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# Magnitude and variation of the burden of cancer mortality in Brazil and Federation Units, 1990 and 2015

## *Magnitude e variação da carga da mortalidade por câncer no Brasil e Unidades da Federação, 1990 e 2015*

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**ABSTRACT:** ***Objective:*** To analyze the mortality rates from malignant neoplasia in Brazil and Federal Units (FU) in the years 1990 and 2015, according to sex and main types of cancer. ***Methods:*** Using estimates of global disease burden for Brazil made by the GBD 2015 study, age-adjusted cancer mortality rates and respective 95% uncertainty intervals were calculated for Brazil and FU in 1990 and 2015, as well as their percentage variation in the period. The main causes of cancer mortality by sex were analyzed, considering the five highest rates in the country and for each state. ***Results:*** The cancer mortality rate for male and female population remained stable between the two years in the country. The same behavior pattern was observed in almost all the FU, and the majority of states in the northeast region and half of the north region showed a non-significant increase in mortality rates. Regarding the types of cancer, there was a drop in mortality rates for stomach cancers in both sexes (women: -38.9%, men: -37.3%), cervical cancer in women (-33.9%), and lung and esophagus cancer in men (-12.0% and -14.1%, respectively); in contrast, there was an increase in lung cancers in women (+20.7%) and colon and rectum cancers in men (+29.5%). ***Conclusion:*** Differences in the behavior of major cancers, with a decrease mainly in the more developed regions and an increase in the less developed regions of the country, seem to reflect the socioeconomic inequalities as well as difficulties in access to health services by the Brazilian population.

***Keywords:*** Mortality rate. Neoplasms. Temporal distribution. Brazil. Health Evaluation.

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**RESUMO:** ***Objetivo:*** Analisar as taxas de mortalidade por neoplasia maligna no Brasil e nas Unidades da Federação (UF) nos anos de 1990 e 2015, segundo o sexo e principais tipos de câncer. ***Métodos:*** Com as estimativas de carga global de doença para o Brasil, foram calculadas taxas de mortalidade por câncer, ajustadas por idade e respectivos intervalos de incerteza de 95%, para o Brasil e UF, em 1990 e 2015, bem como a variação percentual dessas no período. Foram analisadas as principais causas de mortalidade por câncer segundo sexo, considerando as cinco taxas mais elevadas no país e para cada estado. ***Resultados:*** A taxa de mortalidade por câncer para homens e mulheres manteve-se estável entre os dois anos no país. O mesmo padrão de comportamento foi observado em praticamente todas as UF, sendo que a maioria dos estados da região Nordeste e metade da região Norte exibiram aumento não significativo das taxas de mortalidade. Em relação aos tipos, houve queda nas taxas de mortalidade para os cânceres de estômago em ambos os sexos (mulheres: -38,9%; homens: -37,3%), colo do útero em mulheres (-33,9%), e pulmão e esôfago em homens (-12,0% e -14,1%, respectivamente); em contrapartida, houve aumento para os cânceres de pulmão em mulheres (+20,7%) e de cólon e reto em homens (+29,5%). ***Conclusão:*** As diferenças de comportamento dos principais tipos de câncer, com queda principalmente nas regiões mais desenvolvidas e aumento nas regiões menos desenvolvidas do país, parecem refletir as desigualdades tanto socioeconômicas quanto de acesso aos serviços de saúde pela população brasileira.

***Palavras-chave:*** Taxa de mortalidade. Neoplasia maligna. Distribuição temporal. Brasil. Avaliação em saúde.

## INTRODUCTION

The number of new cancers has generally increased worldwide between 1990 and 2013, although there are important differences between countries and cancers types. This situation highlights the need to structure health systems, especially in developing/underdeveloped countries, to handle the high costs associated with the diagnostic and therapeutic procedures inherent to the disease[1]. In low- and middle-income countries, chronic noncommunicable diseases, including cancer, are outpacing infectious diseases in the use of health care services[2]. Although the incidence of cancer is still higher in the more developed countries, mortality has been proportionally higher in developing countries, a disparity that primarily reflects differences in disease profiles and in the access to diagnosis and treatment[3]. It is estimated that malignant neoplasms will represent the major cause of morbidity and mortality in the coming decades in all regions of the world, surpassing cardiovascular diseases regardless of their level of development[4].

Although Latin America has an overall lower cancer incidence than Europe and the United States, it has a higher mortality burden, which is mainly related to diagnosis in later stages and partially to the difficulty of access to treatment[2]. In addition, in Central and South America, there is a double burden of cancer in many countries, which is represented by high rates of both infection-related and lifestyle-related cancers, with significant differences according to the level of human development among countries and within regions, and also according to gender[5].

In Brazil, analysis of the corrected trend of general cancer mortality and major cancer types in capitals and other municipalities between 1980 and 2006 showed that although the magnitude of cancer mortality rates in the country is generally lower than that of developed countries, the total trends and those for the main types do not indicate a reduction. Exceptions are stomach and cervix cancers, which show declining rates, but which are considered high in relation to those of other countries[6]. Analysis of the trend of cancer mortality in Brazil and geographic regions between 1996 and 2010 revealed a considerable difference in the pattern of deaths between the regions of the country and between the sexes, with a significant trend of increase throughout the historical series. However, for 2011 to 2030, a trend of increase in cancer mortality was estimated only for the north and northeast regions, and stability and/or decrease for other regions[7].

Since 1990, the Global Burden of Disease (GBD) study has grown in importance in monitoring the burden of disease in different countries[8]. Global measures for a broad set of countries began with GBD 2000. By 2015, all databases were updated, allowing the analysis of information from 1990 to 2015 to more than 190 countries in the world, including Brazil and the 27 Federative Units (FU), on 249 causes of death, injuries, and sequelae, as well as the burden attributable to the risk factors for 20 age groups and both sexes[9].

This study used data from GBD 2015 and aimed to analyze the cancer mortality rates in Brazil and FU, in 1990 and 2015, according to sex and main types, describing the magnitude of the variation of mortality in the period.

## METHODS

A descriptive study was carried out based on the estimates of global disease burden for Brazil made by the GBD 2015 study, coordinated by the Institute for Health Metrics and Evaluation (IHME). In the mortality analysis, deaths by cancer from the Mortality Information System (SIM) of the Brazilian Ministry of Health were used, with adjustment for under-registration of deaths and declaration of ill-defined/nonspecific causes, called garbage codes[9].

The standardized analysis methodology adopted by the GBD makes it possible to compare countries, regions, and subnational data, and it is also possible to analyze the trends, as the time series data are adjusted and comparable[10,11]. To classify the specific causes of death, the GBD 2015 study uses a list of 249 causes of death, within a four-level hierarchy. For all metrics, uncertainty intervals are calculated at 95% (95%UI), which provide information on the variability of estimates resulting from errors due to the sampling process and from non-sample errors due to adjustments of data sources and modeling[9].

In this study, cancer mortality rates per 100,000 inhabitants, adjusted for age and with their respective 95%UI for Brazil and FU, were estimated for 1990 and 2015, as well as their percentage variation between the two years. The main causes of cancer mortality by sex

were analyzed, considering the five highest rates in the country and for each state. State rates, stratified by gender, were grouped in quintiles and presented on maps to allow spatial visualization of the distribution of cancer deaths in the national territory, in general and for the two most important types in men and women.

This study was approved by the Research Ethics Committee of Universidade Federal de Minas Gerais (CAAE no. 62803316.7.0000.5149).

## RESULTS

In Brazil, malignant neoplasms were responsible for 105,275 deaths in 1990 and 236,345 deaths in 2015, corresponding to 11.6% and 17.4% of the total estimated deaths, respectively. For both sexes, mortality rates showed stability (non-expressive decline) from 1990 to 2015 (Tables 1 and 2).

