

Original Article

Lung cancer, cancer of the trachea, and bronchial cancer: mortality trends in Brazil, 1980–2003*

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Abstract

Objective: To describe the mortality trends for lung cancer, cancer of the trachea, and bronchial cancer in relation to gender and age brackets in Brazil. **Methods:** Data related to mortality between 1980 and 2003 were collected from the Brazilian Mortality Database. A trend analysis of mortality was carried out, nationwide and in selected states, using the LOWESS technique for rate smoothing and model adjustments. **Results:** In Brazil, the standardized mortality rate for lung cancer, cancer of the trachea, and bronchial cancer increased from 7.21/100,000 inhabitants in 1980 to 9.36/100,000 inhabitants in 2003. Specific mortality rates decreased in males in the 30–49 and 50–59 age brackets. In the 60–69 age bracket, the rates for males increased from 1980 to 1995 and declined thereafter. There was a trend toward higher mortality rates in males over 70, as well as in females over 30, throughout the period evaluated. **Conclusions:** The decrease in the mortality rates in younger males might have resulted from recent national interventions aimed at reducing the prevalence of smoking and reducing exposure in younger cohorts. High mortality rates in older populations remained constant due to prior tobacco use. Increased mortality rates in females are a worldwide trend and are attributable to the recent increase in smoking prevalence in females.

Keywords: Lung neoplasms/epidemiology; Mortality/trends; Brazil.

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Submitted: 9 October 2006. Accepted, after review: 24 January 2007.

Introduction

Cancer is considered a public health problem in developed and in developing countries. Worldwide statistics show that, in the year 2000, new cases of cancer occurred in 5.3 million men and 4.7 million in women, with 6.2 million deaths (3.5 million men and 2.7 million women), corresponding to 12% of the total number of deaths from all causes. Lung cancer is the most prevalent, accounting for approximately 1.2 million new cases every year.⁽¹⁾

The Brazilian National Cancer Institute estimated the number of new cases of lung cancer at 17,850 among men and 9230 among women in Brazil in 2006. These values correspond to an estimated risk of 19/100,000 men and 10/100,000 women.⁽¹⁾ The total accumulated mean five-year survival rate ranges from 13 to 21% in developed countries and from 7 to 10% in developing countries.⁽¹⁾

In the United States, between 1990 and 2000, there was a statistically significant reduction in deaths due to lung cancer and bronchial cancer in men. Mortality rates went from 90.6/100,000 in 1990 to 76.9/100,000 inhabitants in 2000. An increase in mortality rate among women occurred in the same period, from 36.8/100,000 inhabitants to 41.2/100,000 inhabitants.⁽²⁾ It is argued that the differences in the magnitude of rates between genders are due to the habit of smoking being more intense among men. The decline in rates among men in the last decade is attributed to the reduction in the smoking habit in the last decades. The still increasing rise in mortality rates among women is attributed to the increased prevalence of smoking, which declined only in the 1970s. It is argued that 90% of deaths from lung cancer in the United States are caused by the smoking habit.⁽²⁾

In the United Kingdom, there is a trend toward a decrease in lung cancer deaths among men in all age brackets. In the case of women, this decrease has occurred since the 1990s in some age brackets (55 to 64 years and 64 to 74 years) Among women in the 44-54 age bracket, this number is stable, whereas among those over 75 years of age, the trend is toward an increase in mortality rates. There are also higher rates of lung cancer among men.⁽³⁾

The World Health Organization considers smoking a great public health problem in the history of mankind.⁽⁴⁾ Smoking can increase the risk of death by 20 to 30 times in long-term smokers

and by 30% to 50% in passive smokers. The incidence rates of lung cancer in a certain country reflect the consumption of cigarettes.^(1,4) In the male population, the habit of smoking continues to be responsible for most cases of diagnosed lung cancer, which remains a lethal disease.

The present article aims to describe the mortality trend for lung cancer, cancer of the trachea and bronchial cancer in relation to gender and age brackets in Brazil.

