Mortality due to Colon and Rectal Cancer in Brazil and its Regions between 2006 and 2020

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Mortalidade por Câncer de Cólon e Reto no Brasil e suas Regiões entre 2006 e 2020

Mortalidad por Cáncer de Colon y Recto en Brasil y sus Regiones entre 2006 y 2020

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ABSTRACT

Introduction: In Brazil, 704 thousand new cases of cancer were estimated for each year of the triennium 2023-2025, and colon and rectal cancer (CRC) is the type of neoplasm responsible for the third highest mortality rate for both sexes in the country. **Objective:** To analyze the temporal trend of premature mortality by CRC from 2006 to 2020, for both sexes, in Brazil and its five macroregions, and to evaluate whether the goal proposed by the Strategic Action Plan for Tackling Chronic non Communicable Diseases in Brazil 2011-2022 of the Ministry of Health (MH) in relation to CCR has been met. **Method:** Time series study of standardized premature mortality rates by CRC (ICD-10: C18-21); the study population is Brazil's population obtained from DATASUS' Mortality Information System from 2006 to 2020. **Results:** Premature mortality rates by CRC in Brazil and in all five macroregions increased linearly over the period investigated, but with important regional differences. The target proposed by the MH's Plan for CRC was not met. **Conclusion:** There was an increase in premature mortality rates by CRC in Brazil, a trend expected for developing countries. As it is a type of cancer that involves modifiable risk factors, continuous actions to manage these factors are important, such as national health promotion policies. Furthermore, studies are needed to support preventive policies for screening and early diagnosis programs.

Key words: Epidemiology/statistics & numerical data; Colorectal Neoplasms; Time Series Studies; Brazil.

RESUMO

Introdução: No Brasil, estima-se a ocorrência de 704 mil casos novos de câncer para cada ano do triênio 2023-2025, sendo o câncer de cólon e reto (CCR) o tipo de neoplasia responsável pela terceira maior taxa de mortalidade para ambos os sexos. **Objetivo:** Analisar a tendência temporal de mortalidade prematura por CCR de 2006 a 2020, em ambos os sexos, no Brasil e em suas cinco Macrorregiões, e avaliar o alcance da meta proposta pelo Plano de Ações Estratégicas para o Enfrentamento das Doenças Crônicas não Transmissíveis no Brasil 2011-2022 do Ministério da Saúde (MS) em relação ao CCR. **Método:** Estudo de séries temporais das taxas de mortalidade prematura e padronizada de CCR (CID-10: C18-21) tendo como população de estudo a do Brasil, com dados obtidos a partir do Sistema de Informação sobre Mortalidade do DATASUS de 2006 a 2020. **Resultados:** As taxas de mortalidade prematura por CCR apresentaram aumento linear ao longo do período observado, porém com importantes diferenças regionais. Em relação ao CCR, a meta proposta pelo plano do MS não foi alcançada. **Conclusão:** Houve um aumento das taxas de mortalidade prematura por CCR no Brasil, tendência esperada em países em desenvolvimento. Por ser um câncer que envolve fatores de risco modificáveis, são importantes ações contínuas voltadas para o manejo desses fatores, tais como políticas nacionais de promoção de saúde. Além disso, são necessários estudos que subsidiem políticas preventivas de programas de rastreamento e diagnóstico precoce.

Palavras-chave: Epidemiologia/estatística & dados numéricos; Neoplasias Colorretais; Estudos de Séries Temporais; Brasil.

