Colorectal Cancer Mortality in the BRICS Countries from 1990 to 2019: Age-Period-Cohort Analysis

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Mortalidade por Câncer Colorretal nos Países dos BRICS de 1990 a 2019: Análise de Idade-Período-Coorte

Mortalidad por Cáncer Colorrectal en los Países BRICS de 1990 a 2019: Análisis de Cohortes por Periodos de Edad

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ABSTRACT

Introduction: Colorectal cancer (CRC) is responsible for over 900,000 deaths annually worldwide, with marked regional differences. **Objective:** To analyze the trends in CRC mortality in BRICS countries between 1990 and 2019, and to estimate the effects of age, period, and cohort. **Method:** An ecological time series study of CRC mortality in adults aged 30 to 69 years, using data from the "Global Burden of Disease 2019". Age-period-cohort effects were analyzed using the "Age-Period-Cohort Analysis Tool" developed by the United States National Cancer Institute. **Results:** An increase in mortality was observed between 1990 and 2019 in all BRICS countries. An age effect was identified in all countries, with higher rates in older age groups. Regarding birth cohort, a steady increase in male mortality was observed in Brazil, China and India, and a decrease in female mortality in China and Russia. **Conclusion:** The age-period-cohort analysis showed that the increase in mortality is mainly concentrated among men born after 1960 and within economically active age groups, while Russia illustrates the potential of control policies to reverse this trend. The results indicated a rise in CRC mortality rates in all founding BRICS countries, although this growth did not occur uniformly.

Key words: Colorectal Neoplasms/mortality; Mortality/trends; Cohort Studies.

RESUMO

Introdução: O câncer colorretal (CCR) é responsável por mais de 900 mil óbitos anuais no mundo, com diferenças regionais marcantes. **Objetivo:** Analisar a evolução da mortalidade por CCR nos países membros originais do BRICS entre 1990 e 2019 e estimar os efeitos de idade, período e coorte. **Método:** Estudo ecológico de séries temporais da mortalidade por CCR em adultos de 30 a 69 anos, utilizando dados do *Global Burden of Disease* 2019. Os efeitos de idade, período e coorte foram analisados utilizando a ferramenta *Age-Period-Cohort Analysis Tool* do Instituto Nacional do Câncer dos Estados Unidos. **Resultados:** Observou-se aumento da mortalidade entre 1990 e 2019 em todos os países do BRICS. O efeito de idade foi identificado em todos os países, com maiores taxas em faixas etárias mais avançadas. Quanto à coorte de nascimento, observaram-se aumento constante na mortalidade masculina no Brasil, China e Índia, e diminuição na mortalidade feminina na China e na Rússia. **Conclusão:** A análise idade-período-coorte demonstrou que o acréscimo da mortalidade se concentra sobretudo em homens pertencentes a coortes pós-1960 e em faixas etárias economicamente ativas, ao passo que a Rússia exemplifica o potencial de políticas de controle para reverter a tendência. Os resultados apontaram para um aumento nas taxas de mortalidade por CCR em todos os países originais do BRICS, embora esse crescimento não ocorra de maneira uniforme.

Palavras-chave: Neoplasias Colorretais/mortalidade; Mortalidade/tendências; Estudos de Coortes.

RESUMEN

Introducción: El cáncer colorrectal (CCR) es responsable de más de 900 000 muertes anuales en el mundo, con marcadas diferencias regionales. **Objetivo:** Analizar la evolución de la mortalidad por CCR en los países BRICS entre 1990 y 2019, y estimar los efectos de edad, período y cohorte. **Método:** Estudio ecológico de series de tiempo de la mortalidad por CCR en adultos de 30 a 69 años, utilizando datos del *Global Burden of Disease* 2019. Los efectos de edad, período y cohorte fueron analizados utilizando la herramienta *Age-Period-Cohort Analysis Tool* del Instituto Nacional del Cáncer de los Estados Unidos. **Resultados:** Se observó un aumento de la mortalidad entre 1990 y 2019 en todos los países BRICS. El efecto de la edad fue identificado en todos los países, con tasas más altas en los grupos etarios de mayor edad. En cuanto a la cohorte de nacimiento, se observaron un aumento constante en la mortalidad masculina en Brasil, China e India, y una disminución en la mortalidad femenina en China y Rusia. **Conclusión:** El análisis de edad-período-cohorte demostró que el aumento de la mortalidad se concentra sobre todo en hombres pertenecientes a cohortes nacidas después de 1960 y en grupos de edad económicamente activos, mientras que Rusia ejemplifica el potencial de las políticas de control para revertir la tendencia. Los resultados señalaron un aumento en las tasas de mortalidad por CCR en todos los países originales BRICS, aunque este crecimiento no se presenta de manera uniforme.

