Estimated Cancer Incidence in Brazil, 2023-2025

doi: https://doi.org/10.32635/2176-9745.RBC.2023v69n1.3700

Estimativa de Incidência de Câncer no Brasil, 2023-2025

Incidencia Estimada de Cáncer en Brasil, 2023-2025

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ABSTRACT

Introduction: Cancer is a worldwide public health problem, in the last decade there was an increase of 20% of the incidence and more than 25 million new cases are expected by 2030. Estimates of the number of new cancer cases are a powerful tool to support public policies and rational allocation of resources to fight cancer. Cancer surveillance is paramount for planning, monitoring and evaluating cancer control programs. **Objective:** To estimate and to describe the incidence of cancer in the country, geographic regions, states, Federal District and capitals, by sex, for the 2023-2025 period. **Method**: Cancer mortality and incidence information were extracted from the Mortality Information System and from Population-Based Cancer Registries. The number of new cases and their respective incidence rates were estimated by time-linear prediction models or by the incidence and mortality ratio. **Results:** 704,000 new cases of cancer are expected for the triennium 2023-2025. Except for non-melanoma skin cancer, 483,000 new cases will occur. Female breast cancer and prostate cancer were the most frequent with 73,000 and 71,000 new cases, respectively, followed by colorectal cancer (45,000), lung (32,000) and stomach (21,000), and cervical cancer (17,000). **Conclusion:** In Brazil, due to its continental dimensions and heterogeneity both in terms of population and territory, the incidence profile reflects the diversity of geographic regions, and patterns similar to developed and developing countries.

Key words: neoplasms/epidemiology; neoplasms/mortality; incidence; statistics; Brazil.

RESUMO

Introdução: O câncer é um problema de saúde pública mundial. Na última década, houve um aumento de 20% na incidência e espera-se que, para 2030, ocorram mais de 25 milhões de casos novos. Estimativas do número de casos novos de câncer são uma ferramenta poderosa para fundamentar políticas públicas e alocação racional de recursos para o combate ao câncer. A vigilância do câncer é um elemento crucial para planejamento, monitoramento e avaliação das ações de controle do câncer. **Objetivo:** Estimar e descrever a incidência de câncer no país, Regiões geográficas, Unidades da Federação, Distrito Federal e capitais, por sexo, para o triênio 2023-2025. **Método:** As informações foram extraídas do Sistema de Informação sobre Mortalidade e dos Registros de Câncer de Base Populacional. Foram estimados os casos novos e suas respectivas taxas de incidência pelos modelos de predição tempo-linear ou pela razão de incidência e mortalidade. **Resultados:** São esperados 704 mil casos novos de câncer para o triênio 2023-2025. Excetuando o câncer de pele não melanoma, ocorrerão 483 mil casos novos. O câncer de mama feminina e o de próstata foram os mais incidentes com 73 mil e 71 mil casos novos, respectivamente. Em seguida, o câncer de cólon e reto (45 mil), pulmão (32 mil), estômago (21 mil) e o câncer do colo do útero (17 mil). **Conclusão**: No Brasil, por suas dimensões continentais e heterogeneidade, em termos de território e população, o perfil da incidência reflete a diversidade das Regiões geográficas, coexistindo padrões semelhantes ao de países desenvolvidos e em desenvolvimento.

Palavras-chave: neoplasias/epidemiologia; neoplasias/mortalidade; incidência; estatística; Brasil.

RESUMEN

Introducción: El cáncer es un problema de salud pública mundial, en la última década, hubo un incremento de un 20% en la incidencia y se espera, para 2030, más de 25 millones de nuevos casos. Estimaciones del número de nuevos casos de cáncer son una herramienta poderosa para fundamentar políticas públicas y la asignación racional de recursos para el combate contra el cáncer. La vigilancia es un elemento crucial para la planificación, monitoreo y evaluación de las acciones de control del cáncer. **Objetivo:** Estimar y describir la incidencia de cáncer en el país, regiones geográficas, Unidades de la Federación, Distrito Federal y capitales, por género, para el trienio 2023-2025. **Método:** Las informaciones fueron extraídas del Sistema de Información sobre Mortalidad y de los Registros de Cáncer de Base Poblacional. Fueron estimados los nuevos casos y sus respectivas tasas de incidencia mediante los modelos de predicción tiempo-lineal o por la razón de incidencia y mortalidad. **Resultados:** Se prevén 704 mil nuevos casos de cáncer para el trienio 2023-2025. Exceptuando el cáncer de piel no-melanoma, ocurrirán 483 mil nuevos casos. El cáncer de mama femenino y el de próstata fueron los que tuvieron mayor incidencia con 73 mil y 71 mil nuevos casos, respectivamente. Les siguen el cáncer de colon y recto (45 mil), pulmón (32 mil), estómago (21 mil) y el cáncer del cuello uterino (17 mil). **Conclusión**: En el Brasil, por sus dimensiones continentales y heterogeneidad, en términos de territorio y población, el perfil de la incidencia refleja la diversidad de las regiones geográficas, coexistiendo estándares similares al de los países desarrollados y en vías de desarrollo.

Palabras clave: neoplasias/epidemiología; neoplasias/mortalidad; incidencia; estadística; Brasil.

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INTRODUCTION

Cancer is a major public health problem worldwide, being one of the main causes of death and an important barrier to increase life expectancy. It is the first or second cause of premature death before 70 years of age in most of the countries. Incidence and mortality rates are rapidly increasing worldwide due to demographic and epidemiological transitions[1]. It reflects ageing, behavior and environmental changes, including structural conditions that have impacts on mobility and recreation, diet and exposure to environmental pollutants which can increase the incidence of and mortality by cancer[2].

In countries with high HDI (Human Development Index) effective interventions for prevention, early detection and treatment have a substantial impact on reducing incidence and mortality rates by cancer. These rates continue to increase or are stable in countries in transition, a challenge for resources allocation and efforts to improve cancer control[1].