RESUMEN

Introducción: En el Brasil, se estimó la aparición de 704 000 nuevos casos de cáncer para cada año del período 2023-2025, siendo el cáncer de colorrectal (CCR) el tipo de neoplasia responsable de la tercera mayor tasa de mortalidad para ambos sexos en el país. **Objetivo:** Analizar la tendencia en el tiempo de la mortalidad prematura por CCR en el período de 2006 a 2020, en ambos sexos, en el Brasil y sus 5 macrorregiones, y evaluar si fue alcanzada la meta propuesta por el Plan de Acción Estratégica para el Enfrentamiento de las Enfermedades Crónicas no Transmisibles en el Brasil 2011-2022 del Ministerio de Salud (MS) con relación a la CCR. **Método:** Estudio de series de tiempo de tasas de mortalidad prematura estandarizadas por CCR (CIE-10: C18-21) utilizando como población de estudio toda la población del Brasil, con datos obtenidos del Sistema de Información sobre Mortalidad del DATASUS de 2006 a 2020. **Resultados:** Las tasas de mortalidad prematura por CCR en el Brasil y en las cinco regiones mostraron un aumento lineal durante el período observado, pero con importantes diferencias regionales. Con relación al CCR, la meta propuesta por el Plan del MS no fue alcanzada. **Conclusión:** Hubo un aumento de las tasas de mortalidad prematura por CCR en el Brasil, tendencia esperada en países en desarrollo. Al tratarse de un tipo de cáncer que involucra factores de riesgo modificables, son importantes las acciones continuas encaminadas a gestionar estos factores, como las políticas nacionales de promoción de la salud del CCR. Además, se necesitan estudios que respalden las políticas preventivas para los programas de detección y diagnóstico temprano.

Palabras clave: Epidemiología/estadística & datos numéricos; Neoplasias Colorrectales; Estudios de Series Temporales; Brasil.

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INTRODUCTION

Cancer is one of the main public health problems worldwide and one of the four major causes of premature death in most of the countries. The World Health Organization – WHO estimates that in 2020, 19,292,789 cases occurred predominantly in males, responsible for 9,958 deaths in the world[1]. In Brazil, neoplasms are the second main cause of general and premature mortality, behind only cardiovascular diseases[2,3]. Due to the processes of demographic and epidemiologic transition which, combined, contribute to the population ageing and change of the epidemiologic profile, the incidence and mortality by cancer and other non-communicable diseases is increasing worldwide, becoming one of the main causes of death[2,4]. The occurrence of 704 thousand new cases of cancer are estimated for each year of the triennium 2023-2025 in the country[5].

According to data of the National Cancer Institute (INCA), except non-melanoma skin cancer, colorectal cancer (CRC) is the second most incident neoplasm for both sexes with 6.4% for men, behind only prostate cancer and 6.5% for women, behind only breast cancer[5]. In 2021, the male mortality rate by CRC, in relation to other neoplasms, was 8.8% and for females, 9.6%, the third neoplasm with high mortality for both sexes[6].

CRC encompasses tumors located in the large intestine, rectum and anus. The most frequently associated symptoms are: blood in feces, change of bowel habits (alternating diarrhea and constipation), frequent abdominal pain, weakness, anemia, weight loss with no apparent cause and abdominal tumor.

The etiology of this neoplasm is complex and multifactorial involving hereditary, behavioral factors and age. Among the modifiable risk factors are: obesity, few physical activity/sedentarism, smoking, high intake of ultra-processed food, red meat, excessive use of alcohol and low intake of vegetal fibers[7]. These tumors usually exhibit precursor lesion known as adenomatous polyp detected by colonoscopy – gold-standard method for early diagnosis of CRC. Studies have demonstrated that endoscopic polypectomy, early diagnosis and timely treatment reduce the incidence of and mortality by CRC since there is no difference in treatment's results according to the diseases' staging[8,9].

The data of the study Global Cancer Statistics 2020[2] indicate that globally, CRC accounts for 10% of all the diagnoses of cancer and for 9.4% of the total mortality by cancer, behind only breast cancer (11.7%) and lung (11.4%) in terms of incidence and lung cancer (18%) for mortality.

Different trend patterns of mortality rates by CRC have been detected in the world since 2012, increasing in developing countries – Eastern Europe, Latin America and Asia – and declining in developed countries – United States, Australia, New Zealand and some countries of Western Europe[2,9]. In addition, all five BRICS countries have witnessed a rise of their mortality rates by CRC since 2010[9,10]. A Brazilian study on the progression of premature mortality for 2030 highlights CRC as the type of cancer with the highest predicted increase for both sexes for all Brazilian regions, except the Southeast region[11]

Strategies to reduce the incidence of these diseases have been implemented in recent years globally and nationally. In 2011, Brazil launched the Strategic Action Plan for Tackling Chronic Non-Communicable Diseases (NCD)[12], reaching goals and actions to reduce the premature mortality rates by these diseases in 2% yearly between 2011 and 2022. In 2013, WHO implemented the NCD Global Action Plan determining a reduction of 25% of premature mortality by chronic NCD for country-members between 2013 and 2020[13].