Methods

Data related to mortality were collected from the *Sistema de Informações sobre Mortalidade* (SIM, Mortality Database) of the Brazilian Department of Health Oversight.⁽⁵⁾ For calculating the rates we used the population counts obtained by the Brazilian Institute of Geography and Statistics in the Censuses of 1991 and 2000, population counts in 1996 and population estimates.⁽⁶⁾ The SIM data were related to the following causes of death: cancer of the trachea, bronchial cancer and lung cancer, based on the Ninth and Tenth Revisions of the International Classification of Diseases (ICD-9 162 and ICD-10 C33-C34).^(7,8)

Trend analysis was conducted in two steps: descriptive analysis and model adjustment. In the descriptive analysis, figures with standardized mortality rates (direct method) are presented for Brazil in the 1980-2003 period. The population used for standardization was the Brazilian population in 2000. In order to facilitate the visualization of trends over time, we included rate smoothing, using the LOWESS technique.⁽⁹⁾

In order to analyze the mortality trend in each state of Brazil, negative binomial regression models were adjusted. These belong to the class of generalized linear models.⁽¹⁰⁾ For model adjustment, aiming at the calculation of the annual percentage variation of mortality rate, we used data from 1990 and 2003. This is due to a change in trend behavior over time, which occurred principally in the 1980s. This can be seen in the graphs of mortality trends. In the process of date modeling, we considered that mortality trends might be different between genders and in the various age brackets. Therefore, the response variable was the number of deaths and the explanatory variables of mortality were gender, age bracket, time (in years), the state and the

possible interactions. For the inclusion of the state in the model, we considered SIM coverage higher than 80%, the proportion of poorly defined causes of death lower than 20% and the existence of stable data over time that allowed the adjustment of the model. The states that satisfied this criteria were as follows: Minas Gerais, Espírito Santo, Rio de Janeiro, São Paulo, Paraná, Santa Catarina, Rio Grande do Sul, Distrito Federal, Mato Grosso do Sul and Mato Grosso. The state of Pernambuco was included in order to allow the comparison with a state of the northeast region, since it presents the greatest data in the region, although it does not entirely meet the criteria shown above. In 2003, there was 76% SIM coverage and 19.6% poorly defined death causes.

In order to facilitate the analysis, the tables contain three basic sources of information: the adjusted value for mortality rate in 1990 and in 2003, the annual percentage variation in this rate and the descriptive level (p value). We adopted a significance level of 5% to reject the null hypothesis that there is no difference in the annual percentage.

Results

The number of deaths caused by cancer of the trachea, bronchial cancer and lung cancer in Brazil, according to the Brazilian mortality database in 2003 was 11,057 deaths among men and 5398 deaths among women. These values correspond to a rate of 15.2/100,000 men and 8.7/100,000 women.

In Brazil, the standardized mortality rates for lung cancer, cancer of the trachea and bronchial cancer increased from 7.2/100,000 inhabitants in 1980 to 9.4/100,000 inhabitants in 2003. However, specific mortality rates decreased in males in the 30-49 and 50-59 age brackets throughout the period evaluated (Figures 1 and 2). Among men in the 60-69 age bracket, there was an increase in death rates in the first period (1980s to 1995), followed by a decline (Figure 3). Among men over 70 and among women over 30, there is a trend toward higher mortality rates throughout the period evaluated.

In all age brackets, the rates are higher among men, and there was an increase in