Estimates of new cases of cancer are a strong tool to develop public policies and rational allocation of resources to fight cancer. Cancer surveillance is a pivotal element for planning, monitoring and evaluating cancer control actions. The availability and quality of information about cancer incidence and mortality had an expressive improvement in the last decade in Brazil. Cancer surveillance within the framework of non-communicable diseases control, supported by the best available data from cancer registries (population and hospital-based) and the Mortality Information System (SIM)[3], provides managers with elements to organize cancer control actions and guidance for cancer research.

The objective of this study was to estimate the incidence and distribution of the main cancer types which will occur in the triennium 2023-2025 in the geographic regions, Federation Units (FU), Federal District and state capitals of the country by sex[4].

METHOD

Incidence data were provided by 30 Brazilian Population-Based Cancer Registries (PBCR), from 1987 to 2019 available at the National Cancer Institute – INCA's Website (INCA)[5]. Mortality data from 1979 to 2020 were provided by the SIM[3] at the Online Mortality Atlas, also available at INCA's Website[6].

The census populations (1980, 1991, 1996, 2000 and 2010) and intercensal populations (1981 to 2020)[7,8] were used to calculate the incidence rates for Brazil, regions and FU. The projected population for 2023[9] was utilized to obtain the estimated number of new cancer cases.

The following 21 primary sites or groups were selected: oral cavity (C00-C10); esophagus (C15); stomach (C16); colorectal (C18-C21); liver (C22); pancreas (C25); larynx (C32); trachea, bronchus and lung (C33-C34); melanoma of skin (C43); non-melanoma skin cancer (NMSC) (C44); female breast (C50); cervix uteri (C53); corpus uteri (C54); ovary (C56); prostate (C61); bladder (C67); brain, central nervous system (C70-C72); thyroid (C73); Hodgkin lymphoma (C81); non-Hodgkin lymphoma (C82-C85, C96) and leukemia (C91-C95). Cancer types not selected were titled "other sites". All cancers combined (C00-C97; D46) is the result of the sum of these categories. In addition, a group of childhood tumors was selected to calculate the estimate of childhood and adolescents cancer (0 to 19 years)[10-12].

The following methods were used to compile cancer incidence estimates for the country as a whole (five regions, 26 FU, Federal District and capitals):

TIME-LINEAR PREDICTION MODELS

Used for capitals and states with information on incidence with at least six and maximum 15 years of time-series and at least 50 cases of cancer per year (all age-groups). The estimates were calculated with the short-term model (prediction of up to five years), based in time-linear prediction models[13-15].

$$E(rate(i,t))=\alpha\_i+\beta\_i\times t$$
$$Log(E(rate(i,t)))=\alpha\_i+\beta\_i\times t$$
$$Log(E(rate(i,t)))=\alpha\_i+\beta\times t$$

E(rate(i, t)) = Expected incidence rate for age i, year t, where α_i, β and β_i are parameters.

INCIDENCE AND MORTALITY RATIO

Adopted when the information on incidence could not be estimated by the time-linear prediction model. If an active local PBCR existed, its respective incidence/mortality ratio (I/M) was used. Otherwise, the median of the I/M ratio of the geographical region of the location for which the estimate was calculated was preferred[16].

This ratio was applied to estimated (by linear regression) mortality rates for 2023, per FU, capitals and Federal District. If the linear model was unfit, the mean rate of the available five years was used instead (2016 to 2020)[6].

$$TI_L = TM_L \times \left(\frac{I_R}{M_O} \right)$$

Where:

TI_L = Estimated incidence rate (crude or adjusted) for FU, Federal District or capital.

TM_L = Estimated mortality rate (crude or adjusted) for the time-series of mortality for FU, Federal District or capital.

I_R = Ratio of the number of new cases (incidence) where local PBCR exist (from 2008 to 2019) and the square root of the population.

M_O = Ratio of the number of deaths where local PBCR exist (from 2008 to 2019) and the square root of the population obtained from SIM.

The estimate of new cases for the five geographical regions and Brazil was obtained by the sum of the absolute values per FU. The respective crude rates were calculated by dividing the number of new cases of the geographical regions or Brazil by their respective populations. The adjusted rate for the geographical regions and Brazil was obtained by the median of the rates of the FU of the respective region.

The correction proposed by Loos et al.[17] was applied to make the information about the mortality by cervix and corpus uteri cancers more trustworthy.

Software R version 3.4.1 was utilized to calculate the linear regression and mean rate and the software Depred developed by the International Agency for Research on Cancer (IARC) to estimate the time-linear model[13,18].

The approval by an ethics committee was waived because only secondary unidentified data were utilized in compliance with Ordinance 466, dated December 12, 2012 of the National Health Council[19].

RESULTS

704 thousand new cases of cancer were estimated for 2023 in Brazil. Excluding non-melanoma skin cancer, it is expected the occurrence of 483 thousand new cases, being 49.5% in males (239 thousand new cases) and 50.5% (244 thousand new cases) in females (Table 1A). Childhood and adolescent cancer (0 to 19 years) will account for 7,900 cases with slight predominance of males with 4,200 new cases (53.2%) and 3,700 (46.8%) for females (Table 2).

Except non-melanoma skin cancer, the most incident types of cancer will account for 70.0% of all the cases. Female breast cancer and prostate cancer represent nearly 15% of the new cases each, followed by colorectal (9.4%), trachea, bronchus and lung (6.7%), stomach (4.4%) and cervix (3.5%). The analysis by sex indicates that prostate cancer is the most frequent in males (30.0%), followed by colorectal (9.2%), trachea, bronchus and lung (7.5%), stomach (5.6%) and oral cavity (4.6%). Breast cancer is the most common tumor among women (30.1%) followed by colorectal (9.7%), cervical cancer (7.0%), trachea, bronchus and lung (6.0%) and thyroid (5.8%) (Figure 1).