Due to the impact of this disease on public health, it is essential the monitoring of mortality rates by CRC to stimulate debates and studies to further public policies in relation to their several levels of prevention.

The objective of this study is to analyze the time trend of premature mortality by CRC from 2006 to 2020 for both sexes in Brazil and its five macroregions and evaluate whether Brazil has met the goal proposed by the Strategic Actions Plan for Tackling Chronic Non-Communicable Diseases (NCD) to reduce premature mortality by CRC.

METHOD

Time-series ecologic study of premature mortality rate by CRC (ICD-10: C18-21); the sample is the Brazilian population and its five macroregions.

The Mortality Information System (SIM)[14] of the Computer Department of the National Health System (DATASUS) of the Ministry of Health (MS) was the source of the data from 2006 to 2020. The direct method of standardization of the premature mortality rate was utilized[15]. The standard population was the Brazilian population from the Census 2010 according to the data of the Demographic and Socioeconomic Information System which utilizes projections of "*Instituto Brasileiro de Geografia e Estatística (IBGE)*"[16].

The premature mortality rate is a health indicator to follow-up the goals of reduction of chronic NCD in Brazil[12]. Premature deaths of individuals by CRC in the age-range between 30 and 69 years old were included[15].

The number of deaths of the population of a certain year and place in the age-range of 30-69 years and the resident population between 30-69 years of a certain year

and place were considered for the calculation of the annual premature mortality rate (PMR) by CRC in Brazil's five regions from 2006 to 2020. The measure unit is expressed in number of deaths per 100 thousand inhabitants[15].

$$\text{PMR} = \frac{\text{Total number of deaths between 30-69 years by CRC/100 thousand inhabitants}}{\text{Total resident population between 30-69 years}}$$

The number of deaths by CRC was corrected according to the methodology of Mathers et al.[17] and adaptation proposed by Girianelli, Gamarra and Azevedo-Silva[18], which consists in redistributing proportionally 50% of the deaths classified as ill-defined (ICD-10: R00-R99). The adaptation was deemed necessary because cancer is the least found among ill-defined deaths than well-defined[19]. Therefore, the correction factors were calculated for each age-range (30-39, 40-49, 50-59, 60-69), calendar-year, sex and macroregion of residence (North, Northeast, Midwest, South and Southeast).

Upon the correction, the direct standardization method was applied to annual mortality rates per 100 thousand inhabitants referred to the Brazilian population of 2010, stratified by sex[15]. The corresponding values to "age ignored" and "sex ignored" were excluded in the calculation of the rates, representing < 0.001% of the sample in the period investigated.

The difference between the standardized annual premature mortality rate by CRC and the goal of 2% of reduction of chronic NCD was calculated since 2011, the year when the Tackling Plan of Chronic NCD of the MS initiated and applying the reduction of 2%/year with the formula of $tx_i = taxa2011*(1\text{-}0{,}02)^t$ where: tx_i is the rate after the reduction of 2%/year for the year i (for instance, 2012 would be t = 1, i = 1 and so on). While listing the expected series of reductions and comparing with the series of the *taxa* ($tx_{observada} - tx_i$), the differences of the format of the table of each year were detailed, the negative values were those whose $tx_{observada}$ were lower than the expected rate of reduction.

Test *t* was utilized for independent samples to compare the means of the standardized rates of premature mortality by CRC for the Brazilian regions from 2006 to 2020 stratified by sex. The normality hypotheses of the values and homogeneity of variances were tested with Shapiro-Wilk tests for factors levels and by the Levene test, respectively.

Considering the time dependence of the annual rates of the period investigated, the autoregressive integrated moving means model – Arima was utilized, allowing the standardized mortality rate to be explained by values lagged in time and also to analyze the intervention[20]. In the case, a binary variable that would assume value 0 for the period 2006-2011 was utilized, being 2011 the year when the goal of the Strategic Plan For Tackling Chronic NCD in Brazil was agreed upon for 2011-2022 and assuming value 1 for the post-implementation period from 2012 to 2020. Assuming the normality of the standardized rates, a time series stochastic process for a model Arima (2,1,1), the biggest possible model for these data will be given as:

$$\Delta z_t = \varphi_1 \Delta z_{t-1} + \varphi_2 \Delta z_{t-2} + \theta_1 a_{t-1} + a_t$$

