Transition towards cancer mortality predominance over cardiovascular disease mortality in Brazil, 2000–2019: a population-based study

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Summary

Background Cardiovascular disease (CVD) and cancer are the first and second leading causes of death in Brazil and worldwide. However, an ongoing epidemiological transition in which cancer surpasses CVD has been observed in many high and middle-income countries. In this study, we provided a nationwide analysis of the transition towards cancer mortality predominance over CVD mortality in Brazil.

Methods We leveraged data from 5570 municipalities using the Mortality Information System and classified the causes of death using ICD-10 codes. Age-standardized CVD and cancer mortality rates were calculated annually between 2000 and 2019. Mortality rate ratios (MRRs = CVD rates divided by cancer rates) described the predominance of cancer or CVD mortality across municipalities and states. Choropleth maps displayed state-specific MRRs and the transition in the predominant cause of death over time.

Findings From 2000 to 2019, CVD mortality rates declined in 25 out of 27 states, whereas cancer mortality increased in 15 states, indicating a shift towards cancer predominance. While in 2000 cancer mortality was lower than CVD in all states and only exceeded the latter in 7% of the municipalities, by 2019 the gap narrowed considerably, with 13% of municipalities displaying higher cancer mortality rates vs CVD mortality rates. Additionally, higher household income correlated with higher mortality from cancer vs CVD.

Interpretation An ongoing epidemiological transition in which cancer mortality surpasses CVD mortality is occurring in Brazil, particularly in municipalities with higher household incomes. Our findings may provide important information for policymakers and public health practitioners in Brazil.

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Keywords: Cancer; Cardiovascular diseases; Epidemiolocal transition; Brazil

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Research in context

Evidence before this study

We searched Pubmed for studies on epidemiological transition in which cancer surpasses cardiovascular diseases (CVD) mortality as the leading cause of death. We used the following search terms: (((cardiovascular disease [Title]) OR (heart [Title])) AND (cancer [Title])) AND ("leading cause of death" [tiab]). A total of 40 studies published before September 2024 were retrieved, mostly conducted in the USA and multicountry studies. Studies also examined the epidemiological transition by countries' income, socioeconomic status and states. Existing evidence suggests an ongoing epidemiological transition in which cancer surpasses CVD mortality, particularly in high-income countries and geographic regions with high socioeconomic status. Comprehensive nationwide studies comparing the transition from CVD to cancer mortality in Latin America, including Brazil, are scarce.

Added value of this study

Our study provides a comprehensive view of the transition in mortality from CVD to cancer over two decades in Brazil. This includes a detailed examination of 5570 municipalities in the 26 states and the Federal District. Mortality Rate Ratios (MRRs) were calculated to provide a clear representation of the epidemiological transition across the country, illustrating the magnitude and pace of this shift at both state and municipal levels.

Implications of all the available evidence

Our findings reinforce the pressing need for Brazil to pivot its public health strategies, emphasising cancer prevention and control without neglecting CVD. The evident socioeconomic disparities in the transition pace across municipalities underline the importance of tailored interventions. Future research should focus on understanding the drivers behind these trends and devising effective, region-specific prevention and intervention strategies.

Introduction

An ongoing epidemiological transition in which cancer surpasses cardiovascular disease (CVD) mortality has been observed in many high-income countries.[1] In 2019, 57 (31%) out of the 183 countries included in the WHO estimates already listed cancer as the leading cause of death.[2] Time trends of mortality rates in twenty geographically and economically diverse countries have shown a uniform decline in mortality in all high-income countries between 2000 and 2019, with a greater decline in the probability of dying from CVD (from 30% to 60%) than from cancer (from 20% to 30%). Despite mixed results, middle-income countries have also achieved success in controlling CVD mortality.[1] By 2030, one-third of the premature mortality (defined as deaths between 30 and 69 years of age) from non-communicable diseases (NCDs) should be reduced, as per the UN Sustainable Development Goals (SDGs) target 3.4.[3] Although the world has made some progress towards NCD mortality reduction, most countries are unlikely to meet the target reduction of one-third.[4] In 2019, NCDs were responsible for more than 75% of the 20.4 million premature deaths worldwide, and CVD and cancer were the first and second leading causes of death, respectively.[5]

Brazil is an illustrative example of a middle-income country (i.e., transitioning nations). Being the fifth largest country in the world, and the largest in Latin America, both in area and population, the country is facing a rapid demographic, socioeconomic and environmental transformations.[6] Advances in public health and access to healthcare resulted in a life expectancy increase from 53 years in the early 1960s to 73 years in 2021, although with notable regional and socioeconomic disparities.[7] Although considerable advances have been made (e.g., the creation of the Brazilian Unified Health System and expansion of community-based primary care), the transition toward cancer predominance in a profoundly unequal nation may put further pressure on the already underfinanced Brazilian Unified Health System, limit the continuity of life expectancy increase and reaching of SGDs goals on reducing NCDs premature mortality in the next years.