Palabras clave: Neoplasias Colorrectales/mortalidad; Mortalidad/tendencias; Estudios de Cohortes.

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INTRODUCTION

Colorectal cancer (CRC) is the third most common neoplasm and the second leading cause of death from cancer, causing over 900 thousand annual deaths in the world[1]. In high-income countries, advances in regular screening, surgery, radiotherapy, and chemotherapy have reduced mortality over the last decades. However, an accelerated increase in CCR cases has been observed in middle-income nations, driven by urbanization, nutritional transition, and population aging[2,3].

Among these nations are the original BRICS countries – Brazil, Russia, India, China, and South Africa –, which account for 40% of the global population, and are facing rapid economic expansion and deep demographic and lifestyle changes[1,4]. These countries represent 42% of deaths from cancer and, in 2012, have lost 46.3 billion dollars in productivity (0.33% of the collective GDP) due to premature deaths by neoplasms[5].

Most publications on CCR in BRICS countries are based on national time series or reviews focused on a single country[6-9]. On the other hand, global comparative analyses often include countries with great heterogeneity in terms of income, age structure, screening coverage, and quality of records, with no specific framing for BRICS countries, which limits the direct transference of policies between similar contexts[1,2,5,10,11]. Mapping CCR mortality rates jointly in the original BRICS countries can accelerate the exchange of strategies to address rising risk factors such as diets high in ultra-processed foods, sedentary lifestyles, and obesity[3,12], in addition to highlighting internal inequalities in access to screening and treatment.

The Global Burden of Disease (GBD) 2019 provides harmonized annual series of CCR mortality rates from 1990 to 2019, based on death records, population census, and adjustments for under-recording[13]. These data enable the application of the age-period-cohort model (APC), which breaks down variations in rates into life-cycle effects (age), historical changes (period), and generational experiences (cohort)[14]. The approach identifies groups at greater risk, assesses the temporal impact of public policies, and guides resource allocation. As an external reference, we used the category "High-income North American countries", composed of the United States, Canada, and Greenland.

Given this context, the objective of this study is to analyze the evolution of standardized CCR mortality rates in the original BRICS countries from 1990 to 2019 and estimate the effects of age, period, and cohort on these trends.

METHOD

Data was obtained from GBD 2019, which estimates mortality, morbidity, and risk factors at a global scale[13]. Developed by the Washington University Institute for Health Metrics and Evaluation, GBD provides detailed estimations on mortality, morbidity, and the impact of the main diseases, lesions, and risk factors on the health of the global population[13]. Data is available online[15].

For each country, we collected the annual number of deaths by CCR (ICD-10, C18–C21) and age-standardized mortality rates (ASR) in the 30-34 to 65-69 years age groups, over the 1990-2019 period. The five original BRICS countries (Brazil, Russia, India, China, and South Africa) were included, and as an external reference, the aggregate of North American high-income countries (the United States, Canada, and Greenland).

BRICS assembles great emerging economies in an accelerated demographic and nutritional transition, sharing trends in the growth of chronic non-communicable diseases[3,13]. Comparing the group internally allows us to examine how different health systems, levels of screening coverage, and risk patterns modify CCR mortality.

Data from high-income North American countries were selected for comparison, considering they already went through the demographic and epidemiological transition process, possess better access to screening and treatment programs for this cancer, and recently presented lower incidence and mortality rates than the middle-income countries[1], configuring a comparative pattern to assess the distance between BRICS trajectories and a supposed maximum-control-possible scenario[16]. Greenland integrates the category per GBD's methodological convention and, due to its reduced population contingent, exerts minimal numerical impact on the aggregated.

Population data corresponds to the official United Nations projections, available online[17].

This is an ecological time series study of CCR mortality in adults aged 30-69 years, the age group that accounts for most deaths, and avoids instability of records in the age extremes. The APC model includes parameters that describe mathematical relations between the CCR mortality rate and the age of individuals, the period of diagnosis, and the birth cohort, in the general and sex-stratified populations[18,19].

In the APC model, net drift represents the log-linear trend per period and cohort for the entire population, and local drift represents the log-linear trend per period and cohort for each age group[20]. For the mortality calculation per age and period, a quinquennial grouping was done (between 1990 and 2019). The model estimations were performed on the online Age Period Cohort Analysis Tool,

developed by the United States' National Cancer Institute, available online[21]. The Wald test was used to analyze the significance of parameters and estimable functions.

The study used exclusively secondary public domain bases, with no individual identification. According to Resolution N. 510/2016[22] of Brazil's National Health Council, studies of this nature are exempt from appraisal by an Ethics committee.

