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Luciana de Paula Viana[a]
https://orcid.org/0000-0002-0406-2239

Maria Teresa Bustamante-Teixeira[b]
https://orcid.org/0000-0003-0727-4170

Deborah Carvalho Malta[c]
https://orcid.org/0000-0002-8214-5734

Flavia Araújo Girardi[a]
https://orcid.org/0000-0003-1759-0943

Mário Círio Nogueira[a]
https://orcid.org/0000-0001-9688-4557

Valéria Maria de Azeredo Passos[d]
https://orcid.org/0000-0003-2829-5798

Maximiliano Ribeiro Guerra[a]
https://orcid.org/0000-0003-0234-7190

[a]Universidade Federal de Juiz de Fora, Graduate Program in Public Health. Juiz de Fora, MG, Brazil.

[b]Universidade Federal de Juiz de Fora, Health Advisory, Training, and Studies Center, Graduate Program in Public Health. Juiz de Fora, MG, Brazil.

[c]Universidade Federal de Minas Gerais, Department of Maternal and Child Nursing and Public Health. Belo Horizonte, MG, Brazil.

[d]Universidade Federal de Minas Gerais, Minas Gerais Medical Sciences School. Belo Horizonte, MG, Brazil.

Contact:
Luciana de Paula Viana
E-mail:
luciana.viana@estudante.ufjf.br

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Laryngeal cancer mortality and burden attributable to occupational risks in Brazil: 2019 Global Burden of Disease

Mortalidade e carga do câncer de laringe atribuíveis aos riscos ocupacionais no Brasil: estudo da Carga Global de Doença, 2019

Abstract

Objective: to describe mortality and disability-adjusted life years (DALYs) due to laryngeal cancer attributable to occupational and behavioral risk factors in Brazil. *Methods:* this is an ecological study with data from the 2019 Global Burden of Disease. Mortality and DALY rates for laryngeal cancer attributable to occupational (sulfuric acid and asbestos) and behavioral (tobacco and alcohol) risks were obtained from 1990 and 2019. *Results:* in 2019, the mortality rate from laryngeal cancer attributable to occupational hazards (sulfuric acid and asbestos) totaled 0.28 (95%UI: 0.17; 0.43) and 0.03 (95%UI: 0.02; 0.04), whereas and DALY rates, 7.33 (95%UI: 4.28; 11.44) and 0.64 (95%UI: 0.35; 0.03) in men and women in Brazil, respectively. Sulfuric acid configured the main occupational risk for the disease. The rates attributable to tobacco (mortality: −45.83%; DALYs: −47.36%) and occupational hazards (mortality: −23.20%; DALYs: −26.31%) decreased in Brazil but increased in some Northern and Northeastern states. *Conclusion:* laryngeal cancer mortality and burden attributable to occupational factors decreased in the period (although less than that for smoking), reinforcing the importance of actions to reduce the impact of occupational risks, such as the regulatory measures applied to tobacco.

Keywords: years of potential life lost; occupational risks; laryngeal neoplasms; occupational health; epidemiology, descriptive.

Resumo

Objetivo: *descrever a mortalidade e os anos de vida ajustados pela incapacidade (disability-adjusted life years – DALYs) para câncer de laringe no Brasil atribuíveis a fatores de risco ocupacionais e comportamentais.* Métodos: *estudo ecológico com dados do estudo Global Burden of Disease 2019. Foram obtidas taxas de mortalidade e de DALYs para o câncer de laringe atribuíveis aos riscos ocupacionais (ácido sulfúrico e amianto) e comportamentais (tabaco e álcool), de 1990 e 2019.* Resultados: *no Brasil, em 2019, a taxa de mortalidade por câncer de laringe atribuível aos riscos ocupacionais (ácido sulfúrico e amianto) foi 0,28 (II95%: 0,17;0,43) no sexo masculino e 0,03 (II95%: 0,02;0,04) no feminino, e a de DALYs foi 7,33 (II95%: 4,28;11,44) e 0,64 (II95%: 0,35;0,03), respectivamente. O ácido sulfúrico foi o principal risco ocupacional para a doença. Houve redução das taxas atribuíveis ao tabaco (mortalidade:-45,83%; DALYs:-47,36%) e aos riscos ocupacionais (mortalidade:-23,20%; DALYs:-26,31%), no Brasil, com aumento em alguns estados das regiões Norte e Nordeste.* Conclusão: *houve redução na mortalidade e na carga do câncer de laringe atribuível aos fatores ocupacionais no período, porém menor em comparação ao tabagismo, reforçando a importância de ações para reduzir o impacto dos riscos ocupacionais, como as medidas regulatórias aplicadas ao tabaco.*

Palavras-chave: *anos potenciais de vida perdidos; riscos ocupacionais; neoplasias laríngeas; saúde do trabalhador; epidemiologia descritiva.*

Introduction

Occupational hazards contributed to 1,220,501 deaths worldwide in 2019, 23,741 of which were in Brazil. According to the 2019 Global Burden of Disease (GBD), 27% of these deaths were due to cancer[1,2].

Until the identification of the carcinogenic effects of smoking, the main known causes of cancer referred to occupational exposures in specific activities, with little or no information that enabled the attribution of risks to a particular chemical compound[3]. Data from the World Health Organization (WHO) International Agency for Research on Cancer (IARC) suggest that the number of recognized occupational carcinogens has increased over time. However, this figure probably remains underestimated as most exposures are yet to be evaluated for their carcinogenic potential due to inadequate epidemiological evidence and scarce quantitative exposure data[4].

Laryngeal cancer ranks third among the malignant neoplasms affecting people's heads and necks worldwide, including Brazil[1,4,5]. IARC/WHO estimates suggest that men and women suffered with 180,000 and 28,000 new cases, respectively, in 2018 worldwide[6]. The disease occurs mainly in men over 40 years of age and is the most frequent diagnosis during the sixth or seventh decades of their lives. Brazil has one of the highest incidences of the disease, with an estimated risk of 6.2 new cases per 100,000 men and 1.06 per 100,000 women for 2020-2022[3.5-7]. Most cases are diagnosed in their advanced phases (more than 75% in stages III or IV), when therapeutic options have a remarkably reduced impact on prognosis. Lower survival in advanced cases is partly attributed to delayed diagnosis—in patients with treatable diseases, survival averages 80 and 50% for glottic (the most frequent) and supraglottic cancer, respectively[8.]