Among women, breast cancer had the highest mortality rate in 2015, followed by lung, colon and rectum, cervix, and stomach cancers. Among men, the main one was prostate cancer, followed by lung, stomach, colon and rectum, and esophagus cancers. However, the analysis of the five main disaggregated locations by state presented a different pattern. For female population, cervical cancer had the highest mortality rate in some states of the north (Amazonas, Para, Amapá and Tocantins) and northeast (Maranhão and Piauí) regions, while breast cancer was the main cause in all the states of the south, southeast, center-west (except Goiás, which occupies the second position), and northeast regions (except Maranhão and Piauí). In men, prostate cancer had the highest mortality rates in almost all states except Amapá, Santa Catarina, and Rio Grande do Sul (Tables 1 and 2).

With regard to the significant changes in mortality due to the main types of cancer between the two years in the country, there was a drop in mortality rates for stomach cancers in both sexes (women: -38.9%, men: -37, 3%), cervix cancer in women (-33.9%), and lung and esophagus cancer in men (-12.0% and -14.1%, respectively). In contrast, there was an increase for lung cancers in women (+20.7%) and colon and rectum cancers in men (+29.5%). Figures 1 and 2 show the distribution of cancer deaths in the national territory, in the years 1990 and 2015, in general and for the two most important types in women (breast and lung) and in men (prostate and lung).

Breast cancer had the highest rates of mortality due to neoplasms in women in Brazil, both in 1990 (16.4) and in 2015 (16.3), with stability in rates between the two years, which was also observed in all states. Although not expressive, all states of the north and northeast regions showed a percentage increase in the period, with the highest increases seen in Amapá, Piauí and Acre. São Paulo, Rio Grande do Sul, Federal District and Rio de Janeiro showed the highest reductions, also not expressive. The highest mortality rates in 2015 were observed in Rio de Janeiro, Rio Grande do Sul, and São Paulo (Figure 1B).

Table 1. Standardized mortality rates/100,0000 inhabitants (Brazil and FU) 2015 and percentage variation from 1990 to 2015 for five main types of cancers, women.

| FU | Women | | | | | |
|---|---|---|---|---|---|---|
| | All | Breast | Lung | Colon/Rectum | Cervix | Stomach |
| BR | 106.8 (-7.5) | 16.3 (-0.5) | 12.8 (+20.7) | 11.1 (+12.5) | 9.6 (-33.9) | 7.0 (-38.9) |
| RO | 93.5 (-15.9) | 10.8 (+1.4) | 13.3 (+15.8) | 6.5 (+6.3) | 11.6 (-38.5) | 7.9 (-41.1) |
| AC | 102.6 (+7.7) | 11.5 (+27.2) | 17.2 (+44.1) | 6.7 (+34.2) | 15.6 (-19.5) | 7.6 (-25.2) |
| AM | 132.3 (-0.6) | 14.0 (+18.2) | 18.4 (+30.0) | 9.5 (+20.0) | 26.2 (-13.0) | 12.2 (-27.7) |
| RR | 103.5 (-9.3) | 14.1 (+2.0) | 16.0 (+18.1) | 5.7 (+17.8) | 15.1 (-34.7) | 6.6 (-35.9) |
| PA | 101.3 (-4.8) | 12.3 (+14.0) | 11.2 (+26.9) | 8.0 (+17.4) | 16.9 (-28.8) | 10.3 (-28.4) |
| AP | 119.2 (+2.0) | 9.3 (+30.9) | 14.1 (+38.2) | 5.9 (+42.8) | 22.6 (-22.3) | 13.6 (-24.6) |
| TO | 98.0 (+2.9) | 11.9 (+25.9) | 10.6 (+30.7) | 7.3 (+35.4) | 14.5 (-21.8) | 6.3 (-20.5) |
| MA | 107.8 (+5.2) | 12.5 (+25.7) | 10.9 (+36.1) | 7.4 (+21.2) | 23.1 (-11.1) | 6.8 (-13.6) |
| PI | 93.5 (+3.2) | 13.2 (+27.5) | 9.4 (+36.2) | 6.6 (+17.4) | 13.6 (-22.1) | 5.2 (-19.2) |
| CE | 115.6 (+15.2) | 16.7 (+23.9) | 15.6 (+62.9) | 8.1 (+43.2) | 12.4 (-12.5) | 9.5 (-14.4) |
| RN | 99.5 (+3.9) | 14.0 (+10.4) | 12.0 (+56.2) | 7.6 (+18.7) | 10.4 (-31.6) | 7.1 (-24.0) |
| PB | 99.6 (+13.4) | 14.8 (+21.5) | 10.8 (+48.3) | 7.0 (+23.0) | 10.8 (-15.8) | 7.3 (-2.1) |
| PE | 104.5 (-0.1) | 16.5 (+9.9) | 11.1 (+36.8) | 8.3 (+17.5) | 11.2 (-31.1) | 6.0 (-21.4) |
| AL | 88.6 (-7.8) | 12.9 (+12.3) | 10.3 (+21.8) | 6.8 (+14.0) | 12.4 (-33.3) | 4.9 (-30.7) |
| SE | 98.6 (-0.3) | 15.4 (+21.3) | 10.6 (+25.1) | 7.7 (+18.9) | 12.3 (-29.5) | 5.4 (-23.6) |
| BA | 102.7 (+3.4) | 15.1 (+14.3) | 10.0 (+44.6) | 9.4 (+18.0) | 11.0 (-23.4) | 7.5 (-24.3) |
| MG | 102.2 (-11.8) | 15.0 (-0.3) | 11.3 (+9.0) | 10.4 (+13.3) | 7.9 (-39.7) | 7.1 (-46.9) |
| ES | 98.5 (-11.4) | 14.3 (+5.7) | 10.8 (+8.1) | 10.0 (+9.1) | 9.0 (-38.7) | 7.2 (-44.6) |
| RJ | 111.2 (-11.2) | 20.4 (-7.2) | 12.8 (+9.8) | 13.2 (+7.6) | 8.7 (-32.8) | 7.0 (-40.5) |
| SP | 105.4 (-13.3) | 17.2 (-9.4) | 12.7 (+12.2) | 13.4 (+11.6) | 6.5 (-45.9) | 6.6 (-49.0) |
| PR | 113.5 (-9.3) | 16.2 (+4.6) | 14.4 (+15.8) | 12.2 (+15.9) | 8.3 (-41.2) | 7.8 (-46.8) |
| SC | 108.5 (-10.2) | 15.9 (+0.1) | 14.0 (+17.8) | 10.7 (+2.6) | 7.9 (-38.2) | 7.5 (-44.8) |
| RS | 122.3 (-12.2) | 18.6 (-9.2) | 18.3 (+20.2) | 13.5(-4.9) | 7.9(-41.5) | 6.1(-43.4) |
| MS | 102.4 (-9.1) | 14.7 (+4.8) | 13.0 (+18.1) | 10.2 (+15.7) | 11.1 (-38.5) | 6.6 (-38.6) |
| MT | 100.7 (-4.1) | 13.8 (+16.1) | 13.1 (+18.2) | 8.9 (+19.7) | 11.8 (-32.1) | 6.6 (-32.3) |
| GO | 99.6(-13.0) | 13.6 (+3.3) | 13.9 (+10.8) | 10.2 (+8.8) | 9.6 (-44.8) | 5.9 (-42.0) |
| DF | 97.2(-20.8) | 15.4 (-8.5) | 10.7 (+0.2) | 11.1 (+3.2) | 7.2 (-51.0) | 5.2 (-48.5) |

Note: percentage variation 1990 and 2015 in parenthesis; BR: Brazil; FU in acronyms.