Unlike CVD, which share a set of common risk factors, cancer is characterised as a group of heterogeneous diseases with distinct aetiology and latency periods,[8] which may partly explain the difficulties in cancer prevention and control. In Brazil, the mortality rate from CVD sharply declined by 39% between 2000 and 2019, whereas the mortality rate from cancer decreased by only 10% during the same period; suggesting that cancer may surpass CVD as a leading cause of death in the near future. During this period, several anti-smoking public health measures (e.g., taxation, labelling, and smoking-free zones) have contributed to the reduction in the prevalence of cigarette smoking in the country.[9] In addition, advancements in early diagnosis and treatment of CVD and some types of cancer may have contributed to the epidemiological transition towards cancer predominance. Primary cancer prevention is pivotal to coping with the epidemiological transition towards cancer as the leading cause of death, particularly in settings with limited access to affordable and effective cancer treatment. Of note, the prohibitive increase in cancer treatment costs is a concern.

As a continental country with wide socioeconomic and geographical inequalities,[10] this transition is expected to differ across Brazilian regions and

municipalities – especially due to prevailing socioeconomic differences. Between 1980 and 2017, CVD mortality has decreased in the whole country,[11] whereas cancer mortality decreased in more developed regions, but increased in poorer regions.[12] While several studies have documented trends of CVD and cancer mortality across different Brazilian regions over time,[1,2] a nationwide analysis of the epidemiologic transition towards cancer predominance over CVD in Brazil is lacking. Of note, identifying time trends in premature mortality may add information to the study of epidemiologic transition towards cancer predominance over CVD as it may indicate whether this phenomenon is due to population ageing or could be prevented in principle.

In this study, we leveraged data from 5570 municipalities to provide a nationwide analysis of the transition towards cancer mortality predominance over CVD mortality in Brazil, considering both overall and premature mortality across 26 states and the Federal District between 2000 and 2019. We additionally compared the transition towards cancer predominance over CVD by quintiles of municipalities' per capita income to identify socioeconomic inequalities in the epidemiological transition.

Methods

We analysed nationwide mortality data from the Brazilian Mortality Information System, which is publicly available and contains deidentified information from medical death certificates. Of note, the completeness of death registration with cause-of-death information exceeded 85% in 2000 and reached 99% in 2016 onwards.[13] We assessed the underlying causes of death for each of the 26 states, the Federal District, and the 5570 municipalities for each calendar year from 2000 to 2019. Brazil is a federative republic administratively divided into 26 states and the Federal District, where the federal government headquarters are located. Each state is comprised of a varying number of municipalities. Hereafter, the Federal District will be considered a state. The underlying causes of death from CVD (I00–I99) and cancer (C00–C97) were classified based on the International Classification of Diseases, 10th Revision (ICD-10).[14]

Ill-defined causes of death were redistributed according to the World Health Organization (WHO) method, where deaths by ill-defined causes (R00-R99) are proportionally redistributed in the remaining chapters of the ICD-10.[15] This method assumes that if we remove deaths by external causes, the distribution of the unknown causes of death is the same distribution of the known causes of death for a given sex, age group, and region. This method can be applied to any death registry and geographical locations of any size, increasing the comparability and reproducibility of the results. Another key aspect of the method is that its impact on overall mortality decreases as the quality of the reporting increases. In the year 2000, 14.3% of all deaths in Brazil were reported as ill-defined. This proportion dropped to its lowest value in 2018, reaching 5.3% of all deaths, and by 2019, 5.5% of all deaths were reported as ill-defined.

We calculated age-standardized mortality rates from CVD and cancer per 100,000 persons yearly. Age-standardized mortality rates were calculated using direct standardisation relative to the WHO standard population for the entire study period and per year. Age-standardisation was used to reduce the effect of different age distributions across years, states, municipalities, and capitals on mortality rates. We also calculated premature mortality rates (30- to 69-year-olds) from CVD and cancer per year by state.