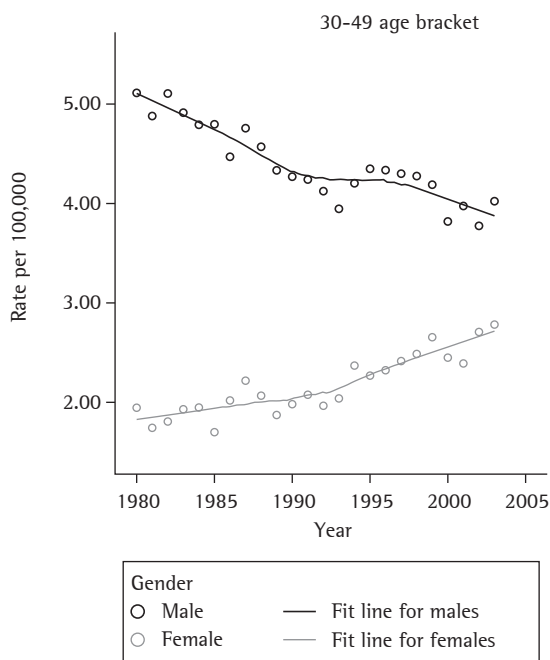


Figure 1 - Specific mortality rate for cancer of the trachea, bronchial cancer and lung cancer by gender in the 30-49 age bracket - Brazil, 1980-2003.

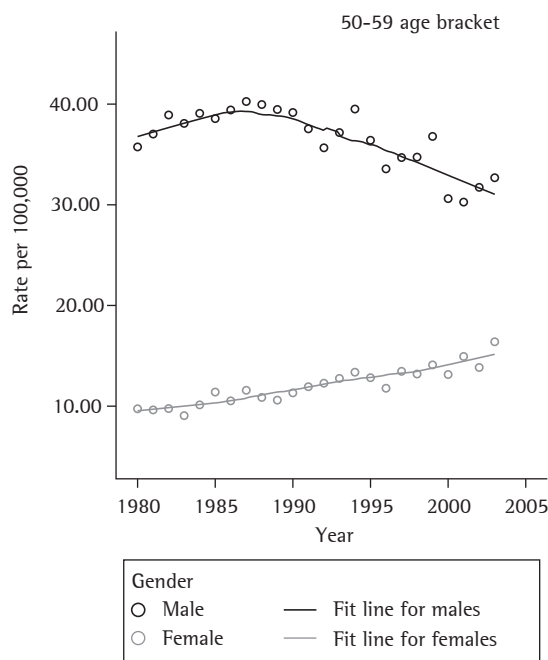


Figure 2 - Specific mortality rate for cancer of the trachea, bronchial cancer and lung cancer by gender in the 50-59 age bracket - Brazil, 1980-2003.

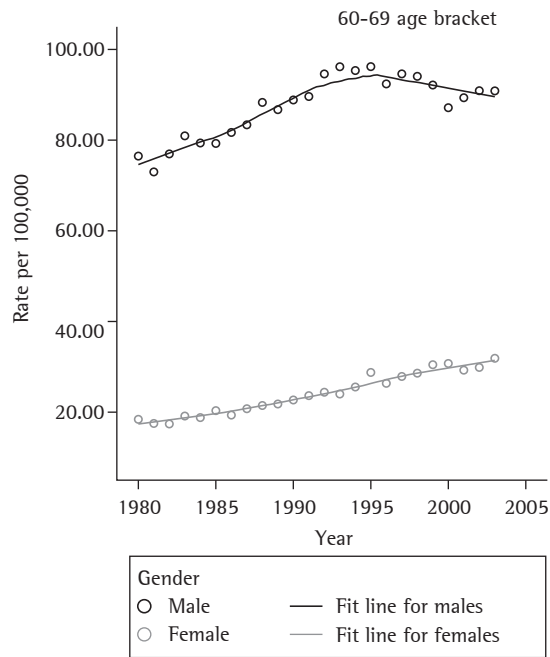


Figure 3 - Specific mortality rate for cancer of the trachea, bronchial cancer and lung cancer by gender in the 60-69 age bracket - Brazil, 1980-2003.

parallel with the advance of age in both genders (Figures 1, 2 and 3).

Figure 1 shows that the 30-39 age bracket presented lower mortality rates for both genders. In 1980, the rates were 5.1/100,000 men and 1.9/100,000 women, and the male/female ratio was 2.6:1. In 2003, the rates were 4.0/100,000 men and 2.9/100,000 women, and the male/female ratio decreased to approximately 1.5:1.