Where the first difference $\Delta z_t = z_t - z_{t-1}$
$\varphi_{1\,e\,2}$ represents the autoregressive parameter
θ_1 represents the parameter of moving mean
z_t standardized rate for instant t
$a_t \sim N(0,1)$ represents the random error of the model

The choice of the autoregressive integrated moving mean between (2,1,1) and (1,1,0) will be given through the comparison of their criteria AIC (Akaike information criterion) and BIC (Bayesian information criterion), keeping the one with lower values[20]. The development of the series occurs by its time relation, with the year when the data was extracted as the time unit and the estimation of the model was made by the function of likelihood[21]. The characteristics of the model, the significance of the parameters estimated, and the mean absolute error of the predictions were evaluated by the test Box-Pierce-Ljung[20] within the sample (Mean Absolute Percentage Error – MAPE)[22]. The software utilized in the analysis was R[23], version 4.1.0, adopting the packages Forecast and lmtest.

To estimate the linear trend, the autoregressive distributed lag model was utilized. Considering the lagging of the dependent variable and lagging of the explanatory variables (confounders) considering its chronological successions.

The general form with one lag:

$$y_t = m + \alpha_1 y_{t-1} + \beta_0 x_1 + \beta_1 x_{t-1} + \epsilon_t$$

The model utilized was:

$$\Delta z_t = \varphi_1 \Delta z_{t-1} + \varphi_2 \Delta z_{t-2} + \beta_1 x_t + \epsilon_t$$

Where:
y_t is the standardized rate and Δz_t is the difference of the rate with its successor in t-1
$\beta_1 x_t$ is the parameter of the lagged explanatory variable utilized for the linear trend and explanatory variables were not utilized in this model, being the time as explanatory variable in form 1 for the first year, 2006 and 15 for 2020.
$\epsilon_t \sim N(0,\sigma_t)$ normal variance constant in t

Considering the dynamic balance and the utilization of only one exogenous variable to diagnose the model, only the test of Box-Pierce-Ljung was utilized, being the white noise the expected residue[20]. In the context of the language R for this model, it is possible to adjust Arima (1,1,0) utilizing the estimated drift by maximum likelihood. As example, the package forecast and the order Arima C (data, order = c(1,1,0), include.drift = T) were adopted.

The Institutional Review Board waived the review and approval of the study because only deidentified and public data were utilized according to Directive 510/2016[24] of the National Health Council (CNS).

RESULTS

The rates of premature mortality rate by CRC in Brazil and its five regions have risen linearly in the period investigated but important regional differences exist. In 2020, general mortality rates per 100,000 inhabitants were higher in the South (11.23), Southeast (10.89) and Midwest (10.26) regions and lower in the Northeast (6.34) and North (5.95) regions (Table 1).

When general and premature mortality rates by sex are compared, an even higher rate for males in all regions was found in 2020: 12.39 (South), 11.71 (Southeast), 11.00 (Midwest), 6.49 (Northeast) and 6.21 (North). Also in the same year, the highest rates of premature death for females were detected for the South (10.18) and Southeast (10.15) regions, followed by Midwest (9.22), Northeast (6.20) and North (5.69).

Despite higher mortality rates for males in all regions for 2020 have been found, the North region presented higher mortality rates for females in this same period and male mortality exceeded females rates only in 2007, 2013, 2019 and 2020 after analyzing the mean rates of the period investigated. However, the North and Northeast regions were the only ones which did not present statistically significant mortality rates by CRC according to the test *t* of difference in means (Table 2).

The charts of the standardized rate with the adjusted model show goodness-of-fit. The Southeast region had the highest time-dependence with one model Arima (2,1,0) with drift, for the other regions the model Arima (1,1,0) was utilized. All the models presented goodness-of-fit, even in the Midwest and North regions, with 4.62% and 4.21%, respectively. The values MAPE for the other regions and the national values fluctuated between 1.2 and 1.4%. All the regions presented rising trend of the

Table 1. Standardized rates of premature mortality by CRC stratified by sex. Brazilian regions