Table 2. Standardized mortality rates/100,0000 inhabitants (Brazil and FU) 2015 and percentage variation from 1990 to 2015 for five main types of cancers, men.

| UF | Men | | | | | |
|---|---|---|---|---|---|---|
| | All | Breast | Lung | Colon/Rectum | Cervix | Stomach |
| BR | 172.1 (-5.6) | 33.4 (+12.2) | 25.9 (-12.0) | 19.5 (-37.3) | 14.1 (+29.5) | 10.5 (-14.1) |
| RO | 149.9 (-13.3) | 32.8 (+8.4) | 21.9 (-7.5) | 22.1 (-42.8) | 8.1 (+15.2) | 8.3 (-15.8) |
| AC | 153.9 (+3.7) | 32.5 (+25.8) | 24.0 (+6.0) | 23.0 (-22.2) | 8.8 (+33.5) | 5.6 (-0.3) |
| AM | 184.5 (+1.0) | 33.9 (+17.7) | 33.5 (-8.1) | 31.6 (-18.1) | 9.7 (+31.7) | 6.2 (-1.1) |
| RR | 157.6 (-5.5) | 37.4 (+14.0) | 23.2 (-12.3) | 23.5 (-36.0) | 7.4 (+35.1) | 5.7 (-8.0) |
| PA | 148.3 (+0.2) | 31.4 (+26.5) | 23.2 (-8.5) | 26.3 (-26.7) | 8.7 (+32.9) | 4.9 (-4.4) |
| AP | 175.4 (+10.6) | 34.0 (+36.6) | 28.6 (+8.6) | 38.6 (-17.1) | 7.7 (+61.9) | 5.8 (+19.5) |
| TO | 141.1 (+17.9) | 38.5 (+41.8) | 18.2 (+20.5) | 13.5 (-23.4) | 9.0 (+63.1) | 5.7 (+15.0) |
| MA | 136.3 (-16.2) | 32.8 (-0.1) | 18.6 (-18.9) | 18.0 (-42.8) | 8.0 (-0.7) | 4.1 (-18.0) |
| PI | 138.2 (+16.8) | 33.3 (+26.0) | 19.6 (+18.1) | 13.0 (-13.0) | 8.8 (+51.0) | 6.4 (+22.7) |
| CE | 185.7 (+34.6) | 36.8 (+41.5) | 26.4 (+55.2) | 28.6 (-1.4) | 11.1 (+84.9) | 11.6 (+55.6) |
| RN | 164.5 (+28.0) | 34.9 (+40.9) | 21.1 (+36.1) | 22.8 (-2.5) | 10.2 (+53.4) | 8.7 (+40.8) |
| PB | 162.1 (+40.9) | 35.0 (+45.0) | 19.5 (+54.1) | 21.3 (+14.0) | 9.5 (+66.5) | 9.4 (+47.3) |
| PE | 152.1 (+17.1) | 34.8 (+26.8) | 20.8 (+16.7) | 15.8 (-4.5) | 8.8 (+48.3) | 7.5 (+21.8) |
| AL | 125.6 (+6.9) | 29.3 (+22.4) | 15.8 (-3.2) | 13.6 (-18.5) | 8.2 (+40.0) | 5.9 (+7.6) |
| SE | 152.0 (+15.0) | 38.4 (+38.5) | 21.1 (+6.0) | 14.5 (-12.2) | 10.0 (+47.1) | 6.1 (+11.8) |
| BA | 162.6 (+19.7) | 38.7 (+40.9) | 19.1 (+12.6) | 18.7 (-13.8) | 11.2 (+44.2) | 10.0 (+27.3) |
| MG | 167.0 (-8.0) | 32.3 (+9.8) | 21.8 (-8.7) | 20.4 (-43.9) | 12.6 (+31.8) | 13.4 (-14.5) |
| ES | 168.1 (-8.5) | 31.9 (+14.0) | 23.9 (-11.6) | 20.5 (-46.5) | 11.6 (+27.3) | 14.4 (-9.1) |
| RJ | 176.0 (-16.6) | 34.2 (+2.9) | 28.5 (-31.2) | 17.8 (-44.2) | 17.5 (+17.0) | 9.0 (-23.3) |
| SP | 173.4 (-17.4) | 31.1 (-0.9) | 25.1 (-24.5) | 18.6 (-50.0) | 17.9 (+22.5) | 9.8 (-27.1) |
| PR | 190.2 (-7.4) | 34.0 (+14.6) | 27.2 (-4.9) | 21.7 (-44.7) | 16.4 (+30.1) | 13.9 (-25.5) |
| SC | 195.0 (-13.2) | 31.0 (+2.8) | 36.7 (-10.8) | 21.4 (-43.7) | 14.0 (+13.7) | 14.2 (-30.6) |
| RS | 216.1 (-18.2) | 34.4 (-5.1) | 46.2 (-26.8) | 17.2 (-44.7) | 18.3 (+6.2) | 16.7 (-32.0) |
| MS | 167.2 (+3.3) | 34.8 (+19.5) | 24.8 (+3.0) | 18.7 (-36.3) | 13.7 (+50.1) | 10.6 (+3.1) |
| MT | 164.9 (-1.4) | 36.9 (+16.4) | 25.1 (+3.4) | 19.5 (-42.6) | 11.3 (+33.0) | 9.6 (+0.5) |
| GO | 155.6 (-4.9) | 33.3 (+9.3) | 24.0 (-3.9) | 15.7 (-40.5) | 12.0 (+25.0) | 8.1 (-12.7) |
| DF | 156.6 (-12.2) | 33.2 (+0.6) | 23.4 (-16.1) | 14.9 (-43.5) | 14.0 (+25.9) | 7.5 (-18.4) |

Note: percentage variation 1990 and 2015 in parenthesis; BR: Brazil; FU in acronyms.

Mortality due to cervical cancer, the fourth cause of death due to cancer in women in 2015, showed a marked reduction in Brazil from 1990 to 2015 (-33.9%), and also in Rondônia, Roraima, Alagoas, in all states in the south and southeast regions and in almost all states of the Midwest. The highest mortality rates in 2015 were observed in the north and northeast regions, especially in Amazonas.

The mortality rate for prostate cancer showed stability from 1990 to 2015 in Brazil, with the same pattern of behavior in all states. In 2015, rates were similar among states, with higher values in Bahia, Tocantins, Sergipe, and Roraima (Figure 2B).

Lung cancer, the second leading cause of cancer deaths in 2015 for both sexes, had a higher mortality rate in men than in women. The highest rates were observed in Rio Grande do Sul, Santa Catarina, and Amazonas for men, and in Amazonas, Rio Grande do Sul, and Acre for women. Although there was a marked reduction in mortality from 1990 to 2015 in men in Brazil (-12.0%) and in the states of Rio de Janeiro, Rio Grande do Sul, and São Paulo, there was a marked increase in Ceará and Paraíba; whereas in women, there was an increase in the country and in the states of Ceará, Rio Grande do Norte, and Bahia (Figure 1C and Figure 2C).

Colon and rectum cancer, the third cause of death in women and the fourth in men in 2015, had higher mortality rates in men and in the states of the south and southeast regions. There was a sharp increase in mortality from 1990 to 2015 in men in Brazil (+29.5%) and in almost all states of the northeast region, in Amapá and Mato Grosso do Sul, with the highest increase in Ceará. In women, there was stability in Brazil and in all states.

Mortality from stomach cancer, the third cause of cancer death in men and fifth in women in 2015, showed a significant reduction in the country from 1990 to 2015 by sex (-38.9% for women and -37.3% for men). The same pattern was observed in all states of the southeast, south, and center-west regions in people of both sexes, with the highest drop observed in São Paulo. The highest mortality rates in 2015 were observed in the states of the north region and Ceará.