RESULTS

Table 1 and Figure 1 show that, from 1990 to 2019, the CCR age-standardized mortality rate (ASMR) dropped 33% in high-income North American countries but increased approximately 25% in the BRICS group. In 2019, the group accounted for 41.5% of the global population and 38.3% of global CCR deaths, with a mean ASMR of 11.1 per 100,000 inhabitants compared to the 13.2 of the reference countries.

The internal trajectories were heterogeneous. Russia kept the highest ASMR but reduced it after 2000. China and India accounted for the absolute growth of deaths, with relative elevations of 26% and 27%. Brazil had a moderate increase (12%) followed by stabilization, while South Africa remained practically stable, with a discrete decline among women.

The differences per sex were striking. All the BRICS nations reported faster growth among men, especially China. In high-income countries, ASMR dropped in similar proportions for men and women, while still remaining at absolute levels higher than those of the emerging countries. (Table 1).

Figure 1 highlights divergent trajectories throughout three decades. In high-income North American countries, ASMR and CCR participation among all neoplasms dropped continuously until the mid-2000s, stabilizing at an inferior level. In BRICS countries, trajectories were heterogeneous: China and India showed persistent increases; Brazil increased until 2005 and stagnated; Russia went from a peak in the early 1990s to a sustained decline since 2000; and South Africa remained close to stability, with a slight increase among men.

Proportional CCR mortality increased for all BRICS countries, but more sharply in China, especially between the late 1990s and early 2010s. Brazil's CCR mortality rates increased until the 2000s and stabilized. In high-income economies, the relative proportion decreased almost linearly between 1990 and 2005 and remained stable, reflecting advances in the control of other tumors, and CCR screening and treatment (Figure 1).

Figure 2 summarizes the annual percentage variation of mortality rates (net drift) and the corresponding age differences (local drift). Between 1990 and 2019, only Russia presented a global decline (-0.6%/year), with a more accentuated drop among women (-1.0%/year). Brazil and China showed the greatest average increase (+0.7%/year each), followed by India (+0.6%) and by a non-significant oscillation in South Africa.

Per sex, the male growth was expressive in China (+1.8%/year) and Brazil (+1.0%/year); female mortality dropped in Russia and China but rose in Brazil and India.

In the age pattern (local drift), notable findings included an increase in women aged 30-39 and men aged 45-54 in South Africa; a decrease in the 45-54 age group for both sexes in Russia; and a persistent increase in the 50-59 age group among Chinese men. Such patterns point to economically active cohorts as priority targets in emerging countries and suggest the efficacy of Russian strategies initiated in the 2000s (Figure 2).

The APC analysis confirmed the strong CCR age gradient: in all BRICS countries, rates increased exponentially with age, culminating at 65-69 years. The maximum contrast was in Russia, where this group presented ten times more risk than at age 40, and the minimum was in India (Figure 3).

The period effects differ. In Brazil, the increase was fast until the early 2000s, then it stabilized with a slight drop for women. Russia recorded a small initial increment and continuous decline since 2000, but it was stronger in women. India maintained stability until the mid-2000s and later observed increases for both sexes. In China, women prolonged the decline initiated in 1990, while men rose until 2009 and then stabilized. South Africa did not vary much, showing a male peak in the 1990s, which softened after 2000.

Regarding cohorts, the risk increased among men in Brazil, China, and India, especially in the post-1960 Chinese generations, while it dropped almost linearly for Russian and Chinese women. South Africa showed an irregular pattern, with peaks in the 1930-40, 1950-60, and 1970-80 cohorts. Thus, the recent BRICS growth in CCR mortality is concentrated on men from young cohorts, while Russia presents systemic reductions that benefit all groups, mainly women (Figure 3).

DISCUSSION

Between 1990 and 2019, the original BRICS countries presented heterogeneous CCR mortality rates, a consequence of the different stages of demographic and epidemiological transition and the variable efficacy of their health systems. In high-income countries, rates have dropped due to population screening and therapeutic advancements, while middle and low-income nations still show an increase[6,7]. The growth of deaths by CCR

Table 1. Population and colorectal cancer mortality characteristics in the original BRICS countries from 1990 to 2019

