THE IMPACT OF SMOKING-RELATED MORTALITY ON CHANGES IN LIFE EXPECTANCY IN BRAZIL

INTRODUCTION

Smoking is recognized as one of the main challenges to global public health, being one of the most relevant risk factors for chronic non-communicable diseases, such as cardiovascular disease, cancer, and respiratory diseases[1–4]. Although it is a global health concern, its burden falls disproportionately on developing regions, as about 80% of tobacco users live in low- and middle-income countries[5]. According to the Global Burden of Disease study, smoking accounted for approximately 160,000 deaths in Brazil in 2017, more than 12% of all deaths nationwide[6].

Since the 1980s, Brazil has implemented a broad set of public policies to control tobacco use under the National Tobacco Control Program (PNCT)[7,8]. Among the main measures are the bans on advertising and sponsorship, the creation of 100% smoke-free environments, the inclusion of pictorial health warnings on cigarette packages, tax increases, and the establishment of minimum prices for tobacco products[1,8-11]. As a result, the prevalence of smoking fell from 34.8% in 1989 to 12.6% in 2019, one of the largest relative declines observed worldwide[1,7,9]. These achievements have established Brazil as an international benchmark in tobacco control, placing it among the countries that have advanced the most in implementing effective measures to reduce consumption[12].

While reductions in smoking-related mortality typically lag two to three decades behind declines in smoking prevalence[13,14], Brazil already has experienced significant decreases in mortality rates[1,11,13]. However, this progress has been uneven across the country. The largest declines were observed in the South and Southeast, which, despite exhibiting the highest tobacco-related mortality rates, also have higher levels of sociodemographic development. In contrast, reductions were more modest in less developed states, particularly in the North and Northeast[1]. Despite these significant advances, the impact of tobacco consumption is still reflected in health indicators, especially chronic diseases[15], and continues to represent a significant economic burden on the healthcare system[1,8].

Several studies have already examined trends in smoking-related mortality in Brazil, but it remains unclear how changes by sex and age group have affected adult life expectancy across different regions. In this context, the present study examines the contribution of age-specific smoking-related mortality to changes in life expectancy in Brazil and its states between 2000 and 2023. This analysis enhances understanding of regional disparities in smoking-related mortality and offers new evidence on the role of tobacco control policies in shaping recent changes in adult mortality in Brazil.

DATA AND METHODS

Age- and cause-specific mortality rates were estimated by applying the proportion of deaths from each cause, obtained from the Mortality Information System of the Brazilian Ministry of Health, to the age-specific mortality rates derived from life tables produced by the Brazilian Institute of Geography and Statistics (Instituto Brasileiro de Geografia e Estatística, IBGE) for the period 2000–2023. The estimates are calculated both at the national level and by Federative Units (UF).

Smoking-related deaths were defined using two well-established methods: the Peto–Lopez[16] and Preston–Glei–Wilmoth (PGW)[17] approaches. Both methods rely on lung cancer mortality as a proxy to estimate total smoking-attributable mortality, with the advantage of not requiring mortality data disaggregated by smoking status for the study population, but only aggregate lung cancer mortality rates. The Peto–Lopez method applies relative risks from large cohort studies to estimate the proportion of deaths attributable to smoking across major disease categories. In contrast, the PGW method uses regression models linking lung cancer mortality to deaths from other causes, capturing observed relationships across populations without relying on fixed relative risks. Using both methods allows for assessing the robustness of the results. In addition to smoking-related mortality, five additional cause groups were analyzed: infectious diseases (except tuberculosis), external causes, maternal, perinatal, and congenital causes, alcoholic liver cirrhosis and other non-related causes. Smoking-related mortality rates were presented as age-standardized rate, using the Brazilian population of both sexes in 2000 as the reference, allowing comparisons across different states and periods.

The contribution of smoking-related mortality on life expectancy changes was estimated using the Horiuchi decomposition[18], implemented through the *DemoDecomp* package in R. This method assumes that

changes in aggregate indicators, such as life expectancy, can be approximated by a linear combination of partial derivatives of a function defined by the vector $X = [x_1, x_2, ..., x_n]$, where each x_n represents the age- and cause-specific mortality rate. X is assumed to vary with time (t), and data are available for two points, t_1 and t_2. This allows quantifying the contribution of each age group and cause of death to changes in overall mortality and life expectancy over time.