The main behavioral risk factors for laryngeal cancer stem from tobacco and alcohol consumption, which have been proven to be associated with its development, especially in well-differentiated squamous cell carcinomas, which account for 98% of cases[9].

Among the occupational risk factors related to laryngeal cancer, exposure to asbestos and strong acids (classified as known carcinogens listed in Group 1 of the IARC)[4,10,11], stands out. Occupational exposure to asbestos occurs in mining, milling, bagging, cement product manufacturing, industrial thermal seals installation and maintenance, textile manufacturing, auto mechanics, demolition, and civil construction tailing recycling[10-13]. Regarding strong acids, exposure to sulfuric acid stands out, which has wide application in industries and laboratories and is one of the most widely used substances worldwide[12,14].

The role of working conditions as one of the main determinants of social inequalities in relation to cancer has received increasing attention[7]. Studies have shown that occupational exposure to carcinogens is associated with a substantial global, regional, and national burden of disease and that occupational diseases have increasingly attracted attention worldwide[2,12].

This study aims to describe mortality and the disability-adjusted life years (DALYs) due to laryngeal cancer attributable to occupational and behavioral risk factors in Brazil.

Methods

An ecological study was conducted with data from the 2019 GBD, which includes estimates on 369 diseases and 87 risk factors from 204 countries and territories from 1990 to 2019. Data were extracted using the Global Health Data Exchange query tool (http://ghdx.healthdata.org/gbd-results-tool)[1,2].

GBD estimates are based on a modeling process for the most reliable data available for each region[2]. In the 2019 GBD, data from the Brazilian Mortality Information System were used to estimate mortality in the country with adjustments for underreporting of deaths and nonspecific causes, called garbage codes[1,2,15]. Its world population was used as the standard population to adjust for age-standardized rates[1,15-17].

The theoretical minimum risk exposure level was the concept used to calculate the fraction of the population risk attributable to different causes of death, diseases, or disabilities, which

aims to measure any reduction in disease burden if population exposure has changed in the past to a minimum level of theoretical exposure risk, damaging health less. Considering this level and the available epidemiological studies, GBD defined a minimum level of exposure for each risk factor in which the probability of occurrence of an event would be as low as possible. The theoretical minimum risk exposure level was assumed to be no exposure for all occupational hazards[2,16].

In the GBD, the causes of health harm and risk factors are organized into hierarchical categories called "levels". At the least aggregated level, such causes and risk factors are divided into behavioral, metabolic, and environmental risks[17]. This hierarchization resulted in 87 risk factors, such as tobacco, alcohol, and drugs (behavioral risks); blood glucose, blood pressure, and cholesterol (metabolic risks); and air pollution and occupational hazards (environmental hazards). In total, 13 occupational carcinogens were organized in detail[2,12,16]. In the 2019 GBD, work-environment carcinogens (considered risk factors for laryngeal cancer) referred to asbestos and sulfuric acid, the exposure to which were estimated based on proportion of the population occupationally exposed to asbestos (using mesothelioma mortality rates as an analogue) and the proportion of the population occupationally exposed to sulfuric acid at high or low levels of exposure based on the distributions of the population in certain economic activities[2,18].

In this study, these occupational carcinogens were compared to behavioral risk factors (tobacco and alcohol). More details on the risk factors considered by the 2019 GBD can be found in another publication[2].

The GBD study uses disability-adjusted life years (DALYs) as indicators to express the total burden of a disease, combining years lived with disability (prevalence estimates multiplied by disease or disability burdens) and years of life lost due to premature deaths (subtracting the age of death from the longest possible life expectancy for a person at that age) into one measure[1,17].

In this study, mortality rates and DALYs were obtained to measure the impact of occupational risk factors on laryngeal cancer mortality and burden in the Brazilian Federation Units.

Laryngeal cancer mortality and DALY rates attributable to occupational and behavioral risk factors were analyzed in general, for each risk factor, and according to gender. The comparison between 1990 and 2019 in Federation Units was made by analyzing the standardized rates by age per 100 thousand inhabitants. Each estimate was expressed with its 95% uncertainty intervals (95%UI), which consider possible errors in modeling and reflect the uncertainty associated with sample size used as data sources. Each estimate was calculated 1000 times, and the 95%UI was defined as the 2.5% and 97.5% percentiles of these values after they were ordered from lowest to highest[1,2].

Due to the marked predominance of laryngeal cancer among men, age-standardized mortality and DALY rates attributable to occupational risk factors for the Brazilian states were specifically shown for this gender.

The GBD was approved in Brazil by the Universidade Federal de Minas Gerais (UFMG) Research Ethics Committee, registered under protocol number 62803316.7.0000.5149, on December 19, 2016.

Results

The Brazilian mortality rate from laryngeal cancer attributable to occupational factors (asbestos and sulfuric acid) in 1990 totaled 0.36 (95%UI: 0.22;0.53) in men and 0.04 (95%UI: 0.02;0.06) in women. In 2019, this rate totaled 0.28 (95%UI: 0,17;0.43) and 0.03 (95%UI: 0,02;0.04), respectively. The considered period showed a decline of −45.83% (95%UI: −52.07;−39.09), −27.27% (95%UI: −33.04;−16.12), and −21.00% (95%UI: −29.45;−13.36) in the mortality rates from laryngeal cancer attributable to tobacco, sulfuric acid, and asbestos, respectively (**Table 1**).

Brazilian states showed Inequalities between 1990 and 2019 and an increase in mortality due to laryngeal cancer attributed to work environments in some northern and northeastern states (**Figure 1**).