Mortality rate ratios (MRRs) were calculated as CVD mortality rates divided by cancer mortality rates. MRRs lower than 1 indicates cancer mortality predominance (i.e., a higher cancer mortality rate relative to CVD mortality). MRRs greater than 1 indicates CVD mortality predominance (i.e., a higher CVD mortality rate relative to cancer mortality). Values equal to 1 indicates equivalent CVD and cancer mortality rates. MRR is a simple and useful measure which quantifies the size of the gap between mortality rates from different underlying causes of death in a given place and time. We treated MRR as a continuous variable to quantify the magnitude of transition towards cancer mortality predominance by calendar year and municipality.

We generated a choropleth map of state-specific adjusted mortality rates for CVD and cancer and MRRs for 2000, 2010 and 2019. At the municipal level, we compared MRR distributions in 2000 and 2019 by quintile of per capita income retrieved from the municipality human development index. Information on average household per capita income across municipalities was derived from the Decennial Demographic Censuses, namely the 2000 and the 2010 Census. Municipalities are classified in household per capita income quintiles separately for 2000 and 2010, with quintile 1 representing the lowest average income quintile, and quintile 5 the highest income.

All statistical analyses were performed using Stata (version 17.0; StataCorp) and R (R version 4.3.1, and RStudio version 2023.06.1 + 524).

Role of the funding source

The funders had no role in the study design, data collection or analysis, interpretation, writing of the report or the decision to submit for publication.

Results

Time trends (2000–2019) in adjusted mortality from CVD and cancer in Brazil by state

Fig. 1 portrays the time trends in the age-standardized mortality rates from CVD and cancer annually over the

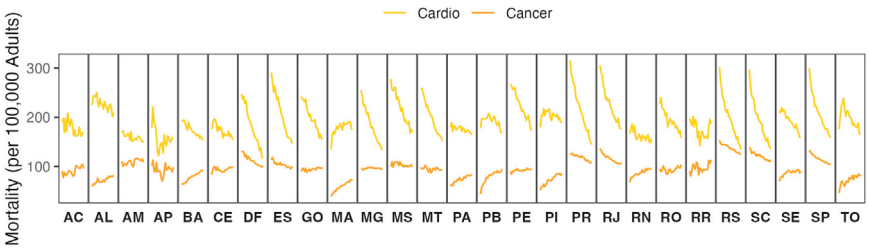

Fig. 1: Age-standardized mortality rates from CVD and cancer in Brazil 2000 and 2019 by state.

20 years between 2000 and 2019, by state. In all 27 Brazilian states, the mortality rate from CVD was higher than that from cancer in 2000. The trend in CVD mortality was negative (–1.7430, t-value: –7.027), whereas trend in cancer mortality was positive (0.7432, t-value: 5.007). The difference in trends between cancer and CVD mortality was statistically significant (3.8811, t-value: 15.77), meaning that every year cancer mortality increases by 3.8811 (per 100,000 individuals) relative to CVD mortality. From 2000 to 2019, CVD mortality rate decreased for 25 Brazilian states, notably Paraná (mortality $rate_{2000}$ = 315.3; mortality $rate_{2019}$ = 144.4), Rio Grande Do Sul (mortality $rate_{2000}$ = 301.8; mortality $rate_{2019}$ = 134.4), Santa Catarina (mortality $rate_{2000}$ = 296.5; mortality $rate_{2019}$ = 136.1), Espirito Santo (mortality $rate_{2000}$ = 291; mortality $rate_{2019}$ = 147.2), and São Paulo (mortality $rate_{2000}$ = 300; mortality $rate_{2019}$ = 158.8). Cancer mortality rate increased in 15 states, especially in Paraíba (mortality $rate_{2000}$ = 43.8; mortality $rate_{2019}$ = 95.0), Tocantins (mortality $rate_{2000}$ = 45.9; mortality $rate_{2019}$ = 80.1), Piauí (mortality $rate_{2000}$ = 52.0; mortality $rate_{2019}$ = 86.1), and Maranhão (mortality $rate_{2000}$ = 38.7; mortality $rate_{2019}$ = 72.2). Altogether, this reflects the transition towards cancer predominance in this 20-year period. In 12 states, there was a reduction in the mortality rate for both diseases.