PRELIMINAR RESULTS

We present results estimating smoking-related mortality using the Peto–Lopez method. In 2000, over 67,896 deaths, approximately 9% of all deaths above age 35, were attributable to smoking in Brazil, rising to 95,866 deaths (7.2%) in 2023.

Age-standardized smoking-related mortality rates in 2000 were 23.53 per 10,000 population for men and 3.73 for women, with significant regional variation, particularly among men (Figure 1). Northeastern states, such as Alagoas (AL), Paraíba (PB), and Rio Grande do Norte (RN), exhibited lower rates, whereas states in the South and Southeast showed higher rates, with Rio Grande do Sul (RS) reaching 53.11 per 10,000 among men. Between 2000 and 2023, smoking-related mortality declined substantially nationwide, with rates falling to 11.86 for men. This reduction was accompanied by a decrease in regional disparities, largely driven by declines in the South and Southeast. Among women, rates increased slightly to 4.29 per 10,000.

Life expectancy at age 35 increased from 37.81 to 41.55 years for men (a gain of 3.73 years) and from 43.35 to 46.59 years for women (a gain of 3.24 years) in Brazil between 2000 and 2023. Decomposition of these changes shows that smoking-related causes (in red shades in Figure 2) contributed 1.01 years to increasing male life expectancy at age 35, while slightly reducing female life expectancy by 0.06 years. The contribution of smoking-related mortality varies across age groups (Figure 2). For men, it positively influenced life expectancy between ages 40 and 59, with the strongest effect among those aged 55–59. Between 60 and 89, the contribution remained positive but diminished, and after age 90, it became negative. For women, smoking -related mortality contributed positively between ages 40 and 59 but negatively from age 60 onward, reflecting increased mortality among older cohorts, likely related to behavioural patterns of women born before 1960.

Regional variation is also substantial (Figure 3). Among men, smoking-related mortality increases reduced life expectancy in Acre (AC), Paraíba (PB), Tocantins (TO), Rio Grande do Norte (RN), and Alagoas (AL), with the largest negative effect in Acre (-0.65 years, 20% of the total change). In contrast, reductions in other states, particularly Rio Grande do Sul (RS), contributed up to 2.14 years (58% of the total change). For women, most states experienced negative contributions, with Acre showing the largest (-0.42 years, 15% of the total change), while Paraná (PR), Rio de Janeiro (RJ), Distrito Federal (DF), Goiás (GO), Rondônia (RO), Amazonas (AM), and Roraima (RR) showed positive contributions, the highest being 0.70 years in Roraima (15% of the total change).

DISCUSSION

The decline in smoking-related deaths, particularly among men in the more developed states of the South and Southeast, has made a substantial contribution to the increase in life expectancy at age 35 between 2000 and 2023. These findings are consistent with previous research documenting a marked decline in smoking mortality over recent decades[1,12]. In contrast, states in the North and Northeast have experienced smaller improvements, leading to a persistent regional gap in adult mortality.

The results also reveal opposite trends by sex: while smoking-related mortality has dropped sharply among men, it has increased among women in most Brazilian states. When age patterns are considered, middle-aged men benefited the most from the reduction in smoking-related mortality, whereas rising deaths among older women offset part of the gains in female life expectancy. Overall, these results suggest that Brazil's tobacco control policies, implemented since the 1980s, have been highly effective in reducing male mortality, but have faced challenges associated to behavioral changes among women.

This work is still in progress: by the time of the European Population Conference, we aim to compare these findings with results from the Preston–Glei–Wilmoth method, estimate confidence intervals using Monte Carlo simulations, and further explore sex and regional patterns to better understand the effects of tobacco control policies on adult life expectancy.