Table 1 Age-standardized mortality rates (per 100,000 inhabitants) and age-adjusted disability-adjusted life years (DALYs) for laryngeal cancer attributable to behavioral and occupational risk factors in Brazil in 1990 and 2019 and percentage change in the period

	Mortality rates					
	Behavioral factors			*Occupational factors*		
	1990	*2019*	Δ% *1990-2019*	*1990*	*2019*	Δ% *1990-2019*
	Tobacco			**Sulphuric acid**		
All genders	2.43 (2.16 ; 2.60)	1.35 (1.06 ; 1.53)	–45.83 (–52.07 ; –39.09)	0.11 (0.04 ; 0.19)	0.08 (0.03 ; 0.15)	–27.27 (–33.04 ; –16.12)
Men	4.59 (4.16 ; 4.96)	2.61 (2.13 ; 3.06)	–43.14 (–50.13 ; –36.57)	0.27 (0.01 ; 0.03)	0.15 (0.063 ; 0.28)	–23.00 (–32.12 ; –13.23)
Women	0.49 (0.41 ; 0.57)	0.23 (0.17 ; 0.29)	–53.06 (–61.08 ; –44.21)	0.02 (0.01 ; 0.03)	0.01 (0.01 ; 0.03)	–19.00 (–33.24 ; –3.16)
	Alcohol			**Asbestos**		
All genders	0.54 (0.29 ; 1.58)	0.47 (0.27 ; 0.65)	–12.96 (–25.12 ; 4.37)	0.08 (0.05 ; 0.12)	0.07 (0.04 ; 0.10)	–21.00 (–29.45 ; –13.36)
Men	1.11 (0.60 ; 1.58)	0.99 (0.57 ; 1.37)	–10.81 (–23.22 ; 06.58)	0.16 (0.08 ; 0.25)	0.13 (0.07 ; 0.21)	–16.00 (–26.32; –07.69)
Women	0.03 (0.01 ; 0.06)	0.04 (0.02 ; 0.06)	33.33 (–23.63 ; 55.85)	0.02 (0.01 ; 0.04)	0.01 (0.01 ; 0.02)	–33.00 (–51.69 ; –12.09)
	DALYs*					
	Behavioral factors			**Occupational factors**		
	1990	**2019**	Δ% **1990-2019**	**1990**	**2019**	Δ% **1990-2019**
	Tobacco			**Sulphuric acid**		
All genders	63.53 (57.57 ; 68.78)	33.44 (27.43 ; 39.12)	–47.36 (–54.36 ; –41.42)	3.37 (1.40 ; 6.22)	2.44 (1.02 ; 4.52)	–27.60 (–36.36 ; –19.23)
Men	120.62 (109.76;130.01)	66.00 (54.77 ; 77.09)	–45.28 (–52.39 ; –39.35)	6.44 (2.66 ; 11.82)	4.73 (1.97 ; 8.71)	–26.55 (–35.19 ; –17.27)
Women	12.03 (10.1 ; 13.8)	5.63 (4.20 ; 7.11)	–53.20 (–61.06 ; –44.54)	0.54 (0.21 ; 1.01)	0.41 (0.17 ; 0.79)	–24.07 (–36.34 ; –6.29)
	Alcohol			**Asbestos**		
All genders	16.18 (8.92 ; 22.74)	13.69 (7.88 ; 18.73)	–15.39 (–27.16 ; –1.34)	1.75 (0.96 ; 2.67)	1.34 (0.74 ; 2.08)	–23.43 (–31.13 ; –15.02)
Men	32.65 (18.06 ; 45.58)	28.13 (16.3 ; 38.41)	–13.84 (–25.24 ; –1.34)	3.36 (1.68 ; 5.34)	2.70 (1.40 ; 4.32)	–19.64 (–29.03 ; –11.34)
Women	1.09 (0.46 ; 1.90)	1.10 (0.48 ; 1.75)	0.92 (–23.32 ; 41.06)	0.35 (0.16 ; 0.57)	0.23 (0.10 ; 0.38)	–34.29 (–53.31 ; –13.05)

Source: Institute for Health Metrics and Evaluation (IHME), Global Health Data Exchange (GHDx), available at: http://ghdx.Healthdata.org/gbd-results-tool[1,2,19].

*DALYs – disability-adjusted life years.

The data in parentheses are 95% uncertainty intervals.

Age-standardized rates (per 100,000 population).

