastreamento e tratamento de neoplasias na população.

Palavras-chave: Neoplasias/mortalidade; Análise Espacial; Fatores Socioeconômicos; Demografia; COVID-19.

RESUMEN

Introducción: El cáncer es una de las principales causas de muerte en todo el mundo, y las diferencias socioeconómicas y ambientales se reflejan en las tasas de mortalidad entre diferentes Regiones. **Objetivo:** Caracterizar y describir el perfil de la población fallecida debido a neoplasias en Ribeirão Preto/SP, en el bienio 2019-2020, comparando los dos años según raza/color de piel, grupo etario y lugar de residencia y establecer una relación con las defunciones de COVID-19 en 2020. **Método:** Estudio transversal, observacional, en el que se analizaron los datos de declaraciones de defunción con algún tipo de neoplasia como causa principal y se realizaron cálculos de frecuencias absolutas y relativas para el perfil poblacional de defunciones, coeficientes de mortalidad y agrupaciones por sistemas, según la CID-10. Se identificaron las defunciones según las características económicas de las regiones del municipio, y se crearon mapas con las principales causas encontradas, relacionándolas con la condición económica, según datos del IBGE. También se calculó la tasa de mortalidad estandarizada. **Resultados:** Hubo 1766 defunciones, con predominio de personas de entre 61 y 80 años (52,8%). Hubo un aumento del 19,4% en el segundo año. Las neoplasias del aparato digestivo fueron más frecuentes (33,7%), pero el órgano más afectado fue el pulmón (14,4%). Del total, el 8,9% de las defunciones estuvo asociado con la infección por COVID-19. La región central presentó el mayor coeficiente (2,5/mil habitantes) en ambos años, pero la Zona Norte mostró la mayor tasa de mortalidad estandarizada (27,9/mil habitantes). El estudio sugiere que hubo una distribución heterogênea en todo el municipio, con vulnerabilidades como el ingreso, que contribuyeron al resultado analizado. **Conclusión:** Es importante considerar la disparidad socioeconómica-espacial de Ribeirão Preto en la creación y aplicación de programas de prevención, detección y tratamiento de neoplasias en la población.

Palabras clave: Neoplasias/mortalidad; Análisis Espacial; Factores Socioeconómicos; Demografía; COVID-19.

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INTRODUCTION

Cancer is one of the main causes of death worldwide with 9.6 million deaths estimated for 2018 and 10 million for 2020, a rise of 4.1%. Lungs, breast, colorectal and prostate are the main neoplasms. Several lifestyle factors are associated with higher risk of carcinogenesis as tobacco and alcohol use, obesity and air pollution. In addition, some infections as hepatitis B and C and human papillomavirus (HPV) are associated as well to high risk of developing liver and cervical cancer, respectively. If early detected, cure is potentially high, as the Papanicolaou test for cervical cancer and mammogram for breast cancer^{1,2}.

Socioeconomic disparities also play a key role on the different rates of mortality by cancer. Mortality rates are low in high-income countries because of available economic resources and infrastructure for early detection and effective treatments; however, developing countries may experience large increases of mortality rates due to poor infrastructure and limited funds³. The authors have also found that other types of neoplasm have been diagnosed due to the increase of breast, prostate and colon cancer screening.

The prevalence of non-communicable diseases (NCD) increased in the last decades due to longevity. In Brazil, more than 70% of deaths are related to these diseases, and cancer is the most prevalent in older than 60 years adults^{4,5}.

Brazil's death rate by cancer has been increasing steadily in the last years for both sexes, although not higher than cardiovascular diseases as already happens in the United States of America⁶. In 2012, 188,379 deaths by cancer were registered in Brazil⁷, rising to 256,954 in 2020, a 36.4% growth. In that year, this result accounted for 2.6% of the world total, 52.7% of which in males⁸.

Smoking, one of the risk factors associated with lifestyle, accounted for 28.4% of men's death, while alcohol use, poor physical activity and diet and high body mass index were the main causes of women's death, mainly breast cancer⁷. In addition, the study revealed that 33.6% of these deaths could be avoided with lifestyle improvement.