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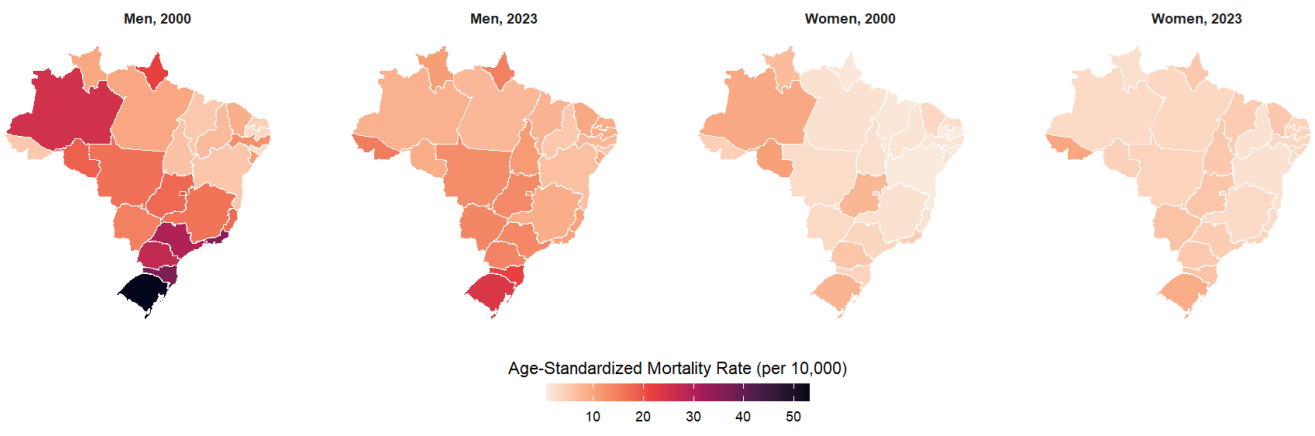
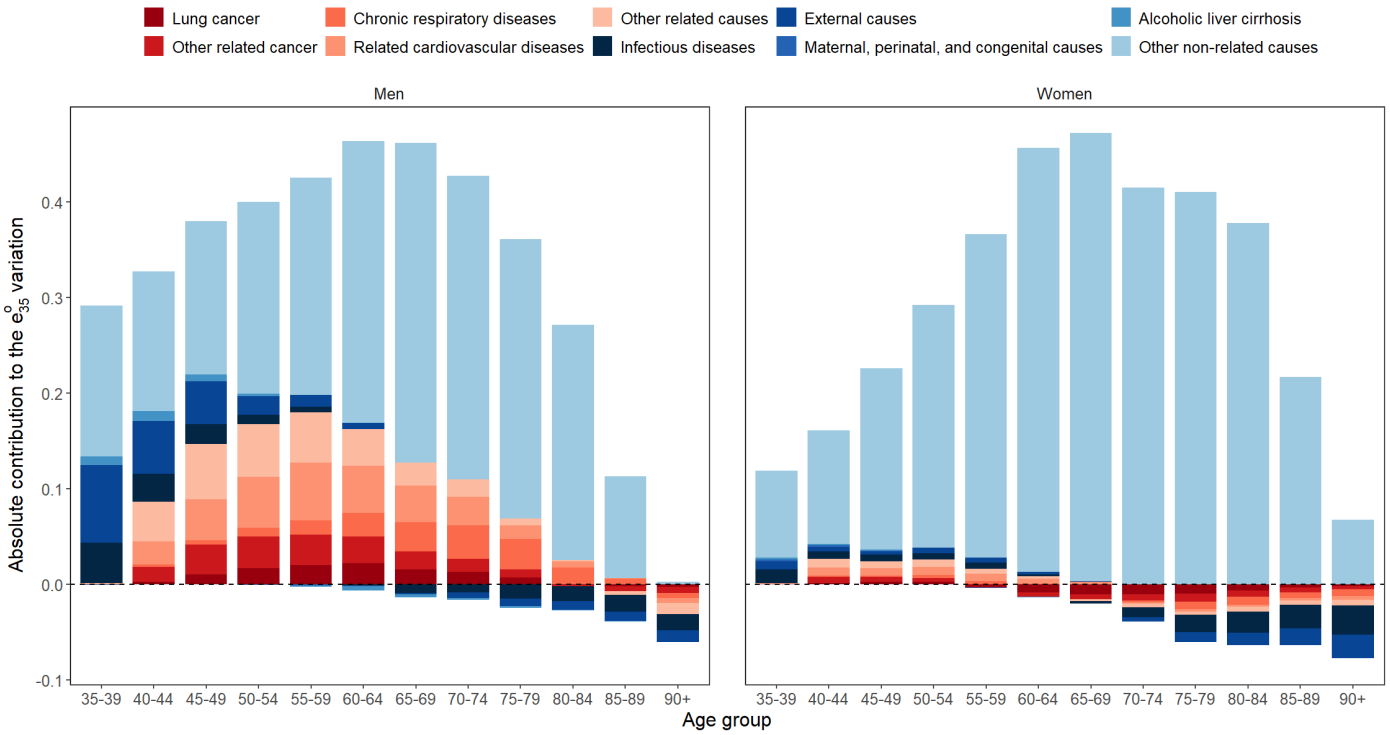
FIGURES