Mortality from esophageal cancer, fifth cause of death in men in the country, in 2015, showed a significant reduction from 1990 to 2015 in men (-14.1%). The same pattern was observed in Rio de Janeiro, São Paulo, Santa Catarina, and Rio Grande do Sul. In contrast, Ceará and Paraíba presented an expressive increase.

The percentage contribution of the various types of cancer to mortality in Brazil in 2015, by age group, is presented in Figure 3. Leukemias, brain tumors (CNS), non-Hodgkin's lymphomas, renal tumors, Hodgkin's lymphoma, and the group of "other neoplasms" were responsible for most childhood tumors (0–15 years of age), in addition to nasopharyngeal and thyroid tumors in the population aged 5–14 years. In the age group of 15–49 years, tumors of the breast, cervix, "other neoplasias", colorectal, lung, and CNS were responsible for the greater number of deaths. From 50–69 years of age, the main neoplasms responsible for mortality were lung, stomach, colorectal, breast, and esophagus, whereas for the group >70 years of age were neoplasms of prostate, lung, colorectal, stomach, pancreas, and breast.

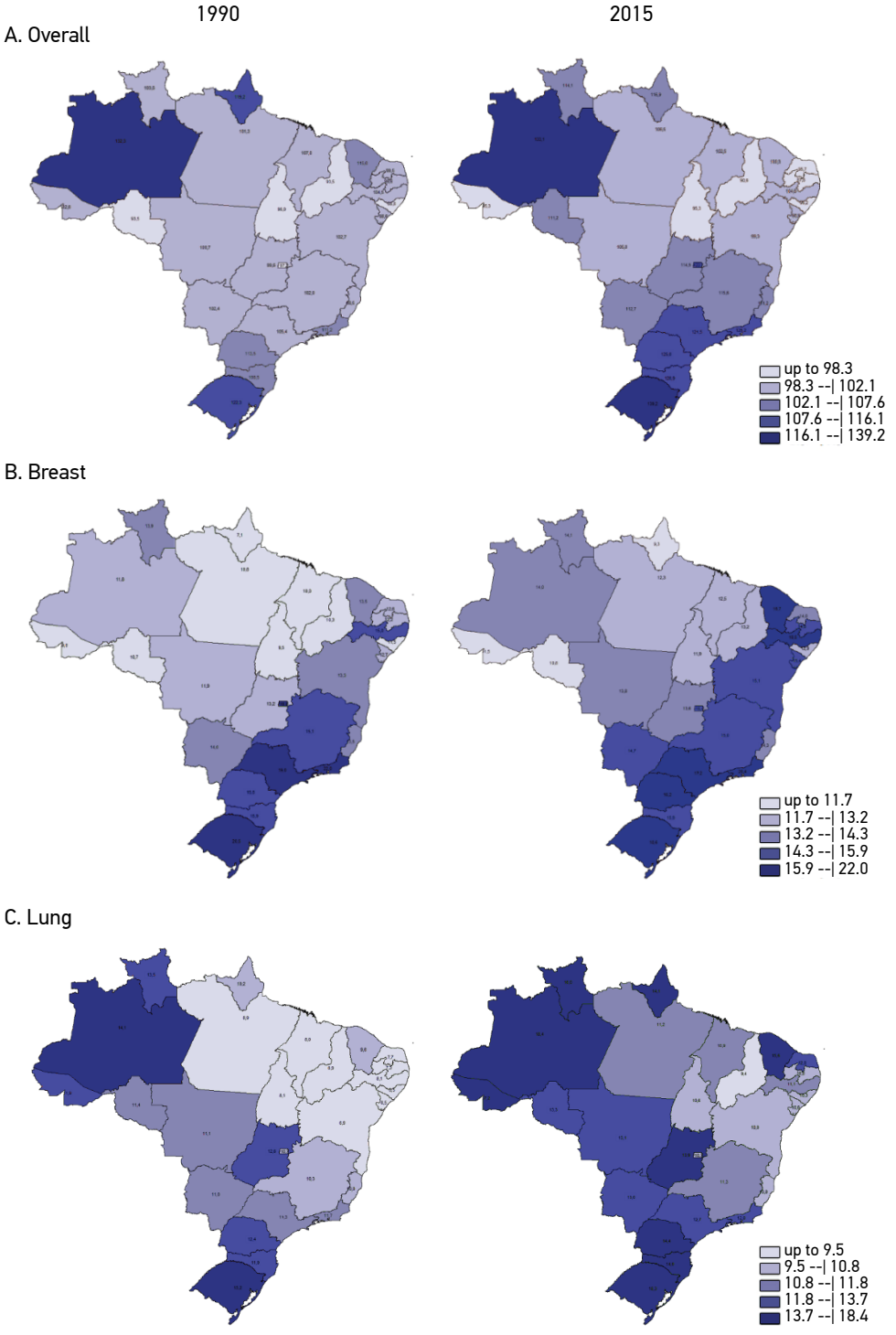


Figure 1. Standardized rates of cancer mortality in women: (A) overall, (B) breast, and (C) lung. States of Brazil, 1990–2015.