Mortality rates progress in the subsequent age brackets, with a consequent increase in morbidity and mortality in the more advanced age brackets. In 1980, the rates were 35.7/100,000 men and 9.7/100,000 women in the 50-59 age bracket, and the male/female ratio was 3.7:1. These rates changed over the last two decades, resulting in a decrease among men to 32.7/100,000 and in an increase among women to 16.4/100,000 in 2003, the male/female ratio being 2:1 (Figure 2).

In 1980, in the 60-69 years age bracket, the rates were 76.5/100,000 men and 18.4/100,000 women, and the male/female ratio was 4.2:1. Between the 1980s and 1995, there was a trend toward an increase among men, followed by a decline thereafter. In

2003, the mortality rate was 90.9/100,000 men. Among the women, the increase was steady. By 2003, the rate had risen to 31.9/100,000 women, and the male/female ratio was 2.8:1 (Figure 3).

In the over-70 age bracket, the rates were ascendant during the two decades evaluated, increasing from 106.4/100,000 men in 1980 to 158.3/100,000 men in 2003 and from 31.8/100,000 women to 57.4/100,000 women. The male/female ratio changed from 3.4:1 to 2.8:1.

Tables 1 and 2 present annual percentage variations in the adjusted mortality rates for lung cancer, cancer of the trachea and bronchial cancer, according to gender and age bracket for the states of Pernambuco, Minas Gerais, Espírito Santo, Rio de Janeiro, São Paulo, Rio Grande do Sul, Paraná, Santa Catarina, Distrito Federal, Mato Grosso do Sul and Mato Grosso. Considering that in these states, in 2003, the percentage of deaths was higher than 80% and the proportion of poorly defined causes was lower than 20%, the comparison between rate evolution throughout that period was possible.

Through the analysis of variations in mortality rates between 1990 and 2003 in the 11 states selected, we observed that, among men, the mortality rate decreased in the 30-49 and 50-59 age brackets. The rate remained stable among men in the 60-69 age bracket and increased among men over 70. The mortality rate showed a significant increase among women in all age brackets (Table 1).

We observed a decline in mortality rates in the states of Rio de Janeiro (-2.9%/year), Espírito Santo (-2.2%/year) and Rio Grande do Sul (-1.8%/year) among men in the 30-49 age bracket. The state of Mato Grosso presented an increase in the mortality rate (8.1%). However, in the remaining states, there were no significant changes (Table 1).

In the states of São Paulo, Minas Gerais, Rio de Janeiro, Espírito Santo, Pernambuco, Santa Catarina and Rio Grande do Sul, there was a significant decrease in mortality among men in the 50-59 age bracket. The most significant decrease occurred in Rio Grande do Sul, where the mortality rate in 1980 was 106.2/100,000 men and decreased to 64.7/100,000 men in 2003, with a decrease of -3.4%/year (Table 1).

There was a decrease in the lung cancer mortality rate among men in the 60-69 age bracket in Rio de Janeiro (-1.7%/year), in Rio Grande do Sul (-1.1%/year) and in the Distrito Federal

Table 1 - Adjusted mortality rates for cancer of the trachea, bronchial cancer and lung cancer by gender in 1990 and 2003, annual percentage variation and descriptive level (p value) - Males

