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## Economic Impact Analysis of Cancer in the Health System of Brazil: Model Based in Public Database

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### Abstract

**Objectives:** To analyze the economic impact of cancer in the Brazilian health system from 2010 to 2015 and to forecast the impact until 2020.

**Methods:** Public databases were used to estimate cancer costs to which were added hospitalization costs, outpatient visits and treatments. Indirect costs were added to the calculation of income loss caused by neoplasms morbidity or mortality.

**Results:** The estimated costs amounted to INT\$ 59.7 billion in the year 2015 with an exponential increase from 2010 to 2015. The costs of mortality represent 63% of total costs of cancer, direct costs account for 20% and morbidity, 17%. Health expenditures are estimated at 9.5% of GDP and the average cost with cancer was estimated at 1.7% of GDP per year. It is expected that cancer costs reach approximately INT\$ 81 billion in 2020.

**Conclusion:** Cancer costs have increased significantly over the past five years and will increase until 2020.

**Keywords:** Cost analysis; Cancer; Health care cost; Cost of illness; Health spending

2013, while the number of deaths increased from 47.5 million to 54.9 million over the same interval [2].

The economies of Latin America and the Caribbean are growing rapidly, and the standard of living is improving. This scenario has also ensued sedentary lifestyles, unhealthy dietary habits, smoking, alcohol consumption, environmental carcinogenic pollutants, sun exposure, urbanization, and population aging. The increase of life expectancy and of the population with 60 years old and older accounted for a higher incidence of cancer in developing countries. More than 60% of cancer cases occur in Africa, Asia, Central America and South America, and 70% of cancer deaths worldwide occur in these regions. WHO (The Global Economic Burden of Non-communicable Diseases) estimated that these numbers may increase further yet because of lack of early detection and poor access to treatment.

In 2013, more than 190 thousand Brazilians died of cancer [2] and 596 thousand new cases are expected for 2016, including cases of non-melanoma skin [4]. The non-melanoma skin cancer (182 thousand new cases) is the most frequent in the Brazilian population, followed by prostate tumors (69 thousand), female breast cancer (57 thousand), colon and rectum (33 thousand), lung (27 thousand), stomach (20 thousand) and cervical uteri (15 thousand) [4].

The global economic cost of new cancer cases in 2009, including medical and non-medical costs, productivity losses, and the cost of cancer research, was estimated to be at least US\$286 billion [5]. The current health expenditure in Brazil is approximately 9.5% of the GDP per capita. WHO data show US \$ 1,085 spent in health per capita in 2013 in Brazil, 48.2% of these costs are government costs. The USA (United States of America) was the country with the highest health expenditure in the world, with annual spending of US\$ 9,146 per capita in the same period, representing 17.1% of the GDP [6].

### Introduction

Cancer is the leading cause of death worldwide, responsible for 8.2 million deaths in 2012 [1,2] with increasing numbers of new cases in the past years. There were 14 thousand new cases of cancer and 32.6 million people living with cancer in 2012 (within 5 years of diagnosis) [3]. Global life expectancy for both sexes increased from 65.3 in 1990 to 71.5 years in

The estimated economic impact of cancer in the Brazilian health system is a growing concern, especially nowadays with increased mortality and incidence of neoplasms in Brazil.

The aim of the study was to estimate the economic impact of cancer in the Brazilian health system from 2010 to 2015 and to evaluate this impact within the perspective of the Brazilian society—morbidity and mortality—public and private care. As the core data source, the Brazilian health system database was used.

## Methods

This is a descriptive study with retrospective data analysis.

### Source of data

Source of data included public available databases on hospital admissions (SIH-SUS – Unique Health System) and outpatient care (SIA-SUS) from the public health care system (SUS) [7], mortality [8], and social security (DATAPREV) [9]. Population data were taken from national database (IBGE) [10]. All data from public database cover the period from 2010 to 2015.

### Medical care

The number of public hospital admissions was obtained from the Hospital Information System (SIH-SUS) and include the admissions covered only by SUS.