The National Cancer Institute (INCA) determined to discontinue cancer screening in asymptomatic individuals soon after COVID-19 pandemic was declared to prevent virus spread⁹. A decline of 26% of hospital admissions and 28% of surgeries were detected in the first five months of the pandemic, with higher rates in the South and Southeast regions¹⁰. Lung cancer diagnosis mostly in males dropped 18.8% compared with the past three years, but for women, surgeries increased¹¹.

Life expectancy declined in 2020 as COVID-19 advanced for some countries, setting back Brazil back to 2012¹².

The objective of this study is to characterize deaths by cancer in the municipality of *Ribeirão Preto* in the biennium 2019-2020, analyze the death toll increase in the period and find a correlation with COVID-19 deaths in 2020. In addition, the socioeconomic levels of the population was compared through thematic maps for easy visualization.

METHOD

Cross-sectional, observational study with analysis of deaths primarily caused by neoplasms in 2019 and 2020, in *Ribeirão Preto*, a countryside municipality of the State of *São Paulo*. Death certificates (DC) registered in public notaries were analyzed and the following variables were investigated: sex (male/female), race/color (White, Black, Brown and Yellow), age-range (0-20 years, 21-40 years, 41-60 years, 61-80 years and ≥ 81), cause of death and residence.

The baseline causes were classified according to Chapter 2, Neoplasms of the International Classification of Diseases and Related Health Problems, 10th edition (ICD-10)¹³. This chapter lists 14 categories: malignant neoplasms of the lip, oral cavity and pharynx, digestive organs, respiratory and intrathoracic organs, bones and articular cartilage, melanoma and other malignant neoplasms of the skin, mesothelial tissue and soft tissues, breast, female genital organs, male genital organs, urinary tract, eyes, brain and other parts of the central nervous system, thyroid and other endocrine glands, ill-defined, secondary location and non-specified locations, lymphatic, hematopoietic tissues and correlate tissues.

The place of residence was grouped according to six administrative regions of the municipality according to the Demographic Census of 2010¹⁴. The municipality was divided in 1,004 census tracts, which were the source of average income of the head of the family and later a mean was calculated according to each administrative region and the total of the population for each region. The results for the regions were: Central (R\$4,124.64, 18,599 inhabitants); East Zone (R\$2,413.41, 129,934 inhabitants); North Zone (R\$1,273.41, 205,185 inhabitants); West Zone (R\$1,523.12, 180,780 inhabitants); South Zone (R\$5,353.46, 58,363 inhabitants); district of *Bonfim Paulista* (R\$3,191.89, 11,812 inhabitants).

The analysis of the profile of neoplasm-related deaths was performed through spreadsheets calculated per age-range, sex, race/color and region of domicile, and the relative and absolute frequencies, comparing years and sexes and the regions of the municipality. The mortality rates of the Administrative regions of the municipality were calculated and the standardized mortality rate

through direct method to avoid biases in relation to the population of each region; the population of the Central region was adopted as base.

The addresses were inserted into Google[®] Maps for geographical visualization of deaths and their relation with the regions of the municipality, generating a dot map later elaborated with the software QGIS 3.30.1¹⁵. For DC without address, the respective neighborhood of each region was adopted for visualization. Kernel technique was utilized for thematic maps with deidentified individuals, only the density of deaths for spatial analysis of the regions. The map of monthly nominal income per head of the family was created with data produced by “*Instituto Brasileiro de Geografia e Estatística (IBGE)*” of 2010 according to the census tract¹⁴.

The Institutional Review Board of “*Centro Saúde Escola – Faculdade de Medicina de Ribeirão Preto – Universidade de São Paulo*” report number 5,707,523 (CAAE (submission for ethical review): 41215220,0,0000,5414) approved the study in compliance with Directive 466/2012¹⁶ of the National Health Council for studies with human beings. The access to DC was approved by the chief magistrates of the Notary Public and Civil Registry of the municipality according to confidentiality and ethical guidelines enforced by the General Data Protection Regulation¹⁷.