The distribution of cases by region shows that the Southeast will concentrate 48.4% of the new cases. The Northeast region (22.8%) is ranked second followed by South (17.1%), Midwest (7.3%) and North (4.4%) regions. Together, the most developed regions (South and Southeast) gather 65.5% of the new cases of cancer. The Southeast region will also concentrate the highest proportion of childhood and adolescents cancer with 41.7% of the new cases (Tables 1A, 1B and 2).

Except non-melanoma skin cancer, prostate cancer will be the most incident for all FU and Federal District. For most of the FU of the North and Northeast regions, stomach and lung cancer are the second or third most common tumors for males. Stomach cancer is the second most incident for the FU of the North region, Amazonas, Amapá and Pará, while for the Northeast region, lung cancer is the most frequent in Maranhão, Piauí, Ceará, Paraíba and Pernambuco. Colorectal and oral cavity cancers are the three most important. In the Midwest region, colorectal is the second most incident in all FU followed by lung cancer. The same profile was detected for the Southeast and South regions, except Espírito Santo, Santa Catarina and Rio Grande do Sul, where lung cancer is the second most incident (Figure 2).

Women's profile reveals the predominance of breast cancer for all the geographic regions and in most of the FU and Federal District. Cervix uteri cancer is the most incident in Amazonas and Amapá (North region) and in the other states it is ranked second. It is the second most incident in the Northeast regions, except in Rio Grande do Norte and Paraíba. It swaps positions as second most incident with colorectal cancer in the Midwest region for all the FU. Colorectal is the second most incident in the Southeast and South regions for all FU. Lung cancer stands out in third place in Paraná and Rio Grande do Sul (Figure 2).

The most common cancer types found across different FU were breast female cancer, prostate, colorectal, lung, stomach, cervix uteri, thyroid and oral cavity. Female breast cancer is the most incident with higher age-adjusted rates in the Southeast and Midwest regions (52.83 and 47.31/100,000 women, respectively). Northeast and South regions present similarity to the country rate (nearly 40/100,000 women), while the North region has the lower rate (27.73/100,000 women) (Table 1A and Figure 3).

The opposite occurs for cervix uteri cancer with the highest rate with 16.77 per 100,000 women in the North region. The Northeast region is ranked second with quite low magnitude, similar to the results for the entire country. The Midwest, South and Southeast regions present the lower age-adjusted rates, between 8 and 11 per 100,000 women (Table 1A and Figure 3).

Table 1A. Estimated new cancer cases and age-adjusted incidence rates[a] per 100,000 by sex and cancer type. Brazil and geographic regions, 2023-2025

Primary site Malignant neoplasms	Males												Females											
	Brazil		North		Northeast		Midwest		Southeast		South		Brazil		North		Northeast		Midwest		Southeast		South	
	New cases	AR	New cases	AR	New cases	AR	New cases	AR	New cases	AR	New cases	AR	New cases	AR	New cases	AR	New cases	AR	New cases	AR	New cases	AR	New cases	AR
Female breast	-	-	-	-	-	-	-	-	-	-	-	-	73,610	41.89	2,410	27.73	15,690	42.11	4,950	47.31	39,330	52.83	11,230	41.06
Prostate	71,730	55.49	2,760	38.88	20,650	61.16	5,210	60.97	34,470	52.41	8,640	33.94	-	-	-	-	-	-	-	-	-	-	-	-
Colorectal	21,970	12.43	690	8.30	3,100	10.44	1,460	17.63	12,660	20.32	4,060	19.44	23,660	11.06	740	8.50	3,930	10.31	1,460	13.94	13,440	16.60	4,090	14.99
Lung	18,020	12.73	880	10.72	3,450	11.26	1,290	13.50	7,640	12.89	4,760	24.19	14,540	9.26	650	8.27	3,120	8.46	1,150	10.60	6,320	8.92	3,300	15.54
Stomach	13,340	9.51	1,200	11.78	3.450	10.70	860	9.00	5,570	6.40	2,260	9.28	8,140	4.92	630	5.46	2,230	4.96	570	5.15	3,380	2.81	1,330	4.31
Cervix	-	-	-	-	-	-	-	-	-	-	-	-	17,010	13.25	1,980	16.77	5,280	13.85	1,440	11.09	6,020	8.57	2,290	9.77
Thyroid gland	2,500	1.84	130	0.82	760	2.57	190	2.07	1,120	1.91	300	1.40	14,160	6.68	320	3.96	4,060	11.21	1,030	8.81	7,700	5.97	1,050	3.00
Oral cavity	10,900	7.64	440	6.21	2,350	8.92	690	7.55	5,830	10.37	1,590	9.16	4,200	2.61	190	2.20	1,150	2.83	260	2.69	2,040	2.75	560	2.03
Non-Hodgkin's Lymphoma	6,420	4.55	210	2.90	1,270	4.61	490	5.55	2,960	4.73	1,490	7.22	5,620	3.00	150	1.82	1,200	3.47	360	3.52	2,780	3.34	1,130	3.19
Leukemias	6,250	4.75	440	4.66	1,770	5.13	360	4.64	2,580	4.51	1,100	5.57	5,290	3.95	350	3.98	1,530	4.04	290	3.37	2,030	3.08	1,090	4.33
Central Nervous System	6,110	4.56	320	3.66	1,410	4.39	500	5.42	2,590	4.54	1,290	6.06	5,380	3.80	270	2.84	1,360	4.00	440	3.87	2,190	3.36	1,120	4.66
Bladder	7,870	3.96	220	2.68	1,240	4.12	540	5.22	4,290	6.42	1,580	5.83	3,500	1.58	110	1.15	620	1.46	230	2.14	1,990	2.09	550	1.95
Esophagus	8,200	5.46	270	3.83	1,630	4.83	600	6.60	3,710	7.04	1,990	9.57	2,790	1.43	110	1.00	660	1.43	190	1.56	1,150	1.45	680	2.67
Pancreas	5,290	3.74	250	3.27	990	3.19	350	4.81	2,480	4.39	1,220	5.88	5,690	3.22	240	2.75	1,120	2.78	370	3.65	2,730	3.44	1,230	4.49
Liver	6,390	5.18	430	5.23	1,600	5.17	400	4.68	2,550	4.35	1,410	8.04	4,310	3.14	320	3.69	1,360	3.30	270	2.91	1,500	1.84	860	3.61
Skin melanoma	4,640	2.24	100	1.31	640	2.28	240	2.74	2,420	3.22	1,240	4.83	4,340	1.56	90	0.60	580	1.52	350	2.24	2,160	1.77	1,160	3.30
Corpus uteri	-	-	-	-	-	-	-	-	-	-	-	-	7,840	4.13	270	3.26	1,550	4.13	560	5.88	4,380	5.75	1,080	4.23
Larynx	6,570	5.07	260	3.37	1,450	5.24	490	5.15	3,250	5.31	1,120	5.24	1,220	0.72	80	0.50	300	0.72	100	1.02	530	0.73	210	0.70
Ovary	-	-	-	-	-	-	-	-	-	-	-	-	7,310	5.01	340	3.53	1,960	5.35	490	4.83	3,430	4.50	1,090	5.26
Hodgkin's Lymphoma	1,500	0.84	80	0.52	250	0.76	120	1.17	780	0.80	270	0.84	1,580	0.78	90	0.47	250	0.77	120	1.08	750	1.04	370	1.33
Other sites	41,730	26.17	1,730	20.47	8,260	26.53	4,120	35.02	19,660	31.51	7,960	32.59	33,970	19.70	1,410	16.56	7,910	19.91	2,960	23.66	15,670	19.24	6,020	19.88
All neoplasms except non-melanoma skin	**239,430**	**185.61**	**10,410**	**138.24**	**54,270**	**168.08**	**17,910**	**209.28**	**114,560**	**208.90**	**42,280**	**213.49**	**244,160**	**154.08**	**10,750**	**135.16**	**55,860**	**145.95**	**17,590**	**168.08**	**119,520**	**168.32**	**40,440**	**170.62**
Non-melanoma skin	101,920	-	1,710	-	19.420	-	6,560	-	53,730	-	20,500	-	118,570	-	2,590	-	23,380	-	9,280	-	57,420	-	25,900	-
All neoplasms	**341,350**	**-**	**12,120**	**-**	**73.690**	**-**	**24,470**	**-**	**168,290**	**-**	**62,780**	**-**	**362,730**	**-**	**13,340**	**-**	**79,240**	**-**	**26,870**	**-**	**176,940**	**-**	**66,340**	**-**