The outpatient treatments (including radiotherapy and all types of chemotherapy) were obtained from outpatient information system (SIA-SUS) covered only by the public health care system (SUS). The number of medical visits per disease is not available. We used the number of medical visits from all diseases available in the system to estimate the number of medical visits in the public system. The rate applied was 6%. The number of cancer home visits was not included in this study.

Private data for cancer care are not available. To estimate the number of hospital admissions and the outpatient's treatments we used the distribution of hospital and outpatient coverage provided with open data by the National Supplementary Health Agency (ANS) each year [11].

### Costs and definition

Direct costs are defined as the direct health-care costs [12]. In the study herein, the costs for medical procedures and services associated with treatment and cancer care were included in the direct costs of the medical care, plus hospitalization costs, outpatient visits and prescription drugs.

Indirect costs are defined as the costs resulting from productivity losses due to morbidity and premature mortality. Morbidity costs are defined as the time and economic output lost or forgone by the patient from his/her usual activities and work because of cancer and its treatment [13,14]. Mortality costs, as the value of the goods and services that would have

been produced over the remaining lifetime by persons who died prematurely, are expressed as the present value of future productivity lost because of premature death [13].

The intangible or psychosocial costs of cancer include the pain and suffering from the disease and its treatment that affect health and well-being according to the Guidelines of Economic Evaluation of the Brazilian Ministry of Health [15]; these factors are not considered in this study.

The cancer costs were estimated based in the public funds assigned to the billing approved in the public system (SUS). Costs were calculated in Brazilian currency (BR R\$) from 2010 to 2015, and converted into International Dollar (US INT \$) from World Bank (Exchange rate BR R\$ per (INT US\$) = 1.4) data (Purchasing power parity conversion factor).

### Direct costs

The total cost cancer-related estimated for the public sector is the result of the sum of the hospitalization and outpatient care costs from SUS patients.

Cancer outpatient costs spent by the Brazilian government are not available. To estimate the direct costs with oncological pharmaceutical assistance, data from the government expenditure in the same period from all causes were obtained. The same percentage of the hospital admissions cancer-related (6% of overall expenditure) was assigned. This cost was similar to other national [16,17] and international studies [18-20].

### Indirect costs

We estimated lifetime disease burden using the years of life lost due to premature mortality (years of life lost {YLLs}) and to morbidity or disability, while alive (years lost due to disability {YLDs}).

The costs related to loss of productivity resulting from morbidity, disability and premature death were estimated using the human capital approach, which assumes that the monetary value of lost productivity equals the current wage.

Morbidity costs were obtained by multiplying days lost from work due to cancer by an average age and gender-specific daily wage. The number of days lost was calculated by adding the number of hospital in-patient days to half the number of outpatient visits.

The estimated mortality costs are the product of the number of deaths and the expected value of an individual's future earnings during the potential years of life lost, considering age and gender [21,22]. To estimate the mortality cost life-expectancy based on age and gender, employment rates and the appropriate discount rate to convert a stream of earnings into its present worth were adopted. To convert the stream of lifetime earnings into a present value, a 3% or 5% discount rate was used.

Per the human capital approach, the monetary value of lost productivity after 65 years of age becomes zero. However, it is inaccurate and unethical to place no economic value on a

person's life after age 65. Therefore, the average annual earnings of those between 60 and 64 years were used as a proxy for the economic value of the years remaining after 65 years. For a sensitivity analysis, the premature death costs were recalculated using 50% of the average annual earnings for ages 60–64 for the economic value of those aged over 65 years, instead of 100% [13,23].

### Forecast of the cost of cancer care in the next five years

The forecast of the cancer cost was calculated by the sum of all direct and indirect costs in public and private care in Brazil. The progression was based in the temporal series analysis with data from 2010 to 2015. The Autoregressive Integrated Moving Average (ARIMA) [24] was adopted. The estimated costs over the next five years was carried out based on the 2010-2015 time series from a model (ARIMA) with the dependent variable transformed by natural logarithm.

**Table 1** Population, number of deaths, admissions, outpatient's visits for cancer and health expenditure to cancer care, Brazil, 2010-2015.