RESULTS

Of the 9,702 deaths in the biennium 2019-2020 in *Ribeirão Preto*, 1,766 (18.2%) were primarily caused by neoplasms. There were 805 deaths in 2019 and 961 in 2020, a 19.4% increase. Most of the deaths were reported by individuals who claimed they were White (81.7%), males (51.8%), in the age-range of 61-80 years (52.8%). Female deaths increased (29.4%), as well as older than 80 years (48.6%) and those claimed Brown (58.3%). The age ranged from three days to 102 years (Table 1).

The most incident primary cause was digestive organs cancer (33.7%), with higher prevalence on intestines – 250 deaths (41.9%) – followed by respiratory and intrathoracic related causes (16.5%); lung was the most prevalent organ with 254 deaths (87%), followed by breast (8.8%) and lymphatic, hematopoietic tissues and correlates (7.2%).

Bones and articular cartilage presented the highest increase (100%), lymphatic, hematopoietic tissues and correlates (96.35%), urinary tract (50%), thyroid (40%) and breast (38.5%). Lips, oral cavity and pharynx (-14.29%) and ill-defined location (-28.57%) were the most significant decreases (Table 1).

The North Zone registered the highest number of deaths, 38.6%, and the West Zone was the second

highest and the most expressive growth was noticed on the East Zone (34.7%) and South Zone (27.6%). Central Zone presented the most significant populational density, 2.5/thousand inhabitants for both years. The South Zone and the East Zone registered the highest growth from 1.5 to 1.9/thousand inhabitants and from 1.1 to 1.5/thousand inhabitants, respectively. Next, the North Zone from 1.5 to 1.7/thousand inhabitants, the West Zone from 1.1 to 1.3/thousand inhabitants and *Bonfim Paulista* from 0.7 to 0.9/thousand inhabitants. However, the age standardized rates were higher on the North and South Zones (27.9/1,000 inhabitants) in 2019, followed by East (22.3/1,000 inhabitants), West (20.5/1,000 inhabitants) and *Bonfim Paulista* (16.7/1,000 inhabitants). In 2020, the highest rate was registered at the South Zone (35.3/1,000 inhabitants), followed by North (33.5/1,000 inhabitants), East (29.7/1,000 inhabitants), West (24.2/1,000 inhabitants) Zone and *Bonfim Paulista* (18.6/1,000 inhabitants).

In 2020, the number of female deaths by neoplasms of all organs and systems increased, except genital organs (-3.8%) and central nervous system (-13.6%). Deaths more than the doubled for neoplasms of the urinary tract (142.9%), bones (133.3%), lymphatic tissues (133.3%), skin (100%) and ill-defined locations (200%) (Table 2).

Similar behavior was found for males, except lips, oral cavity and pharynx (-29.2%), respiratory and intrathoracic organs (-8.4%), skin (-33.3%) and ill-defined locations.

Although deaths by neoplasms on digestive and respiratory systems were more prevalent for both sexes, males predominated, in addition to lips, oral cavity and pharynx, but breast and genital organs cancer were more frequent in females. The predominant age range was 61-80 years for nearly all the organs and systems, except skin which was predominant for the age-range of 41-60 years and bones and articular cartilage for those older than 80 years of age.

The mean age of male patients who died by prostate cancer was 76.3 years; for women, the mean age for those who died by cervical cancer was 62.5 years; due to endometrium-related causes, the mean age was 67.2 years and 56.3 for cervical cancer.

Deaths by cancer for Black and Brown individuals were more frequent on the digestive organs with 52 deaths (34%), 18 (11.8%), respiratory and intrathoracic and 17 (11.1%), lymphatic and hematopoietic tissues and correlates. For other races/skin color, 248 deaths occurred on digestive organs (32.8%), 18 (11.8%), respiratory and intrathoracic and 72 (9.5%), breast.