Mortality rate ratio (MRR) for the transition towards cancer mortality predominance over CVD mortality in Brazil (2000–2019) by year and state

Fig. 2 shows the age-standardized CVD and cancer mortality rates in maps for 2000, 2010, and 2019, as well as the MRR for the same years. Overall, although states have transitioned towards cancer predominance over CVD from 2000 to 2019, no state had completed this epidemiologic transition (MRR < 1) until 2019. In 2000, states in the Northeast and Midwest regions had higher MRR values compared to other regions. Paraíba state had the highest state-specific MRR (4.07 per 100,000 individuals), meaning that the CVD mortality rate was 4.07 times higher than the cancer mortality rate, as indicated by the darker shade of red in Fig. 2, while Amazonas had the lowest MRR (1.53).

In 2019, Alagoas state had the highest state-specific MRR (2.54), meaning that CVD mortality was 2.54 times higher than cancer mortality rates. Alagoas was followed by Maranhão (2.44), Piauí (2.20), Tocantins (2.08), Pará (1.99), and Pernambuco (1.85). Rio Grande do Sul state had the lowest MRR (1.07), indicating that the CVD mortality rate was only 7% higher than the cancer mortality rate. Rio Grande do Sul was followed by Distrito Federal (1.15), Santa Catarina (1.25), Paraná (1.36), Amazonas (1.41), and Minas Gerais (1.42).

Fig. 3 shows the transition towards cancer predominance in all 5570 Brazilian municipalities, from 2000 to 2019. We presented age-standardized CVD and cancer mortality rates for each of the municipalities, showed pooled by the density of municipalities per mortality rate. The MRR analysis was used to show the differential trend between the two diseases. An MRR lower than 1 shows a trend towards cancer mortality predominance, while an MRR higher than 1 indicates a trend towards CVD mortality predominance. We observed a greater density of Brazilian municipalities had an age-standardized MRR lower than 1 over time, indicating a trend towards cancer predominance in the country. While only 366 (6.8%) of existing municipalities had MRR lower than 1 in 2000, in 2019 that number almost doubled, reaching 727 (13.1%) municipalities with MRR<1. The trends in CVD and cancer mortality rates, as well as the differential trend between the two diseases, were statistically significant across municipalities.

Fig. 4 depicts the distribution of MRR in 2000 and 2019 by quintile of household per capita income, across municipalities. The transition towards predominance occurred in all income quintiles between 2000 and 2019. However, an income gradient in MRR across municipalities was observed, with higher household income per capita presenting lower MRR values. In 2019, 20.1% of municipalities in the highest income quintile had MRR lower than 1 (indicating a trend towards cancer mortality predominance), compared to 6.2% in the lowest income quintile.

Time trends (2000–2019) in premature mortality from CVD and cancer in Brazil

Premature mortality rates (30- to 69-year-olds) from CVD and cancer were calculated for 2000–2019, as well