Data/Year	2010	2011	2012	2013	2014	2015
Brazilian population	195,497,797	197,397,018	199,242,462	201,032,714	202,768,562	204,450,649
People older than 65 years	13,253,407	13,749,501	14,289,040	14,870,086	15,489,166	16,143,835
Number for deaths*	1,136,947	1,170,498	1,181,166	1,210,474	1,199,937	1,217,673
Numbers of deaths for cancer*	178,990	184,384	191,577	196,954	200,867	206,545
Public Admissions	11,357,965	11,281,571	11,092,589	11,197,160	11,320,287	11,357,491
Public Admissions for cancer	604,809	624,035	659,788	691,543	725,685	754,488
Public Outpatients Visits for cancer†	313,773,227	308,379,266	298,261,747	316,000,066	339,903,558	323,142,992
Coverage private rate assistance (%)	23.6	24	24.6	25.5	26	25.6
Estimated private admissions for cancer	186,826	197,064	215,262	236,703	254,970	259,609
Estimated private outpatient's visit for cancer	9,213,321	9,908,628	10,061,180	10,816,110	11,942,557	11,118,899

Source: IBGE, SIA/DATASUS e SIH/DATASUS

\*number of death in 2014 and 2015 was estimated using data from temporal series from 2008 through 2013 with ARIMA progressing model

†Estimated by the rate of total outpatient's visits in the public system (6%)

## Results

### Brazilian population profile and health expenditures

**Table 1** presents the Brazilian population, the percentage of people older than 65 years, the number of deaths and the number of cancer deaths. Cancer public admissions and the number of cancer outpatient visits care were taken from the public health system, and are included in **Table 1**. The number of admissions and outpatient's visits using the coverage private rate assistance was estimated for each year. In 2010, the Brazilian population reached 199,242,462 people and in 2015, 204,450,649 (5% rise in the period). People older than 65 years were 14,289,462 in 2010 and 16,143,835 in 2015, a growth of 22%. The number of cancer deaths was 16% of the total death from diseases in Brazil in this period.

Cancer admissions increased 125% in the period (from 659,788 to 754,488 in the public system and from 215,262 to 259,609 in the private system). Outpatient visits attributed to

cancer care were 10,061,080 in 2010 and 11,118,899 in 2015 (8% growth).

The medical care cost is shown in **Table 2**. Public direct costs from admissions and outpatient's visits were US INT\$ 3.8 billion in 2010 and increased to US\$ INT 4.8 billion in 2015. Brazil spent US INT\$ 439,293,112 in 2010 and US INT\$ 571,328,769 with prescription drugs in the public system. There was a 26% increase in direct costs in the period (from US INT \$ 9,538,319,392 in 2010 to US INT \$ 12,031,303,533 in 2015).

**Table 2** Direct costs of cancer (US INT \$), Brazil, 2010-2015.

Data/Year	2010	2011	2012	2013	2014	2015
Public direct costs (admissions and outpatient)	3,852,950,614	4,128,832,692	4,193,930,263	4,603,129,132	4,966,081,355	4,842,757,821
Public prescription drugs	439,293,112	455,326,335	547,960,211	525,577,122	586,874,061	571,328,769
Private expenditure on health (%)	54	55	56	55	54	55
Private estimated direct costs	4,709,161,861	5,046,351,068	5,125,914,766	5,626,046,716	6,069,654,990	5,918,926,225
Private prescription drugs	536,913,804	556,509,965	669,729,146	642,372,038	717,290,519	698,290,718
Total direct costs	9,538,319,392	10,187,020,060	10,537,534,385	11,397,125,008	12,339,900,925	12,031,303,533
Direct costs per person (\$)	9,366	10,003	9,764	10,560	10,282	10,025

Source: SIA/DATASUS, SIH/DATASUS, Spending from Brazil's government site and WHO

Cancer-related retirement and disability benefits are shown in **Table 3**. In Brazil, these expenditures are higher than with retirement. The Brazilian government spent approximately US INT \$ 8.2 million in 2010 and US INT \$ 12.9 million in 2015. Cancer disability benefits were responsible for approximately US NT \$ 73.4 million in 2010 and US INT \$ 131.5 in 2015.