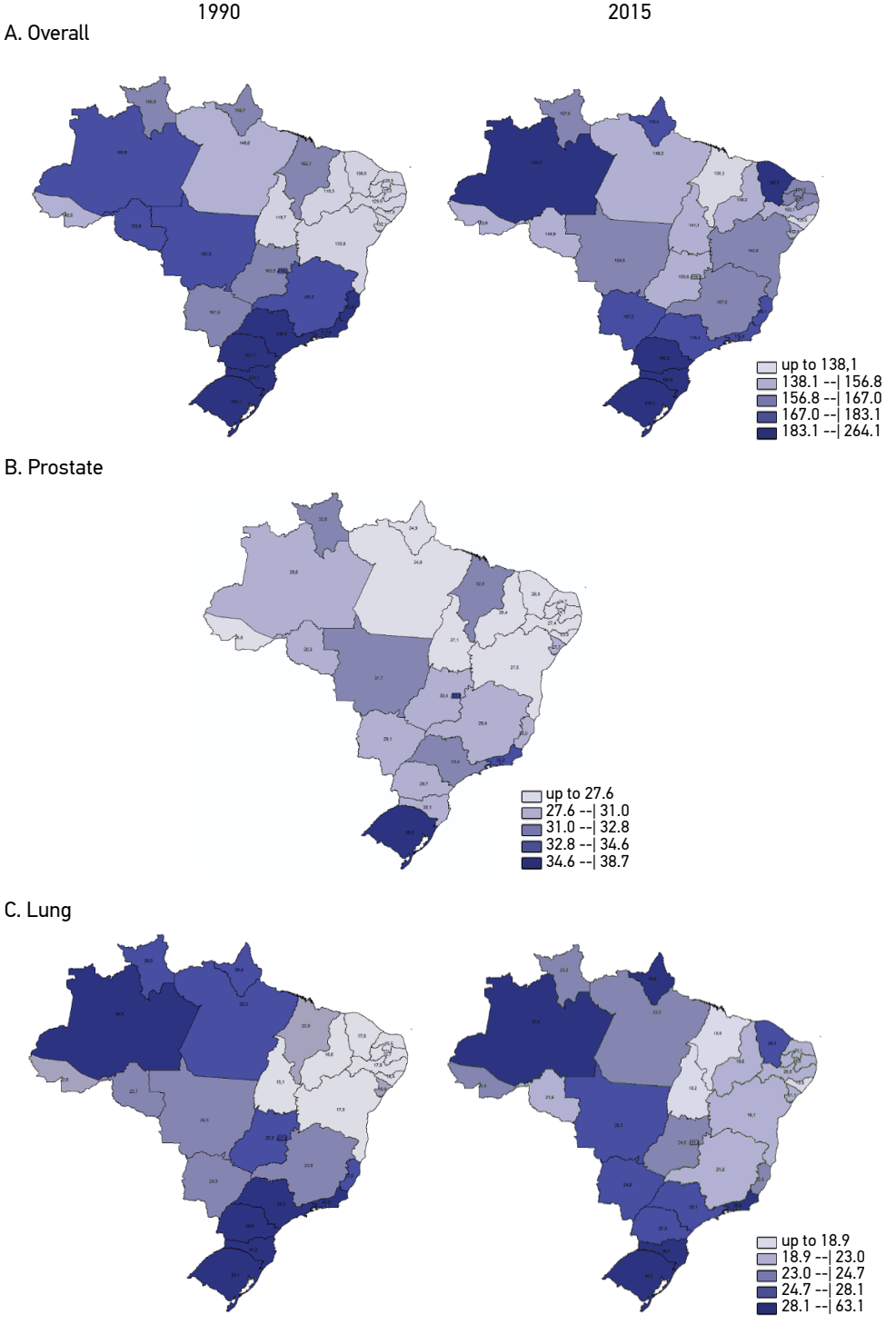


Figure 2. Standardized rates of cancer mortality in women: (A) overall; (B) prostate; and (C) lung. States of Brazil, 1990–2015.

## DISCUSSION

Cancer mortality in Brazil from 1990 to 2015 remained stable. Among the five most frequent locations in the country and for each state, there was a significant reduction in mortality due to cancers of the esophagus and stomach for both sexes, cervix, and lung and esophagus in men. In contrast, there was an expressive increase for lung cancers in women and colorectal cancer in men, whereas mortality due to female breast and prostate cancer showed stability. Corroborating our findings, one study observed a downward trend in mortality from stomach and cervix cancer between 1980 and 2006 in the capitals and other municipalities of Brazil[6]. However, another study observed a trend of increased cancer mortality in the country between 1996 and 2010. For the period from 2011 to 2030, an increase was estimated only for

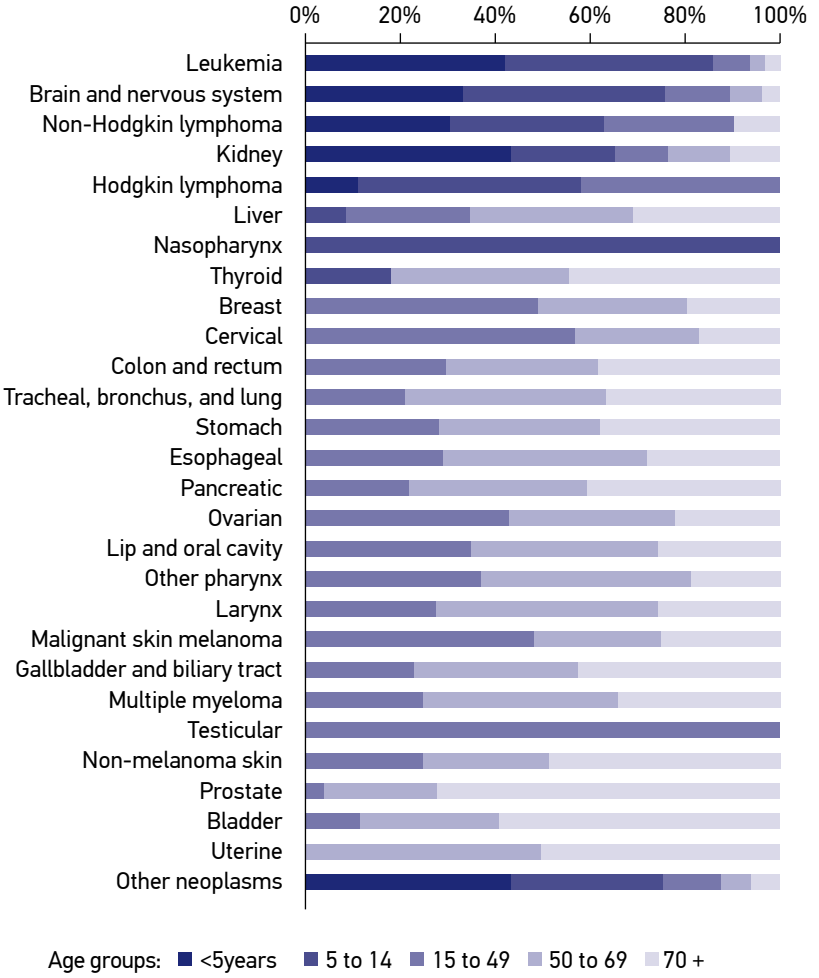


Figure 3. Percentage contribution of cancer types to mortality due to neoplasia by age group. Brazil, 2015.

the north and northeast regions[7] – the least developed regions, which also showed an increase, although predominantly not significant, between the years considered in this study.

The variation from 1990 to 2015 for the leading causes of cancer mortality in the states was most pronounced for cervical and stomach cancer in both sexes, which showed a decline particularly in the more developed regions of the country. This situation seems to reflect both inequalities socioeconomic, and of access to health services by the population[12].

Regarding breast cancer in female, there was stability in mortality from 1990 to 2015 in Brazil and the states, although with a non-expressive increase in all the states of the north and northeast regions, the least developed in the country. Reinforcing these findings, a study conducted to evaluate the temporal trend of mortality from the disease in the period from 1990 to 2011 and its association with social inequality also verified a stable trend in the country between 1994 and 2011, indicating a significant reduction trend in Rio Grande do Sul, Rio de Janeiro, and São Paulo, and an increase in Maranhão, Piauí, and Paraíba. However, no significant correlations were found between changes in mortality rates and indicators of social inequality[13]. In contrast, another study found a tendency to increase breast cancer mortality rates in Brazil, in the north, northeast, and center-west regions for the period from 1991 to 2010. The southeast region showed a decline in mortality rates, whereas the south region showed stability[14]. Analysis performed with aggregate data from 30 years (1980–2010) of breast cancer mortality in Brazil found a trend of increase, with a decline in mortality in the capitals from the end of the 1990s[12]. Such studies emphasize, as this study, the regional disparities in the behavior of mortality due to the disease, with a tendency of reduction and/or stability in the more developed regions and of increase in the less developed regions. It is important to highlight the need to expand the breast cancer prevention network in the country, especially in less developed regions[15].

Similar to our findings, analysis of cervical cancer mortality in Brazil between 1996 and 2010 found a downward trend in the country and in the Midwest, southeast, and south regions, with stability in the north and northeast regions[16]. Another study found a decline in mortality in the country (1980–2010), except in municipalities outside of capitals of the north and northeast regions[12]. The drop in mortality for cervical cancer probably reflects the expansion of the coverage of the screening performed by the Pap test to women aged 25–64 years, from 65.5% in 2003 to 78.8% in 2013, almost reaching the recommended goal of 80%. In all regions, coverage was above 75%, highlighting the importance of the role of the Family Health Program in the universalization of this preventive test[17]. However, the north and northeast regions show the highest mortality rates, reflecting the regional inequality of access to preventive measures that is still present in Brazil. The National Health Survey of 2013 found a high screening coverage throughout the country, but it found higher proportions of women with lower educational levels and no private health plan in the north and northeast regions, and these variables showed an inverse association with performing the test[17].