In 2020, deaths by neoplasm increased on the North and East Zones, contrary to a minor variation noticed in Central and *Bonfim Paulista*. Death by urinary tract cancer increased across all regions in the period investigated,



Table 1. Profile of deaths by neoplasms in *Ribeirão Preto*, SP and variation 2019-2020

	2019		2020		Total	
	n	%	n	%	n	Variation (%)
Total	805	100	961	100	1766	19.4
Sex						
Male	434	54.0	481	50.1	915	10.8
Female	371	46.0	480	49.9	851	29.4
Race/color						
White	688	85.5	755	78.6	1443	9.7
Black	52	6.5	58	6.0	110	11.5
Brown	60	7.5	95	9.9	155	58.3
Yellow	04	0.5	05	0.5	09	25.0
No record	01	0.1	48	5.0	49	4.800
Age-range						
0-20	04	0.5	04	0.4	08	0.45
21-40	30	3.7	36	3.8	66	20
41-60	199	24.7	197	20.5	396	-1.0
61-80	428	53.2	510	53.1	938	19.2
81+	144	17.8	214	22.3	358	48.6
Group/neoplasm/ICD-10						
Lip, oral cavity and pharynx	28	3.5	24	2.5	52	-14.3
Digestive organs	280	34.8	316	32.8	596	12.9
Respiratory and intrathoracic organs	147	18.1	146	15.2	292	-0.7
Bones and articular cartilage	05	0.6	10	0.9	15	100.0
Skin	19	2.4	22	2.3	41	15.8
Soft tissues and mesothelial tissue	10	1.2	12	1.4	23	30.0
Breast	65	8.1	90	9.4	155	38.5
Female genital organs	53	6.7	51	5.5	104	-3.8
Male genital organs	37	4.6	48	5.0	85	29.7
Urinary tract	34	4.2	51	5.3	85	50.0
Eyes, brain and other parts of the nervous system	35	4.4	48	5.0	83	37.1
Thyroid and other endocrine glands	05	0.6	07	0.7	12	40.0
Ill-defined location	07	0.9	05	0.5	12	-28.6
Lymphatic, hematopoietic tissues and correlates	43	5.3	84	8.7	127	95.4
Undetermined primary location	37	4.6	45	4.7	82	21.6
Region of Domicile						
Central	46	5.7	48	5.1	94	4.3
East Zone	144	17.9	194	20.2	338	34.7
North Zone	311	38.6	360	37.5	672	15.8
West Zone	206	25.6	235	24.4	441	14.1
South Zone	87	10.8	111	11.5	198	27.6
Bonfim Paulista	11	1.4	12	1.3	23	9.1
Unknown	0	00	01	0.1	0.1	100

but mainly on the East Zone (350%), South (250%) and West (133.3%). Breast neoplasms accounted for an increase of 33.3% deaths on the East Zone, 54.5% on the North Zone and 200% on the South Zone. The percent of neoplasms of the lymphatic and hematopoietic tissues and correlates increased on the East (100%), North (138.5%) and West Zones (200%) (Table 3).

Density maps show the main neoplasms and compares the nominal monthly income per head of family. Some primary cancer sites as uterus, lung, intestine and prostate were detected in low income administrative regions while organs and hematopoietic systems and breast cancer in high-income regions, although the distribution covers the whole municipality. Except for hematopoietic organs and breast cancer, the other maps are referred to the most affected organ in the system: intestine, 250 (41.9% of the digestive organs), prostate with 85 (94.1% of genital male organs, lung with 254 (87% of the respiratory and intrathoracic organs), uterus with 68 (65.4% of the female genital organs), 18 (25.6%) by endometrium and 33 (48.5%) by cervical cancers (Figure 1).

Intestine cancer accounted for 83.3% of all the neoplasms of the digestive organs on the North Zone, and neoplasms of the lymphatic, hematopoietic tissues and correlates were more frequent on the West Zone.

In 2020, of the 961 deaths by neoplasms, 85 (8.9%) were associated with COVID-19; of these, one third was related to digestive organs, 12 (14.1%) of hematopoietic organs, 11 (12.9%), to breast and the

remaining 31 (36.5%), to other organs and systems. The association between neoplasm and COVID-19 had similar distribution among the zones, ranging from 17.6% on the West to 27% on the East Zones.

DISCUSSION

The profile of deaths by neoplasms in *Ribeirão Preto, São Paulo* in the biennium 2019-2020 was analyzed. 2020 was marked by the beginning of the COVID-19 pandemic and the results indicate that most of the deaths occurred in males, White, in the age-range of 61-80 years. The main primary sites were digestive and respiratory and intrathoracic organs, and lung was the most prevalent of deaths in the period.