**Table 3** Retirement and disability benefits by cancer (US INT \$), Brazil, 2010-2015.

Data/Year	2010	2011	2012	2013	2014	2015
Retirement spending's	8,205,725	9,178,770	10,062,525	11,655,770	12,053,762	12,942,432
Disability benefits spending's	73,431,201	82,325,271	97,913,626	111,852,999	120,192,054	131,528,740
Total spending's	81,636,927	91,504,042	107,976,152	123,508,769	132,245,816	144,471,173

Source: DATAPREV

The morbidity costs of cancer, defined as the value of lost earnings and the opportunity cost of lost productivity among currently employed persons are shown in **Table 4**. The number of admissions and outpatient visits were used to calculate the absenteeism. The morbidity cost of cancer was US INT \$ 8,250,748,246 in 2010 and US INT \$ 10,387,578,042 in 2015.

**Table 4** Morbidity and mortality costs by cancer, Brazil, 2010-2015.

Data/Year	2010	2011	2012	2013	2014	2015
Number of male admissions	242,245	254,860	269,417	285,322	297,996	315,280
Number of female admissions	362,564	369,175	390,371	406,221	427,689	440,005
Average length of staying	5.7	5.6	5.5	5.5	5.4	5.4

Absenteeism, male (admissions)	1,380, 797	1,427, 216	1,481, 794	1,569, 271	1,609, 178	1,702, 512
Absenteeism, female (admissions)	2,066, 615	2,067, 380	2,147, 041	2,234, 216	2,309, 521	2,376, 027
Number of outpatient visits	298,261, 747	313,773, 227	308,379, 266	316,000, 066	339,903, 558	323,142,992
Average male salary	\$994	\$957	\$1,021	\$1,100	\$1,189	\$1,151
Average female salary	\$702	\$543	\$588	\$644	\$714	\$639
Morbidity cost of male by absenteeism in admissions	\$45,730, 336	\$45,534, 987	\$50,451, 541	\$57,539, 937	\$63,754,116	\$65,318, 890
Morbidity cost of female by absenteeism in admissions	\$48,386,833	\$37,458, 957	\$42,122, 890	\$47,982, 438	\$54,988, 586	\$50,643, 318
Morbidity cost of absenteeism in outpatient care	\$4,215, 361,671	\$3,924, 330,033	\$4,137, 421,816	\$4,593, 286,668	\$5,389, 899,277	\$4,821, 293,447
Morbidity cost of care	\$4,309, 478,840	\$4,007, 026,976	\$4,229, 996,247	\$4,698, 809,042	\$5,508, 641,978	\$4,937, 254,854
Price of bus ticket	\$1.67	\$1.67	\$1.74	\$1.9	\$1.9	\$2.16
Transportation cost of care	\$1,994, 092,820	\$2,097, 798,145	\$2,149, 844,024	\$2,400, 558,740	\$2,582, 146,480	\$2,791,103,209
Public morbidity cost	\$6,303, 571,660	\$6,104, 825,12	\$6,379, 840,27	\$7,099, 367,78	\$8,090, 788,458	\$7,728,358,063
Coverage private rate assistance (%)	24	24	25	26	26	26
Overall Morbidity Cost	\$8,250, 748,246	\$8,032, 664,633	\$8,461, 326,619	\$9,529, 352,728	\$10,933, 497,916	\$10,387, 578,042
YLL, male	1648346	1692340	1718265	1815967	1810314	1814562
YLL, female	1418614	1485474	1508988	1582710	1577039	1581984
Mortality Cost	\$31,610, 195,445	\$29,127, 267,284	\$31,718,779,982	\$36,207, 376,284	\$39,337, 717,890	\$37,200,903,018
Source: SIA/DATASUS, SIH-DATASUS, SIM, PME/IBGE						

Premature mortality from cancer significantly affects the productive capacity of the economy. The years of life lost (YLL) to cancer was used to estimate the mortality costs in Brazil in the period. The YLL in male are higher than in female. From 2010 to 2015, 19.6 million years of life were lost to cancer (10.5 million in male and 9.1 million in female). The mortality cost in 2010 was US INT \$31.6 billion and 37.2 billion in 2015 (Table 4).