	BRICS		Brazil	
	1990	2019	1990	2019
Population				
Total (millions)	2,360	3,223	150	211
Global percentage	44.39%	41.51%	2.81%	2.72%
Male (millions) (%)	1,198 (50.85)	1,639 (50.96)	74 (49.66)	104 (49.29)
Female (millions) (%)	1,158 (49.15)	1,577 (49.03)	75 (50.34)	107 (50.71)
Colorectal cancer				
Deaths	141,359	415,359	8,340 (7,991; 8,610)	27,051 (25,084; 28,402)
Male deaths	70,306	237,355	3,940 (3,779; 4,086)	13,406 (12,520; 14,212)
Female deaths	71,049	178,002	4,399 (4,165; 4,575)	13,645 (12,369; 14,593)
Relative proportion*	6.26%	9.73%	7.09%	10.17%
Male proportion	5.31%	9.32%	6.16%	9.40%
Female proportion	7.62%	10.35%	8.20%	11.05%
ASMR**	8.86	11.14	10.21 (9.68; 10.57)	11.67 (10.81; 12.28)
Male ASMR	9.87	13.80	10.32 (9.79; 10.72)	13.09 (12.14; 13.88)
Female ASMR	8.25	9.13	10.07 (9.40; 10.52)	10.52 (9.54; 11.25)
	Russia		**India**	
	1990	2019	1990	2019
Population				
Total (millions)	148	150	870	1383
Global percentage	2.78%	1.88%	16.20%	17.73%
Male (millions) (%)	69 (46.94)	67 (46.21)	449 (52.12)	714 (51.67)
Female (millions) (%)	78 (53.06)	78 (53.79)	420 (48.78)	668 (48.33)
Colorectal cancer				
Total number of deaths	29,696 (28,698; 30,770)	42,834 (37,637; 48,395)	21,971 (19,161; 25,094)	79,097 (67,137; 92,723)
Deaths among men	12,151 (11,670; 12,669)	19,267 (15,992; 22,930)	11,225 (9,579;14,024)	37,614 (29,868; 46,220)
Deaths among women	17,544 (16,897; 18,482)	23,567 (19,759; 27,651)	10,745 (8,563; 13,329)	41,483 (32,822; 50,946)
Relative proportion*	10.76%	14.43%	5.83%	8.48%
Male proportion	8.08%	12.38%	5.55%	8.00%
Female proportion	13.96%	16.70%	6.16%	8.97%
ASMR**	16.71 (16.11; 17.33)	18.17 (15.96; 20.54)	5.47 (4.77; 6.25)	7.50 (6.35; 8.76)
Male ASMR	21.62 (20.83; 22.53)	23.10 (19.25; 27.29)	5.48 (4.61; 6.84)	7.42 (5.92; 9.05)
Female ASMR	14.80 (14.24; 15.61)	15.46 (12.88; 18.23)	5.47 (4.30; 6.84)	7.58 (6.02; 9.26)

To be continued

Table 1. Continuation

	China		South Africa	
	1990	2019	1990	2019
Population				
Total (millions)	1153	1421	39	58
Global percentage	21.52%	18.29%	0.74%	0.74%
Male (millions) (%)	587 (51.36)	726 (51.09)	19 (48.72)	28 (49.12)
Female (millions) (%)	565 (49.43)	695 (48.91)	20 (51.28)	29 (50.88)
Colorectal cancer				
Number of deaths	79,322 (69,661; 89,294)	261,776 (224,403; 303,317)	2,030 (1,721; 2,491)	4,601 (4,159; 5,197)
Male deaths	42,023 (34,898; 49,395)	164,729 (132,244; 202,320)	967 (809; 1,255)	2,339 (2,084; 2,700)
Female deaths	37,298 (31,305; 43,321)	97,046 (78,376; 117,167)	1,063 (870; 1,310)	2,261 (1,966; 2,594)
Relative proportion*	5.44%	9.64%	7.32%	8.40%
Male proportion	4.70%	9.42%	6.58%	8.16%
Female proportion	6.59%	10.03%	8.15%	8.65%
ASMR**	10.18 (9.03; 11.37)	13.86 (11.92; 16.01)	10.39 (8.75; 12.96)	11.21 (10.13; 12.60)
Male ASMR	11.73 (9.95; 13.59)	19.32 (15.80; 23.15)	11.65 (9.72; 15.36)	14.01 (12.56; 15.98)
Female ASMR	9.14 (7.73; 10.58)	9.68 (7.82; 11.68)	9.38 (7.60; 11.71)	9.31 (8.10; 10.64)

Captions: * = Proportion in comparison to all the neoplasm types (deaths by colorectal cancer/deaths by all neoplasms); ** = Age-standardized mortality rate by colorectal cancer per 100 thousand inhabitants.