Source: Extracted from Estimate 2023: INCA's Cancer Incidence in Brazil[4].
Caption: AR = age-adjusted rate.
([a]) World standard population (1960).
Note: lung = trachea, bronchus and lung (C33-C34); colorectal = colon, rectosigmoid junction, rectum and anus (C18-C21); oral cavity = lip, tongue, oral cavity and oropharynx and major salivary glands (C00-C10).

Table 1B. Estimated new cancer cases and age-adjusted incidence rates[a] per 100,000 by cancer type. Brazil and geographic regions, 2023-2025

Primary site Malignant Neoplasm	Total											
	Brazil		North		Northeast		Midwest		Southeast		South	
	New cases	AR	New cases	AR	New cases	AR	New cases	AR	New cases	AR	New cases	AR
Female breast	73,610	41.89	2,410	27.73	15,690	42.11	4,950	47.31	39,330	52.83	11,230	41.06
Prostate	71,730	55.49	2,760	38.88	20,650	61.16	5,210	60.97	34,470	52.41	8,640	33.94
Colorectal	45,630	11.43	1,430	8.04	7,030	10.26	2,920	16.21	26,100	18.17	8,150	16.72
Lung	32,560	10.52	1,530	10.47	6,570	10.47	2,440	11.95	13,960	10.41	8,060	18.55
Stomach	21,480	7.08	1,830	8.65	5,680	7.47	1,430	6.37	8,950	4.18	3,590	6.33
Cervix	17,010	13.25	1,980	16.77	5,280	13.85	1,440	11.09	6,020	8.57	2,290	9.77
Thyroid gland	16,660	4.83	450	2.16	4,820	7.73	1,220	4.75	8,820	5.55	1,350	2.52
Oral cavity	15,100	4.95	630	4.14	3,500	5.41	950	4.14	7,870	6.35	2,150	5.39
Non-Hodgkin's Lymphoma	12,040	3.79	360	2.37	2,470	4.12	850	4.47	5,740	3.94	2,620	4.72
Leukemias	11,540	4.43	790	4.43	3,300	4.65	650	4.49	4,610	4.20	2,190	4.90
Central Nervous System	11,490	4.33	590	3.21	2,770	4.46	940	4.47	4,780	3.86	2,410	5.31
Bladder	11,370	2.75	330	1.84	1,860	2.66	770	3.03	6,280	3.70	2,130	3.67
Esophagus	10,990	3.38	380	2.28	2,290	3.13	790	3.60	4,860	4.07	2,670	5.55
Pancreas	10,980	3.31	490	3.02	2,110	3.07	720	4.16	5,210	3.86	2,450	5.22
Liver	10,700	4.29	750	4.47	2,960	4.54	670	3.87	4,050	3.08	2,270	5.41
Skin melanoma	8,980	1.88	190	1.06	1,220	1.81	590	2.72	4,580	2.31	2,400	3.98
Corpus uteri	7,840	4.13	270	3.26	1,550	4.13	560	5.88	4,380	5.75	1,080	4.23
Larynx	7,790	2.68	340	2.04	1,750	2.71	590	2.98	3,780	2.79	1,330	3.07
Ovary	7,310	5.01	340	3.53	1,960	5.35	490	4.83	3,430	4.50	1,090	5.26
Hodgkin's Lymphoma	3,080	0.75	170	0.48	500	0.75	240	1.11	1,530	0.70	640	1.21
Other sites	75,700	21.96	3,140	19.01	16,170	22.82	7,080	28.45	35,330	24.34	13,980	25.55
All neoplasms except non-melanoma skin	**483,590**	**169.63**	**21,160**	**136.82**	**110,130**	**164.54**	**35,500**	**192.32**	**234,080**	**183.51**	**82,720**	**189.22**
Non-melanoma skin	220,490	-	4,300	-	42,800	-	15,840	-	111,150	-	46,400	-
All neoplasms	**704,080**	**-**	**25,460**	**-**	**152,930**	**-**	**51,340**	**-**	**345,230**	**-**	**129,120**	**-**