Region	Year	Population	Total deaths	Rates of premature death by sex		
				Female	Male	General
Midwest	2006	13,333,632	645	8.088	7.798	8.194
	2010	14,292,945	834	8.518	8.481	8.715
	2015	15,442,232	1,103	7.941	10.858	9.519
	2020	16,496,340	1,419	9.222	10.996	10.265
Northeast	2006	52,499,041	1,342	3.794	3.842	3.817
	2010	54,506,351	1,744	4.380	4.900	4.617
	2015	56,560,081	2,566	5.733	5.483	5.620
	2020	58,174,912	3,238	6.202	6.486	6.340
North	2006	15,085,215	230	4.463	2.980	3.721
	2010	16,206,409	335	4.382	3.856	4.126
	2015	17,472,636	519	5.762	4.504	5.141
	2020	18,583,035	753	5.692	6.210	5.957
Southeast	2006	79,318,449	6,208	8.788	10.449	9.567
	2010	82,392,683	7,686	9.493	11.114	10.258
	2015	85,745,520	9,163	9.974	11.346	10.619
	2020	88,601,482	10,794	10.149	11.713	10.895
South	2006	27,098,800	2,394	9.290	11.494	10.338
	2010	28,099,409	2,745	9.394	11.873	10.570
	2015	29,230,180	3,345	9.639	12.217	10.874
	2020	30,221,606	4,041	10.185	12.387	11.234

standardized mortality rates by CRC from 2006 to 2020 (Graph 1).

The South and Southeast regions presented the highest standardized rates of premature death for the general population in 2020, 11.23% and 10.89% respectively, with lower growth trends (0.079% and 0.106%), but the trend for the South region was not statistically significant. North, Northeast and Midwest regions had increasing trend above the national mean of 0.124% (Table 3).

The South region was the only Brazilian region which met the goal of reduction of mortality of at least 2% between 2012 and 2014. In 2020, all the regions exceeded at least two points above the goal of premature standardized mortality rate, the results show that premature mortality by CRC kept an increasing trend even after the implementation of the strategic plan (Table 4).

DISCUSSION

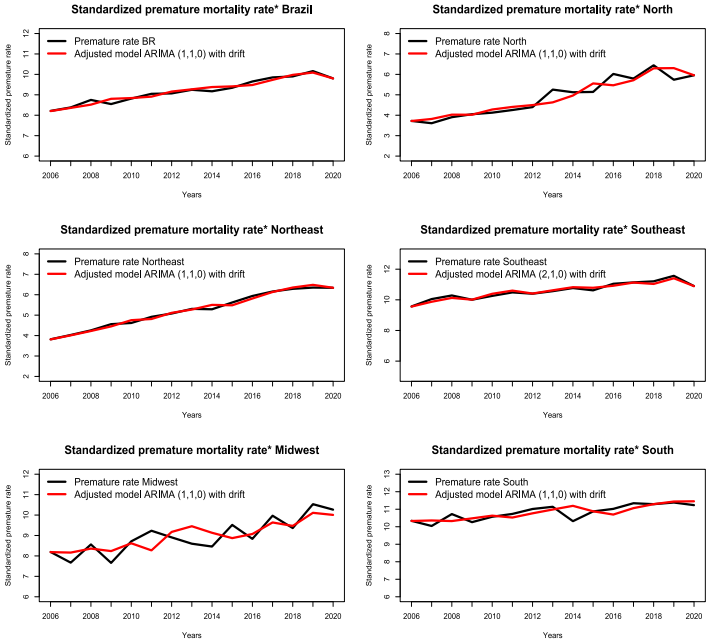
The increasing time trend of premature mortality rate by CRC in Brazil was observed for both sexes across all the country's regions during the years investigated. From 2011 to 2020, the goal of reduction of CRC determined by the Strategic Plan for Tackling Chronic NCDs (2%/year) was not met.

As the South and Southeast regions are the most economically developed regions and the Northeast and North are the less developed, some findings deserve attention: a) the highest mortality rates were found at the most economically developed and declining trend in time and b) the lowest mortality rates were found on the least developed regions and rising trend in time. The model for the Midwest region with the highest trend among the regions varied significantly, with consistent

Table 2. Standardized mean of the rates of premature death by CRC stratified by sex, Brazilian regions, 2006-2020

Region	Mean by Sex (2006-2020)			Test t	CI 95%	
	Female	General	Male	*p*	Lower	Upper
Brazil	8.57	9.20	9.87	<0.01	-1.75	-0.83
North	5.16	4.90	4.63	0.17	-0.23	1.27
Northeast	5.40	5.24	5.48	0.80	-0.77	0.61
Midwest	8.35	8.97	9.23	0.02	-1.64	-0.11
Southeast	9.88	10.59	11.40	<0.01	-1.94	-1.10
South	9.71	10.82	12.04	<0.01	-2.71	-1.94

Caption: CI = confidence interval.