Figure 1: Age-Standardized Smoking Related Mortality by Federal Units – Brazil, Men and Women (2000 and 2023)



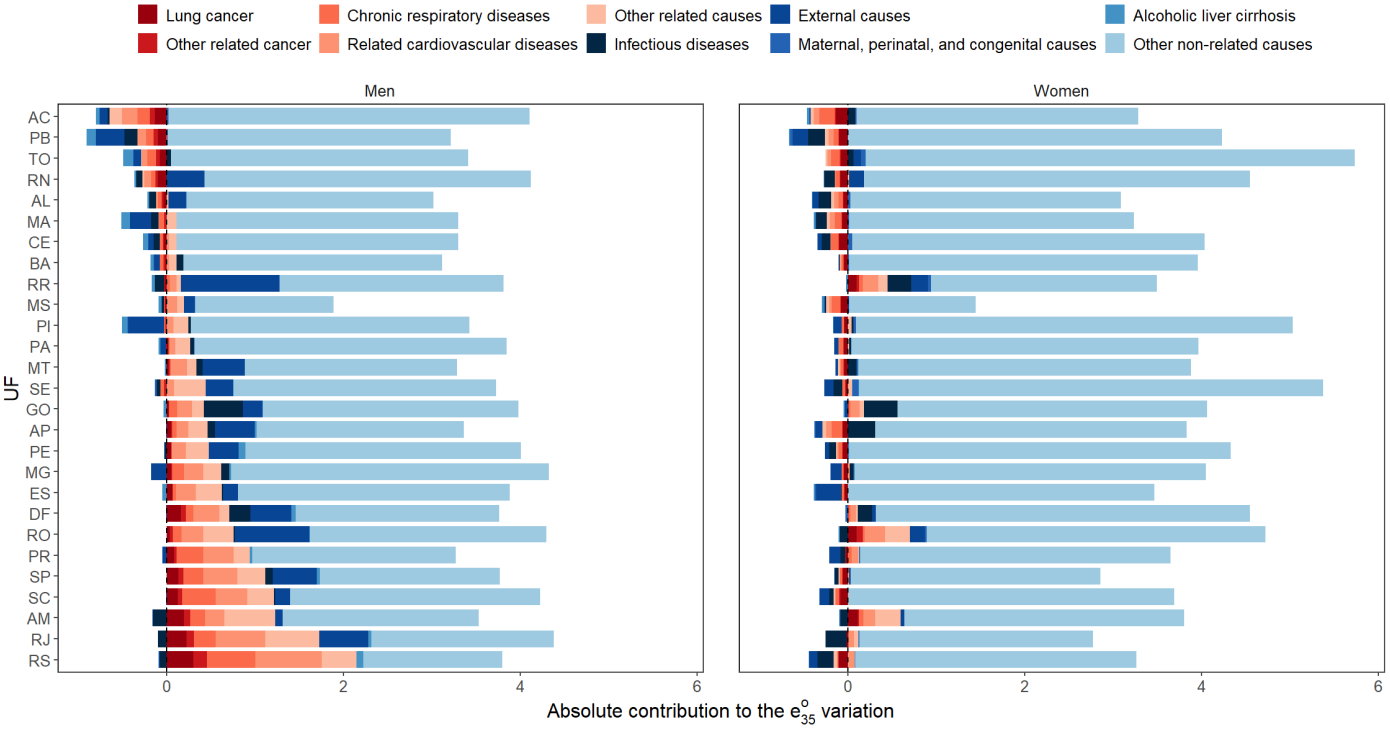
Source: SIM/DATASUS/MS and IBGE.

Figure 2 – Decomposition of changes in life expectancy at age 35 by causes of death and age groups - Brazil, Men and Women (2000 to 2023)



Source: SIM/DATASUS/MS and IBGE. **Note:** Smoking-related causes are shown in red shades, and non–smoking-related causes in blue shades.

Figure 3 – Decomposition of changes in life expectancy at age 35 by causes of death - Federative Units, Men and Women (2000 to 2023)



Source: SIM/DATASUS/MS and IBGE. **Note:** Smoking-related causes are shown in red shades, and non–smoking-related causes in blue shades.