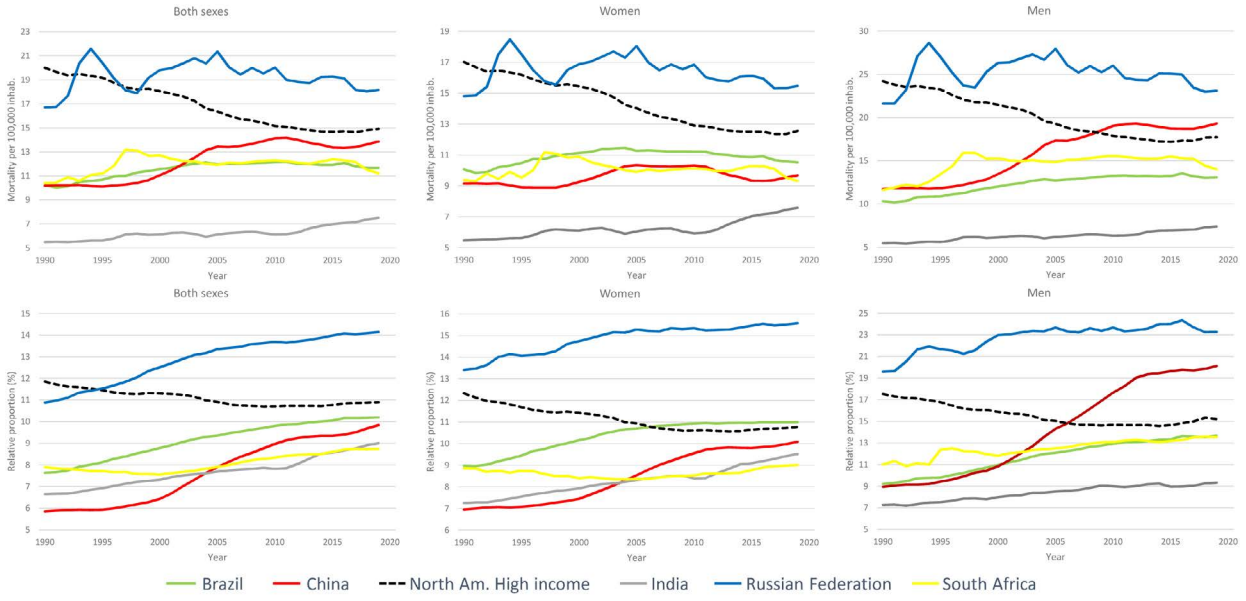

Figure 1. Age-standardized mortality rates and relative proportion of colorectal cancer in relation to all deaths by neoplasms, stratified by sex, in Brazil, Russia, India, China, South Africa, and high-income North American countries from 1990 to 2019

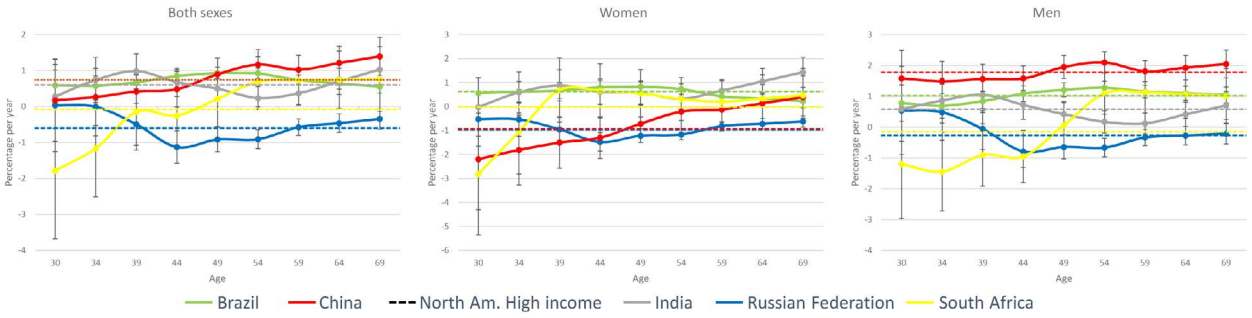

Figure 2. Local drift* with net drift* values for mortality by CCR stratified by sex in Brazil, Russia, India, China, and South Africa, in the 30-69 years population, from 1990 to 2019
Note: Net drift (dotted line) represents the general annual percentage variation, and the local drift values (solid line) represent the annual percentage variation in each age group. Values below 0 indicate reductions in CCR mortality throughout the period studied.