The total economic cost of cancer, including all cost components, was estimated to be US INT \$49.5 billion in Brazil

in 2010 and US INT \$59.7 billion in 2015, which represents the average of 1.7% of the GPD in the period (Table 5). The cost per person and the mortality cost per death are showed in Table 5. Direct costs comprised 20% of total costs, morbidity costs 17%, and mortality costs 63%. The direct costs raised 26% in the period, the morbidity costs, 48% and mortality costs, 18%.

**Table 5** Total costs by cancer (US INT \$), Brazil, 2010-2015.

Data / Year	2010	2011	2012	2013	2014	2015
Direct costs (\$)	9,538,319, 391	10,187,020, 060	10,537,534, 386	11,397,125,008	12,339,900,925	12,031,303,533

Direct costs per person (\$)	9,366	10,003	9,764	10,560	10,282	10,025
Morbidity costs (\$)	8,250,748, 246	8,032,664, 633	8,461,326, 619	9,529,352,728	10,933,497,916	10,387,578,042
Morbidity costs per person (\$)	8,102	7,887	7,840	8,829	9,110	8,655
Mortality costs (\$)	31,610,195, 445	39,127,267, 284	31,718,779, 982	36,207, 376,284	39,337,717,890	37,200,903,018
Mortality costs per death (\$)	176,603	157,971	165,567	183,837	195,840	180,110
Retirement and disability benefits costs (\$)	81,636,927	91,504,042	107,976,152	123,508, 769	132,245, 816	144,471, 173
Total cost of cancer (\$)	49,480,900,009	47,438,456, 018	50,825,617,139	57,257,362,789	62,743,362,546	59,764,255,765
Total cost of cancer per person (\$)	48,586	46,581	47,092	53,052	52,280	49,797
Total cost of cancer per capita (\$)	253.10	240.32	255.09	284.82	309.43	292.32
% GDP with cancer	1.88%	1.60%	1.62%	1.89%	1.82%	1.62%

Source: calculated by the author

The forecast of the cost of cancer used the total amount of public and private care costs in Brazil. The progression was based in the temporal series analysis with data from 2010 to 2015, using ARIMA model. After adjustment of the model, the linear progression was made with natural log. The stationary R2 was significant (0.860).

The observed cost of cancer in Brazil from 2010 to 2015 is shown in **Figure 1**. The values were used to estimate cost of cancer in Brazil from 2016 to 2020, showed in black. The dot lines depict the confidence interval (upper and lower). The predicted total cost of cancer in Brazil is rising exponentially and will reach nearly US INT \$ 81 billion in 2020.

## Discussion

This is the first study that evaluated the direct and indirect costs of cancer under the perspective of the Brazilian society. Health expenditures in Brazil are estimated at 9.5% of GDP and the average cost with cancer was estimated at 1.7% of GDP per year, reaching almost US\$ 60 billion in 2015. Direct costs account for 20% of total costs of cancer in Brazil, morbidity costs, 17%, and mortality costs, 63% which means that cancer imposes a high corporate burden for the society.

The cost of cancer per person found in this study is similar to the cost of cancer in South Korea. Kim SG et al. published an important study that estimated the cost of cancer in the country in 2002. To compare this study with the results found in 2010 we converted the cost of cancer in Korea to the present value in 2010, using a 5% discount rate.