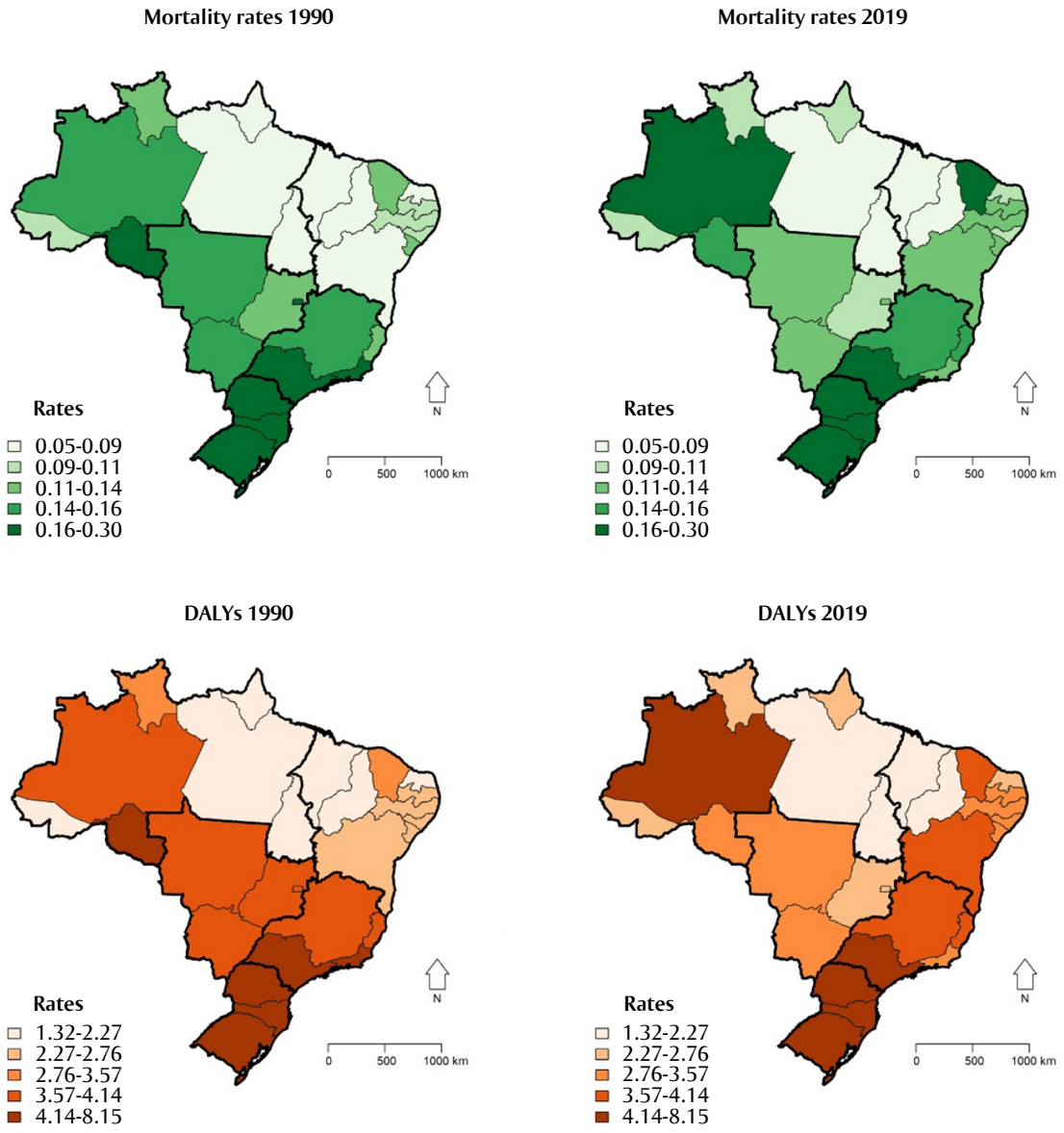

Figure 1 Age-standardized rates (per 100,000 inhabitants) of deaths and disability-adjusted life years (DALYs) from laryngeal cancer attributable to occupational factors in Brazilian states, 1990 and 2019

Men also showed regional inequalities, with a significant increase in mortality rates in the northern state of Amapá and in the northeastern states of Ceará, Rio Grande do Norte, Pernambuco, and Bahia. On the other hand, the northern state of Rondônia, the southeastern states of Rio de Janeiro and São Paulo, the southern states of Rio Grande do Sul and Santa Catarina, and the Federal District showed a significant decline in mortality rates (**Table 2**).

Table 2 Age-standardized mortality rates (per 100,000 inhabitants) and age-adjusted disability-adjusted life years (DALYs) in men due to laryngeal cancer attributable to occupational risk factors in Brazil and its federation units in 1990 and 2019 and percentage change in the period

Mortality rate	DALYs*					
	1990	2019	Δ% 1990-2019	1990	2019	Δ% 1990-2019
Brazil	0.36 (0.22 ; 0.53)	0.28 (0.17 ; 0.43)	–22.22 (–28.02 ; –13.12)	9.67 (5.50 ; 15.26)	7.33 (4.28 ; 11.44)	–24.20 (–32.14 ; –16.25)
North						
Rondônia	0.33 (0.20 ; 0.50)	0.25 (0.14 ; 0.39)	–26.00 (–46.32 ; –2.45)	7.71 (4.66 ; 12.10)	6.16 (3.41 ; 9.89)	–20.10 (–41.24 ; 6.33)
Acre	0.17 (0.10 ; 0.25)	0.20 (0.12 ; 0.29)	13.00 (–9.01 ; 41.22)	3.65 (2.15 ; 5.68)	4.37 (2.53 ; 6.81)	19.73 (–4.12 ; 49.01)
Amazonas	0.27 (0.16 ; 0.42)	0.31 (0.18 ; 0.48)	14.81 (–11.24 ; 49.33)	6.92 (3.91 ; 11.42)	7.91 (4.40 ; 12.78)	14.31 (–12.42 ; 51.31)
Roraima	0.23 (0.14 ; 0.35)	0.18 (0.11 ; 0.28)	–21.74 (–38.21 ; 0.03)	5.17 (3.05 ; 8.14)	4.17 (2.39 ; 6.79)	–19.34 (–38.11 ; 5.02)
Pará	0.15 (0.08 ; 0.23)	0.15 (0.08 ; 0.22)	–1.00 (–27.06 ; 36.34)	3.76 (2.11 ; 6.17)	3.60 (1.96 ; 5.80)	–4.26 (–31.28 ; 35.32)
Amapá	0.15 (0.08 ; 0.23)	0.20 (0.11 ; 0.30)	33.33 (7.02 ; 64.26)	3.79 (1.99 ; 6.40)	4.98 (2.79 ; 8.06)	31.40 (5.03 ; 69.11)
Tocantins	0.10 (0.06 ; 0.16)	0.13 (0.08 ; 0.21)	26.00 (–8 ; 86)	2.43 (1.29 ; 4.04)	3.17 (1.73 ; 5.25)	30.45 (–8 ; 86)
Northeast						
Maranhão	0.11 (0.06 ; 0.18)	0.13 (0.07 ; 0.21)	18.18 (–21.32 ; 79.32)	3.12 (1.60 ; 5.25)	3.20 (1.74 ; 5.37)	2.56 (–32.22 ; 59.01)
Piauí	0.09 (0.05 ; 0.15_	0.09 (0.05 ; 0.14)	0.00 (–28.22 ; 25.01)	2.36 (1.24 ; 4.06)	2.37 (1.29 ; 3.94)	0.42 (–25.40 ; 35.32)
Ceará	0.20 (0.10 ; 0.33)	0.30 (0.17 ; 0.47)	53.00 (2.07 ; 139.01)	5.37 (2.75 ; 9.26)	7.52 (4.07 ; 12.66)	40.04 (–8.21 ; 117.32)
Rio Grande do Norte	0.14 (0.08 ; 0.22)	0.20 (0.11 ; 0.32)	47.00 (5.01 ; 105.03)	3.59 (1.87 ; 6.12)	5.20 (2.74 ; 8.62)	44.85 (0.01 ; 109.21)
Paraíba	0.20 (0.11 ; 0.32)	0.25 (0.14 ; 0.40)	26.00 (–9.32 ; 72.42)	5.20 (2.87 ; 8.53)	6.56 (3.65 ; 10.83)	26.15 (–11.41 ; 75.31)
Pernambuco	0.20 (0.12 ; 0.31)	0.26 (0.15 ; 0.41)	30.00 (2.01 ; 66.32)	5.26 (2.92 ; 8.49)	6.67 (3.80 ; 10.74)	26.81 (–3.42 ; 66.42)
Alagoas	0.16 (0.09 ; 0.25)	0.20 (0.11 ; 0.32)	25.00 (–9.32 ; 64.22)	4.12 (2.29 ; 6.79)	5.35 (2.93 ; 8.88)	29.85 (–6.22 ; 74.43)
Sergipe	0.21 (0.12 ; 0.32)	0.22 (0.12 ; 0.36)	7.00 (–25.28 ; 48.21)	5.17 (2.90 ; 8.56)	6.06 (3.27 ; 10.28)	17.21 (–17.31 ; 62.20)
Bahia	0.15 (0.08 ; 0.25)	0.28 (0.16 ; 0.45)	82.00 (22.24 ; 167.34)	4.19 (2.20 ; 7.15)	7.31 (3.99 ; 12.28)	74.46 (16.20 ; 162.12)