These findings are consistent with the Global Burden Disease¹⁸ study, which show that lung cancer is the most prevalent worldwide in addition to being listed as one of the six major causes years of healthy life lost by disability for older than 50 years. It has also been identified that respiratory organs and systems dropped 0.7% in the biennium, while deaths related to digestive organs increased 12.9%, the lowest figure among those which grew in the same period.

Other studies have also concluded that deaths by neoplasm were more predominant in males¹⁹. A more than two-decades analysis of new cases and deaths by neoplasm was more incident in women (53%) but deaths were higher in men (52%)²⁰, similar to the present study

Table 2. Deaths by sex and percent of increase by neoplasms according to ICD-10 primary location in *Ribeirão Preto, SP*, 2019 and 2020

	2019		2020		% difference	
	M	F	M	F	M	F
Lip, oral cavity and pharynx	24	4	17	7	-29.2	75.0
Digestive organs	158	122	159	157	0.6	28.0
Respiratory and intrathoracic organs	95	52	87	59	-8.4	13.0
Bones and articular cartilage	2	3	3	7	50.0	133.3
Skin	12	7	8	14	-33.3	100.0
Soft tissues and mesothelial tissue	4	6	4	8	0.0	33.3
Breast	0	65	7	83	700.0	27.7
Female genital organs	-	53	0	51	0.0	-3.8
Male genital organs	37	-	48	-	29.9	0.0
Urinary tract	27	7	34	17	25.9	142.9
Eyes, brain and other parts of the nervous system	13	22	29	19	123.1	-13.6
Thyroid and other endocrine glands	3	2	4	3	33.3	50.0
Ill-defined locations	6	1	2	3	-66.8	200.0
Lymphatic, hematopoietic tissues and correlates	28	15	49	35	75.0	133.3
Undetermined primary location	25	12	30	17	20.0	41.7



that found higher prevalence of deaths by neoplasms in men, but deaths in females increased more in the first year of the COVID-19 pandemic, 2019.

According to the Computer System of the National Health System (DATASUS)²¹, 8,440 admissions by cancer occurred in the period investigated, 4,800 in 2019 and

3,640 in 2020. In the first year, admissions were slightly higher in females, 2,488 against 2,312 in men. In 2020, even with admissions decline, the results indicated that women were more predominant than men, 1,899 *versus* 1,741, respectively. Admissions of individuals claimed White reduced 40% according to the same source.

Table 3. Distribution of deaths by neoplasms in the Administrative Regions of *Ribeirão Preto*, SP, 2019 and 2020

	Central		East Zone		North Zone		West Zone		South Zone		B. Paulista		Total
	2019	2020	2019	2020	2019	2020	2019	2020	2019	2020	2019	2020	
Total	45	44	144	194	301	361	206	235	87	111	11	12	1,766
Lip, oral cavity and pharynx	00	00	03	02	09	09	15	09	00	04	01	00	52
Digestive organs	12	10	54	68	110	119	78	77	23	38	03	04	596
Respiratory and intrathoracic organs	14	11	22	35	67	51	31	36	11	12	01	01	292
Bones and articular cartilage	00	02	01	02	02	04	00	01	01	00	01	00	15
Skin	02	01	03	04	08	07	03	07	02	03	01	00	41
Soft tissues and mesothelial tissue	01	01	02	04	03	05	01	01	03	01	00	01	23
Breast	02	04	15	20	22	34	18	18	07	14	01	00	155
Female genital organs	03	02	11	10	17	24	15	11	08	06	00	00	104
Male genital organs	03	03	06	09	12	16	10	16	05	04	01	00	85
Urinary tract	00	01	02	09	14	18	06	14	02	07	00	02	85
Eyes, brain and other parts of the nervous system	03	03	11	09	07	15	05	13	08	06	01	02	83
Thyroid and other endocrine glands	01	00	00	01	01	04	02	00	01	02	00	00	12
Ill-defined location	00	00	00	01	04	04	03	00	00	00	00	00	12
Lymphatic, hematopoietic and correlate tissues	04	06	07	15	13	31	07	21	11	10	01	01	127
Undetermined location	00	00	07	05	12	20	12	11	05	04	00	01	82