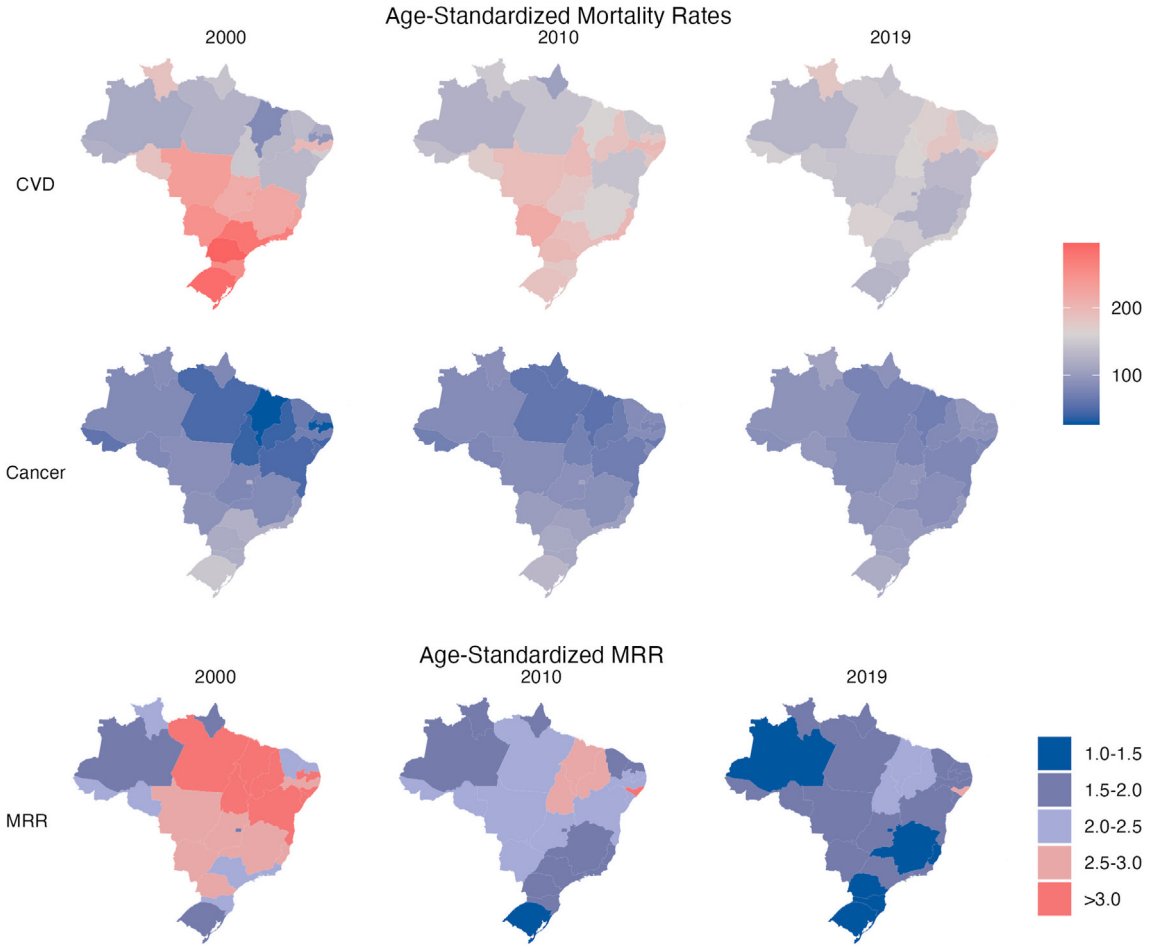

Fig. 2: Age-standardized mortality rates by CVD and cancer (per 100,000 individuals) and mortality rate ratio (MRR) between CVD and cancer in Brazil by year and state. Mortality Rate Ratio (MRR) is the age-standardized mortality rate from cardiovascular diseases divided by the age-standardized mortality rate from cancer.

as MRR, and analysed at the national, state and municipality levels. In 2000, the premature mortality rate from CVD (202 per 100.000) was higher than from cancer (115 per 100.000) in Brazil, with an MRR of 1.8. From 2000 to 2019, the premature CVD mortality rate decreased by 29%, from 202 in 2000 to 143 in 2019. Cancer premature mortality rates, on the other hand, increased by 9%, from 115 in 2000 to 125 in 2019. In 2019, the premature mortality rate from CVD was still higher than that from cancer in Brazil, but the MRR decreased to 1.1, suggesting a transition towards cancer premature mortality predominance over CVD premature mortality. In 2019, six (Amazonas, Amapa, Federal District, Paraná, Rio Grande do Sul, and Santa Catarina) out of the 26 states and the Federal District had premature cancer mortality higher than CVD premature mortality (Supplementary Fig. S1 and Table S1). This pattern can also be observed at the municipality level. Over the period analysed, a greater density of Brazilian municipalities had MRR for premature mortality rates lower than 1, indicating a trend towards cancer premature mortality predominance in the country. While only 793 (15.5%) of existing municipalities had MRR for premature mortality rates lower than 1 in 2000, in 2019 that number reached 1852 (33.5%) municipalities with MRR<1 (Supplementary Fig. S2).

Discussion

This is the first study to comprehensively describe the epidemiologic transition towards cancer mortality predominance over CVD mortality in Brazil by leveraging data from 5570 municipalities. We observed that Brazilian municipalities with higher cancer mortality rates than CVD mortality rates increased from 7% in 2000 to 13% in 2019, underscoring the ongoing epidemiological transition in the country. The driving force behind this epidemiological transition has been the steep decline in