Graph 1. Standardized premature mortality rates by CRC adjusted per Brazilian Regions, 2006-2020

Captions: BR = Brazil; Arima = autoregressive integrated moving average.
(*) standardized by annual mortality rates per 100,000 thousand inhabitants in relation to the Census 2010 of the Brazilian population.

growth curve and wider amplitude of the confidence interval, which can explain its rising trend compared to other regions (Table 3).

Socioeconomic level and CRC is a well-established relation in the literature. Studies show the rising time trend by CRC in Brazil, a developing country and positive association between the rates and level of local development[4,11,25]. The premature mortality rate by CRC was higher in the South, Southeast and Midwest regions, the most economic developed. Globally, there is a rising trend of the morality rate by CRC in less developed countries, mainly in Eastern Europe, Latin America and Asia, while in the Western European countries, a declining trend was noticed[2]. Although in USA the rate declines continuously, deaths by CRC in individuals younger than 55 years have increased nearly 1% annually[26].

The rising trend of the mortality in Brazil reflects the heterogeneity across the Brazilian regions, similar to what other national studies have concluded[4,11,27]. Although lower rates of premature mortality have been found in the North and Northeast regions, there is an increasing trend compared with the South and Southeast regions for both sexes, similar to other studies which estimated significant rise of the mortality rate for the least developed regions until 2030 due to late diagnosis that could have been diagnosed earlier contrary to the most developed regions[28-30].

Many studies have shown highest premature mortality rates in men than in women[4,28,31,32]. However, other Brazilian studies concluded otherwise[33]. These results can be explained by poor search of men for health services, higher alcohol intake and cultural issues, in addition to few health units for males only[34]. On the other hand, a possible protective effect of female hormones against colorectal tumors with the use of oral contraceptives and hormone replacement therapy[35] has been described.

Higher premature mortality rates were found for Brazilian men in every region, except the North region, however, no statistically significant difference was detected among premature mortality rates for men and women in the North and Northeast regions.

The study by Barbosa[30] emphasizes the differences among sexes with relative stable female mortality rates until 2030 and reduction of male mortality. Souza et al[29], in their study, show increase of male mortality rates nationally and by geographical regions, except for the South region (a drop is anticipated) until 2025. Rising rates are expected for women in the whole country,

Table 3. Increasing trend of premature mortality – 2006-2020

	Trend	Standard Deviation	Confidence Interval	
			Lower	Upper
Brazil	0.124	0.031	0.056	0.192
North	0.165	0.062	0.031	0.299
Northeast	0.181	0.028	0.119	0.242
Midwest	0.182	0.082	0.006	0.358
Southeast	0.106	0.019	0.065	0.147
South	0.079	0.057	-0.043	0.201

Table 4. Difference between the annual premature standardized mortality rate by CRC and goal of 2% of reduction of NCD

Year	Brazil	North	Northeast	Southeast	Midwest	South
2011	0.00	0.00	0.00	0.00	0.00	0.00
2012	0.20	0.22	0.26	0.12	0.49	-0.14
2013	0.55	1.16	0.58	0.49	0.83	-0.27
2014	0.65	1.12	0.66	0.90	0.21	-0.23
2015	0.99	1.21	1.08	0.94	0.97	1.00
2016	1.47	2.17	1.49	1.57	1.31	0.49
2017	1.83	2.02	1.80	1.85	1.83	1.79
2018	2.04	2.75	2.02	2.10	1.97	1.35
2019	2.46	2.11	2.16	2.64	2.25	2.67
2020	2.25	2.40	2.24	2.15	2.28	2.56

Captions: CRC = colorectal cancer; NCD = chronic non-communicable diseases.

increasing in the North, Northeast and Midwest regions and declining in the South and Southeast regions, but other factors may affect the heterogeneity of the mortality by CRC in the regions.