Age bracket	UF	Adjusted rates		annual % variation	p	
		1990	2003			
30-49	PE	2.9	3.1	0.5	0.727	
	MG	2.6	3.1	1.4	0.103	
	ES	6.2	4.6	-2.2	0.004	
	RJ	8.2	5.6	-2.9	<0.001	
	SP	4.7	4.7	0.0	0.916	
	PR	3.6	3.4	-0.5	0.047	
	SC	5.9	5.3	-0.9	0.417	
	RS	10.0	7.9	-1.8	0.003	
	DF	2.9	3.5	1.4	0.572	
	MS	3.8	3.7	-0.2	0.931	
	MT	1.7	4.6	8.1	<0.001	
	Brazil	4.3	4.0	-0.6	0.053	
	50-59	PE	14.0	18.9	2.3	<0.001
		MG	25.3	20.9	-1.4	0.023
ES		26.6	24.8	-0.5	0.031	
RJ		66.8	44.1	-3.2	<0.001	
SP		44.6	36.9	-1.4	<0.001	
PR		36.1	33.8	-0.5	0.472	
SC		64.5	51.3	-1.8	0.015	
RS		106.2	67.6	-3.4	<0.001	
DF		39.8	28.9	-2.4	0.123	
MS		31.2	32.1	0.2	0.881	
MT		19.1	26.0	2.4	0.166	
Brazil		38.9	31.4	-1.6	<0.001	
60-69		PE	41.6	55.2	2.2	0.005
		MG	61.5	58.1	-0.4	0.117
	ES	75.3	82.0	0.7	0.500	
	RJ	160.6	128.6	-1.7	<0.001	
	SP	118.1	111.9	-0.4	0.115	
	PR	90.2	103.4	1.1	0.034	
	SC	136.9	162.3	1.3	0.018	
	RS	242.4	209.0	-1.1	<0.001	
	DF	102.8	78.7	-2.0	0.142	
	MS	78.1	80.8	0.3	0.825	
	MT	48.0	69.6	2.9	0.040	
	Brazil	93.6	91.0	-0.2	0.331	
	≥70	PE	48.5	89.7	4.9	<0.001
		MG	109.3	120.3	0.7	0.079
ES		134.5	152.3	1.0	0.291	
RJ		245.4	213.8	-1.1	0.002	
SP		196.0	215.7	0.7	0.004	
PR		141.7	207.7	3.0	<0.001	
SC		195.2	254.3	2.1	<0.001	
RS		316.8	341.2	0.6	0.003	
DF		225.2	235.7	0.4	0.782	
MS		147.0	136.8	-0.6	0.619	
MT		57.9	164.3	8.4	<0.001	
Brazil		134.8	159.9	1.3	<0.001	

PE: Pernambuco; MG: Minas Gerais; ES: Espírito Santo; RJ: Rio de Janeiro; SP: São Paulo; PR: Paraná; SC: Santa Catarina; RS: Rio Grande do Sul; DF: Distrito Federal; MS: Mato Grosso do Sul; and MT: Mato Grosso.

(-2.0%/year). Mortality rates increased in the states of Pernambuco (2.2%/year), Santa Catarina (1.3%/year), Paraná (1.1%/year) and Mato Grosso (2.9%/year) (Table 1).

In the states of Pernambuco, Minas Gerais, São Paulo, Rio Grande do Sul, Paraná and Santa Catarina there was a 1.3%/year increase in the mortality rate among men over 70. The greatest increase (8.4%/year) occurred in the state of Mato Grosso, whereas in Rio de Janeiro there was a decrease of -1.1%/year (Table 1).

There was an increase in mortality rates among women in the 30-39 age bracket in the states of Pernambuco (3.8%/year), São Paulo (2.9%/year), Rio de Janeiro (2.5%/year), Santa Catarina (2.7%/year) and Rio Grande do Sul (2.1%/year) (Table 2).

The mortality rate among women in the 50-59 age bracket increased in Pernambuco (5.1%), Mato Grosso do Sul (4.8%/year), Paraná (3.0%/year) and São Paulo (2.1%). We observed a decrease in Espírito Santo (-1.1%/year) and Rio Grande do Sul (-0.1%/year) (Table 2).

We observed the greatest variations in mortality rates among women in the 60-69 age bracket in the following states: Mato Grosso (6.7%/year), Espírito Santo (6.0%/year), Santa Catarina (5.0%/year), Rio Grande do Sul (2.4%/year), Paraná (2.2%/year), São Paulo (1.9%/year) and Rio de Janeiro (1.5%/year) (Table 2).

Among individuals over 70, the mortality rate increased in Pernambuco and Mato Grosso do Sul, with annual variations of 4.6% and 4.2%, respectively. Less significant annual variations were found in the states of Minas Gerais (1.0%), São Paulo (1.4%), Paraná (1.9%), Rio Grande do Sul (2.2%) and Distrito Federal (2.3%) (Table 2).