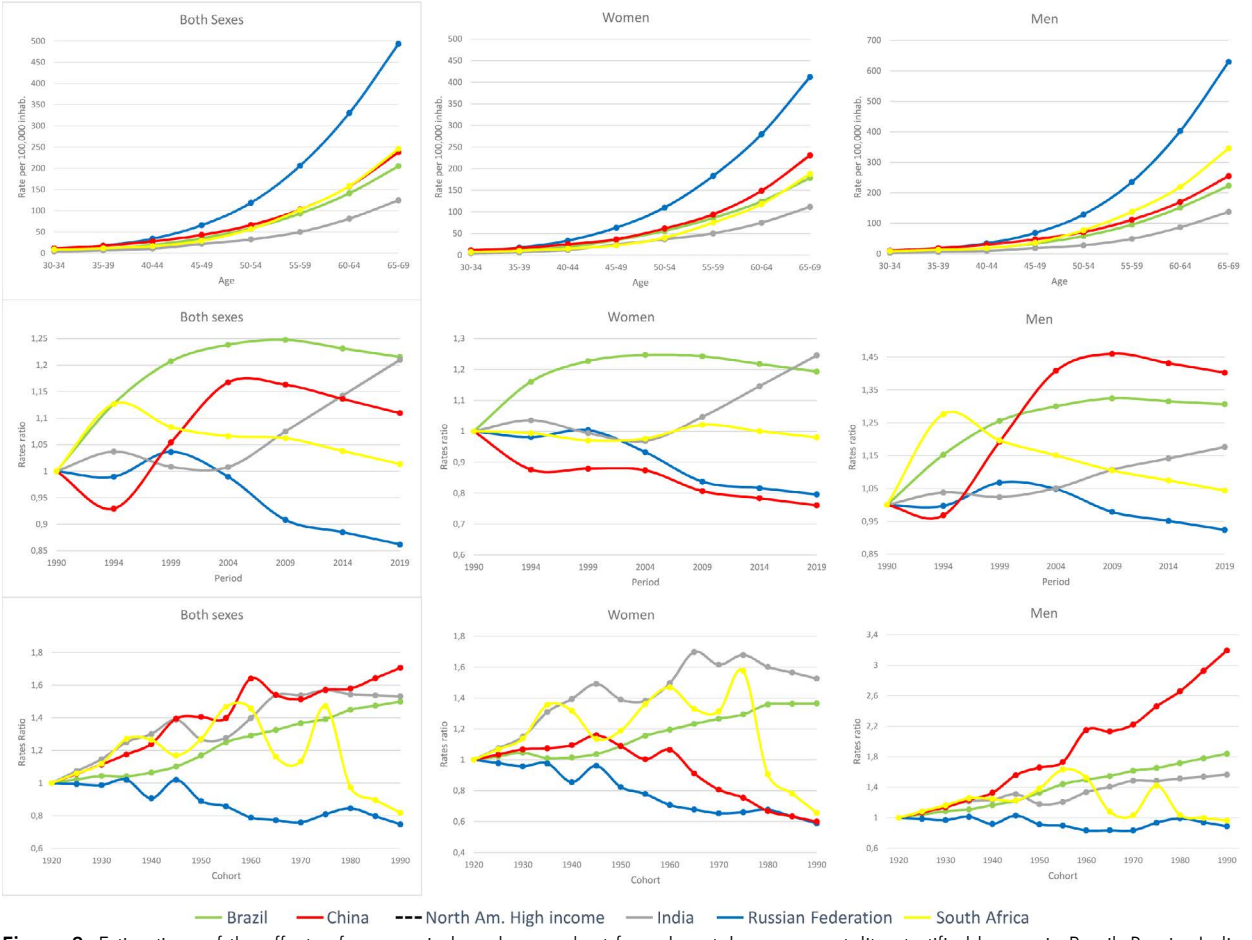

Figure 3. Estimations of the effects of age, period, and age cohort for colorectal cancer mortality, stratified by sex, in Brazil, Russia, India, China, and South Africa from 1990 to 2019

predominated in the group, but at diverse paces, with recent signs of stabilization or decline where control policies have been reinforced.

BRAZIL

In Brazil, CCR mortality rates grew consistently from 1990 onwards, but there are signs of deceleration in the last decade. The increase was less intense between 1990 and the mid-2000s; it later stabilized, and there was a discrete decline in the 2010s. A GBD analysis identified inflexion in 2011, with annual variation of -0.05% until 2019[23]. The result suggests advancements in the early detection and oncological therapy offered by the Brazilian National Health System (SUS) and the first screening initiatives. It is one of the few middle-income Latin American countries

with population-targeted actions, such as the São Paulo pilot program that combines fecal occult blood tests and colonoscopy for people aged 50-74 years[24]. Although the coverage is still incipient, between 2000 and 2017, Brazil had the greatest expansion in primary care among the BRICS countries[25], favoring early diagnosis.

Paradoxically, the South and Southeast Regions, which are more economically developed, have the highest rates. In 2020, around ten deaths per 100 thousand men and eight per 100 thousand women were estimated for those areas, outgrowing the North and Northeast Regions[26]. The gradient reflects greater urbanization, aging, and prevalence of risk factors (Western diet, sedentary lifestyle, overweight, and obesity)[26,27], in addition to improved access to diagnostic services, which increases the identification of cases and deaths. In less favored Regions, access barriers may generate under-records, despite the actual increase of risk associated with nutritional transition.