Source: Extracted from Estimate 2023: INCA's Cancer Incidence in Brazil[4].
Caption: AR = age-adjusted rate.
([a]) World standard population (1960).
Note: lung = trachea, bronchus and lung (C33-C34); colorectal = colon, rectosigmoid junction, rectum and anus (C18-C21); oral cavity = lip, tongue, oral cavity and oropharynx and major salivary glands (C00-C10).

Prostate cancer is the second most incident and age-adjusted rates vary from 33.94 to 61.16 per 100,000. Northeast and Midwest regions present the highest rates (61.16 and 60.97/100,000 respectively) (Table 1A and Figure 3).

Colorectal cancer has the highest rates in the Southeast (20.32/100,000 men; 16.60/100,000 women), South (19.44/100,000 men; 14.99/100,000 women) and Midwest regions (17.63/100,000 men; 13.94/100,000 women). The lowest rates were detected in the Northeast (10.44/100,000 men; 10.31/100,000 women) and North regions (8.30/100,000 men; 8.50/100,000 women) (Table 1A and Figure 3).

An opposite pattern was found in the age-adjusted rates of stomach cancer where the North region had the highest rates for men (11.78/100,000) and women

Table 2. Estimated new cancer cases* and crude incidence rates[a] per 1,000,000 in children and adolescents (0-19 years), by sex. FU, geographic regions and Brazil, 2023-2025

Federation Unit	Total		Males		Females	
	Cases	Crude rates	Cases	Crude rates	Cases	Crude rates
North Region	**650**	**99.59**	**370**	**111.10**	**280**	**87.56**
Acre	40	102.80	20	105.73	20	99.75
Amapá	30	89.47	20	108.68	**	69.51
Amazonas	200	123.03	120	142.55	80	102.64
Pará	280	95.54	160	106.42	120	84.17
Rondônia	40	76.80	20	81.05	20	72.34
Roraima	20	94.86	**	92.13	**	97.71
Tocantins	40	80.85	20	86.21	20	75.27
Northeast Region	**2,130**	**126.42**	**1,190**	**138.10**	**940**	**114.23**
Alagoas	130	126.52	70	137.70	60	114.86
Bahia	430	102.19	240	110.32	190	93.70
Ceará	340	129.77	190	141.61	150	117.40
Maranhão	280	116.57	160	132.23	120	100.19
Paraíba	170	148.26	100	172.97	70	122.36
Pernambuco	410	146.84	230	159.73	180	133.39
Piauí	150	151.41	80	157.78	70	144.78
Rio Grande do Norte	130	132.76	70	136.40	60	128.98
Sergipe	90	131.64	50	143.44	40	119.38
Midwest Region	**660**	**136.21**	**360**	**143.89**	**300**	**128.19**
Distrito Federal	130	162.48	80	189.34	50	134.40
Goiás	280	138.43	150	144.67	130	131.93
Mato Grosso	130	115.41	70	117.83	60	112.89
Mato Grosso do Sul	120	132.20	60	131.59	60	132.84
Southeast Region	**3,310**	**144.88**	**1,700**	**145.61**	**1,610**	**144.11**
Espírito Santo	150	130.61	90	155.96	60	104.19
Minas Gerais	680	127.20	340	124.20	340	130.33
Rio de Janeiro	630	144.62	320	143.92	310	145.35
São Paulo	1.850	154.17	950	154.77	900	153.55
South Region	1,180	152.26	610	153.29	570	151.19
Paraná	470	152.17	240	153.76	230	150.50
Rio Grande do Sul	400	143.69	210	145.11	190	142.20
Santa Catarina	310	165.01	160	164.54	150	165.51
Brazil	**7,930**	**134.81**	**4,230**	**140.50**	**3,700**	**128.87**

Source: Data extracted from Estimate 2023: INCA's Cancer Incidence in Brazil[4].
(*) rounded to multiples of 10.
(**) cases lower than 20.

(5.46/100,000). The Northeast region has the second highest incidence rate (10.70/100,000 men and 4.96/100,000 women). The lowest rates are found in the Southeast region (6.40/100,000 men and 2.81/100,000 women) (Table 1A and Figure 3).

Lung cancer is the most incident in males of the South region (24.19/100,000), the double in comparison with other regions and Brazil. Women of the South Region presented highest rates but with lower magnitude (15.54/100,000). The Midwest region, ranked second,