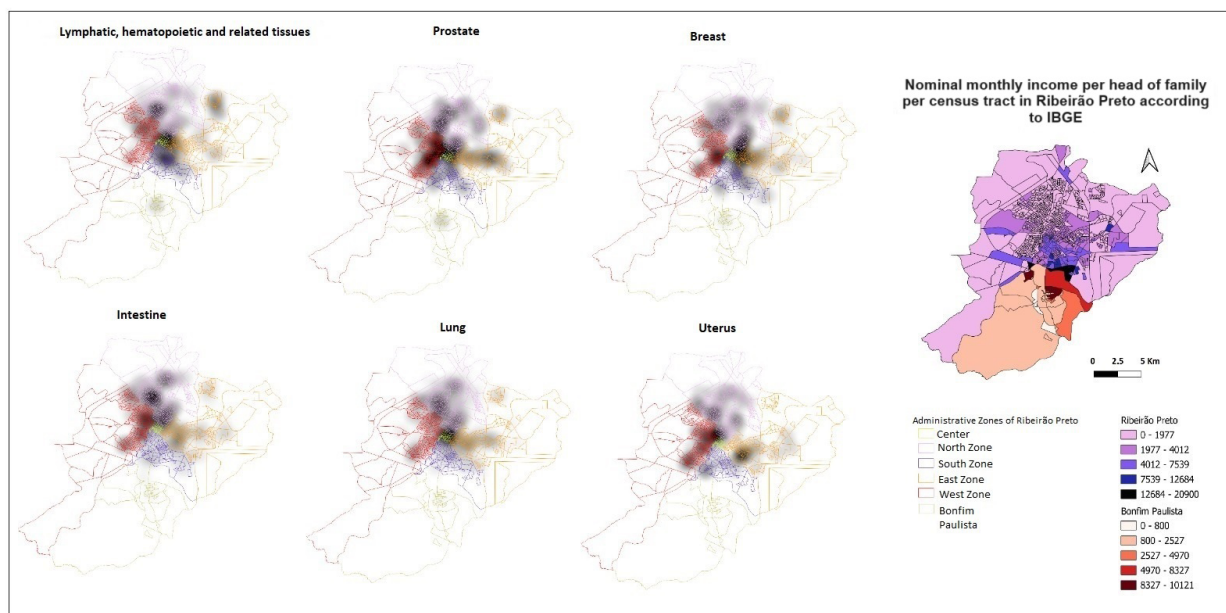


Figure 1. Map of the monthly nominal income per head of family and Kernel density map for main organs and systems in *Ribeirão Preto*, SP, 2019 and 2020

Source: The Authors, in addition to data by IBGE¹⁴.



Admissions per age-range based on the same source (DATASUS)²² increased only for lower than one-year of age and between one-and- four years in the period investigated and decreased for the other age-ranges. However, despite the drop of admissions, the number of deaths for all age-ranges grew, except for 41-60 years, which declined according to this study.

A Latin American analysis²³ on the reduction of screening, admissions and chemotherapy during the first year of the COVID-19 pandemic found a decline of 29.4% of surgeries, 2.8% of chemotherapy in adults and 5.5% in children, 54.7% of prostate screening and 81.8% of mammograms in Brazil.

Most of the studies identified older adults as the most affected by the disease, both youngest older adults (60-79 years) or oldest-old adults >80 years. The majority of deaths occurred in youngest older adults as the present study concluded, however, a significant rise was detected in older than 80 years (48.6%) in 2020. These results corroborate a five-year study conducted in the State of *Rio Grande do Norte*²⁴, where most of the deaths by cancer occurred in the age-range of 60-79 years (48.3%). Oldest-old adults accounted form 26.9% of the deaths in the period.