(Continue)

Table 2 Continuation...

Mortality rate	DALYs*					
	1990	2019	Δ% 1990-2019	1990	2019	Δ% 1990-2019
Southeast						
Minas Gerais	0.30 (0.18 ; 0.46)	0.29 (0.17 ; 0.45)	–3.33 (–23.21 ; 19.02)	7.74 (4.52 ; 12.34)	7.71 (4.41 ; 12.56)	–0.39 (–22.44 ; 24.09)
Espírito Santo	0.25 (0.15 ; 0.39)	0.29 (0.16 ; 0.48)	16.00 (–10.37 ; 47.16)	6.61 (3.56 ; 11.01)	7.98 (4.28 ; 13.66)	20.73 (–8.22 ; 56.37)
Rio de Janeiro	0.42 (0.25 ; 0.64)	0.28 (0.16 ; 0.43)	–33.33 (–45.09 ; –19.27)	11.52 (6.52 ; 18.15)	7.05 (4.03 ; 11.23)	–38.80 (–50.24 ; –25.03)
São Paulo	0.59 (0.35 ; 0.90)	0.35 (0.21 ; 0.54)	–42.00 (–53.22 ; –29.37)	16.01 (8.98 ; 25.02)	8.87 (5.09 ; 14.40)	–44.60 (–56.28 ; –33.39)
South						
Paraná	0.35 (0.21 ; 0.54)	0.31 (0.18 ; 0.50)	–11.43 (–29.38 ; 10.22)	9.26 (5.28 ; 14.76)	8.12 (4.50 ; 13.39)	–12.31 (–30.08 ; 10.21)
Santa Catarina	0.49 (0.29 ; 0.74)	0.33 (0.19 ; 0.52)	–32.65 (–46.24 ; –15.34)	12.44 (7.18 ; 19.98)	8.27 (4.58 ; 13.50)	–33.52 (–48.32 ; –16.11)
Rio Grande do Sul	0.59 (0.35 ; 0.88)	0.38 (0.22 ; 0.59)	–35.59 (–49.39 ; –22.23)	15.59 (9.13 ; 24.16)	9.63 (5.40 ; 15.63)	–38.23 (–51.30 ; –23.14)
Midwest						
Mato Grosso do Sul	0.26 (0.16 ; 0.39)	0.24 (0.14 ; 0.38)	–5.00 (–26.06 ; 21.37)	6.67 (3.78 ; 10.82)	6.29 (3.56 ; 10.06)	–5.70 (–28.34 ; 23.32)
Mato Grosso	0.24 (0.14 ; 0.38)	0.24 (0.14 ; 0.39)	2.00 (–23.06 ; 38.44)	6.13 (3.57 ; 10.11)	6.37 (3.49 ; 10.47)	3.92 (–23.24 ; 41.28)
Goiás	0.23 (0.13 ; 0.39)	0.19 (0.10 ; 0.32)	–17.39 (–42.16 ; 19.24)	6.47 (3.41 ; 11.31)	5.10 (2.61 ; 8.86)	–21.17 (–45.04 ; 15.24)
Federal District	0.38 (0.23 ; 0.58)	0.24 (0.15 ; 0.37)	–36.84 (–50.06 ; –17.22)	8.08 (4.82 ; 12.94)	4.84 (2.78 ; 7.84)	–40.10 (–54.34 ; –22.40)

Source: Institute for Health Metrics and Evaluation (IHME), Global Health Data Exchange (GHDx), available at: http://ghdx.Healthdata.org/gbd-results-tool[1,2,19].

*DALYs – disability-adjusted life years.

The values in parentheses refer to the 95% uncertainty intervals.

Age-standardized rates (per 100,000 population).

In 2019, the 60-64 age group had the highest laryngeal cancer mortality rate attributable to exposure to sulfuric acid in all genders in Brazil (0.49; 95%UI: 0.20; 0.90). The group aged 70 years or older showed the highest asbestos exposure rate (0.67; 95%UI: 0.38; 1.00) (**Figure 2**).

In Brazil, occupational risk factors had a 5.06 age-standardized DALY rate per 100,000 inhabitants (95%UI: 2.91;7.97); 9.67 (95%UI: 5.50;7.97) in men and 0.88 (95%UI: 5.50;15.26) in women in 1990. In 2019, the same rates averaged 3.73 (95%UI: 2.21;5.82), 7.33 (95%UI: 4,28;11.44), and 0.64 (95%UI: 0.35; 0.03), respectively. The rates of age-standardized DALYs and laryngeal cancer attributable to occupational risk factors declined −25.26% (95%UI: −32.91;−18.88) in Brazil from 1990 to 2019. Sulfuric acid DALYs rates decreased by −27.60% (95%UI: −36.36;−19.23) and that of asbestos, by −23.43% (95%UI: −31.13;−15.02) in the period (**Table 1**).