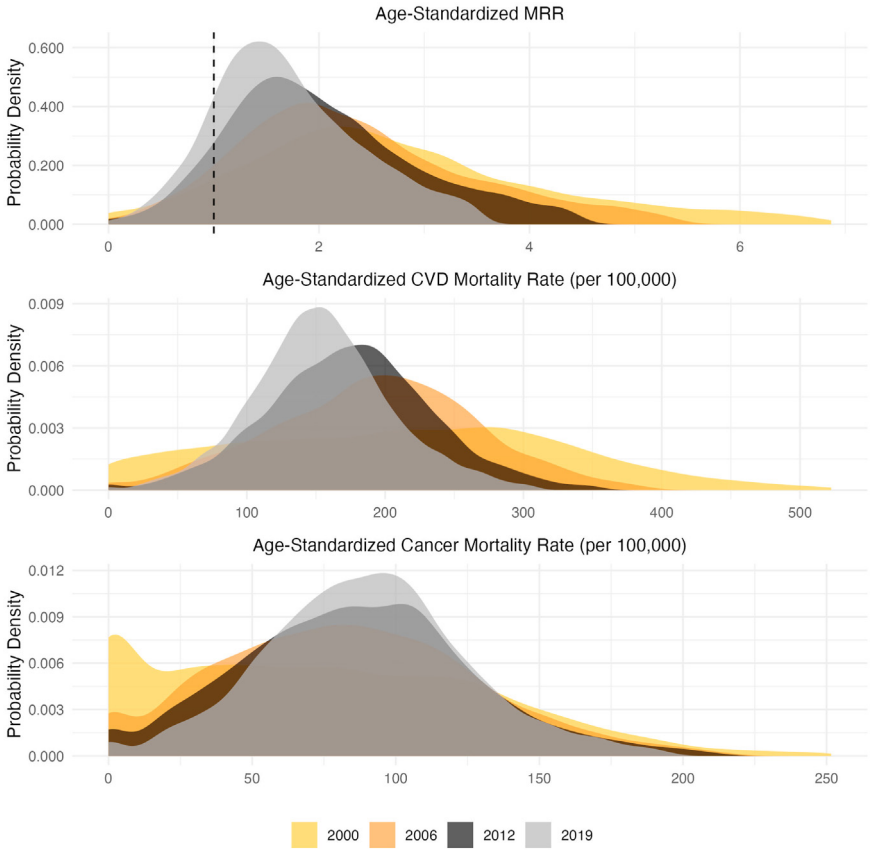

Fig. 3: Age-standardized mortality rates by CVD and Cancer, mortality rate ratio (MRR) between CVD and cancer in Brazil by year across municipalities. (i) Mortality Rate Ratio (MRR) is the age-standardized mortality rate from CVD divided by the age-standardized mortality from cancer; (ii) Dashed line indicates MRR equal to 1; (iii) Finite values of MRR capped at 90th percentile; (iv) Mortality rates capped at 99th percentile.

CVD mortality compared to a modest decline in cancer mortality. Of note, we documented a similar transition for premature mortality rates between 2000 and 2019, with a 29% decrease in CVD premature mortality and a 9% increase in cancer premature mortality. While 15.5% of existing municipalities had premature cancer mortality rates higher than CVD in 2000, in 2019 that number reached 33.5% of municipalities. Our findings on the epidemiologic transition towards cancer predominance in Brazil can aid public health and medical professionals in interpreting vital statistics, creating public health messaging, and setting priorities in NCD prevention and control.

We identified an income gradient in MRR across municipalities, indicating that higher-income municipalities were more advanced in the transition towards cancer predominance. This observation highlights the role of socioeconomic factors in shaping health outcomes and calls for targeted interventions to reduce health inequalities. The identification of uneven transitions at the municipality level may be an important contribution of our study as it can help direct efforts to places where preventable deaths, particularly from CVD, are still an opportunity for greater impact. Regional disparities were also evident, likely reflecting different access to healthcare and socioeconomic status, with wealthier states located in the South, Southeast, and Midwest regions presenting a more advanced epidemiologic transition. Even though Brazil has a Unified Health System, inequalities in the access and quality of the healthcare provided have been reported, highlighting frailties in smaller and poorer municipalities.[14] These findings emphasise the need for region-specific policies that address the underlying determinants of health and improve access to quality healthcare and preventive services in disadvantaged areas, particularly to address premature deaths from CVD and cancer.

The transition towards cancer as the leading cause of overall and premature death is in advanced stages in high-income countries, whereas results from low- and middle-income countries, such as Brazil, suggest a slower transition. A previous study[1] showed that among