Discussion

The results of the present study demonstrate that, in the Brazilian states selected, the standardized mortality rate for cancer of the trachea, lung cancer and bronchial cancer decreased among men in the 30-69 age bracket. In men over 70, the mortality continues to rise. In women, rates are ascendant for all age brackets.

The state of Rio Grande do Sul presented the highest mortality rates in 1990 and 2003. In that state, there was a reduction in the mortality rate in men in the 30-69 age bracket and an increase in

Table 2 – Adjusted mortality rates for cancer of the trachea, bronchial cancer and lung cancer by gender in 1990 and 2003, annual percentage variation and descriptive level (p value) – Females.

Age bracket	UF	Adjusted rates		annual % variation	p
		1990	2003		
30-49	PE	1.5	2.4	3.8	0.020
	MG	1.8	2.1	1.2	0.251
	ES	1.7	1.9	1.0	0.695
	RJ	2.9	4.0	2.5	0.002
	SP	2.1	3.0	2.9	<0.001
	PR	2.4	2.6	0.6	0.645
	SC	2.1	2.9	2.7	0.100
	RS	3.8	5.0	2.1	0.015
	DF	2.3	1.7	-2.0	0.483
	MS	2.7	2.7	0.0	0.996
	MT	2.0	2.3	1.1	0.693
Brazil	2.0	2.7	2.5	<0.001	
50-59	PE	6.3	12.0	5.1	<0.001
	MG	8.7	10.1	1.2	0.176
	ES	18.9	16.3	-1.1	0.002
	RJ	18.0	17.5	-0.2	0.749
	SP	12.9	16.9	2.1	<0.001
	PR	14.0	20.7	3.0	<0.001
	SC	16.5	19.1	1.1	0.348
	RS	24.5	24.2	-0.1	0.049
	DF	9.6	14.7	3.4	0.202
	MS	10.7	19.7	4.8	0.036
	MT	8.7	14.9	4.2	0.111
Brazil	11.6	15.0	2.0	<0.001	
60-69	PE	14.2	19.1	2.3	0.052
	MG	20.1	22.2	0.8	0.263
	ES	15.6	33.5	6.0	<0.001
	RJ	32.0	38.8	1.5	0.005
	SP	26.0	33.1	1.9	<0.001
	PR	35.8	47.8	2.2	0.002
	SC	17.5	33.0	5.0	<0.001
	RS	40.2	54.3	2.4	0.002
	DF	40.6	33.5	-1.5	0.462
	MS	26.9	37.3	2.5	0.193
	MT	11.1	25.9	6.7	0.015
Brazil	23.2	32.0	2.5	<0.001	
≥70	PE	16.1	28.8	4.6	<0.001
	MG	41.7	47.7	1.0	0.076
	ES	49.7	62.5	1.8	0.177
	RJ	58.4	62.8	0.6	0.257
	SP	57.7	69.3	1.4	<0.001
	PR	64.7	82.9	1.9	0.005
	SC	55.4	62.9	1.0	0.313
	RS	64.5	86.0	2.2	0.004
	DF	61.5	82.9	2.3	0.030
	MS	47.7	81.9	4.2	0.013
	MT	41.1	62.4	3.3	0.133
Brazil	42.0	56.1	2.2	<0.001	

PE: Pernambuco; MG: Minas Gerais; ES: Espírito Santo; RJ: Rio de Janeiro; SP: São Paulo; PR: Paraná; SC: Santa Catarina; RS: Rio Grande do Sul; DF: Distrito Federal; MS: Mato Grosso do Sul; and MT: Mato Grosso.

men over 70. Among women, there was an increase in all age brackets. In Santa Catarina and Rio de Janeiro, the higher mortality rates occurred, being surpassed only by Rio Grande do Sul. Women, principally those in the 60-69 age bracket, presented the highest mortality rates in the south and south-east regions.