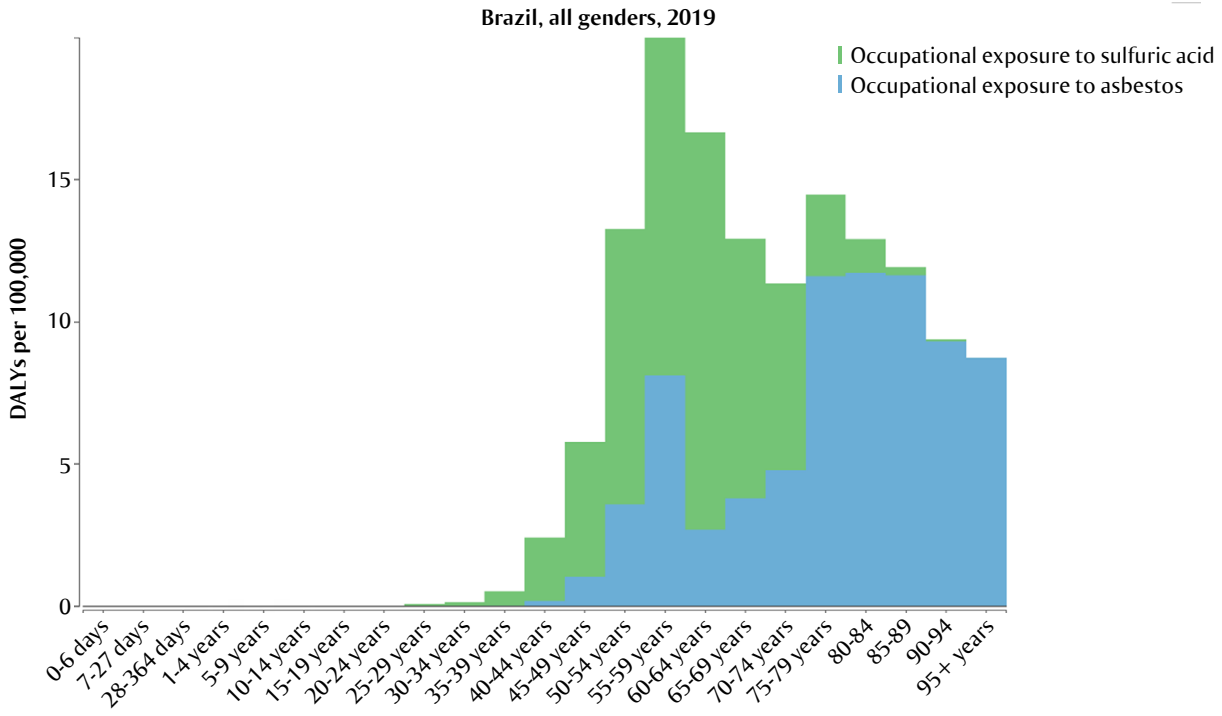

Figure 2 Distribution by age group in all genders of the disability-adjusted life years (DALYs) rate for laryngeal cancer attributable to occupational carcinogens, Brazil, 2019

Source: Institute for Health Metrics and Evaluation (IHME)[1,2,19].

DALYs per 100,000 population.

All genders also showed reduced rates of DALYs attributable to behavioral [tobacco by −47.36% (95%UI: −54.36;−41.42) and alcohol by −15.39% (95%UI: −27.16;−1.34)] and occupational risk factors [sulfuric acid by −27.60% (95%UI: −36.36;−19.23) and asbestos by −23.43% (95%UI: −31.13;−15.02)] (**Table 1**).

Among occupational factors, DALY rates due to laryngeal cancer attributable to sulfuric acid exposure were nearly double that attributable to asbestos in 1990, remaining so in 2019 (**Table 1**).

The analysis of the variations in DALYs rates due to laryngeal cancer attributable to both occupational factors from 1990 to 2019 showed a significant increase in men in Amapá (North) and Rio Grande do Norte and Bahia (Northeast) and a significant decline in Rio de Janeiro and São Paulo (Southeast), Rio Grande do Sul and Santa Catarina (South), and the Federal District (**Table 2, Figure 1**).

Estimates suggest that men in São Paulo in 1990 (16.01; 95%UI: 8.98; 25.02) and Rio Grande do Sul in 2019 (9.63; 95%UI: 5.40; 15.63) had the highest DALY rates due to laryngeal cancer attributable to occupational factors (**Table 2**).

As with mortality rates per 100,000 inhabitants, Rio Grande do Sul, had the highest DALY rates due to laryngeal cancer attributable to occupational factors, followed by Espírito Santo and São Paulo (**Figure 3**).