Heterogeneous food profiles of each region may impact the distribution of mortality rates by CRC[27]. The Family Budget Research of 2017-2018 investigated the Brazilian food diet by comparing the macroregions: fruits and vegetable per capita intake (kg) in the North region is well below other regions. The intake of meats is higher in the South region, followed by the Midwest, Southeast, North and Northeast. Beverages in general has risen from 9.7% in 2008-2009 to 10.6% in 2017-2018 with the same behavior of annual intake of meats *per capita* in the regions, higher in the South region, followed by Midwest, Southeast, North and Northeast regions[36,37]. The analyzes of regions' intake rates should include dietary standards in addition to family income because it can impact the consumption of food with protective effect against CRC[4].

The time since diagnosis and treatment of CRC varies in States and Regions. The waiting time to start treatment can reflect deficiencies of access to treatment and negatively impact the prognosis of CRC. Lima and Villela[38] showed the long waiting time in Brazil and differences among macroregions and found that the mean time to start the treatment is less than 60 days, but in some states, the time exceeded 60 days as in the North Region (Pará and Amazonas), Northeast (Sergipe and Bahia), Midwest (Goiás and Federal District) and Southeast (Rio de Janeiro).

The goal of the Strategic Action Plan for Tackling Chronic NCD for CRC is challenging for the government. Screening and detection are the main strategies to reduce the mortality. The etiology of CRC favors screening because the time of onset of the adenoma, growth and transformation in tumor exceeds ten years, quite long to allow the identification, resection and prevention[39,40].

The WHO recommends early diagnosis and screening for men and women older than 50 years (the incidence below 50 years is 10%) in countries with structure to confirm the diagnosis and treatment. In Brazil, screening is indicated for the age-range of 50-75 years with test of occult blood in feces, colonoscopy or sigmoidoscopy and endoscopy polypectomy which reduce the incidence and mortality[10,39,40]. Whether evidences of cost-effectiveness and sustainability are not available, the priority is early and patient-centered diagnosis for high-risk situations. Although clinical trials address the benefits of screening, the implementation of national CRC screening programs in Brazil depends on cost-effectiveness and feasibility in addition to health systems context[39,40].

It is strongly recommended that early diagnosis strategy is implemented in its integrality: ample disclosure to the population and health professionals of signs, immediate access to diagnosis of suspected cases (increased offer of digestive endoscopy and others) and access to correct and timely treatment[39,40].

As CRC is a modifiable type of cancer, national preventive policies are important. Healthy life measures and reduction of chronic NCD were included in public policies as promotion of better feeding, high intake of fruits and vegetables, less salt, public venues for physical activity, anti-smoking campaigns and banning alcohol adds[11,41]. The successful fulfillment of the goal hinges on: ensure the access to health unit, especially for most vulnerable groups, health professionals training, renovation of health units with better equipment, investment in access to high and intermediate complex technologies if applicable.

Notwithstanding what has been achieved in the last decades, some limitations related to the quality of death certificates which feed the database of SIM[42,43] have been found. This reality can interfere in the calculation of rates that differ across the regions with potential subnotification, mainly in the North and Northeast regions undergoing demographic and epidemiologic transition with less coverage, less economically developed and portraying more deaths than notified with clear consequences in the formulation of public policies.

CONCLUSION

The trend of premature mortality by CRC has risen across every Brazilian region for both sexes similar to developing countries, but this result failed to reach the reduction of the goal of premature death proposed by the Ministry of Health, an important public health problem. The definition of priority populations and Brazilian regions for early intervention that increase survival and reduce mortality depends on rates trends.

Regardless of genetic factors and population ageing – risk factors not addressed in this study – the patterns and trends of incidence and premature mortality by CRC are related to levels of human and local development which, if modified, can reflect in healthier lifestyles. Targeted resources-dependent governmental interventions including primary health promotion with early detection to reduce the number of patients with CRC in the upcoming years is required.

Full care to patients with CRC, even if these measures have been implemented, should address the access to health units which offer high-and-middle complex technologies. Cost-effective governmental evaluations to

facilitate the access of vulnerable populations to tests of occult blood in feces and colonoscopy, increasing CRC screening since prognosis and reducing premature death because prognosis is quite often better whether detected in symptomatic stage.

CONTRIBUTIONS

All the authors contributed substantially to the study design, acquisition, analysis and interpretation of the data, wording and critical review. They approved the final version to be published.

DECLARATION OF CONFLICT OF INTERESTS

There is no conflict of interests to declare.

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