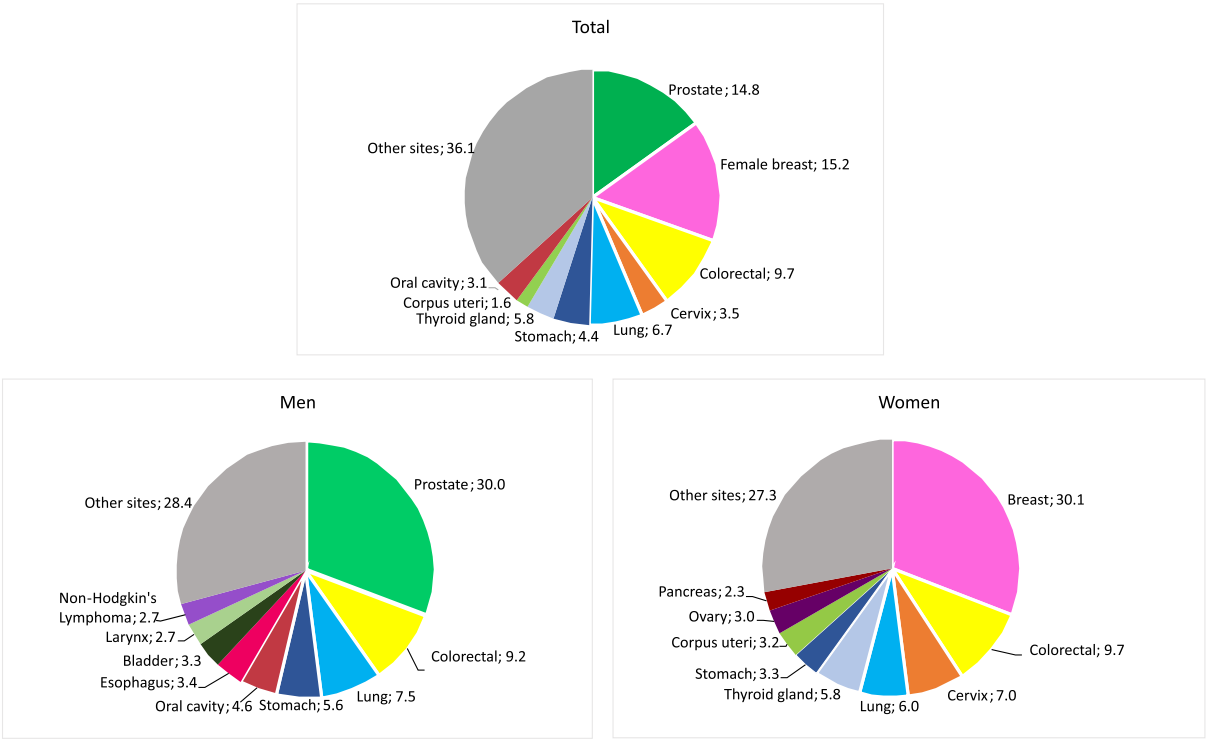

Figure 1. Distribution of ten most incident cancer types estimated for 2023 by sex, but non-melanoma skin cancer

Source: Data extracted from Estimate 2023: INCA's Cancer Incidence in Brazil[4].
Note: lung = trachea, bronchus and lung (C33-C34); colorectal = colon, rectosigmoid junction, rectum and anus (C18-C21); oral cavity = lip, tongue, oral cavity and oropharynx and major salivary glands (C00-C10).

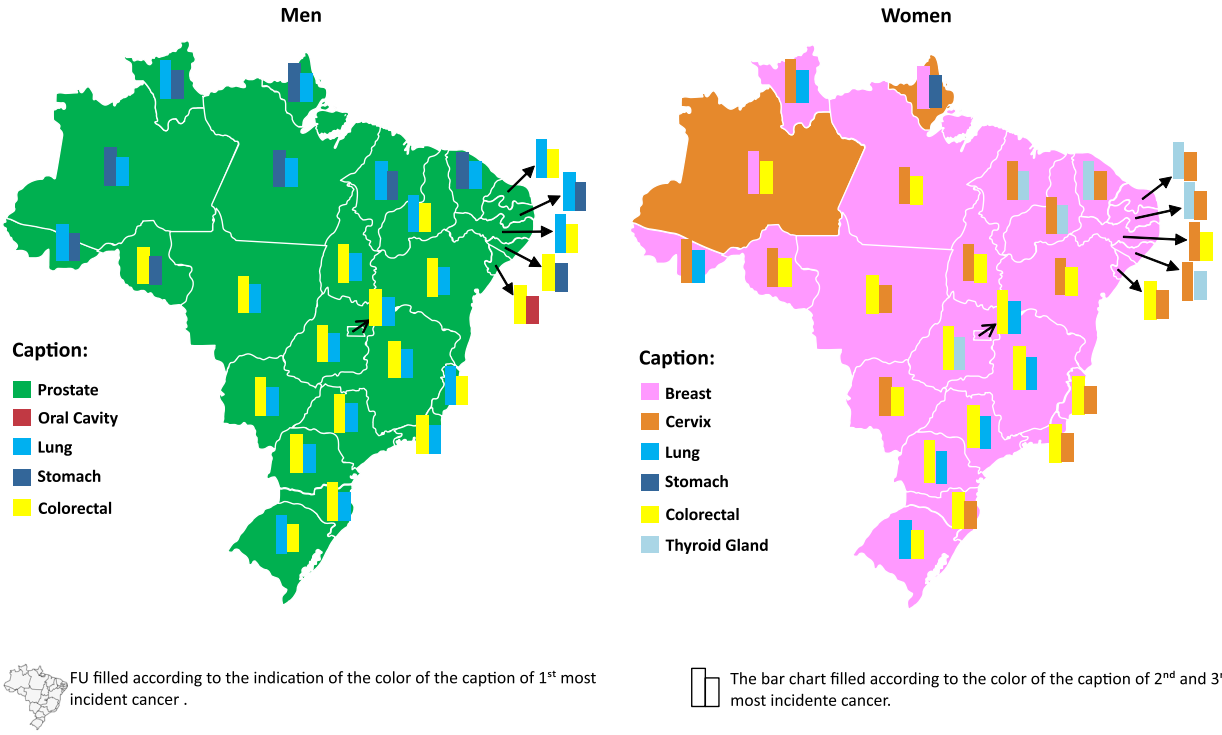

Figure 2. Distribution of three most incident cancer types, but NMSC (age-adjusted rate) by sex. FU, 2023-2025

Source: Data extracted from Estimate 2023: INCA's Cancer Incidence in Brazil[4].
Note: lung = trachea, bronchus and lung (C33-C34); colorectal = colon, rectosigmoid junction, rectum and anus (C18-C21); oral cavity = lip, tongue, oral cavity and oropharynx and major salivary glands (C00-C10).

has more elevated rates than the other regions for both sexes (13.50/100,000 men; 10.60/100,000) (Table 1A and Figure 3).