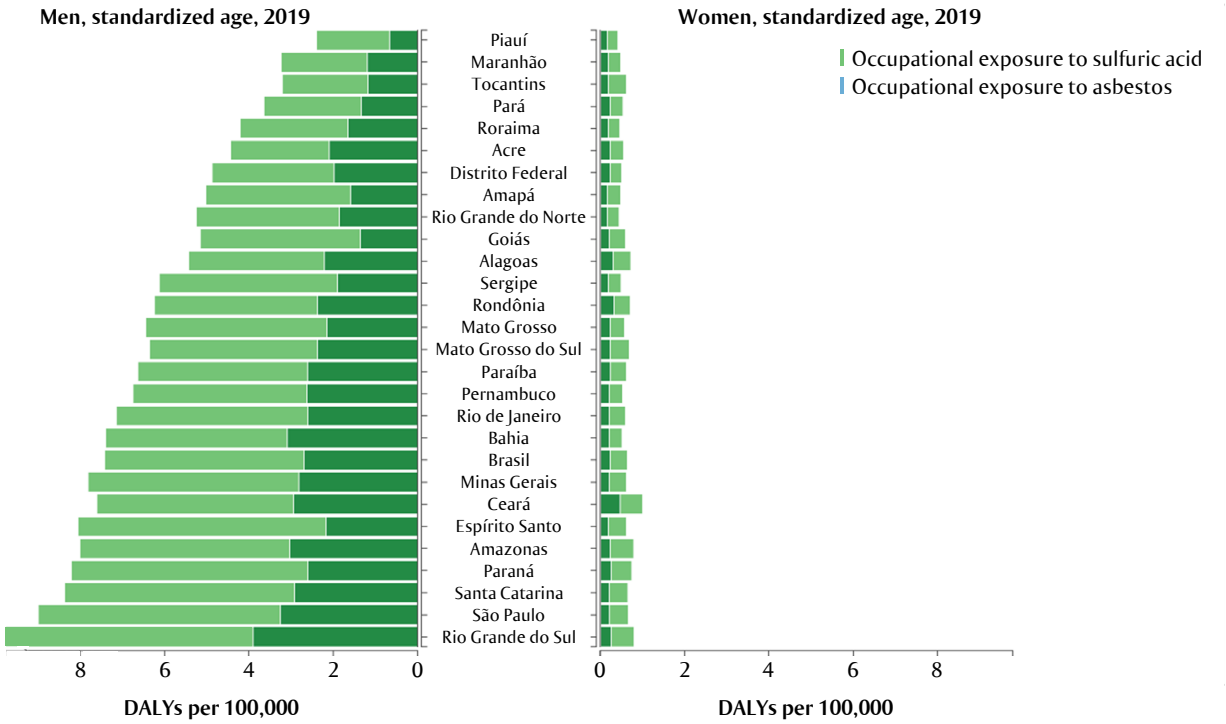

Figure 3 Ranking of states for disability-adjusted life years (DALYs) rates for laryngeal cancer attributable to exposure to occupational hazards, Brazil, 2019 DALYs per 100,000 population

Source: Institute for Health Metrics and Evaluation (IHME)[1,2,19].

The highest rates of DALYs due to laryngeal cancer for all genders attributable to sulfuric acid and asbestos exposure featured those aged 60 to 64 years (13.99; 95%UI: 5.78; 25.68) and in those aged 70 years or older (8.75; 95%UI: 4.92; 13.09), respectively (**Figure 3**).

Discussion

Estimates of mortality and DALY rates due to laryngeal cancer attributable to occupational risk factors decreased in Brazil in the studied period (1990-2019). Mortality DALY rates related to tobacco and alcohol exceed those attributable to occupational hazards (asbestos and sulfuric acid).

In 2019, mortality and DALY rates from laryngeal cancer attributable to occupational risk factors in Brazil exceeded those of the world average[18]. Mortality rates worldwide in 2019 totaled 0.19 (95%UI: 0.11;0.27) in men and 0.02 (95%UI: 0.01; 0.02) in women, whereas they totaled 0.28 (95%UI: 0.17; 0.43) and 0.03 (95%IU 0.02; 0.04) in Brazil, respectively. Age-standardized DALY rates for laryngeal cancer attributable to occupational factors averaged 4.44 (95%UI: 2.62; 6.86) in men and 0.41 (95%UI: 0.22;0.66) in women in 2019. In Brazil, these rates averaged 7.33 (95%UI: 4.28; 11.44) and 0.64 (95%UI: 0.35; 1.03), respectively.

In a time-series study from 1990 to 2013 including data from South and Central American countries, Brazil showed the highest incidence rate of laryngeal cancer, with 5.9 new cases per 100,000 men, and Uruguay, the highest mortality rate from laryngeal cancer, followed by Brazil with 4.2 and 3.2 deaths per 100,000 male inhabitants, respectively[20].

Although the burden of laryngeal cancer decreased in Brazil in the studied period, regional inequalities in the country remain evident, especially for men[21]. This study found disparities between Brazilian states, with higher mortality and DALY rates attributable to occupational risk factors from 1990 to 2019 in some Northern and Northeastern states. The distinct regional characteristics of human development and socioeconomic conditions are directly related to the prevalence of exposure factors, access to prevention, and diagnosis and treatment services, providing greater occupational risk in regions with later economic development and interfering with opportunities for adequate diagnosis and treatment, highlighting the differences between areas with better urban structures and those with unequal distribution of health equipment and services. Better

planning/structuring of the health service network, reduction of the distances patients must travel, and the organization of treatment demand by region can contribute to reducing inequalities in access to cancer treatment among Brazilian states[22,23].

On the other hand, Rio Grande do Sul and São Paulo had the highest mortality and DALY rates due to laryngeal cancer attributable to occupational risk factors. Although other methodologies can better evaluate these higher rates in richer and industrialized states, these trends can be partially explained by the better record quality and greater diagnostic opportunity in more developed regions, resulting in their better collection and diagnosis, thus expressing more reliable rates[22,23].

Notification inequalities and different exposures explain the disparities between states. Minas Gerais, São Paulo, and Goiás had the highest numbers of workers registered in sulfuric acid industrial manufacturing activities in the country in 2020. On the other hand, São Paulo, Minas Gerais, and Paraná had the highest number of workers registered in industrial extraction and processing of asbestos and in the manufacture of products containing the substance in that same year[24,25].

The Brazilian Federal Supreme Court ruled against the use of asbestos in 2017, after the IARC/WHO pointed out that all its types can cause lung, mesothelioma, laryngeal, and ovarian cancer and lung fibrosis[26]. Until then, the extraction, industrialization, use, and trade of chrysotile asbestos had a legal provision under the terms of Law no. 9.055, of June 1, 1995, which established the possibility of its controlled use as it is widely used to manufacture tiles, sheets, partitions, water tanks, coatings, tubes, clutch discs, thermal insulators, and vehicle brake pads and linings. This decision by the Supreme Court was ratified in February 2023, after the conclusion of appeal judgments. However, mining still takes place in the state of Goiás, in which excavation activities continue to extract chrysotile asbestos for export, supported by a state law[27,28].