Although not expressive, prostate cancer mortality increased from 1990 to 2015 in Brazil in practically all states, with the highest increases in the states of the north and northeast regions. For the period from 1980 to 2010, there was an upward trend in mortality from the

disease to Brazil and all regions, with the northeast showing the highest variation, while the south and southeast showed the lowest[18]. Similarly, analysis of the trend of prostate cancer mortality rates in Brazil and regions in the period 1996 to 2010 showed a significant increase between 1996 and 2006, followed by a non-significant decrease, with an estimate of decrease at national level until the year 2025 and in the Midwest, south, and southeast regions, as opposed to an increase in the north and northeast regions[19]. However, a study that evaluated the burden of the disease in Central and South America found, for Brazil, a practically stable trend in mortality rates between 1997 and 2008[20]. The number of new cases of prostate cancer in the country is expected to grow steadily, with a consequent increase in the number of deaths from the disease in all regions[19]. However, the impact of specific control actions already underway on mortality still needs to be elucidated[20].In contrast, a study conducted in the male population between 30 and 69 years of age in Brazil and its regions indicated a reduction in mortality from 1996 to 2011, as well as a decrease in regional differentials in 2011[21]. However, these findings may not be observed in elderly men.

Corroborating the findings of this study, analysis of the trend of mortality from lung cancer from 1996 to 2011 in Brazil in people aged 30–69 years also observed higher mortality rates in men, with a reduction of mortality for men in the country and in all regions, and an increase for women, except for the north region[22]. Another study on the trend of lung cancer mortality from 1980 to 2007, analyzing the effects of "age," "period," and "cohort", also found higher mortality rates in men. There was also an increase in the specific rates for men aged over 64 years and women of all ages, with the highest growth of adjusted rates in women. There was also an increase in risk from earlier ages, a lower risk for men born after 1950 and an increased risk for women from all cohorts[23]. It reinforces, therefore, the role of tobacco control measures adopted in the country since 1986, with a broader focus on the female sex.

For colon and rectum cancer, mortality rates increased from 1990 to 2015 in men in Brazil, with no expressive increase in women. The highest rates were observed in states the south and southeast regions. This increase is in accordance with a study that analyzed the trend of mortality from colorectal cancer from 1980 to 2013 and verified an increased risk of death in both sexes in the country, being higher in men[24]. There was also a trend of increase in mortality from the disease from 1979 to 2010, in both sexes in Latin American countries, particularly Brazil, Chile, and Mexico[25]. There was a strong correlation between socioeconomic indicators and mortality due to colorectal cancer in the country[26], which may partially explain the higher mortality rates in the south and southeast regions.

In general, the mortality rate from stomach cancer presented a reduction in the country from 1990 to 2015, with the highest rates observed in men and in the states of the north region. Another study also found a higher mortality rate among men from 1980 to 2009, in Brazil and in all major regions, with reduced risk of death in the country and in the south, southeast, and center-west regions for both sexes. In the northeast region, for both sexes, and in the north region, for male population, there was progressive decline in rates until 1995–1999, followed by an increase. According to projections of mortality by the disease up to 2030, the north and northeast regions will show an increase in rates for both sexes,

which can be explained by the greater difficulty in accessing diagnostic and treatment services in these regions[27].

An important limitation of this study is the fact that the analysis was based on mortality rates calculated for only two point temporal cuts (1990 and 2015), which impairs the prediction of trend of the disease in the period. It should also be taken into account that the differences in the temporal changes of cancer in Brazil, in general or in a particular type observed in the identified studies, can be attributed, at least in part, to the different periods evaluated.

## CONCLUSION

This study allowed a comprehensive evaluation of cancer mortality in Brazil and FU, with an analysis of the spatial distribution of deaths from the disease (in general and of the main tumors), according to sex. It allowed for considerations regarding the changes observed in the mortality rates of two years separated by a long interval (25 years), contributing to the structuring of disease control measures to be prioritized in the country.

It was highlighted the potential use of estimates from the GBD 2015 study, which corrected the underreporting of deaths by estimating overall corrected mortality (envelope mortality) and declared deaths with a baseline cause classified as a garbage code, for the analysis of mortality due to cancer in the Brazil and states.

The possible reduction in cancer mortality in recent years may be related to efforts to provide access to early diagnosis and treatment for major cancers, in line with the National Cancer Care Policy[28].

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## ERRATUM / *ERRATA*

In the manuscript "Magnitude and variation of the burden of cancer mortality in Brazil and Federation Units, 1990 and 2015", DOI: 10.1590/1980-5497201700050009, published in the Rev. bras. epidemiol. 2017; 20 (Suppl 1): 102-115.

**Page 107, Where it reads:**

Table 2. Standardized mortality rates/100,0000 inhabitants (Brazil and FU) 2015 and percentage variation from 1990 to 2015 for five main types of cancers, men.

| UF | MEN | | | | | |
|---|---|---|---|---|---|---|
| | All | Breast | Lung | Stomach | Colon/Rectum | Esophagus |
| BR | 172.1 (-5.6) | 33.4 (+12.2) | 25.9 (-12.0) | 19.5 (-37.3) | 14.1 (+29.5) | 10.5 (-14.1) |
| RO | 149.9 (-13.3) | 32.8 (+8.4) | 21.9 (-7.5) | 22.1 (-42.8) | 8.1 (+15.2) | 8.3 (-15.8) |
| AC | 153.9 (+3.7) | 32.5 (+25.8) | 24.0 (+6.0) | 23.0 (-22.2) | 8.8 (+33.5) | 5.6 (-0.3) |
| AM | 184.5 (+1.0) | 33.9 (+17.7) | 33.5 (-8.1) | 31.6 (-18.1) | 9.7 (+31.7) | 6.2 (-1.1) |
| RR | 157.6 (-5.5) | 37.4 (+14.0) | 23.2 (-12.3) | 23.5 (-36.0) | 7.4 (+35.1) | 5.7 (-8.0) |
| PA | 148.3 (+0.2) | 31.4 (+26.5) | 23.2 (-8.5) | 26.3 (-26.7) | 8.7 (+32.9) | 4.9 (-4.4) |
| AP | 175.4 (+10.6) | 34.0 (+36.6) | 28.6 (+8.6) | 38.6 (-17.1) | 7.7 (+61.9) | 5.8 (+19.5) |
| TO | 141.1 (+17.9) | 38.5 (+41.8) | 18.2 (+20.5) | 13.5 (-23.4) | 9.0 (+63.1) | 5.7 (+15.0) |
| MA | 136.3 (-16.2) | 32.8 (-0.1) | 18.6 (-18.9) | 18.0 (-42.8) | 8.0 (-0.7) | 4.1 (-18.0) |
| PI | 138.2 (+16.8) | 33.3 (+26.0) | 19.6 (+18.1) | 13.0 (-13.0) | 8.8 (+51.0) | 6.4 (+22.7) |
| CE | 185.7 (+34.6) | 36.8 (+41.5) | 26.4 (+55.2) | 28.6 (-1.4) | 11.1 (+84.9) | 11.6 (+55.6) |
| RN | 164.5 (+28.0) | 34.9 (+40.9) | 21.1 (+36.1) | 22.8 (-2.5) | 10.2 (+53.4) | 8.7 (+40.8) |
| PB | 162.1 (+40.9) | 35.0 (+45.0) | 19.5 (+54.1) | 21.3 (+14.0) | 9.5 (+66.5) | 9.4 (+47.3) |
| PE | 152.1 (+17.1) | 34.8 (+26.8) | 20.8 (+16.7) | 15.8 (-4.5) | 8.8 (+48.3) | 7.5 (+21.8) |
| AL | 125.6 (+6.9) | 29.3 (+22.4) | 15.8 (-3.2) | 13.6 (-18.5) | 8.2 (+40.0) | 5.9 (+7.6) |
| SE | 152.0 (+15.0) | 38.4 (+38.5) | 21.1 (+6.0) | 14.5 (-12.2) | 10.0 (+47.1) | 6.1 (+11.8) |
| BA | 162.6 (+19.7) | 38.7 (+40.9) | 19.1 (+12.6) | 18.7 (-13.8) | 11.2 (+44.2) | 10.0 (+27.3) |
| MG | 167.0 (-8.0) | 32.3 (+9.8) | 21.8 (-8.7) | 20.4 (-43.9) | 12.6 (+31.8) | 13.4 (-14.5) |
| ES | 168.1 (-8.5) | 31.9 (+14.0) | 23.9 (-11.6) | 20.5 (-46.5) | 11.6 (+27.3) | 14.4 (-9.1) |
| RJ | 176.0 (-16.6) | 34.2 (+2.9) | 28.5 (-31.2) | 17.8 (-44.2) | 17.5 (+17.0) | 9.0 (-23.3) |
| SP | 173.4 (-17.4) | 31.1 (-0.9) | 25.1 (-24.5) | 18.6 (-50.0) | 17.9 (+22.5) | 9.8 (-27.1) |
| PR | 190.2 (-7.4) | 34.0 (+14.6) | 27.2 (-4.9) | 21.7 (-44.7) | 16.4 (+30.1) | 13.9 (-25.5) |
| SC | 195.0 (-13.2) | 31.0 (+2.8) | 36.7 (-10.8) | 21.4 (-43.7) | 14.0 (+13.7) | 14.2 (-30.6) |
| RS | 216.1 (-18.2) | 34.4 (-5.1) | 46.2 (-26.8) | 17.2 (-44.7) | 18.3 (+6.2) | 16.7 (-32.0) |
| MS | 167.2 (+3.3) | 34.8 (+19.5) | 24.8 (+3.0) | 18.7 (-36.3) | 13.7 (+50.1) | 10.6 (+3.1) |
| MT | 164.9 (-1.4) | 36.9 (+16.4) | 25.1 (+3.4) | 19.5 (-42.6) | 11.3 (+33.0) | 9.6 (+0.5) |
| GO | 155.6 (-4.9) | 33.3 (+9.3) | 24.0 (-3.9) | 15.7 (-40.5) | 12.0 (+25.0) | 8.1 (-12.7) |
| DF | 156.6 (-12.2) | 33.2 (+0.6) | 23.4 (-16.1) | 14.9 (-43.5) | 14.0 (+25.9) | 7.5 (-18.4) |