Oral cavity cancer has 2-to-4-fold higher incidence in men than in women. The highest rates were found in the Southeast (10.37/100,000 men; 2.75/100,000 women) and South (9.16/100,000 men; 2.03/100,000 women) regions. The North region has the lowest rates (6.21/100,000 men; 2.20/100,000 women) (Table 1A and Figure 3).

Thyroid cancer is 2 -to-5-fold more frequent in women than in men. The Northeast (11.21/100,000 women; 2.57/100,000 men), Midwest (8.81/100,000 women; 2.07/ 100,000 men) and Southeast (5.97/100,000 women; 1.91/100,000 men) regions have the highest rates while the North (3.96/100,000 women; 0.82/100,000 men) and South (3.00/100,000 women; 1.40/100,000 men) regions have the lowest rates (Table 1A and Figure 3).

The estimated incidence risk of childhood and adolescent (0-19 years) cancer is 135 per one million. The highest rates were found in the South (152/1 million) and Southeast (145/1 million) regions (Table 2).

DISCUSSION

For the country as a whole, the age-adjusted rates of cancer incidence present an intermediate pattern (169.6/100,000 inhabitants). The world estimate indicates a range of 104.3 and 335.3 per 100,000 inhabitants, but non-melanoma skin cancer, matched to the countries' HDI[1].

The epidemiological profile is similar to developed countries (high HDI) where the main cancer types are female breast cancer, prostate, colorectal, lung, cervix uteri, stomach and oral cavity. Worldwide, the main cancer types were female breast cancer, lung, colorectal and prostate. For men, prostate cancer was more frequent for most of the countries, followed by lung and colorectal. Breast cancer predominates in women, followed by cervix uteri cancer in lower magnitude[1].

Notwithstanding the same overall pattern similar to developed countries, important regional inequalities occurred. While at the most developed regions (South and Southeast) the age-adjusted incidence rates range between 180 and 190 cases per 100,000 inhabitants, the rates of the North and Northeast regions with lower HDI vary from 157 to 164 cases per 100,000 inhabitants. Globally, this same pattern is found in countries or continents with different HDI[1,2,20,21].

Although prostate cancer is predominant at the North and Northeast regions, the cancers associated with infections as stomach and cervix uteri are among the main cancer types. Nearly 2/3 of the cancer cases attributed to infections occur in less developed countries. The highest age-adjusted incidence rates for stomach cancer were observed in Western Asia and East Europe. The highest incidence rates of cervix uteri cancer were observed in Sub-Saharan Africa, 7 to 10-fold higher than in North America and Oceania[1]. Brazil's North region has the highest age-adjusted incidence rates for these cancer types, the double compared to the Southeast region.

The economic transition which took place at the Midwest region, results in an intermediate pattern of incidence in comparison to the South/Southeast and North/Northeast regions. A transition of the profile is also observed for the most incident cancers, similar to the cancer types observed in the most developed Regions[1]. In the same way, the cancer types associated with infections in high HDI countries, have been replaced by those related to lifestyle and behavior as lung, female breast cancer, prostate and colorectal.

The Southeast is one of the most urbanized and developed regions of the country. The pattern of cancer incidence is similar to developed countries with colorectal cancer ranked second for men and women. The most evident changes of lifestyle as increase of intake of processed food, sedentarism and overweight are more evident in that region[22]. The South, also one of the most developed regions of the country, received European immigrants and has its own characteristics. Lung cancer stands out as the second most incident for men and women, similar to European Eastern countries mostly for prevalence of tobacco use, were the highest percentages are found in Southeast Asia, Central and Eastern Europe[1,2,23,24].

Prostate cancer and thyroid cancers in women deserve special attention as their rates are overestimated due to diagnostic practices of the country. In the European North and East countries together with some Latin American and Central countries and Asia, similar patterns were detected, as they reflect the same diagnostic practices (prostate-specific antigen (PSA) and thyroid ultrasound). Estimated overdiagnosis in females is within 80% and 95% of the cases at the Korean Republic, Belarus, China, Italy, Croatia, Slovakia and France from 2008 to 2012[1,25].

Worldwide, the estimated risk of childhood and adolescents cancer is 155.8 per million, similar to Brazil's estimate. Likewise, the slight predominance of males is similar to the world's pattern. The main cancer types affecting children are leukemias, tumors of brain, central nervous system and lymphomas. Middle-and-low developed countries concentrate approximately 70% of the new cancer cases[26-28].