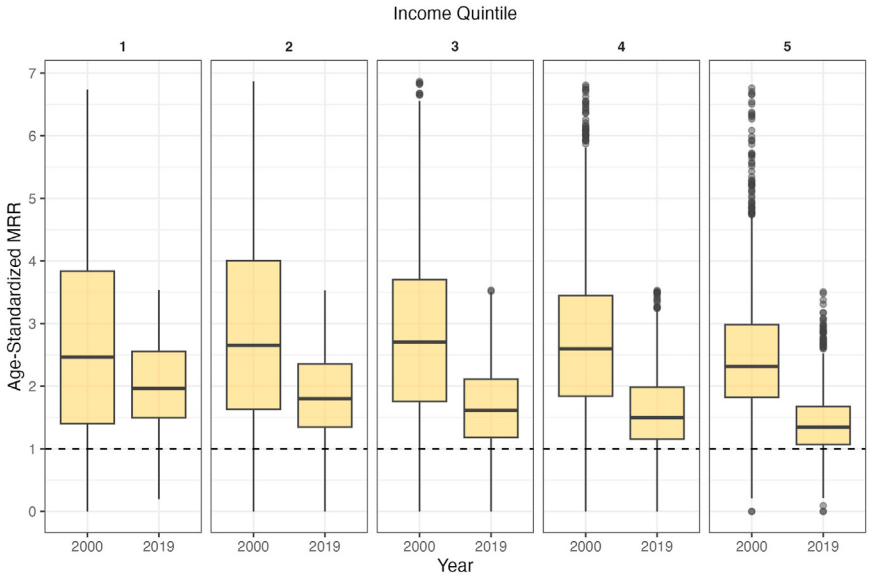

Fig. 4: Distribution of Age-Standardized MRR by Household Income Quintile (2000 and 2019). (i) Mortality Rate Ratio (MRR) = Mortality Rate from Cardio divided by Mortality from Cancer; (ii) Finite values capped at 90th percentile. We use the mean household income by municipality from the Demographic Censuses of 2000 (for the 2000 MRR) and 2010 (for the 2019 MRR) to identify the quintiles relevant for each of the two years. Note that 2010 was the most recent Census available before the 2019 data point.

20 selected countries, all 10 high-income countries had cancer as the leading cause of premature deaths in 2019, while 8 out of 10 middle-income countries had CVD as the leading cause of mortality in the same year. Predicted cancer mortality from 2026 to 2030 in Brazil suggests that the UN SDG target of one-third reduction in premature NCD mortality by 2030 is not expected to be met,[16] although a decrease in mortality is expected, as supported by our results. Despite an anticipated decrease in cancer mortality, the pace of progress falls short of the SDG target. This underscores the need for concerted efforts and sustainable policies that prioritise primary prevention to effectively address the burden of cancer in the country. Prevention and early detection are key strategies to reduce cancer mortality specifically, while comprehensive policies targeting modifiable risk factors are pivotal to substantially reduce mortality from all NCDs – including cancer and CVDs.

Efforts to reduce tobacco smoking, obesity and alcohol use are needed for effective primary prevention strategies.[17] In addition, equitable access to preventive and curative care is essential for achieving significant reductions in the burden of NCDs, including cancer. Since the establishment of SUS in 1990, Brazil has enacted policies for the surveillance,[18] controlling[19] and reduction of CVD.[20] Remarkable examples are the anti-tobacco policies and a national plan for obesity prevention and control.[17] The Brazilian plan to tackle obesity included the development of the Dietary Guidelines for the Brazilian Population, a document that aims to promote the health and well-being of Brazilian people, families, and communities through dietary recommendations.[21] Alongside the Dietary Guidelines for the Brazilian Population, the national plan for obesity control introduced food marketing regulation to children and other industry regulations focusing on trans fats and sodium content in ultra-processed foods. A Global Burden of Disease Study on CVD in Brazil concluded that these health policies were likely successful and that this success could be exemplified by Brazil having one of the largest relative drops in mortality rates among BRICS countries.[22]

Assessing the findings of our study through the lenses of the inherent differences between CVD and cancer is necessary. Although many cancers share the same risk factors of CVD, cancers are highly heterogeneous in terms of aetiology and latency, which presents an additional challenge for prevention and early diagnosis strategies. The treatment and management of CVD and cancer diverge greatly. While both CVD and cancer require a multidisciplinary approach to treatment,[23] cancer treatments are often disease-specific including not only surgery but different classes of medication.[24] In Brazil, treatment for CVD most often addresses systemic and lifestyle factors. In contrast, cancer treatment focuses mainly on eradicating localised disease processes, often detected in advanced stages. Systemic treatment is also an integral part of cancer management strategies. Individuals undergoing cancer treatment need to address lifestyle factors, while

also checking for cancer recurrence and, in some cases, resorting to palliative care.[25] Cancer detection, treatment, and management are often more costly than CVD, also requiring more specialised human resources and facilities.[26,27] These differences may explain the pace of the transition in different regions of the country. Moreover, the challenges in cancer care lie in the increasing incidence due to ageing and limited improvement in cancer survival. This combination may result in harder-to-transpose challenges for reducing cancer mortality, especially in specific cancer types. The Brazilian Unified Health System has focused on prevention strategies through primary care expansion during its first three decades (1990s to late 2010s)[28] especially to cope with underlying causes of infectious diseases and CVDs. Epidemiological transitions presented in our study are relevant to inform and prepare the Brazilian Unified Health System for 21st-century challenges.