Note: percentage variation 1990 and 2015 in parenthesis; BR: Brazil; FU in acronyms.

**It should read:**

Table 2. Standardized mortality rates/100,0000 inhabitants (Brazil and FU) 2015 and percentage variation from 1990 to 2015 for five main types of cancers, men.

| UF | MEN | | | | | |
|---|---|---|---|---|---|---|
| | All | Prostate | Lung | Stomach | Colon/Rectum | Esophagus |
| BR | 172.1 (-5.6) | 33.4 (+12.2) | 25.9 (-12.0) | 19.5 (-37.3) | 14.1 (+29.5) | 10.5 (-14.1) |
| RO | 149.9 (-13.3) | 32.8 (+8.4) | 21.9 (-7.5) | 22.1 (-42.8) | 8.1 (+15.2) | 8.3 (-15.8) |
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| AM | 184.5 (+1.0) | 33.9 (+17.7) | 33.5 (-8.1) | 31.6 (-18.1) | 9.7 (+31.7) | 6.2 (-1.1) |
| RR | 157.6 (-5.5) | 37.4 (+14.0) | 23.2 (-12.3) | 23.5 (-36.0) | 7.4 (+35.1) | 5.7 (-8.0) |
| PA | 148.3 (+0.2) | 31.4 (+26.5) | 23.2 (-8.5) | 26.3 (-26.7) | 8.7 (+32.9) | 4.9 (-4.4) |
| AP | 175.4 (+10.6) | 34.0 (+36.6) | 28.6 (+8.6) | 38.6 (-17.1) | 7.7 (+61.9) | 5.8 (+19.5) |
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| CE | 185.7 (+34.6) | 36.8 (+41.5) | 26.4 (+55.2) | 28.6 (-1.4) | 11.1 (+84.9) | 11.6 (+55.6) |
| RN | 164.5 (+28.0) | 34.9 (+40.9) | 21.1 (+36.1) | 22.8 (-2.5) | 10.2 (+53.4) | 8.7 (+40.8) |
| PB | 162.1 (+40.9) | 35.0 (+45.0) | 19.5 (+54.1) | 21.3 (+14.0) | 9.5 (+66.5) | 9.4 (+47.3) |
| PE | 152.1 (+17.1) | 34.8 (+26.8) | 20.8 (+16.7) | 15.8 (-4.5) | 8.8 (+48.3) | 7.5 (+21.8) |
| AL | 125.6 (+6.9) | 29.3 (+22.4) | 15.8 (-3.2) | 13.6 (-18.5) | 8.2 (+40.0) | 5.9 (+7.6) |
| SE | 152.0 (+15.0) | 38.4 (+38.5) | 21.1 (+6.0) | 14.5 (-12.2) | 10.0 (+47.1) | 6.1 (+11.8) |
| BA | 162.6 (+19.7) | 38.7 (+40.9) | 19.1 (+12.6) | 18.7 (-13.8) | 11.2 (+44.2) | 10.0 (+27.3) |
| MG | 167.0 (-8.0) | 32.3 (+9.8) | 21.8 (-8.7) | 20.4 (-43.9) | 12.6 (+31.8) | 13.4 (-14.5) |
| ES | 168.1 (-8.5) | 31.9 (+14.0) | 23.9 (-11.6) | 20.5 (-46.5) | 11.6 (+27.3) | 14.4 (-9.1) |
| RJ | 176.0 (-16.6) | 34.2 (+2.9) | 28.5 (-31.2) | 17.8 (-44.2) | 17.5 (+17.0) | 9.0 (-23.3) |
| SP | 173.4 (-17.4) | 31.1 (-0.9) | 25.1 (-24.5) | 18.6 (-50.0) | 17.9 (+22.5) | 9.8 (-27.1) |
| PR | 190.2 (-7.4) | 34.0 (+14.6) | 27.2 (-4.9) | 21.7 (-44.7) | 16.4 (+30.1) | 13.9 (-25.5) |
| SC | 195.0 (-13.2) | 31.0 (+2.8) | 36.7 (-10.8) | 21.4 (-43.7) | 14.0 (+13.7) | 14.2 (-30.6) |
| RS | 216.1 (-18.2) | 34.4 (-5.1) | 46.2 (-26.8) | 17.2 (-44.7) | 18.3 (+6.2) | 16.7 (-32.0) |
| MS | 167.2 (+3.3) | 34.8 (+19.5) | 24.8 (+3.0) | 18.7 (-36.3) | 13.7 (+50.1) | 10.6 (+3.1) |
| MT | 164.9 (-1.4) | 36.9 (+16.4) | 25.1 (+3.4) | 19.5 (-42.6) | 11.3 (+33.0) | 9.6 (+0.5) |
| GO | 155.6 (-4.9) | 33.3 (+9.3) | 24.0 (-3.9) | 15.7 (-40.5) | 12.0 (+25.0) | 8.1 (-12.7) |
| DF | 156.6 (-12.2) | 33.2 (+0.6) | 23.4 (-16.1) | 14.9 (-43.5) | 14.0 (+25.9) | 7.5 (-18.4) |

Note: percentage variation 1990 and 2015 in parenthesis; BR: Brazil; FU in acronyms.