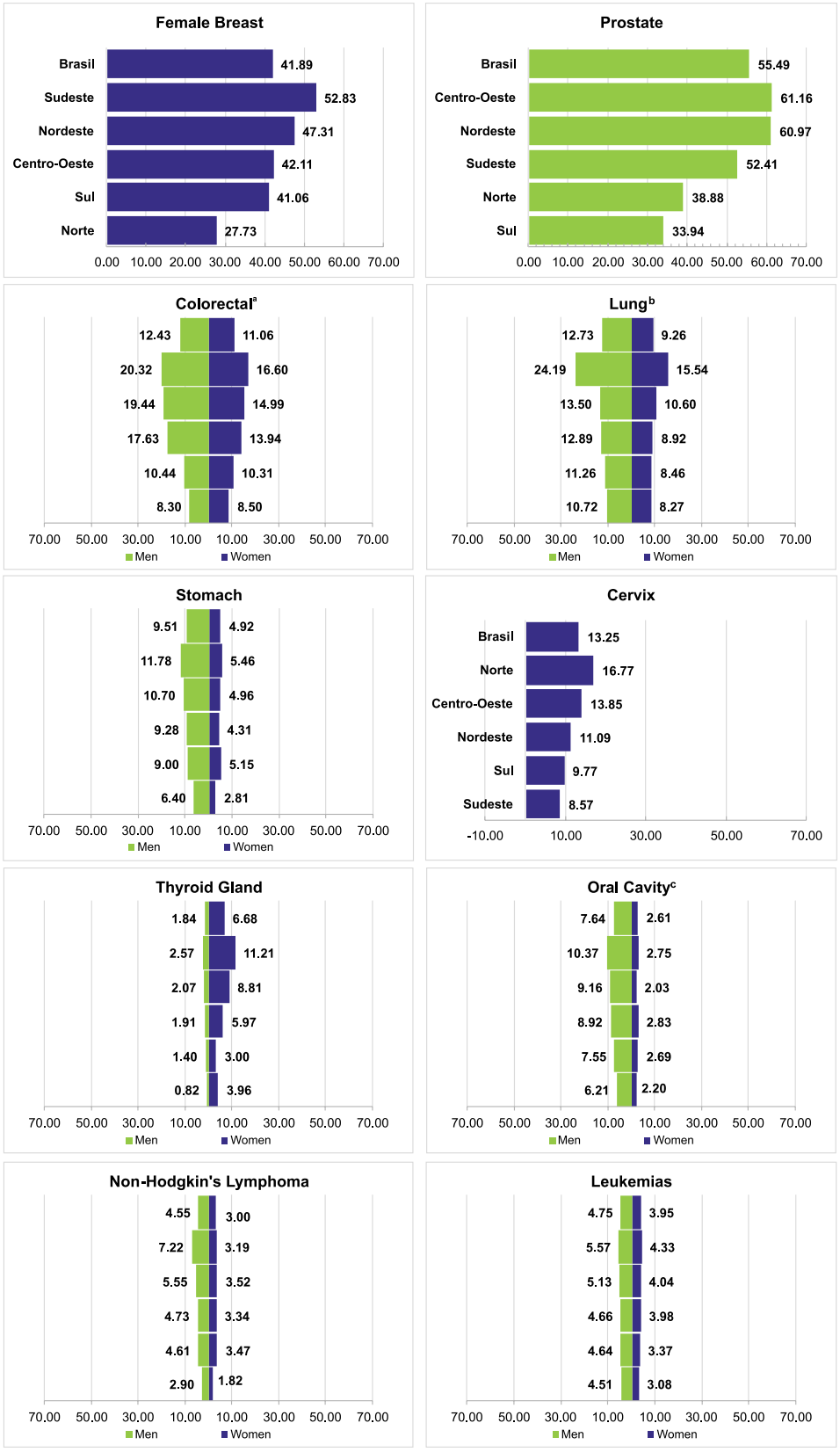

Figure 3. Age-Adjusted cancer incidence rates*by sex, Brazil and Geographical Regions, 2023-2025

Source: Data extracted from Estimate 2023: INCA's Cancer Incidence in Brazil[4].
([a]) colorectal = colon, rectosigmoid junction, rectum and anus (C18-C21)
([b]) lung = trachea, bronchus and lung (C33-C34);
([c]) oral cavity = lip, tongue, oral cavity and oropharynx and major salivary glands (C00-C10).
(*) per 100,000 inhabitants.

CONCLUSION

The estimated cancer incidence in Brazil presents the burden and profile of cancer and it is essential for planning and defining cancer control policies in the country.

The information extracted from PBCR, and SIM are the main tools for cancer surveillance in Brazil. The Brazilian PBCR are improving its coverage, validity and timeliness allowing the comparability and definition of the cancer incidence profile by different places and times. The short-term estimates within this context are the best alternative to offer updated information about cancer in the country. The methodology is similar to the one employed by the Globocan, elaborated by the International Agency for Research on Cancer – IARC.

The inclusion of childhood and adolescent's cancers per FU was an important advance, creating an essential parameter for the implementation of public policies targeting this population.

It is yet unknown how COVID-19 pandemic will affect definitively the burden of new cancer cases. This uncommon situation was not incorporated into the estimates for 2023-2025, they were based on past years trends of incidence and mortality. COVID-19 pandemic has also affected the collection of information from PBCR, especially in low-and-middle income countries and may cause delays of the incidence reports.

Notwithstanding the limitations, the estimates are able to describe the current patterns of cancer incidence in Brazil. Although the estimates provide global analysis on the burden and distribution of the main cancer types by sex, geographic region, Federal Units and capital cities, the purpose is not to replace the continuous and systematic management of information produced by PBCR and SIM, but to offer elements to plan, monitor and evaluate cancer control actions.

ACKNOWLEDGMENT

To all the coordinators of PBCR who contributed to this article, including the following locations: Acre, Alagoas, Angra dos Reis/RJ, Aracaju/SE, Belém/PA, Belo Horizonte/MG, Municipal Health Secretary (SMS) of Campinas/SP, Campo Grande/MS, Curitiba/PR, Federal District, Regional Health Department (DRS) of Barretos/SP, Espírito Santo, Fortaleza/CE, Florianópolis/SC, Goiânia/GO, Jahu/SP, João Pessoa/PB, Manaus/AM, Mato Grosso/MT, Natal/RN, Palmas/TO, Poços de Caldas/MG, Porto Alegre/RS, Recife/PE, Rondônia, Roraima, Salvador/BA, Santos/SP, São Paulo/SP, Teresina/PI.

CONTRIBUTIONS

Marceli de Oliveira Santos, Fernanda Cristina da Silva de Lima, Luís Felipe Leite Martins and Julio Fernando Pinto Oliveira contributed to the study design, acquisition, analysis and/or interpretation of the data, wording and/or critical review. Liz Maria de Almeida and Marianna de Camargo Cancela contributed to the wording and/or 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.

FUNDING SOURCES

None.

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Recebido em 26/1/2023
Aprovado em 26/1/2023

Scientific-Editor: Anke Bergmann. Orcid iD: https://orcid.org/0000-0002-1972-8777