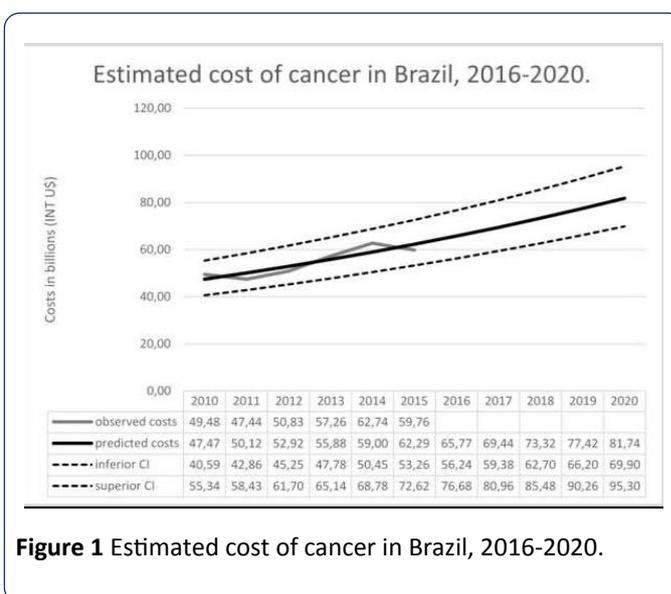


Figure 1 Estimated cost of cancer in Brazil, 2016-2020.

To estimate the burden of cancer in Brazil in the decade (from the beginning of 2010 through the end of 2020), the present value from 2010 through 2015 and the future value from 2016 through 2020 were used (discount rate of 5%). The present value found was US INT \$368.4 billion and the future value is US INT \$211.6 billion. The predicted impact of cancer in Brazil in this decade is US INT \$580 billion, higher than the GPD of Switzerland in 2015 (US INT \$501.6 billion).

The cost of cancer per person in Korea in 2002 was US INT \$ 30,195. Converting to the present value in 2010, the cost

would be US INT \$ 51,539. In Brazil, the cost per person in the same year was US INT \$ 45,846. Direct cost in Korea was 20% of the total, morbidity cost, 15% and mortality cost, 65%. In 2015, Kim SY et al. published a study that estimated the cost of cancer in 2009 that shows an important rise in direct cost. In that study, the mortality cost has constituted the overwhelming majority of the total productivity loss [25].

Premature deaths caused by cancer are one of the priorities to be discussed in Brazil. The cost of mortality due to the years of life lost (YLL) because of cancer are one of the highest compared to other countries [26], estimated the cost of cancer in USA at 2009 and in this study the mortality cost represents 35% of the total cost. Luengo-Fernandez et al. [27] estimated the economic burden of cancer across the European Union (EU) in 2008. Per this study, the mortality cost in EU was 41% of the total cost of cancer in 2008, and in United Kingdom it was 51%. Only Korea has a similar scenario in the year of 2002 (65% of the total cost) [13,24].

According to the World Bank (World Bank Group, 2016), in 2010 health costs represented 17.02% in USA, 10.2% in EU, 9.51% in UK, 8.27% in Brazil and 6.79% in South Korea. The present value spent with cancer in 2010 using a discount rate of 5% was estimated to compare the cost of cancer in different regions and studies. USA is the country with the highest percentage of GDP with cancer-related expenditure (2.58%), followed by Korea (1.27%), EU (0.94%) and UK (0.78%). In this study, Brazil spent 1.88% of GDP with cancer in 2010.

Because cost data comes from approved billing in the public database, most likely the cost is underestimated. This occurs in Brazil because the government has a budgeted cap in each state or municipality, so when the cost reaches the settled ceiling the billing is rejected. For this reason, the estimated cost of cancer in this study is considered conservative.

The oncological market information in Brazil is not available in public database. However, to overcome this limitation, national and international studies that showed that the oncological market is 6.7% of the total cost in the pharmaceutical arsenal were used [17].

Finally, to calculate the economic losses due to morbidity and mortality, we used the human capital approach. This method undervalues some groups, such as children and retired.

Although there is considerable variation in methodology and cost of illness (COI) analyses, a systematic COI study can provide valuable data for the relative socioeconomic burden of the disease [13,28].

Despite these acknowledged and data limitations, this is the first study to quantify the economic burden of cancer in Brazil using public database [29-31]. The economic burden is considerable and indicates a need for increased prevention, earlier diagnosis and cancer control policies in Brazil [32-35].

## Conclusion

More than 60% of cancer cases occur in Africa, Asia, Central America and South America, and 70% of cancer deaths worldwide occur in these regions. Cancer costs have increased significantly over the past five years and will increase until 2020. Costs of cancer have sharply increased significantly in this decade, specially attributed to premature deaths mortality.

## Ethical Statement

This research was made with public database, not requiring ethical statement.

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