**Page 110, Where it reads:**

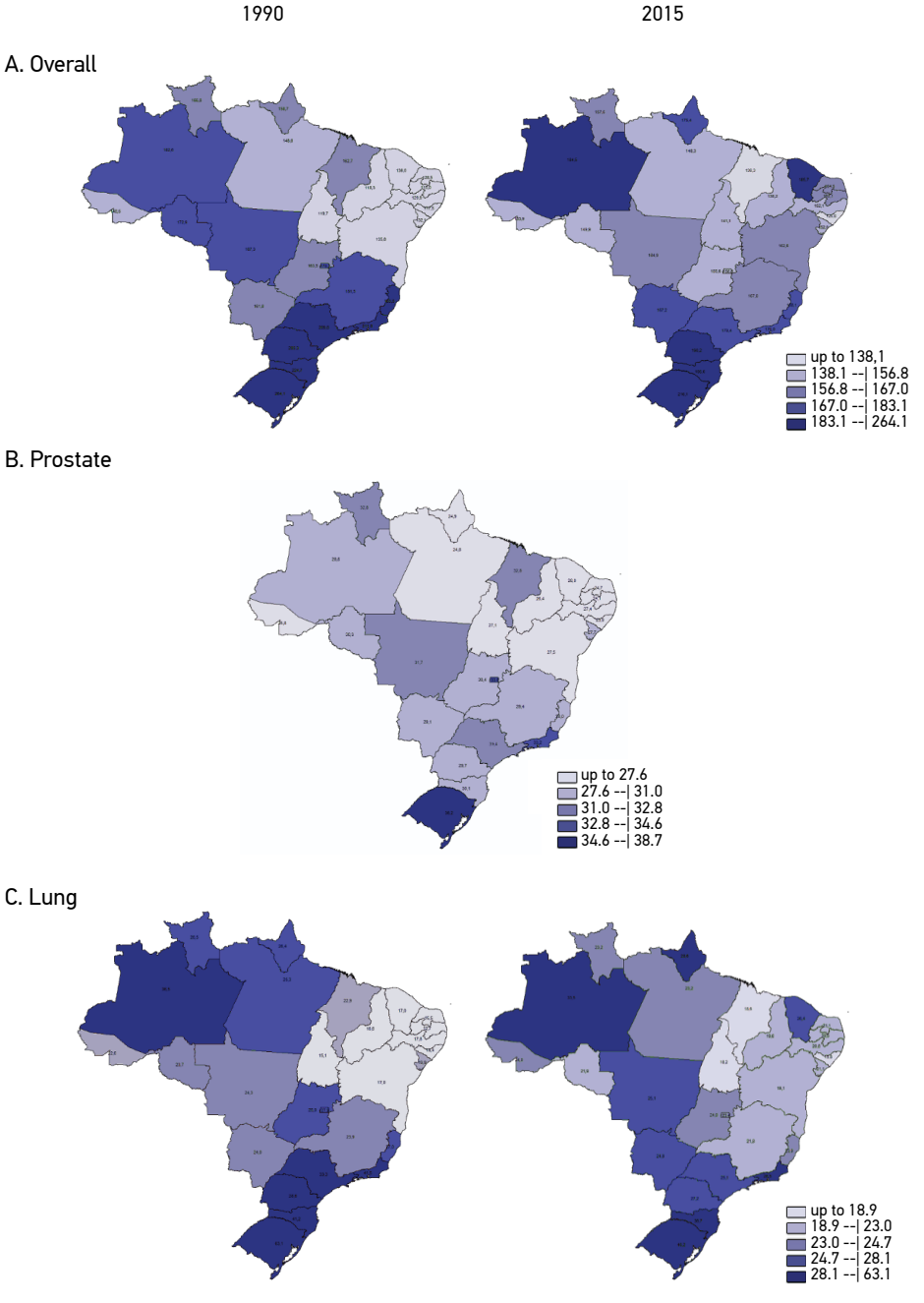


Figure 2. Standardized rates of cancer mortality in women: (A) overall; (B) prostate; and (C) lung. States of Brazil, 1990–2015.

**It should read:**

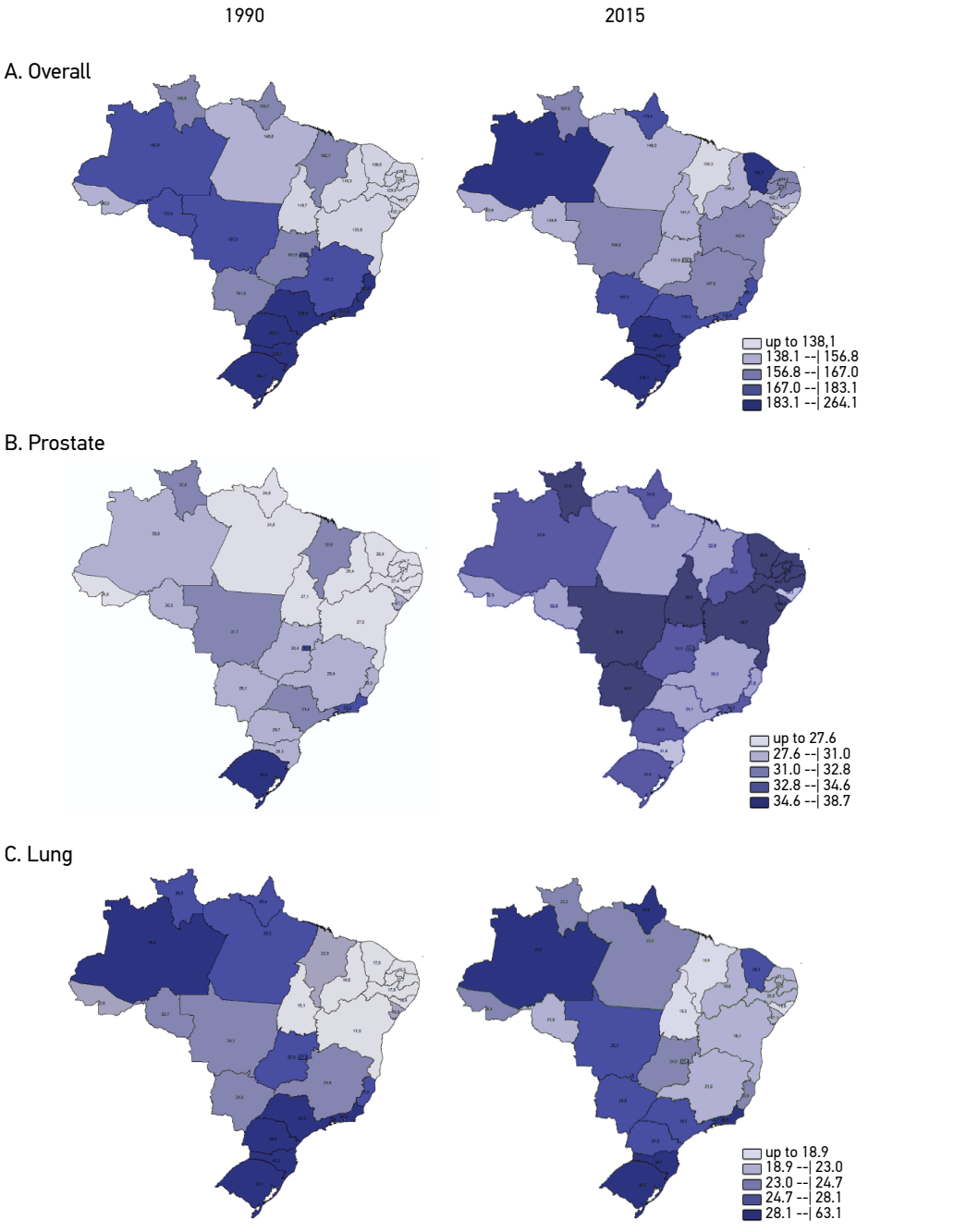


Figure 2. Standardized rates of cancer mortality in men: (A) overall; (B) prostate; and (C) lung. States of Brazil, 1990–2015.