Internal socioeconomic inequalities also manifest among individual groups: mortality increase has been more pronounced in lower-income groups, who historically presented low risk, but nowadays accumulate risk factors and have less access to screening and treatment. To mitigate these disparities, the Brazilian Ministry of Health launched the Radiotherapy Expansion Plan and the Strategic Action Plan to Tackling NCDs, both with specific CCR goals[28,29]. However, recent assessments indicate that the goal to reduce mortality by 2% per year has not yet been reached[8], pointing to the need to organize screening programs, expedite treatment, and address the regional and social determinants of the disease.

RUSSIA

Russia faces an increasing burden of CCR since the 1990s, driven by population aging and post-Soviet behavioral changes. The tumor is already one of the main causes of cancer death: second in women (behind breast cancer) and third in men (after lung and stomach). Between 1993 and 2019, the standardized incidence increased from 16.9 to 24.3/100 thousand in women and from 22.7 to 35.3/100 thousand in men, indicating a substantial increase in the disease burden[28]. Parallel to that, the elderly dependence ratio grew from 18% in 2000 to 23.5% in 2020, amplifying the vulnerable contingent[30].

Despite international recommendations, CCR was not in the national screening priority in the 2000s[31]. In that period, around 25% of patients already presented a stage IV at diagnosis, and a third died in the first year – signs of late detection and limited access to treatment[31].

Reformations started in 2011 included CCR in routine appointments, and in 2013, colonoscopies began to be covered by the public system[32]. The National Cancer Control Plan[33] defined clinical guidelines, assistance parameters, and a budget for prevention, diagnosis, and treatment. Although these actions have contributed to the recent drop observed in mortality rates, the levels remain high. Studies conducted in 2022[34,35] still report barriers in access to oncology, absence of organized screening programs, and a high proportion of advanced cases[34]. On the other hand, the latest reports highlight improvements in specialized care and a reduction of late staging[35].

INDIA

Historically, India recorded low CCR rates, but incidence and mortality have been increasing with the population's epidemiological and nutritional transition[36]. In 2022, the tumor was already the fourth most frequent (64,863 new cases) and caused approximately 38,367 deaths, evidencing high lethality; while rates drop in high-income countries, several Indian Regions show an upward trend[6]. Urban centers and more economically advanced States have a higher incidence and mortality than rural zones, reflecting differences in lifestyle and access to care[37]. Between 2000-2019, national mortality grew on average +0.02%/year (both sexes), with a more striking increase among women; although modest, this variation implicates a great absolute number of lives lost due to the size of the population[38].

CCR advancement is related to demographic aging, diffusion of Western diets (less vegetarianism, more processed meat, fats, and sugar), and an increase in sedentary lifestyle and obesity, especially for the urban middle class[6]. India has the smallest primary care coverage in their health system and the smallest public expense among the BRICS[23,36] members, with a private sector that dominates service provision in all income groups, while the public system remains frail[39]. This arrangement makes oncological treatment financially prohibitive for many: the weekly cost of radiotherapy, with or without chemotherapy, may equal 60% of the average monthly income[40,41].

Policies launched in the 2010s, such as the *National Cancer Control Programme*, prioritized more incident neoplasms (oral, cervical, mammary), leaving CCR without a robust programmatic approach[42]. To restrain the projected advance, authors like Shaji et al.[37] recommend awareness campaigns about intestinal symptoms, expansion of sanitation (due to the association with intestinal inflammatory diseases), and inclusion of screening tests into public policies.

CHINA

Annual CCR deaths in China more than doubled between 1990 and 2019 [11]. In this period, the standardized

mortality rate rose from 10.2 to 13.9 per 100 thousand inhabitants, a 36% increase[43], despite therapeutic advancements. The incidence grew even more: among men, it went from 14.2 to 41.4 per 100 thousand[9]. This leap follows the accelerated urbanization, the adoption of diets with a higher intake of red meat and processed food, a sedentary lifestyle, and increased life expectancy[9,44].

Despite the strong increase in cases, evidence shows gradual progress in outcomes thanks to the health system's improvement. Over the last couple of decades, the country has strongly invested in the health system, expanding oncological centers, training specialists, and broadening insurance coverage. In 2021, it led the investment in primary care within BRICS[38]. This might have contributed to attenuating the growth of mortality in relation to incidence, that is, although more people are developing CCR, a slightly greater proportion of them are surviving longer or being healed, in comparison to the past. Studies in big cities already suggest stabilization or a slight drop in mortality[45].