This study showed a decrease in rates and DALY rates attributable to asbestos exposure from 1990 to 2019, which may be related to improved access to diagnostic and therapeutic methods since its earlier diagnosis enables less aggressive and more effective therapeutic methods, reducing related deaths. Since the 1990s, several countries have taken measures to minimize exposure to asbestos, including, more recently, Brazil[28,29]. Although several countries have implemented measures prohibiting the use of asbestos, it remains in use. Moreover, even with the complete cessation of exposure to the substance, cancer deaths attributable to it are expected to continue to occur for another four to five decades[10].

Moreover, exposure to sulfuric acid exceeds that to asbestos in the proportion of laryngeal cancer burden attributable to occupational factors in Brazil from 1990 to 2019. Exposure to strong inorganic acid mists containing sulfuric acid may occur by inhalation, ingestion, and dermal contact. The IARC/WHO evaluated strong acid mists, finding their carcinogenic potential and providing sufficient evidence that they cause laryngeal cancer in humans[4,11]—although other authors have found no association between this occupational exposure and laryngeal cancer[30]. Soskolne et al. (1992) evaluated the duration and intensity of exposure to sulfuric acid in cases of the disease in a case-control study in Canada and found a 5.6 odds ratio (95%CI: 2.0;15.5) for exposures exceeding 10 years[31]. Another case-control study in Uruguay found a 1.2 OR for laryngeal cancer (95%CI: 0.6;2.5) in subjects exposed to acid mists for up to 20 years and a 1.8 OR (95%CI: 1.1;3.1) for 21 or more years of exposure[32].

Occupational Health Surveillance agencies should prioritize prevention measures aimed at cancer (particularly laryngeal cancer) for workers exposed to all forms of sulfuric acid and asbestos (especially insulating, agricultural, metallurgy, mining, and construction industry workers)[7].

The potential interaction between occupational and behavioral risk factors should also be considered. Thus, a population-based case-control study conducted in France suggested that a combined exposure to asbestos, tobacco, and alcohol caused a significant number of cases of laryngeal cancer, emphasizing the need for specific prevention measures in certain work activities, such as civil construction, which offers permanent exposure to asbestos-containing materials[33]. Algranti[34] highlights the link between smoking and occupation, signaling the importance of anti-smoking campaigns aimed at groups with synergistic risks between smoking and exposure to occupational carcinogens. Clinical and epidemiological evidence supports that smoking exacerbates asbestos-induced neoplasms. Thus, it has been suggested that the combined effect of exposure to these factors reflects that both are complex carcinogens and may affect more than one stage of carcinogenesis[33,34].

The strengths of this study refer to its methodological standardization, the determination of the estimate uncertainty (95%UI), the long analyzed period (30 years), the evaluation of risk factors of different natures (behavioral and environmental risk factors), and the possibility of temporal and inter-location comparisons. On the other hand, its possible

limitations stem from the low availability of primary data (with the possibility of underreporting, an issue a recent study involving lower-than-expected asbestos-related death records pointed out due to the use of the substance in Brazil)[35] and the fact that the GBD considered only sulfuric acid and asbestos as occupational risk factors for laryngeal cancer, despite previous studies mentioning other carcinogens[13,14,36]. Another limitation refers to the dichotomy in the categorization of occupational and behavioral risk factors. To illustrate this, prior to the implementation of restriction policies related to tobacco consumption (considered behavioral exposure in this study), this carcinogen configured a relevant occupational exposure in the work context of certain sectors, such as gastronomic and entertainment establishments. It is also important to point out the way exposure to asbestos was measured, based on mesothelioma mortality rates, may underestimate exposure to this behavioral risk factor due to the lack of identification and underreporting of mesothelioma cases in Brazil.

One of the main challenges of occupational epidemiology is the long latency between exposure to carcinogens and the onset of cancer. Although the list of occupational carcinogens has increased, many may still remain undiscovered or properly documented due to the absence of relevant epidemiological evidence on their carcinogenic risk[7,10]. Even if data on long-term exposure were available, the statistical modeling of such information offers significant challenges, including unreliable data on potential confounding variables such as smoking[33]. It would be beneficial if medical entities and government agencies collaborated to include professional occupations in cancer registries but this rarely occurs. The occupational environment is complex and inconstant and comprises many agents, which brings significant difficulties in assessing the risks of work environments[3].

It is worth noting that, due to the greater reduction in rates attributable to behavioral risk factors (especially smoking), the proportional contribution of occupational risk factors to laryngeal cancer mortality and burden increase from 1990 to 2019. Thus, the implementation of regulatory measures related to tobacco has probably contributed to the decline in cancer mortality attributable to smoking in Brazil in recent decades[37], which is the main established risk factor for laryngeal cancer[38]. We stress the need for the adoption of policies and strategies to find, reduce, or even eliminate the impact of occupational risks on the burden and mortality of laryngeal cancer in Brazil, as with the application of tobacco (behavioral risk) regulatory measures in the last 30 years in the country.

Despite laryngeal cancer having a lower burden than other cancers, the relevance of this research lies in the fact that the adequate evaluation and prevention of its main risk factors may reduce its occurrence.

Conclusions

Laryngeal cancer is a health problem with important clinical and social impacts. This study showed that exposure to sulfuric acid surpasses exposure to asbestos in the proportion of laryngeal cancer burden attributable to occupational factors in Brazil, with higher mortality and DALY rates in those aged from 60 and 64 years, especially men. Laryngeal cancer mortality and burden attributable to occupational risks decreased in Brazil from 1990 to 2019 but with lower percentages than the reduction in indicators attributed to tobacco for the same period.

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Authors' contribution

Viana LP, Bustamante-Teixeira MT, Girardi FA, Nogueira MC and Guerra MR contributed to data survey, analysis, and interpretation and to the preparation and critical revisions of the manuscript. Malta DC and Azeredo Passos VM contributed to the critical revisions of the manuscript. All authors contributed to the design of the study, approved the final version of the manuscript and assume full public responsibility for the work carried out and the content published content.

Data availability

The entire dataset supporting the results of this study is available at the Global Health Data Exchange (https://ghdx.healthdata.org/) repository, year of registry: 2019.

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