The association between lung cancer, cancer of the trachea, bronchial cancer and smoking is well established in literature.⁽²⁾ Smoking cessation is the factor that has the greatest positive impact on the incidence of cancer.^(4,11) The most significant reduction would be in the incidence of lung cancer and other cancers, including those of the mouth, pharynx, larynx, esophagus, bladder, pancreas and kidney.^(11,12) Other etiological factors, such as exposure to mineral dust, silica, asbestos and pesticides, as well as to radioactive agents such as radon, have been linked to lung cancer.^(13,14)

The risk attributed to smoking as an etiological agent of lung cancer is greater than 90%, which makes it potentially susceptible to preventive measures of public health.^(2,15,16)

The association between smoking and the development of lung cancer was suggested for the first time in England, in 1927.⁽¹³⁾ The first studies confirming the association between smoking and cancer were those conducted by Doll & Hill.⁽¹⁵⁾

We believe that, by the year 2030, smoking will be the major isolated cause of mortality and could be responsible for 10 million deaths annually.⁽¹²⁾

According to the Brazilian National Health and Nutrition Survey, among individuals over 15 years of age, approximately 40% of men and 26% of women were smokers in 1989. In 2003, the Household Survey on Risk Behavior and Morbidity Referred to Diseases and Non-transmissible Risks, conducted in 16 capitals in Brazil, showed that this tendency is maintained in most capitals.⁽¹⁶⁾ By comparing the prevalence of smoking observed in the 1989 Brazilian National Health and Nutrition Survey to the 2002/2003 Brazilian Prevalence of Risk factors in Nontransmissible Chronic Illnesses Survey, we observed a reduction in the prevalence of smoking during that period.^(16,17) The decline in the total prevalence of smoking was 20.8% in Manaus, 45.2% in Belém, 38.5% in Natal, 35.7% in Recife, 41.7% in Campo Grande, 34.6% in the Distrito Federal, 43.3% in Rio de Janeiro, 33.3% in São Paulo and 10.3% in Porto Alegre.⁽¹⁶⁾

According to the data of this same survey in 2003, in the cities of the south and southeast regions, the prevalence of smoking among women is already approximate to that observed among men. This fact demonstrates the increase in the exposure to tobacco among women, probably as a result of publicity campaigns aimed at this population group, leading to the incidence of this type of cancer.⁽¹⁶⁾

Significant differences in the mortality rates between genders were found. A reduction of the proportion between rates for men and women occurred during the period evaluated. This might reflect the tendency toward a reduction of the prevalence of smoking among men in that period and an increase in the prevalence among women during the same period. This tendency has been discussed by other authors in Brazil, the United States and the United Kingdom.^(2,3,11,16,17)

Aiming at the prevention and control of smoking, the National Program for the control of Smoking was implemented in Brazil. This program has been coordinating educational and preventive interventions, as well as articulating regulatory measures. Measures related to an increase in prices and taxes, as well as the congressional approval of law 9294/96, which prohibits smoking in public places, were implemented. In 1999, the Brazilian National Health Products Oversight Agency began to regulate, control and monitor products derived from tobacco, using the definitions of maximum tar levels allowed for cigarettes; product packaging and labeling regulation; restricting marketing; prohibiting smoking in planes and other public forms of transportation, as well as prohibiting tobacco advertising on the Internet. These measures are important and should be amplified in order to reduce exposure to smoking in Brazil, considering the implementation of the Framework Convention on Tobacco Control in Brazil and worldwide.⁽¹⁶⁾

Lung cancer presents a long period of latency. Therefore, the trend toward a decrease in mortality rate among younger men in Brazil might be the result of national interventions to reduce the prevalence of smoking in Brazil in recent years, reducing the exposure to younger cohorts. High mortality rates in older populations remained constant due to prior tobacco use.⁽¹⁶⁾ Increased mortality rates in females are a worldwide trend and are attributable to the recent increase in smoking prevalence in females.^(2,4,16)

The results of this analysis demonstrate that lung cancer in Brazil presents a distribution pattern with a reduction in mortality for males and an increase in mortality for females. Therefore, these data might be used in the planning of public policies, aiming at smoking prevention and control in Brazil, since they show the need to develop new strategies and measures for the prevention and control of smoking, especially among the women.

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