In the scope of prevention, the main advancement was the Cancer Screening Program in Urban China, initiated in 2012, which combines fecal immunologic tests and risk questionnaires[46]. However, these types of programs remain limited in reach. Recent estimations suggest that only about 2.7% of the eligible population (aged 40–74 years) participated in some organized CCR screening program in 2020[47]. Until 2022, there was no nationwide program that covered the whole country[48]. This means that most diagnoses remain asymptomatic. China also has no universal public health system like the one seen in Brazil. Despite the country obtaining over 95% population coverage, including public and private health insurances, until the mid-2010s, its refund policy impaired poorer families' access to health services[40]. Moreover, health insurance in China is tied to the Chinese housing system (hùkǒu), hampering access to health services when the user is out of their official residence location in a country where around a fifth of the population consists of migrant workers[49].

SOUTH AFRICA

South Africa presents a singular CCR profile, marked by historical differences within population groups. The White population, with a Western diet and lifestyle, has always shown high incidence and mortality, while the Black population has kept much lower rates. This disparity has been decreasing: between 2002-2014, mortality by CCR grew on average 1.3% per year, driven mostly by Black men (+4.2%/year) and Black women (+3.4%/year), while higher income groups showed a stable trend[7].

The reasons for CCR mortality increase in South Africa are multifactorial. From a demographic point of view, the Black population, the largest in the country, underwent social, economic, and health improvements after the 1990s, which led to longer longevity, allowing more individuals to reach ages at which CCR becomes prevalent. In parallel, urbanization and the globalization of eating habits also influenced changes in the diets of this population, with greater intake of processed and animal-based foods and reduced fiber intake, in addition to an increase in sedentary lifestyles. These risk factors that were once unusual among Black South Africans are associated with the growth of CCR incidence, as observed in other parts of transitioning Africa[50].

In South Africa, great inequalities in access to health persist. Their system is dual, with a well-structured private sector aimed at the higher-income minority and a limited-resource public sector. In the private sector, tests such as screening colonoscopy and early treatment are more frequent, while on the public network, diagnoses tend to occur late. Until 2020, there was no public program for population screening. The national policies include promotion of healthy diets and physical activity, but with no specific guidelines for CCR[51]. Standalone initiatives, like mobile colonoscopy units, remain experimental, and most cases are still detected late, contributing to high lethality[52].

Some of the limitations imposed to this analysis must be underlined, such as: a) this study uses GBD estimations, subject to variations in the quality of death records for BRICS countries and possible biases, in addition to employing an APC model that, due to requiring restrictions to solve collinearities, provides essentially ecological effects sensitive to parametrization; b) the work with national data and quinquennial time frames also hides regional disparities and may soften subtle variations; and c) the lack of individual information on incidence and survival impairs the distinction of changes in disease occurrence and therapeutic advancements. Further studies should gather information on mortality, incidence, and survival on a regional and individual scale to fine-tune the understanding of CCR trends in the different BRICS contexts.

CONCLUSION

From 1990 to 2019, standardized CCR mortality rates dropped in high-income North American countries but grew by about a fourth in the original BRICS countries, with a striking internal heterogeneity: expressive increase in China and India, recent stabilization in Brazil, sustained decline in Russia, and discrete variation in South Africa. The APC analysis showed that the increase in mortality is mainly

concentrated among men born after 1960 and within economically active age groups, while Russia illustrates the potential of control policies to reverse this trend.

The findings indicate that organized screening initiatives, expansion of access to early diagnosis, and reduction of behavioral risk factors are a priority in the countries where mortality continues to rise, especially for male populations and young cohorts. For Brazil, strengthening already existing programs and equitably expanding coverage are plausible strategies; for China, the challenge is to scale screening pilots; for India and South Africa, establishing national policies for early detection and overcoming cost and access barriers; and for Russia, consolidating the obtained gains. By providing a standardized comparison between emerging economies, this study aims to contribute with evidence that can guide oncological planning and resource allocation within the BRICS countries, reinforcing the need for approaches adapted to each country's demographic, epidemiological, and systemic trajectories.

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CONTRIBUTIONS

Marcus Verly-Miguel has contributed to the study design, planning, data acquisition, analysis, and interpretation, as well as the wording. Caroline Madalena Ribeiro has contributed to the study design, planning, and critical review. Both authors approved the final version for publication.

DECLARATION OF CONFLICT OF INTERESTS

There is no conflict of interest to declare.

DATA AVAILABILITY STATEMENT

The generated data sets analyzed during the current study are available at the following links: "https://www.healthdata.org/data-visualization/gbd-results" and " https://population.un.org/wpp/downloads?folder=Standard%20Projections&group=Population".

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