A study analyzed the incidence of deaths by different types of cancer as prostate, breast, cervix, larynx, stomach and colorectal in Cuiabá, the capital of the State of *Mato Grosso*²⁵. Higher incidence rates were found in 50-year or older males, except prostate cancer, which dropped, but cervical and breast cancer were more incident in younger than 50-year women. But lung, stomach and colorectal cancer were higher in older than 60-years women and breast cancer increased for both sexes.

Most of the studies analyze deaths by cancer per region, States and countries, but for municipalities, in general, specific and more prevalent cancers are investigated as lung, uterus and breast.

A study conducted in the city of *São Paulo* which analyzed breast and cervical cancer²⁶, indicated different patterns of spatial distribution and socioeconomic data for these neoplasms. For breast cancer, the highest incidence was in the Central zone, but along the years, more cases were found on the periphery of the city. Cervical cancer was higher in the periphery for the whole period analyzed and deaths declined for both cancers in the same period.

In the present study, high number of deaths was found on the North Zone, but the highest mortality rates were found on high-income zones as Central and South Zones with older population. However, the age-standardized rate was higher on the North Zone and the most significant growth was found on the East Zone (33.2%) followed by South Zone (26.5%).

The analysis of the Kernel density maps revealed that prostate cancer concentrated in the West and Central regions, breast cancer, more at the North-East and uterus on the East and West-North regions close to the Central region. Lung cancer presented high density in the Central region. Lymphatic and hematopoietic tissues and correlates were distributed more homogeneously in the North-Central-South axis. Intestines presented high density on the North and West regions and barely occurred on the South and Central regions.

A study conducted in the State of *Rio Grande do Norte* revealed a relation between socioeconomic condition and cervical cancer. A main cluster of women who died by this type of cancer was identified in a region with better access to health services and offer of cytopathological tests, but with low municipal Human Development Index (HDI-M)²⁷.

A study revealed some associations among COVID-19, admissions and deaths in Brazil. Most of the patients who died after diagnosis of COVID-19 were older than 60 years, with medical history, smokers with comorbidities and respiratory tract cancer²⁸. Another study found higher rates of deaths by COVID-19 on the country's North Regions and lower on the South Region. In addition, the number of deaths by cancer varied less than anticipated on the South and high on the Mid-West²⁹. This study attributed the change of the basic cause of death by COVID-19 to the lower number of deaths found and not by neoplasms and even by cardiovascular diseases²⁹.

The utilization of deaths by neoplasms occurred in 2020 allowed to evaluate the COVID-19 impact in its first year. Discrepancies on deaths in the period were found not only worldwide but in *Ribeirão Preto* as well, further to screening decline. Through spatial analysis, geographic and economic associations have been identified, revealing socioeconomic disparities in health exacerbated by the pandemic with increased deaths in the low-income areas. In addition, the utilization of Administrative Regions matched to health district regions form a well-established health network in the municipality. The spatial analysis can help to identify priority areas for primary health services to focus on early detection of the disease on their respective regions.

The identification of variables listed in the DC with potential sub-notification is one of the study limitations, in addition to the short period of analysis to understand the patterns and trends, further to the COVID-19 pandemic and association with neoplasms. The non-updated populational data may have compromised the calculation of the rates of mortality, producing statistics that do not reflect the current status of the municipality. Therefore, future



studies should investigate data related to the neoplasms of the municipality and improving the data found in the current investigation.

CONCLUSION

The distribution of types of death by cancer may vary across *Ribeirão Preto* regions as concluded herein. Socioeconomic status, age, demographics and environmental aspects can be factors influencing the distribution. Within health policies and planning, it is important to consider these disparities beyond prevention and treatment programs for the population of the municipality and the spatial analysis is an important tool to help best management with fast interventions.

CONTRIBUTIONS

João Paulo Lima Moreira contributed to the study design, acquisition, analysis and interpretation of the data and wording of the manuscript. Ana Priscila Eleodoro Rosa contributed to the acquisition, analysis and interpretation of the data and wording of the manuscript. João Paulo Souza and Luciane Loures dos Santos contributed to the study design, analysis and interpretation of the data and critical review. All the authors approved the final version to be published.

DECLARATION OF CONFLICT OF INTERESTS

There is no conflict of interests to declare.

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