Our study has some limitations. Since our study utilised data from 2000 to 2019, it is important to acknowledge that the years of the COVID-19 pandemic were not included in the analysis. The pandemic has undoubtedly disrupted NCD primary prevention, as well as secondary and tertiary prevention efforts, thereby impacting disease trends. Future research should consider the influence of the pandemic on age-standardized rates and premature mortality of CVD and cancer.

Additionally, the study has inherent limitations related to the quality of underlying causes of death and misclassification of deaths in some cities. However, the underlying mortality data were considered of reasonable quality in Brazil, particularly in the South, Southeast and Midwest regions, providing a robust basis for our analysis.[27,28] The completeness of death registration in 2000 was above 85% and exceeded 99% in 2016 onwards. Regional disparities in the completeness of death registrations persist and may partially explain differences observed between regions and household per capita income across municipalities.[13] High-quality population-based cancer registries also play a crucial role in accurately abstracting and analysing data related to cancer incidence, prevalence, and mortality. In Brazil, the quality of cancer registries has historically faced challenges, including incomplete coverage, inconsistency in data collection methods, and lack of standardisation across regions, besides the delay in releasing incidence data yearly. However, efforts have been made to improve these registries in recent years, leading to advancements in data collection and analysis.[29] Therefore, the quality of population-based cancer registries may partially identify the observed transition towards cancer mortality (overall and premature) predominance over CVD mortality.

Additionally, our study lacks sex-disaggregated analysis, as previous studies in other countries.[1,2] Differential transitions towards cancer predominance by sex are expected due to multiple factors. For instance, cancer mortality in Brazil has shown great variation over the last 40 decades by sex, particularly due to a decline in lung cancer rates among men, contrary to the trends among women.[12] In addition, CVD rates have declined more rapidly among men than women in the last decades.[11] Trends in other risk factors for cancer and CVD have also varied by sex, such as inadequate diet and alcohol consumption (both higher among men) and obesity (higher among women).[11]

Another possible limitation of our study is that we used the WHO method for redistributing ill-defined causes of death to correct the sub-notification of deaths by cancer and CVD. Other methods for redistributing deaths were available, however, since there is no consensus on a standard methodology, we chose the one that is well-documented in Brazil and is easy to apply in other countries. The WHO method is also the most reproducible and accessible method for city-level estimates, making it the ideal choice for this study.

In conclusion, the epidemiologic transition where cancer surpasses CVD mortality in Brazilian states and municipalities reflects an ongoing epidemiological shift, with notable economic and regional disparities. Our findings on premature mortality suggested that population ageing alone does not explain the ongoing epidemiological transition, and thus a coordinated national program is pivotal to reducing cancer premature mortality. Addressing disparities and accelerating progress towards meeting SDG targets requires prioritising social policies and adequately planning primary prevention, early detection, and disease management strategies tailored to regional differences, particularly where preventable deaths by CVD are still an opportunity for greater impact. Our findings on the unequal socioeconomic and regional transition toward cancer predominance, particularly regarding premature mortality, may limit the continuity of life expectancy increase, as well as reaching of SGDs goals on NCDs premature mortality reduction in the next years. Finally, our results provide important information for policymakers and public health practitioners in Brazil and other countries facing similar challenges, contributing to the global efforts to reduce the burden of NCDs and achieve the SDGs.

Contributors

LFMR and BR participated in the design and conceptualisation of the study. BR and AB were responsible for the data curation. BR, AB and LFMR conducted the formal analysis. CMA, BR and LFMR wrote the original draft. All authors revised and edited the manuscript and approved the final version of the manuscript.

Data sharing statement

All datasets are publicly available online and are de-identified. We describe the data sources in the manuscript. The code is available upon request.

Editor note

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Declaration of interests

AB has worked as a Healthcare System Evidence Manager at Novartis since September 2023. Novartis had no role in the design, analysis or writing of this manuscript. All other authors declared no conflict of interest.

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Appendix A. Supplementary data

Supplementary data related to this article can be found at https://doi.org/10.1016/j.lana.2024.100904.

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